A TAXONOMIC REVISION OF *EUPHRASIA* L. (SCROPHULARIACEAE)

IN AUSTRALIA

by

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SUMMARY

The classification of Euphrasia in Australia has had to be completely restructured. Five sections comprising seventeen species, of which seven are described as new and one is an upgrading of status, are recognized. The difficulties met with by previous workers in the genus in Australia are found to have been caused mainly by the complexities of the highly polymorphic species, E. collina. This species encompasses thirteen previously described species, reduced to synonymy, and is more or less equivalent to "E. brownii FvM." Fifteen subspecies have been formally described, five being new, the rest new combinations or changes in status of previously described taxa; there are apparently several other subspecies requiring further field study before formal recognition. Four other species contain infraspecific taxa, in particular E. gibbsiae with nine subspecies, of which four are described as new and the remainder are new combinations and changes of status. Where species are highly variable the degree and nature of distinction and the amount of intergradation between the subspecies is discussed, sometimes as a result of detailed field study. Clines and a limited amount of hybridization occur within the species. Contrary to recent opinion interspecific hybrids are rare. All taxa have limited geographical and ecological ranges. The recognition of the subspecies as "microspecies", which has been done elsewhere in the genus, is considered unwarranted because it would camouflage the well-defined species in Australia.

A revised, infrageneric classification of Euphrasia, which represents a radical departure from the concepts in previous works, is proposed. The genus is recognized as containing twelve sections of which two are divided into subsections. The modifications of the past classifications have been made on the basis of the increased knowledge of the plants of the southern hemisphere and tropics since the last monograph of the genus by Wettstein in 1896. Material, including the majority of types of species from these regions (excluding those of the distinctive South American species), has been studied.

The origin and diversification of Euphrasia is discussed. The genus is clearly unable to disperse over long distances, and is therefore a useful indicator of historic links between disjunct areas of land. The centre of origin of Euphrasia seems to be among its very close relatives, Bartsia and Odontites, in the northern hemisphere. A scheme of evolution is the genus, based purely on morphological grounds and the premise that the annuals of the northern hemisphere are the primitive stock, is proposed. Several lines of evolution from a common ancestral stock closely related to the northern annuals seem to exist. The Australian species, which have sometimes been considered to be primitive, are advanced in comparison with their northern congeners on the basis of both morphology and their high chromosome number. It seems possible to describe the history of the three main lines of evolution entirely on the geological and floristic events which have occurred since the Paleocene - Pleistocene uplift of the mountains in Australia. There appears to have been little extinction of intermediate forms which cannot be explained by climatic changes dating from that time. The means by which Euphrasia and other mainly alpine and subalpine genera of apparently northern origin reached the southern hemisphere and tropics is a biogeographical riddle, the solution to which may be in the geological history of the central Pacific Ocean, which is not yet completely understood.

STATEMENT OF ORIGINAL WORK

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University; nor does it include, to the best of my knowledge, any information previously published or written by any other person, except where due reference is made in the text.

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CHAPTER I

INTRODUCTION

The choice of project for this revision was founded on two requirements, the first that the group selected required taxonomic revision, the second that the study could involve a group of plants with geographically disjunct distributions in order to assess their usefulness as indicators of floristic relationships between the isolated land masses in which they occur. A plant group which seemed to provide a varied selection of disjunct distributions and yet was still hardly treated taxonomically in recent times was the family Scrophulariaceae, and in particular its temperate genera. Of the twelve or more indigenous temperate Australian genera, only the *Veronica* group (including *Hebe* and *Parahebe*: Briggs & Ehrendorfer) and *Ourisia* (Arroyo) are currently being worked on. The remainder, namely *Morgania*, *Stemodia*, *Mimulus*, *Gratiola*, *Mazus*, *Peplidium*, *Glossostigma*, *Limosella*, *Elacholoma* and *Euphrasia*, have received little attention with respect to the Australian species since Bentham's (1868) "Flora Australiensis".

Euphrasia was an ideal group to concentrate on initially. Not only is it an important genus whose taxonomy in Australia is inadequately understood, but it is also a genus which is often mentioned in treatises on plant geography and the various theories of the origins of the world's flora. The study of this genus proved so complex that for the other genera there was insufficient time to do anything but preliminary studies. These preliminary studies have not been incorporated in the thesis.

All the recent treatments of Euphrasia in Australia refer to the inadequacies of the present taxonomic knowledge and complex variation with possible hybridization. A number of the species recognized by Wettstein (1896) and Du Rietz (1948a,b) (who respectively revised and surveyed the genus in Australia) have been questioned, for example by Willis (1967), and there have been obvious difficulties in the application of names to taxa (e.g. Burbidge & Gray 1970). It was proposed that the genus be revised by studies of a wide range of herbarium material supplemented by extensive field observations, with an emphasis on the interaction of sympatric taxa.

Many have remarked on the completeness of the link on the isolated mountain tops of Malesia between the widespread temperate distributions of the genus in both hemispheres. For all its biogeographic importance, the overall infrageneric classification had been analysed critically only by Wettstein (1896) since that proposed by Bentham in 1846. It was intended to do as much as possible to revise the classification of the genus on the basis of the large amount of new knowledge accumulated since Wettstein's time, especially in the southern hemisphere and tropics. (The classification in Europe and North America has been recently revised by Sell & Yeo (1970; see also Yeo 1972). This would provide a framework for speculation on the possible origin of the genus and evolution in the present day. It was intended, if possible, to base a hypothesis of evolution in the genus purely on morphological grounds, and then to relate it to theories on the past history of land connections and migration of floras which might explain the present-day distribution of the genus.

The revision has been based mainly on a study of material (including types) from the following Australian herbaria: AD,

ADW, BRI, CANB, CBG, GAUBA, HO, MEL, MELU, NE, NSW, PERTH, SYD, the private herbarium of Mr. Cliff Beauglehole of Portland, Victoria (cited as BEAUGLEHOLE) and the herbarium of the New South Wales National Parks and Wildlife Service at Waste Point, via Cooma (cited as COOMA). Additional material which included types of taxa in Australian, New Zealand, the Juan Fernandez Islands, Malesia and Taiwan, was obtained from the following herbaria: A, AK, B, BM, CANTY, CHR, FI, G, GB, GH, HBG, K, L, LY, PH, S, TAI, UPS, W, WU. Unfortunately the specimens from FI and many of those from BM had to be returned before the classification had been decided upon, and therefore not all sheets could be annotated. However, where it was not clear from previous annotations, type specimens were designated with their type status.

Field trips to two of the main centres of diversity of Euphrasia in Australia were made. In late 1970-early 1971 two months were spent in Tasmania. In late 1971-early 1972 a brief visit to the Grampians, Victoria was made and six weeks were spent in the Australian Alps. Unfortunately time could not be spared for a visit to central and northern New South Wales, where it was soon clear that there were several undescribed taxa. The main sheet of all collections made during this study will be housed in AD; the many duplicate sheets will be distributed to other herbaria.

CHAPTER 2

THE TAXONOMIC HISTORY OF THE AUSTRALIAN SPECIES OF EUPHRASIA

In reviewing the taxonomic history of the Australian species of Euphrasia it has been considered too large a task to outline the diagnostic characters used in each work. In Euphrasia only a few species are readily distinguishable by a singular character. Rather the species tend to be separated by a combination of characters which are not individually unique to the species. These characters may be difficult to define and may overlap in their variation. Difficulties in determining and delimiting reliable diagnostic characters have contributed greatly to the failure of botanists in the past to agree upon a reasonably stable classification reflecting the true nature of the genus in Australia. In this review reference has generally been made only to the recognition of characters important in separating infrageneric taxa formulated in the past or found in this revision.

The first Australian collections of Euphrasia seem to have been made by Labillardière in 1792 from the southern part of Tasmania ("in capite van Diemen"). They comprised immature material of E. gibbsiae Du Rietz and vegetative specimens of E. collina R.Br. Because of the inadequacies of these collections and perhaps the perennial habit of the plants, it is understandable that Labillardière considered them to be E. cuneata Forst.f., a New Zealand perennial and the sole known representative of the genus in the Southern Hemisphere to that time.

It was Robert Brown who made the initial contribution to the knowledge of Euphrasia in Australia. He based his study on perhaps no more than a dozen specimens collected by him between 1802-1805 while he was botanist on Flinders's voyage of exploration of Australia. Ten of these are described exhaustively in his manuscript (Brown, unpubl.). The exact number of specimens seen by him, however, is difficult to determine as his collections, such as those from Memory Cove, South Australia and Port Phillip, Victoria, are not cited in his manuscript. Brown (1810) described eight species, all new, from localities throughout temperate Australia; they were E. striata and E. alpina (non Lam.) from Hobart and Mt. Wellington, southern Tasmania, E. tetragona from the Albany and Port Lincoln areas of Western and South Australia, respectively, E. speciosa, E. paludosa and E. arguta from the Sydney region of New South Wales and E. scabra from the coastal regions of Melbourne, Victoria and Launceston, northern Tasmania. A character diagnostic at the subsection level in the present revision, that of corolla striations, was used by him to separate E. striata from the other species. The annual nature of E. scabra and E. arguta was referred to in his manuscript but not used in the short descriptions of the Prodromus (Brown 1810).

In Sprengel's (1825) review of Scrophulariaceae the treatment of Euphrasia in Australia is almost entirely a restatement of Brown's system. The descriptions are rearrangements of those published by Brown and J.G.A. Forster (1786), still the only botanists who had worked on the southern species. Sprengel made two modifications of taxonomic importance. Firstly, he considered the Tasmanian species, E. collina, to be synonymous with E. cuneata Forst.f. of New Zealand, a concept that was never taken up by subsequent botanists. Secondly, he observed that E. alpina R.Br. (1810) was predated by the European annual E. alpina Lamarck (1786), and renamed the Australian species, E. diemenica. Although Sprengel's action was in accordance with our current rules of nomenclature (Stafleu (ed.) 1972:Art.64), E. alpina R.Br. was generally preferred in Australian works until 1896 when Wettstein in his monograph on Euphrasia took up E. diemenica.

In his enumeration of the plants collected by Preiss from Western Australia in 1840, Bartling (1845) recorded E. scabra and E. tetragona from that State. The descriptions are a straight copy from Brown's Prodromus, but they are supplemented by valuable data on locality and flower colour.

With Bentham's (1846) large monograph of Scrophulariaceae came the first real test of Brown's treatment of the Australian members of Euphrasia. Although more than 30 years had passed, Brown's concepts were little changed; Bentham retained all but one of his predecessor's species and could discern only one as new. Yet less than one third of the Australian species were known to that time. The remainder occurred mainly in the little-explored alpine and montane areas of eastern temperate Australia and Tasmania. Furthermore, it was still a year prior to the arrival in Australia of Ferdinand Mueller, the botanist who was to make prolific collections in most of these areas in the following years.

Unfortunately, Bentham's new species, E. multicaulis, was synonymous with E. collina. This mistake arose through a misapplication of Brown's name to a species which was to that time undescribed and which remained unnamed until 1919 when Gandoger, probably unknowingly, provided it with two different names. The actual error was first detected by Du Rietz (1948b) 102 years later.

Bentham recognised eight species in Australia. In addition to the above two species he retained Brown's E. alpina, E. tetragona (which he partly confused with E. multicaulis), E. striata and E. scabra; E. speciosa and E. paludosa were also distinguished as species but with the reservation that they could really be separable only as varieties. E. arguta was reduced to a variety of E. scabra.

In addition, three new infraspecific taxa, presumably varieties, were described. Two of these, var. humilis and var. angustifolia of E. alpina R.Br., were later considered by Bentham (1868) to be synonymous with E. striata and E. collina, respectively. The other, E. paludosa var. pedicularoides, was apparently taken up from Allan Cunningham's manuscript name but was never mentioned in later works.

Bentham did not postulate any classification at an infrageneric level of the Australian species, which together formed his §Australes*. However, he did recognise that both annual and perennial forms were present. He repeated Brown's reference to the striated corollas of E. striata, but this is merely because his description is a straight copy of Brown's. That he and Brown failed to recognise the important differences between E. striata and the other Australian species in the extent of the anther indumentum is a reflection of the scarcity of material of this alpine species and its relatives that they had seen.

As a result of his wide-ranging botanical explorations Ferdinand Mueller (1855, 1856) described a new species, E. alsa, a tiny annual which he had discovered in the summit regions of the Snowy Mountains of south-eastern Australia (called by him the Munyang Mountains).

Two years later, in his Flora of Tasmania, J.D. Hooker (1857) described another new alpine species, E. cuspidata, "quite unlike any of those described before", presumably because of its remarkable

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*Sell & Yeo (1970, p.203) conclude that it is impossible to assign rank to categories designated " §" in Bentham's (1846) monograph, since he was inconsistent in his use of the symbol in various genera treated in his monograph.

multi-digitate leaves.

This new discovery excepted, Hooker (1857) found that Bentham's concept of the Tasmanian species stood the test of both his own rather limited observations of living material and the many collections, made mainly by Gunn, donated to the British herbaria following the publication of Bentham's monograph. He stated:

> "I have adopted Bentham's characters for the Tasmanian species, which he has unravelled with great skill."

Thus he retained all Bentham's taxa which were listed as occurring on the island, including the two varieties of E. alpina R.Br.; E. multicaulis and E. collina R.Br. remained confused. However, he was not entirely convinced of Bentham's concepts; concerning E. multicaulis he said:

> "As a species it (as Bentham remarks under collina) is very closely allied to E. alpina, nor do I think that it is possible to give any specific characters that will distinguish all the states of these three plants."

To give support to this criticism Hooker (1859b) later commented that the Tasmanian collector Archer considered the three to be forms of the one species.

In his Fragmenta Phytographiae Australiae Mueller (1865) published an invaluable account of his rather different viewpoint of Euphrasia in Australia. His observations were based on both a wide field experience in southern and eastern mainland Australia and the expanding collections of the herbarium at Melbourne.

Mueller's most radical departure from the classifications of previous workers (although hinted at in particular cases by both Bentham and Hooker) was his union of five of Brown's species and one of Bentham's into a single species which he called E. brownii. The species names considered by him to be synonymous were E. alpina R.Br. and its synonym, E. diemenica, E. tetragona, E. collina, E. paludosa E. speciosa and E. multicaulis. Included in the synonymy was a reference to Bentham's (1846) alleged description of E. collina. Despite a recent opinion to the contrary (van Royen, 1972)*, the name E. brownii is illegitimate by current nomenclatural practice (Stafleu (ed.) 1972:Art.63) as the author clearly and deliberately based the new name upon seven validly published species names, most of which are legitimate.

In addition E. striata and E. brownii were considered by Mueller to be distinct but he doubted their separation at the species level. He may have reconsidered this opinion had he not confused E. striata, a distinctive Tasmanian alpine species which he had not seen in the field but later saw in 1869, with an undescribed species which he had collected in the alpine regions of the "Munyang Mountains". This Australian Alps taxon, which Wettstein (1896) later named E. glacialis, has all the characters of E. brownii as enumerated by Mueller and only approaches E. striata in its occasionally sparse anther indumentum. Following his discussion of E. striata Mueller referred to a closely related new variety of E. brownii, var. psilantherea, which he based on specimens from South Port, Tasmania and Mount Wellington, Victoria.

Mueller mentioned E. scabra, E. arguta, E. alsa and E. cuspidata as species, although he seemed uncertain as to the status of E. arguta. It is obvious in his discussion of these species and E. brownii that he recognised the importance of all the major characters used in distinguishing the infrageneric taxa in the current revision.

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*In a personal communication (18.ix.1972) van Royen has since expressed some doubts as to the correctness of his conclusions concerning the legitimacy of E. brownii.

He refers clearly to the presence of striations on the corollas of E. striata and was the first botanist to recognise the diagnostic importance of the absence of hairs from the backs of the anthers (hence his name "psilantherea" for the South Port plant). From the annotations on the syntype material from South Port it is probable the collector Stuart directed Mueller's attention to the character. Finally he realised that the species could be divided into annuals and perennials.

As part of his Flora Australiensis, Bentham (1868) published his second account of the Australian members of Euphrasia. He was able to refine greatly his previous work on the genus, aided not only by the works published in the intervening period but also by a large complement of Mueller's personal collections and those of Tasmanian collectors such as Gunn and Archer.

Bentham recognised eight species but considered "some of them.....scarcely more than marked varieties". Under what Mueller regarded to be E. brownii he listed four species. About the first, E. speciosa, he wrote, "F. Mueller may be right in considering this a remarkably large-flowered variety of (E. collina)". E. tetragona, E. multicaulis and his E. alpina var. angustifolia were treated as synonymous with his second species, E. collina; E. paludosa was reduced to a variety of this species. The third and fourth species, E. alpina and E. striata, had E. diemenica and E. alpina var. humilis respectively cited as synonyms. Of these species E. alpina and E. striata were said to be confined to alpine regions of both Tasmania and mainland Australia, while most other collections of perennials were attributed to E. collina; E. speciosa was represented by only two geographically distant collections. Concerning these four species he stated:

"E. speciosa.......E. alpina and even E. striata, are not separated from E. collina by any very marked characters, and F. Mueller.....unites them all under E. brownii. It does not appear necessary, however, to discard Brown's names E. collina and E. speciosa, either of which might, without inconvenience, be applied to the collective species..."

Bentham's four remaining species were E. scabra, spread throughout lowland extra-tropical Australia, E. arguta, endemic in the New England area of New South Wales but for one specimen from the Cobberas Mountains of Victoria, E. cuspidata, from western and south-western Tasmania, and E. antarctica, restricted to the "summits of the Munyong (=Munyang) Mountains". These species, all of which he considered to be annuals, were clearly distinguished by characters used in the current revision. Thus, in this work Bentham reinstated E. arguta to species rank after previously (Bentham 1846) reducing it to a variety of E. scabra; the change was made because he found that he had misapplied the former name. Nevertheless, he maintained that the two species were "very closely allied". In addition, Bentham considered Mueller's tiny annual, E. alsa, together with New Zealand plants to be conspecific with the diminutive South American annual, E. antarctica, which he had described in his earlier (1846) treatment of Euphrasia.

Following this productive half century in the taxonomy of Euphrasia came a period of almost a century in which the only two works showing real progress towards a satisfactory classification went unrecognised by Australian botanists.

Mueller retained his viewpoint on Euphrasia in his subsequent works on the Australian flora, namely his "Key to the System of

Victorian Plants" (1885-1888) and his first and second census of Australian plants (1882, 1889). He continued to use "E. brownii" in these works, arguing (Mueller 1882, p.vii) that, "Where authors bestowed several names at the same time on a species, it should be free to those, who effect the reductions, to choose a collective designation for the consolidated species." However, he followed Bentham in reducing E. alsa to a synonym of E. antarctica. Early Australian botanists tended to favour his concepts in the genus, as evidenced by the works of Spicer (1878) on the Tasmanian flora, Tate (1890) on the South Australian flora, and Moore (1884), Moore & Betche (1893) and Dixon (1906) on the New South Wales flora.

Bentham's ideas concerning Euphrasia, which differed from Mueller's only in his recognition of four closely related species under E. brownii of his contemporary, were followed in the majority of other floristic works, such as those of Woolls (1891) on the plants of the Sydney region, Bailey (1883, 1890, 1901, 1913) on the Queensland flora, Gardner (1931) on Western Australian plants, Ewart (1931) and Galbraith (1955, 1967) on the Victorian flora, and Black (1926) and Robertson (1957) on the South Australian flora.

Rodway (1903) in his "Tasmanian Flora" and Maiden & Betche (1916) in their "Census of New South Wales Plants" went a stage further with Mueller's ideas, by proposing as varieties of E. brownii some or all of the four species and one variety which Bentham had distinguished under that species. Mueller at no stage proposed this idea as Maiden & Betche state, except with E. striata. Thus, under E. brownii Rodway recognised var. striata and var. alpina as distinct, while Maiden & Betche listed four varieties, var. speciosa, var. collina, var. paludosa and var. alpina.

Ignored or overlooked in Australia until 1965 were the works of three overseas botanists, Wettstein (1896), Gandoger (1919) and

Du Rietz (1948). Two of these works are of importance equal to Bentham's and Mueller's publications of the 1860s, and their use would have greatly increased the understanding of the genus in Australia. The lack of reference to the latter two works is perhaps understandable; Gandoger's study was taxonomically superficial, and he had previously written a Flora of Europe which was highly unconventional (Stafleu 1967; Stafleu (ed.) 1972; McGillivray 1973), while little was published on the genus for almost twenty years after the publication of Du Rietz's revision of the Tasmanian species. However, the total lack of reference to Wettstein's treatise, other than by Du Rietz, is astounding, for this was a monograph of the whole genus in which the classification of the Australian species was dealt with in great detail and differed significantly from previous works. Several factors may have combined to cause this omission. Its publication as a German book may have restricted the number of Australian readers. Perhaps it resulted from the recession in Australian taxonomic botany which followed the death of Mueller in 1895; important German works in other genera, such as Plantago, Epilobium and Blennodia were also ignored during this period (Eichler pers. comm. 1973). It may have arisen to some extent from the fact that Wettstein saw little type material of the Australian species. Finally, it may have resulted from feelings that the genus was taxonomically very difficult as expressed in more recent works (e.g., Willis, 1967; Burbidge & Gray 1970); this uncertainty probably stemmed from the inability of Bentham and Mueller to sort out the "E. brownii complex", within which many taxa are recognised in the current revision.

In his "Monographie der Gattung Euphrasia" Wettstein (1896) described 12 species from Australia. His work was based entirely upon collections from European herbaria, with the notable exceptions of British Museum and Kew, which housed most type specimens of the species described by Brown, Bentham and Hooker. E. glacialis from the Munyang Mountains and E. muelleri from the lowlands of south-eastern mainland Australia were described as new. Other species recognised in the monograph were E. multicaulis, occurring in Tasmania and doubtfully south-eastern Australia, E. diemenica of montane Tasmania, E. striata of the alps of Tasmania and doubtfully south-eastern Australia, E. collina (sensu Benth. in DC. & Hook. f.) of Tasmania, E. paludosa and E. speciosa of south-eastern mainland Australia, E. scabra from throughout extra-tropical Australia and Tasmania, E. arguta from south-eastern Australia, E. alsa from the highest mountains of New South Wales and Victoria, and E. hookeri Wettst. from the mountains of Tasmania. Specimen photographs and illustrations were provided for each species. E. hookeri was formulated as a substitute for E. cuspidata Hook.f. (1857), the earlier homonym of which had been used by Host (1831) to describe a European species. For the same reason Wettstein reinstated the name E. diemenica Spreng. to replace its synonym, E. alpina R.Br. (1810), which had been used as the name for the species concerned in all previous works, but which was predated by E. alpina Lam. (1786).

Wettstein grouped the Australian and New Zealand species under "Subsection Australes Benth.", which he further divided into two groups, Perennes and Annuae.* E. hookeri was considered doubtfully to be an annual. The characters used to distinguish this

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*Sell & Yeo (1970, p.210) argue that the rank of the last two names must be series for two reasons; firstly, they are immediately subordinate to subsection or section (where no subsections are proposed) and, secondly, Wettstein has made reference to "Reihe" (=series) in discussing one of these names.

subsection from that of the Northern Hemisphere were the incidence of perennial forms and the allegedly subequally mucronate anthers, while it was distinguished from the South American Section Trifidae by the characteristically undivided leaves and hairy anthers. These are the same characters used by Bentham in his monograph of 1846. Thus E. alsa of Australia and E. antarctica of South America, which had previously been considered synonymous, were placed in different sections.

Gandoger (1919) published seven new binomials in the Australian "E. brownii complex" in his "Sertum plantarum novarum". There is no evidence that he saw any material other than the single specimens upon which he based the names. Whereas such a course of action is non-scientific, his names are validly published with short diagnoses (in key form) and with specimens adequately cited. The species described were E. walteri, E. trichocalycina and E. crassiuscula from Victoria, E. tasmanica and E. deflexifolia from Tasmania, and E. novaecambriae and E. maidenii from New South Wales. Until very recently (Briggs in McGillivray 1973) subsequent workers in Euphrasia have rarely attempted to apply Gandoger's names because of the brevity of descriptive information and the lack of opportunity to see the pertinent types.

In the Queensland Naturalist Blake (1945) described and figured a distinctive new species, E. bella, from the mountains of southern Queensland.

As a continuation of his earlier papers on Euphrasia in the Southern Hemisphere and Malesia (Du Rietz 1932a,b), Du Rietz (1948a,b) published two papers primarily to clarify the classification of the Tasmanian species. He went further than this, however, and meticulously discussed the taxonomy of the Australian species as a whole and their affinities in the genus elsewhere. His work was based mainly on material from European herbaria, including the valuable collections of British Museum and Kew. A few specimens were sent to him from the herbarium of the Botany Department, University of Adelaide (now housed in AD).

The importance of Du Rietz's work stems from his meticulous taxonomic analysis in which greater significance than in the past was placed upon characters, either difficult to put into words, such as depth of leaf toothing and leaf shape, or showing a degree of overlap from one taxon to the next, such as number of leaf teeth, the type of habit and the shape of the inflorescence. Throughout the work he mentioned possible distinct taxa which required further investigation. On such little material as he saw his predictions often have proved remarkably good.

Du Rietz's (1948a) initial paper on the Tasmanian species involved a discussion of E. striata and a related undescribed species also from alpine regions of the island. This new species, E. gibbsiae, had been mentioned without description with other nomina nuda in his previous paper on the Philippine species of Euphrasia (Du Rietz 1932a, p.532). He provided detailed descriptions, illustrations and specimen photographs of both species. Within E. gibbsiae he recognised a number of forms. He considered two of these to be worthy of taxonomic treatment as formae, although he believed that further material and field studies could show them as distinct species. They were f. comberi from an unknown Tasmanian alpine location above 910m (3000 feet) and f. subglabrifolia from Mt. Mueller, Gippsland, Victoria at 1520m (5000 feet), with its close relative from Mt. Olympus, central Tasmania. In addition he recognised two other forms under E. gibbsiae from the Tasmanian mountains, but refrained from giving them taxonomic status. Concerning these species, Du Rietz wrote:

"According to the scanty material available at the time of these studies, E. gibbsiae consists of a highly polymorphic population, and possibly further studies....may reveal the existence of some more new species belonging to the same group as E. striata and E. gibbsiae. The polymorphic character of E. gibbsiae, however is no sufficient reason to lump it into E. striata which seems to be a clear and not very polymorphic species...Possibly hybridism plays an important role in the Tasmanian Euphrasia-population."

To end this initial paper Du Rietz discussed the taxonomic affinities and geography of the two species. He united the two into a new series, Ser. Striatae, characterised by: "Suffrutices pumilae, microchamaephyticae, repentes (interdum semisedentariae), semiprostratae. Folia subdigitata." The series was known only from Tasmania and the single Victorian locality mentioned above.

In his second paper on the Tasmanian species Du Rietz (1948b) rectified the misapplication of E. collina R.Br. At the same time the species which Bentham had called "E. collina" was renamed E. gunnii. One of the specimens cited in Bentham's (1846) description of E. collina was selected as the holotype of the newly recognised species. Du Rietz copiously described the holotypes and isotypes (which he called syntypes) of E. collina and E. gunnii and provided illustrations and specimen photographs.

Also in this second paper, Du Rietz discussed in great detail the characters distinguishing E. collina R.Br. and E. gunnii firstly from E. striata and E. gibbsiae and then from the Australian mainland species of Euphrasia. In the latter context he detailed the distinctions of E. collina from E. paludosa from the New South Wales tablelands, E. muelleri from Victoria, and E. tetragona confined to south-west Western Australia (with which he included a description of the British

Museum holotype). In addition he mentioned forms from Victoria intermediate between E. collina and E. paludosa which he provisionally named E. collinoides because he was uncertain of their taxonomic status. He made special mention of two forms related to E. collina, one from sandhills in north-eastern Tasmania, the other from the Launceston area of northern Tasmania. In discussing E. gunnii and its related species he was able to distinguish E. diemenica from montane Tasmania, an undescribed species, provisionally named E. milliganii from south-west lowland Tasmania, another undescribed species, provisionally E. osbornii, from South Australia, and E. speciosa from lowland New South Wales.

Following this discussion Du Rietz formed a new series, Ser. Collinae, characterised by:

"Suffrutices pumili, microchamaephytici, sedentarii, raro semisedentarii (E. diemenica?) vel repentes (E. glacialis) erecti vel raro (E. diemenica and E. glacialis) semiprostrati. Folia non distincte subdigitata."

The series consisted of E. collina and E. gunnii and the species discussed with them in the second paper (Du Rietz 1948b) excluding E. striata and E. gibbsiae. Also included in the series was E. glacialis. Within this series he considered that E. glacialis and E. speciosa formed their own subseries, "differing from the other species by shorter, broader, more multidentate leaves."

He formulated two other series which covered the remaining Australian species, all of them annual. These were Ser. Hookeriae ("Herbae annuae. Folia subdigitata"), based on the single Tasmanian species. E. hookeri, and Ser. Scabrae ("Herbae annuae. Folia non digitata, longa, dentata"), based upon the widespread lowland species, E. scabra, E. arguta from New South Wales, and E. alsa from the Australia Alps.

In a short discussion of the geographical relationships in the genus in the Southern Hemisphere, he united the Australian species into a new subsection, Subsect. Australienses ("Capsula acuminata"), distinct from, but closely related to, the New Guinea mountain species and the newly formed New Zealand subsection, Subsect. Novae-Zealandiae ("Capsula emarginata vel truncata"). In addition, Du Rietz rejected the character of sub-equally mucronate anthers used by Bentham and Wettstein to distinguish Subsect. Australes from Subsect. Semicalcaratae. Finally, Du Rietz appended a key to the Tasmanian species known to that time.

Beard (1965; 1970) listed only E. scabra in his two editions of "A Descriptive Catalogue of West Australian Plants". The omission of E. tetragona probably arose because of its absence from the collections housed in the Perth herbarium.

In his "Supplement to J.M. Black's Flora of South Australia" Eichler (1965) became the first Australian botanist to mention the studies by Wettstein and Du Rietz of the Australian taxa of Euphrasia. He considered that several species were involved under E. collina as cited by Black (1926) and Robertson (1957) for the State. Closely related to the South Australian species or actually conspecific with them were E. speciosa, E. aff. collina R.Br., E. paludosa, E. multicaulis and E. muelleri as well as Du Rietz's nomen nudum, E. osbornii.

Curtis (1967a) recognised eight species of Euphrasia in her "Student's Flora of Tasmania". She described one new species E. kingii, endemic to the south-west of Tasmania in peaty heaths. The predominantly mountain species were E. diemenica, which occurred at about 760m (2500 feet) and also at sea level on the west and south-west coasts, E. striata on mountains and in the south-west, E. gibbsiae above altitudes of 1070m (3500 feet), and also occurring in Victoria, and E. hookeri confined to the western mountains. E. collina and E. gunnii were described as lowland species, the former extending into montane grassland and also occurring in Victoria and the latter confined to the north and east of the island. *E. scabra* was cited from near the coast and on dry hillsides.

Curtis considered *E. gibbsiae* to be polymorphic. She recognised Du Rietz's two forms, f. *comberi* and f. *subglabrifolia*, and referred to variants in "cushion plants e.g. *Donatia novae-zelandiae* or in *Sphagnum* moss". Under her circumscription of *E. diemenica* she perceived two "groups of variants", namely a group approaching *E. collina* in their inflorescences in montaine areas, and plants with smaller flowers and more acutely toothed leaves from peaty heaths near the west and south-west coasts.

Characters used in her key were indumentum, leaf shape and degree of toothing, inflorescence shape, habit and flower colour. *E. striata*, *E. hookeri*, *E. kingii* and *E. gibbsiae* were described as having corollas lined with purple, but this character, as in the past, was only used to distinguish *E. striata* in the key.

In the same year the Victorian botanist Willis (1967) published his notes on the Australian members of *Euphrasia*, mainly on the taxa occurring in the Australian Alps. He also made use of the works of Du Rietz and Wettstein. Concerning the taxonomy of *Euphrasia* he stated:

> "Satisfactory delimitation of taxa within this genus is by no means easy, being complicated by intraspecific polymorphy and extensive hybridism........Until population and genetical studies are carried out extensively in Australia, there is need for conservatism in the recognition of distinct species. Thus the writer currently prefers to express in terms of varietal rank the more obvious morphological differences between highland populations of the series *Scabrae* and *Collinae*."

Under *E. glacialis* the typical plants of which extended from the alps of New South Wales into the Cobberas Mountains of extreme east Victoria, Willis recognised a new variety, var. *eglandulosa*, distinct from the typical variety by its indumentum. Although it is doubtful that he saw the type he was certain that Gandoger's "inadequately described" E. crassiuscula was identical. The new variety was "abundant on the higher Victorian alps......, with an outlying, more elongated form on the Buffalo Plateau." He also listed plants from the highlands of New South Wales and Australian Capital Territory, under the new variety. In his discussion of E. gibbsiae, Willis mentioned the record of f. subglabrifolia, from the Baw Baws having seen a duplicate of the Mt. Mueller type. He also published a new record of a form close to f. comberi from the "summit of Mt. Speculation, Barry Mountains" and referred to a possible reduced form of E. gibbsiae from the Cobberas. Finally, he expressed doubts about the specific status attributed to some Tasmanian species, stating:

> "E. gibbsiae seems to differ from E. striata.......only in being glandular, while R. Brown's E. alpina.......is probably no more than a glabrescent alpine form of E. gibbsiae."

Under E. scabra Willis proposed two varieties, one new, namely var. caudata, and the other, var. alsa based upon Mueller's E. alsa. Both varieties were recorded from the Australian Alps, but var. alsa tended to be confined to the higher alpine areas, while var. caudata also occurred in subalpine areas as well as further north in the Australian Capital Territory. The two varieties were distinguished on the basis of flower colour, while the var. scabra was distinct from them both in its indumentum.

Burbidge & Gray (1970) could provide only a tentative treatment of Euphrasia in the Australian Capital Territory. Of the five taxa recognised, two only were attributed published names. They were E. scabra var. caudata and E. glacialis var. eglandulosa. The other taxa were designated "E. sp", "E. aff. paludosa R.Br." and "E. aff. glacialis Wettst."

In his "Handbook of the Plants of Victoria" Willis (1973a) extended the concepts of his prior publication on _Euphrasia_, by adding _E. collina_ to his list of Victorian species. The species was reported as widespread in lowland and montane areas. He considered _E. speciosa_ "to be only a robust form, not differing from _E. collina_ in any significant feature except flower-size."

In a work (McGillivray 1973) dealing with Gandoger's names of Australian plants, Briggs has listed the seven names which Gandoger assigned to _Euphrasia_ in Australia, together with their probable synonyms, and an enumeration of the holotype specimens (all are from LY, with one isotype in NSW). _E. crassiuscula_ was considered synonymous with _E. glacialis_ var. _eglandulosa_, _E. deflexifolia_ possibly with _E. tasmanica_ and _E. gunnii_, _E. maidenii_ with _E. glacialis_ var. _glacialis_, and _E. novae-cambriae_ with _E. speciosa_ s.l., while _E. trichocalycina_ and _E. walteri_ were thought to be allied to both _E. collina_ and _E. speciosa_. A plate of the holotype of _E. maidenii_ was included in the publication.

In conclusion, throughout the various taxonomic works dealing with _Euphrasia_ in Australia there have been frequently expressed doubts as to the status of most species recognised to this time. Thus, species placed in separate infrageneric taxa by one worker (Du Rietz 1948a,b) have been considered distinguishable only at the infraspecific level in a later publication (Willis 1967). In addition much difficulty has also been found in applying correct names to the taxa (e.g. Burbidge & Gray 1970) and consequently names have sometimes been misapplied. These deficiencies obviously stem from the lack of a detailed taxonomic study of _Euphrasia_ throughout Australia based on an extensive field experience.

CHAPTER 3

MORPHOLOGY

The following is an enumeration of the characters which have been found useful in taxonomic treatments of Euphrasia. Consideration is given to the nature and significance of the variability of characters and their usefulness at the various levels of classification.

I. SPECIAL TERMS USED

In several cases in this work a terminology has been used which is either at variance from customary useage or is in need of definition.

A floral axis is any axis terminating in an inflorescence. It includes the axis of the inflorescence.

Main axis is taken to include a stem, or the most robust flowering branches on the perennials after the first year.

Stem has been used in the sense of Jackson (1928: "the main ascending axis"), Lawrence (1951: "the main axis of a plant, leaf-bearing and flower-bearing as distinguished from the root-bearing axis") and the Oxford Dictionary (1964: "the main body or stalk....of tree, shrub or plant"). The term stem seems to have been used incorrectly by Wettstein (1896), Pugsley (1936) and Du Rietz (1948a,b), as well as the majority of flora writers, in describing the perennials and prostrate annuals. The first-year plants of several Australian species may have a single axis which is erect or ascending, is often profusely branched, and produces an inflorescence. On the above definitions this would be the only true stem with any axes arising from this being branches. In subsequent years the stem may die back, often to the region of the upper branches. If the branching is confined to near ground level the plant has a "many-stemmed" appearance (hence Bentham's "*E. multicaulis*" for the perennial *E. collina* ssp. *tetragona*). These axes are, however, of a secondary (or greater) nature and should not by the above definitions be called stems. The presence of a single stem is clearer in the perennials of Sect. *Australes* and Sect. *Striatae* which branch high above ground level. In these much of the stem persists throughout the life of the plant. The situation is perhaps most confusing in the procumbent perennials of Sect. *Striatae* Subsect. *Humifusae*, the annuals of Sect. *Anagospermae* and in some of the perennial alpine species with many ascending axes. These plants appear to lack a single flowering stem in the first year or possess one which is very obscure. Either the stem could be considered completely absent or the major axes arising from the base of the plant could all be considered stems.

Indumentum terminology is outlined under the discussion of its variation and diagnostic importance (see this chapter).

Blade has been used in the special sense of that part of the leaf excluding the teeth, apex and attenuate part of the base, if it is of that shape (see fig. 2).

Tooth and apex terminology for the calyces, bracts and leaves (see fig. 1): In an attempt to give a more precise statement of the shapes of the lobes or teeth of the calyces, bracts and leaves, and the apex (apical tooth) of the bracts and leaves, the following method has been found useful. To describe the shape of the tooth or apex (apical tooth) overall, i.e. from base to apex, the terms obtuse, acuminate, acute, caudate etc. have been used as defined in Stearn (1966) and Jackson (1928). This

FIGURE 1

Tooth and apex terminology in *Euphrasia*.

TOOTH AND APEX TERMINOLOGY IN <u>EUPHRASIA</u>

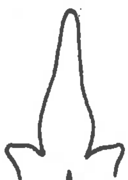
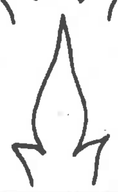
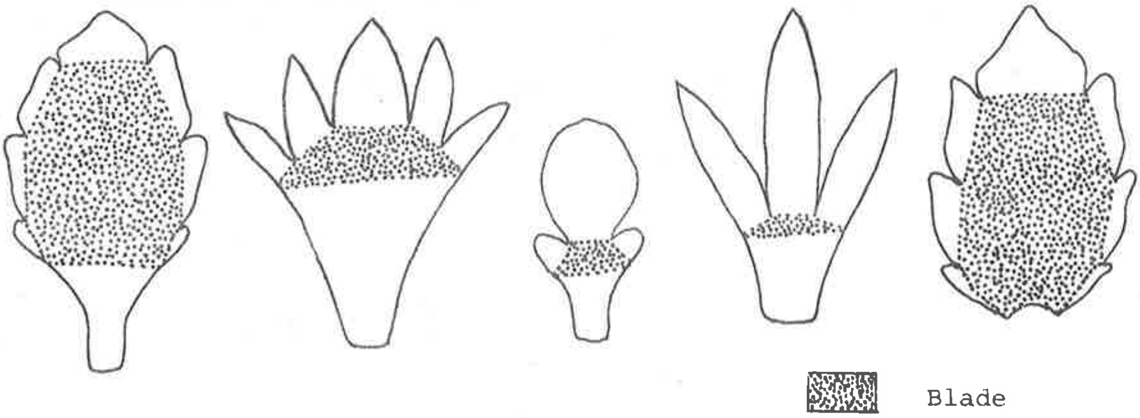
APEX (APICAL TOOTH)		TOOTH or LOBE
	Bluntly broad obtuse	—
	Sharply broad obtuse	—
	Bluntly obtuse	
	Sharply obtuse	
	Bluntly acute	
	Sharply acute	
	Bluntly broad acuminate	—
	Sharply broad acuminate	—
	Bluntly acuminate	
	Sharply acuminate	
	Bluntly narrow acuminate	
	Sharply narrow acuminate	
	Bluntly caudate	
	Sharply caudate	

FIGURE 2

Usage of the term "blade", and definition of the measured parts of the corolla and anthers.

USAGE OF THE TERM "BLADE"

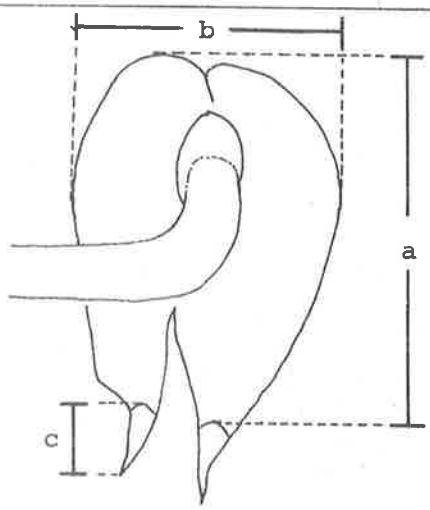


ANTHER MEASUREMENTS

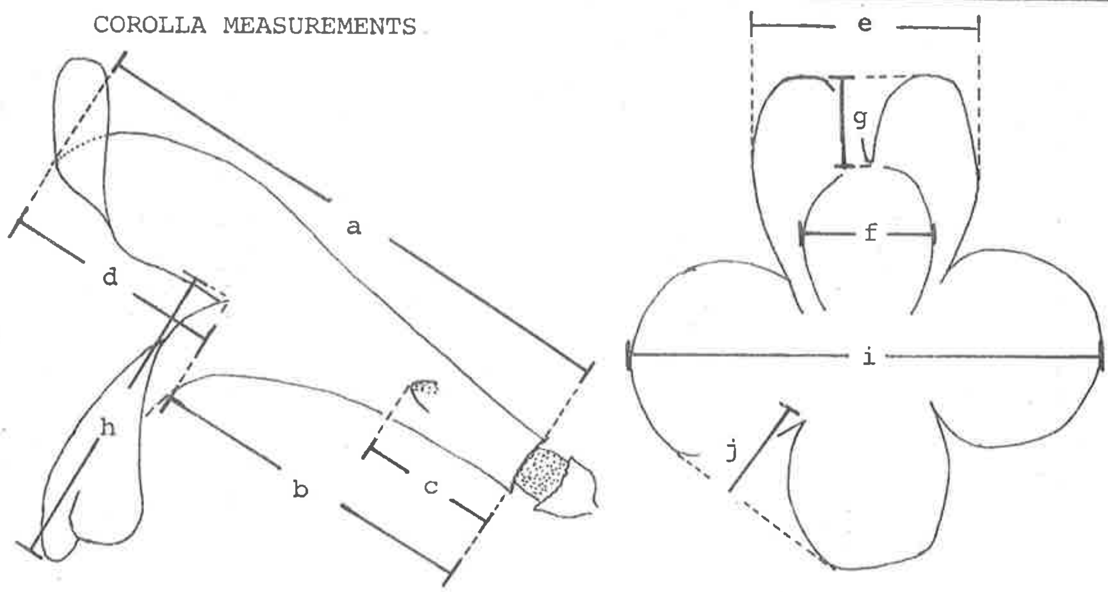
a. Anther length

b. Anther breadth

c. Awn length



COROLLA MEASUREMENTS



a. Length of upper side

b. Length of tube

c. Length from base of corolla to point of insertion of anterior filaments

d. Length of hood

e. Width of hood (including lobes)

f. Width of hood (excluding lobes)

g. Depth of cleft between upper lobes

h. Length of lower lip

i. Width of lower lip

j. Depth of cleft between lower lobes

seems more precise than methods entailing terms such as triangular. The very apex is then described by the terms blunt and sharp (which it is realized are the respective English equivalents of obtuse and acute). Although the use of these characters has been avoided in the keys because the terms describing them could be misinterpreted, they are nevertheless diagnostic in many cases.

Bract has been used for the leaf subtending the flowers of Euphrasia. This term has been used by Wettstein (1896), Chabert (1902), Joergensen (1919: "Deckblatter"), Du Rietz (1932b; 1948a,b) and Smekjal (1963). The British taxonomists, Pugsley (1930,1936), Sell & Yeo (1970) and Yeo (1972), and the Russian Juzepcuk (1955) have used the term "floral leaf" in its place.

II. MEASUREMENTS

Much of the taxonomic difficulty in Euphrasia stems from the closeness of the taxa, with the major differences often overlapping to a greater or lesser extent. It has therefore been considered advisable to adhere to a policy of using quantitative terms wherever possible to describe diagnostically useful characters in cases where the lack of precision, characteristic of many qualitative terms, might obscure the true variability of the characters. The expression of characters in a quantitative form gives an accurate and clear picture of the range of variation in a particular character for each taxon and the degree to which there is overlap between taxa. Qualitative terms, such as those used to describe leaf shape and which include general statements like "branched in the lower half of the axis, usually near ground level", cover a range of variation in themselves. In addition, although precise mathematical definition has been given to some of these terms (e.g. the chart of simple symmetrical plane shapes: Stearn 1966), their actual usage is liable not to be so precise.

For each taxon the measurements of each character were usually taken from a selected sample of between twenty and thirty specimens in which it was attempted to incorporate, where available collections permitted, variation in typical populations and a cover of material from the extremes of geographical, ecological and altitudinal range of the taxon. In the more widespread taxa, such as E. scabra and E. collina ssp. collina, measurements of the variable characters (such as leaf shape) number many more than this. The range of variation has been portrayed in the descriptions as follows. The extremes of variation, sometimes modified slightly after perusal of other material, are placed in round brackets at either end of the range. Between these bracketed figures occurs either the average of the total sample of measurements (often done where too few specimens are available to give what is considered to be an adequate sample) or, more commonly, the range covering the 80% or more of values remaining after no more than the 10% smallest and 10% largest values have been removed. In several obviously distinct taxa insufficient material was seen to give an adequate picture of the variation and only the overall range of values has been given.

All measurements in centimetres (such as plant height) were taken to the nearest millimetre, using a ruler, while all millimetre measurements (such as corolla and leaf length and those of leaf apex and tooth size) were measured using a low-power microscope at 10x magnification with an ocular micrometer and were recorded to the nearest tenth of a millimetre. Measurements of less than a millimetre (such as awn length) were recorded to the nearest twentieth of a millimetre using this latter technique.

It is unfortunate that many of the major diagnostic characters require measurements to this degree in order to give an adequate picture of their variation, as it means that the descriptions and keys are of limited use without access to a low-power microscope. This has to be accepted as a characteristic of the genus. However, in order to identify material all that is required is the knowledge of where the measurement of a character falls in relation to a certain range of values; this does not require an exact measurement. With respect to the data on the proportion of the main axis which is simple, it was deemed reasonable on the basis of the accuracy of the measurements to give the ratio to the nearest 0.05 ($\frac{1}{20}$); measurements of length above 10cm were made to at least two significant figures, while those below 10cm were taken to the nearest $\frac{1}{2}$cm.

III. CHARACTERS

1. LIFE-SPAN

Both annual and perennial types of life-span are common in Euphrasia and their distinction is one of the major characters used in the infrageneric classification proposed in this work, and in the previous ones of Wettstein (1896) and Pugsley (1936). The groups distinguished in part on the basis of life-span seem naturally delimited and monophyletic. There appear to be several independent cases of annuals giving rise to perennials. For details see Chapter IV on evolution in the genus.

The age reached by the perennial species has not been investigated, but it is possible that the Australian perennials survive longer than five years. Generally in populations of perennials first-year plants appear scarcer than latter year plants (detected by weather worn infructescences of the previous year), but E. hookeri is one species which has the capacity to perennate but rarely appears to do so (q.v.: Note 2).

2. ROOT SYSTEM

The root system of Euphrasia consists of a single main axis branched laterally into secondary axes which are in turn branched.

The plant is a facultative semi-parasite (Yeo 1964) and the swellings or "haustoria" are located on the finer rootlets and attach to the fine rootlets of the host. Evidence of these haustoria is present in most specimens which have been extracted from the soil with care. However, actual remnants of fragments of the host roots still attached to the haustoria are less common. Even if the greatest care is used in extracting the plant and its probable host from the soil such attachments are seldom found. Haustoria do not appear to be absent from any taxon in Australia. Their relative prevalence, however, is difficult to determine because of the difficulties associated with finding attachment to a host. The presence of haustoria is well-documented in Europe and has been described in New Zealand (Philipson 1959) for E. cockayniana, E. zelandica and E. revoluta. Yeo(1964) has reviewed experimental work in semi-parasitism in the genus.

Simple slender roots may emerge from the axes which are at ground level, and probably are a response to moist conditions, as they often occur in plants from permanently damp areas.

3. HABIT

Within both the perennials and annuals of Euphrasia there are a variety of habit types. Differences in habit often appear to be correlated with climate. Thus similar habit types may be found in distantly related species in similar climatic conditions, while closely allied taxa, sometimes within a species or even variants in the one subspecies, may differ markedly in habit.

The height of the plant (or, to exclude variation caused by differences in the stage of development of the inflorescence, the height of the main floral axis to the base of the inflorescence), the position of the uppermost branches or young shoots on the main floral axis (measured by the number of nodes below the inflorescence, and the proportion of main floral axis between the inflorescence and the node bearing the uppermost shoot), the sequence of development and direction of the branches, and the number and length of the internodes on the main floral axis (relative to the length of the leaves) were found useful to define the observed differences in habit type.

a. Habit in the annuals

The habit type consisting of a single erect stem often branched in successive nodes is characteristic of almost all annual species of *Euphrasia*. In the Australian annuals (Sect. *Scabrae* and Sect. *Lasiantherae*) the branches develop basipetally in consecutive nodes. Elsewhere however, the order and consistency of branch development is not so strict. In Sect. *Euphrasia* of the northern hemisphere there is a tendency for branches also to develop basipetally but they are often, in the less robust plants, very few or even absent. In Sect. *Novaezeelandiae* branching is similarly rather sporadic and tends to be acropetal. The more ordered and consistent development of branching in the Australian species may be related to their apparent capacity for more vigorous growth, with stems able to bear many internodes and flowers being produced in large numbers.

Two species of Sect. *Anagospermae*, *E. disperma* Hook.f. and *E. integrifolia* Petrie, have a very different habit. Plants of these species form loose mats with almost completely prostrate branches arising from a reduced stem (see Ashwin 1961). The remaining two species of the section, E. repens Hook.f. and E. dyeri Wettst., are intermediate in their habit (in addition to other characters) between these species and Sect. Novaezeelandiae.

Until the present revision of the Australian species, habit in the annual species had only been studied in the extensive northern representatives of Sect. Euphrasia. It is in these species that the phenomenon of "seasonal dimorphism" has been widely documented. Similar "seasonal (or pseudoseasonal) polymorphism" occurs in other genera of the Tribe Rhinantheae e.g. Melampyrum and Rhinanthus (Soo & Webb 1973a,b). The two habit types of Sect. Euphrasia have been characterized as follows by Pugsley (1930):

1. Aestival or Early Summer-flowering form

   Internodes very long. Flowers forming from generally the 4th stem node. Branching consequently limited.

2. Autumnal or Late Summer-flowering form

   Internodes very short in lower parts, (?longer above). Flowering from the 5th-12th (or more) stem node. Branching copious.

Yeo (1964: p.7) has made slight modifications of these limits.

The various habit types have been correlated with climatically based differences in the duration of the growing season. In Euphrasia the aestival form is found in alpine or arctic regions with shorter growing seasons. It is also found in meadows which are frequently mown and the time between germination and the production of seed must be as short as possible. The autumnal or late summer-flowering forms occur in more lowland regions of lower latitudes with the correspondingly longer annual periods of growth.

Pugsley (1930, 1936) defined a number of series in Sect. Euphrasia (his Sect. Semicalcaratae) partly on the basis of these habit differences. However, he and subsequent workers, such as Juzepcuk (1955), Sell & Yeo (1970), Yeo (1972), have found the distinctions between the autumnal and aestival types too unreliable to be useful in defining species. They have preferred to describe each taxon by its range of variation in the number of stem nodes, the length of the internodes and the relative abundance of branching.

Yeo (1964) has shown that differences of this type are retained when cultivated together indicating that they are determined by genetic differences. In addition, he observed precocious flowering (with a consequently reduced stem node number) in some plants of the normally late summer-flowering E. pseudokerneri Pugsley during periods of unusually high temperatures. He states that "this suggests that temperature is one of the main factors controlling flowering in Euphrasia, and that given sufficiently high temperatures E. pseudokerneri can be made to flower at about as low a node as the high mountain species". The prematurely flowering plants were the most developed of a crop of seedlings. He further states that "precocious flowering of very young plants after hot weather has occurred repeatedly in my greenhouse cultures" and he gives evidence of early flowering in natural populations after hot spells. In his glasshouse conditions the naturally early summer-flowering species, E. brevipila Burnat & Gremli* (from Sweden), began flowering before plants had become sufficiently robust to produce a normal number of flowers.

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*Now apparently considered to be E. stricta Wolff ex Lehm. or E. arctica Lange ex Rostrup (Yeo 1972).

The length of the potential growing season as determined by the climate also appears to be a critical factor in determining the habit type of the annuals of Sect. Scabrae and Sect. Lasiantherae of Australia. The longest potential growing season in the regions occupied by the annuals are found in montane and lowland northern New South Wales, which has summer and winter rains and an absence of winter snows. The two annuals of this region, E. arguta and E. orthocheila, possess the tallest habit and the largest number of stem nodes of the Australian annuals. Elsewhere in Australia the length of the potential growing season is shortened in one of two ways with an accompanying reduction in height and number of stem nodes (see Table 1). In montane and lowland temperate Australia, in which E. scabra is widespread, snows are generally absent but rainfall is confined to the winter months and the summers are hot and dry. The growing season is thus effectively shortened. The reduction in growing season for the remaining annuals which occupy alpine and subalpine zones is caused by the winter snows. Those taxa occupying mainly subalpine localities, namely E. ciliolata and E. caudata ssp. caudata, are intermediate in stem length and number of nodes between the montane and lowland northern New South Wales species and the purely alpine taxa, E. alsa and E. caudata ssp. nana; this is probably related to the earlier spring than in subalpine locations. E. caudata ssp. caudata of subalpine and rarely, montane localities, has many nodes like its montane and lowland relatives, E. arguta and E. orthocheila, but instead of having their more or less equally spaced nodes its lower internodes are extremely short, with the tallness being contributed by a few widely spaced upper nodes. This may also relate to the above-mentioned differences in climatic conditions. Finally, E. eichleri, which occupies both alpine and subalpine localities,

TABLE 1: The climatic ranges and variation in selected characters of the Australian annuals of *Euphrasia*
(Climatic zone: A = alpine, S = subalpine, M = montane, L = lowland)

Taxon	Height of stem to base of inflorescence (cm)	No. of stem nodes	No. of flowers in stem inflorescence	No. of ovules	Length of seeds (mm)	Climatic Zone			
						A	S	M	L
E. alsa	1.3-5.0(6.5)	(1)3-4(5)	c.15-30	10-12(15)	1.8-2.5	+			
E. caudata									
ssp. *nana*	(3.5)6.7(11.0)	(5)6-8(9)	(10)18(26)	(20)37(45)	(0.9)1.2-1.5(1.9)	+			
ssp. *caudata*	(7.3)11-24(30)	(8)10-14(17)	(12)24(32)	(30)62(110)	(1.0)1.3-1.5(2.0)		+	(+)	
E. eichleri	(2.5)5-11(14)	(5)6-8(12)	>15	(20)30(40)	1.5-2.0	+	+		
E. ciliolata	(11)16-23(25)	(10)13-16(19)	(10)16-26(36)	c. 30-75	(0.9)1.0-1.2(1.4)		+	+	
E. scabra	(7.5)11-25(45)	(6)8-18(24)	(10)14-32(54)	(57)90(140)	(0.4)0.5-0.8(1.0)			+	+
E. arguta	(12)22(33)	(18)24(30)	(30)50-90	c. 35-80	(0.4)0.6-0.8(1.0)			?+	?+
E. orthocheila	(15)17.5-37(50)	(10)13-30(36)	(15)25-40	(20)45-100	(0.4)0.5-0.8(0.9)			+	?+

has stem lengths and internode numbers intermediate between the values for purely alpine and subalpine taxa.

b. Habit in the perennials

A habit polymorphism also exists in the perennial members of *Euphrasia*. As in the annuals the differences in habit type are geographically restricted and are apparently related to climate. The characters involved in determining the different types of habit are the area in which the main axes (axis) develop branches and the area which remains simple, the direction of branching, whether the branching is in consecutive or occasional nodes, and the sequence of development of the branches. The various types are illustrated diagrammatically in fig. 3, and are described as follows:

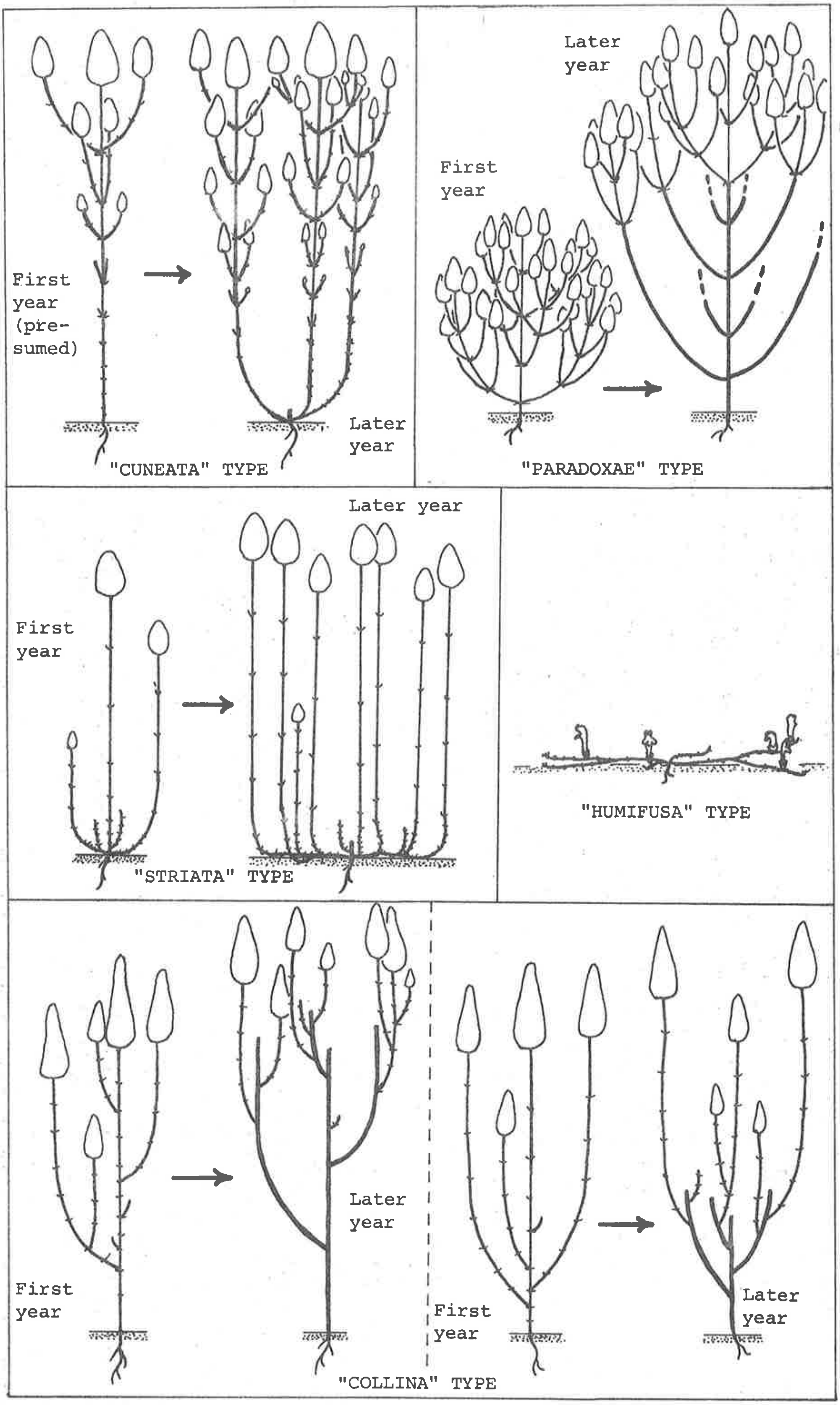
1. The "Cuneata" type (as in *E. cuneata*) e.g. pl. 15.

This type of habit is confined to Sect. *Cuneatae*. Plants of this type have branches developing in consecutive axils from high up an erect floral axis just below the inflorescence down to ground level in a more or less rigid basipetal sequence as in the Australian annuals. Insufficient material has been studied to be able to determine the true nature of first-year plants. At least occasionally, however, these plants may consist of a single erect or ascending stem in the first year, which dies back completely (as in *E. durietziana*) with several erect or ascending stem-like main axes developing from the perennating base in subsequent years. In other cases there may be several branches developing from the base. Rooting may occur in the very proximal part of the axes. The species of the section all occupy montane regions, with *E. durietziana* and *E. cuneata* extending into subalpine habitats.

Sect. *Malesianae* and *E. culminicola*, *E. lamii* and

FIGURE 3

Habit types in the perennials of *Euphrasia*.


First year (presumed)
Later year
"CUNEATA" TYPE
Later year
First year
"PARADOXAE" TYPE
Later year
First year
"STRIATA" TYPE
"HUMIFUSA" TYPE
First year
Later year
First year
Later year
"COLLINA" TYPE

E. versteegii, three closely related members of Sect. Striatae Subsect. Pauciflorae (they may actually be conspecific) have habit types resembling the "Cuneata" type in the branching well up the axes, and the development of several to many axes from the root stock. They diverge by their more sporadic incidence of branching in the nodes of the main axes. This difference may be related to their less robust nature. These plants occur in alpine, subalpine and high montane zones (Stapf 1894, van Royen 1972).

2. The "Paradoxae" type (as in E. formosissima)

This habit type is known only in the single species, E. formosissima, of the Juan Fernandez Islands. Skottsberg (1921) referred to its unusual habit when he first described the species. The plant consists of a single erect stem with branches developing in consecutive axils. As Skottsberg (l.c.) observed, the stem and lateral branches flower simultaneously. The number of nodes on the branches decreases from the base of the plant, where they have ca. 4 nodes, to the branches below the inflorescence, which lack nodes. Accordingly it appears that the development of the branches is acropetal. This is unique among the perennials. The species is also unique in its apparent means of perennation, in which the stems and main branches do not die back but continue (possibly after a dormant period) to develop leaves and new shoots. The species is apparently confined to the alpine zone.

3. The "Striata" type (as in E. striata) e.g. pl.16,17,18(p.p.),29.

Plants of this type apparently have an erect or ascending stem terminated by an inflorescence in the first-year. The vegetative buds are confined to ground level, and branches which are formed are prostrate in the proximal parts (sometimes rooting at the nodes) and distally erect. The majority of plants of Sect. Australes have this type of habit and it may also occur in Sect. Trifidae. The habit found in E. hookeri (q.v.: Note 2) is clearly a derivative of this type. Plants of this species are single-stemmed, sometimes with shoots forming at the base. The rare later-year plants have one to several simple, erect branches developed from ground level. The "Striata" type habit mainly occurs in alpine and subalpine zones.

The habit typical of E. collina ssp. muelleri is somewhat divergent from this type. The subspecies has been recorded throughout lowland and montane regions (it may now be extinct) but never above the snowline. It resembles the "Striata" type of habit by the confinement of the vegetative shoots to near ground level. Although sometimes an occasional branch or young shoot may develop in the lower half of the main branches above ground level, in many plants the great majority of branches arise from a perennating base composed of many densely clustered young shoots. This compact perennating base is not known elsewhere in the genus and may be a response to the prolonged hot dry periods which are characteristic of Australian conditions. The many young shoots may be dormant and develop only after rains.

4. The "Humifusa" type (as in E. humifusa)

This is a type probably derived from either the "Cuneata" type (as in the Malesian species) or the "Striata" type of habit. The axes are procumbent and root at the nodes. Van Royen (1972) has stated that the floral axes may be erect in E. callosa. The habit type is confined to Sect. Striatae Subsect. Humifusae of the alpine and subalpine grasslands (at least of New Guinea: van Royen l.c.).

5. The "Collina" type (as in E. collina ssp. collina)

In this type first year plants consist of a single erect stem, terminated by an inflorescence and developing branches above ground level in occasional axils with no fixed sequence. At the end of the first season the stem dies back to the upper branches and in the next season further branches develop from this region and below. There is never the perennation from the base of the plant that often occurs in the "Cuneata" type of habit. This habit is found among the Australian members of Sect. Australes and occurs only in lowland and montane habitats.

The range of variation in the position of the uppermost branches or shoots on the stem relative to its height differs, apparently significantly, between taxa having the "Collina" type of branching. For example, the position of the branching in the forms of E. collina ssp. speciosa and ssp. paludosa which have the "Collina" type habit (these subspecies also exhibit the "Striata" type habit) tends to be much lower than that seen in ssp. collina. Within E. collina ssp. tetragona, which has consistently the "Collina" type of habit, there is a geographically based transition in the position of branching, from branching in the upper half of the stem or main branches to branching restricted more to the lower half of the plant (see E. collina ssp. tetragona: Note 2; fig. 24).

Each habit type apparently represents an adaptation to the climatic factors characteristic of its range of distribution. Outside Australia it is difficult to gauge the degree of correlation between habit and climate without having a first hand knowledge of either the plants or their habitats. However it is possible to speculate upon such relationships in the Australian perennials.

The confinement of the vegetative buds to ground level in the "Striata" type of habit is probably a result of the extreme cold experienced in their natural habitats, and the fact that the ground is somewhat warmer and less variable in temperature than the air or snow above. The "Striata" type, however, is not confined to subalpine and alpine areas, as _E. lasianthera_, _E. collina_ ssp. _diemenica_, ssp. _paludosa_, ssp. _muelleri_ and ssp. _speciosa_ all occur in montane and lowland regions. The possible climatic significance of the unique habit type in ssp. _muelleri_ has been discussed previously.

The "Collina" type of habit is absent from areas with snow. Vegetative shoots are developed above ground level with a resultant increase in height of the plants which may become even greater in successive years and assist the plant in the competition for light in the forests and dense shrubberies which it occupies.

In Australia habit types may vary within taxa: It is not known whether this occurs elsewhere. In _E. collina_ both ssp. _speciosa_ and ssp. _paludosa_ may have either the "Striata" type of habit or the "Collina" type. The specimens with the "Collina" type occur only north of Sydney in northern New South Wales. This may be related to the year-round rains in this region.

In addition there are several cases of intergradation between taxa which are characterized by different habit types. Thus _E. collina_ ssp. _collina_ (of montane and lowland regions) with "Collina" type of habit and ssp. _diemenica_ (of alpine and subalpine regions) with "Striata" type, intergrade in the upper limits of forest and woodland (see _E. collina_: Intraspecific variation). Similarly, the upper portion of an apparent intergradation between _E. gibbsiae_ ssp. _comberi_ of alpine zones and of the "Striata" type of habit and ssp. _kingii_ of wet lowland and montane moors with the "Collina" type, has been observed, (see _E. gibbsiae_: Intraspecific variation).

The various habit types, in the perennials of Euphrasia appear to be genetically determined. This is reflected by the fact that they overlap in their climatic tolerances. Sympatric occurrences are a good guide to genetically based differences. The lowland and montane areas of south-eastern Australia contain taxa characterized by three of the five habit-types (the "Humifusa" and "Paradoxae" types are lacking). Unfortunately while there are probably many cases of sympatric occurrences of taxa of the "Striata" and "Collina" types in montane and lowland central Victoria and northern Tasmania, there has been too little collecting in these areas to be certain that differences are maintained when sympatric. In my visit to northern Tasmania a population of plants most closely related to E. collina ssp. diemenica (q.v.: Note 2) and with the "Striata" type of habit was found in a montane forest a few kilometres from a population of E. collina ssp. gunnii of the "Collina" type habit. In central Victoria it seems that ssp. muelleri, ssp. speciosa and ssp. paludosa with the "Striata" type of habit occur together with ssp. collina and ssp. trichocalycina of the "Collina" type. As yet there is no evidence that there is any breakdown of these habit types in this region, although field studies are required to verify this.

4. INDUMENTUM

(Excluding that on corolla, stamens and ovary which is discussed in the relevant sections.)

The distribution, composition, length and density of the indumentum on the axes, leaves, rachis, bracts, pedicels and outer surface of the calyx are of major diagnostic importance at the specific and infraspecific level throughout the genus. Hairs of both the glandular and eglandular type are common.

The length of the different types of hairs varies from organ to organ on a plant and upon the one organ. For example the glandular indumentum on the rachis and the axis is generally longer than that on the calyx and leaves, respectively and the indumentum on the calyx shortens towards the base. Therefore, to compare taxa which are distinct in this variation the length on each particular organ has been described. Rather than make exact measurements of many specimens, the lengths have generally been described in words covering particular ranges, as displayed in the following table (Table 2).

TABLE 2: Terminology of the length of indumentum used in the descriptions of Euphrasia

TERM	RANGE OF LENGTH (mm)
very short	-0.05
short	0.05-0.1
moderately long	0.11-0.29
long	0.3-ca. 0.45
very long	ca. 0.45-

Where the indumentum length has been particularly important in distinguishing the taxa an exact statement of the range of variation has been given on one or two organs. In particular the length of the glandular hairs on the outer surface of the calyx and on the axis or leaves of the lower parts has often been measured.

The means by which density has been determined is rather inexact. If the hairs are almost touching or within a few hairs breadth, they are described as dense, if widely spaced they are called sparse; intermediate conditions have been termed moderately dense.

a. Glandular hairs

The presence or absence of glandular hairs (more than 0.05mm long when on the leaves, bracts and calyces) over all or some of the axis, leaves, rachis, bracts and calyces is of special diagnostic importance in almost every instance where there is variation in the incidence of glandular indumentum, as it is generally found to correlate with other character differences. The terms "non-glandular" and "glandular" have been used to describe these character states. Such terms do not encompass the corolla, stamens and ovary, the indumentums of which are independent of these parts (see relevant sections).

The presence of tiny subsessile glandular hairs less than 0.05mm long is not of diagnostic use. These hairs are common in all taxa at the base of the clefts between the leaf and calyx teeth and along the narrow grooves which are on the upper sides of the leaves. Morphologically these hairs are similar to the longer diagnostically important glandular hairs; they differ only in the length and the number of cells of the stalk (see E. collina: Note 3). In addition in the highest parts of its range the typically non-glandular E. collina ssp. paludosa (q.v.: Note 2) has a sparse to dense cover of these subsessile glandular hairs. The presence of a number of populations with glandular and non-glandular plants and the lack of correlation with other varying characters have meant that recognition of the plants with sessile glands as a distinct taxon above the level of forms is not justified. Quite common specimens of the other wise non-glandular E. arguta with very sparse subsessile hairs on the calyces, bracts and leaves have similarly been considered unworthy of taxonomic recognition. It is likely that these hairs are identical to the very short ones found sporadically in Sect. Euphrasia of the northern hemisphere.

Yeo (1972) attributed to these no taxonomic importance.

b. Eglandular hairs

The eglandular hairs vary in rigidity and length. Length and density characters for weak eglandular hairs are described as outlined previously for glandular hairs. However, in the case of plants which are covered on some or all parts by rigid sharp eglandular hairs, another type of terminology, which is more descriptive of the nature and length of the indumentum, has been used. "Scabrous" has been used for such hairs over ca. 0.1mm long (they rarely attain more than 0.2mm); these occur in E. scabra and to some extent in E. collina ssp. muelleri. "Scaberulous" has been used to describe a cover of shorter hairs or sharp excresences (ca. 0.02-0.1mm long), such as are characteristic of E. ciliolata, E. durietziana and some individuals of E. collina ssp. muelleri.

In related taxa with non-glandular upper parts, the presence or absence of an eglandular indumentum on the external surface of the calyx and sometime also on the bracts and upper leaves may be a character of diagnostic importance. However, taxa with dense glandular hairs often also have an eglandular indumentum, which is too variable in incidence to be of diagnostic value.

The length and nature of the eglandular hairs may also be characteristic of taxa. Thus E. crassiuscula is almost unique in the genus, in at least the southern hemisphere, by its indumentum of long woolly eglandular hairs which line the calyces, bracts and leaves (similar hairs are found in E. collina ssp. diversicolor, ssp. lapidosa and ssp. glacialis but, unlike E. crassiuscula, their upper parts are very glandular).

The eglandular hairs which line the axis and rachis in a characteristic, but somewhat variable, manner are generally of no taxonomic value. The indumentum usually becomes much sparser lower down the axis except when a dense glandular indumentum is present on the lower parts. In some cases eglandular hairs may surround the whole axis, e.g. in _E. scabra_ and _E. orthocheila_, but more commonly they are confined to two rows or two pairs of lines decurrent from between the leaf bases. _E. humifusa_ Pennell and _E. callosa_ Pennell of Sect. _Striatae_ Subsect. _Humifusae_ in New Guinea, have been separated almost entirely on this character, the eglandular hairs of the former being distributed around the entire axis, while those of the latter are confined to two opposite rows.

5. LEAVES AND BRACTS

Leaf and bract characters are of major importance in distinguishing taxa at all levels in _Euphrasia_. The major characters involved are the overall size and shape, the shape of the base, the number, length and region of distribution of the teeth, the size and shape of the apex, the distribution and pattern of the sessile gland patches on the lower surface and the indumentum, which has been described in the previous section.

The uppermost leaves and lowermost bracts are similar in all characters except sometimes for those of indumentum (see previous section). In the Australian species and probably elsewhere, there tends to be slight narrowing of the blade and broadening of the base (sometimes accompanied by an increase of an extra pair of teeth) from the lowermost bract down to two or three leaves below the inflorescence. Below them the leaves gradually shorten and sometimes decrease in the degree of toothing. Often correlated with these trends are transitions in the nature of the indumentum. From the lowest bracts to the last-formed ones there is a decrease in size and the degree of toothing. In order to make consistent comparisons between taxa, the characteristics of the bracts and leaves have been described on the basis of a detailed analysis of the uppermost pair of leaves on the main floral axis of the plant. The indumentum characters of the bracts and lower leaves are also often described by a comparison with the detailed description of indumentum of the uppermost leaves, but the changes in shape and size as described above are only occasionally referred to.

Because of the great importance of leaf characters at the specific and infraspecific level in Australian taxa and in the genus as a whole, a series of plates (pl. 5 -- 11) showing the type of uppermost leaves on the main floral axes of almost all Australian taxa is supplied. Where possible a sample from a population is displayed. If representative collections of a taxon were few, only one or two leaves were removed for display. In cases where material was taken from collections other than my own the leaves have been returned to the relevant sheets accompanied by appropriate annotations.

At the specific and infraspecific level, of particular diagnostic importance are the characters of the number and distribution of the teeth, the length of the teeth, the size of the apex and the overall shape of the leaf (either measured as a ratio of length : breadth as in separating the three species of Sect. Lasiantherae or, where either length or breadth are more or less identical, described simply on the basis of the breadth or length respectively). The reason for their usefulness lies with their quantitative nature. Qualitative characters such as overall shape and the shape of the base, teeth and apex are also potentially good diagnostically (compare the illustrations of the leaves of the related species, although it is stressed that these do not cover the whole range of variation), but lack sufficiently precise terminology to be used widely.

There are several very distinctive leaf and bract types varying at the sectional and subsectional level. Attention is drawn to the special use of the term blade (see beginning of chapter). The shape of the base is particularly important diagnostically. In Sect. Striatae, E. bella of Sect. Australes and all members of the genus outside Australia the base of the leaf is attenuate. The members of Sect. Cuneatae (pl. 11), E. borneensis in Sect. Malesianae (Du Rietz 1932b: fig. 8) Sect. Euphrasia Subsect. Angustifoliae (Wettst in 1896: pl. 3 fig. 2-94) and at least some members of Subsect. Japonicae (Wettstein l.c.: pl.3-5 fig. 95-99, 178-181, 366-368), and E. bella of Sect. Australes (pl. 11) all have long narrow attenuate leaves with a prominent blade. Sect. Atlanticae (Wettstein l.c.: pl. 5 fig. 361-365), Sect. Euphrasia Subsect. Ciliatae (Wettstein l.c.: pl. 3-5 fig. 102-176, 186-359) and possibly some members of Subsect. Japonicae, and most species in Sect. Malesianae (see Du Rietz 1932a: fig. 3,4,10) have typically a short petiole-like base abruptly spreading into a broad blade. In Sect. Striatae Subsect. Striatae (pl. 5), Sect. Trifidae (see Wettstein l.c.: pl. 6 fig. 455-486), Sect. Anagospermae (see Ashwin 1961: fig. 34) and some members of Sect. Striatae Subsect. Pauciflorae (see also Ashwin 1961: fig. 34), the leaves are narrow attenuate but a blade is absent or diminished and the leaf is taken up by the prominent teeth and the apex. These are the "subdigitate-toothed" and "digitate" types of Du Rietz (1948a).

Sect. Lasiantherae, Sect. Scabrae and Sect. Australes, which are all from Australia, form an evolutionary line away from these types (pl. 6-11). The base is cuneate, rounded or truncate and because of this most of the leaf is composed of blade. These are the only truly non-attenuated bases in the genus (although in some of the taxa outside Australia there may be narrow cuneate bases of narrow-leaved types which are extremes in variation of species with attenuate leaf bases). The difference in the form of the leaf base among the Australian members of Euphrasia seems to be directly related to the nature of the vascular system of the leaf at its very base. In all extra-Australian species, E. bella of Sect. Australes and commonly Sect. Striatae Subsect. Striatae there are only three main vascular strands arising from the base. In leaves with very shortly attenuate leaf bases abruptly expanded into the blade, the lateral pair of main strands may be branched a short distance from the base. In the long attenuate types the three strands may remain simple for their whole length or branch towards the base. The non-attenuated types have 3-7 vascular strands arising from the base. Even taxa with narrower leaves, such as E. collina ssp. collina, may sometimes have 5 vascular strands arising from the base.

Sect. Trifidae, Sect. Anagospermae and E. hookeri of Sect. Striatae Subsect. Striatae are all distinctive by their deeply divided leaves. E. hookeri is distinct from the first two sections by the large number and remarkable form of its teeth, the margins of which are recurved so greatly that they meet along their whole length (pl.1, 5). In the other two sections the leaf margins are recurved, but as in the rest of the genus they do not meet. On the basis of these leaf characters, E. hookeri was given a separate status as a monotypic series by Du Rietz (1948b). This distinction as a series has been retained in the revised infrageneric classification, under Subsect. Striatae. In Sect. Anagospermae there is a line of evolution terminating in the loss of the teeth (in E. integrifolia). The New Guinean species of Sect. Striatae (Subsects. Humifusae and Pauciflorae) are characterized by curious leaves which have all but lost their lateral teeth and are dominated by the hooded apex which is often half the length of the leaf.

The characters of the distribution and pattern of the patches of sessile glands on the lower surface of the leaves and bracts have apparently not been used in previous classifications in Euphrasia. They have been found to be of diagnostic importance in some instances in Australia and an extended, more critical view of the characters elsewhere in the genus may show further examples of differences between taxa.

The sessile glands (which are not to be confused with the very shortly stalked subsessile glandular hairs, described above and under E. collina ssp. paludosa: Note 2) occur on the lower surface in dense patches always in rows parallel to and just inside the margins; these rows are branched sporadically on their inner margin, the lateral extensions being short or very long and always being confined to the areas between the main veins of the leaf.

E. hookeri (Sect. Striatae Subsect. Striatae) is the only member of the genus known to seemingly lack sessile gland patches on the lower surface. These are not absent from the leaf however. Microscopic examination shows them to be located on the inside of the greatly recurved margins in a position typical of the rest of the genus. Their absence from the lower surface is thus a result of the extreme recurvature of the teeth margins (pl. 1, 5), the lower surface of the teeth in E. hookeri in fact being analogous to part of the upper surface of the teeth and the outer surface of the margins of the leaves in the rest of the genus.

Whether the sessile glands occur towards the base of the leaf is related to the distribution of the teeth along the leaf. Except when the leaf teeth are very reduced (as they often are in the New Guinea species), sessile glands are always distributed along the margins from the apex at least as far as the extent of the toothed parts of the leaf. Thus if the leaf teeth reach the base of the leaf so do the sessile glands. However, if the teeth are confined to the distal ½ of the leaf in the non-attenuate-based types of Australia (e.g. in E. collina ssp. collina) the sessile glands may extend along the margins well below the teeth and onto the lower half. In such cases, however, the sessile gland patches never reach the base. In the members of Euphrasia with attenuate leaf bases the sessile gland patches hardly (if at all) extend onto the attenuated regions of the leaf.

The pattern of the sessile glands on the lower surface has been used in E. collina to distinguish ssp. diemenica from ssp. paludosa, ssp. glacialis, ssp. diversicolor and ssp. lapidosa. The sessile glands of ssp. diemenica are almost entirely confined to the marginal rows except for very short lateral branches. Those of the other subspecies outlined above and a number of other subspecies have long lateral extensions of the marginal rows. Ssp. collina shows a transition in the nature of pattern of the sessile glands which appears to be correlated to an altitudinal cline in leaf shape (q.v.: Note 2). Its south-eastern Tasmanian populations which resemble ssp. diemenica by their short apex and lobes have a pattern of sessile gland patches also similar to that of ssp. diemenica; the populations in the Grampians, however approach ssp. paludosa by their longer leaf apex and teeth and like that subspecies often have correspondingly long lateral extensions of the marginal rows of sessile glands.

There are almost certainly other cases where the pattern of sessile glands is of importance diagnostically. In the Australian members of the genus the sessile glands are apparently distributed over wider areas of the lower surface in the annuals than in most of the perennials. However in some densely glandular species of the perennials such as E. lasianthera (which with two annual species belongs to a separate section) and E. collina ssp. diversicolor, the sessile glands are distributed as widely over the lower surface as in the annuals. Elsewhere it has been noted that E. cuneata of Sect. Cuneatae and Sect. Paradoxae have very distinctive, reticulate patterns of sessile gland patches. Unfortunately time was insufficient to allow for a detailed study of these potentially useful characters.

6. INFLORESCENCE

The arrangement and number of flowers is of importance in the infrageneric classification of Euphrasia. Throughout the genus the flowers develop acropetally along the axes. In the major part of the genus the flowers are arranged decussately in racemes. The pair of flowers at one node generally develop simultaneously, but in certain conditions, such as where plants grow from the side of a dense shrub, development may be much earlier on the outward-facing side. This is possibly caused by consistently uneven illumination on the young inflorescence.

Whenever plants of Euphrasia are completely prostrate, i.e. in the perennial Sect. Striatae Subsect. Humifusae and the annual Sect. Anagospermae, the flowers are distributed sporadically along the axes with usually one flower only at a node. Sect. Malesianae which is closely related to Subsect. Humifusae, is characterized by racemes which are sometimes interrupted by the absence of flowers from some nodes and which sometimes have only one flower at a node. I have seen transformations of a similar nature from inflorescence to vegetative axis to inflorescence on the one axis in rare specimens of E. gibbsiae ssp. kingii of Sect. Striatae Subsect. Striatae. Yeo (1964) has also seen this phenomenon in the annual E. pseudokerneri of Sect. Euphrasia, and has linked it with abnormal temperature fluctuations. In the perennial E. formosissima (Sect. Paradoxae), however, this apparently occurs regularly (Skottsberg 1921) and is probably the means of perennation, with the transformations from a flower-producing to a leaf-producing axis and vice-versa being seasonally induced.

The number of flowers has been used diagnostically to separate the New Guinea and New Zealand species of Sect. Striatae from the Australian species of the section. In Australia flower number has also been useful for separating species and subspecies. In the annual species there is a correlation between the number of flowers in the main inflorescence and the climatic range of the species (see Table 1). The relationship parallels that between climatic range and the number of stem nodes and stem height and ovule number and seed size (see relevant sections) in the same species. The number of flowers produced may be linked with the relative sizes of the plants of the species and hence their capacity to continue maintaining the production of flowers. This is possibly applicable throughout the genus.

Pedicel length shortens from the flowers of the lowermost node to the apex. Although not of major diagnostic importance in the genus in Australia, it is useful in separating the New Zealand species of Sect. Striatae Subsect. Pauciflorae and Sect. Novaezeelandiae. It has apparently been little-used elsewhere in the genus.

Except in plants with very few flowers, the buds and bracts of the young inflorescence are generally crowded together at the tip of the axis in what has been termed in this work the "apical bud cluster". In most of the genus this is broadly ellipsoid or ellipsoid-ovoid to spherical in shape. However in Australia in the larger number of flowers produced there is some variation in the shape and degree of exsertion from the uppermost flowers of the apical bud clusters. Two types are discernable which have been given diagnostic importance in the past by Wettstein (1896), Curtis (1967a) and Burbidge (Burbidge & Gray 1970); whether the differences have any genetic basis, however, is open to question. In the alpine species the apical bud clusters are short and broad and soon after flowering commences become hidden in the uppermost flowers of the inflorescence. Inflorescences of this type have been termed "capituliformis" (Wettstein l.c.; Du Rietz 1948a) or "capitata" (Wettstein l.c., Curtis l.c.). In the lowland and subalpine members of E. collina the apical bud cluster is narrow cylindrical or narrow conical and remains extended above the upper corollas after the flowers at many (sometimes over 20) nodes have matured. Inflorescences of this type have been termed "elongata" (Wettstein l.c.) "spiciformis" (Du Rietz 1948b) and "conica" (Wettstein l.c.; Curtis l.c.). In the past the character has been used particularly in separating the taxa now grouped under E. collina. It is considered that it may be an environmental response, particularly as the two types have never been observed to grow together. In the two subspecies of Tasmania and south-east Australia which are common to the subalpine zones there is a breakdown in the character. Ssp. paludosa is normally characterized by a narrow subconical apical bud cluster but in the highest parts of its range (e.g. on Mt. Speculation, Victoria) it may have apical bud clusters of the other type. Ssp. diemenica typically has the short, broad type of cluster, quickly hidden by the upper flowers. However, montane and even subalpine occurrences may have conical apical bud clusters. Because of this uncertainty in the nature of the variation the initial shape and subsequent development of the apical bud cluster have been described in detail, but have not been used in the keys.

7. CALYX

The structure of the calyx is essentially the same throughout the genus. There is variation in size and the depth of the lateral and median clefts; these are of some diagnostic importance at the specific and infraspecific level. The shape of the teeth and the degree of recurvature of the margins parallels analogous characters in the uppermost leaves and bracts, although they are not identical. The margins of the teeth are often somewhat recurved. However if the leaf teeth of one taxon are more recurved or more acute than those of another, the calyx teeth of the former will be more recurved or more acute than those of the latter. A special terminology has been devised to describe the shape of the calyx teeth; it is discussed at the beginning of this chapter. The indumentum on the outer surface of the calyx is of major diagnostic importance. It is closely related to the general indumentum of the bracts, rachis, leaves and axis and is discussed under the general treatment of indumentum.

8. COROLLA

The shape, size, colour and its distribution, and indumentum are of diagnostic importance at various levels of classification.

a. Shape and Size

In the descriptions of the Australian species it has been attempted to describe shape and size of the corolla lobes by measuring various parameters which together make up corolla shape. The parts of the corolla measured are the length along the upper side (i.e. excluding the lobes), the length of the tube from the base of the corolla to the point of insertion of the anterior filaments, the length of the hood (upper lip), the breadth of the hood (including and excluding the lobes), the length and breadth of the lower lip and the depths of the clefts between the upper and lower lobes. These parts measured are portrayed in fig. 2 . All have been found to be of diagnostic value. The measurements for all taxa were taken from the lowermost flowers of the main inflorescence. Those used in the species description were made on flowers which had been either fixed in the field in *FAA and transferred to 70% ethanol for measurement, or taken from herbarium specimens and boiled in a weak household detergent solution. However measurements for the description of the subspecies of *E. collina* were taken from pressed material. In well-pressed material there seems to be little difference in corolla size from boiled material.

The overall shape of the corolla is not of diagnostic importance at the level of section and subsection. It is however, useful in separating the more distantly related section and subsection. Generally closely related infrageneric taxa are connected by a series of gradually changing forms of corolla.

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* FAA - Formalin-acetic-alcohol mixture, consisting of 90 parts 70% ethanol : 5 parts 100% glacial acetic acid : 5 parts formalin (4% formaldehyde).

The type of corolla characteristic of Sect. Euphrasia as illustrated in Wettstein (1896: pl. 2) is the basic type which occurs throughout much of the range of distribution of Euphrasia. Corollas of this type are two-lipped, with the tube directed obliquely away from the axis; the tube is cylindrical in the basal parts and distally expanded laterally and ventrally. The upper lip is hooded and more or less porrect with the lobes recurved sharply so that they are directed upwards and approximately lie in the same plane (i.e. they face forward). The lower lip spreads from its base away from the base of the upper lip; it is concave from above at its base. Similarly shaped corollas found in Sect. Malesianae (Du Rietz 1932b: fig. 3,8; van Royen 1971: fig. 2), Subsect. Humifusae, (van Royen 1971: fig. 1, 1972: fig. 15,16), Subsect. Pauciflorae (Salmon 1967: pl. 368,369,371, 475; van Royen 1972: fig. 11,12) and Subsect. Striatae (pl. 1, 18) of Sect. Striatae, Sect. Novaezeelandiae (Salmon l.c.: pl. 370,372), Sect. Paradoxae (Skottsberg 1921: pl. 15,20) and Sect. Cuneatae (Salmon l.c.: pl. 366,367; Hodgson & Payne 1971: pl. facing p. 222). From dried material the corollas in the specimens seen in Subsect. Humifusae seem to be commonly more widely spreading from the upper lip than is shown in the illustrations quoted above.

There are a number of types of corolla divergent from this basic form in the genus in the southern hemisphere.

In Australia the corollas of Sect. Scabrae (pl. 3) are the most divergent. They are characterized by a porrect flat lower lip which lies against or hardly spreads from (except in E. caudata in distal regions) the upper lip. The lower side is broadly grooved and flat or slightly convex from above. The upper lobes are sharply reflexed, but are at a sharp angle to each other because they are more or less appressed against the side of the hood.

The corollas of Sect. *Lasiantherae* (pl. 2), *E. collina* (pl. 4) and possibly *E. bella* of Sect. *Australes* are intermediate between that found in Sect. *Scabrae* and the basic type described above. In these the upper corolla lobes are directed forward and lie in the same plane and the lower lip, although initially porrect, is spreading in the distal regions. The lower side is flat and sometimes broadly grooved. It appears that sometimes, however, for example in *E. lasianthera* and *E. collina* ssp. *glacialis*, the lower lip and tube may be concave from above. Because these characters have been discerned from fixed material and photographs, which are inadequate for determining the characteristics of the lower side, study of living material is required to verify these differences.

In the New Guinea perennials (Sect. *Striatae* Subsect. *Humifusae* and Subsect. *Pauciflorae*) and the New Zealand annuals of Sect. *Anagospermae* the corolla tube is sometimes very long relative to the two lips. Except in *E. disperma* of the latter section and possibly *E. scutellarioides* of Subsect. *Pauciflorae*, plants with a relative tube length more typical of the genus occur in each of the species.

Finally, Sect. *Trifidae* diverges from the rest of the genus by the production of some remarkable corolla types. Some members of the section, for example *E. antarctica* (Vallentine & Cotton 1921: pl. 45), differ very little from the basic corolla shape although by the arrangement and equal size of the upper and lower lobes the corolla appears almost regular when viewed from the front. Similarly Wettstein (1896: pl. 6, fig. 472,473) has illustrated *E. chrysantha* and *E. flavescens* in which the lower corolla lip is abruptly reflexed such that the corolla lobes are in the same plane. In another illustration (pl. 6, fig. 482) he depicts E. meiantha with a very long porrect hood and a minute lower lip reflexed from its base. This section clearly shows the greatest divergence from the basic type and the greatest diversity.

A character sometimes important at all levels of classification is the shape of the corolla lobes. Sect. Euphrasia Sect. Atlanticae (ex Wettstein 1896), Sect. Malesianae and Sect. Striatae Subsect. Humifusae of the northern hemisphere and tropics always have emarginate lobes. Throughout the remainder of the genus in the southern hemisphere and in Sect. Striatae Subsect. Pauciflorae in New Guinea the lobes vary from obtuse to emarginate, sometimes within populations. Occasionally a species or subspecies may be characterized by consistently emarginate lobes, but in other cases in the same section or subsection a taxon may have acute, obtuse or truncate lobes.

b. Colour and coloration

The "ground" colour of the corolla (i.e. excluding striations and yellow nectar guides) is of limited diagnostic value, at least in Australia. It is useful, however for separating the yellow-flowered species, namely E. scabra and E. orthocheila in Sect. Scabrae, and E. cockayniana in Sect. Novaezeelandiae from related species with corollas with a ground colour of white to purple or violet. In Sect. Euphrasia the presence of a yellow corolla is apparently not diagnostic at the species level (e.g. E. minima Jacq. et DC.: Pugsley 1930, Yeo 1972). The loss of purple striations in the Australian members of Euphrasia (see below) has probably led to an increased incidence of non-white corollas. Colours vary from white to maroon or pink to violet or blue. A particular taxon may vary through all or part of this range, and may show different ranges of variation in different geographical regions. Elsewhere in the genus the ground colour is usually white, although sometimes lilac or purple corollas may occur. This is sometimes diagnostic at the species level in Sect. Euphrasia (Yeo l.c.).

The purple- to violet-striated corolla with a yellow blotch on the lower lip and two yellow blotches in the tube is apparently characteristic of much of the genus (pl. 1), although data are lacking for many species outside Australia. Yeo (1968) has given an identical account of the basic corolla coloration in the genus from his wide experience of Sect. Euphrasia. References to this type of coloration are also found in Ashwin (1961) for New Zealand species and van Royen (1972) for a number of the New Guinea species. However, in each case it seems that while the yellow blotch is considered always present, there is less certainty about the incidence or distribution of the striations. From my own observations of the Australian taxa in the field and of the extra-Australian members from colour photographs, specimen annotations and well-preserved herbarium material it seems certain that there is a wide variation, potentially of diagnostic importance at least at the specific and infraspecific level, in the pattern and extent of both the yellow blotches and violet to purple striations. Little emphasis has been placed on these characters in past classifications in the genus. The following paragraphs are an outline of the variation in corolla coloration as far as can be determined.

The basic type of corolla coloration which is common in Euphrasia consists of up to 3(5) purple or violet striations on each lobe, with those on the upper lips extending from the hood, a yellow blotch on the lower lip, and two smaller blotches in the tube at the point of insertion of the anterior filaments. Sometimes the striations on the lower lip may be absent or shortened, or only the middle one may be apparent. In Sect. Striatae Subsect. Striatae such variation is of diagnostic importance. Generally in the subsection the lower lip is extensively striated (pl. 1). However, E. semipicta and E. gibbsiae ssp. pulvinestris are distinguished from the other members of the subsection by the limited occurrence and distribution of the striations.

The other Australian species show divergence from the basic type of corolla coloration. In Sect. Lasiantherae, E. alsa has the basic coloration (pl. 12) but E. lasianthera has a distinctive divergent type. The corollas of this latter species (pl. 2 , 12) are very open, and prominently and extensively striated. A yellow blotch is absent from the lower lip. Instead, occupying a central position in the flower and high-lighted by the radiating striations are two small but distinctly demarcated yellow blotches, one at the base of each anterior filament. The coloration of E. eichleri, which is morphologically intermediate between E. alsa and E. lasianthera, is not known.

Sect. Australes and Sect. Scabrae differ apparently from the rest of the genus by the complete and consistent absence of striations on the corolla. They also diverge in characters involving the yellow corolla blotch. E. collina, the highly polymorphic member of Sect. Australes is variable in the presence or absence of the yellow blotches. The subspecies which consistently occur in alpine regions, namely ssp. diversicolor, ssp. lapidosa and ssp. glacialis, the alpine populations of ssp. diemenica (q.v.: Note 1) and ssp. tetragona of lowland areas always have a yellow blotch on the lower lip and two others deep in the throat (sometimes the blotches are continuous). The yellow blotches are apparently completely lacking from ssp. deflexifolia and possibly ssp. speciosa. In all the other subspecies the incidence of the yellow blotches is varied. They are usually present in ssp. collina. Their presence or absence varies on a geographical basis in ssp. osbornii (q.v.: Note 1) and ssp. paludosa (see E. collina: Intraspecific Variation Sect. IIb 2). In Sect. Scabrae the nectar guides on the lower lip of at least E. caudata (pl. 3) and E. ciliolata consist of a yellow to red streak down the middle of the lower lip. This seems to be unique in the genus.

Outside Australia the sections and subsections each show a greater or lesser divergence from the basic type of coloration. In Sect. Euphrasia the basic type is found in Subsect. Euphrasia (Yeo 1968,1972; Sell & Yeo 1970). The species of Subsect. Alpicolae have the normal distribution of yellow blotches, but have a distinctive and possibly unique deep purple blotch on either side of the hood just above its base and also at the point of insertion of the anterior filaments (Pugsley 1936; Yamakei Color Guide 1967: pl. on p.40; Takeda 1959: pl. 65 no. 35,36). Subsect. Japonicae has the normal yellow blotch on the lower lip (Takeda l.c.; pl. 65 no. 34) but I have been unable to determine other details on coloration. Sect. Cuneatae (Hodgson & Payne 1971; Salmon l.c.: pl. 366,367; Skottsberg 1921: pl. 15,20) and Sect. Paradoxae apparently have the basic coloration. The only record of coloration in Sect. Malesianae is that of Stapf (1894) for E. borneensis, which is identical to the basic type.

Data on corolla coloration in Sect. Striatae Subsect. Humifusae and the New Guinea species of Sect. Striatae Subsect. Pauciflorae from specimen labels, well-preserved herbarium material and van Royen (1972) indicate that in at least most of the representatives the coloration is more or less of the basic type. However, sometimes the purple striations on the hood, where they may often be confined, are replaced by a purple spread of colour all over the hood. The New Zealand members of Subsect. Pauciflorae also have a basic corolla coloration (Salmon 1967: pl. 368,369,371) although the yellow areas are continuous and occur well back towards the base of the tube. This may be related to the fact that the mouth of the corolla, at least in E. revoluta, is directed upwards rather than horizontally as normally occurs in Euphrasia.

E. zelandica of Sect. Novaezeelandiae is apparently divergent from the basic coloration type. While there is the typical yellow blotch on the lower lip (Salmon l.c.: pl. 370), it is evident from herbarium material that there is often a broad purple streak along the midline of the hood, sometimes with a similar streak on either side along the edge of the hood. Purple striations often appear to be absent elsewhere on the corolla. The other species of the section apparently lack this type of coloration. However, E. dyeri and E. disperma and possibly all species of Sect. Anagospermae possess it. This emphasizes the close relationship between E. zelandica and these species.

Sect. Trifidae may also have a somewhat divergent coloration. E. antarctica apparently has a more or less basic type of yellow coloration distributed about the join of the lower lip with the tube (Vallentin & Cotton 1921: pl. 45), but it has a single purple striation down the midline of each lobe (verified by Skottsberg 1913). Apparently nowhere else in the genus are the striations consistently single on each lobe. It is not known whether this is a characteristic of the whole section or just E. antarctica.

It seems clear that in the variation in coloration throughout the genus there are a number of characters possibly diagnostic at the level of section and subsection, and certainly useful in clarifying morphological relationships between species. These can only be recognized if collectors of Euphrasia record details of the characters described above.

c. Corolla indumentum

The distribution of the indumentum on the inner and outer surfaces of the corolla is somewhat variable and furnishes characters of diagnostic importance at the level of species and below. The composition of the indumentum in relation to whether or not both glandular and eglandular hairs are present and in what proportion also varies with the region on the corolla and, within limits, from plant to plant. Much attention has been given in this study to producing detailed accounts of the variability of the corolla indumentum on the various parts of the corolla, in the hope that diagnostic characters might be discovered. The density and length of the glandular and weak eglandular hairs were described in the terms used for indumentum on the calyx, bracts, rachises, leaves and axes (see Indumentum).

Consistencies seen in the corolla indumentum of the Australian species are:

i. the dense eglandular indumentum on the outer surface of the hood and extending to a greater or lesser extent onto the tube,

ii. the small or large patch of glandular hairs on the outer surface extending from the region about the lateral clefts towards the point of insertion of the anterior filaments,

iii. the dense patch of long eglandular hairs on the inner surface of the hood at the base of the sinus (or cleft) between the two upper lobes,

iv. the glabrous nature of both the inner and outer surfaces of the very base of the tube.

These regions may vary in the incidence of the hair type not cited as consistently present. In all other regions the indumentum is variable in its incidence and composition. Of particular diagnostic importance is the presence or absence of an indumentum on the external surface of the lobes (for the lower lobes best seen in mature buds), the presence or absence of an indumentum on the inner surface of the tube, the presence or absence of hairs lining the margins of the lobes, and the presence or absence of hairs at the base of the lower lip.

The indumentum of the corollas of the extra-Australian members of the genus has not been investigated, although it is noted that Sell & Yeo (1970) mention that the inner surface of the throat is "papillose-hairy", presumably on the basis of their combined experience of the North American and European members of Sect. Euphrasia.

9. ANDROECIUM

The length and indumentum of both the anterior and the posterior filaments, the length, breadth and indumentum of the anthers (excluding the awns) and the length and shape of the posterior pair of anther awns have been described for all species. All except the indumentum of the filaments have been found to be of diagnostic importance, some more so than others.

Measurements of the stamens have been taken from the lowermost flowers of the main inflorescence. There is some decrease in size of the filaments and anthers in successively formed flowers.

However, even when the anthers are much-reduced from those in the lowermost flowers, the posterior pair of anther awns apparently remains a similar length (see E. collina: Intra-specific Variation Sect. IIb 2).

In the major part of Euphrasia the arrangement of the stamens is very constant. The stamens are didynamous. The anthers are fused along their narrowest sides in a U-shaped configuration, with the two posterior anthers quite free from each other, but connected with the two anterior anthers, which are themselves fused. The cluster of anthers is enclosed in the hooded upper lip and the anther awns project from the base of each cell into the mouth of the corolla. The posterior pair of awns projects further than the other awns into the mouth as it is situated closer to the lower lip (being nearest the join of the two lips) and is longer than the other awns.

The members of Sect. Trifidae and E. disperma of Sect. Anagospermae are the only exceptions to this situation. In both, the anthers are free. In E. disperma and some species of Sect. Trifidae the anthers occur at different levels and still lie under the hood. However, in other members of Sect. Trifidae the anthers are at the same level and are exserted from the corolla.

The length of the two sets of filaments seems to be directly related to the length of the hood. These characters are distinct between related species in several cases.

The size of the anthers is also diagnostic at the specific and infraspecific level. The length of the anther is measured from the apex to the point where the awns arise, which is taken to be the point on the outward-facing surface of the anther where the colour abruptly changes from the light brown, orange or deep purple of the main body of the anther to the white or yellow of the awn (this is slightly higher than the actual point where the attenuation begins: see fig. 2).

The indumentum of the anthers is of major diagnostic importance. Throughout most of the genus the anthers are completely glabrous but for dense hairs which line the slits of the inner surface. This is typical of Sect. Euphrasia, apparently Sect. Atlanticae (Bentham 1846), Sect. Malesianae and Sect. Striatae (pl. 1). Sect. Australes, Sect. Scabrae and Sect. Lasiantherae, which are confined to Australia, have an anther indumentum unique in the genus. Not only do the anthers have hairs, which are probably longer and denser than anywhere else in the genus, lining the dehiscence slits, but they are almost always hairy on the outer surface. This indumentum on the outer surface is composed of straight or flexuose eglandular hairs identical to those occurring along the slits. It is usually very dense and long. However, sometimes the indumentum may be sparse and short, as sometimes in E. collina ssp. glacialis or on the anterior pair of anthers of the annuals. On rare occasions in some taxa, for example E. scabra and E. collina ssp. lapidosa and ssp. diemenica, the anthers may be completely glabrous on their outer surface. In the remaining portion of the genus there is a trend towards the complete loss of hairs from the anthers.

Sect. Trifidae is distinctive in the genus for its completely glabrous anthers. Although no anatomical studies have been made, it seems certain that the loss of fusion of the anthers, a characteristic of almost all the rest of the genus, is linked with the loss of the hairs lining the uppermost parts of the dehiscence slits. E. disperma of Sect. Anagospermae, the only other member of the genus with free anthers, also has completely glabrous anthers. Sect. Paradoxae, Sect. Novaezeelandiae and Sect. Anagospermae link that part of the genus characterized by hairy anther slits with Sect. Trifidae with its completely glabrous anthers. E. formosissima (Sect. Paradoxae) has fused anthers which bear a few hairs within the slits. The anthers of Sect. Novaezeelandiae are also fused, but show a transition from the type with densely hairy slits (E. cockayniana, E. cheesemanii) to very sparsely hairy slits (E. australis, E. zelandica).

The anther awns of Euphrasia are with one exception alike in morphology. They usually are very narrow and sharp (pl.1-4). However, the posterior awns of E. phragmostoma are remarkable, not only in their extreme length but also in the broadened, somewhat twisted, erosulate tip (pl. 4).

The length of the posterior pair of anther awns has been found to be of diagnostic importance at the specific and infra-specific level throughout the genus in Australia. The length appears to be independent in some cases of the size of the corolla (measured, for example, by the length of the upper and lower lips). Thus in similarly sized corollas in E. collina ssp. paludosa, ssp. collina and ssp. diemenica, the range of variation in the length of the posterior anther awns in the first is significantly shorter than in the other two subspecies. In other cases however, such as in Sect. Lasiantherae, the increase in the size of the corolla is correlated with an increase in the length of the posterior pair of anther awns.

As has been pointed out by Du Rietz (1932b, 1948b), Bentham (1846) was incorrect in describing the anther awns of all southern members of the genus, except E. cuneata, as being equal. Du Rietz (1932b: p. 530) considered that "subequally mucronate" anthers were found in (apparently) all the South American species (Sect. Trifidae), all species now belonging to

Sect. Anagospermae, E. monroi, E. papuana and E. striata now in Sect. Striatae and E. merrillii of Sect. Malesianae. In no case however, have I seen any taxon which consistently has equal anther awns. In some taxa the difference in length may by only slight, but it nevertheless exists. The longer posterior anther awns in the taxa with free anthers, E. disperma (Sect. Anagospermae) and Sect. Trifidae, are apparently of a vestigial nature (see floral biology).

Unfortunately time did not permit an intended study of the variation in pollen morphology in Euphrasia (and the other temperate Australian genera of Scrophulariaceae). Microscope slides of pollen for study under the light microscope were prepared by the Department of Biogeography and Geomorphology, Australian National University, Canberra (designated as A.N.U.), which retained the main slide. A duplicate preparation was lodged in AD. The voucher specimens of the pollen slides are cited in the text as a reference for any future work on the slides. Species of all Australian sections of the genus except Sect. Cuneatae are represented. A brief survey of the pollen was made which showed little obvious infrageneric variation. It is stressed, however, that the survey was confined to Australian material only. Differences in size, surface texture, the nature and number of the apertures and also the cohesive properties of the grains clearly exist between genera. These differences seem to be correlated with Wettstein's (1893) tribal divisions of the Scrophulariaceae.

10. GYNOECIUM

The few characters of the gynoecium which show variation in Euphrasia are the indumentum of the ovary, the ovule number, and the shape and size of the stigma. Although the shape of the capsule varies considerably the shape of the ovary seems to show little variation.

The indumentum of the ovary is identical to that on the capsule and is discussed in its treatment.

The number of ovules has been found to be of diagnostic importance at the level of the species and below. In the Australian annuals there is an increase in ovule number as the climatic preferences of each taxon change from alpine through subalpine to montane and lowland (Table 1). The significance of this is discussed under the treatment of seeds.

Generally the number of seeds appears to have been used as a diagnostic character by previous workers in the genus rather than the ovule number (Wettstein 1896, Pugsley 1930, 1936). Du Rietz (1932b) found that E. borneensis differs from E. philippinensis and E. merrillii by its fewer ovules and seeds, but in discussing the relationships with the Formosan, Japanese and Norwegian species, he compared seed numbers. This is probably because none of Takeda (1910), Nakai (1913) or Joergensen (1919) considered the ovule numbers. The use of seed number as a diagnostic character is rather dangerous as the variation in it is not only determined by the number of ovules. In the Australian species there is great variation in the proportion of ovules which develop into mature seed. The failure of seed to develop is influenced by a number of factors which are not genetically determined, as it is dependent on the pollination and subsequent fertilization processes being successful.

The number of ovules seems to be of particular diagnostic importance in the New Zealand annuals (Ashwin 1961). There is apparently a progressive reduction in ovule number as the habit becomes more procumbent and the corolla lengthens in size (see Chapter 4). Counts of the ovule number are too few, however, to be certain of this trend (Ashwin l.c.). From a few samples of ovule numbers in each section it seems that the Australian species have the highest number. However, because of the possible variation in these sections between taxa from different climatic zones and the lack of sufficient material to obtain an adequate cover of the variation, it was not considered in gauging the differences between the sections and subsections.

The size of the stigma is of great importance at the sectional level as it is the one character which divides the northern members of the genus as a whole from all southern members. In the tropics it separates Sect. *Malesianae* from Sect. *Striatae*. Care should be taken in measurements from flowers in which fertilization has taken place as the stigma soon shrivels. Although described in some cases as capitate or capitulate the stigma is probably always bilobed with the lobing often obscure either by its small size or the reduction of the upper lobe.

11. CAPSULES:

The overall shape and size, indumentum, and shape of the apex of the capsule in lateral view are of diagnostic importance, usually at the level of species or below, but sometimes at the level of section or subsection.

Measurements have been made on the capsules at the lowest nodes of the main infructescence. Capsule size is often greatly reduced higher up the rachis; the last capsules formed are usually well below the last-formed flowers.

Apart from the remarkable bicornute capsules which occur in a single species of Sect. *Atlanticae* (not seen; described in Pugsley 1936) and Sect. *Anagospermae*, the capsule shape varies within rather narrow limits. The variability in the capsule shape is a product of the shape in lateral view; the median view is apparently consistently ovate to elliptic and usually caudate or acuminate. Capsule shape has been described excluding the persistent base of the style which always tops the capsules.

Although there is not a great diversity of capsule shapes in the genus, apparently no section or subsection encompasses the whole range of variation in shape. Broadly obovate or obcordate capsules occur throughout Sect. Striatae Subsect. Humifusae, Sect. Novaezeelandiae and apparently Sect. Trifidae. The species of Sect. Anagospermae without the bicornute capsule are probably also of this type, although little fruiting material has been seen (see also Ashwin 1961). Sect. Cuneatae, Sect. Malesianae and Sect. Striatae Subsect. Pauciflorae (especially the New Guinea species) have some species with capsules of this type, and others (e.g. E. merrillii and E. lamii) which are oblong with obtuse to emarginate apices. Australian members of the genus and Sect. Paradoxae have oblong to ovate-elliptic capsules. In the latter the apex is obtuse to shallowly emarginate, but the former shows a wide variation. Some Australian taxa have oblong capsules with shallowly emarginate apices, others have narrow-ovate to ovate-caudate capsules with obtuse to acute apices. Most, however, fall between these extremes. Although capsules of only a few species in Sect. Euphrasia have been seen, it appears that the broadly obovate type of capsule is absent.

From the survey of the variation in capsule shape it is clear that Du Rietz's (1932b, 1948b) notion of an "acuminate" type of capsule, which he considered to be restricted to and consistent throughout the Australian and South American species, is a misconception. Although he did not state from what aspect he was describing the capsule, he could only have been referring to the lateral view, as the shape in the median view is more or less constant throughout the genus. It seems that his mistake arose mainly from the fact that he saw little or no fruiting material of any of the several Australian species with capsules broadly obtuse or emarginate in lateral view. He could not have included the base of the style in his description of the capsule apex as otherwise a number of the species of other sections (such as Sect. Euphrasia) would have been termed "acuminate".

The distribution and density of the capsule indumentum is a useful character in Australia for the separation of the species and infraspecific taxa. In Sect. Euphrasia it is one of the characters used to separate Subsect. Angustifoliae from Subsect. Ciliatae (Pugsley 1930, 1936; Sell & Yeo 1970; Yeo 1972).

12. SEEDS

Seed number and size are very useful diagnostically at the level of species and below in the Australian taxa. Sell & Yeo (1970) state that (in Sect. Euphrasia) "seed size tends to be proportional to capsule size and inversely proportional to the number of seeds in the capsule". This does not hold in the Australian species.

Measurements of the capsules and the seed were made at the same time. Although the seed number is to some extent genetically determined, it is less reliable diagnostically than the related character of ovule number, because ovules do not consistently develop into seed (see Gynoecium).

In the Australian annual species (Sect. Scabrae and Sect. Lasiantherae) there is a clear correlation between the number of ovules, the seed size and the climatic range of each taxon (Table 1). The fewest ovules and largest seed are found in alpine areas, while the highest ovule numbers and smallest seeds occur in the three lowland and montane species. A similar relationship is found in the Australian perennials. E. striata of alpine and subalpine areas has larger seed and fewer ovules than its close relative E. semipicta of lowland windswept moorland. There is a similar tendency for the seed size in the alpine subspecies of E. collina to be larger than that of the subspecies of montane and lowland regions. Ssp. lapidosa of the exposed fjaeldmark of the highest alpine areas is one exception; its seed size is somewhat intermediate between the two extremes, but tends more to the size of the lowland subspecies. Within ssp. paludosa (q.v.: Note 2) there is an increase in seed size with increasing altitude. Although sampling of ovule number is insufficient to make a definite statement on the variation in ovule number in E. collina, the ovule number in the three subspecies in the alpine region of the Snowy Mountains of New South Wales appears to be significantly smaller than that for lowland subspecies, such as ssp. tetragona, ssp. osbornii, ssp. collina and ssp. paludosa. It is impossible to speculate on the meaning of this variation without further genetic and ecological studies.

13. CHROMOSOME NUMBER

With the exception of two counts, one of n=11 for E. mirabilis of New Guinea (Borgmann 1964: "E. rectiflora") and the other of n=44 for E. antarctica from the Falkland Islands (D.M. Moore fide Yeo 1968), studies of chromosome numbers in Euphrasia have been confined to Subsect. Ciliatae and Subsect. Angustifoliae of Sect. Euphrasia in the northern hemisphere (e.g. Yeo 1954, 1970). The current knowledge of chromosome numbers in Sect. Euphrasia is summarized in Yeo (1972) and placed in abbreviated form in Table 3. The notion that diploid numbers (n=11) are confined to Ser. Glandiflorae as initially suggested by Yeo (1954, 1966, 1968: as "Ser. Hirtellae") has been disproved by Yeo's (1970) discovery that E. alpina Lam also has a diploid chromosome number.

Since Euphrasia shows a comparatively higher degree of morphological diversity in the southern hemisphere and in view of the promising chromosomal data from the northern hemisphere, material from Australian members of the genus has been investigated for chromosome numbers. The results were intended to supplement morphological data in an evolutionary appraisal of the genus.

a. Method

Bud material from plants in the field was used exclusively. Young inflorescences were fixed immediately after collection in a mixture of 3 parts ethanol:1 part acetic acid, transferred to 70% ethanol after approximately 24 hours, and stored, wherever possible, in ice until transfer to temperates of below $0^{o}C$. The material was studied up to 18 months after collection.

In the fixed material it was found that pollen mother cell meiosis was confined to one or two consecutive bud pairs in each inflorescence. These buds were about 2mm long and usually about five to seven nodes above the youngest open flowers. Preparations were made of the combined contents of all four anthers from a single bud; within these preparations the variation in the stage of meiosis which could be attributed partly to the differences between anthers was not sufficient to warrant the extra time involved in selecting single anthers.

Difficulties were experienced in obtaining preparations suitable for accurate determination of chromosome numbers. These difficulties have been described by Yeo (1954) in Euphrasia and Heckard (1968) in the North American genus Castilleja, another member of the semiparasitic Tribe Rhinantheae. They involved poor differential staining of the chromosomes against the cytoplasm, as well as overlap of chromosomes in a high percentage of well-spread pollen mother cells at late prophase to anaphase of the first meiotic division, the best stages for study. Because of these difficulties most of the counts cited (Table 3) are only approximate.

To arrive at a consistent technique for studying the chromosomes of Euphrasia, variations in acid hydrolysis and a variety of stains were tested with little initial success. Hydrolysis of inflorescences in 1N hydrochloric acid at room temperature for 3-10 or more minutes had little effect on the spreading of the chromosomes and often reduced the cytoplasm-chromosome constrast. Furthermore it may have contributed to the observed variability of staining in acetic-orcein, although different samples of orcein are known to vary in staining properties (Dyer 1963). Carmine gave more consistent staining in hydrolysed material than the orcein in both acetic and propionic acids. Propionic acid was used as a solvent in preference to acetic acid because of reports (Dyer 1963) of its more consistent staining and reduced uptake of stain by the cytoplasm.

The use of lactic acid in acetic and propionic acid stains has been shown to reduce cytoplasmic staining considerably without affecting the staining of the chromosomes in a wide range of material (Dyer 1963; Cooperrider & Morrison 1967) and Cooperrider & McCready (1970) have used the stain successfully in a chromosome survey of the genus Chelone, a non-parasitic member of Scrophulariaceae. However, neither lactic-aceto-carmine nor lactic-propiono-carmine were satisfactory in the present study. Cytoplasmic staining was much reduced but there was a corresponding decrease in uptake of stain by the chromosomes.

The technique finally arrived at was recommended by Dr. B.A. Barlow (pers. comm. 1972). Standard anther squash techniques (Darlington & La Cour 1969) were employed using a light propiono-carmine stain of concentration of 1% carmine (or slightly less) in 45% propionic acid; no iron mordant or acid hydrolysis was found necessary. Meiotic figures were studied with the aid of phase contrast illumination and permanent slides were made by Conger & Fairchild's quick-freeze method (Darlington & La Cour 1969) using "Euparal" as a mountant. This technique was not entirely satisfactory but was sufficient to give an approximate indication of the number of chromosomes in the Australian species.

b. Results

The results of the study and a summary of existing knowledge of the chromosome numbers in the genus are displayed in Table 3. The chromosome numbers for the Australian species cover representatives of all sections in Australia except Sect. Cuneatae, which is only indirectly related to the rest of the genus in Australia.

Unfortunately, insufficient time and material were available to bring this study to its desired conclusion. Because of the problems of overlap and poor staining properties described above, in almost all cases only a tentative estimate of chromosome number (often only a range of values) could be supplied. However, it is fairly certain that the haploid chromosome number of E. alsa is n=27, while E. caudata clearly has a chromosome number of n=27 or 28 or both, with some evidence for abnormalities

TABLE 3: A survey of the present knowledge of chromosome numbers in *Euphrasia*, with the source of information in extra-Australian taxa, and the voucher specimen (in AD) for Australian material.

Sect. *Euphrasia*		
Subsect. *Ciliatae*		
Ser. *Grandiflorae*		
E. rostkoviana Hayne		
ssp. *rostkoviana*	n=11	(Yeo 1972)
E. rivularis Pugsley	n=11	(Yeo 1954)
E. anglica Pugsley	n=11	(Yeo 1954)
E. vigursii Davey	n=11	(Yeo 1972)
E. hirtella Jordan ex Reuter	n=11 n=c.11	(Yeo 1954) (Yeo 1970)
All other series: c. 12 species	n=22	(Sell & Yeo 1970; Yeo 1954, 1970, 1972)
E. alpina Lam.	n=11	(Yeo 1970)
Subsect. *Angustifoliae*		
E. salisburgensis Funk	n=22	(Yeo 1972)
Sect. *Striatae*		
Subsect. *Pauciflorae*		
E. mirabilis	n=11	(Borgmann 1964)
Subsect. *Striatae*		
E. striata	n=c.20-30	Barker 1060
E. hookeri	n=c.25-30	Barker 1212
Sect. *Australes*		
E. crassiuscula		
ssp. *eglandulosa*	n=c.28-33 n=c.28	Barker 1590 Barker 1593
E. collina		
ssp. *paludosa*	n=c.28 n=c.45-60	Barker 1489 Barker 1504
ssp. *collina*	n=c.28-30	Barker 1439, 1440
ssp. *tetragona*	n=c.30	Barker 1374
ssp. *trichocalycina*	n=c 28-30 [2n]=c.56	Barker 1438 Barker 1438 (tapetal cell mitosis)
ssp. *diversicolor*	n=c.45-60	Barker 1685
ssp. *glacialis*	n=c.45-60	Barker 1685

.... cont.

TABLE 3 (continued):

Sect. <u>Scabrae</u>		
<u>*E. caudata*</u>	n=27,28, 27II+2I, 25II+2III	Barker 1649
Sect. <u>Lasiantherae</u>		
<u>*E. alsa*</u>	n=27	Barker 1696
<u>*E. lasianthera*</u>	n=c.45-60	Barker 1536
Sect. <u>Trifidae</u>		
<u>*E. antarctica*</u>	n=44	(D.M. Moore fide Yeo 1968)

at meiosis (see below). Sketches of the meiotic configuration of these species at diakinesis (E. caudata) and anaphase I (E. caudata and E. alsa) are shown in pl. 13-14.

estimates of chromosome number are sufficient to show that the Australian species studied appear to differ in chromosome number from the rest of the genus and, unlike previous records, their number is not a multiple of 11. Only E. antarctica of Sect. Trifidae has a higher number and this is apparently an octoploid based on n=11. The counts of the Australian species clearly show two levels of ploidy, with E. collina ssp. paludosa apparently showing both. There is also some suggestion of an aneuploid series ranging between n=27 and approximately n=33, but this apparent variation between taxa may in fact reflect a capacity for the chromosome complement to vary in different individuals of a population. This is suggested by the variable estimates of chromosome number from apparently good spreads of chromosomes in E. crassiuscula ssp. eglandulosa. The variation in this species may be a product of its possible hybrid origin (see Chapter 4).

There is some evidence that there are abnormalities in the chromosome complement of E. caudata, at least in the population Barker 1649. Within the one flower some meiotic figures apparently showed 28 bivalents and others 27 bivalents with two univalents and possibly 25 bivalents and two trivalents. These are illustrated in pl. 13 and 14. Similar abnormalities might explain the variation in E. crassiuscula ssp. eglandulosa.

It is felt that the interpretation of these preparations would be facilitated by comprehensive study of the karyotypes in the genus.

IV. FLORAL BIOLOGY

The flowers of *Euphrasia* are clearly adapted to cross-pollination by insects. With few exceptions the process of flower development important to pollination is identical to that reviewed by Yeo (1966) for Sect. *Euphrasia*. The stigma in the newly opened flower is placed forward and often below the stamens or well above them, depending on the type of flower (see below). The corolla continues to elongate while the style remains the same length, causing the stigma to come into contact with the anthers, and self-pollination to occur if there has been no successful cross-pollination. Even in relatively tiny flowers such as those of *E. dyeri* this occurs. However, as has been found in the small-flowered European annuals (Yeo 1966), other species such as *E. cockayniana* and *E. australis* may be mainly self-pollinated. The relative frequency of fertilization caused by cross- and self-fertilization is not known. However, in the Australian species if cross-pollination fails to fertilize all ovules the "insurance" that self-pollination will occur instead is not complete. Usually several to many ovules fail to be fertilized. This may be related to the fact that the flowers are apparently protogynous and the stigma may lose its receptivity by the time it comes into contact with the anthers. In the European species Yeo (1966) has described how the larger-flowered species are essentially adapted to out-crossing, while the smaller-flowered species are strongly adapted to self-pollination as the dehiscing anthers and stigma have come into contact with each other by the time the flower opens. In the small-flowered annual, *E. antarctica*, of Sect. *Trifidae*, "when the flower opens, the anthers stand exactly above the stigma, which is fully developed before the flower is opened. It is inevitable that pollen falls upon the stigma" (Skottsberg 1913: p. 51). As was observed by Skottsberg (l.c.) the style is extended well past the anthers in the newly opened flowers of the other species of Sect. Trifidae for which material was seen. The stigma is finally situated below the anthers apparently by the elongation of the corolla as described above.

The flowers of Euphrasia can be divided into two general types. One is distinctly bilabiate, with a large lower lip, with anthers which are fused together and rigidly held to the upper side of the mouth under the hood and with the stigma initially placed well in front of, and often below, the level of the anthers. The other is bilabiate, sometimes erect, but tending to be falsely actinomorphic by the upper and lower lobes being sharply reflexed and more or less equal, with a short lower lip and large upper lip, and often a long tube. The stamens are free and appear to take up more room in the mouth and tube than in the other type. The stigma is initially directed well above or in front of the anthers.

The first type of flower is characteristic of most of the genus including all species except the South American species and E. disperma of New Zealand. It is clearly adapted to pollination by bees, as described by Faegri and van der Pijl (1971), although other insects may perform this function less frequently. In this flower type the structure of the anthers, which have rigid awns protruding into the corolla mouth and anther slits opening downwards, ensures that an insect entering a tube to gather nectar knocks pollen onto its upper parts. The awns of the posterior pair of anthers are clearly most functional in this process as they are longer than the other awns and nearer the tube. It is not known whether the difference in length of these awns between taxa of this corolla type has any significance in pollination. It does not seem to be always related to variation in size of the corolla mouth (see Androecium). However, the remarkably long and oddly shaped posterior awns of E. phragmostoma may suggest some unusual pollinator.

The Australian species of Euphrasia have this type of flower and all those seen in the field were found to be pollinated mainly by native bees. One or two native bees were collected whenever they were seen visiting flowers of Euphrasia. In all sites the bees visited flower after flower in a population. They entered the tube, apparently to feed on nectar and crawled over the anthers to gather pollen. Their attraction for the flowers of Euphrasia was well-illustrated when a plastic bag containing three copiously flowering plants of E. collina ssp. osbornii (Whibley 4155) was found to contain about twenty native bees hidden within the flowers. Bees have also been seen visiting flowers of Euphrasia in the northern hemisphere, but according to Yeo's (1966) observations their interest was mainly confined to gathering nectar rather than pollen.

Dr. T. Houston of the South Australian Museum has kindly identified these visitors (see Table 4). It seems remarkable that out of the large variety of native bees (probably about 3000 species) which occur in Australia (Michener 1970), only three genera, each from a different family, were found in the eleven collections made, totalling 28 bees (excluding the unidentified bees from Whibley 4155). Lasioglossum predominated in these collections. Leioproctus and Lasioglossum appear to show no preferences for any one flower colour and coloration in Euphrasia. Thus Lasioglossum was found in striated and non-striated flowers, and flowers with or without yellow blotches. In the South

TABLE 4: An enumeration of the native bees collected from populations of *Euphrasia* in Australia, with corolla coloration of the flowers visited. (Insect determination by courtesy of Dr. Terry Houston.)

Euphrasia population	Corolla coloration: [Presence (+) or absence (-)] Striations	Yellow blotch	*Euphrasia* collection (Barker)	Native bee Genus, subgenus, species and sex
E. collina ssp. *osbornii*	-	-	858 861 863 869 1346	*Lasioglossum* (*Chilalictus*) *lanarium* ♂♂
E. collina ssp. *deflexifolia*	-	-	942	*Lasioglossum* (*Austrevylaeus*) sp. ♀♀ *Lasioglossum* (*Lasioglossum*) sp. ♀♀
E. striata	+	+	994	*Lasioglossum* (*Austrevylaeus*) sp. ♀♀ (same as 942)
[*E. collina* ssp. *diemenica* also in same locality]	-	+	-	
E. lasianthera	+	+	1498	*Lasioglossum* (*Chilalictus*) sp. ♀ *Lasioglossum* (*Parasphecodes*) sp. ♀ *Exoneura* (*Exoneura*) sp. ♀♀
E. lasianthera	+	+	1535	*Leioproctus* (*Leioproctus*) sp. ♀♀ *Lasioglossum* (*Parasphecodes*) sp. ♀♀ (same as 1498)
E. collina ssp. *diversicolor*	-	+	1665	*Leioproctus* (*Leioproctus*) sp. ♀ (same as 1535)

Families and subfamilies of the native bees -

Leioproctus = Colletidae: Paracolletini; *Lasioglossum* = Halictidae: Halictinae; *Exoneura* = Xylocopidae: Ceratininae

Australian gatherings from E. collina ssp. osbornii in widely-spaced areas, one in the Mt. Lofty Ranges and the other from Yorke Peninsula, only one species was collected. However, although in this case there may be some oligo-relationship between the bee and the particular taxon (the sample is too low to determine this), elsewhere several species of Lasioglossum may visit the one species of Euphrasia.

Unfortunately at no time were native bees found visiting the flowers of the two annual species, E. alsa and E. caudata (one striated and the other non-striated). Both diverge from the perennials which have been observed with pollinators in floral characters, which might signify different pollinators. E. alsa has the smallest flowers of the Australian species, but may nevertheless be cross-pollinated by insects as the stigma initially projects out in front of the anthers, while E. caudata differs in its closed and elongated corolla mouth (pl. 3) and narrow nectar guide.

Corollas of this first type are usually purple-striated and have yellow nectar guides. Yeo (1968) considers that in Euphrasia these are guides to the presence of pollen as they are placed on the lower lip below the anthers. However, it is probable that the yellow colour in the tube has no relation to pollen and serves as a guide to the nectary. The yellow blotches and purple striations are lacking from some species of Euphrasia in Australia. This may be related to the fact that Australian native bees can recognize suitable flowers without such nectar guides (Dr. T. Houston, pers. comm. 2.iv.1973). The myrtaceous plants, which provide the major source of nectar and pollen for these bees (Michener 1970), lack such stripes and yellow areas. Thus, the significance of the prominent pair of yellow blotches in the centre of the flowers of E. lasianthera is obscure.

Whereas the native bees seem to be the most prevalent visitor to the flowers of Euphrasia, several other flying insects were seen visiting them. Among these were several species of butterflies. Graphium macleayanus was recognized visiting E. crassiuscula ssp. crassiuscula. It alternated between the flowers of Euphrasia and those of other plants. The variant of E. collina related to ssp. diversicolor on the Cobberas was also visited by a butterfly. A "hover-fly" (Syrphidae) was seen visiting flowers of E. collina ssp. collina (Barker 982). Butterflies and hover-flies have also been observed visiting the flowers of the same type in the northern hemisphere (Yeo 1966).

It is uncertain whether the obvious differences between the second floral type and the one described above reflect a general change in pollinator. The type is found only in Sect. Trifidae and E. disperma of Sect. Anagospermae. It seems possible that the flowers are adapted to pollination by butterflies or moths. This certainly seems so for the extremely long and narrow tubed flowers of E. disperma. In some of the species of Sect. Trifidae the mouth of the flower opens downwards because of the longer upper lip and very short lower lip. These seem indicative of a type of flower pollinated by moths as described by Faegri and van Pijl (1971). Only field studies can show to what extent the different floral morphology in Sect. Trifidae and Sect. Anagospermae has been paralleled by change in the nature of the pollinator, and whether such characters as the glabrous anthers have any significance in the pollination process. The lack of hairs along the slits may enable the pollen to be dispersed in larger masses. It seems unlikely that the anther awns would have much significance in these flowers, although they remain long in some species. On two of the anthers it has been found that one of the awns is always longer than the other. These are clearly a vestige of the posterior pair of awns in the bilabiate bee-pollinated flower from which this flower type has almost certainly evolved.

CHAPTER 4

THE ORIGIN AND DIVERSIFICATION OF *EUPHRASIA*

A. PAST HYPOTHESIS

The means by which *Euphrasia* attained its distribution in the temperate regions of both hemispheres with its greatest diversity in the southern hemisphere and a series of "connecting species" on the isolated mountain peaks of Malesia has been the subject of much speculation.

This short review deals only with works in which the site of origin and evolution in all or part of *Euphrasia* were specifically discussed. A consideration of the large number of biogeographical hypotheses concerning the means by which distributions of the kind found in *Euphrasia* have originated has been well-summarized by several authors with the necessary expertise (van Steenis 1934,1935,1936,1962, 1964,1971; Burbidge 1960; Darlington 1965; Schuster 1972; Raven & Axelrod 1972: and many others).

The biogeographical problems posed by the distribution of *Euphrasia* were referred to by J.D. Hooker (1859b) in the Introductory Essay to his "Florae Tasmaniae". In commenting on the remarkably many European features of the Australian flora (p.xciv), of which *Euphrasia* was listed as one of the many genera occurring in both parts of the world, Hooker, who believed that Darwin's newly proposed theory of natural selection would eventually account for this anomaly, was led to state:

> "In one respect this is by far the most difficult subject to treat of to the satisfaction of many persons interested in the study of the distribution of plants; for situated as Australia

is, at the antipodes of Europe, the presence in it of many forms common to both, whether generic or specific, affords so strong an argument in favour of there being many centres of creation for each vegetable form, that I cannot expect the believers in that doctrine to follow me far".

Hooker (p.xviii) proposed that partially submerged former mountain chains could have provided a means of dispersal between Japan and Australia. Supporting this he cites the existence of Euphrasia on "the lofty mountain Kini Balou in Borneo"; this material probably came from Sir Hugh Low's 1851 expedition (see Stapf 1894: p.69) to the mountain.

Stapf (1894) in his work "On the Flora of Mount Kinabalu" commented that his newly described species E. borneensis was "nearly allied to E. collina R.Br. The New Zealand species are also allied". Occupying an intermediate locality was E. brownii (= E. papuana Schlecht.) on the Owen Stanley Range in New Guinea. The boreal members of the genus were only distantly related. Although not mentioning Euphrasia specifically, Stapf considered that it was impossible to account for a large proportion of the boreal and austral elements by means of long distance dispersal via various natural or biological vectors. He believed that there must have been a time when the highland vegetation of Mt. Kinabalu was connected directly with similar vegetation in New Guinea and Australia and continental East Asia. This may have been facilitated by a fall in sea-level of about 500m which would make the necessary land connections, and an extreme glaciation which would depress the line of vegetation.

In his discussion of the evolution of Euphrasia, Wettstein (1896) proposed that the genus had a common origin with its close relatives in the Tribe Rhinantheae, namely Bartsia, Bellardia, Odontites, Orthantha (now regarded as a synonym of Odontites: Webb

& Camarasa 1972), Parentucellia and Omphalothrix. He considered that the perennial species of Euphrasia Sect. Trifidae and Bartsia of South America were certainly closely related but their divergence occurred long ago, while the species of Euphrasia in the northern hemisphere had a common origin with Bellardia, Odontites, Orthantha, Parentucellia and Omphalothrix. On account of the overall morphological similarities between these genera he concluded that all the genera had come from a common basic type ("Grundtypus") similar in morphology to the present-day genus Bartsia. He postulated that the present-day palearctic genera had a common origin from a large widely-scattered polymorphic ancestor ("Formenkreiss") with its various groups being morphologically and geographically isolated by environmental events. Wettstein believed that Siphonidium and Anagosperma of New Zealand, which he treated as genera distinct from Euphrasia, were derived from their definite relatives, E. repens and E. zelandica, which also occur in New Zealand.

Concerning the course of evolution in Euphrasia he wrote (p.49, 50: translated from the German):

> "It follows from what has been said before that the present genus Euphrasia comprised two evolutionary lines which are derived in different directions from the same Basic Type. These two lines are also morphologically clearly distinct from each other, one of them being the South American section "Trifidae", the other the Australian and northern circumpolar extratropical section "Eueuphrasia". The theoretically constructable centre of origin, which is very probable, for both lines is situated on a presumed land mass, which formerly was extended over a part of the present South Pacific Ocean ["Suedsee"]; the radiation from this centre appears on the one side the area of distribution of the South American Andes,

on the other side that of New Zealand and the Australian continent, and on another side that of East Asia which undoubtedly became the origin for the species of the northern hemisphere. Since the separation of these areas of distribution the species of the Andes evolved quite separately, which is expressed in their very distinct morphological characteristics and is further demonstrated in the fact that they show no close relationship to any single species of the other regions. Even the so often postulated concordance between E. antarctica of the Andes and a New Zealand or Australian species has proved non-existent. Certain analogies between the South American and Australian species, such as the division into annual and perennial species, the occurrence of trifid leaves in E. repens of New Zealand, the similarity in the calyx and fruit structure between E. zelandica and E. antarctica, I would prefer to regard as adaptation to analogous environmental conditions than as indications of a common origin."

Skottsberg (1921) proposed that by its type of perennation and habit E. formosissima of the Juan Fernandez Islands (see Chapter 3) may represent the most primitive type of Euphrasia known. Wettstein (1921) in the same work believed that the species was morphologically intermediate between E. cuneata of New Zealand and E. insignis and its related species in Japan. He found it remarkable that the Juan Fernandez species, so near to the South American continent, was not morphologically related to the species of that continent.

Du Rietz (1932b) in his discussion of the taxonomic and phytogeographic relationships of the Philippine and Bornean species of Euphrasia stated that:

"the tropical species of Euphrasia occurring on the high mountains of new Guinea, Borneo, Luzon, and Formosa [discovered since Wettstein's time] thus obviously form a natural connection and gradual transition between the austral and boreal parts of the genus ....[p. 530]. Some characters found in this tropical population are not yet known in any austral or boreal species of Euphrasia ...... p.[531] The occurrence of such endemic characters ...., together with the gradual transition between the boreal and austral populations formed by this tropical population, strongly supports the assumption that this population is not only [?] the result of accidental colonization of isolated tropical mountains by species from the main distribution areas of the genus in the north and south, and the subsequent transformation of these species into the present tropical species, but that these tropical species are really remains of the old bridge once forming a more continuous connection between the boreal and the austral populations .... The Euphrasia-population of Australia and New Zealand is clearly intermediate between the boreal population and South American one, containing a most remarkable mixture of boreal and South American characters together with many endemic ones. This fact, together with the entire lack of such relations between the Euphrasia-populations of North and South America, clearly proves that the only connection between the South American Euphrasia-population and the boreal one must have gone along the Trans-Antarctic bridge to Tasmania and New Zealand and from there along the Papuan-Malayan bridge to Japan and the Asiatic continent".

Du Rietz (l.c.) felt that the boreal relationship of E. formosissima was overrated by Skottsberg and Wettstein; he showed that the species is "nearest related to the New Zealand Euphrasia-population, though some characters could possibly indicate a direct relationship also with the population of Borneo and New Guinea". He later (Du Rietz 1948b) stated that the Juan Fernandez species was best placed between the species of Australia and New Zealand (Sect. Australes) and those of the South American continent (Sect. Trifidae).

At no stage does Du Rietz postulate which part of the genus contains the more primitive characters. His references to the transition between the northern Australian and South American populations were given no direction. He did say, however (Du Rietz 1948a), that the "austral populations of Euphrasia are the last remnants of a much larger Tertiary population once inhabiting the Antarctic continent and stretching itself along now disappeared land bridges to the homes of the present austral populations of the genus".

Van Steenis (1962: p.259) proposed a hypothesis of evolution similar to that of Wettstein's. (His belief that Wettstein and all who followed him proposed a northern origin for Euphrasia is incorrect.) He stated:

> "The genus finds its largest morphological diversity in New Zealand and New Guinea, with semi-frutices, etc., to which the very uniform habit of the northern hemisphere species stands in marked contrast. The fact that from the northern hemisphere a host of species have been described does mean little; many of them are, undoubtedly, microspecies due to racial segregation. It is far more important in my opinion that from New Zealand two other allied genera have been described, viz. Siphonidium and Anagospermae which, rightly merged with Euphrasia by Du Rietz, provide evidence that morphological potentialities in the southern hemisphere exceed those in the Holarctis; besides there is a large development in the alpine zone of Malaysia with subligneous forms, a habit unknown in the northern hemisphere. For this reason I am tempted to believe that Euphrasia is orig-

inally a South West Pacific genus, which has spread from there to the northern hemisphere and has been successful because of its capacity to create hardy, microtherm species".

Dawson (1963) in his paper on the "Origins of the New Zealand alpine flora" placed Euphrasia among the large number of New Zealand genera with a suggested origin in the northern hemisphere.

In his paper on "Speciation of Euphrasia in Europe" Yeo (1968) believes, on the basis of chromosome configurations of hybrid forms, that the present European members of the genus must have evolved from three well-differentiated diploid species or groups. "Because of the numerous interfertile species, many of them endemic to comparatively small areas, the genus Euphrasia gives the impression of having undergone rapid and recent evolution in Europe, which may well be still continuing". Yeo supported the premise that Australian species of Euphrasia, especially the large-flowered perennials, are the more primitive members of the genus by noting that the flower types most resembling the basic type in Euphrasia (see Chapter 3) are also found in Australia, in Ourisia (also of Scrophulariaceae) and especially Prostanthera (Labiatae).

Van Royen (1971) stated without amplification that the species of Euphrasia from New Guinea, Ceram, the Celebes and Borneo formed "part of the group of Euphrasia species that had its origins clearly in the southern hemisphere".

In his paper dealing with the biogeography of Nothofagus of the southern hemisphere and tropics and Fagus, the other genus in Fagaceae Subfam. Fagoideae, of the northern hemisphere, van Steenis (1971) compared the Fagoideae with Euphrasia and other generic groups which have similar bi-hemispheric areas of distribution. Both the Fagoideae and Euphrasia have their centre of diversity in the southern hemisphere. Among many conclusions van Steenis (p. 94) makes the following points:

"The occurrence of ranges which are equiformal (homologous) to that of Fagoideae and which show a similar bi-hemispheric affinity either on family level... or on generic level... is assumed to point to an ancient synchronous development of many unrelated groups in the plant kingdom, involving both ligneous and herbaceous plant groups.

For the cradle of these lineages the Sino-Malesian subtropics and montane tropics represent a crucial region.

Among these lineages Euphrasia is exemplary in exhibiting a remarkably unimpaired, ecological similar distribution and speciation pattern to such an extent that it must be concluded that this distribution is as ancient as that of Fagoideae, Magnoliaceae/Winteraceae, and many other groups mentioned...

Although Euphrasia and many other lineages are morphologically far more "advanced" in the taxonomic system as compared with Fagaceae or Magnoliaceae/Winteraceae, they must be of great antiquity and date back to the Cretaceous..

We must obviously abandon the current view that morphologically advanced groups are necessarily of young age."

According to Moore (1972) the perennial species of Euphrasia in the northern hemisphere need not have evolved from the austral perennial species as might be interpreted from Yeo (1968) and van Steenis (1962). He continued:

"It is also likely that the perennial Euphrasia diverged in the north and south from the common ancestors and that they were largely eliminated in North Temperate regions by the late Tertiary or Quaternary climatic changes which permitted the derived annual species to spread and hybridize there. This would accord the possibility that the Southern Hemisphere can serve as a reservoir of old types."

In their paper on "Plate tectonics and Australasian paleobiogeography" Raven & Axelrod (1972), apparently unable to find a suitable sequence of land connections with alpine and sub-alpine environments to explain the bipolar distributions of high mountain plants with an apparently northern origin, have used long-distance dispersal to explain such distributions. They stated:

> "Other groups migrated into the Southern Hemisphere by long-distance dispersal across mountains uplifted in Malaysia and New Guinea in the late Pliocene and Pleistocene; these presumably include *Veronica*, *Euphrasia*, *Poa*, *Carex*, the apioid *Umbelliferae*, and others that account for many bipolar distributions. The rich secondary radiation of species of some of these taxa in the newly formed subalpine and alpine habitats of New Zealand has at times led to the unwarranted assumption that they must possess great antiquity in Australasia, although it agrees in rate with other examples of adaptive radiation on islands. We suggest that all groups reached New Zealand by the prevailing westerlies in the Pliocene or more recently."

In his discussion of the systematic position and classification of *Euphrasia*, Hartl (1972) believed that *Bartsia*, *Odontites* and *Euphrasia* (regarded by him as doubtfully distinguishable at the generic level) form a close-knit central group of the Tribe *Pediculariinae* (referred to as *Rhinantheae* in this work) with *Bellardia* and *Parentucellia* somewhat distantly related to the group. *Odontites* seemed to certainly be the link in the three genera, although *Bartsia* and *Euphrasia* tend to each other independently of *Odontites*. If only the northern representatives of the group were considered, Hartl suggested that *Euphrasia* would be at the end of the evolutionary line ("obere Ende der Reihe"). However, he refrained from coming to this conclusion until the relationships with the southern representatives of Bartsia and Euphrasia had been investigated. In spite of this he suggested that the primitive stock of the genus may be Sect. Australes which comprises a variety of robust forms. From this there is on the one hand a link via Sect. Paradoxae with Sect. Trifidae and on the other a connection with Sect. Atlanticae and Sect. Euphrasia In comparison with this, the "monotonous" ("ein tonige") Sect. Euphrasia seemed to him to be a terminal link.

In a paper on the "Evolution of subalpine and alpine plant groups in New Zealand, Raven (1973) repeated his earlier assertion that Euphrasia reached Australasia via the mountains of Malaysia in the upper Pliocene or later, and subsequently reached South America by long-distance dispersal. He considered the seeds of Euphrasia might be carried in mud caked on the feet of birds. On mainly geological evidence he stated that it was unlikely that alpine and subalpine conditions existed in Australasia, southern South America and even Antarctica until the late Pliocene-Pleistocene period when a number of glacial cycles occurred. It was during this period that the present mountains of New Guinea and elsewhere in Malesia, Australia and Tasmania, and New Zealand were uplifted. On the basis of evidence from the fossil pollen record produced by Muller (1970) he stated:

> "In evaluating the probable time of arrival of some other groups of plants into Australasia, it is important to remember that the major evolutionary radiation of sympetalous angiosperms is a Tertiary phenomenon (Muller 1970). The genera of herbaceous plants of this group with specialised pollination systems must in most cases have evolved only in Neogene times. Orders such as Scrophulariales and Lamiales were radiating in Paleogene time, as were the groups of insects that pollinate them. There-

fore, it is improbable that any genus of Tubiflorae with a specialised pollination system was in existence when direct migration across Antarctica was possible. In other words, we must seek alternative explanations for the transantarctic distributions of such plants when they occur."

B. SPECULATION ON THE ORIGIN AND DIVERSIFICATION OF EUPHRASIA

1. Means of dispersal

Although there has been a recent statement to the contrary (Raven and Axelrod 1972; Raven 1973), there is no evidence that *Euphrasia* can be dispersed over long distances. The genus is characterized by small seeds with a characteristic many sulcate-scalariform surface. They have no adaptations, such as appendages or a sticky surface, which would facilitate dispersal by animals. It is also unlikely that they are light enough to be dispersed by wind. Ridley (1930) has cited examples from Sect. *Euphrasia* of dispersal by the excreta of horses, cattle and reindeer; but there seems to be no evidence that this has caused wide dispersal. The nature of the present-day ranges of distribution, which are characteristic of taxa at all levels throughout the genus, points to an inability of these taxa to disperse across even the smallest disjunctions between regions with apparently suitable ecological conditions. Examples of this are seen in the distribution patterns of the Australian taxa, especially the three species of Sect. *Lasiantherae* (fig. 14). There seems to be no example of a species which is distributed across wide water barriers although sections and subsections do cross such barriers (e.g. Sect. *Striatae*, Sect. *Malesianae*, Sect. *Euphrasia*, Sect. *Trifidae*). Species may occur on either side of narrower barriers of water or apparently uninhabitable land. Such disjunctions in distribution are seen in *E. gibbsiae* and the subspecies of *E. collina* in Australia and in several New Zealand species occupying both the North and South Islands. These can be readily explained by the spread of their respective habitat types between the disjunct regions during glaciations with their cooler conditions and drop in sea level. It seems clear not only from field observation of sympatric taxa but also from the high endemism in *Euphrasia* that endemics can either tolerate little change in their habitat, such that any seed which might be long-distance dispersed fails to become established, or that long-distance dispersal does not occur at all. Whichever is the case it seems certain that the present-day distribution of *Euphrasia* is a result of dispersal over short distances into suitable habitats. As such it can be a very useful indicator of links between now disjunct land-masses.

2. Speculation of the origin of Euphrasia

The centre of origin of *Euphrasia* seems clearly to be among its very close relatives, *Bartsia* and *Odontites*, in the northern hemisphere. It is surprising that with all the various hypotheses of the origin and diversification of *Euphrasia*, only Wettstein (1896), (presumably) Dawson (1963) and Hartl (1972) have investigated and at least attempted to use the number of genera which are closely related to *Euphrasia* in relation to their postulates on the origins of the genus. Both Wettstein (l.c.) and Hartl (l.c.) considered *Bartsia* and *Odontites* to be very closely related to *Euphrasia*. Wettstein also included *Parentucellia*, *Bellardia* and *Omphalothrix* among this group of closely related genera, but Hartl regarded them to be more distant morphologically from *Euphrasia* than *Bartsia* and *Odontites* on the basis of their divergent seed characters. Only in the northern hemisphere does *Euphrasia* occur in the same region as closely related genera.

Postulates that the Australian, New Zealand and Malesian species represent the primitive stock of *Euphrasia* are not convincing.

Within the limits of _Euphrasia_ there is certainly a greater diversity in the southern representatives. This has been considered by a number of workers, notably van Steenis (1962, 1971), to signify that the "cradle" of _Euphrasia_ lies in this region. However, the relatively greater diversity of these southern representatives is diminished when the northern representatives of _Euphrasia_ are expanded to include their sympatric very close relatives, _Bartsia_ and _Odontites_. This seems quite feasible, especially as Hartl (1972) has questioned the distinction of the three at the generic level. When adding to this the fact that the greatest diversity of the hemiparasitic Tribe _Rhinantheae_, to which these genera belong, occurs in the northern hemisphere, while Malesia and temperate Australasia completely lack representatives of the tribe but for _Euphrasia_, there seems to be no morphological or chorological reason for postulating that _Euphrasia_ originated in Australasia and Malesia.

The South American representatives of the genus (Sect. _Trifidae_) also appear to be of an advanced type, although this is less certain because of the apparent lack of a modern taxonomic comparison between the members of _Bartsia_ and _Euphrasia_ on that continent. _Bartsia_ has its centre of diversity in South America (Edwin 1971; Hartl 1972), where it is confined in the northern half of the continent (Hartl l.c.). In contrast, Sect. _Trifidae_ occupies the southern half of the continent. Whether there is some overlap in the areas of distributions of the two genera has not been ascertained. Nevertheless the general allopatry of the two genera in South America makes it unlikely on distributional grounds that South America is the area of origin of _Euphrasia_ from a _Bartsia_-like stock, when the two genera and _Odontites_ are sympatric throughout much of the northern hemisphere.

Morphologically _Bartsia_ and _Euphrasia_ seem more distinct in South America than they are in the northern hemisphere. From descriptions of _Bartsia_ (Edwin l.c.) and descriptions (Wettstein l.c.)

and material of Euphrasia, the two genera are clearly distinct in leaf shape. Bartsia apparently has the serrate, many-toothed leaves which characterize many genera of the Tribe Rhinantheae, including the majority of representatives of Euphrasia. In contrast the trifid leaves of the South American species of Euphrasia are apparently unique in the Tribe. Whether the anther and corolla characters also diverge from Bartsia must await an investigation of the two genera. At this stage, however, it seems likely that Bartsia and Euphrasia are relatively very distinct morphologically compared with the narrow distinction between the two genera in Europe, which has been stressed by Hartl. Wettstein (1896) also implied that the South American representatives of the two genera were very different by postulating that they separated from a common stock in the distant geological past.

Unless Euphrasia Sect. Atlanticae of the Azores shows as great or greater similarity to other genera in Tribe Rhinantheae than Sect. Euphrasia does, there seems no reason to postulate that this represents a relict of a primitive stock, elsewhere extinct, as postulated by Moore (1972). As Odontites (completely) and Bartsia, as well as many other genera in Tribe Rhinantheae, contain annual species, there seems no reason to doubt that the annual Sect. Euphrasia represents a primitive stock.

3. The diversification of Euphrasia from its postulated centre of origin

It will be seen that an evolutionary scheme can be formulated based purely on morphological grounds and on an origin of Euphrasia among Bartsia and Odontites, and other closely, but somewhat more distantly related, genera of the Tribe Rhinantheae in the northern hemisphere, with the species of Sect. Euphrasia considered to be the primitive stock. In this scheme there is no evidence of mass extinction or gaps between infrageneric taxa. On the contrary almost all links seem to exist today. The proposed scheme of evolution based on such an origin does throw up a number of immense biogeographical problems, the most obvious of which are discussed later.

A method for determining such an evolutionary scheme by a modification of the means of determining "Wagner Trees" has been described by Whiffin & Bierner (1972). This method requires only a postulation of the centre of origin and no determination of primitive and advanced stages for each character. As in all methods of determining evolutionary models, whether intuitive or mathematical, this approach still suffers from unavoidable subjectivity in the selection of characters. Mathematical methods such as this have the advantage, however, of removing much subjectivity by treating every character, as defined, as equal. The method of calculation of the evolutionary tree is also somewhat subjective in the method of treatment of secondary centres of diversification, i.e. other than that from the origin, which may cause problems because of possible cases of parallel or convergent evolution. Thus in one of their examples, Whiffen & Bierner have treated individually complex phyletic lines which correspond to sections. Such an approach has been used in speculating on evolution in the Australian sections of the genus.

The characters and their various states which have been found useful in separating the sections and any subordinate subsections are listed in Table 5. The total number of characters for which each pair of taxa has different states has been calculated from this table; these are shown in Table 6. There are several cases where certain characters are not known for all the infrageneric taxa. In such cases the character states which might possibly pertain to such taxa have been marked with "?", and the taxon is treated as having all such character states for the purposes of computing the "Wagner Tree". It is believed that the discovery of the true character states of

TABLE 5: The character states for each section and subsection of *Euphrasia*.
("+" indicates the possession of a character state, "−" its absence, and "?" its possible presence).

	I. Sect. *Euphrasia*	A. Subsect. *Ciliatae*	B. Subsect. *Angustifoliae*	C. Subsect. *Japonicae*	D. Subsect. *Alpicolae*	II. Sect. *Atlanticae*	III. Sect. *Coneatae*	IV. Sect. *Malesianae*	V. Sect. *Striatae*	A. Subsect. *Paucifiorae*	B. Subsect. *Humifusae*	C. Subsect. *Striatae*	VI. Sect. *Lasiantherae*	VII. Sect. *Scabrae*	VIII. Sect. *Australes*	IX. Sect. *Novaezeelandiae*	X. Sect. *Paradoxae*	XI. Sect. *Anagospermae*	XII. Sect. *Trifidae*
LIFE-SPAN																			
1. Annual		+	+	+	+	−	−	−		−	−	−	+	+	−	+	−	+	+
2. Perennial		−	−	−	−	+	+	+		+	+	+	+	−	+	−	+	−	+
MAIN FLORAL AXIS																			
Direction																			
1. ± entirely prostrate		−	−	−	−	−	−	−		−	+	−	−	−	−	−	−	+	−
2. Initially prostrate, distally erect, simple above ground level		−	−	−	−	+	−	−		+	−	+	+	−	+	−	−	−	+
3. Erect, branched well above ground level		+	+	+	+	+	+	+		+	−	+	+	+	+	+	+	+	+
Incidence of branching																			
1. Consecutive nodes		+	+	+	+	?	+	+		−	+	−	+	+	−	+	+	+	+
2. Sporadic nodes		−	−	−	−	?	−	+		+	+	+	+	−	+	−	−	+	+
Order of branch development																			
1. ± basipetal		+	+	+	+	?	+	−		−	−	−	+	+	−	−	−	−	−
2. No fixed order		−	−	−	−	?	−	+		+	+	+	+	−	+	+	−	+	+
3. ± acropetal		−	−	−	−	?	−	−		−	−	−	−	−	−	+	+	+	−
UPPERMOST LEAVES																			
Depth of toothing																			
1. Crenate		+	+	+	+	?	+	+		+	+	+	+	+	+	+	+	−	−
2. Serrate		+	+	+	?	?	−	+		+	+	+	+	+	+	+	−	+	−
3. (Pinatti)fid		+	+	?	?	?	−	−		−	−	−	+	+	+	−	−	+	+

..... continued

TABLE 5 (cont.):

	I. Sect. Euphrasia	A. Subsect. Ciliatae	B. Subsect. Angustifoliae	C. Subsect. Japonicae	D. Subsect. Alpicolae	II. Sect. Atlanticae	III. Sect. Cuneatae	IV. Sect. Malesianae	V. Sect. Striatae	A. Subsect. Pauciflorae	B. Subsect. Humifusae	C. Subsect. Striatae	VI. Sect. Lasiantherae	VII. Sect. Scabrae	VIII. Sect. Australes	IX. Sect. Novaezeelandiae	X. Sect. Paradoxae	XI. Sect. Anagospermae	XII. Sect. Trifidae
UPPERMOST LEAVES (cont.)																			
Number of pairs of teeth																			
1. (0)1(2)		-	-	-	-	-	-	-		+	+	+	-	+	+	-	-	+	+
2. (1)2-6(more)		+	+	+	+	+	+	+		+	-	+	+	+	+	+	+	+	-
3. c.6-many		-	-	-	-	+	-	-		-	-	-	-	-	-	-	-	-	-
Base																			
1. Attenuate, abruptly expanded into blade		+	-	+	?	+	-	+		+	+	-	-	-	-	+	+	-	-
2. Attenuate, gradually expanded into blade.		-	+	+	+	-	+	+		+	+	+	-	-	+	+	-	+	+
3. Narrow cuneate to truncate		-	-	-	-	-	-	-		-	-	-	+	+	+	-	-	+	+
Blade (defined Chapt.3)																			
1. Large cf. base and teeth		+	+	+	+	+	+	+		+	-	-	+	+	+	+	+	-	-
2. Small cf. base and teeth.		-	-	-	-	-	-	-		+	+	+	-	-	-	-	-	+	+
Distribution of teeth																			
1. Distal ½ or less		-	-	-	-	-	-	-		+	-	+	-	-	+	-	-	-	-
2. Distal ½ or more		+	+	+	+	+	+	+		+	+	(+)	+	+	+	+	+	+	+
No. of main veins produced from base																			
1. (1)3		+	+	+	+	+	+	+		+	+	-	-	-	+	+	+	+	+
2. 3(5)		-	-	-	-	-	-	-		-	-	+	+	+	+	-	-	-	-
3. 3-5 or more		-	-	-	-	-	-	-		-	-	+	+	+	+	-	-	-	-
FLOWERS																			
Occurrence																			
1. Sporadic along axes		-	-	-	-	-	-	+		-	+	-	-	-	-	-	-	+	-
2. Racemes usually with less than 10		+	+	?	?	?	-	+		+	-	-	-	-	+	+	-	+	-
3. Racemes usually with 10-20		+	+	+	?	?	+	+		-	-	+	+	+	+	+	+	-	+
4. Racemes usually with more than 20		+	+	+	?	?	+	-		-	-	+	+	-	+	-	-	-	+

TABLE 5 (cont.):

	I. Sect. Euphrasia	A. Subsect. Ciliatae	B. Subsect. Angustifoliae	C. Subsect. Japonicae	D. Subsect. Alpicolae	II. Sect. Atlanticae	III. Sect. Cuneatae	IV. Sect. Malesianae	V. Sect. Striatae	A. Subsect. Pauciflorae	B. Subsect. Humifusae	C. Subsect. Striatae	VI. Sect. Lasiantherae	VII. Sect. Scabrae	VIII. Sect. Australes	IX. Sect. Novaezeelandiae	X. Sect. Paradoxae	XI. Sect. Anagospermae	XII. Sect. Trifidae
COROLLA																			
Striations																			
1. Present, but absent along midline of hood		+	+	?	+	?	+	+		+	+	+	+	−	−	?	+	?	+
2. Present, at least along midline of hood		−	−	−	−	−	−	−		−	−	−	−	−	−	+	−	+	−
3. Absent		−	−	?	−	?	−	−		−	?	−	−	+	+	−	−	−	−
Blotch on Lower lip																			
1. Present		+	+	+	+	?	+	?		+	+	+	+	+	+	+	+	?	+
2. Absent		−	−	−	−	?	−	−		−	−	−	+	?	+	−	−	?	−
Lower side																			
1. Concave from above		+	+	+	+	?	+	+		+	+	+	+	−	+	+	+	+	+
2. Flat or grooved		−	−	−	−	−	−	−		−	−	−	+	+	+	−	−	−	−
Lobes (lower)																			
1. Emarginate		+	+	+	+	+	+	+		+	+	+	+	+	+	+	−	−	+
2. Acute or obtuse to truncate		−	−	−	−	−	+	−		+	−	+	+	+	+	+	+	+	?
ANTHERS																			
Fusion																			
1. Fused		+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	−
2. Free		−	−	−	−	−	−	−		−	−	−	−	−	−	−	−	+	+
Area about connectives																			
1. Glabrous		+	+	+	+	+	+	+		+	+	+	−	−	−	+	+	+	+
2. Hairy, at least on posterior anthers		−	−	−	−	−	−	−		−	−	−	+	+	+	−	−	−	−
Slits																			
1. Densely hairy		+	+	+	+	+	+	+		+	+	+	+	+	+	+	−	−	−
2. One or two hairs		−	−	−	−	−	−	−		−	−	−	−	−	−	+	+	+	−
3. Glabrous		−	−	−	−	−	−	−		−	−	−	−	−	−	−	−	+	+

.....continued

TABLE 5 (cont.):

	I. Sect. Euphrasia	A. Subsect. Ciliatae	B. Subsect. Angustifoliae	C. Subsect. Japonicae	D. Subsect. Alpicolae	II. Sect. Atlanticae	III. Sect. Cuneatae	IV. Sect. Malesianae	V. Sect. Striatae	A. Subsect. Pauciflora	B. Subsect. Humifusae	C. Subsect. Striatae	VI. Sect. Lasiantherae	VII. Sect. Scabrae	VIII. Sect. Australes	IX. Sect. Novaezeelandia	X. Sect. Paradoxae	XI. Sect. Anagospermae	XII. Sect. Trifidae
STIGMA																			
1. 0.1-0.3mm long		+	+	+	+	?	-	+		-	-	-	-	-	-	-	-	-	-
2. 0.3-0.5mm long or longer		-	-	-	-	-	+	-		+	+	+	+	+	+	+	+	+	+
CAPSULES																			
Lateral view (overall)																			
1. Oblong order		+	+	+	?	?	+	+		+	-	+	+	+	+	-	+	-	?
2. Broad ovate order		-	-	-	-	?	-	+		+	+	-	-	-	-	+	-	+	+
Lateral view of apex																			
1. Acute (acuminate) to obtuse		?	?	?	?	+	+	+		+	+	+	+	+	+	+	?	+	+
2. Shallowly emarginate to emarginate		+	+	+	+	-	+	+		+	+	+	+	+	+	+	+	+	?
3. Deeply cleft		-	-	-	-	+	-	-		-	-	-	-	-	-	-	-	+	-
CHROMOSOME NUMBER																			
1. n=11		+	-	?	?	?	?	?		+	?	-	-	-	-	?	?	?	?
2. n=22		+	+	?	?	?	?	?		?	?	-	-	-	-	?	?	?	?
3. n=44		-	-	?	?	?	?	?		?	?	-	-	-	-	?	?	?	+
4. n=27-33		-	-	?	?	?	?	?		?	?	+	+	+	+	?	?	?	?
5. n=45-60		-	-	?	?	?	?	?		?	?	+	+	+	+	?	?	?	?

TABLE 6: Table showing the total number of absolute character state differences between each pair of sections or subsection of *Euphrasia*.

	I. Sect. *Euphrasia*	A. Subsect. *Ciliatae*	B. Subsect. *Angustifoliae*	C. Subsect. *Japonicae*	D. Subsect. *Alpicolae*	II. Sect. *Atlanticae*	III. Sect. *Cuneatae*	IV. Sect. *Malesianae*	V. Sect. *Striatae*	A. Subsect. *Pauciflorae*	B. Subsect. *Humifusae*	C. Subsect. *Striatae*	VI. Sect. *Lasiantherae*	VII. Sect. *Scabrae*	VIII. Sect. *Australes*	IX. Sect. *Novaezeelandiae*	X. Sect. *Paradoxae*	XI. Sect. *Anagospermae*	XII. Sect. *Trifidae*
I. Sect. *Euphrasia*		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. Subsect. *Ciliatae*	–		1	0	0	1	3	2	–	4	8	8	5	7	8	3	5	7	7
B. Subsect. *Angustifoliae*	–	1		0	0	2	2	1	–	4	8	7	5	7	7	3	6	6	6
C. Subsect. *Japonicae*	–	0	0		0	1	2	2	–	4	8	6	4	5	5	3	5	6	6
D. Subsect. *Alpicolae*	–	0	0	0		1	2	2	–	4	8	6	4	6	6	3	5	6	6
II. Sect. *Atlanticae*	–	1	2	1	1		2	0	–	1	5	4	4	6	3	2	3	6	6
III. Sect. *Cuneatae*	–	3	2	2	2	2		2	–	3	6	4	3	6	4	3	3	7	6
IV. Sect. *Malesianae*	–	2	1	2	2	0	2		–	1	4	3	4	8	3	2	4	5	6
V. Sect. *Striatae*	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
A. Subsect *Pauciflorae*	–	4	4	4	4	1	3	1	–		2	2	4	9	2	2	4	2	4
B. Subsect. *Humifusae*	–	8	8	8	8	5	6	4	–	2		4	8	10	6	5	8	3	5
C. Subsect. *Striatae*	–	8	7	6	6	4	4	3	–	2	4		3	8	3	5	6	5	4
VI. Sect. *Lasiantherae*	–	5	5	4	4	4	3	4	–	4	8	3		1	1	4	5	6	6
VII. Sect. *Scabrae*	–	7	7	5	6	6	6	8	–	9	10	8	1		3	7	8	9	8
VIII. Sect. *Australes*	–	8	7	5	6	3	4	3	–	2	6	3	1	3		5	6	6	5
IX. Sect. *Novaezeelandiae*	–	3	3	3	3	2	3	2	–	2	5	5	4	7	5		2	1	5
X. Sect. *Paxadoxae*	–	5	6	5	5	3	3	4	–	4	8	6	5	8	6	2		6	7
XI. Sect. *Anagospermae*	–	7	6	6	6	6	7	5	–	2	3	5	6	9	6	1	6		1
XII. Sect. *Trifidae*	–	7	6	6	6	6	6	6	–	4	5	4	6	8	5	5	7	1	

these taxa will reinforce rather than alter the "evolutionary pathways" which have been determined.

Whenever there is some overlap in the character states in two taxa, they are treated as being identical. (Whiffin & Bierner suggest that these may be given intermediate values of $\frac{1}{2}$.) Thus the "Wagner Tree" produced emphasizes similarities in taxa and is based only upon absolute differences. It is felt that this should be done for at least the infrageneric taxa.

For reasons outlined in the previous section Sect. Euphrasia is taken to represent the primitive stock of Euphrasia. Subsect. Ciliatae, which is the most widespread and diverse subsection of Sect. Euphrasia, is used as the most primitive stock for the purposes of this scheme. It contains the only know diploid chromosome number (n=11) in the northern representatives of the genus: this seems especially significant when it is considered that Odontites has a chromosome number of n=10 or 20 in the European species (Yeo 1972) and Bartsia alpina has a chromosome number of n=12,24 or 36 (Yeo l.c.).

Following the method of Whiffen and Bierner (1972) the infrageneric taxa have been listed in order of number of characters for which they differ absolutely from Subsect. Ciliatae (Table 7) and a "Wagner Tree" has been drawn up (fig. 4).

The evolutionary scheme as determined indicates that the Malesian and southern members of the genus evolved in four or possibly five evolutionary lines from a common stock, which originated directly from Sect. Euphrasia of the northern hemisphere.

Sect. Malesianae of western Malesia and Taiwan represents the evolutionary line from the common stock most closely related to Sect. Euphrasia. It differs only in its perennial habit and retains the tiny stigma and consistently emarginate corolla lobes, which are found only in the members of the genus in the northern hemisphere.

Sect. Cuneatae of Australasia also represents the end point of

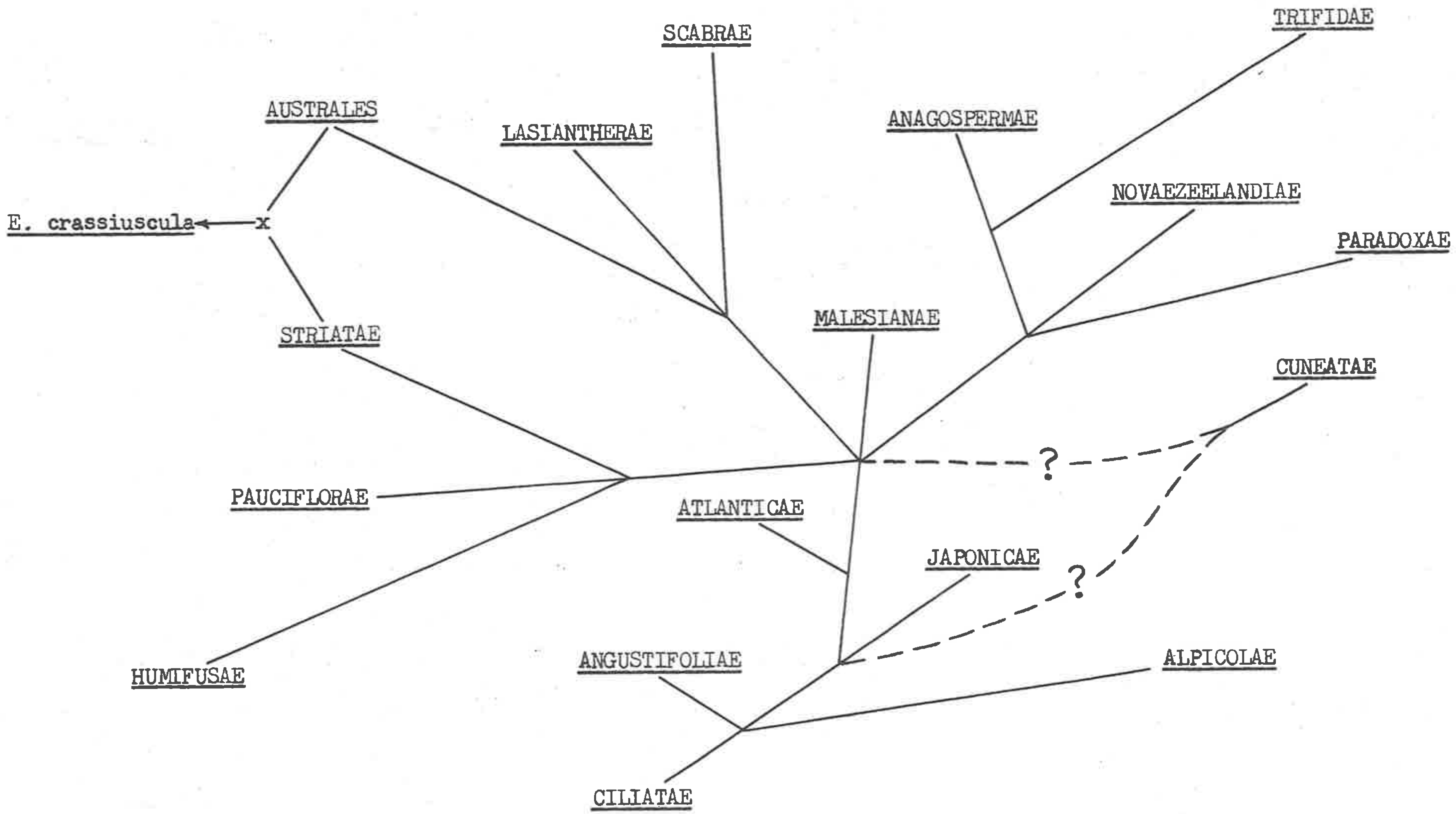

FIG. 4: Postulated evolution of the sections and subsections of Euphrasia

TABLE 7: The taxa listed in the order of magnitude of their differences from Sect. Euphrasia Subsect. Ciliatae

Sect. Euphrasia	
Subsect. Ciliatae	Datum taxon
Subsect. Japonicae	0
Subsect. Alpicolae	0
Subsect. Angustifoliae	1
Sect. Atlanticae	1
Sect. Malesianae	2
Sect. Cuneatae	2
Sect. Novaezeelandiae	3
Sect. Striatae Subsect. Pauciflorae	4
Sect. Lasiantherae	5
Sect. Paradoxae	5
Sect. Scabrae	7
Sect. Anagospermae	7
Sect. Trifidae	7
Sect. Striatae Subsect. Humifusae	8
Sect. Striatae Subsect. Striatae	8
Sect. Australes	8

an evolutionary line very close to Sect. Euphrasia. It may have originated either directly from that section or from the common ancestral stock from which the austral and tropical members of the genus evolved. It differs absolutely from Sect. Euphrasia only by its perennial habit and its large stigma, and also diverges by the absence of consistently emarginate corolla lobes. As the last two characters are found only among the New Guinea and south-temperate taxa, it seems more probable that it evolved from the common ancestral stock from which these taxa originated.

The line of evolution in which Sect. Novaezeelandiae has the most primitive characters is confined to New Zealand, South America and the Juan Fernandez Islands. There is a clear-cut line of evolution between the present-day species of Sect. Novaezeelandiae and Sect. Anagospermae characterized by a progressive reduction in ovule number, a gradual change from an erect to a prostrate habit, a reduction in the number and an increase in the length of the leaf teeth, an increase in the length or the corolla tube, and a reduction in the pilosity of the anthers, which at the end of the line of evolution, in E. disperma, are glabrous and free. The South American Sect. Trifidae has clearly evolved from the same ancestral stock as the present-day members of Sect. Anagospermae as both sections are unique in containing species with deeply incised, few-toothed leaves and glabrous free anthers. On the other hand Sect. Paradoxae of the Juan Fernandez Islands has evolved from the immediate ancestors of Sect. Novaezeelandiae. The latter is the only section other than Sect. Paradoxae in the genus in which the branches may develop acropetally on the stem.

The three subsections of Sect. Striatae represent an independent line of evolution from the ancestral stock from which the austral and Malesian members of the genus evolved. Subsect. Pauciflorae is the most primitive of three and is widely distributed in both New Guinea and New Zealand. The New Guinea representatives diverge by their remarkable leaves with a large hooded apex and often tiny lateral teeth. However, E. revoluta of New Zealand has similar leaves, while E. papuana of New Guinea, which is known only from the type collection, may have leaves resembling more the New Zealand representatives (or even the Australian members of the section). These two species form a link between the representatives of the two countries. The New Guinea representatives tend towards Sect. Malesianae in the size of the leaves and flowers and the robustness of the habit; those of New Zealand tend more towards the southern perennials, especially Sect. Cuneatae. On the basis of leaf shape and flower size and shape it is certain that Subsect. Striatae of Tasmania, with a single outlier in Victoria, evolved from ancestors of Subsect. Pauciflorae similar to those now represented in New Zealand, while Subsect. Humifusae of New Guinea and the Celebes originated from ancestors similar to the New Guinea species of Subsect. Pauciflorae.

The present-day representatives of one line of evolution from the common ancestral stock of the austral and tropical members of Euphrasia are confined entirely to Australia. They all have hairy anther backs, leaves with usually non-attenuated bases and chromosome numbers based on x=c.27-30; they comprise both annuals and perennials. Sect. Lasiantherae has retained the most primitive characters, notably striated corollas. Sect. Scabrae and Sect. Australes are unique in the genus by their nonstriated corollas, and the tendency for the lower side of the corolla to be porrect, and flat or sometimes broadly grooved. Evolution in these three sections is discussed further under the treatment of the evolution of Euphrasia in Australia.

E. crassiuscula is regarded as a hybrid between Sect. Australes and Sect. Striatae Subsect. Striatae. It is polymorphic in the presence and absence of corolla striations and the incidence of hairs on the anther backs, which are two major characters distinguishing the two sections.

Thus it can be seen that if the premise that Sect. Euphrasia (in particular Subsect. Ciliatae) is the primitive stock of Euphrasia is correct, then a clear scheme of evolution showing the origins of the present-day sections and subsections, based solely on morphology, can be erected with no large gaps and little convergent evolution. If the postulated scheme of evolution is similar to the evolutionary history of Euphrasia, one must propose that at some stage in the past there were connections between the present-day alpine to high montane floras of Eurasia, the Malesian and Taiwan region, New Guinea, New Zealand, south-east Australia and Tasmania, South America, and the Juan Fernandez Islands.

The lack of long distance dispersal, the origin among genera mainly confined to the northern hemisphere and the mainly alpine, subalpine and montane preferences of Euphrasia produce major biogeographical problems if one accepts the view of the geological and floristic evolution of the southern "Gondwanan" continents, as portrayed in Raven & Axelrod (1972) and Raven (1973). Such problems are also posed by at least some other genera of apparent northern origin in the southern hemisphere, e.g. the 36 listed by Dawson (1963) in the New Zealand alpine and subalpine flora. Ridley (1930: p.692) has remarked that such genera as Viola, Ranunculus, Anemone and Gentiana, which are cited in Dawson's list are unlikely to have been dispersed over long distances to their isolated outposts on the Malesian mountains.

Raven and Axelrod state that Australasia, Malesia and southern South America all gained their present high mountain tracts during the late Pliocene-Pleistocene period apparently with subalpine and alpine vegetation non-existent before this time. Yet their postulation of the means by which Euphrasia (and probably other groups of northern origin) attained their high diversity and widespread distribution by long distance dispersal seems inconceivable upon the apparent facts of the dispersal characteristics, ecological amplitude and distribution patterns of the genus in the southern hemisphere and tropics. By the time of the postulated arrival of Euphrasia in the southern hemisphere, the Gondwanan continents had, on present geological evidence, severed land connections long before and were separated by wide tracts of ocean. Euphrasia, it seems, cannot cross such tracts. There is not a single species of Euphrasia which has a range of distribution bridging such disjunctions. The taxa cannot even bridge gaps in apparently suitable conditions of more than 30-40km. If Raven and Axelrod's viewpoint of the means of migration of Euphrasia into the southern hemisphere is taken as correct, one must make the inconceivable postulation that the genus has somehow lost its means or vehicle of long-distance dispersal. Migration routes of effectively continuous (not necessarily all at once) tracts of probably cold montane to alpine habitats must be looked for to account for the migration of Euphrasia into the southern continents and Malesia from its site of origin among its closest relatives in the northern hemisphere. The answer to the biogeographical riddle of Euphrasia and other mainly alpine and subalpine genera of apparently northern origin may lie in the geological history of the central Pacific Ocean which is still being investigated. As yet there has apparently been no consideration of the biogeographical implications of the present investigations in the region.

4. The evolution of Euphrasia in Australia

The following schemes of evolution of the sections which occur in Australia are based on an appraisal of the morphology of the various species, subspecies and varieties. The most primitive present-day members of each of the three postulated independent lines of evolution in Australia have been determined in relation to the scheme of evolution of the sections and subsections of the genus proposed in the previous section. If the postulated centre of origin of the genus is found to be incorrect, the following schemes of evolution may have to be modified.

Evolutionary line 1: Sect. Cuneatae

Sect. Cuneatae represents a distinct line of evolution in Euphrasia, with uncertain origins (see previous section). However, the evolutionary relationships of the three existing species seems reasonably clear (fig. 5).

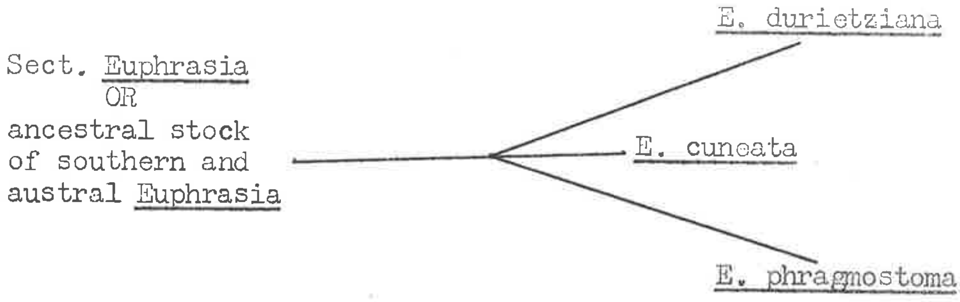

FIG. 5: Postulated evolution in Sect. *Cuneatae*

E. cuneata of New Zealand seems to be the most primitive member of the section, and is intermediate morphologically between the two Australian species. By its consistently emarginate corolla lobes and general flower shape it tends more to Sect. *Euphrasia* than to any of the large-flowered southern species. *E. durietziana* tends more to the southern representatives of the genus by its often obtuse corolla lobes and apparent flower shape. The flower shape of *E. phragmostoma* has not been determined but it is apparently the most advanced species of the section by its remarkable pair of posterior anther awns.

The section is remarkable for the wide disjunction of its three species. It is difficult to speculate on the meaning of these disjunctions without a better knowledge of the ecological range of each species. Further investigation may show that the two Australian species may require special conditions which have not been maintained in the past and present in intermediate localities. Yet the fact that the two Australian species are morphologically closer to *E. cuneata* of New Zealand than to each other, may be of biogeographical importance.

Evolutionary line 2: Sect. *Striatae* Subsect. *Striatae*

Sect. *Striatae* Subsect. *Striatae* constitutes a separate line of evolution of Euphrasia in Australia (see section 3). The proposed scheme of evolution (fig. 6) has been determined using Whiffen & Bierner's (1972) method of computing "Wagner Trees".

On the basis of the proposed scheme of evolution, the present-day members of Subsect. Striatae are apparently the remnants of two short lines of evolution, which have a common origin from the stock resembling Subsect. Pauciflorae in New Zealand. E. gibbsiae and E. striata are the species of the two lines of evolution which are closest to this stock.

The "E. gibbsiae line" is apparently at present undergoing active speciation. By their high degree of endemism, narrow ecological preferences, and apparently common presence of barriers to interbreeding (see E. gibbsiae: Intraspecific Variation), the many subspecies of E. gibbsiae clearly have the potential for further morphological divergence into species. The present distribution of the subspecies indicates that E. gibbsiae has been much more widely spread in the past. The initial divergence which has led to the present-day polymorphy of E. gibbsiae may have arisen entirely through the shrinkage (possibly occurring several times) of the wide area of distribution of the species which almost certainly existed during the glacial periods of the Pleistocene (Costin 1959; Raven 1963) when conditions were cooler than today. In particular the presence of a single outlier in the subalpine regions of the Baw Baw plateau in southern Victoria seems to require such a wide past distribution of the species. It probably represents (with E. crassiuscula ssp. eglandulosa: see below) the last remnant of Subsect. Striatae which had dispersed over the land-bridge postulated by Costin (1959) and Banks (1965) to have occurred between Tasmania and mainland Australia during the Pleistocene glaciations. This would require the existence of a continuous (not necessarily simultaneous) distribution of subalpine vegetation between the two regions. This has been considered feasible by

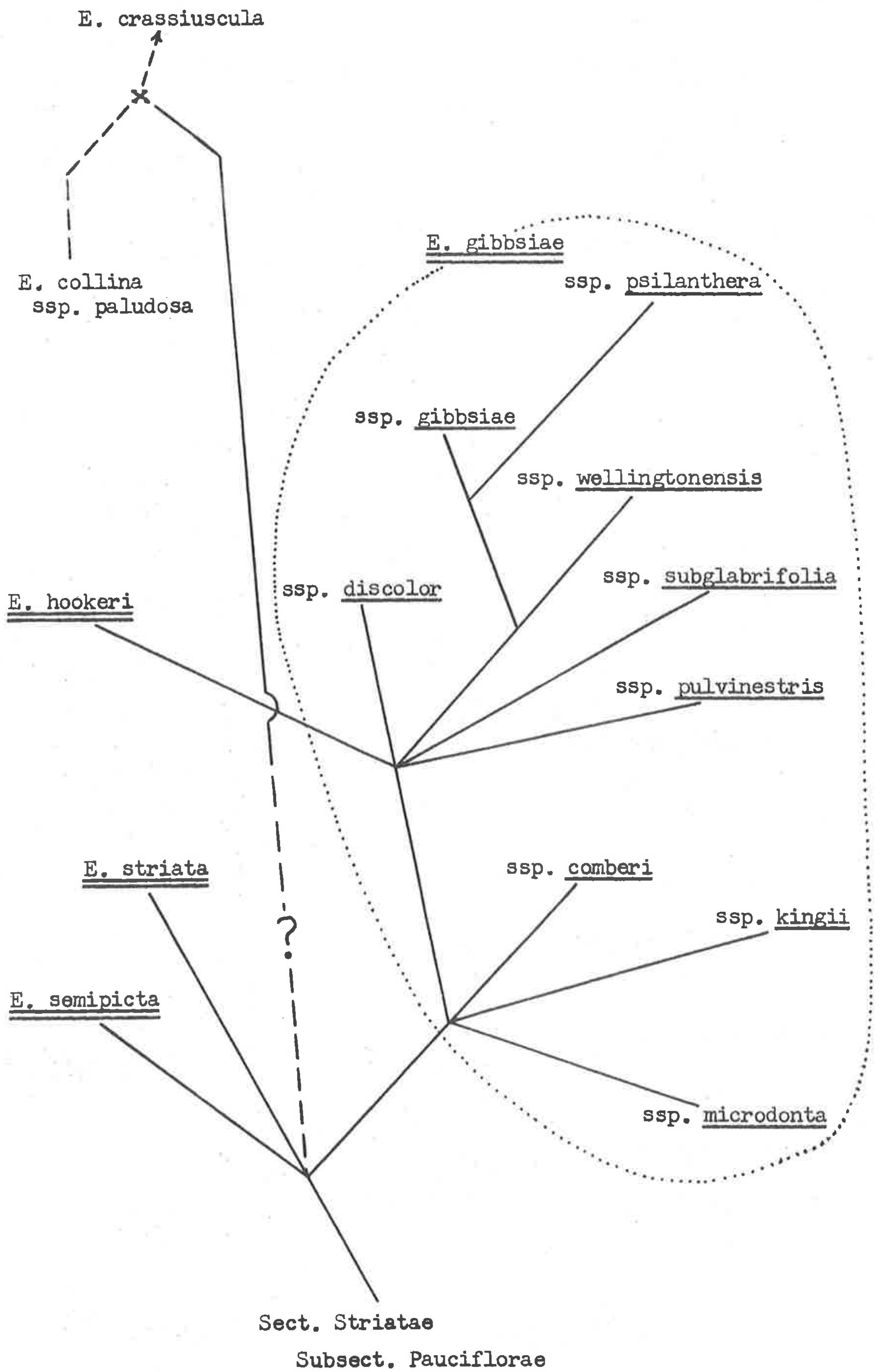

FIG. 6: Postulated evolution in Sect. Striatae Subsect. Striatae

Costin (l.c.).

E. hookeri has clearly evolved from E. gibbsiae. However, with the existence of a form apparently intermediate between ssp. comberi and E. hookeri, the proposal in the scheme of evolution that E. hookeri evolved from the immediate ancestors of ssp. discolor ssp. wellingtonensis, ssp. subglabrifolia and ssp. pulvinestris may be incorrect.

The "E. striata line" shows little evidence of the speciation which is apparently occurring at the present time in E. gibbsiae. Although E. striata occurs in the subalpine zone and above and E. semipicta occurs at sea level, the ecological conditions in which the two species grow are similar. Both occupy heath areas which are exposed to cold wet conditions during the summer. The wide disjunction between the two areas of distribution was probably bridged by similar vegetation types during the Pleistocene glaciations. It was probably under such conditions that E. semipicta evolved.

E. crassiuscula seems clearly to be hybrid between Sect. Australes and Sect. Striatae Subsect. Striatae. By its often shallowly cleft and rounded leaves it resembles the New Zealand members of Subsect. Pauciflorae, such as E. monroi. Because of its lack of affinities to any existing member of Subsect. Striatae, there are grounds for considering that a complete line of evolution in the subsection occupying the mountains of mainland Australia has become extinct.

E. crassiuscula occupies the Bogong-Hotham mountain system, which contains the highest mountain in Victoria and is over a 100km north of the only known occurrence of Subsect. Striatae on mainland Australia. In between there are wide areas of mountains which are apparently not high enough to support members of the subsection even though, the altitude of the alpine and subalpine vegetation decreases to the south. It seems possible that the parent species in Subsect. Striatae involved in the hybrid origin of E. crassiuscula resembled ssp. eglandulosa, but had consistently striated corollas and glabrous anther backs, which are diagnostic of the subsection, but break down in ssp. eglandulosa. Of the two subspecies of E. crassiuscula which vary in these characters, ssp. eglandulosa tends to have prominently striated corollas and glabrous anther backs. It occupies the high range of altitudinal distribution. Ssp. crassiuscula also varies in these characters, but tends to have the hairy anther backs and non-striated corollas which characterize Sect. Australes. It occurs at lower altitudes. (Ssp. glandulifera, the remaining subspecies of E. crassiuscula always resembles Sect. Australes in these characters and has clearly evolved from ssp. crassiuscula.) There is thus an altitudinal correlation in the characters separating the two sections in the subspecies of E. crassiuscula which vary in these characters. On the basis of these observations it seems feasible that a series of taxa representing a distinct line of evolution in Subsect. Striatae has become extinct in the south-eastern highlands of Australia through the loss of suitable habitats between glaciations.

Evolutionary line 3: Sect. Lasiantherae, Sect. Scabrae and Sect. Australes

This is the main evolutionary line of Euphrasia in Australia. The lines of evolution between species and subspecies seem reasonably clear, without having to resort to the use of mathematical methods of determination.

Sect. Lasiantherae, the most primitive section in the line, consists of three species which form a "linear" evolutionary series (fig. 7). E. alsa retains the most primitive characters, with its small ovule number, large seed size, yellow-blotched lower corolla lip and small annual habit. E. lasianthera clearly terminates the line of evolution in the section, by its perennial habit and particularly by the absence of a yellow blotch on the lower corolla lip and the presence of conspicuous pair of yellow blotches at the point of insertion of the anterior filaments, a character which is apparently unique in the members of the genus with striated corollas. E. eichleri is morphologically intermediate between the two species.

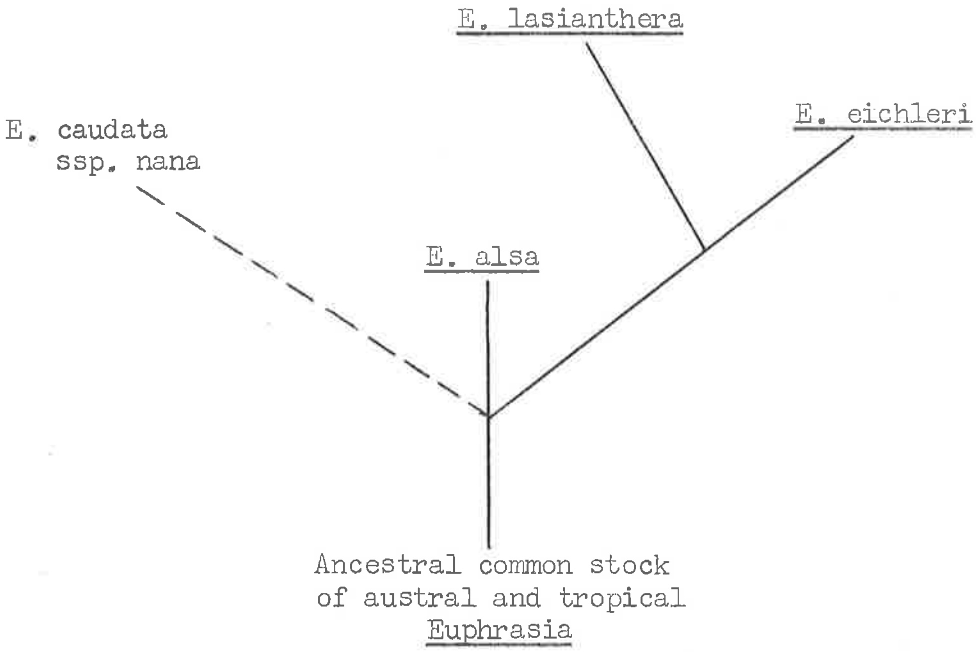

FIG. 7: Postulated evolution in Sect. Lasiantherae

The three species occupy successive disjunct mountain regions in the order of the proposed line of evolution. There is a gradual broadening of the range of ecological preferences away from the most primitive species. E. alsa is exclusively alpine, E. eichleri, the intermediate species, occurs in subalpine and alpine areas, while E. lasianthera, which terminates the line, extends from alpine areas into montane forest. The ancestral stock from which the three present-day species evolved must have encompassed the three mountain regions during the glacial periods. The divergence of the species probably dates from those times. The differences between the species are very large in comparison to the differences between related species in Euphrasia. It is possible that intermediate forms have become extinct as the mountains between the three disjunct regions lost their alpine vegetation.

The evolutionary pathways (see fig. 8) in Sect. Scabrae seem reasonably clear. E. caudata ssp. nana has characters closest to Sect. Lasiantherae, from which the section clearly evolved. In particular it is morphologically very close to E. alsa. In support of the view that the two taxa have a close evolutionary relationship, E. caudata ssp. nana is sympatric with E. alsa and since it also occupies the alpine zone it is the only member of Sect. Scabrae which extends into this region.

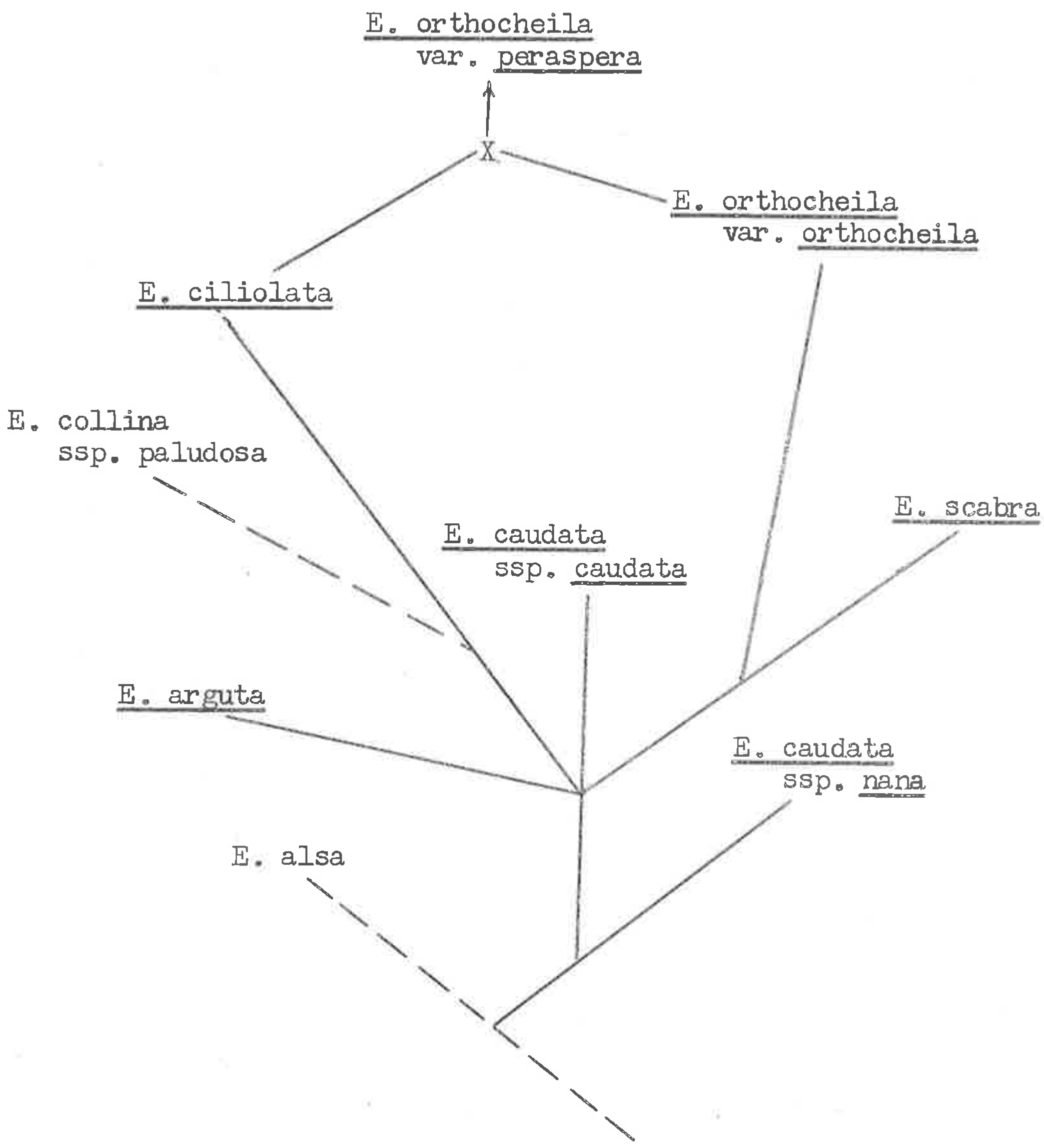

FIG. 8: Postulated evolution in Sect. Scabrae

The evolution of E. caudata ssp. caudata or its immediate ancestor from the precursors of E. caudata ssp. nana seems to have been a necessary step before the evolution of the other present-day species in the section occurred. E. arguta, E. ciliolata and E. scabra apparently evolved from such a stock. The first two species occur well to the north of the range of distribution of E. caudata. The land connections between the two regions which are necessary for the evolution of these species probably occurred during the Pleistocene glaciations. E. ciliolata is similar to E. caudata ssp. caudata by its subalpine-montane distribution, while E. arguta (now probably extinct) seems to have a lower climatic range, being absent from the subalpine zone. Forms intermediate between E. arguta and E. caudata ssp. caudata may occur in the Blue Mountains which lie between the ranges of distribution of the two taxa (see E. arguta: Note 2).

E. scabra and E. orthocheila var. orthocheila make up a short evolutionary branch characterized by yellow corollas, a short glandular indumentum and densely setose capsules. Of the two, E. scabra is the most closely related to E. caudata ssp. caudata and significantly it is sympatric with that species. It also approaches the ecological preferences of E. caudata ssp. caudata more closely than E. orthocheila. Possible remnants of the ancestral connections between E. scabra and E. caudata ssp. caudata occur in subalpine regions in the eastern highlands of Victoria (see E. scabra: Intraspecific Variation). The many characters distinguishing the two taxa break down to some extent in these populations. E. orthocheila var. orthocheila is confined to northern and central New South Wales and diverges from both these species by its small capsules and flowers, and few-toothed leaves.

E. orthocheila var. peraspera is probably a stabilized hybrid with E. ciliolata and E. orthocheila var. orthocheila the parent taxa. The three taxa occur together in the Northern Tablelands of New South Wales.

E. orthocheila var. peraspera has the yellow corolla, small flowers, small capsules, small seeds and short anther awns of var. orthocheila, but has a non-glandular indumentum resembling E. ciliolata.

Sect. Australes gives the impression of undergoing active speciation at the present time. It consists mainly of the highly polymorphic E. collina, the fifteen formally described subspecies of which are distributed in almost all possible vegetation types from temperate lowland to high alpine regions.

The scheme of evolution in Sect. Australes is shown in fig. 9. E. collina ssp. paludosa of the section is found to be morphologically very close to E. ciliolata of Sect. Scabrae. The two differ mainly in their life-span and associated habit characters. The corollas of E. ciliolata may also be more elongated, with a more porrect lower lip and a denser indumentum. The two taxa overlap in their distribution and ecological range. It is even possible that they occur side by side in the Barrington Tops area. There is apparently no similarly close morphological connection between Sect. Australes and either of the other two sections. Accordingly, it is proposed that Sect. Australes originated from an ancestral stock similar to E. ciliolata and E. collina ssp. paludosa.

The diversification from the primitive stock resembling E. collina ssp. paludosa and E. ciliolata apparently occurred in the sclerophyll forests of south-eastern or eastern Australia, the present main areas of distribution of the former species. The subspecies of E. collina which appear to have directly evolved from this stock all occur, at least partly, in these areas. The formation of E. crassiuscula apparently by hybridization between E. collina ssp. paludosa and a stock resembling E. crassiuscula ssp. eglandulosa also occurred in this region (see under the treatment of evolution in Sect. Striatae Subsect. Striatae). In the cool climatic periods of the Pleistocene glaciations ssp. paludosa and at least its close relatives ssp. collina,

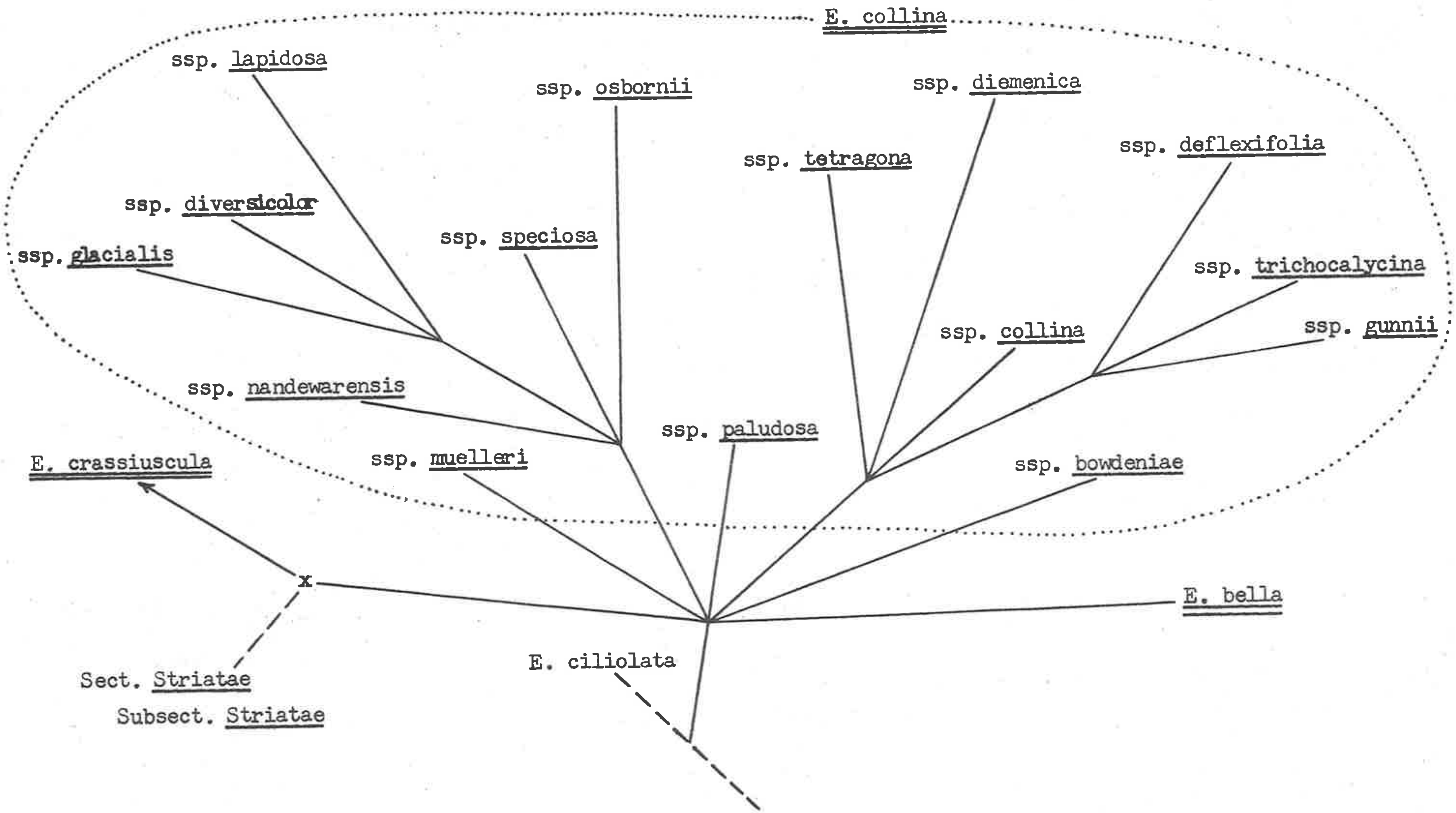

FIG. 9: Postulated evolution in Sect. Australes

ssp. speciosa and ssp. muelleri probably spread into Tasmania and South Australia, with the wider continuous distribution of their habitats. The entry into Tasmania may have been across a land bridge exposed by the fall in sea level during the glaciations (Costin 1959, Banks 1965).

Relict occurrences (possibly now extinct) of ssp. muelleri and ssp. paludosa in the Mount Lofty and Flinders Ranges of South Australia provide evidence for such migration taking place. In addition, there must have been some connection between the present-day ranges of distribution of ssp. speciosa of south-eastern Australia and ssp. osbornii of central South Australia as the two subspecies have clearly evolved from a common stock.

The line in which ssp. collina is the most primitive appears to be the only one which entered Tasmania. Non-glandular and glandular forms resembling ssp. collina and the Grampians populations of ssp. trichocalycina respectively must have reached the island and diversified further. In the lowland sclerophyll forest-woodland regions of northern and eastern Tasmania occur ssp. gunnii, ssp. deflexifolia and a related, probably distinct taxon, all of which have clearly evolved from the glandular stock. Ssp. diemenica is a possibly monophyletic polymorphic group of forms which apparently evolved by the spread of ssp. collina into the subalpine and alpine regions of the island with parallel morphological changes. Possible relicts of the ancestors of ssp. diemenica, or new forms evolved from the subalpine and alpine populations of the subspecies, occur in northern lowland Tasmania. An apparent clinal intergradation between populations of ssp. collina and ssp. diemenica is also known. It is similarly not known whether this is of recent origin or a remnant of the evolution of ssp. diemenica.

Ssp. tetragona also appears to have evolved from the line in which ssp. collina is the most primitive. Its leaf shape in the eastern part of its main mainland area of distribution is very similar to that of ssp. collina in the Grampians and, except for the character of corolla pilosity, these populations are very difficult to distinguish. This may be the region where ssp. tetragona originated, since there is a clinal divergence in leaf shape towards the west. Like many of its relatives in E. collina the subspecies has clearly been more widely dispersed in southern Australia in the past. The disjunction between the south-west Western Australian and South Australian populations, those between mainland Australia and Kangaroo Island and northern Tasmania, and the possible relict occurrence on Wilsons Promontory all seem amply explained by the bridging of the present-day disjunctions during glacial periods aided in at least some cases by the exposure of the intervening sea bed.

From the stock of glandular forms from which ssp. speciosa and ssp. osbornii of lowland and montane areas evolved there is an evolutionary branch which has culminated in the formation of the three subspecies in the alpine zone of the Kosciusko region of south-eastern Australia. There are present today a series of forms which connect this group (in particular ssp. diversicolor), ssp. paludosa and ssp. speciosa (see E. collina: Note 3), in the eastern highlands of Victoria. These may be remnants of the morphological transition from an ancestral stock intermediate between the present-day ssp. speciosa and ssp. paludosa which was much more widespread during the glacial periods. Ssp. diversicolor seems to represent the most primitive member of the three alpine subspecies, although ssp. lapidosa has retained the small seed size which was probably characteristic of the ancestors of these subspecies. The former has the most widely spread habitat and has the capacity to exist at lower altitudes in subalpine regions, while the other two subspecies occur in very local specialized habitats.

The ancestors of the line of which ssp. speciosa is the most primitive must also have once been spread as far north as the Warrumbungles or Nandewar Ranges in northern New South Wales to accommodate the apparent evolution of ssp. nandewarensis from that stock. It is possible however, that ssp. nandewarensis has evolved, independently of the ssp. speciosa line, from ssp. paludosa, which occurs at least in the region of the Warrumbungles.

The origins of E. bella seem somewhat obscure. This species occurs in the mountains of the "MacPherson-MacLeay Overlap" (Burbidge 1960), the region where temperate vegetation reaches its most northern point in eastern Australia. E. bella diverges from E. collina by the apparently primitive character of its narrow attenuate leaves. Ssp. bowdeniae of the Blue Mountains of central New South Wales and a related form (see E. collina: Note 5) from Tamworth, which is located between the areas of distribution of E. bella and ssp. bowdeniae, approach E. bella by their weak habit, lax racemes, and a possibly reduced ovule number. These two forms of E. collina may represent the remnants of a morphological transition between E. collina ssp. paludosa and E. bella. The attenuate leaves of the latter species may either have originated by convergent evolution, or be the product of hybridization with E. durietziana of Sect. Cuneatae (or its immediate ancestors), which occurs a little to the south of E. bella and has similar leaves. The latter explanation seems the less likely in view of the many morphological differences between the two species. It is also possible that the species represents the remnants of the ancient stock from which Sect. Australes evolved, in which leaf bases of the attenuate and non-attenuate types occurred. This seems unlikely in view of the absence of attenuate leaf bases elsewhere in the three sections which make up this major line of evolution in Australia.

In conclusion, it seems possible to explain the evolution of the present-day Australian taxa of Euphrasia and their geographical and ecological distribution, entirely on the geological and floristic events which occurred since the Paleocene-Pleistocene uplift of the mountains in Australia (Raven & Axelrod 1972). There appears to have been little extinction of intermediate forms which cannot be explained by climatic changes during this period. Except in the case of E. bella and Sect. Cuneatae there seems to be a remarkable continuum of taxa grading from the most primitive to the very advanced types. The wide disjunctions between the one New Zealand and two Australian species of Sect. Cuneatae seem difficult to explain.

CHAPTER 5

A REVISED INFRAGENERIC CLASSIFICATION OF EUPHRASIA

A. PREVIOUS INFRAGENERIC CLASSIFICATIONS

Although a number of botanists have discussed the infrageneric classification of Euphrasia, only Bentham (1846), Wettstein (1896), and Hartl (1972) have dealt with the classification on a world-wide basis. The two earlier workers are the only revisers of the entire genus. Except for changes in rank, the addition of two small morphologically and geographically isolated infrageneric taxa, and the segregation of two monotypic genera in New Zealand, which were soon reduced to synonymy, a basic framework of three large infrageneric taxa has been maintained from Bentham's time.

Bentham (1846) divided the genus into three categories of equal status, but with no clear indication of rank (see Sell & Yeo 1970). His § Semicalcaratae, characterized by "Antherae pilosae, mucronatae, duarum breviorum posticarum loculus alter longius calcaratus.....Folia inferiora crenata, floralia summa saepe acutius incisa vel dentata", was confined to the northern hemisphere except for one species in New Zealand (E. cuneata). § Australes, distinguished by its "Antherae pilosae, omnes subaequaliter mucronatae....Folia apice paucicrenata rarius fere a basi crenata", was restricted to "Australasia" (which is probably Australia, as he cited only Australian species and localities). § Trifidae of South America, with one questionable record from the Himalayas, differed by its "Antherae glabrae, aequaliter mucronatae....Folia sessilia cuneato-trifida vel tripartita". Although the Himalayan plant resembled the South American species in habit and leaf shape, Bentham only saw one corolla and was doubtful even of its placement within the genus (he wrote

"E. ? glandulosa"). The specimen was later placed by Bentham and J.D. Hooker (1876) in the related genus Phtheirospermum.

J.D. Hooker (1879) described a new species, E. disperma, from New Zealand which, together with E. repens, he placed in a new subgenus Anagospermae. The subgenus was characterized by its 2-4 ovulate ovaries, solitary flowers, prostrate habit and a remarkably long corolla tube. He considered the subgenus might be worthy of recognition as a distinct genus providing the capsules were found to be indehiscent.

Two years later on the basis of meagre material containing a single flower, Armstrong (1881) described a new genus, Siphonidium, from New Zealand, closely related to Euphrasia but differing "in the long curved gibbous tube and bi-lobed stigma". He did not mention Hooker's subgenus even though there is a distinct resemblance between the two descriptions.

Wettstein (1895), having seen fruiting material of what he considered to be E. disperma, elevated Hooker's Subgenus Anagospermae to a genus distinct from Euphrasia and Siphonidium. He stated its differences as follows:

> "Genus differt ab Euphrasia tubo corollae elongato, labio corollae superiore non excavato, antheris patentibus et glaberrimis, imprimis vero loculis germinis uniovulatis et fructu bicorni bispermo. A Siphonidio Armst. differt tubo corollino recto, stigmate non bilobo, probabiliter etiam fructu et germine."

In the second edition of his "Manual of the New Zealand Flora" Cheeseman (1925) was certain that Anagosperma and Siphonidium were identical, and united them under the latter, earlier-published name.

In his detailed account of "The long-tubed New Zealand species of Euphrasia (= Siphonidium Armstr.)" Du Rietz (1932a) showed that:

> "there is such a gradual transition between Siphonidium and Euphrasia sens. strict., that it is not possible at our present stage of knowledge to retain Siphonidium as a separate genus....it seems

even doubtful whether Siphonidium should be retained as a subgenus or section."

Wettstein (1896) saw much more material of the extra-European members of Euphrasia than Bentham, but like his fellow-European botanist, he knew nothing (except in his addendum) of the Formosan, Malesian and New Guinea species. Notably he saw material of most of the New Zealand species, whereas Bentham apparently only saw E. cuneata. His major classification of the genus was similar to Bentham's. He treated § Semicalcaratae (which included all the northern hemisphere occurrences in the genus) and §Australes (comprising all Australian and New Zealand species, including E. cuneata) as subsections of Sect. Eueuphrasia, which differed from Sect. Trifidae (Bentham's §Trifidae p.maj.p.) in leaf shape and the pilosity of the anthers. Subsect. Australes was distinguished from Subsect. Semicalcaratae by the length of the posterior pair of anther awns relative to the other six anther awns. Sect. Trifidae and Subsect. Australes were divided into annual and perennial groups which were not given formal taxonomic recognition. Wettstein also divided Subsect. Semicalcaratae into three unranked groups, § Parviflorae, § Grandiflorae and § Angustifoliae on the basis of differences in the time of elongation of the corolla tube relative to anthesis, the breadth of the leaves and the indumentum of the capsule. Subsequent European botanists (e.g. Joergensen 1919, Pugsley 1930,1936, Sell & Yeo 1970, Yeo 1972) have considered the character of the elongation of the corolla tube to be of lesser, or even doubtful, diagnostic use (see Pugsley 1930: p.473 and 478).

The upgrading by Joergensen (1919) of Wettstein's sections and subsections to subgenera and sections respectively has been followed in all subsequent works on the genus up to Hartl's recent publication (1972: see below). Joergensen's recognition of two subsections in Sect. Eueuphrasia, namely Subsect. Angustifoliae (equivalent to Wettstein's

§ Angustifoliae) and Subsect. Ciliatae (covering Wettstein's § Parviflorae and § Grandiflorae) on the characters of leaf shape and capsule indumentum, which had been used by Wettstein, has been universally accepted. Joergensen refined the character of leaf shape by recognizing the apparently reliable differences between the two subsections in the proximity of the teeth along the margins. Subsect. Ciliatae has been progressively divided into a number of series from Joergensen's time, especially by Pugsley (1930, 1936) and Sell & Yeo (1970). These series are distinguished by the combination of a number of divergent but often overlapping characters, which include habit, indumentum, leaf and bract shape, corolla size, and capsule size and shape.

Pugsley (1936) erected two new subsections of Sect. Semicalcaratae, Subsect. Japonicae and Subsect. Alpicolae, both confined to Japan, on the basis of habit, leaf shape, calyx shape, corolla size and coloration, and the indumentum on the corolla, anthers and capsule. In the same paper he proposed two new sections. Sect. Atlanticae, endemic to the Azores, was distinguished on the basis of its perennial life-span, rounded leaves and deeply emarginate capsules. Yeo (1972) has recently modified the diagnostic characters of this section, using the perennial life-span, more numerous leaf teeth and the large flowers to distinguish it from the rest of the European and North American species. The distinctive capsule shape described by Pugsley for one species of the section was found not to occur in the other Azorean species.

Pugsley's other new section, Sect. Paradoxae, was based on a single species E. formosissima of the Juan Fernandez Islands off the west coast of South America. The section was characterized by the unique method of perennation and also by "the entire (not emarginate) lobes of the lower lip of the corolla, ...its glabrate, unequally spurred anther-cells and.... its scarcely retuse, setulose-edged capsules". Skottsberg (1921), who described the species, and Wettstein (1921) had previously remarked on its isolated morphological characteristics and its apparent affinities to the Japanese and Australasian members of the genus.

There have been no major changes in the infrageneric classification of Euphrasia in the northern hemisphere since Pugsley's works. Sell & Yeo (1970) have correctly (Stafleu 1972: Art. 22) called the section to which the annual species belong Sect. Euphrasia in place of Sect. Semicalcaratae (Benth.) Joerg., as it is the section containing the type species of the genus. In addition they have revised Pugsley's classification of Subsect. Ciliatae at the level of series.

Although there has been little change in the classification of the genus in the southern hemisphere and Malesia since Wettstein's (1896) monograph, the knowledge of the characters potentially useful in an infrageneric classification has been greatly increased by the work of Du Rietz (1932a,b; 1948a,b). Du Rietz never published his proposed paper (see Du Rietz 1932a: p.121) on the general subdivision of the genus. Considering the depth and breadth of his work he did little formal taxonomic work. He proposed on the basis of capsule shape two subsections, Subsect. Australienses and Subsect. Novaezeelandiae (Du Rietz 1948b), of (presumably) Sect. Australes, covering the Australian and New Zealand species respectively. He also divided the Australian species into four series, Striatae, Collinae, Hookeriae and Scabrae. For this he used characters of life-span, habit and leaf shape (Du Rietz 1948a,b: see Chapter 2).

Of major importance were Du Rietz's critical, lengthy discussions of the relationships between the representatives of the genus in South America, the Juan Fernandez Islands, Australia, Tasmania, New Zealand, New Guinea, Borneo, The Philippines, Taiwan (Formosa) and Japan. Such treatments often involved comparisons of individual species. He found several characters to be useful in distinguishing groups of them. Among these were the pilosity and colour of the anthers, shape of the corolla lobes, leaf shape and habit. It is not clear whether he recognized the importance of the free anthers characteristic of the South American species and E. disperma of New Zealand. His term "patent anthers" seems to refer more to the orientation of the cells of each anther in these species (see Du Rietz 1932a: p.118, especially in his comparison with fig. 1). In descriptions of the long-tubed species of Euphrasia in New Zealand (E. disperma sensu Ashwin 1961) he referred to the anthers as "non cohaerentes". Du Rietz also indicated the unworthiness of the length of the posterior pair of anther awns relative to the other awns, used since Bentham's time as a major character for distinguishing between the species of the southern hemisphere and those of the northern hemisphere. He considered that "subequally mucronate anthers" were characteristic of all the South American species, some New Zealand species and E. striata of Tasmania (Du Rietz 1932b: p.532).

Other than Du Rietz's work and Pugsley's formulation of Sect. Paradoxae the only other treatment of the genus above species level in the southern hemisphere has been that by Ashwin (1961), who gave a synopsis of the main character differences in Euphrasia in New Zealand without proposing any formal infrageneric classification. She divided the perennial species into two main groups, one containing only E. cuneata and characterized by much-branched inflorescences and small bracts, the other with inflorescences simply racemose and with leaf-like bracts. This latter group, which contained the six remaining perennial species, was further divided on the indumentum of the calyx and the relative lengths of the calyx clefts. The annuals were divided into two main groups on leaf and habit characters. The species of the first group, E. cockayniana, E. zelandica, E. australis, and E. cheesemanii, have leaves of the "ovate order, crenate or toothed" with erect branches which never root. Those of the second group, E. dyeri, E. repens, E. integrifolia and E. disperma have mostly decumbent or prostrate branches, which sometimes root and leaves either deeply divided or entire and of the lanceolate type. This second group was further split into three on the basis of the same characters of leaf and habit type.

Hartl (1972) has recently revised the higher classification of Euphrasia on a world-wide basis. Of significance is his treatment of all Joergensen's (1919) and Pugsley's (1936) infrageneric taxa of the rank of subgenus or section at the one level of section. Thus his major classification of the genus is composed of five sections, Sect. Australes, Sect. Paradoxae, Sect. Trifidae, Sect. Atlanticae and Sect. Euphrasia. Pugsley's division of Sect. Semicalcaratae (Hartl's Sect. Euphrasia) into four subsections has been followed without alteration to the somewhat obscure diagnostic characters of the Japanese subsections. Sect. Australes has been expanded to include the Malesian and Formosan species, which had been previously unplaced in the infrageneric classification. He believed that both Sect. Australes and Sect. Trifidae could be subdivided into a number of subsections.

B. A REVISED INFRAGENERIC CLASSIFICATION OF EUPHRASIA

1. Introduction

The proposed classification of Euphrasia represents a radical departure from the concepts in previous works. In these the genus has been divided into three major groups of varying rank. These were "Trifidae", covering the South American species, "Australes", encompassing the occurrences in Australia and New Zealand and recently expanded to include the Malesian and Formosan species (Hartl 1972), and "Semicalcaratae", "Eueuphrasia" or "Euphrasia", representing the annuals of the northern hemisphere and according to Bentham (1846) including E. cuneata of New Zealand, which has otherwise been placed under "Australes". Two peripheral sections, Sect. Paradoxae and Sect. Atlanticae, were proposed by Pugsley (1936) and accepted in all subsequent publications.

In the proposed classification, with the exception of Sect. Striatae (3 subsections distinguished on single characters) and Sect. Euphrasia (the 4 subsections recognized by Pugsley being retained), the infrageneric groups recognized have been given equal status at the sectional level. The worthiness of the many series in Subsect. Ciliatae has not been considered. Each section is separated by only one or two distinct characters from at least one other section, although sometimes there is quite remarkable divergence of a transitional nature, away from the most closely linked species of related sections. The extremes of these divergent lines, such as E. disperma in Sect. Anagospermae, or the lack of recognition or knowledge of charactersin a particular group elsewhere in the genus (e.g. the trifid leaves and subglabrous anthers, which had been used to distinguish the South American species from the rest of the genus, also occur in E. disperma which cannot so readily be separated from the rest of the genus) has led to the major groupings of the past.

There are a number of differences in usage of characters from previous classifications, and several new ones have been discovered. The characters are discussed in detail in the chapter dealing with morphology (Chapter 3). The very obvious free anthers of the South American species and E. disperma of New Zealand have surprisingly never been used diagnostically before, except in the distinction of E. disperma from its related species (Ashwin 1961). The presence or absence of corolla striations, the presence or absence of hairs on the back of the anthers, the number of main veins arising from the very base of the leaf, the distinctive corolla shape of Sect. Australes and especially Sect. Scabrae, and the size of the stigma are all characters which have previously not been used in the infrageneric classification of Euphrasia. Some of them, however, have been used to a small extent at the species level. In addition, other chracters have been refined in their definition. The distinction between "petiolate" and subsessile leaves used by Pugsley (1936) for E. formosissima and Ashwin (1961) for E. cuneata has not been considered an accurate statement of the differences. The shape of leaf bases have in this work been described adhering to a rigid terminology, and their diagnostic value is not in the areas used previously. The depth of the leaf toothing has been treated differently from the rather vague terminology used by Du Rietz (1948a) in which he separated "digitate" and "subdigitate" types from the rest of the genus. As an alternative the size of the "blade", i.e. the area bounded by the teeth, apex and base, which is terminated distally by the beginning of the convex part of the margin, has been divided into small (much less than the area delineated by the outline of the leaf) and large (much of the area delinated by the outline of the leaf).

Two other characters used in the past to distinguish infrageneric taxa have been found to be of little use at that level. In contrast to the opinions of all previous workers on the infrageneric classification, the posterior pair of anther awns has been found to be longer than the other six awns in all the material seen. In some of the species with very short awns the absolute difference in length is much smaller, but the relative difference between the posterior pair of awns and the other six awns is as great as in some of the species with longer awns. The absolute length of awns on particular anther cells is of diagnostic importance at the species level, but not at higher levels. Similarly, Du Rietz's opinion that the Australian and South American species are characterized by a unique "acuminate" capsule shape is a misconception (see Chapter 3).

2. Conspectus of the newly proposed classification

NOTE: The extra-Australian species cited in the text are those recognized in the most recent treatment of the genus in a particular region. These are Wettstein (1896) for South America, Ashwin (1961) for New Zealand, van Royen (1972) for New Guinea, Du Rietz (1932b) and van Royen (1971) for Malesia and Formosa, Skottsberg (1921) for the Juan Fernandez Islands and Yeo (1972) for the Azores. The species in the remaining regions of the northern hemisphere have not been listed in this conspectus.

Where herbarium collections which are not types of a species have been seen, this is designated by "!". If type material has been seen this is designated by "T".

Euphrasia L.,Sp.Pl.(ed 1)(1953)604; Benth.in DC.,Prodr.10(1846)552; Wettst.in Engler & Prantl,Nat.Pflfam.IV3b(1893)100; Wettst.,Monogr. Gatt.Euphrasia (1896)9; Hartl in Hegi,Ill.Fl.Mitteleur.(ed.2)6(1) (1972)335

Siphonidium Armstr.,Trans.Proc.N.Z.Inst.13(1881)341

Anagosperma (Hook.f.)Wettst.,Ber.dtsch.bot.Ges.13(1895)242

DESCRIPTION:

Annual or perennial terrestrial herbs or undershrubs; single main root branched laterally, the lateral rootlets connected to the roots of other plants by haustorial swellings. Axes often with two bands or four lines of eglandular hairs decurrent from between leaf bases, sometimes hairy all round, sometimes glabrous in lower parts. Cotyledons entire, fleshy, glabrous. Leaves decussate, appressed to axis at base, usually then recurved, fleshy, but brittle when dry; abaxial surface with patches of sessile glands symmetrical about midrib, confined to marginal rows or extending over most of blade between veins; margins somewhat revolute, usually shallowly to deeply incised, rarely entire; main veins submerged below adaxial surface and topped by narrow grooves, prominent on abaxial surface. Flowers single in simple, terminal sometimes spike-like racemes, or solitary. Bracts similar in morphology to leaves below inflorescence, but often differing slightly in shape and indumentum. Calyx zygomorphic, campanulate or ± cylindrical, slightly recurved, 4-lobed, with median clefts equal to or longer than lateral clefts. Corolla bilabiate, with tube proximally cylindrical, distally expanded and then divided into hooded, 2-lobed upper lip, which usually encloses the anthers, and three-lobed lower lip, with at least outer surface and front of inner surface of hood pilose. Stamens 4, didynamous, the posterior pair inserted higher on the corolla tube than anterior pair; filaments straight or curved; anthers free, or fused to each other along margins into a "U-shape" with the posterior pair free from each other, with each cell clavate, dehiscing introrsely by longitudinal slit widest towards anther base and terminated in sharp awn, the posterior pair of awns longer than the other six awns. Gynoecium: ovary 2-celled, slightly compressed laterally, with a nectary at base on abaxial side; style filiform passing above or (sometimes when anthers free) between anthers, setose in upper half; stigma capitate, oblong or unequally bilobed; ovules 2-200. Capsule dehiscent loculicidally ?or (in Sect. Anagospermae p.p.) indehiscent, with base of style persistent for short length; seeds 0-150, obliquely ± ellipsoid, longitudinally ribbed, scalariform between, whitish.

TYPIFICATION:

Linneaus (1753) included the currently recognized genera Odontites (his E. odontites, E. linifolia and E. lutea), Bellardia (his E. trixago) and Parentucellia (his E. latifolia) under the genus Euphrasia in the recognized place of first valid publication of the genus in the first edition of Species Plantarum (see Stafleu 1972: Art. 13). Although not investigated, the name Euphrasia apparently was confined to E. officinalis L. and E. tricuspidata L. when the genus of Linnaeus's concept was divided with Odontites, Bellardia and Parentucellia being removed. According to Pugsley (1930) material of the two Linnean species of Euphrasia s. str. is contained in the Linnean herbarium, "the sheet of the former showing three specimens, of which two are the glandular E. rostkoviana Hayne, and the third* an eglandular form that has been referred to E. nemorosa Pers. but is more probably the Scandinavian E. curta Fr. E. tricuspidata is represented by a single unmistakable example".

Britton & Brown (1913) selected E. officinalis as the generic lectotype, but Smejkal (1963) rejected this, as he regarded E. officinalis as a nomen ambiguum et confusum, and designated E. tricuspidata in its place as the lectotype of Euphrasia.

Sell & Yeo (1970) have apparently disagreed with this approach. They have selected as the lectotype of E. officinalis the element from the type which corresponds to E. rostkoviana (see Yeo 1972). They have rejected E. officinalis as a nomen ambiguum, but retain it, as lectotypified, as the lectotype of the genus. There is no discussion of their reasons for rejecting Smejkal's earlier solution to the problem, but their reasons probably lie with his apparently wrong interpretation of Article 70 of the International Code of Botanical Nomenclature (Stafleu 1972).

DISTRIBUTION:

Euphrasia consists of probably more than 150 species distributed widely in the northern temperate zone and occupying Australia, New Zealand, South America and the Juan Fernandez Islands in the southern temperate zone. Connecting these two areas of distribution are a series of species which inhabit the summits of the highest mountains of Malesia and New Guinea. (For maps see van Balgooy 1966: Map 53; Hartl 1972: fig. 168).

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* Now considered to be E. stricta Wolff ex Lehm. (Yeo 1972).

KEY TO THE SECTIONS AND SUBSECTIONS OF EUPHRASIA:

1a. Anthers, at least posterior pair, hairy about connectives. Leaves usually truncate to cuneate at base, rarely (E. bella) attenuate, with (1)3-7 main veins arising from base.

2a. Corolla striated.

VI. Sect. Lasiantherae

2b. Corolla lacking striations.

3a. Perennial. Branches on main floral axis developing in no fixed sequence not consistently in consecutive nodes if high above ground level. Upper corolla lobes ± coplanar, facing forward.

VIII. Sect. Australes

3b. Annual. Branches on main floral axis developing basipetally in consecutive nodes high above ground level from 1-few nodes below inflorescence. Upper corolla lobes angled sharply to each other, facing to side.

VII. Sect. Scabrae

1b. Anthers glabrous about connectives. Leaves attenuate at base, with (1)3(5) main veins arising from base.

4a. Anther slits glabrous or with 1 or 2 tiny hairs along margins.

5a. Perennial.

6a. Leaves shallowly lobed, with (3)4(5) pairs of teeth. Anthers fused, with slits very sparsely hairy. Corolla lobes obtuse.

X. Sect. Paradoxae

6b. Leaves deeply divided with 1(2) pairs of teeth. Anthers free, with slits glabrous. Corolla lobes emarginate or shallowly so.

XII. Sect. Trifidae

5b. Annual

7a. Leaves crenate to serrate. [Anthers fused.]

IX. Sect. Novaezeelandiae

7b. Leaves pinnatifid, trifid or entire.

8a. Flowers more than 10 in inflorescences. Anthers free. Plant erect, with uppermost leaves of main floral axis with 1(2) pairs of teeth.

XII. Sect. Trifidae

8b. Flowers less than 10 in inflorescences or sporadic along axes. Anthers fused or free. Plants either erect with uppermost leaves of main floral axis with 1-3 pairs of teeth or prostrate with leaves entire or with 1 pair of teeth.

XI. Sect. Anagospermae

4b. Anther slits distinctly hairy.

9a. Stigma (0.2)0.3-0.5mm long or longer. Corolla lobes emarginate to obtuse or acute.

10a. Annual.

IX. Sect. Novaezeelandiae

10b. Perennial.

11a. Floral axes prostrate for entire length. Flowers sporadic along axes.

V.B. Sect. Striatae

Subsect. Humifusae

11b. Floral axes, at least in distal parts, erect. Flowers in terminal inflorescences.

12a. Plant tall. Braches or shoots on main floral axis(es) developing in consecutive axils from 1-few nodes below inflorescence, in basipetal sequence.

III. Sect. Cuneatae

12b. Plant short or tall. Branches or shoots on main floral axis(es) developing in sporadic axils, often only near ground level, in no fixed sequence.

13a. Flowers in main inflorescence 2-8(12).

V.A. Sect. Striatae

Subsect. Pauciflorae

13b. Flowers in main inflorescence (7)10-24(36).

V.C. Sect. Striatae

Subsect. Striatae

9b. Stigma 0.1-0.3mm long. Corolla lobes emarginate.

14a. Perennial.

15a. Leaves with from 3(Wettstein 1896) "up to 12 teeth on each side" (Yeo 1972). Flower "13-17mm long along upper side" (Yeo l.c.).

II. Sect. Atlanticae

15b. Leaves with 2-4 teeth along each side. Flowers ca. 6-10mm long along upper side.

IV. Sect. Malesianae

14b. Annual.

I. Sect. Euphrasia

[For differences between subsections see Pugsley 1936, Yeo 1972, Hartl 1972.]

I. Sect. Euphrasia: Sell & Yeo, Bot.J.Linn.Soc.63(1970)203; Yeo, Fl. Europaea 3(1972)260

S Semicalcaratae Benth.in DC., Prodr.10(1846)552, p.p.(as to E. officinalis and E. tricuspidata)

?S Trifidae Benth.in DC., l.c.554, p.p.(probably as to "E.? glandulosa" from the Himalayas)

Sect. Eueuphrasia Wettst.in Engler & Prantl, Nat.Pflfam.IV3b(1893) 100, p.p.(excl. E. grandiflora and species from southern hemisphere); Wettst., Monogr.Gatt.Euphrasia (1896)68, p.p.(as to Subsect. Semicalcaratae)

Subsect. Semicalcaratae (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896)68; Du Rietz,Sv.Bot.Tidskr.42(1948)361

Sect. Semicalcaratae (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid.räekke 2(1919)5,p.p.(excl. the Azorean representatives; as to lectotype) "Subgen. Eueuphrasia Sect. Semicalcaratae"; Pugsley,J.Linn.Soc.Bot.48(1930)484; Pugsley,J.Bot.(Lond.)74 (1936)284

DESCRIPTION:

Annual. Main floral axis single erect stem, developing branches ± basipetally in consecutive nodes from the node below the inflorescence. Uppermost leaves of main axis pinnatifid-serrate to crenate, with base attenuate, abruptly (Subsect. Ciliatae, ? Subsect. Japonicae p.p.) or gradually (Subsect. Angustifoliae, Subsect. Alpicolae) expanded into large blade, with (1)2-6 teeth along distal ca. $\frac{2}{3}$ - $\frac{7}{8}$ of each margin; with 3 main veins arising from base of leaf, branched distally. Flowers 4-50 in racemes. Corolla striated, with yellow blotch on lower lip, or (in Subsect. Alpicolae) with purple blotches behind upper lip and in tube, with lower side apparently concave from above, spreading from base of lower lip; lobes emarginate. Anthers fused, glabrous around connectives, hairy along slits. Ovary with stigma capitulate, 0.1-0.3mm long. Capsules in lateral view usually emarginate, sometimes obtuse or obliquely so. Chromosome number: n=11,22.

TYPIFICATION:

Subsect. Semicalcaratae (Benth.)Wettst.

Lectotype: E. officinalis L., nom. ambig. = (as to lectotype: Sell & Yeo 1970) E. rostkoviana Hayne

The lectotype of Subsect. Semicalcaratae should come from among the species which were included by both Bentham (1846) in his § Semicalcaratae and Wettstein (1896), who was the first to give Bentham's taxon a rank, in his Subsect. Semicalcaratae. This excludes E. cuneata of New Zealand from consideration as a possible lectotype since it was omitted by Wettstein from Bentham's original list. E. officinalis is chosen as lectotype as it almost certainly must have been the most abundant of the three European species seen by Bentham. (It covered a multitude of forms which are now considered to be distinct species.)

E. officinalis L. was originally (Linnaeus 1753) based on a mixture of two species from which Sell & Yeo (1970) have selected a lectotype (see Euphrasia: Typification).

DISTRIBUTION:

Sect. Euphrasia is widespread over the Northern Hemisphere in North America, Eurasia, including the Himalayas, North-west Africa (see Pugsley 1936: p.278) and Japan.

NOTE:

The section has been divided by Pugsley (1936) into four subsections of which two, Subsect. Japonicae and Subsect. Alpicolae, are apparently confined to Japan. The other two, Subsect. Ciliatae and Subsect. Angustifoliae, are widespread in the whole area. I am uncertain of the affinities of the Himalayan (cf. Pennell 1943) and North African species. Furthermore, I am not aware of any work since Pugsley's time on the infrageneric classification of the section except that of Yeo (1972 and other papers) on the European species and Sell & Yeo (1970) on the North American species. In both works Pugsley's separation of Subsect. Ciliatae and Subsect. Angustifoliae was found to be natural. Pugsley (1936) divided Subsect. Ciliatae into a number of species. Sell & Yeo (l.c.) have made a number of modifications of this and described several new ones. As I have seen little material of the Japanese species I am not in a position to assess the worthiness of the two subsections which are endemic in Japan. If the purple corolla blotching is a constant character Subsect. Alpicolae may be worthy of sectional status.

A. Subsect. Ciliatae Joerg. : !

Ca. 40 species in Europe (Yeo 1972), 15 (including possible introductions from Europe) in North America (Sell & Yeo 1970), and an undetermined number in Asia.

B. Subsect. Angustifoliae (Wettst.) Joerg. : !

Ca. 6 species in Europe (Yeo l.c.) and one possibly introduced species in North America (Sell & Yeo l.c.).

C. Subsect. Japonicae Pugsley : !

Undetermined number of species, endemic to Japan.

D. Subsect. Alpicolae Pugsley

Undetermined number of species, endemic to high mountains of Japan.

II. Sect. Atlanticae Pugsley, J.Bot.(Lond.) 74(1936)284; Du Rietz, Sv. Bot.Tidskr. 42(1948)360; Yeo, Fl.Europaea 3(1972)259

§ Semicalcaratae Benth.in DC., Prodr. 10(1846)552, p.p.(as to E. grandiflora)

Sect. Eueuphrasia Wettst.in Engler & Prantl, Nat.Pflfam. IV3b (1893)100, p.p.(as to E. grandiflora); Wettst., Monogr.Gatt. Euphrasia (1896)68, p.p.(as to Azorean species of Subsect. Semicalcaratae)

Subsect. Semicalcaratae (Benth.)Wettst., Monogr.Gatt.Euphrasia (1896)68, p.p.(as to E. grandiflora)

Sect. Semicalcaratae (Benth.)Joerg., Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5, p.p.(as to Azorean representatives; lectotype excl.) "Subgen. Eueuphrasia Sect. Semicalcaratae"

DESCRIPTION:

No material has been seen on which to base a description. The major character of the bilobed capsule which Pugsley (1936) saw in E. grandiflora breaks down in the other member of the section, E. azorica, which has an acuminate or cuspidate capsule (Yeo 1972). By its perennial life-span and leaves with the base shortly attenuate and abruptly expanded into the blade (Wettstein 1896: pl.5 f.362-365) this section approaches Sect. Malesianae. However, the capsule shape of the two species of Sect. Atlanticae are not found in Sect. Malesianae, nor are the leaves as many-lobed or the flowers as large in that section.

TYPIFICATION:

There is need for a lectotype to be chosen from the two species, E. grandiflora and E. azorica, which were listed under the protologue of the section, (Pugsley 1936). Since Pugsley described the capsule of this section to be "profunde emarginata, fere bilobata", E. grandiflora seems to be the better choice. This is especially so as most of the discussion and his knowledge of the morphology was based on that species. However, the lectotypification is left to someone more knowledgeable in the Azorean species.

DISTRIBUTION:

The section consists of the two species of Euphrasia which are endemic in The Azores. They are apparently confined to the mountain regions (Yeo 1972).

E. grandiflora Hochst.

E. azorica Watson

III. Sect. Cuneatae Barker, sect. nov.

§Semicalcaratae Benth. in DC., Prodr. 10(1846)552, p.p. (as to E. cuneata)

Sect. Eueuphrasia Wettst. in Engler & Prantl, Nat. Pflfam. IV3b (1893)100, p.p. (as to E. cuneata); Wettst., Monogr. Gatt. Euphrasia (1896)68, p.p. (as to Subsect. Australes p.p.)

Subsect. Australes (Benth.) Wettst., Monogr. Gatt. Euphrasia (1896 70, p.p. (as to E. cuneata)

Sect. Australes (Benth.) Joerg., Berg. Mus. Aarb. 1916-1917 Naturvid. raekke 2(1919)5, p.p. (as to some New Zealand occurrences; lectotype excl.) "Subgen. Eueuphrasia Sect. Australes"; Du Rietz, Sv. Bot. Tidskr. 42(1948)361, p.p. (as to some New Zealand occurrences)

LATIN DESCRIPTION:

Herba perennis. Axis principalis floralis caulis erectus singularis vel aliquot rami cauli similares, ramis in nodis continuis de 1-aliquot nodis infra inflorescentiam basipete crescentibus. Folia summa axis principalis crenata, base attenuata, in laminam gradatim expensa, (1)2(3) lobis secus $\frac{1}{2}$-$\frac{3}{4}$ partes distales cuiusque marginis; 3 venis principalibus ad basem folii. Flores 10-50 in racemis. Corolla striata, macula flava in labio infero et in tubo, lato infero e base labii inferi de cucullo patenti; lobis emarginatis usque obtusis. Antherae conjunctae, circa connectivas glabrae, secus rimas pilosae. Ovarium stigma oblique oblonga usque inaequaliter bilobata, 0.3-0.7mm longa. Capsulae in aspectu laterali ovatae usque obovato-ellipticae, apice emarginato usque obtuso. Chromosomatum numerus ignotus.

Holotypus: E. cuneata Forst.f.

DESCRIPTION:

Perennial. Main floral axis single erect stem or several erect stem-like branches, with branches developing basipetally in consecutive node, from 1-few nodes below inflorescence. Uppermost leaves of main axis crenate with base attenuate, gradually expanded into large blade, with (1)2(3) lobes along distal $\frac{1}{2}$-$\frac{3}{4}$ of each margin; with 3 main veins arising from base of leaf. Flowers 10-50 in racemes. Corolla striated, with yellow blotch on lower lip and in tube, with lower side spreading from base of lower lip away from hood; lobes emarginate to obtuse. Anthers fused, glabrous around connectives, hairy along slits. Ovary with stigma obliquely oblong to unequally bilobed, 0.3-0.7mm long. Capsules slightly compressed laterally, in lateral view ovate to obovate-elliptic; apex emarginate to obtuse. Chromosome number unknown.

TYPIFICATION:

Holotype: E. cuneata Forst.f.

DISTRIBUTION:

Sect. Cuneatae is confined to montane or subalpine regions of Australia and New Zealand and consists of three species which are endemic to widely disjunct regions.

E. cuneata Forst.f. : !?T

E. durietziana Barker : !T

E. phragmastoma Barker : !T

IV. Sect. Malesianae Barker, sect. nov.

LATIN DESCRIPTION:

Herba perennis. Axes principales florales singularis usque multi, erecti ascendentesve, ramos inordinatos in nodis sporadicis continuisve usoue 1-aliquot nodos infra inflorescentiam crescentes. Folia summa axis principalis crenata usque serrato-crenato, base breve attenuata, in laminam amplam abrupte expansa, 2-4 dentibus secus ca. $\frac{2}{5}$ - $\frac{4}{5}$ partes distales cuiusque marginis; 3 venis principalibus ad basem folii. Flores 2-20 in racemis interdum interruptis. Corolla ca. 6-10mm longa, striata in labio supero, labio infero e base de cucullo patenti; lobis emarginatis. Antherae conjunctae, circa connectivas glabrae, secus rimas pilosae. Ovarium stigma oblique capitulata vel fere inaequaliter bilobata, 0.15-0.3mm longa. Capsulae in aspectu laterali obovatae vel late obovatae, apice obtuso vel non profunde ita, saepe oblique latere ita. Chromosomatum numerus ignotus.

Holotypus: E. philippinensis Du Rietz

DESCRIPTION:

Perennial. Main floral axes one to many, ascending or erect, developing branches in no fixed sequence in occasional or consecutive nodes high above ground level, up to 1-few nodes below inflorescence. Uppermost leaves of main axes crenate to serrate-crenate, with base shortly attenuate, abruptly expanded into large blade, with 2-4 teeth along distal ca. $\frac{2}{5}$-$\frac{4}{5}$ of each margin; with 3 main veins arising from base of leaf. Flowers 2-20 in sometimes interrupted racemes. Corolla striated (data on type of E. borneensis and from dried material of E. merrillii and E. philippinensis) on upper lip, with lower lip spreading from base away from hood; lobes emarginate. Anthers fused, glabrous about connectives, hairy along slits. Ovary with stigma obliquely capitulate or almost (unequally) bilobed, 0.15-0.3mm long. Capsules in lateral view obovate or broadly so, laterally compressed; apex in lateral view obtuse or shallowly emarginate, often obliquely or broadly so. Chromosome number unknown.

TYPIFICATION:

Holotype: E. philippinensis Du Rietz

DISTRIBUTION:

Sect. Malesianae occurs in the highest parts of the mountains of Formosa, Luzon (The Philippines), Borneo (Mt. Kinabalu) and Ceram.

E. nankotaizanensis Yamamoto : T

E. matsudae Yamamoto : T

E. merrillii Du Rietz : T

E. transmorrisonensis Hayata

E. philippinensis Du Rietz : !T

E. ceramensis van Royen : !T

E. borneensis Stapf : !T

V. Sect. Striatae (Du Rietz)Barker, stat. nov.

Ser. Striatae Du Rietz,Sv.Bot.Tidskr.42(1948)113,359 BASIONYM; Willis,Muelleria 1(1967)147

§ Australes Benth.in DC.,Prodr.10(1846)553,p.p.(as to E. striata and E. alpina var. humilis); Pugsley,J.Bot.(Lond.)74(1936)276; Sell & Yeo,Bot.J.Linn.Soc.63(1970)203

Sect. Eueuphrasia Wettst.in Engler & Prantl,Nat.Pflfam.IV3b(1893) 100,p.p.(as to E. cuspidata Hook. and probably one or two N. Zeal. species)

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 68,p.p.

Sect. Australes (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5,p.p.(as to some Austral. and some New Zeal. species; lectotype excl.)"Subgen. Eueuphrasia Sect. Australes"; Schlechter,Bot.Jb.59(1924)117

DESCRIPTION:

Perennial. Main floral axes of variable direction, developing branches in no fixed sequence in occasional nodes. Uppermost occasional nodes in no fixed sequence. Uppermost leaves of main axes crenate to pinnatifid-serrate, otherwise variable. Flowers variable in number and arrangement (see subsections). Corolla striated variably, with yellow blotch on lower lip and in tube, with lower lip concave from above, spreading from base away from hood; lobes variable. Anthers fused, glabrous around connectives, hairy along slits. Ovary with stigma variable in length but rarely less than 0.3mm long. Capsules variable. Chromosome number variable. Variable characters: see under subsections.

TYPIFICATION:

Ser. Striatae Du Rietz

Holotype: E. striata R.Br.

Although no type was cited by Du Rietz (1948a), the selection is automatic as his series name was based upon the epithet of one of the species described in the protologue (Stafleu 1972: Art. 22).

DISTRIBUTION:

Sect. Striatae, which contains three subsections, is distributed over four widely disjunct regions, south-eastern Australia (including Tasmania), New Zealand, New Guinea and the Celebes.

A. Subsect. Pauciflorae Barker, subsect. nov.

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to E. monroi; lectotype excl.)

Subsect. Novaezeelandiae Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p. (lectotype excl.)

LATIN DIAGNOSIS:

Subsectio nova Euphrasiae Sectionis Striatae differt a Subsectione Striatae floribus paucis, a Subsectione Humifusae floribus in racemis axibusque principalibus floralibus non prostratis.

Holotypus: E. revoluta Hook.f.

DESCRIPTION:

Main floral axes either several to many and ascending with simple erect parts, or single to few and erect with branches developing with no fixed sequence high above ground level in occasional nodes. Uppermost leaves of main axes crenate with base attenuate, abruptly or gradually expanded into small to large blade, with 1-2(3) teeth on distal $\frac{1}{4}$ - $\frac{2}{3}$ of each margin, often (in New Guinea species and E. revoluta) with large hooded apex and the small pair of teeth; with 1 or 3 main veins arising from base. Flowers 2-8(12) in racemes. Corolla conspicuously striated, sometimes only on upper lip, with yellow patches on lower lip and tube; lobes emarginate or obtuse. Ovary with stigma obliquely capitate or unequally bilobed, (0.25)0.3-0.55mm long. Capsules in lateral view broadly obovate or obcordate to oblong or obovate; apex in lateral view obtuse or emarginate, often broadly so. Chromosome number: n=11 (known from only one species, E. mirabilis: Borgmann 1964).

DISTRIBUTION:

The subsection comprises the sole representatives of Sect. Australes in New Guinea and New Zealand, where they are confined to high montane to alpine zones.

New Guinea (after van Royen 1972)

E. mirabilis Pennell : !T E. culminicola Wernham : T

E. scutellarioides Wernham : !T E. lamii Diels : !

E. spatulifolia Pennell : T E. versteegii (Diels) Du Rietz : T

E. papuana Schlechter : T

New Zealand (after Ashwin 1961)

E. revoluta Hook.f. : !T E. laingii Petrie : !T

E. drucei Ashwin : T E. townsonii Petrie : !T

E. monroi Hook.f. : !T E. petriei Ashwin : !T

B. Subsect. Humifusae Barker, subsect. nov.

LATIN DIAGNOSIS:

Subsectio nova Euphrasiae Sectionis Striatae differt a Subsectione Striatae Paucifloraeque axibus principalibus prostratis floribusque sporadicis secus axes.

Holotypus: E. humifusa Pennell

DESCRIPTION:

Main floral axes several to many, prostrate and rooting at occasional nodes, developing branches along whole length in no fixed sequence, sporadically or in more or less consecutive nodes which are free of flowers. Uppermost leaves of main axes crenate to serrate-crenate, with base attenuate, abruptly or gradually expanded into small blade, with 1(2) teeth, often small, on distal $\frac{1}{2}$ - $\frac{2}{3}$ of either side, often with large hooded apex; with 1 or 3 main veins arising from base. Flowers sporadic in axils of leaves along axes, one at each node, developing acropetally. Corolla purple on upper lip, from dried material sometimes striated faintly on lower lip (in E. callosa), possibly (in E. humifusa: van Royen 1972) lacking striations, with yellow blotch on lower lip (at least in E. callosa); lobes emarginate or shallowly so.

Ovary with stigma capitate or unequally bilobed, (0.2)0.3-0.5mm long. Capsules in lateral view broadly obovate, laterally compressed; apex in lateral view broadly obtuse to shallowly emarginate. Chromosome number unknown.

TYPIFICATION:

Holotype: *E. humifusa* Pennell

DISTRIBUTION:

The section comprises three species, two from the alpine and subalpine regions of New Guinea, and one from the summit of Mt. Loemuet in the Celebes.

E. humifusa Pennell : !T

E. callosa Pennell : !T

E. celebica van Royen : T

C. Subsect. *Striatae* (Du Rietz)Barker, stat. nov.

Ser. *Striatae* Du Rietz,Sv.Bot.Tidskr.42(1948)113,359 BASIONYM; Willis,Muelleria 1(1967)147

§*Australes* Benth.in DC.,Prodr.10(1846)553,p.p.(as to *E. striata* and *E. alpina* var. *humilis*)

Subsect. *Australes* (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to *E. striata* and *E. hookeri*; lectotype excl.)

Subsect. *Australienses* Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p. (as to Ser. *Striatae*, Ser. *Hookerae* and "*E. milliganii*"; lectotype excl.)

Ser. *Hookerae* Du Rietz,Sv.Bot.Tidskr.42(1948)359("*Hookeriae*")

DESCRIPTION:

Main axes either several to many and ascending with simple erect distal parts or single to few and erect with branches developing high above ground level in occasional nodes, in no fixed sequence. Uppermost leaves of main axes crenate to serrate with base gradually attenuate to cuneate, with blade small to large, toothed in distal $\frac{1}{4}$-$\frac{1}{2}$($\frac{2}{3}$), in Ser. Striatae with 1-2(5) teeth along each margin, in Ser. Hookerae with (3)4-5(7) teeth along each margin; with 3(sometimes in *E. gibbsiae*) 5 main veins arising from base. Flowers (7)10-24(36) in racemes. Corolla conspicuously striated, sometimes only on lateral lobes or on tube, hood and base of lower lip but hardly extending onto lobes, with lower side concave from above, spreading from base of lower lip away from hood. Ovary with stigma obliquely capitate to oblong or unequally bilobed, 0.35-0.8mm long. Capsules in lateral view obovate to ovate-elliptic, sometimes broadly so; apex in lateral view emarginate to obtuse. Chromosome number: n=c.20-30.

TYPIFICATION:

1. Subsect. Striatae (see under Section)
2. Ser. Hookerae Du Rietz

   Holotype: *E. hookeri* Wettst.

   This is the sole representative of the series and hence the holotype species.

DISTRIBUTION:

Subsect. Striatae is restricted to Tasmania, with an outlier on the Baw Baw plateau of the eastern highlands of Victoria. In a mountainous region further north in Victoria is a polymorphic species, *E. crassiuscula*, which varies in the characters distinguishing Subsect. Striatae from Sect. Australes. It is considered to be a stabilized hybrid between the two sections.

Ser. Striatae Du Rietz

E. striata R.Br. : !T

E. semipicta Barker : !T

E. gibbsiae Du Rietz : !T

Ser. Hookerae Du Rietz

E. hookeri Wettst. : !T

VI. Sect. Lasiantherae Barker, sect. nov.

Sect. Trifidae (Benth.)Wettst.in Engler & Prantl,Nat.Pflfam. IV3b(1893)101,p.p.(as to Australian plants of E. antarctica; type excl.)

[Sect. Eueuphrasia auct. non Wettst.,l.c.100: Wettst.,Monogr. Gatt.Euphrasia(1896)68,p.p.(as to Subsect. Australes p.p.)]

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to E. alsa)

Sect. Australes (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5,p.p.(as to some Australian occurrences; lectotype excl.) "Subgen. Eueuphrasia Sect. Australes"; Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p.(as to some Australian occurrences)

Subsect. Australienses Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p. (as to E. alsa)

Ser. Scabrae Du Rietz,ibid.360,p.p.(as to E. alsa); Willis, Muelleria 1(1967)147,p.p.(as to E. alsa)

LATIN DESCRIPTION:

Herba annua perennisve. Axes principales florales vel (in herbis annuis) caulis singularis erectus ramis paucis in nodis continuis infra inflorescentiam basipete crescentibus, vel (in herbis perennibus) rami multi ascendentes, proxime prostrati et saepe ramosi, distale integri erectique. Folia summa axis principalis crenato-serrata usque pinnatifida, base anguste cuneata usque truncata, lamina magna, (1)2-4(7) dentibus secus $\frac{2}{3}$ - totae partes cuiusque marginus; 3-7 venis principalibus ad basem folii. Flores (14)15-26(30) in racemis. Corolla manifeste striata, sum vel sine macula flava in labio infero, labio infero ad basem plus minusve porrecto, distale patenti; lobis plerumque emarginatis, interdum obtusis. Antherae conjunctae, circa connectivas et secus rimas pilosae. Ovarium stigma oblique capitata usque oblonga vel inaequaliter bilobata, 0.3-0.7mm longa. Capsulae in aspectu laterali ovatae usque obovatae, apice plerumque emarginato usque late obtuso, raro acuto. Chromosomatum numerus: n=27 vel circa hic duplex.

Holotypus: E. lasianthera Barker

DESCRIPTION:

Annual or perennial. Main floral axes either (in annuals) a single erect stem with few branches developing basipetally in consecutive nodes below inflorescence or (in perennials) many ascending branches, initially prostrate and often branched, distally simple and erect. Uppermost leaves crenate-serrate to pinnatifid, with base narrow cuneate to truncate, with large blade, with (1)2-4(7) teeth distributed over distal $\frac{2}{3}$-entire length of each margin; with 3-7 main veins arising from base. Flowers (14)15-26(30) in racemes. Corolla prominently striated, with or without yellow blotch on lower lip, with lower side $\pm$ flat crossways, with lower lip $\pm$ porrect near base, spreading distally; lobes usually emarginate, sometimes obtuse. Anthers fused, hairy about connectives and along slits. Ovary with stigma obliquely capitate to oblong, or unequally bilobed, 0.3-0.7mm long. Capsules in lateral view ovate to obovate, slightly compressed laterally; apex in lateral view usually emarginate to broadly obtuse, rarely acute. Chromosome number: n=27 or ca. twice this.

TYPIFICATION:

Holotype: E. lasianthera Barker

DISTRIBUTION:

Sect. Lasiantherae is confined to three disjunct mountain areas of south-east mainland Australia.

E. alsa FvM. : !T

E. eichleri Barker : !T

E. lasianthera Barker : !T

VII. Sect. Scabrae (Du Rietz)Barker, stat. nov.

Ser. Scabrae Du Rietz,Sv.Bot.Tidskr.42(1948)360,p.p.(excl. E. alsa) BASIONYM; Willis,Muelleria 1(1967)147,p.p.(excl. E. alsa)

§ Australes Benth.in DC.,Prodr.10(1846)553,p.p.(as to E. scabra and possibly E. paludosa var. pedicularoides)

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to E. scabra and E. arguta)

Sect. Australes (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5,p.p.(as to some Australian occurrences; lectotype excl.) "Subgen. Eueuphrasia Sect. Australes"; Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p.(as to some Australian occurrences)

Subsect. Australienses Du Rietz,Sv.Bot.Tidskr.42(1948)361, p.p.(as to Ser. Scabrae, but excl. E. alsa)

DESCRIPTION:

Annuals. Main floral axis a single erect stem, with branches developing basipetally in consecutive nodes from 1-few nodes below inflorescence. Uppermost leaves of main floral axis crenate to deeply pinnatifid, with base narrow cuneate to rounded, with blade prominent, with 0-3(5) teeth over distal $\frac{1}{3}$-entire length of each margin; with 3-7 main veins arising from base. Flowers (10)14-90 or more in racemes. Corollas lacking prominent striations with (or ?without) yellow to red patch on lower lip or completely yellow, with lower side ± flat, broadly grooved, with lower lip porrect at least at base, distally in region of lobes sometimes spreading; lobes obtuse, sometimes shortly apiculate, to emarginate. Anthers fused, hairy about connectives, at least of posterior pair, and along slits. Ovary with stigma obliquely oblong to capitate, or unequally bilobed, (0.2)0.35-1.1mm long. Capsules in lateral view oblong-ovate to obovoid elliptic, often obliquely so, sometimes broadly so, slightly compressed laterally; apex in lateral view emarginate to obtuse or acute, often obliquely so. Chromosome number: n=27, 28, 27II+2I, 25II+2III.

TYPIFICATION:

Ser. Scabrae Du Rietz

Holotype: *E. scabra* R.Br.

Although no type species was cited by Du Rietz (1948b) *E. scabra* must be considered the holotype since Du Rietz's series name was based upon the specific epithet (Stafleu 1972: Art.22).

DISTRIBUTION:

Sect. Scabrae is confined to the temperate lowland to alpine regions of southern Australia and Tasmania.

E. caudata (Willis) Barker : !T

E. arguta R.Br. : !T

E. scabra R.Br. : !T

E. ciliolata Barker : !T

E. orthocheila Barker : !T

VIII. Sect. Australes (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5,p.p.(as to lectotype and some other Austral. and some New Zeal. species) "Subgen. Eueuphrasia Sect. Australes"; Du Rietz,Sv.Bot.Tidskr.42(1948)361,p.p.(as to some Austral. and some New Zeal. species

§ Australes Benth.in DC.,Prodr.10(1846)p.p.(excl. E. alpina var. humilis, E. striata, E. scabra and probably E. paludosa var. pedicularoides) BASIONYM; Pugsley,J.Bot.(Lond.)74(1936) 276; Sell & Yeo,Bot.J.Linn.Soc.63(1970)203

Sect. Eueuphrasia Wettst.in Engler & Prantl,Nat.Pflfam.IV3b (1893)100,p.p.(as to E. brownii,?p.p.); Wettst.,Monogr. Gatt.Euphrasia (1896)68,p.p.(as to Subsect. Australes p.p.)

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to perennials excl. E. cuneata, E. monroi, E. striata, and E. repens)

Subsect. Australienses Du Rietz,l.c.36,p.p.(as to Ser. Collinae s.lat., i.e. incl. E. paludosa, E. muelleri, "E. collinoides" and "E. osbornii", excl. "E. milliganii")

Ser. Collinae Du Rietz,l.c.359; Willis,Muelleria 1(1967)147

DESCRIPTION:

Perennial. Main floral axes either several to many and ascending with distal erect parts simple or single to few and erect with branches developing high above ground level in occasional nodes in no fixed sequence. Uppermost leaves of main axes crenate to serrate-pinnatifid, with base attenuate (E. bella) or cuneate to truncate (E. collina), with blade large, with (0)1-6(8) teeth along distal $\frac{1}{8}$ to whole of each margin; with 3-7 main veins arising from base. Flowers (4)6-60(80) in racemes. Corolla lacking striations, and with or without yellow spot on lower lip, with lower side flattened, sometimes forming a broad groove, with lower lip ± porrect proximally, distally in region of lobes spreading. Anthers fused, almost always hairy about connectives, in a few subspecies of *E. collina* rarely glabrous, hairy along slits. Ovary with stigma obliquely oblong to capitate or unequally bilobed, 0.5-1.0mm long. Capsules in lateral view ovate to obovate, sometimes broadly so, or shortly caudate, rarely linear; apex shallowly emarginate to acute or obtuse, rarely shortly broad acuminate. Chromosome number: n=c.28-33 or twice this.

TYPIFICATION:

1. Sect. *Australes* (Benth.)Joerg.

Lectotypus: *E. alpina* R.Br. non Lam., nom. illeg. ≡ *E. diemenica* Sprengel

Except for *E. tetragona* R.Br. and *E. striata* R.Br., the descriptions of which are rearrangements of Brown's (1810) originals, the other six species included by Bentham (1846) under §*Australes* would qualify equally as lectotypes. In considering the characters used by Bentham to delimit §*Australes* none of the species have the allegedly "subequally mucronate anthers" wrongly attributed to this group by Bentham (and other authors), while all bear hairs on the anthers to a greater or lesser extent. The final choice was based on the fact that Bentham saw much material of Brown's "*E. alpina*" and placed it first in the group.

2. Subsect. *Australienses* Du Rietz

Lectotypus: *E. collina* R.Br.

Any of the four species, *E. collina*, *E. gunnii*, *E. striata* and *E. gibbsiae*, described in great detail by Du Rietz (1948a,b) would have been candidates for lectotype. *E. collina* was chosen as it was a type of one of the two Series, *Collinae* and *Striatae*, which encompass these four species. It also has capsules apparently corresponding to the "acuminate" type which was used by Du Rietz to distinguish the subsection from his Subsect. Novaezeelandiae (but see Chapter 3: Capsules).

3. Ser. Collinae Du Rietz

Holotype: E. collina R.Br.

Although no type was cited, E. collina is automatically holotype as the series name is based upon it (Stafleu 1972: Art.22).

DISTRIBUTION:

The section is spread throughout temperate southern Australia, the entire area of which is covered by the one extremely polymorphic species, E. collina. Also included in the subsection are two species which are confined to small mountain regions; one of these, E. crassiuscula, intergrades with Sect. Striatae Subsect. Striatae, and is probably a stabilized hybrid between species in the two sections.

E. crassiuscula Gandoger : !T

E. collina R.Br. : !T

E. bella Blake : !T

IX. Sect. Novaezeelandiae (Du Rietz)Barker, stat. nov.

Subsect. Novaezeelandiae Du Rietz,Sv.Bot.Tidskr.42(1948)361, p.p. BASIONYM

[Sect. Trifidae auct.non §Trifidae Benth.: Wettst.in Engler & Prantl,Nat.Pflfam.IV3b(1893)101,p.p.(as to E. antarctica in New Zealand)]

[Sect. Eueuphrasia auct.non Wettst.in Engler & Prantl: Wettst. Monogr.Gatt.Euphrasia (1896)68,p.p.(as to Subsect. Australes p.p.)]

Subsect. Australes (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to E. zelandica and E. berggrenii)

Sect. Australes (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)9,p.p.(as to some New Zealand occurrences; lectotype excl.) "Subgen. Eueuphrasia Sect. Australes"

DESCRIPTION:

Annual. Main floral axis a single erect stem, with branches developing possibly acropetally or in no fixed sequence in the few consecutive nodes available from 1-few nodes below inflorescence. Uppermost leaves of main axis crenate to crenate-serrate, with base attenuate, gradually or ± rapidly expanded into large blade, with 2-5 teeth distributed over distal ½-entire margin; with 3 main veins arising from base. Flowers 6-14 in racemes. Corolla either conspicuously striated, with yellow patches or (in E. cockayniana) completely yellow, with lower lip spreading from base away from upper lip; lobes obtuse to acute or (in E. cockayniana) shallowly emarginate. Anthers fused, glabrous about connectives, very sparsely to densely hairy along slits. Ovary with stigma obliquely capitate to linear, or unequally bilobed, 0.3-0.6mm long. Capsules in lateral view broadly obovate to shallowly obcordate, greatly compressed laterally; apex in lateral view broadly obtuse to emarginate. Chromosome number unknown.

TYPIFICATION:

Subsect. Novaezeelandiae Du Rietz

Lectotypus: E. zelandica Wettst.

Du Rietz (1932;1948a,b) clearly saw material of E. revoluta, E. monroi, E. laingii, E. townsonii and E. cuneata among the perennials of New Zealand, and all the annuals. His Subsect. Novaezeelandiae was stated to comprise all the New Zealand species (Du Rietz 1948b). Possibly the species he saw most material of was E. zelandica Wettst. Because it has the typical capsules of the New Zealand and tropical species, referred to as "emarginate or truncate" by Du Rietz and providing the basis for his distinction of Subsect. Novaezeelandiae from Subsect. Australienses (but see Chapter 3: Capsules), it has been selected as lectotype.

DISTRIBUTION:

Sect. Novaezeelandiae is confined to the montane to alpine zones of the North and South Islands of New Zealand (ex Ashwin 1961).

E. cockayniana Petrie : !T
E. cheesemanii Wettst. : !T
E. australis Petrie : !T
E. zelandica Wettst. : !T

X. Sect. Paradoxae Pugsley, J.Bot.(Lond.) 74(1936)284; Du Rietz, Sv. Bot.Tidskr. 42(1948)360

DESCRIPTION:

Perennial. Main floral axis a single erect stem, with branches developing in all nodes apparently in an acropetal sequence, with growth continuing from some apices in later years. Uppermost leaves of main axis crenate, with base attenuate, abruptly expanded into large blade, with 3-5 lobes along distal $\frac{2}{3}$ - $\frac{3}{4}$ of each margin; with 3 main veins arising from base. Flowers ca. 10-15 in racemes. Corolla striated on upper and lower lip, with yellow blotches on lower lip and in tube, with lower side concave from above, spreading away from hood from base of lower lip; lobes obtuse. Anthers fused, glabrous around connectives, slightly hairy on slits. Ovary with stigma obliquely capitate or oblong, ca. 0.4mm long. Capsule in lateral view (?obovate) or broadly so, laterally compressed; apex in lateral view shallowly emarginate. Chromosome number unknown.

TYPIFICATION:

Holotype: *E. formosissima* Skottsb.

This was the only species cited for the section in the protologue (Pugsley 1936).

DISTRIBUTION:

Sect. *Paradoxae* is monotypic and restricted to the Juan Fernandez Islands. It is apparently confined to the alpine zone.

E. formosissima Skottsb. : !T

XI. Sect. *Anagospermae* (Hook.f.)Barker, stat. nov.

Euphrasia Subgen. *Anagospermae* Hook.f.,Ic.PI.13(1879)65,t.1283 BASIONYM

Anagospermae (Hook.f.)Wettst.,Ber.dtsch.bot.Ges.13(1895)242; Wettst.,Monogr.Gatt.Euphrasia (1896)10; Cheeseman,Man.N.Z. Fl.(ed.1)(1906)557

Siphonidium Armstr.,Trans.Proc.N.Z.Inst.13(1881)341; Wettst. in Engler & Prantl,Nat.Pflfam.IV3b(1893)101; Wettst.,Monogr. Gatt.Euphrasia(1896)10; Cheeseman,Man.N.Z.Fl.(ed.1)(1906) 558; Cheeseman,Man.N.Z.Fl.(ed.2)(1925)844

Sect. *Eueuphrasia* Wettst.in Engler & Prantl,Nat.Pflfam.IV3b (1893)100,?p.p.(probably as to one of the four New Zealand species); Wettst.,Monogr.Gatt.Euphrasia (1896)70,p.p.(as to Subsect. *Australes* p.p.)

Subsect. *Australes* (Benth.)Wettst.,Monogr.Gatt.Euphrasia (1896) 70,p.p.(as to *E. repens* and *E. dyeri*)

Sect. *Australes* (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5,p.p.(as to some New Zealand occurrences; lectotype excl.) "Subgen. *Eueuphrasia* Sect. *Australes*"

Subsect. *Novaezeelandiae* Du Rietz,Sv.Bot.Tidskr.42(1948) 361,p.p.(as to some New Zealand occurrences)

DESCRIPTION:

Annual. Main floral axes usually several branches either initially prostrate and gradually ascending or completely prostrate, sometimes (E. dyeri p.p.) a single ± erect stem, with branches developing ± acropetally, sporadically or in consecutive axils. Leaves either entire and narrow-acuminate (E. integrifolia) or pinnatifid, with base narrow cuneate or gradually attenuate, pinnatifid to pinnatifid-serrate with only a small blade, with 1-3 teeth distributed over distal $\frac{1}{2}$-$\frac{3}{4}$ of each margin; with 1-3 main veins arising from base. Flowers 2-6 in racemes or (especially in prostrate plants) sporadic. Corolla (at least often) with striations on the midline of hood and sometimes either side (whether on lobes and incidence of yellow spot unknown), with lower lip spreading from base away from hood; lobes obtuse to truncate. Anthers fused or (E. disperma) free, glabrous around connectives, glabrous or with a few hairs along slits. Ovary with stigma narrow oblong, unequally bilobed, 0.35-0.8mm long. Capsules laterally compressed, obovate to obcordate or bicornute in lateral view; apex in lateral view broadly obtuse to very deeply emarginate. Chromosome number unknown.

TYPIFICATION:

1. Subgenus Anagosperma Hookf.

Holotype: E. disperma Hoof.f.

2. Siphonidium Armstr.

Holotype: Siphonidium longiflorum Armstr.

These were the only species cited in the protologues (Hooker 1879, Armstrong 1881, respectively).

DISTRIBUTION:

The section, which contains four species (sensu Ashwin 1961), is endemic to the montane and wet coastal regions of the South Island of New Zealand.

NOTE:

Wettstein (1895), in elevating J.D. Hooker's Euphrasia Subgen. Anagospermae to generic level, incorrectly stated in several places that Hooker had given it the status of section.

E. dyeri Wettst. : !T

E. repens Hook.f. : !T

E. integrifolia Petrie : !T

E. disperma Hook.f. : !T

XII. Sect. Trifidae (Benth.)Wettst.in Engler & Prantl,Nat.Pflfam. IV3b(1893)101,p.p.(excl. E. antarctica in Austral. and New Zeal.); Wettst.,Monogr.Gatt.Euphrasia (1896)70; Du Rietz, Sv.Bot.Tidskr.42(1948)114,361

§ Trifidae Benth.in DC.,Prodr.10(1846)554,?p.p.(excl. "E.? glandulosa"; but material n.v.) BASIONYM; Sell & Yeo,Bot.J. Linn.Soc.63(1970)203

Subgen. Trifidae (Benth.)Joerg.,Berg.Mus.Aarb.1916-17 Naturvid. raekke 2(1919)5

DESCRIPTION:

Annual or perennial. Main floral axes either several to many and ascending, with branches developing in consecutive nodes up to several to many nodes below inflorescence, simple above, or single and erect with branches developing in no fixed sequence in consecutive nodes from 1-few nodes below inflorescence. Uppermost leaves of main axes deeply divided, with base attenuate to cuneate-attenuate, gradually expanded into small blade, with 1(2) pairs of teeth distributed over distal $\frac{1}{2}$-$\frac{7}{8}$ of leaf; with 3 main veins arising from base of leaf. Flowers ca. 10-30 in racemes. Corolla striated with yellow area on lower lip, with lower side apparently concave from above, with lower lip spreading from base away from hood; lobes emarginate, often shallowly so. Anthers free, glabrous around connective and along slits. Ovary with stigma obliquely subcapitate, ca. 0.3-0.5mm long. Capsules in lateral view broadly obovate, greatly compressed laterally; apex in lateral view broadly obtuse. Chromosome number: n=44 (known for a single species: Moore 1967 fide Yeo 1968).

TYPIFICATION:

Holotype: E. trifida Poeppig in Benth.

Under Article 22 of the International Code of Botanical Nomenclature (Stafleu 1972) E. trifida, which was described in the protologue (Bentham 1846), is automatically the type of § Trifidae Benth.

DISTRIBUTION:

From Wettstein's (1896) monograph of the genus, the section is confined to the Andes mountains and their surroundings in the southern half of South America from a latitude of about 98'S in an apparently continuous "line" to Fuegia. E. antarctica also occurs on the Falkland Islands to the east of Fuegia (Skottsberg 1913; Vallentin & Cotton 1921). The map in "Pacific Plant Areas" (van Balgooy 1966) shows the northernmost occurrence to be about 10 degrees to the south. The section is poorly represented in its northernmost occurrence in Peru (Edwin 1971) by a single species, E. pubescens, apparently only represented in herbaria (K,B,P: n.v.) by the type material collected by Dombey (Bentham 1846, Wettstein l.c., Edwin 1971). There is clearly need for verification of the occurrence of the section (and the genus) in Peru.

Annuals (after Wettstein 1896)

E. antarctica Benth. : !T

E. perpusilla Phil.

E. pubescens Benth.

E. meiantha Clos : !

E. philippi Wettst.

Perennials (after Wettstein 1896)

E. andicola Benth.

E. trifida Poepp. : !

E. spectabilis Phil.

E. chrysantha Phil. : !(?T)

E. flavescens Phil.

E. subexserta Benth. : !

E. debilis Wettst.

E. intricata Phil.

E. muscosa Phil.

CHAPTER 6

A TAXONOMIC REVISION OF *EUPHRASIA* IN AUSTRALIA

A. Introduction

The classification of *Euphrasia* in Australia has had to be completely restructured. Wettstein (1896), who published the last revision of the genus in Australia, recognized twelve species and proposed no formal infrageneric or infraspecific taxa. In the proposed classification, seven of his twelve species have been reduced to synonymy.

Euphrasia in Australia consists of five sections with seventeen species, seven of which are newly described and one is an upgrading of status. Five species, in particular *E. gibbsiae* with nine subspecies and *E. collina* with fifteen subspecies, are polymorphic. The difficulties in the taxonomy of *Euphrasia* in Australia encountered by previous taxonomists (see Chapter 2) were mainly caused by the complexities of *E. collina*, which encompasses a large proportion of the Australian populations of *Euphrasia*. *E. collina* as defined in this revision is more or less equivalent to Mueller's (1865) "*E. brownii*". Clines and a limited amount of hybridization occur within the species. Contrary to the belief of some of the more recent workers on the genus (see Chapter 2) interspecific hybrids are rare. All taxa have limited geographical and ecological ranges. The recognition of the variants which have been given the rank of subspecies as "microspecies", which has been done elsewhere in the genus (Sell & Yeo 1970), is considered unwarranted because it would camouflage the well-defined species in Australia.

B. Classification

Euphrasia L.

For synonymy, description, typification and distribution, see Chapter 5: p.127.

KEY TO THE SECTIONS AND SUBSECTIONS OF EUPHRASIA IN AUSTRALIA:

1a. Anthers glabrous about connectives. [Perennial.]

2a. Branches or shoots on main floral axis(es) developing in basipetal sequence in consecutive axils from 1-few nodes below inflorescence.

I. Sect. Cuneatae (p. 162)

2b. Branches or shoots on main floral axis(es) developing in no fixed sequence, not consistently in consecutive nodes if high above ground level, often only near ground level.

II. Sect. Striatae (p. 176)

1b. Anthers, at least posterior pair, hairy about connectives.

3a. Corolla striated.

III. Sect. Lasiantherae (p. 268)

3b. Corolla lacking striations.

4a. Perennial. Branches or shoots on main floral axis developing in no fixed sequence, not consistently in consecutive nodes if high above ground level. Upper corolla lobes ± coplanar, facing forward.

V. Sect. Australes (p.369)

4b. Annual. Branches or shoots of main floral axis developing basipetally in consecutive nodes high above ground level from 1-few nodes below inflorescence. Upper corolla lobes angled sharply to each other, facing to side.

IV. Sect. Scabrae (p. 300)

I. Sect. Cuneatae Barker

For synonymy, latin and english descriptions, typification and distribution, see Chapter 5: p.137.

KEY TO THE AUSTRALIAN SPECIES OF SECT. CUNEATAE:

1a. Posterior pair of anther awns needle-shaped, much shorter than anthers. Calyx, bracts and upper leaves non-glandular. Corolla 8.5-11mm long; lower lobes externally glabrous for most part, usually shallowly to deeply emarginate, rarely truncate. Capsules glabrous or with a very few setae at apex. Uppermost leaves of main axes 5.4-9.2mm long. Main inflorescences with ca. 30-50 or more flowers.

1. *E. durietziana*

1b. Posterior pair of anther awns distally flat, twisted or erosulate, as long as or longer than anthers. Calyx, bracts and upper leaves glandular hairy. Corolla ca. 14-20mm long; lower lobes externally hairy, shallowly emarginate to obtuse. Capsules densely setose. Uppermost leaves of main axes 9-14mm long. Main inflorescences with few (?ca. 12) flowers.

2. *E. phragmostoma*

1. Euphrasia durietziana Barker, species nova

[E. brownii auct. non FvM.(nom. illeg.): Hodgson & Payne,Field Guide Austral.Wildfl.(1971)222,t.col.]

LATIN DIAGNOSIS:

Species nova Euphrasiae Sectionis Cuneatae a E. cuneata et E. phragmostoma differt capsulis subglabris, lobisque inferis corollae extra subglabris; etiam a E. cuneata differt calyce scaberulo, seminibus minoribus et axibus rhachidibusque saepe glandulosis, a E. phragmostoma aristis postremis antherarum acerosis, quibus sunt loculis multo brevioribus, calycibus, bracteis foliisque superis non-glandulosis, corollis minoribus, foliis summis axium primorum floralium brevioribus, inflorescentiisque primis floribus pluribus.

Holotypus (tab. 15): B.R. Paterson s.n., 28.ii.1958. Ebor Falls. NSW126388.

DESCRIPTION:

Perennial herb or undershrub, 25-50cm or more tall, with several or many ascending or erect foliose branches arising from ground level and terminated by inflorescence.

Stem not seen; main floral branches 19-30cm high to base of inflorescence, simple for (0)1-2(4) nodes below inflorescence, i.e. for 0.05-0.24 of height of inflorescence above ground level; upper 4-10 internodes as long as or longer than upper leaves, the longest internode 1.2-2.5 times length of upper leaves; branches developing basipetally in consecutive nodes, with all nodes, except often for node below inflorescence, developing shoots; axes in upper parts with dense very short to short eglandular hairs all around or in two rows decurrent from between leaf bases, sometimes mixed all around with very sparse to moderately dense, very short to moderately long glandular hairs, lower down with sparser shorter eglandular indumentum in two rows apparently lacking glandular hairs, near base usually glabrous, sometimes (Williams ii.1963: NE) bearing moderately dense, long glandular hairs.

Cotyledons not seen

Leaves: uppermost stem leaves 5.4-9.2mm long, 2.3-5.4mm broad, obovate to spathulate, sometimes narrowly so, crenately lobed, with sessile gland patches confined to distal 0.6-0.75 of lower surface, otherwise glabrous; base narrow attenuate-cuneate to attenuate, often subpetiolate; lobes (1)2(3) along each margin, blunt, usually obtuse, sometimes acute, confined to distal 0.26-0.60 of leaf, with longest lobe 0.3-0.8mm long; apex 1.2-1.5mm long, 1.1-2.3mm broad, bluntly broad obtuse to acute; leaves lower down increasingly longer and more attenuate, glabrous or sometimes (Williams -.ii.1963) with sparse moderately long glandular hairs.

Inflorescences racemes, ± dense in bud, sparse to moderately dense in flower and fruit, those of stems with ca. 30-50 or more flowers, with lowest 1-4 nodes bearing single flowers or only with undeveloped buds; pedicels at lowest node 1-3mm long, shorter higher up; rachis bearing moderately dense to dense, very short to short eglandular hairs, usually all around, sometimes in two rows with slightly sparser hairs between, often mixed all around with moderately dense to dense, very short to moderately long glandular hairs; apical bud cluster initially cylindrical to ovoid, sometimes narrowly so, ca. 2-2.5mm long, hidden by or hardly emergent from corollas of uppermost flower pair after flowers at initial ca. 10-15 or more nodes have reached anthesis.

Bracts at lowermost node similar in size, shape and indumentum to uppermost leaves, toothed apparently at all nodes, shorter than or equal to calyx except rarely at lower 1-2 nodes.

Calyx 4.2-6.5mm long, externally minutely scaberulous along ribs, densely so at base, sparsely to moderately densely so towards apex, internally glabrous; lobes blunt or sharp, acute to shortly narrow acuminate; lateral clefts 0.6-1.3mm deep, shorter than median clefts, which are 1.3-3.5mm deep.

Corolla 8.5-11mm long along upper side, "white or slightly yellowish, with dark lines [= striations] on corolla" (Williams xi.1960) with presence of yellow spot unknown (but possibly referred to in above quotation); tube 5.5-8mm long, with base narrow cylindrical, distally near point of insertion of anterior filaments, at a point 4.5-6mm from base, expanded laterally and abaxially, glabrous at very base, otherwise externally covered by short to moderately long eglandular hairs, dense on adaxial and lateral surfaces, sparse or absent on abaxial surface, with a few short glandular hairs behind lateral cleft, internally with dense, short to moderately long eglandular hairs all around; hood 2.5-4.2mm long [excluding lobes ca. 3.5mm broad, including lobes ca. 4.5-5mm broad] externally covered by dense short eglandular hairs, internally glabrous but for dense patch of long to very long eglandular hairs behind sinus; upper lobes emarginate to obtuse, glabrous with cleft between 1.2-2.2mm deep; lower lip 6.5-9.6mm long, 9-19mm broad, externally glabrous or with sparse to moderately dense, moderately long eglandular hairs at base, sometimes extending for a short distance onto lobes, which are otherwise glabrous; lower lobes usually shallowly to deeply emarginate, rarely truncate, with clefts between 3.3-4.7mm deep.

Stamens with filaments sometimes glabrous, sometimes with eglandular hairs, either a few at base or dense over basal half, the anterior pair ca. 4.5mm long, the posterior pair ca. 2-2.5mm long; anthers 1.4-2.1mm long, 0.8-1.0mm broad, with area surrounding connectives glabrous, with slits lined sparsely to densely with moderately long to long eglandular hairs, with awns smooth and sharp, those of the posterior pair 0.3-0.4(0.6)mm long, longer than other three awns.

Ovary in lateral view ovate-oblong to obovate-oblong, sometimes broadly so, laterally compressed, in median view narrow ovate-caudate to linear, glabrous or with a few short setae at apex; apex in lateral view shallowly emarginate to truncate, sometimes obliquely so; ovules 20-35.

Capsules (only 3 mature ones seen) ca. 5-6mm long, in lateral view ovate to elliptic or oblong to obovate-elliptic, 1.8-3.4mm broad, laterally compressed, in median view linear or linear-elliptic to narrow ovate caudate, glabrous or with a few tiny setae at apex; apex in lateral view emarginate, sometimes obliquely so; seeds 8-22, ellipsoid to ovoid, often narrowly or obliquely so, (0.9)1.1-1.5(1.6)mm long, 0.4-0.6mm broad.

Chromosome number: Unknown

Plates: 11, 15

Figures: 10

TYPIFICATION:

Holotype (pl. 15): B.R. Paterson s.n., 28.ii.1958. Ebor Falls. Among granite. NSW126388 (ex NE).

The holotype consists of a single entire plant in good condition, but unfortunately loose in its folder. Buds, flowers and a few mature fruits are present.

It is possible that duplicate material exists in NE. However, since the herbarium was almost completely destroyed by fire a few days before this collection was made (Paterson 1960, Gray 1961), the collector may have decided to send her one specimen to NSW at that time. This seems very likely as Paterson (l.c.) did not retain any of the duplicates of a collection of Acrotriche aggregata R.Br. in NE, made on 26.ii.1958, but distributed them to other herbaria.

The extent of natural vegetation in the type locality is not known. This would have been a useful guide to the probability of populations of E. durietziana still occurring there. However, there is much natural vegetation in the region of Point Lookout (Morcombe 1969), which is near Ebor Falls, and recent collections of the species have come from there. It seems likely, therefore, that the species still occurs in the type locality.

DISTRIBUTION (Fig. 10):

E. durietziana is endemic to the montane and possibly the subalpine zones of the Northern Tablelands (sensu Anderson 1961) of New South Wales.

It may occur as low as 900m and reaches 1600m in the summit areas of the highest mountains in the region.

ECOLOGY:

In the Point Lookout-Ebor Falls area E. durietziana has been recorded from wet (Hore-Lacy 185) or dry (Williams; both collections) sclerophyll forest and "tall woodland margin (E[ucalyptus] rubida-E. obliqua)" (Winterhalder NE). At Wallangarra which is at a lower altitude Boorman (NSW10931), in a reference clearly applying also to the annuals of the region (he refers to flowers being pure white, pale yellow or pink), states that it is "A fairly common bog-plant more especially in cold regions". Anon. 1 was also collected from "rather moist places". There are several references to granite on labels, while the collection Williams ii.1963 came from "Loamy soil on colluvium".

Flowering occurs approximately between November and May, but probably extends outside of this range as the one November collection bears some capsules and the only May collection is in bud and flower.

NOTES:

1. E. durietziana is most closely related to E. cuneata Forst. f. of New Zealand, which is distinguished by its densely setose capsules, lower corolla lobes externally hairy all over, the complete absence of glandular hairs from the rachis, externally glabrous calyx (except at base of median clefts) and larger seeds. The many differences between E. durietziana and E. phragmostoma are detailed in the key to the Australian species of Sect. Cuneatae.

2. E. durietziana shows variation in the incidence of glandular hairs on the rachis and the upper part of the axis. It is impossible to determine on the material available whether the variation occurs between populations constant in this character, in which case taxonomic recognition would be warranted, or consistently within populations. The collection Boorman NSW10931 contains material from apparently several plants which vary in the incidence of the glandular hairs on the rachis.

3. This biogeographically interesting species is named after the late Professor G. Einar Du Rietz who contributed greatly to the elucidation of the taxonomic and biogeographic complexities of Euphrasia in the Southern Hemisphere and Tropics.

SPECIMENS EXAMINED:

New South Wales

Anon. 1, s.dat. Guy Fawkes, New England - head of Clarence River. MEL41426. -- Anon. [Herb. Weber] s.n., s.dat. Liverpool plains. HBG. -- Boorman s.n., -.v.1914. Wallangarra. NSW10931,G. -- Davis per F.A. Rodway s.n., 31.i.1941. Ebor Falls, 50m N.E. of Armidale. NSW22266. -- Department of Agriculture, Leeton 6, 20.i.1963. 30 miles east of Glen Innes. NSW126389. -- Hore-Lacy

185, 30.iv.1961. Pt. Lookout. NE. -- McKie 2308, 20.ii.1940. Point Lookout, New England Natl. Park. 50 miles NE of Armidale. NSW10930,BISH. -- Paterson s.n., 28.ii.1958. Ebor Falls. NSW126388(holotype). -- Williams s.n., -.xi.1960. 2 miles SW of Point Lookout. NE. -- Williams s.n., -.ii.1963. Upper Wright's Lookout track, near Point Lookout. NE. -- Winterhalder s.n., 24.i.1961. Near Pt. Lookout. NE.

2. Euphrasia phragmostoma Barker, species nova

LATIN DIAGNOSIS:

Species nova Euphrasiae Sectionis Cuneatae a E. cuneata et E. durietziana differt calycibus, bracteis foliisque superis glandulosis, longitudine formaque singulari aristarum postremarum antherarum, et lobis inferis corollae truncatis vel nonprofunde emarginatis usque obtusis; etiam a E. durietziana differt corollis maioribus, capsulis dense setosis, foliis summis axium primorum floralium longioribus, inflorescentiisque primis floribus paucioribus.

Holotypus (tab. 15): Rev. J. Bufton 8, 1893. Marion Bay Tasmania. MEL41727.

DESCRIPTION (based on material from two plants):

Erect foliose perennial (?herb) or undershrub, probably over 25cm tall, with many ascending or erect branches arising high above ground level from other branches or stem.

Stem of unknown nature; main floral branches probably over 20cm high to base of inflorescence, simple for 0-9 nodes below inflorescence, i.e. probably for little of the height of the inflorescence above ground level; upper 0(2) internodes as long as or longer than leaves, the longest internode $\frac{1}{2}$-$1\frac{1}{4}$ times length of upper leaves, remaining shorter than leaves lower down; axes in upper parts bearing two rows of dense short eglandular hairs decurrent from between leaf bases, with somewhat sparser eglandular indumentum between, sometimes mixed with dense, long to very long glandular hairs, with indumentum somewhat sparser and shorter lower down.

Cotyledons not seen.

Leaves: uppermost leaves of main floral branches ca. 9-14mm long, 5-7mm broad, spathulate, crenate to serrate-crenate, with sessile gland patches on specimens seen confined approximately to distal 0.5-0.6 of undersurface, otherwise bearing moderately long to long glandular hairs, sparse and confined to base or dense all over, mixed with short to moderately long eglandular hairs moderately dense on upper side, sparse on lower side; base narrow long attenuate, subpetiolate; lobes 2 along each margin but probably more variable, confined to distal ca. 0.3-0.4 of leaf, bluntly obtuse or acute, the longest tooth ca. 0.2-1.2mm long; apex ca. 1.0-2.2mm long, ca. 3.0-3.8mm broad, bluntly broad obtuse or shortly broad acuminate; leaves lower down of similar size but sometimes for relatively shorter subpetiolate base, with similar indumentum; leaves on young shoots small subpetiolate, with 1 lobe along each margin.

Inflorescences racemes, moderately dense to dense in flower, with several (? ca. 12) flowers; pedicels at lowest node ca. 2-3.5mm long, shorter higher up; rachis with indumentum similar to that on upper part of axis; apical bud cluster: initial shape and development unknown.

Bracts: lowermost bracts similar in shape, size and indumentum to uppermost leaves.

Calyx ca. 7-8.5mm long, externally covered by sparse to dense, short eglandular hairs mixed with sparse to dense, short to long glandular hairs, internally bearing a dense mixture of short to moderately long glandular and eglandular hairs; lobes bluntly acute or obtuse; lateral clefts ca. 0.5-1.0mm deep, much shorter than median clefts, which are ca. 3.2-4.2mm deep.

Corolla (3 studied) ca. 14-20mm long along upper side, with colour unknown but probably with purple or indigo striations on lobes; tube ca. 7.3-12mm long, narrow-cylindrical, abaxially and somewhat laterally expanded below point of insertion of anterior filaments which is ca. 4.5-8mm from base of corolla, externally covered all around by dense moderately long to long eglandular hairs, sometimes mixed with moderately long glandular hairs on distal abaxial parts, with patch of glandular hairs behind lateral cleft, internally covered all around by dense long eglandular hairs; hood ca. 6.5-7.7mm long, [?ca. 6.5-7.5mm broad (including lobes), ?ca. 4.5-6mm broad (excluding lobes)], externally covered by dense long eglandular hairs, sometimes mixed with sparse to dense, moderately long to long glandular hairs, internally with dense long eglandular hairs between bases of filaments and a little distally, and dense patch of very long eglandular hairs behind sinus, glabrous in between; upper lobes obtuse to shallowly emarginate, with rear surface covered by sparse short glandular hairs, with margins ciliolate with moderately dense mixture of short moderately long glandular and eglandular hairs, with cleft between ca. 0.5-1.0mm deep; lower lip ca. 7-8.5mm long, ca. 9-11mm broad, concave from above, downturned from base such that at right angles or more to upper side, externally covered by moderately dense mixture of moderately long to long eglandular and glandular hairs, with margins ciliolate with similar indumentum, internally glabrous except at base of lip; lower lobes truncate or shallowly emarginate to obtuse.

Stamens (2 studied) with filaments glabrous but for densely setose base of anterior pair, the anterior pair ca. 6.5mm long; the posterior pair ca. 3.2mm long; anthers 2.3-2.6mm long, 1.2-1.8mm broad, with area about connectives glabrous, with slits lined by dense long eglandular hairs, with posterior pair of awns 2.7-3.2mm long, in distal part flattened or twisted with margins erosulate, with apex acute, with anterior awns 0.1-0.3mm long, smooth and sharp.

Ovary (2 studied) in lateral view ovate-elliptic, compressed laterally, in median view narrow acuminate-elliptic to ovate-caudate with very few [? to dense] short setae in apical region; apex in lateral view broadly acute or obtuse, often oblique; ovules ca. 60-70.

Capsules (few seen) ca. 7-10mm long, in lateral view obovate-elliptic, ca. 3-4mm broad, in median view narrow elliptic-acuminate, or covered in upper $\frac{1}{4}$-$\frac{1}{3}$ by sparse to dense setae 0.2-0.3mm long, apex obtuse; seeds not seen.

Chromosome number: Unknown.

Plates: 4, 11, 15

Figures: 10

TYPIFICATION:

Holotype (pl. 15): Rev. J. Bufton 8, 1893. Marion Bay Tasmania. A distinct variety I think of Euphrasia Brownii - on mountain top. MEL41727.

The holotype is in very good condition and consists of a large leafy fragment, bearing many branches and shoots and buds, flowers and a few capsules without seed. A small fragment with a flower and another, possibly of part of the stem, are also present.

It is imperative that material from the Marion Bay area be found as knowledge of the extent of variation in all characters of this distinctive species is required.

DISTRIBUTION (Fig. 10) AND ECOLOGY:

E. phragmostoma is known from only two localities which both occur in the region of the Tasman and Forestier Peninsulas in the south-east of Tasmania. It is possible that the species is confined there as the region bears mountains reaching between 600-

1000m high (Davies ed. 1965: Map 5), which are isolated from the high mountains to the west, and has a higher rainfall than surrounding lowland regions (Davies ed. 1965: Map 2). The Marion Bay collection (Bufton 8) labelled "on mountain top" may have come from such an area. The other specimen (Bufton 7) was "found on coast" at Port Arthur. Montane vegetation often reaches sea level in this area and thus the species may be restricted to this habitat. It is likely that this species may still survive as large tracts of montane and coastal vegetation exist in the region.

Data on flowering times are unavailable.

NOTES:

1. The distinctive foliose, much branched habit, the petiolate leaves and the posterior anther awns which are unique in the genus set the two specimens of E. phragmostoma collected to this time so greatly apart from the other known Tasmanian species that it is certain that they belong to a distinct species. It is hoped that the publicity gained by its formal recognition will help lead to the fruition of the search for the highly desirable further collections of this remarkable species.

2. E. phragmostoma is the sole member of Sect. Cuneatae in Tasmania and is distinctive in the section and the genus by the remarkable length and shape of its posterior anther awns (pl. 4) which apparently jut out over the lower corolla lip and serve to hinder the entry of nectar-gathering pollinators (hence the specific epithet, literally meaning "screened mouth").

E. cuneata Forst.f., which is endemic to New Zealand, is the species of Sect. Cuneatae most closely related to E. phragmostoma, approaching it by its densely setose capsules and posterior anther awns, which are longer than in E. durietziana, the third species of the section. It differs however by its non-glandular indumentum, its emarginate corolla lobes and its shorter posterior anther awns (only about half the length of the anther cells, whereas those of E. phragmostoma ± equal them) with a sharp tapering ± cylindrical tip. The characters distinguishing E. phragmostoma from its counterpart from northern New South Wales, E. durietziana, are shown in the key to the species of Sect. Cuneatae in Australia.

SPECIMENS EXAMINED:

Tasmania

Bufton 7, 1892. Port Arthur, found on coast. MEL. — Bufton 8, 1893. Marion Bay - on mountain top. MEL(holotype).

II. Sect. Striatae (Du Rietz)Barker Subsect. Striatae

For synonymy, description, typification and distribution, see Chapter 5: p.144.

NOTES:

1. E. crassiuscula (q.v.: Intraspecific Variation) varies in the characters of anther back indumentum and corolla coloration, which are the main characters used to distinguish the two sections, Sect. Australes and Sect. Striatae Subsect. Striatae, to which it has the closest affinities. It seems likely that it is a stabilized hybrid between species of the two sections. It has been included in Sect. Australes because it is closest related to the present-day species of that section. Because E. crassiuscula ssp. eglandulosa usually has the conspicuously striated corollas and glabrous anther backs of Sect. Striatae it has been included in the key to the species of Subsect. Striatae.

2. Three plants apparently linking E. hookeri with the other species of Subsect. Striatae have been collected from Mt. La Perouse in south-western Tasmania (F.A. Rodway NSW22280 p.p.). The plants resemble E. hookeri in size, their apparently single-stemmed habit with small imbricate leaves, their small corollas and their very short glandular indumentum confined mainly to the margins of the bracts and calyces. Only in their leaves, the margins of which are recurved but not coherent, do they differ from E. hookeri. From E. striata and E. semipicta they differ by their glandular inflorescence and habit, while from E. gibbsiae they differ in flower size and habit. A search for identical plants on Mt. La Perouse should be made to determine whether these plants represent an undescribed species or a hybrid between E. hookeri and another species of Subsect. Striatae

SPECIMEN EXAMINED:

F.A. Rodway s.n., -.xii.1899. La Perouse. Tas. NSW22280(p.p.).

3. Two collections from South Port, collected by Stuart and placed under his number 1744, approach E. semipicta by their glabrous-backed anthers, erect stems branched well above ground level, leaves with one tooth along each margin and the absence of glandular hairs from the calyces, bracts, rachises, leaves and axes. Unfortunately the presence of striations on the corollas is not able to be discerned. The material differs in corolla shape from the known representatives of E. semipicta on the Tasman Peninsula, namely by the smaller upper lobes (the cleft between them is ca. 0.5-0.6mm deep), a smaller lower lip (ca. 2.0-3.7mm long, ca. 5-6mm broad) and a contrastingly long tube (ca. 6-7mm long). In addition the seeds are larger in the Stuart collections (1.1-1.4mm long) and the one count made of both ovule number (80) and seed number (43) falls on the lower part of the range of variation for typical E. semipicta.

A search for further material in the South Port region must be made to determine the true meaning of these differences. It is unlikely that these plants are hybrids as pollen from a flower of each collection is almost entirely functional in appearance (Appendix 1: PS168,273). Rather the specimens may represent an undescribed species with a unique corolla shape, the leaves of E. striata and the habit of E. semipicta, and intermiediate between the two species in seed size and ovule and seed numbers.

SPECIMENS EXAMINED:

Tasmania

[Stuart 1744], -.xii.1855. South Port. MEL41437(p.p.). -- Stuart 1744(p.p.), -.xii.1856. South Port. MEL41450(p.p.).

4. The fragment in Scott MEL41790 almost certainly represents a new species or a most unusual monstrosity of unknown origin. It seems unlikely that it is of hybrid origin as it is clearly divergent from all known Australian species. The plant is unique because of its

leaves with a very narrow attenuate base and a large bluntly broad acute to obtuse apex extending well past a pair of short bluntly obtuse lobes. Among the Australian species it approaches E. striata of Subsect. Striatae in leaf shape, although the apex of E. striata is somewhat shorter relative to the lobes. The leaves resemble most closely those of the New Guinea species of Sect. Striatae Subsect. Pauciflorae. The glabrous anther backs of the flowers of the fragment ally it with both these subsections, although the calyces, bracts and rachis are covered by a dense, long [0.3-0.4mm] glandular indumentum, which is unknown in the New Guinea species.

SPECIMEN EXAMINED:

Tasmania

Scott s.n., s.dat. Without locality. MEL41790

KEY TO THE SPECIES OF SECT. STRIATAE SUBSECT. STRIATAE:

1a. Leaves and bracts with margins of apex and teeth recurved so greatly that they cohere along entire length, with sessile glands lacking on underside.

Ser. Hookerae
6. E. hookeri

1b. Leaves and bracts with margins of apex and teeth recurved but clearly separated, with sessile gland patches apparent on underside.

Ser. Striatae

.... cont.

2a. Calyces, bracts, and at least upper leaves lined by long woolly eglandular hairs. Inflorescences bearing ca. 20-40 flowers; apical bud cluster conical, subacute. Sessile gland patches confined to distal $(\frac{1}{2})\frac{3}{4}$ or more of lower surface of uppermost leaves.

17. <u>E. crassiuscula</u>

[see Sect. <u>Striatae</u>: Note 1]

2b. Calyces and bracts bearing short straight eglandular hairs on margins, leaf margins lacking them. Inflorescences bearing (6)10-20(26) flowers; apical bud cluster spherical to conical or ellipsoid, broadly rounded. Sessile gland patches confined distal $\frac{1}{3}$ - $\frac{1}{2}(\frac{2}{3})$ of lower surface of uppermost leaves.

3a. Bracts, outer surfaces of calyces and often uppermost leaves, sometimes almost all leaves bearing glandular hairs. Corolla with hood (4.0)4.2-5.0(5.4)mm long; lower lip (6.8) 7.8-10.8(11.2)mm long, (13)14.5-17.5(20)mm broad. [Corolla partially to extensively striated. Stem reduced or conspicuous. Apices of capsules broadly acute to truncate to emarginate in lateral view. Ovules (38)52(71). Seeds (5) 30(66), (0.8)1.1-2.0(2.2)mm long.]

3. <u>E. gibbsiae</u>

3b. Bracts, outer surfaces of calyces and leaves lacking glandular hairs; rarely with calyces bearing one or two tiny glandular hairs. Corolla with hood 2.3-4.2mm long; lower lip 5.8-8.0mm long, 9.6-15.5mm broad.

4a. Corollas prominently and $\pm$ equally red-purple striated on all three lower lobes. Stem usually reduced; branches ascending, branched and rooting in prostrate regions, simple in erect parts. Hairs lining anther slits 0.05-0.15mm long. Apices of capsules emarginate to broadly obtuse in lateral view. Ovules 25-60. Seeds ca. 7-33, (0.8)1.2-1.8(2.0)mm long.

4. E. striata

4b. Corollas with lateral lobes red-purple striated, with lowest lobe finely blue-striated or lacking striations. Stem conspicuous, bearing inflorescence in first year, then dying back to uppermost branches; branches ascending, arising from stem above ground level. Hairs lining anther slits 0.2-0.4mm long. Apices of capsules broadly acute to truncate in lateral view. Ovules 80-120. Seeds ca. 48-78, (0.5)0.7-0.9(1.0)mm long.

5. E. semipicta

3. Euphrasia gibbsiae Du Rietz, Sv.Bot.Tidskr.42(2)(1948)104, f.2,3,4,5,6,t.3.4: 42(4)(1948)351,362; Curtis, Stud.Fl. Tasm.(1967)531; Willis, Muelleria 1(1967)147, p.p.(as to Tasmanian occurrences and f. subglabrifolia in Victoria); Cochrane, Fuhrer, Rotherham & Willis, Fl.Pl.Vict.(1968)204; Harris, Alp.Pl.Austral.(1970)138, p.p.(excl. "f. comberi" in Victoria); Willis, Hdbk.Pl.Vict.2(1973)573, p.p.(as to f. subglabrifolia).

E. kingii Curtis, Stud.Fl.Tasm.(1967)650,530

[E. gibbsiae Du Rietz, Sv.Bot.Tidskr.24(1932)532, nomen nudum; Comber, Field Notes Tasm.Pl.coll.H.F.Comber 1929/30(1931)32(non vidi)]

[E. brownii FvM., Fragm.Phyt.Austral.5(1865)89, p.p.(as to var. psilantherea p.p.) nom.illeg.; ?Spicer, Hdbk.Pl. Tasm.(1878)77, p.p.(probably as to some plants with "streaked" corollas); ?Rodway, Fl.Tasm.(1903)143, p.p.]

[E. striata auct.non R.Br.: Benth., Fl.Austral.4(1868)521, p.p.(as to Stuart 1745, Milligan MEL41451 p.p., Mueller MEL41539); Wettst., Monogr.Gatt.Euphrasia (1896)252, p.p. (as to Oldfield W36919, W36922)]

[E. collina auct. non R.Br.: Wettst., Monogr.Gatt.Euphrasia (1896)254, p.p.(as to Labillardiere G)]

[E. milliganii Du Rietz, Sv.Bot.Tidskr.42(1948)358,362, nomen nudum; Willis, Muelleria 1(1967)148]

DESCRIPTION:

Perennial herb of variable habit, with axes and rachises and partly leaves, bracts and calyces red-brown.

Cotyledons not seen.

Inflorescences but for lowermost 0-1(3) nodes dense racemes, although buds often undeveloped at lowermost nodes; stem inflorescence or, if stem reduced, branch inflorescences producing (10)14-24(36) flowers; rachis with variable indumentum; internodes hardly elongating after anthesis, such that, except sometimes at wider-spaced lower internodes, capsules usually extending past base of calyx above; pedicels of lowermost flowers 1.0-2.5(4.0)mm long, shorter towards apex; apical bud cluster (excluding buds at widely spaced lower nodes if any) usually ellipsoid to spherical, rarely acutely conical, initially ca. 1-2.5mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 1-3(4) nodes have reached anthesis.

Bracts similar to uppermost leaves, but with variable indumentum.

Calyx (5.0)6.0-10.0(10.8)mm long, with indumentum on outer surface variable, with inner surface of teeth and distal half of tube covered by sparse to dense, usually short to moderately long, rarely long eglandular hairs, usually all over, sometimes confined to distal parts, mixed with usually moderately dense to dense, rarely sparse, usually short to moderately long, rarely long glandular hairs, usually all over, sometimes restricted to proximal parts; teeth sharply to bluntly acute; lateral clefts (1.7)2.2-4.0(5.0)mm deep, shorter than median clefts which are (2.4)3.3-6.0(6.5)mm deep.

Corolla (9.8)11.6(13.0)mm long along upper side, white, lilac, deep lilac, purple or blue, with yellow to orange blotch behind lowest lobe and deep in tube at base of anterior filaments, with red-purple, purple or indigo striations confined almost entirely to tube and hood or with 3-5 striations extending well out onto each of some or all lobes; tube (5.3)7.0(8.5)mm long, narrow cylindrical, abaxially and laterally broadened near point of insertion of anterior filaments which are (3.0)4.5(6.8)mm from base of corolla, externally glabrous at base, on distal, adaxial and lateral surfaces from at least base of anterior filaments covered by usually dense long, rarely moderately dense, moderately long eglandular hairs, glabrous below about base of anterior filaments, on abaxial surface glabrous further forward with widened part bearing moderately dense to dense, short eglandular or glandular hairs or mixture of both, with small dense patch of short glandular hairs about lateral cleft, internally glabrous at base, distally covered by moderately dense to dense, short to moderately long eglandular hairs about filaments and below, sometimes also between them, sometimes glabrous along midline of adaxial side; hood (4.0)4.2-5.0(5.4)mm long, (3.8)4.0-5.0(5.5)mm broad (excluding lobes), (5.8)7.0-9.4(10.2)mm broad (including lobes), externally covered by dense, moderately long to very long eglandular hairs, sometimes with sparse to dense, short glandular hairs on sides, internally usually glabrous but for dense long eglandular hairs sometimes mixed with sparse to dense, short glandular hairs in sinus region, sometimes with dense long eglandular hairs along midline above tube, rarely covered by sparse short glandular hairs denser along midline; upper lobes coplanar or almost so, obtuse to truncate, sometimes praemorsely so, to emarginate, glabrous on front surface and margins, on rear surface usually glabrous or with a few short to moderately long glandular hairs, sometimes mixed with eglandular hairs at base, sometimes covered by moderately dense, short to moderately long glandular hairs, sparser or absent distally, rarely with moderately dense, moderately long eglandular hairs in distal half, with cleft between (0.9)1.4-3.0(3.3)mm deep; lower lip (6.8) 7.8-10.8(11.2)mm long, (13.0)14.5-17.5(20.0)mm broad, concave from above, downturned from base such that more than perpendicular to upper side, externally usually covered by very sparse to dense, short to long eglandular hairs, often mixed with sparse to moderately dense, short to moderately long glandular hairs, rarely glabrous, internally and on margins glabrous except rarely for eglandular hairs lining margins; lower lobes broadly obtuse to truncate to emarginate, sometimes praemorse, with clefts between (3.3)3.8-6.0(6.4)mm deep.

Stamens with filaments glabrous, the anterior pair 4.5-5.7 (6.2)mm long, the posterior pair (1.7)2.2-3.3(3.4)mm long; anthers (1.0)1.3-2.0(2.2)mm long, (0.8)1.0-1.5(1.7)mm broad, with area about connectives usually glabrous, very rarely bearing a few moderately long flexuose eglandular hairs, with slits lined especially towards awns by dense, very short to long eglandular hairs, with posterior pair of awns (0.25)0.3-0.5(0.6)mm long, longer than awns of other three pairs.

Ovary in lateral view usually broad oblong to broad elliptic, sometimes ovate, rarely obovate-elliptic, often oblique, hardly compressed laterally, in median view ovate to elliptic-ovate, glabrous usually except for very sparse to dense, moderately long to very long setae, confined to upper $\frac{1}{6}$ - $\frac{2}{5}$ or very apex; apex in lateral view usually broadly obtuse to truncate rarely broadly acute, often oblique; ovules (38)52(71).

Capsules (6)6.5-10(11)mm long, in lateral view obovate to elliptic, (3)3.5-4.5(4.6)mm broad, laterally compressed, in median view narrow ovate to elliptic, sometimes glabrous, sometimes bearing a few short to long setae at apex or moderately dense setae over upper $\frac{1}{8}$ - $\frac{1}{2}$, short to moderately long at apex, short lower down; apex in lateral view emarginate to truncate or broad obtuse, often obliquely so; seeds (5)30(66), obovoid, oblong or ellipsoid, often obliquely so or flattened, (0.8)1.1-2.0(2.2)mm long, (0.4)0.5-1.0(1.1)mm broad.

Chromosome number: Unknown.

Other characters very variable (habit, stem, branches, leaves, bract indumentum, external indumentum of calyx): see descriptions of infraspecific taxa.

Plates: 1, 5, 16, 17

Figures: 11-12

TYPIFICATION:

Holotype: L.S.Gibbs 6502, -.xi.1914. Lake Fenton, on rocks in open. 3500'. Flowers white, veined mauve. BM(p.p.).

Isotype: K. Illustration: Du Rietz 1948a pl.3, f.2.

The holotype consists of a large part of a plant in full flower with six floral branches. It is mounted with a small fragment of a floral branch from the collection Gibbs 6601; this belongs to one of the subspecies of *E. gibbsiae* with glabrous leaves (cf. Du Rietz 1948a p.109) but unfortunately the specimen was not available at the time when an accurate identification could have been made. The isotype contains a single entire floral branch in full flower.

The populations of ssp. *gibbsiae* which still occur in the region of Lake Fenton are in little danger as they occur in a National Park.

DISTRIBUTION (Figs. 11-12):

E. gibbsiae is widespread in the alpine and subalpine areas of central, southern and western Tasmania and in the southern and western lowland areas of the island where rainfall is extremely high. The species extends into the eastern highlands of Victoria where it is known only from the subalpine areas of the Baw Baw plateau.

It ranges in altitude from sea level to at least 1550m.

The nine subspecies are more restricted in their geographical and altitudinal distributions (for details, see under treatment of distribution for each species).

ECOLOGY:

E. gibbsiae occupies a wide spectrum of habitats, ranging from coastal heath and button-grass moorlands in lowland areas to alpine heath and blanket bog or cushion plant expanses on the highest summits. Nine subspecies are strongly ecotypically defined within this range (for details refer to ecological treatment under each subspecies).

The period of flowering of the montane species is limited to a definite period of two or three months, but the two lowland subspecies, ssp. psilanthera and ssp. kingii, may flower over a longer period (for details see under respective subspecies).

INTRASPECIFIC VARIATION:

E. gibbsiae is highly polymorphic and consists of nine geographically and ecotypically separated subspecies. In the initial description of the species Du Rietz (1948a) referred to its extreme polymorphism and recognised from a small number of specimens several forms which are identical to some of the subspecies of the present work. However his prediction that several species may be discovered within E. gibbsiae as delimited by him has not been realised.

Pure populations

Distribution (figs. 11-12) and ecology of the pure populations of each subspecies are discussed under the treatment of the subspecies concerned. While E. gibbsiae encompasses wide geographical, ecological and altitudinal ranges, the subspecies are much more restricted. Except for the occurrence near Mt. Field East of a population with affinities to ssp. subglabrifolia which is otherwise endemic to the Baw Baw plateau in Victoria (see ssp. subglabrifolia: Note), all subspecies apparently have non-disjunct ranges of distribution. Large discontinuities in distribution seem to have arisen because the intervening areas have been inadequately botanised in the past rather than from a lack of suitable habitats.

Except for ssp. wellingtonensis and possibly ssp. subglabrifolia (if the Mt. Field population proves to be taxonomically distinct) which appear to be completely isolated, the range of distribution of each subspecies coincides with that of at least one other subspecies. Observations of ecological preferences and the ability to retain genetic integrity have been made in these areas of overlap, and it has been found that morphological differences usually are retained but sometimes break down.

a. Subspecies for part of their range geographically sympatric, but ecologically allopatric with no known morphological intergradation.

Ssp. gibbsiae and ssp. pulvinestris are ecotypically differentiated in the western portion of the Mt. Field massif. Generally ssp. pulvinestris exclusively occupies the extensive areas of blanket bog cushion plants in the summit regions, while ssp. gibbsiae occurs in the tall alpine heath, or low heath where clumps of "pineapple grass" (Astelia sp.) predominate. The collections Barker 1168-1169 come from the one area of overlap of populations of the two subspecies observed. Between pure cushion plant and open low heath occurs an ecotone consisting of cushion plants mixed with fine grass. In this ecotone plants of both subspecies were found growing side by side, but no morphological intermediates were observed. Apparently there is some sterility barrier between the two subspecies, since they were flowering simultaneously.

In the eastern portion of the Mt. Field massif a form related closely to ssp. subglabrifolia (q.v.: Note: Barker 1187) occurs on the banks of shallow rivulets (ca. ½m deep) running across a broad low subalpine heathland. Populations of ssp. gibbsiae (Barker 1184) and intergradations between ssp. gibbsiae and ssp. comberi (Barker 1189) occupy the surrounding ridges in snowgum woodland. However no spatial overlap was observed and morphological distinctions were retained, the internodes of ssp. aff. subglabrifolia being much longer, and its glandular indumentum much more restricted. Flowering apparently was more or less simultaneous.

Three subspecies of E. gibbsiae occur in the vicinity of Cradle Mt. Ssp. gibbsiae (Barker 1205, 1216, 1218B) and ssp. discolor (Barker 1206, 1218A) both occupy the upper slopes of the mountain. There are no obvious ecological differences except that ssp. gibbsiae may inhabit more sheltered areas in tall heath or among doleritic boulders. Near the very summit of Cradle Mt. the two subspecies were found growing either together or in close proximity, although there is some doubt on the exact locality details (see ssp. discolor: Note 2). No morphological intermediates were observed, and since flowering occurred simultaneously, there must be some barrier to interbreeding. The third subspecies, ssp. microdonta, apparently grows in button-grass moorland in the broad valleys well below the habitats of the other two subspecies. E. gibbsiae has never been recorded from the slopes between even though the Cradle Mt. region is relatively well-botanised. This spatial separation between ssp. microdonta and the other two subspecies, together with a difference in flowering period (in accordance with altitudinal differences) should give little opportunity for interbreeding even if it is possible.

b. Subspecies geographically and ecologically sympatric with morphological intergradation questionable.

Ssp. comberi and ssp. gibbsiae both occur in subalpine and alpine areas of the Mt. Field massif. The collection Barker 1184 from near Mt. Field East consists mainly of ssp. gibbsiae but contains three fragments of ssp. comberi probably from a single plant. The collection Telford 2233 from Mt. Field West also contains a mixture of both subspecies. It was possibly collected from the wide area of alpine heath above Clemes Tarn along the track to Mt. Field West, between the altitudes of 1250m and 1310m. Plants of ssp. gibbsiae and ssp. comberi were found growing side by side over this entire area (Barker 1173-1175). The specimens of ssp. gibbsiae have the typically dense long glandular indumentum on the lower leaves and at least the distal prostrate parts of the axes, as well as higher up. Those of ssp. comberi also have a typical glandular indumentum generally confined to the inflorescence and the leaves immediately below it (Barker 1174(2), 1175, 1173A), although it rarely extends to the leaves lowermost on the distal erect parts of the branches (Barker 1174(2) p.p.); glandular hairs are absent from the entire axis and sometimes also the rachis. Intermediates, which for example might have had short glandular hairs extending well down the axes but absent from the prostrate or ascending parts, were not observed. Plants from each subspecies were tested for pollen sterility (Appendix 1). Both ssp. gibbsiae (PS141, 154-158) and ssp. comberi (PS143-145) showed almost entirely normal pollen. The plants in Barker 1174(2) with glandular hairs on the leaves well down the branches were similarly tested. Two fragments (PS151, 153) possibly from the same plant showed a high percentage of empty sterile pollen. The other four plants tested (PS142,149,152, 163,164) showed normal pollen.

Because the distinction of the two subspecies is based almost entirely on a single character difference, i.e. the distribution of glandular hairs on the vegetative parts, and as no range of intermediate types of indumentum distribution are apparent, it is impossible to determine from the above evidence whether the two subspecies interbreed or if there are strong barriers preventing this. Certainly there is ample opportunity for interbreeding as both taxa occur together over a wide area and flower simultaneously. If interbreeding does occur it is possible that the two indumentum types which separate ssp. gibbsiae and ssp. comberi are controlled by a simple dominant-recessive effect at a single gene locus, since there is no transitional range of indumentum types. A detailed genecological study of the populations of the two subspecies in the Clemes Tarn area is required and may assist in determining the true nature of the differences between them.

c. Subspecies geographically sympatric, ecologically allopatric, with morphological intergradation along an ecotone.

The two subspecies which are widely spread in south-western Tasmania, ssp. comberi of alpine and subalpine areas and ssp. kingii of lowland areas, apparently intergrade along ecotones between their two habitats. Such an ecotone was observed in the Hartz Mountains National Park along the track to Mount Snowy (Barker 1197, 1191, 1193, 1194). A morphological study of these collections is impaired by the general lack of flowering material. The two subspecies apparently can be distinguished on flower colour, with the corollas of ssp. comberi being consistently white and those of ssp. kingii varying from white to deep purple or blue. They can also be distinguished by their distinct habits, and by the shape of the capsule apex, although this has not been investigated fully (see ssp. kingii: Note 1).

At the highest locality collected from, ssp. comberi was found growing in "cushion plants, or amongst stems of prostrate woody plants in doleritic flat alpine moorland" (Barker 1194). The plants had the typical clusters of decumbent or ascending branches arising from the reduced stem or other branches at ground level, and simple higher up. They also bore broad, emarginate to broadly obtuse capsules. In the lowest locality in snowgum woodland grew plants (Barker 1197) resembling ssp. kingii in their tendency towards erect branches, (although no stem was apparent), the frequent occurrence of shoots and branches in the axils high above ground level, and the narrower broadly obtuse capsules. On the slopes connecting these two localities occurs alpine heath. Forms intermediate between the two subspecies occurred in this area in openings between shrubs, but it is unlikely that these intermediates are sterile hybrids as seed set appears normal. Rather the intermediates appear to be part of a cline or hybrid swarm with fully fertile hybrids along an altitudinal and ecotonal gradient. It is probable that the "cline" continues to lower elevations in the area where pure populations of ssp. kingii may be found. Similar "clines" may also occur on the Snowy Range (Edwards AD97347079) and elsewhere in south western Tasmania. Except for one abnormal plant* the six specimens tested of the

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* A single anomalous specimen with long glandular hairs occurring sparsely well down a floral branch axis in the collection Edwards AD97347079 has a rather high pollen sterility count of 43% Appendix 1: PS162). It may either be a monstrosity or a hybrid between plants of the intergradation between ssp. comberi and ssp. kingii and an unknown parent (?ssp. gibbsiae) with glandular hairs occurring well down the axes.

Edwards collection, contained pollen almost entirely normal in appearance (Appendix 1: PS159-161, 165-167). Thus there is no evidence of any sterile hybrids from either the seed or pollen set in intergradations between the two subspecies.

The existence of these intergradations between ssp. comberi and ssp. kingii must cast some doubt on the genetic basis of their distinguishing characters. An experimental study involving the raising of seedlings of one subspecies in the habitat of the other would help to determine whether they are solely environmental modifications. If the characters were shown to have no genetic basis there would then be no grounds for recognising ssp. comberi and ssp. kingii as distinct taxa.

SPECIMENS EXAMINED FROM A MIXED POPULATION OF SSP. GIBBSIAE AND SSP. COMBERI:

Tasmania

Barker 1173 & 1173A, 19.i.1971. Mt. Field Nat. Park; along track to Mt. Field West between ca. 400 and 1200m west of Clemes Tarn. AD. -- Barker 1174(1), 1174(2) & 1175, 19.i.1971. Mt. Field Nat. Park; ca. 400m west of Clemes Tarn on the track to Mt. Field West. AD. -- Barker 1184, 21.i.1971. Mt. Field Nat. Park; on slopes of Mt. Field East immediately above Windy Moor, ca. ½km south-west of summit. AD. -- Telford per Canning 2233, 2.ii.1969. Mt. Field National Park (Mt. Field West). CBG.

SPECIMENS INTERMEDIATE BETWEEN SSP. COMBERI AND SSP. KINGII

Tasmania

Barker 1191, 23.i.1971. Hartz Mountains National Park; ca. 1km south of hut near car park at end road into Park, on the track to Mt. Snowy. AD. -- Barker 1193, 23.i.1971. Hartz Mountains National Park; ca. 1½km from the hut near the car park at the end of the road into the Park; above the tarns on the Mount Snowy track. AD. -- Barker 1197, 23.i.1971. Hartz Mountains National Park; ca. 100m from hut near the car park at the end of the road into the Park; beside the track to Mt. Snowy. AD. -- Edwards s.n., 27.xii.1970. Snowy Range. From L. Skinner to ½m below L. Skinner. AD97347079.

KEY TO THE INFRASPECIFIC TAXA OF E. GIBBSIAE:

1a. Glandular hairs on inflorescence parts and over all vegetative parts excluding roots and old parts of axes, rarely absent from prostrate parts of axes if present. [Corolla white, with striations usually extending well out onto lobes, rarely confined to tube and hood.]

2a. Plant with single erect stem bearing branches above ground level.

b. ssp. psilanthera

2b. Plant with many branches arising from the base of the stem or prostrate parts of other branches.

3a. Glandular hairs (0.1)0.3-0.4(0.7)mm long on distal prostrate parts of axes. Uppermost leaves of floral branches with (1)2(5) teeth along each margin, (4)6-9(11)mm broad. Floral branches (3)5-9(12)cm high to base of inflorescence. Anthers (1.5)1.7-1.9(2.0)mm long.

a. ssp. gibbsiae

3b. Glandular hairs 0.05-0.2mm long on distal prostrate parts of axes. Uppermost leaves of floral branches with 1-2 teeth along each margin, (2.5)4-6(7)mm broad. Floral branches (1.5)3-6(10)cm high to base of inflorescence. Anthers (1.2)1.4-1.6(1.8)mm long.

c. ssp. wellingtonensis

1b. Glandular hairs usually confined to inflorescence, sometimes extending onto upper vegetative parts, sparse or absent from uppermost parts of axis, lacking from axis lower down and from axes of shoots.

4a. Plant with single erect stem, bearing shoots and branches from ground level to high in upper parts, or with one to several branches developing from base and similar to stem in branching well above ground level. [Corolla usually purple, lilac or blue, sometimes white, with striations extending well out onto lobes. Internodes below inflorescence usually longer than leaves, the longest internode (1)2(4) times length of upper leaves. Uppermost leaves of stem or main floral branches with 1-2(3) teeth along each margin, the longest tooth 0.8-1.5mm long. Anthers (1.0)1.3-1.6(2.2)mm long.]

e. ssp. <u>kingii</u>

4b. Plant with many ascending branches arising from base of stem or prostrate parts of other branches.

5a. Corolla with striations usually confined to tube and hood and hardly extending onto lobes, sometimes extending well out onto lateral lobes. [Corolla white. Upper 0-4(5) internodes of floral branches as long as or longer than upper leaves, the longest ($\frac{1}{2}$)1(2) times length of upper leaves. Uppermost leaves of floral branches longer than broad, (3)4-7(9)mm broad, with 1-2(3) teeth along each margin to longest tooth (1.2)1.4-2.5(3.0)mm long, with cuneate, often narrowly so, to attenuate base. Anthers (1.5)1.6-2.0(2.1)mm long.]

i. ssp. <u>pulvinestris</u>

5b. Corolla with striations usually extending from tube and hood well out onto lobes, sometimes with lowest lobe unstriated, rarely with only upper lobes striated.

6a. Upper (0)3-6(9) internodes of floral branches as long as or longer than upper leaves, the longest ($\frac{7}{8}$)$1\frac{1}{4}$-$2\frac{1}{4}$(4) times length of upper leaves. [In ssp. _micro-donta_ the internodes usually extend even further and are usually longer than these ranges.]

7a. Uppermost leaves of floral branches with (1)2-3 teeth along each margin, the longest tooth 0.5-1.0mm long. [Corolla white. Anthers (1.4)1.5-1.7(2.0)mm long.]

f. ssp. _microdonta_

7b. Uppermost leaves of floral branches with 1-2 teeth along each margin, the longest tooth (0.7)1.2-2.1(2.6)mm long. [Corolla white. Anthers (1.4) 1.5-1.9(2.0)mm long.]

g. ssp. _subglabrifolia_

6b. Uppermost 0(7) internodes of floral branches as long or longer than upper leaves, the longest ($\frac{1}{4}$)$\frac{1}{2}$-$\frac{7}{8}$($1\frac{1}{2}$) times length of upper leaves.

8a. Corolla white. Uppermost leaves of floral branches with (1)2–3(4) teeth along each margin, the longest tooth (0.8)1.5(2.0)mm long. Anthers (1.2) 1.4–1.7(1.8)mm long.

d. ssp. comberi

8b. Corolla white, lilac, deep lilac or purple. Uppermost leaves of floral branches with 1(2) teeth along each margin the longest tooth (1.2)1.5–2.5(3.0)mm long. Anthers (1.6)1.7–2.0(2.1)mm long.

h. ssp. discolor

a. ssp. gibbsiae

E. gibbsiae Du Rietz f. gibbsiae Du Rietz, Sv. Bot. Tidskr. 42 (2)(1948)104, f.2, pl.3

[E. gibbsiae Du Rietz f. comberi auct. non Du Rietz: Willis, Muelleria 1(1967)148, p.p. (as to Curtis MEL41527 from "K. Col on the track to Mt. Field West")]

DESCRIPTION:

Plant in open area (5)7–11(14)cm tall, when sprawling in shrubs up to over 20cm high, with many long ascending branches, finally erect, arising from reduced stem or prostrate or procumbent parts of other branches.

Floral branches: distal erect part (3)5–9(12)cm long to base of inflorescence; internodes between uppermost 0–3(5) nodes as long as or longer than upper leaves, the longest internode $(\frac{1}{2})\frac{3}{4}$–$1\frac{1}{2}(2)$ times length of upper leaves, shorter than leaves lower down; axis covered by usually two rows, sometimes two pairs of lines of sparse to dense, moderately long to long eglandular hairs decurrent from between leaf bases, mixed all round with usually long to very long, rarely short glandular hairs, the glandular hairs extending from the erect parts on to at least the leaves, young shoots and distal axes [where (0.1)0.3-0.4(0.7)mm long] of the prostrate parts, absent from older proximal parts.

Leaves: uppermost leaves of floral branches (6)7-11(13)mm long, (4)6-9(11)mm broad, obovate to broad ovate or spathulate in outline, covered by usually dense, sometimes moderately dense, usually moderately to very long, rarely short glandular hairs; base usually attenuate or narrow cuneate to broad cuneate, rarely rounded-cuneate; teeth (1)2(5) along each margin, the longest tooth (1.0)1.8(2.5)mm long; apex bluntly or sharply, usually shortly acuminate, sometimes acute, rarely obtuse or broadly short acuminate (1.3)2.2(3.0)mm long, (1.3)2.2(3.2)mm broad; lower leaves with similar indumentum.

Inflorescences with rachis with indumentum similar to upper axis.

Bracts with indumentum similar to uppermost leaves.

Calyx with outer surface covered on teeth and distal part of tube by dense, usually moderately long to long, rarely short glandular hairs, sparser on proximal part of tube.

Corolla white, with yellow blotch behind lowest lobe and deep in throat, with usually indigo, sometimes purple striations usually extending well onto lobes, sometimes almost confined to tube and hood.

Stamens with anthers (1.5)1.7-1.9(2.0)mm long.

Plates: 1, 5

Figures: 11

DISTRIBUTION (Fig. 11):

Ssp. gibbsiae is at present known only from three disjunct mountain areas of Tasmania, namely Mt. Anne and the Mt. Field massif in south-west Tasmania and Cradle Mt. at the northern end of the Western Mountains. Future collections will probably show that the subspecies occurs in intervening high mountains such as the Mt. Ossa - Mt. Pelion group.

The subspecies occurs at altitudes ranging from as low as 3380 feet (1030m), which is the altitude of Lake Dobson, the locality of many collections from Mt. Field National Park, to the summits of the highest peaks, the highest record so far being the collection (Barker 1218B) from near the summit of Cradle Mt. at an altitude of 1520m.

ECOLOGY:

Ssp. gibbsiae occupies generally the more protected sites above the tree-line. It is commonly found in usually dense alpine heath (Barker 1173, 1177) often where it is interspersed with outcrops of dolerite rock (Barker 1157, 1158, 1164, 1216, 1218B). Plants either sprawl within shrubs or form large spectacular clumps in the open areas between. It has also been found in an ecotone between the alpine heath and "blanket bog" on the summit of Mt. Field West (Barker 1165, 1169). Plants of the subspecies are rarely found in extensive cushion plants of that area (Barker 1165A). There, as in most other localities which I have visited, ssp. gibbsiae is commonly found growing in the mats of "pineapple grass" (Astelia sp.) which are abundant in the more open areas of heath. At lower altitudes it is also known from subalpine woodland (Barker 1189), while there is a very unusual and therefore questionable record from "Rainforest" at Lake Dobson (Phillips 878).

Flowering occurs between the beginning of January and early February at localities above the tree-line. At lower altitudes such as at Lake Dobson it may start at the beginning of December.

NOTE:

The specimen Fenton AD97121102 from Mt. Anne contains a mixture of plants belonging to ssp. gibbsiae and ssp. comberi (tending somewhat to ssp. kingii). The two plants of ssp. gibbsiae had only just begun to flower, while the five specimens of ssp. comberi were profusely fruiting. Either the collections came from separate localities or they came from a locality where perhaps there is a difference in flowering times.

SPECIMENS EXAMINED:

Tasmania

Barker 1157 & 1157A, 19.i.1971. Mt. Field Nat. Park; at south end of Rodway Range above saddle leading to Mt. Mawson Plateau. Ca. 50m from turnoff to Tarn Shelf along track to Mt. Field West. AD. -- Barker 1158, 19.i.1971. Mt. Field Nat. Park; at south end and on east face of Rodway Range, ca. 200m from saddle leading to Mt. Mawson Plateau. Ca. 250m along track to Mt. Field West from turnoff to Tarn Shelf. AD. -- Barker 1164, 19.i.1971. Mt. Field National Park; summit of Mt. Field West. AD. -- Barker 1165, 19.i.1971. Mt. Field National Park; immediately east of Mt. Field West on plateau extending to Naturalist Peak. AD; pollen slide A.N.U., AD. -- Barker 1169, 19.i.1971. Mt. Field Nat. Park; ca. 100m east of Mt. Field West summit on plateau extending to Naturalist Peak. AD. -- Barker 1177, 19.i.1971. Mt. Field Nat. Park; ca. 50m east of Clemes Tarn, near track to Mt. Field West from K. Col. AD. -- Barker 1189, 21.i.1971. Mt. Field Nat. Park; on ridge between Lake Fenton and Windy Moor on track to Mt. Field East. AD. -- Barker 1205, 28.i.1971. Cradle Mt.-Lake St. Clair National Park; just below west edge of saddle between Little Horn and Weindorfers Tower, on Cradle Mt. AD. -- Barker 1216, 28.i.1971. Cradle Mt.-Lake St. Clair National Park; Cradle Mt., on track to summit from Kitchen Hut, ca. 50 feet (15m) below the top of initial part of the climb. AD. -- Barker 1218B, Lake St. Clair - Cradle Mt. National Park. On track to summit of Cradle Mt. from Kitchen Hut, on the east face between the first outcrop encountered on the climb and the summit. AD. -- Burbidge 3297, 23.i.1949. Mount Mawson, National Park. CANB,L,HO. -- Curtis s.n., 2.i.1948. Lake Dobson. HO. -- Curtis s.n., 6.i.1948. Golden Stairs, Lake Dobson. MEL41529. -- Curtis s.n., 7.i.1948. K Col, track to Mt. Field West, Mt. Field National Park. HO, MEL41527. -- Eichler 16498, 8.i.1960. Cradle Mountain. Between Kitchen Hut and summit of Cradle Mountain. AD. -- Eichler 16766, 23.i.1960. Mount Field National Park. On track from Lake Dobson to Mt. Field West, between turn-off to Tarn Shelf and Clemes Tarn. AD. -- Elliott s.n., 12.xii.1945. Above Lake Dobson. HO. -- Fenton s.n. per Barker, 30.xi.1970. Mt. Anne. AD97121102 (p.p.). -- Fenton & Rimmer 3 per Barker, 21.i.1971. Mt. Field National Park. Lake Newdegate to Twisted Tarn. AD. -- Gibbs 6502, -.xi.1914. Mt. Field East, Lake Fenton. BM (p.p.: holotype), K. -- Jackson s.n., 18.ii.1965. K Col. HO. -- Lindon s.n., -.xii.1926. Cradle Mt. HO. -- Moore s.n., 7.i.1949. Golden Stairs, National Park. CHR66873. -- Mueller s.n., -.i.1869. Mt. Field East. MEL41537(p.p.). -- Phillips 878, 1.xii.1965. Lake Dobson, Mt. Field National Park. CBG. -- S[omerville] s.n., 18.xii.1962. Lake Dobson. HO. -- Telford per Canning 2196, 2.ii.1969. Mt. Field National Park (Rodway Range). CBG.NE.

b. ssp. psilanthera (FvM.)Barker, comb. & stat. nov.

E. brownii FvM.(nom. illeg.) var. psilanthera FvM.,Fragm. Phyt.Austral.5(1865)89,p.p.(as to lectotype and isolectotype, Stuart 1745) "psilantherea" BASIONYM; Wettst., Monogr.Gatt.Euphrasia (1896)253; Du Rietz,Sv.Bot.Tidskr. 25(1932)532

[E. striata auct. non R.Br.: Benth.,Fl.Austral.4(1868)521, p.p.(as to Stuart 1745)]

[E. collina auct. non R.Br.: Wettst.,Monogr.Gatt.Euphrasia (1896)254,p.p.(as to Labillardiere G)]

DESCRIPTION:

Plant ca. 20-30cm or more high, with single erect stem bearing ascending branches above ground level.

Stem to base of inflorescence ca. 15-20cm high; internodes on stems or main branches longer than upper leaves between upper (3)5-10(15) nodes i.e. sometimes for whole length, the longest node (1)2(3) times longer than upper leaves; axis in upper parts with two rows of moderately dense to dense, short eglandular hairs decurrent from between leaf bases, mixed with moderately dense to dense, moderately long to long glandular hairs all around, in lower parts with shorter eglandular indumentum, and sparse, often long glandular indumentum.

Leaves: uppermost stem leaves ca. 5-8mm long, ca. 2.5-4.5mm broad, in outline elliptic to obovate, covered by moderately long to long glandular hairs, usually moderately dense to dense all over, sometimes dense on margins and towards base, sparser in middle and distally; base rounded-cuneate to cuneate; teeth (1)2 along each margin, the longest 0.5-1.3mm long; apex bluntly or sharply, obtuse or acute, (1.2)1.8(2.1)mm long, (1.2)1.6(2.5)mm broad; leaves lower down covered by a sparser shorter indumentum.

Inflorescence with rachis covered by indumentum similar to upper axes.

Bracts covered by short to moderately long glandular hairs, dense towards base, sparser towards apex.

Calyx with external surface covered by short to moderately long glandular hairs, dense on teeth and distal part of tube, sparser or glabrous at base of tube.

Corolla "white striated with dark lines" (Stuart 1745: MEL41688).

Stamens with anthers 1.5-1.8mm long.

Plates: 5

Figures: 11

TYPIFICATION:

Lectotypus: [C.Stuart] 1745, s.dat. South Port. Leaves ovate, or ovately cuneate trifid or sometimes 4 toothed at apex and on as well as the stem [sic] scabrous, calyx rather acute scabrous, spike of flowers obtuse segments of corolla the upper ones emarginate anthers not bearded. Flowers white striated with dark lines. moist places frequently in water all winter flowering at all seasons. I think a sp. distinct. Very local in its habitat. MEL41688. Isolectotypus: C.S[tuart] 1745, -.ix.1855. Moist boggy places nr. South Port. Otherwise similarly annotated. MEL41687. Syntypus alter probabilis: [F.Mueller] s.n., -.iii.1861. Mount Wellington, Gippsland. MEL41653.

The protologue (Mueller 1865) of E. brownii var. psilanthera FvM. reads as follows:

> "Planta procerior quam E. striata, a formis ordinariis E. Brownii non externe distinguenda sed nuditate antherarum paulo diversa crescit in pratis hieme inundatis prope South Port Tasmaniae. Hanc varietatem psilanthereum voco. Eandem habeo a monte Wellingtoni terrae Gipps's Land."

The collections mentioned from South Port are clearly the two duplicates of Stuart 1745 each of which has been annotated "Euphrasia Brownii F.M. var. psilantherea" by Mueller. These have been chosen as lectotype material as Mueller has based his discussion more on these plants than the Mount Wellington collection, which is mentioned more in passing than as an integral part of the protologue. Both duplicates would have been equally suited as lectotype as each bears very similar annotations by both Stuart and Mueller and both are in good condition (although there is some breakage of axes). MEL41688 was chosen as lectotype because it contained more flowering material. Together the lectotype and isolectotype contain a single specimen with a number of floral branches (on the lectotype) and nine other fragments, eight of which are almost entire floral stems or floral branches. They bear buds, flowers and immature fruits.

b

It is clear from the annotations on both the duplicates that Stuart [correctly] considered the collection to represent an undescribed species, which he named "E. semperflorens", a name which was apparently never published. He noted that the anthers were "not bearded".

It is imperative that topotype material be found as the lectotype collection, made over a century ago, is apparently the most recent collection of the subspecies and it provides the only record of a specific locality.

It is somewhat doubtful whether the Mount Wellington collection cited above is the one referred to in the protologue. On the label bearing the locality annotations Mueller has identified the specimen, which contains a single plant allied to E. caudata ssp. caudata (see E. caudata: Note 2), as E. scabra. If this collection is the other syntype, Mueller in apparently finally placing it under E. brownii must have changed his mind as to its affinities. The annotation "This may possibly be a variety of E. scabra" on a separate label with the specimen, indicates that Mueller was in doubt as to its exact identity. In the treatment containing the protologue, Mueller discusses exhaustively the differences between the yellow-flowered annual E. scabra, and the non-yellow-flowered perennial E. brownii, to which he ascribed his var. psilanthera. He must finally have placed greater emphasis on the apparently non-yellow flower colour of the Mt. Wellington specimen than on its annual habit. Mueller's account of the anther indumentum on a third label gives further support to the possibility that it is the syntype as he has referred specifically to the glabrous anther backs of the specimen; it reads:

"Antherae dorso imberbes secus rimas parum ciliatae".

The epithet "psilantherea"[*] clearly refers to the lack of indumentum from the anther backs only, as on the South Port specimens Mueller also wrote "Antherae parum bar[b]atae" and "Antherae brevissime barbatae". No other material that would qualify as the Mt. Wellington syntype is known in MEL.

DISTRIBUTION (Fig. 11):

The only specific locality recorded for ssp. psilanthera is that of the type "nr. South Port" in the extreme south of Tasmania. This locality is close to sea level. Labillardiere's collection probably also came from this general area since most of the collections of both his visits to Tasmania were made there (Stafleu 1966). However, he may have collected along the east coast of Tasmania (Mr. E.C. Nelson pers. comm. December 1973).

ECOLOGY:

The sole ecological record of ssp. psilanthera is given with Stuart's (1745) type material. He found it in boggy localities frequently inundated in winter.

As to flowering time Stuart has noted on the isolectotype that the collection, in full flower, was made in "Sept. 55 but in flower almost at all seasons".

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[*] Mueller's spelling is clearly in error and has been corrected to psilanthera in this work.

NOTES:

1. The description given is only a preliminary account of the characters considered, as it is based on a small number of often fragmentary specimens. It is definite however that the habit is erect, and the glandular indumentum extends probably almost to ground level. Further collections are required to determine the full extent of the variation of the subspecies. The rank of subspecies seems most appropriate for the taxon so long as the other infraspecific taxa of E. gibbsiae are given that rank.

2. The collections of Euphrasia made by Labillardiere in Australia are intermixed and found in a number of herbaria. He apparently made at least three collections as a FI specimen bears a description of the characteristics of a collection "no. 43" with the note:

> "...haec est tertia eiusdem generis lecta in terra van Diemen."

The specimens from FI (2 specimens), G, GH, L, NY and PH can be sorted into three groups probably corresponding to these separate collections. The FI (both specimens), NY(p.p.) and L(p.p.) specimens contain plants or fragments of E. collina ssp. collina, vegetative but for the presence of old dehisced capsules. The G and PH sheets bear specimens typical of E. gibbsiae ssp. psilanthera each bearing young inflorescences. Glandular hairs occur on upper and lower parts of the plant. They are 0.2-0.5mm long in the upper parts and sometimes longer lower down. Finally the GH, L(p.p.) and NY(p.p.) sheets bear fragments of ssp. kingii. The glandular indumentum is confined to the inflorescence and upper vegetative parts and is rather short (0.1-0.2mm long).

SPECIMENS EXAMINED:

Tasmania

Labillardiere s.n., s.dat. Van Diemen. G. -- Milligan 16, s.dat. Without locality. AD(p.p.). -- Stuart 1745, s.dat. South Port. MEL41688 (lectotype); MEL41687. -- Stuart s.n., s.dat. V.D.L. MEL 41465.

Locality extremely doubtful

Labillardiere s.n., s.dat. N. Zealand. PH.

c. ssp. wellingtonensis Barker, subspecies nova

E. gibbsiae Du Rietz, Sv.Bot.Tidskr.42(2)(1948)104, p.p.(as to all specimens cited on p.106 as very nearly related to f. gibbsiae, and f.3,4)

[E. striata auct. non R.Br.: Wettst., Monogr.Gatt.Euphrasia (1896)252, p.p.(as to Oldfield W36919, W36922)]

LATIN DIAGNOSIS:

Subspecies nova prope ssp. gibbsiae indumento glanduloso ab inflorescentia ad planum terrae extenso ramisque supra planum terrae simplicibus, sed differt indumento glandulosa breviore praecipue versus basem, foliis summis ramorum floralium dentibus minoribus, antherisque minoribus; inter subspecies indumento glanduloso ad inflorescentiam et proxime infra cam limitato proxima ssp. comberi sed differt non solum indumento latius patenti sed etiam foliis summis ramorum floralium dentibus minoribus.

Holotypus (tab. 36): W.R.Barker 1008, 3.i.1971. Tasmania, Southern. Summit of Mt. Wellington; moorland west of The Pinnacle. AD97117025. Isotypi: 2 distribuendi.

DESCRIPTION:

Plant (3.5)5-10(13)cm tall, with many usually ascending, sometimes decumbent branches arising from reduced stem or prostrate parts of other branches.

Floral branches (1.5)3-6(10)cm high to base of inflorescence;

internodes between uppermost (0)2-3(7) pairs of leaves as long as or longer than upper leaves, the longest ($\frac{3}{4}$)1-1$\frac{1}{2}$(2) times length of upper leaves, lower down much shorter than leaves; axis with two pairs of lines of very short, sparse to moderately dense eglandular hairs, often almost absent, covered also by sparse to dense, very short to moderately long glandular hairs, the glandular hairs extending from upper parts down to ground level, where 0.05-0.2mm long, on young shoots and often on prostrate parts of axes.

Leaves: uppermost leaves of floral branches 5-9(11)mm long, (2.5)4-6(7)mm broad, obovate or spathulate in outline, covered by sparse to dense, usually short to moderately long, rarely long glandular hairs; base usually attenuate or narrow cuneate, rarely rounded-cuneate; teeth 1-2 along each margin, the longest (1.0)1.9(2.5)mm long; apex sharply or bluntly acute or acuminate, (1.3)2.1(3.0)mm long, (1.2)1.9(2.6)mm broad; leaves lower down with similar indumentum.

Inflorescences with rachis similar to axis.

Bracts with indumentum similar to uppermost leaves.

Calyx with outer surface covered by dense, usually short to moderately long, rarely long glandular hairs, sometimes mixed with a few to moderately dense, short to moderately long eglandular hairs.

Corolla white, with yellow blotch on lower side of mouth and deep in tube, with purple to indigo striations on tube and hood and extending well out onto lobes.

Stamens with anthers (1.2)1.4-1.6(1.8)mm long.

Plates: 5, 16

Figures: 11

TYPIFICATION:

Holotype (pl. 16): W.R.Barker 1008, 3.i.1971. Tasmania, Southern. Summit of Mt. Wellington; moorland west of The Pinnacle. Growing within shrubs over 20cm high of alpine heath, together with small grasses or sedges and sometimes liverworts. Altitude ca. 4000 feet (1200m). Population distinct from later-flowering Euphrasia sp. (Barker 1011). Corollas white, with purple striations, with yellow blotch on lower lip behind lowest lobe and often extending behind lateral lobes, continuing into throat, with base of each filament yellow. One plant (1008C) with flowers open only on side facing away from bush in which growing. AD97117025. Isotypes: 2 to be distributed.

The holotype collection is in good condition and contains about 20 specimens, which are either whole or large parts of plants or single floral branches. All stages of floral developments are represented, i.e. from inflorescences completely in bud to plants almost fully in fruit. The isotype material is in poorer condition because of the breakage of some specimens, but each duplicate contains flowers and fruits and several entire floral branches.

The subspecies is known only from the region of the type locality where it is not in any apparent danger of extinction.

DISTRIBUTION (Fig. 11):

Ssp. wellingtonensis is apparently confined to the summit plateau of Mt. Wellington near Hobart, at about 1200m altitude. A very doubtful record from Ben Lomond in north-east Tasmania (Oldfield W36919) is discussed under Note 1.

ECOLOGY:

The subspecies occurs in subalpine heath either in open areas betwen shrubs and then often in "cushion plants" (mainly Abrotanella sp.) or within the shrubs themselves.

It is the earliest flowering of the three species of Euphrasia which occur on the alpine summit plateau of Mt. Wellington (see also quotation in Note 2). Flowering occurs from November (Rupp MEL41697) to early January, or perhaps later in some years.

NOTES:

1. The collection Oldfield W36919 of ssp. wellingtonensis allegedly comes from Ben Lomond, an isolated massif in north-eastern Tasmania. If correct it would constitute not only the sole known record of E. gibbsiae on this plateau, but also the only known occurrence of Subsect. Striatae there. However, it is very likely that there is an error in the locality cited especially since ssp. wellingtonensis is otherwise only recorded from Mt. Wellington well to the south, and Oldfield has made a collection (W36922) of it from there.

2. In a letter presumably to Sir Joseph Banks, Caley (in Currey 1966: p.122) refers to several alternative names for the high mountain in the neighbourhood of Hobart, namely "Skiddaw", "Table Mountain" and "Snowy Mountain". His collections of ssp. wellingtonensis in BM(p.p.) and W came from the summit of "Skiddaw" and "Table Mountain" respectively. From his letter it can be inferred that these names refer to Mt. Wellington and that the collections were made on the 6th December 1805. He included the following notes about the variety (Currey l.c.: p.123):

"The top of Skiddaw .... in moist places a very small species of Euphrasia, with large flowers. This was the only herbaceous plant I met with in flower, and it grew in patches in a matted form."

SPECIMENS EXAMINED:

Tasmania

Barker 1008, 3.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD (holotype). -- Barker 1012, 3.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD. -- Barker 1123, 15.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD. -- Caley s.n., [6].xii.1805. Wet places on top of Skiddaw. BM(p.p.). -- Caley s.n., 6.xii.1805. On the summit of Table Mountain. W(s.n.). -- C[urtis]s.n., 6.i.1947. Mt. W. Summit. HO. -- Curtis & Nordenskiold s.n., 5.xii.1957. Mt. Wellington. HO. -- Gulliver s.n., 1873. Mt. Wellington. MEL41533. -- Lawrence 213, 1831. Without locality. K [Herb. Hook.]. -- Oakden 220, 31.xii.1891. Mt. Wellington. MEL41786. -- Oldfield s.n., s.dat. Summit of Mt. Wellington. W36922. -- R[upp]s.n., -.xi.1920. Summit of Mt. Wellington. MEL41697. -- Tribe s.n., s.dat. Top of Mt. Wellington. K.

Locality doubtful

Oldfield s.n., s.dat. Summit of Ben Lomond, Tasmania. W36919.

Locality unknown

Anon. s.n., s.dat. MEL41536(p.p.).

d. ssp. comberi (Du Rietz)Barker, stat. nov.

E. gibbsiae Du Rietz f. comberi Du Rietz.Sv.Bot.Tidskr.42(2) (1948)108 f.5,pl.4 BASIONYM; Curtis,Stud.Fl.Tasm. (1967)531

?E. gibbsiae Du Rietz aff. f. subglabrifolia Du Rietz,Sv.Bot. Tidskr.42(1948)109 (as to Gibbs 6601: see E. gibbsiae: Typification)

DESCRIPTION:

Plant, in open areas (3.5)5-12(15)cm tall, with many ascending branches arising from reduced stem or prostrate parts of other branches, when growing in bushes reaching up to 25cm in height with many ascending branches, simple and erect distally from near perimeter of bush, arising from reduced stem or proximal ascending parts of other branches.

Floral branches: distal erect parts (2.5)3-10(12)cm long to base of inflorescence; internodes between uppermost 0(7) nodes as long as or longer than uppermost leaves, the longest internode $(\frac{1}{4})\frac{1}{2}$-$\frac{7}{8}(2)$ times length of upper leaves; axis in upper distal erect parts with two rows or two pairs of lines of dense, short to moderately long eglandular hairs decurrent from between each leaf base, sometimes also with very few to moderately dense, short to moderately long glandular hairs, in lower parts with shorter similar eglandular hairs but lacking glandular hairs; young shoots with axis with two rows of eglandular hairs but lacking glandular hairs.

Leaves: uppermost leaves of floral branches (5)7-9(10)mm long, (4)6-9(10)mm broad, usually broadly obovate or broadly spathulate to broadly elliptic in outline, sometimes obovate to spathulate, usually covered by sparse to dense, short to moderately long glandular hairs, sometimes glabrous; base shortly attenuate or narrow cuneate to rounded-cuneate; teeth (1)2-3(4) along each margin, the longest (0.8)1.5(2.0)mm long; apex usually blunt, rarely sharp, usually broadly shortly acuminate, sometimes obtuse or shortly acuminate, (1.0)1.7(2.2)mm long, (2.0)2.7(4.1)mm broad; leaves lower down glabrous or with sparser indumentum; lowermost leaves usually glabrous, sometimes with moderately dense, short to moderately long glandular hairs usually confined to apex, rarely along margins.

Inflorescences with rachis with indumentum similar to upper axis with somewhat denser glandular pilosity.

Bracts usually covered by very sparse to dense, short to long glandular hairs, sometimes mixed with very short eglandular hairs on margins of apex and teeth, rarely glabrous.

Calyx with external surface of teeth and distal part of tube covered by very sparse to dense, usually short to moderately long, rarely long glandular hairs, sparse or glabrous on base of tube.

Corollas white, [? with yellow blotches behind lowest lobe and deep in tube at point of insertion of anterior filaments], with 3-5 purple [mauve: Edwards AD97121103] striations extending onto each lobe from hood and tube.

Stamens with anthers (1.2)1.4-1.7(1.8)mm long.

Plates: 5

Figures: 11

TYPIFICATION:

Holotype: H.F.Comber 1835, 1930. Tasmania. Common in a variety of situations above 3000 ft. Alpine perennial, forming masses of large white flowers. K. Illustration: Du Rietz (1948a): pl.4, fig.5

The holotype is in very good condition and consists of a single complete plant with many floral and vegetative branches. Mostly flowers are present, with few buds and no fruits. It is slightly atypical of ssp. comberi as delimited herein as its upper internodes are $1\frac{1}{4}$-$1\frac{1}{2}$ times the length of the upper leaves and its smallish anthers are 1.2mm long. However, these values do not fall outside the range of variation of these characters in the subspecies.

There is no specific type locality. A study of Comber's collection numbers either side of the collection 1835 may give some evidence as to its whereabouts.

DISTRIBUTION (Fig. 11):

Ssp. comberi appears to be confined to parts of the south-west of Tasmania nearest the centre of the island, where it is known from only a few of the many high mountain areas (by contrast plants relating to ssp. discolor are located more to the extreme south and west of these localities). At present pure populations are known with certainty only from the Hartz Mountains, Federation Peak, the Snowy Range, Mt. Anne and Mt. Rufus. It is possible that pure populations of ssp. comberi also occur on the Mt. Field massif where plants of ssp. comberi and ssp. gibbsiae occur side by side over wide areas (see E. gibbsiae: Intra-specific Variation).

The subspecies has been recorded on herbarium labels from altitudes between 3000 and 4000 feet (910-1220m). It may occur at higher altitudes, as mountains in the region reach 1310m (Mt. Picton) and 1430m (Mt. Anne).

ECOLOGY:

Ssp. comberi has been recorded mainly from alpine or subalpine heath (Barker 1194, Edwards AD97121103,AD97121099). It may grow within the prostrate branches of woody perennials, or, from the habit of some of the plants collected, it apparently sprawls within the taller shrubs, just as ssp. gibbsiae does. However, unlike ssp. gibbsiae, it has been observed growing abundantly in areas of "cushion plants" (Barker 1194, ?Edwards AD97121099). Barker 1194 and Edwards AD97121103 were found in doleritic areas.

From the scanty material available flowering occurs at least in the period between early December and late January.

NOTES:

1. Ssp. comberi and ssp. kingii intergrade along an ecological gradient and it is uncertain whether the morphological differences between them are environmental modifications or genetically based. This is discussed under E. gibbsiae: Intraspecific Variation.

Specimens which may represent an ecotone between the two subspecies have usually been placed under the subspecies to which they have closest affinities unless they have clearly come from such an ecotone.

Populations containing a mixture of ssp. comberi and ssp. gibbsiae occur on the Mt. Field massif. These are also discussed under E. gibbsiae (Intraspecific Variation), and the specimens are cited separately as mixtures of the two subspecies.

2. The only note on flower colour is that by Edwards (AD97121103), who wrote: "Flower; white with mauve striations. Striations varying in extent & intensity". On all plants in the collection the striations are prominent and extend at least onto the basal part of the lobes, and on many occasions stretch over almost their entire length. Thus the striations are not as restricted as in ssp. pulvinestris.

SPECIMENS EXAMINED:

Tasmania

Barker 1194, 23.i.1971. On plateau at the south junction of the tracks to Lake Hartz and to Mt. Snowy; Hartz Mountains National Park. AD. -- Comber 1835, 1930. Without locality. K (holotype). -- Curtis s.n., -.i.1942. National Park. HO. -- Edwards s.n., 5.xii.1970. Federation Peak, ...from top of Luckman's Load to Goon Moor. AD97121103; pollen slide A.N.U.,AD. --

Edwards s.n., 27.xii.1970. Snowy Range above L. Skinner. AD97121099. — Eichler 16603, 13.i.1960. Lake St. Clair National Park. Mt. Rufus, summit region. AD. — Elliott s.n., 9.xii.1945. Mt. Mawson, National Park. HO. — Fenton per Barker s.n., 30.xi. 1970. Mt. Anne. AD97121102(p.p.),AD97121101. — Johnson 123, s.dat. Huon River. MEL. — Rodway s.n., –.x.1920. Mt. Field. HO(p.p.). — Telford per Canning 2408, 6.ii.1969. Hartz Mts. National Park (track to Lake Hartz). CBG.

e. ssp. kingii (Curtis)Barker, comb. & stat. nov.

E. kingii Curtis,Stud.Fl.Tasm.(1967)650,530 BASIONYM

[E. milligani Du Rietz,Sv.Bot.Tidskr.42(1948)358,362 nomen nudum; Willis,Muelleria 1(1967)148]

[E. striata auct.non R.Br.: Benth.,Fl.Austral.4(1868)521, p.p.(as to Milligan MEL41451 p.p.)]

DESCRIPTION:

Plant (12)20–35(50)cm high, with single erect stem, bearing shoots and ascending branches from ground level to high in upper parts, after flowering dying back to either upper branches which develop further, or ground level in which case 1–several ascending stem-like branches develop from very base.

Stem, or main branches if no stem present, with internodes longer than uppermost leaves between uppermost (0)3 or more nodes, sometimes for whole length, the longest internode (1)2(4) times length of upper leaves, sometimes shorter than leaves lower down; axis bearing two rows of dense, short to moderately long eglandular hairs decurrent from between leaf bases.

Leaves: uppermost leaves of floral stem, or of main floral branches if upper part of stem absent, (5)6–8(10)mm long, 3–7mm broad, obovate to elliptic in outline, usually glabrous, rarely covered in distal parts by sparse to dense, short glandular hairs; base usually cuneate, often narrowly so, sometimes narrow attenuate;

teeth 1-2(3) along each margin, the longest tooth 0.8-1.5mm long; apex sharp or blunt, usually shortly acuminate, often broadly so, sometimes acute, (1.0)1.4(2.1)mm long, (1.1)1.6 (2.4)mm broad; leaves lower down glabrous.

Inflorescences with rachis with indumentum similar to axis, sometimes also with a few short glandular hairs.

Bracts sometimes glabrous, sometimes covered by sparse to dense, short glandular hairs, denser in the apical half, the upper (younger) bracts sometimes with denser indumentum than lowermost ones.

Calyx with external surface usually bearing short glandular hairs, sparse to dense towards apices and margins of teeth, absent or sparse on tube, and short eglandular hairs mainly confined to distal part of teeth, sometimes ± glabrous.

Corolla usually purple, lilac or blue, sometimes white, with orange (Barker 992) [? to yellow] blotch behind lowest lobe, with deep red-purple striations on tube, extending well out onto lobes.

Stamens with anthers (1.0)1.3-1.6(2.2)mm long.

Plates: 1, 5

Figures: 11

TYPIFICATION:

Holotype: C.D.King s.n., 23.ii.1966. Port Davey. K.

Isotype: HO.

The holotype specimen is in good condition and comprises two copiously branched plants, one without the root system, the other complete. Buds and flowers but no mature fruits are present. The isotype consists of a single complete plant in a similar state. It lacks the locality "Port Davey" and has the extra annotation "peaty heath", but has been clearly labelled as an isotype of _E. kingii_ by Dr. W.M. Curtis, the author of the species.

The type populations are in no apparent danger as they inhabit a remote, almost uninhabitated area.

DISTRIBUTION (Fig. 11):

Ssp. _kingii_ is confined to low altitudes of the west, south-west and extreme south of Tasmania. It has been recorded from sea level to about 400m.

ECOLOGY:

The subspecies is apparently common in "Button-grass (_Gymnoschoenus sphaerocephalus_) plains" (see Curtis 1969), which are also called "wet hummock sedgeland" (Jackson 1965). The MEL duplicate of M. Davis 1172 has been labelled "General throughout Button grass ass. in S.W. Tas.". Other records from this habitat, are Barker 992 and Hamilton HO (Lake Pedder Site 2). It has also been recorded from "Heathy plains" (Milligan 371, 766: 1.viii.1846/-.x.1846), "wet heath" (Carroll NSW87057), "peaty heath" (King HO: isotype & 22.iii.1965) and "Peaty flats" (Milligan 766: 8.x.1846). Rodway's (HO) collection apparently came from the vicinity of a swamp.

The subspecies flowers from October or even earlier until March. A depauperate flowering specimen was collected by Milligan (371) on 24th May.

NOTES:

1. Ssp. _kingii_ is most clearly related to ssp. _comberi_ and ssp. _microdonta_ which are distinguishable by the confinement of their branching to ground level or on the proximal ascending parts of the branches if growing in shrubs. Ssp. _microdonta_ and ssp. _comberi_ apparently also differ by their consistently white corolla colour. The character of the shape of the mature capsule apex may also

prove valuable. The only specimens seen with fruiting material, Barker 992, M.Davis 1172, Carroll NSW87057 and Hamilton HO (1 specimen), all bear capsules with apices broadly acute to obtuse in lateral view. Ssp. comberi has capsules with broad apices shallowly emarginate to truncate-obtuse in lateral view, and tending to be broader. This is so for all other Tasmanian subspecies seen including ssp. psilanthera, which like ssp. kingii occurs in lowland areas.

Ssp. kingii and ssp. comberi intergrade along an ecological gradient and it is uncertain whether the morphological differences between them are environmental modifications or genetically based (see E. gibbsiae: Intraspecific Variation).

Specimens which may represent an ecotone between the two subspecies have usually been placed under the subspecies to which they have closest affinities unless they have clearly come from such an ecotone.

2. Specimens of ssp. kingii collected by Labillardiere (GH, L908227161 p.p., NY p.p.) are discussed in relation to the French botanist's overall collections under the treatment of ssp. psilanthera (Note 2).

3. Some of Milligan's collections of plants of E. gibbsiae ssp. kingii from the west coast of Tasmania approach E. striata by their small flowers and very sparse glandular indumentum (e.g. 766: 1.viii.1846/-.x.1846. Heathy Plains M.Qr.Hb.). It is important that a study is made of E. gibbsiae in the Macquarie Harbour region to determine whether these plants represent extremes of variation of populations typical of ssp. kingii or if they come from populations distinct from typical ssp. kingii and linking it to E. striata.

SPECIMENS EXAMINED:

Tasmania

Anon. [C.D.King] s.n., 21.x.1965. Port Davey. HO. — Barker 992, 24.xi.1970. Long Plains; ca. 2km from Savage River on road to Corinna. AD; pollen sample A.N.U.,AD. — Bufton 128, 1893. Bathurst Harbour. MEL. — Carroll s.n., 20.x.1968. 15 miles from Strahan on Queenstown road. NSW87057. — C. Davis s.n., 8.ii.1937. Port Davey, New Harbour. NSW22282. — C. Davis s.n., 9.ii.1937. Bramble Cove, Port Davey. NSW22285. — M. Davis 1172, 10.iii.1954. Head of Melaleuca Inlet, Bathurst Harbour, Port Davey. MEL,CANB,A. — Hamilton s.n., -.xii.1969. Vicinity of L. Pedder. HO (2 specimens). — Hamilton s.n., -.xii.1969. L. Pedder (Site 2). HO. — Jackson 433, -.i.1954. Corinna....Long Plains. HO. — King s.n., 22.iii.1965. Port Davey. HO. — King s.n., s.dat. Port Davey. HO. — King s.n., 23.ii.1966. Port Davey. K (holotype),HO. — [Labillardiere] s.n., s.dat. N. Holl. C.v. Diemen. L908227161(p.p.). — Long s.n., -.ii.1929. Port Davey. HO. — Milligan 371, 24.v.1842. Spring River - Port Davey. BM. — Milligan 766, 1.viii.1846/-.x.1846. M.Qr.Hr.[Macquarie Harbour]. BM,K(p.p.). — [Milligan] 766, 8.x.1846. Peaty flats on the terrace grounds between Gordon River & Birchs Inlet. K(p.p.). — Milligan 766, s.dat. Birch's Inlet Mcquarie Hb. MEL(p.p.),BM(p.p.). — Milligan 766, s.dat. Gordon R. V.D.Land. NY(p.p.). — L.Rodway s.n., -.xii.1901. Cockle Creek Swamp. Recherche. HO.

Australia

Labillardiere s.n., s.dat. Nova Hollandia. GH,NY(p.p.).

f. ssp. microdonta Barker, subspecies nova

LATIN DIAGNOSIS:

Subspecies nova prope ssp. subglabrifoliam et ssp. kingii internodiis longis ramorum floralium caulisve indumentoque glanduloso ad et proxime infra inflorescentiam limitato, sed differt ab illa foliis summis ramorum floralium dentibus pluribus brevioribusque, ab hac ramis supra planum terrae simplicibus, corollis albis, foliisque summis ramorum floralium dentibus pluribus.

Holotypus (tab. 16): M.E. Phillips 87, 12.xi.1965. Lake Dove, $1\frac{1}{2}$ miles from Cradle Mt. settlement, Tas. CBG034557.

DESCRIPTION:

Plant (10)13-22(25)cm tall, with ascending branches arising from the reduced stems or lower ± prostrate parts of other branches.

Floral branches (6)9-15(18)cm high to base of inflorescence; internodes between uppermost 4-8(10)nodes as long as or longer than upper leaves, the longest internode $(1\frac{1}{8})2\frac{1}{4}(3\frac{1}{2})$ times length of upper leaves; axis bearing two rows of moderately dense to dense, very short eglandular hairs decurrent from between leaf bases, in uppermost parts sometimes mixed with sparse to moderately dense, very short to moderately long glandular hairs confined to rows of eglandular hairs or also in areas between where sparser.

Leaves: uppermost leaves of floral branches 5.5-10mm long, 3.5-6mm broad, obovate or spathulate in outline, sometimes glabrous, sometimes with sparse to dense, short glandular hairs confined to margins or all over, or with very short to short, sparse to dense eglandular hairs confined to margins of upper side, or all over, or with a mixture of both; base attenuate to narrow cuneate; teeth (1)2-3 along each margin, the longest tooth 0.5-1.0mm long; apex bluntly or sharply, shortly acuminate, usually broadly so, (0.9)1.3(1.8)mm long, (1.3)2.1(2.5)mm broad; leaves lower down glabrous.

Inflorescences with rachis with two rows of dense very short to short eglandular hairs, sometimes mixed with sparse to moderately dense, subsessile to short glandular hairs, mainly confined to rows of eglandular hairs.

Bracts bearing short to moderately long glandular hairs, dense on margins, sparse to dense on upper and lower surfaces, sometimes, especially towards margins of upper side, with dense short eglandular hairs.

Calyx with outer surface of teeth and distal part of tube covered by moderately dense to dense, short to moderately long glandular hairs, with base of tube having sparser indumentum or glabrous.

Corolla white [Anderson 8], [from observation of dried specimens] with 3 dark ?purple striations extending well out onto each lobe from tube and hood; [presence of yellow blotch unknown].

Stamens with anthers (1.4)1.5-1.7(2.0)mm long.

Plates: 5, 16

Figures: 11

TYPIFICATION:

Holotype (pl. 16): M.E. Phillips 87, 12.xi.1965. Lake Dove, $1\frac{1}{2}$ miles from Cradle Mt. settlement, Tas. Alpine community. CBG034557.

The holotype is in excellent condition and consists of 7 floral branches, all but one of which are full length. Flowers and young capsules are present.

The type locality occurs in the Cradle Mt.-Lake St. Clair National Park. It is unknown how abundant the subspecies is around Dove Lake, but the other collections from "Cradle Mountain" (F.A.Rodway NSW97863) and "Cradle Valley" (Anderson 8) may have come from that area and may indicate that it is not rare.

DISTRIBUTION (Fig. 11):

Ssp. microdonta is known only from near Cradle Mountain, in the north western mountains of Tasmania, and the King William Range in mid-western Tasmania. The intervening mountains are mainly accessible only on foot and are very poorly botanized.

The subspecies is known only from altitudes of 3000 feet (910m: Anderson 8), which is the same altitude as Dove Lake, and 2720 feet (830m: Phillips GBG015456).

ECOLOGY:

Nothing is known of the ecology of ssp. microdonta other than the annotation "plains" (Anderson 8) and "alpine community" (Phillips 87). However, it is possible that the subspecies occurs in the "button grass moorland" in which the closely related ssp. kingii abounds and which occurs in the broad valley in the region of Dove Lake (Curtis 1969 pl. between pp.86,87; pers. observ.) and throughout the western part of Tasmania (Jackson 1965).

Flowering starts probably in late October (Phillips 87 was collected on 12th November and has some almost mature fruits) and continues well into December.

SPECIMENS EXAMINED:

Tasmania

Anderson 8, 2.xii.1931. Cradle Valley. HO(2 specimens). — Phillips 87, 12.xi.1965. Lake Dove. $1\frac{1}{2}$ miles from Cradle Mt. settlement. CBG (holotype). — Phillips s.n., 24.xi.1965. King William Saddle. CBG015456. — F.A.Rodway s.n., —.xii.1915. Cradle Mountain. NSW97863,BISH.

g. ssp. subglabrifolia (Du Rietz)Barker, stat. nov.

E. gibbsiae Du Rietz f. subglabrifolia Du Rietz,Sv.Bot.Tidskr. 42(2)(1948)110,f.6. BASIONYM; Curtis,Stud.Fl.Tasm.(1967) 531; Willis,Muelleria 1(1967)147

[E. striata auct.non R.Br.: Benth.,Fl.Austral.4(1868)521,p.p. (as to Mueller MEL41539)]

DESCRIPTION:

Plant (4)8-15(18)cm high, with many crowded branches, ascending with short to very long proximal prostrate parts, arising from reduced stem or prostrate parts of other branches.

Floral branches (3)5-12(14)cm high to base of inflorescence; internodes between upper (0)3-6(9) leaf pairs as long as or longer than upper leaves, the longest $(\frac{7}{8})1\frac{1}{4}$-$2\frac{1}{4}(4)$ times length of upper leaves, much shorter than leaves lower down; axis with two rows or two pairs of lines of moderately dense to dense, short to moderately long eglandular hairs decurrent from between leaf bases, sometimes in uppermost internodes mixed with sparse, short to moderately long glandular hairs all around axis.

Leaves: uppermost leaves of floral branches (5)7-11(13)mm long, (3)4-7(8)mm broad, obovate or spathulate to oblong-elliptic in outline, usually covered by sparse to dense, subsessile to moderately long glandular hairs, and then towards margins, especially distally, sometimes mixed with sparse to dense, usually short, rarely long eglandular hairs on upper surface, sometimes glabrous; base usually narrow-cuneate, sometimes long attenuate or cuneate; teeth 1-2 along each margin, the longest tooth (0.7)1.2-2.1(2.6)mm long; apex sharply or bluntly acute or shortly acuminate, sometimes narrowly so, (1.3)2.0(3.0)mm long, (1.1)1.8(3.0)mm broad; middle leaves with sparser indumentum or glabrous; lower leaves at least those on prostrate parts glabrous.

Inflorescences with rachis bearing two rows of dense, very short to moderately long eglandular hairs decurrent from between bases of bracts, usually mixed with sparse to moderately dense, short to moderately long glandular hairs, denser within rows of eglandular hairs or similarly dense all round.

Bracts with indumentum similar to but slightly denser than uppermost leaves, never glabrous.

Calyx with outer surface bearing usually subsessile to short, sometimes moderately long glandular hairs, sparse to dense on margins and distal parts of teeth, sparser or absent towards base, sometimes with sparse to moderately dense short eglandular hairs lining margins of teeth.

Corolla white, with yellow blotch on lower lip behind lowest lobe extending to deep in tube about point of insertion of anterior filaments and sometimes behind two lateral lobes, with 3(4) striations on each lobe, purple to indigo on tube and hood, usually prominent and extending well out onto lobes, sometimes with lowest lobe unstriated, rarely with only upper lobes striated.

Stamens with anthers (1.4)1.5-1.9(2.0)mm long.

Plates: 1, 5

Figures: 12

TYPIFICATION:

Holotype: J.G.Luehmann & C.French Jr. s.n., 1892. Mt. Mueller 5000', Gippsland. BM. Isotype: MEL41526. Probable isotype: As above, but dated 1893. GH.

All type material is in good condition. The holotype comprises one fragment with two floral branches and three single more or less complete floral branches. Flowers and immature fruits are present. The MEL isotype contains one large specimen with four floral branches as well as three other single floral branches; it bears flowers and fruits. The GH specimen is almost certainly isotypic as it is annotated identically to both other type specimens as to both data and handwriting. The difference in the date is probably an error in copying. This "isotype" consists of six single entire floral branches with flowers and immature fruits.

Although no material other than the type specimens has been collected specifically from Mt. Mueller, there seems no reason to doubt that the subspecies is as prolific as in other localities in the Baw Baws from which most of the recent collections have been made. Although in recent years a ski village has been established on the Baw Baws, there seems little danger to the vegetation away from the ski tows and the village itself. The Baw Baws are under the control of the Forests Commission of Victoria.

DISTRIBUTION (Fig. 12):

But for a population (Barker 1187) of doubtful affinities from near Mt. Field East in central or south-west Tasmania (see Note), ssp subglabrifolia is known only from the Baw Baw plateau in the south-west part of the eastern Victorian highlands. As yet it has not been recorded from neighbouring, but disjunct subalpine areas such as Mt. Donna Buang and the Lake Mountain-Mt. Torbreck region. However, from the distribution of plants similarly restricted to this part of Victoria, ssp. subglabrifolia may also occur there. Wittsteinia vacciniacea is confined to "Mt. Donna Buang, Lake Mtn., Baw Baws, King R. valley near Mt. Cobbler", while Coprosma moorei, which also occurs in western and southern Tasmania, extends only to the Baw Baws and Lake Mountain (Willis 1973a, 1973b).

The subspecies is known from altitudes above 1300m up to the summit of the highest peak, Mt. Baw Baw, which is 1550m high.

ECOLOGY:

Ssp. subglabrifolia is abundant in the extensive subalpine heathland (Barker 1469, 1473, 1474, 1476) which occurs in the hollows between the snow-gum covered ridges on top of the Baw Baw plateau. It is common in the sphagnum bogs which occur in this heathland (Barker 1466; Beauglehole 41292; Tindale NSW 84432, NSW126381; Willis MEL41532) and in damp areas near the watercourses sometimes within clumps of "pineapple grass" (*Astelia* sp.) (Barker 1467, 1468) within which ssp. gibbsiae is often found. It also occurs within open areas in sparse snowgum (*Eucalyptus pauciflora*) woodland (Barker 1470, 1471, 1472; Whaite 3232) bordering the heathland.

Flowering occurs mainly between December and January, but possibly begins in November as plants collected in early December by Willis (MEL41532) bear flowers and fruits. The one February collection (Stone MEL15993) is in fruit.

The allied specimens (Barker 1187) from central Tasmania (see Note) also come from an area of low subalpine heathland in a hollow between snowgum-covered ridges. The plants occurred sporadically along the steep-sided banks about $\frac{1}{2}$m high bordering narrow rivulets which traversed the hollow. Many plants were profusely fruiting at the time of collection in late January.

NOTE:

Barker 1187 is an unusual collection from near Mt. Field East in south-west Tasmania. It closely resembles ssp. subglabrifolia by its long upper internodes [($1\frac{3}{4}$)2-3 times length of upper leaves], the restriction of its glandular hairs mainly to the inflorescence and its uppermost leaves with 1-2 teeth along each margin. The uppermost leaves diverge slightly from the Victorian representatives by their sometimes broad apices.

It is possible that the population has originated independently of ssp. subglabrifolia, and that this occurred by hybridisation between ssp. gibbsiae (or forms intergrading into ssp. comberi) and E. striata, both of which occur in the area. Plants tested showed a low degree of pollen sterility (Appendix 1: PS 12,13,15,16).

SPECIMENS EXAMINED:

Victoria: Baw Baw Plateau

Barker 1466, 22.xii.1971. On the longer or southern snowpole line to Mt. Baw Baw, ca. 1km SE of the Baw Baw Alpine Village. AD. -- Barker 1467, 22.xii.1971. On the longer or southern snowpole line to Mt. Baw Baw, ca. 1km SE of the Baw Baw Alpine Village. AD. -- Barker 1468, 22.xii.1971. On the longer or southern snowpole line to Mt. Baw Baw, ca. 1km SE of the Baw Baw Alpine Village. AD. -- Barker 1469, 22.xii.1971. On the longer or southern snowpole line to Mt. Baw Baw from Alpine Village, ca. ½km S of the summit. AD. -- Barker 1470, 22.xii.1971. Ca. 50m below the summit of Mt. Baw Baw. AD. -- Barker 1471, 22.xii. 1971. Ca. 50m below the summit of Mt. Baw Baw. AD. -- Barker 1472, 22.xii.1971. On Mt. Baw Baw summit. AD. -- Barker 1473, 22.xii. 1971. Ca. 200m NW of Mt. St. Phillack at the junction of the Baw Baw, Erica, Whitelaw, Mustering Flat tracks. AD. -- Barker 1474, 22.xii.1971. On the Mt. Baw Baw track, ca. 400m from the junction on the Mt. St. Phillack-Mt. Whitelaw track. AD. -- Barker 1475, 22.xii.1971. In the Mt. Baw Baw Alpine Village. AD. -- Barker 1476, 23.xii.1971. Immediately SSE of Baw Baw Alpine Village along edge of East Tanjil Creek, from near bridge at foot of ski run to ca. 200m upstream. AD. -- Beauglehole 15343, 22.i.1966. N.E. of Ski Village. MEL. -- Beauglehole 15344, 22.i.1966. N.E. of Ski Village. MEL. -- Beauglehole 41292, 27.i.1973. Scattered from Ski Village to beyond Mt. Baw Baw. AD, MEL. -- Beauglehole 41295, 27.i.1973. Scattered from the Ski Village to beyond Mt. Baw Baw. MEL. -- Luehmann & French s.n., 1892(1893 on GH specimen). Mt. Mueller, Gippsland. BM (holotype); MEL41526, GH. -- Mueller s.n., -.xii.1860. Sources of the Yarra and Mt. Baw Baw. MEL41539. -- Stone s.n., 14.ii.1965. Baw Baws. MELU15993. -- Tindale s.n., 22.i.1967. Mt. Baw Baw. NSW84432. -- Tindale s.n., 22.i.1967.

Mt. Baw Baw. NSW126381. — Whaite 3232, 9.i.1969. Mt. Erica. NSW87876. — Willis s.n., 10.xii.1963. Mt. Baw Baw. MEL41532.

Locality uncertain

Frost s.n., -.xii.1895. N.E. mountains. MEL41542(p.p.).

SPECIMEN WITH AFFINITIES TO SSP. SUBGLABRIFOLIA:

Tasmania

Barker 1187, 21.i.1971. Mt. Field Nat. Park; Windy Moor, along track to Lake Fenton between ca. ½ to 1¼km south-west of Mt. Field East Summit. AD.

h. ssp. discolor Barker, subspecies nova

LATIN DIAGNOSIS:

Subspecies nova prope ssp. pulvinestrem et ssp. subglabrifoliam indumento glanduloso ad et proxime infra inflorescentiam limitato, ramis supra planum terrae simplicibus, et foliis summis ramorum floralium secus quemque marginem 1(2) dentibus, sed differt a duabus corollis albis, lilacinis, profunde lilacinis, purpureisve, etiam ab illa corollis extense striatis, ab hac internodiis brevioribus.

Holotypus (tab. 17): W.R.Barker 1218A, 28.i.1971. Cradle Mt. - Lake St. Clair National Park; Cradle Mt., on track to summit from Kitchen Hut, on east face between the first outcrop encountered on the climb and the summit, and on the summit itself. AD97126159. Isotypi: 8 distribuendi.

DESCRIPTION:

Plant (4)4.5-10(13)cm tall, taller when in fruit, with many ascending branches arising from reduced stem or prostrate parts of other branches.

Floral branches (1.5)3.5-8(11)cm high to base of inflorescence;

internodes between upper 0(4) nodes as long as or longer than the upper leaves, the longest internode $(\frac{1}{4})\frac{1}{2}-\frac{7}{8}(1\frac{1}{2})$ times length of upper leaves, shorter below; axis covered for all length by two rows or two pairs of lines of dense, short to moderately long eglandular hairs, decurrent from between leaf bases, sometimes mixed in upper parts with short to long glandular hairs all around axis.

Leaves: uppermost leaves of floral branches (6)7-10(13)mm long, 4-7(9)mm broad, obovate in outline, usually glabrous, sometimes with very few short to moderately long glandular hairs or sparse to dense patch of short eglandular hairs on margins of teeth and apex; base narrow cuneate; teeth 1(2) along each margin, the longest tooth (1.2)1.5-2.5(3.0)mm long; apex sharply or bluntly acute or acuminate, (1.8)2.6(3.2)mm long, (1.6)2.2(3.4)mm broad; leaves lower down glabrous but for short eglandular hairs on tip of apex and teeth.

Inflorescences with rachis covered by two rows of sparse to dense, short to long eglandular hairs decurrent from between bases of bracts, sometimes with sparser eglandular hairs between or with sparse to moderately dense, short to moderately long glandular hairs all around or mixed with rows of eglandular hairs only.

Bracts with upper surface usually covered by moderately dense to dense, short to moderately long eglandular hairs, mixed towards margins with sparse to dense, short to moderately long glandular hairs, rarely glabrous, with lower side usually bearing sparse to dense similar glandular hairs, sometimes glabrous.

Calyx with external surface of teeth and distal part of tube covered by sparse to dense, usually short to moderately long, rarely long glandular hairs, sometimes mixed with sparse to moderately dense, short to moderately long eglandular hairs, base of tube with sparser indumentum, sometimes glabrous.

Corolla white, lilac, deep lilac or purple, with yellow to yellow-orange patches at base of the anterior filaments and behind lowest lobe, with purple to deep purple, indigo or blue-indigo striations extending for tube and hood onto lobes.

Stamens with anthers (1.6)1.7-2.0(2.1)mm long.

Plates: 5, 17

Figures: 12

TYPIFICIATION:

Holotype (pl. 17): W.R.Barker 1218A, 28.i.1971. Cradle Mt. - Lake St. Clair National Park; Cradle Mt., on track to summit from Kitchen Hut, on the east face between the first outcrop encountered on the climb and the summit, and on the summit itself. Common and the dominant perennial on the very summit of Cradle Mt., in flat exposed areas between dolerite boulders. Altitude 5060 feet (1540m). Corollas white to lilac to deep lilac to purple, with yellow to yellow-orange areas at base of throat and often also at the lower side of the mouth, with purple to deep purple to indigo to blue-indigo striations. N.B. The majority of plants, if not all, were collected from the extreme summit. However, some may have come from the east face cited above where the plants of the segregate (Barker 1218B) from this collection occurred. AD97126159. Isotypes: 8 duplicates to be distributed. Pollen slides: A.N.U.,AD.

The type collection is well-preserved, although some flowers have been eaten by insects and the corollas have dried a brown colour. It consists of about 25 fragments of plants with two or more floral branches and vegetative branches and about the same number of single floral branches. The collection contains buds, flowers and a single mature fruit.

The type population is in little danger, especially as it occurs in a National Park.

The mixture of material of ssp. gibbsias with the type collection is discussed under Note 2.

DISTRIBUTION (Fig. 12):

Ssp. discolor is at present known with certainly only from the region of the type locality, Cradle Mt., in north-eastern Tasmania. Its range may be extended well into the south-west depending on the true affinities of a number of specimens which appear closely related to it (see Note 1).

The Cradle Mountain specimens come from the upper slopes at altitudes of 1200m (Barker 1206) and 1540m (Barker 1218A). The allied plants in southern and western Tasmania have been recorded from altitudes of 3000 feet (910m: Olsen 39, Whaite 2267) and 4000 feet (1220m: Whaite 2257,2262).

ECOLOGY:

The Cradle Mountain specimens of ssp. discolor come mainly from the summit "in flat exposed areas between dolerite boulders" (Barker 1218A). The collection Eichler 16508 was similarly recorded as coming from "between rocks on the crest of Cradle Mountain". One outlier (Barker 1206) was found near the base of the steep dolerite cap of the mountain "on a steep slope, in small area of soil in crevice between rocks".

The records of habitats of the collections of plants considered to be very closely related to ssp. discolor (see Note 1) are not dissimilar from those of the Cradle Mountain collections. The plant in Olsen 39 was found on a "rock ledge" while the two collections made by the Whaites (2237,2262) from an altitude of 1220m were made from "sheltered spots between dolerite rocks".

Lower down from these localities at 910m altitude plants were found "in sphagnum bog on exposed dolerite plateau" (Whaite 2267). The only other ecological annotations provided on these specimens are "sub-alpine herb community" (Telford 2481) and "straggling in dwarf shrubs" (Gordon HO). From all these annotations it is likely that the subspecies and its close relatives occur exclusively in the alpine and subalpine zones.

Flowering in the Cradle Mountain area apparently occurs throughout January and well into February, while further south it appears to happen approximately between mid-December and mid-February.

NOTES:

1. Although closely allied, ssp. discolor and ssp. comberi differ in the degree of leaf toothing, anther size and flower colour. The differences between the two subspecies have been gauged from a few large gatherings of each, from which it is clear that their recognition as distinct subspecies is fully justified. These copious collections of each subspecies come from widely separate localities, those of ssp. discolor from Cradle Mt. in the north of Tasmania and those of ssp. comberi from various areas of the south-west. Fragmentary or small collections resembling more ssp. discolor than ssp. comberi have been made in certain areas of south-western and western Tasmania, in particular from Frenchman's Cap, (Gordon HO, Olsen 39), the Western Arthur Range (Fenton AD97121112, Olsen 65), Adamson's Peak (Black 4, Telford 2481; Whaite 2257, 2262, 2267) and Mt. La Perouse (F.A.Rodway NSW22280 p.p.). These collections have been placed under ssp. discolor for the present on the basis of their uppermost floral branch leaves bearing 1-2 teeth along each margin. In addition, the flower colour in one specimen (Whaite 2262) has been recorded

as "purplish" which also links the specimen with ssp. discolor. Copious collections and field observations are required to determine the true nature of these specimens.

2. There is some doubt as to the spatial differences between the type population and the population of ssp. gibbsiae both of which occur in the summit region of Cradle Mt. The majority of plants placed initially under the number 1218 were gathered from the summit area. The occurrence and distribution of the glandular indumentum was closely examined on these plants at the time of collection and I am almost certain that they all resembled ssp. discolor. However, the several additional plants collected away from the actual summit were little studied and may have included representatives of ssp. discolor as well as ssp. gibbsiae (see also E. gibbsiae: Intraspecific Variation).

SPECIMENS EXAMINED:

Tasmania

Barker 1206, 28.i.1971. Cradle Mt. - Lake St. Clair National Park; just below west end of saddle between Little Horn and Weindorfers Tower, on track along north side of Cradle Mt.; ca. 100m east of plateau. AD. — Barker 1218A, 28.i.1971. Cradle Mt. - Lake St. Clair National Park; Cradle Mt., on track to summit from Kitchen Hut, on the east face between the first outcrop encountered on the climb and the summit, and on the summit itself. AD(holotype); pollen slides A.N.U.,AD. — Eichler 16508, 8.i.1960. On the crest of Cradle Mountain. AD.

SPECIMENS WITH CLOSE AFFINITIES TO SSP. DISCOLOR:

Tasmania

Black 4, 29.xii.1913. Adamson's Peak. MEL. — Fenton per Barker s.n., -.i.1971. Western Arthur Range. Mt. Scorpio. AD97121112. — Gordon s.n., 13.xii.1944. Just below Barron Pass, Frenchman's Cap. HO. — Olsen 39, 29.xii.1966. Near Barron Pass, Frenchman's Cap. NSW95460. — Olsen 65, 6.i.1967. Mt. Hayes, Western Arthur Range. NSW95459,BISH. — F.A.Rodway s.n., -.xii.1899.

La Perouse. NSW22280. — Telford per Canning 2481, 7.ii.1969. Adamson's Peak. CBG. — Whaite 2257, 21.i.1961. On Adamson's Peak. NSW53956. — Whaite 2262, 21.i.1961. On Adamson's Peak. NSW53955. — Whaite 2267, 22.i.1961. Near Fine Hut, Adamson's Peak. NSW53954.

i. ssp. pulvinestris Barker, subspecies nova

E. gibbsiae Du Rietz: Curtis, Stud. Fl. Tasm. (1967) 531, p.p. (partly as to "variants, which often grow in cushion plants e.g. Donatia nova-zelandiae........., with simple flowering stems 2-8cm high"); Harris, Alp. Pl. Austral. (1970) 138, p.p. (partly as to plants "often growing among cushion bushes.... in Tasmania").

LATIN DIAGNOSIS:

Subspecies nova prope ssp. subglabrifoliam et ssp. discolorem indumento glanduloso ad et proxime infra inflorescentiam limitato, ramis supra planum terrae simplicibus, et foliis summis ramorum floralium secus quemque marginem 1-2(3) dentibus. Differt a subspeciebus totis E. gibbsiae striis plerumque ad tubum cucullumque corollae limitatis, etiam a ssp. subglabrifoliam internodiis brevioribus et a ssp. discolori corollis albis.

Holotypus (tab. 17): W.R.Barker 1181, 19.i.1971. Tasmania, South-west. Mt. Field Nat. Park; on top of K. Col from the middle and east towards the Rodway Range. AD97116046. Isotypi: 7 distribuendi.

DESCRIPTION:

Plant (3.5)7-10(13)cm high, usually with a few to many densely crowded branches, ascending or shortly prostrate proximally, erect distally (above ground level), sometimes simple and erect.

Floral branches (2.5)4-7(9)cm high to base of inflorescence; internodes between upper 0-4(5) leaf pairs as long as or longer than upper leaves, the longest ($\frac{1}{2}$)1(2) times length of upper leaves, shorter than leaves lower down; axis with four lines of short to moderately long eglandular hairs decurrent from either side of each leaf base, with short glandular hairs often on internode above uppermost leaf pair, absent below.

Leaves: uppermost leaves of floral branches (5)7-9(10)mm long, (3)4-7(9)mm broad, spathulate to obovate in outline, usually glabrous but for a few eglandular hairs on extremities, sometimes with sparse to dense short glandular hairs; base cuneate, often narrowly so, to attenuate; teeth 1-2(3) along each margin, the longest (1.2)1.4-2.5(3.0)mm long; apex sharp or blunt, acute or acuminate, often narrowly so, (1.2)2.0(3.2)mm long, (0.8)1.3(2.0)mm broad; leaves lower down glabrous.

Inflorescences with rachis with two rows of dense, short to moderately long eglandular hairs, usually mixed with sparse to dense, short to moderately long glandular hairs.

Bracts glabrous but for short eglandular hairs at extremities, or with short glandular hairs, usually sparse and confined to upper surface and distal margins, rarely dense all over, mixed with short eglandular hairs, usually confined to extremities, sometimes covering upper surface.

Calyx with outer surface bearing short to moderately long eglandular hairs, dense on margins of teeth, sparse elsewhere, usually mixed with short to moderately long glandular hairs, sparse to dense on margins and distal part of teeth, absent to moderately dense at base of tube.

Corolla white, with yellow blotch on lower lip behind lowest lobe to deep into tube about point of insertion of anterior filaments, with indigo striations usually contined to tube and hood and hardly extending onto lobes, sometimes extending well out onto lateral lobes.

Stamens with anthers (1.5)1.6-2.0(2.1)mm long.

Plates: 1, 5, 17

Figures: 12

TYPIFICATION:

Holotype (pl. 17): W.R.Barker 1181, 19.i.1971. Tasmania, South-west. Mt. Field Nat. Park; on top of K. Col, from the middle and east towards the Rodway Range. In the extensive areas of cushion plant. Altitude ca. 4050feet (1230m). Corollas white, with yellow spots on lower side of mouth and deep in throat, with indigo striations, varying in extent, (one plant - A - with only a single indigo striation on each lateral lobe, otherwise the lobes lacking striations). Ca. 200m west of Euphrasia sp. (WRBarker 1182). AD97116046. Isotypes: 7 duplicates to be distributed

The type collection consists of about 50 specimens, many of these being entire plants, some being single broken-off floral branches. Buds and mature flowers but no mature fruits are present. Because of difficulties in drying in the field some mould is present in many of the flowers and the originally white corollas have turned brown. In addition the leaves are liable to drop off if handled carelessly. Unfortunately no better material is available for type purposes.

The type population as well as the subspecies in general should not be endangered as it occurs in a National Park.

DISTRIBUTION (Fig. 12):

Ssp. pulvinestris is known only from the western half of the Mt. Field massif in central or south-west Tasmania. The records from Mt. Field West, K. Col and Mt. Mawson will almost certainly be expanded to include neighbouring high mountains in the same area bearing similar "cushion plant" expanses such as Mt. Tyenna. However whether it is confined entirely to this region must await a study of the nearby mountains of the south-west, which are relatively little known botanically.

The subspecies is known only above an altitude of 1200m, and reaches almost the summit of Mt. Field West which is ca. 1450m high and the highest mountain in the region.

ECOLOGY:

The subspecies is usually found growing in areas of pure blanket bog (described by McVean 1969; Curtis 1969), which is a mixture of hard mat-forming species of Donatia, Abrotanella etc., collectively known as "cushion plants" (Barker 1166, 1167, 1170, 1181, 1182). The only record from a different habitat is that of Barker 1178A, a single plant typical of the subspecies which was found growing on a steep slope in low alpine heath. It has also been found from an ecotone between the two habitats (Barker 1168: see Intraspecific Variation).

The subspecies is known to flower in January and February. However collections are too few to determine the limits of the flowering season.

SPECIMENS EXAMINED:

Tasmania: Mt. Field National Park.

Barker 1166, 19.i.1971. Immediately east of Mt. Field West on plateau extending to Naturalist Peak. AD. — Barker 1167, 19.i.1971. Ca. 100m east of Mt. Field West summit on plateau extending to Naturalist Peak. AD. — Barker 1168, 19.i.1971. Ca. 100m east of Mt. Field West summit on plateau extending to Naturalist Peak. AD. — Barker 1170, 19.i.1971. From ca. 200m east of Mt. Field West summit over plateau for distance of ca. 500m towards Naturalist Peak. AD;

pollen slide A.N.U.,AD. — Barker 1178A, Ca. 400m east of Clemes Tarn, on track from K. Col to Mt. Field West. AD. — Barker 1181, 19.i.1971. On top of K. Col, from the middle and east towards the Rodway Range. AD (holotype). — Barker 1182, 19.i.1971. Ca. 300m east of the middle of K. Col, on track to top of the Rodway Range, on east side of scree. AD. — Eichler 16750, 23.i.1960. Plains immediately below the summit of Mt. Field West towards Naturalist's Peak. AD. — Elliot s.n., -.ii.1948. Summit Plateau, Mt. Field West. HO. — Jackson s.n., 18.ii.1965. Mt. Mawson summit. MEL41530.

SPECIMENS INADEQUATE OR UNAVAILABLE FOR INFRASPECIFIC DETERMINATION:

Tasmania:

Gibbs 6601, -.i.1915. Mt. Olympus. BM(p.p.). — Hamilton s.n., -.xii.1969. Vicinity of L. Pedder. HO.

Without locality:

[Stuart] 83, s.dat. Without locality. MEL(p.p.).

4. Euphrasia striata R.Br.,Prodr.(1810)436;[R.Br.,Manuscript (unpubl.)]; Spreng.,Linn.Syst.Veg.(ed.16)2(1825)777; Benth.in DC.,Prodr.10 (1846)554; Hook.f.,Fl.Tasm.1(1857)297 p.p.(excl. glandular-pubescent forms); Benth.,Fl.Austral.4(1868)521,p.p.(as to Tasmanian plants, excl. glandular-pubescent forms); Wettst., Monogr.Gatt.Euphr.(1896)252,t.5 f.396-403,t.13 f.9,p.p.(as to Tasmanian plants lacking glandular hairs from herbaceous parts); Gandoger,Bull.Soc.Bot.France 66(1919)217; Du Rietz,Sv.Bot. Tidskr.25(1932)529,532, 42(2)(1948)100,f.1,t.1,2(p.p.), 42(4) (1948)351,362; Curtis,Stud.Fl.Tasm.3(1967)530,p.p.(excl. plants with glandular hairs on both surfaces of calyx); Willis, Muelleria 1(1967)148; Curtis,End.Fl.Tasm.1(1967)26,27(t.col.),p.p.(excl. occurrences at sea level near the west and south-west coasts).

E. alpina R.Br. β[=var.] humilis Benth.in DC.,Prodr.10(1846)553; Hook.f.,Fl.Tasm.1(1857)296

[E. brownii FvM. var. striata (R.Br.)Rodway,Tasm.Fl.(1903)143; Curtis,Stud.Fl.Tasm.3(1967)530(as syn. of E. striata); Curtis,End.Fl.Tasm.1(1967)26(as syn. of E. striata)]

[E. brownii auct. non FvM.(nom.illeg.): Spicer,Hdbk.Pl.Tasm. (1878)77,127,p.p.(as to syn., E. striata); FvM.,Syst.Cens. Austral.Pl.1(1882)97,p.p.(as to some Tasmanian occurrences); FvM.,Sec.Syst.Cens.Austral.Pl.1(1889)165,p.p.(as to some Tasm. occurrences)]

DESCRIPTION:

Perennial herb, (3)7-14(18)cm tall, with many crowded ascending branches arising from very short stem or prostrate parts of other branches, often rooting on prostrate parts.

Stem reduced; floral branches (2)5-11(15)cm high to base of inflorescence with distal erect parts simple; upper (1)3-5(7) internodes longer than leaves, the longest internode (1)2-3(5) times length of uppermost leaves, those lower down much shorter than leaves; axis purple-brown, bearing two distichous rows of very short, dense eglandular hairs decurrent from between leaf bases, the rows sometimes divided by central glabrous band over all or part of internode.

Cotyledons not seen.

Leaves: uppermost leaves of floral branches (4.0)5.0-7.5(9.0)mm long, (2.5)3.0-6.0(8.0)mm broad, obovate, or broadly so in outline, purple-brown entirely or partly green and partly purple-brown, glabrous but for patches of sessile glands confined to distal half of lower surface; base long, narrow attenuate, almost petiole-like; teeth 1-2(3) along each margin, sharp, usually acuminate or acute, rarely obtuse, confined to distal $\frac{1}{4}$-$\frac{1}{2}$($\frac{5}{8}$) of leaf, with longest tooth (0.9)1.0-2.0(2.3)mm long; apex sharp, acuminate to acute or broadly so, (1.0)1.2-2.5(2.7)mm long, 1.1-1.8(2.2)mm broad; lower leaves of similar dimensions; leaves on proximal parts of prostrate parts and on young shoots smaller.

Inflorescences but for lowermost 0-1(2) nodes dense racemes bearing (7)10-16(22) flowers, with lowermost node often bearing only one flower; rachis as for axis; internodes not elongating after anthesis; pedicels of lowermost flowers (0.6)1.0-3.5(4.0)mm long, shorter towards apex, i.e. (0.4)0.6-1.2(1.5)mm long, not elongating after anthesis; apical cluster (excluding buds at widely spaced lower nodes) spherical to broadly oblong-ellipsoid, initially (0.5)0.7-1.1(1.5)mm long, becoming hidden by corollas of uppermost flower pair after opening of flowers at first (1)2-3(4) nodes.

Bracts similar in shape and indumentum to uppermost leaves, but somewhat broader.

Calyx (4.5)5.5-8.2(10.0)mm long, ribbed, externally glabrous but for a small dense patch of tiny glandular hairs at base of each cleft, rarely with one or two tiny glandular hairs elsewhere, internally with short eglandular hairs, dense in apical half of teeth, sparser lower down, rarely extending onto tube, mixed with short glandular hairs, sparse to moderately dense in basal half of teeth, absent from tube and usually apical half of teeth, rarely sparse on the latter; teeth ± bluntly to sharply acute; lateral clefts 1.5-4.0mm deep, shorter than median clefts, which are 2.3-5.5mm deep.

Corolla (7.8)8.5-10.5(12.5)mm long along upper side, white with yellow patches on lower side of mouth and deep in throat, with 3(4) red-purple striations extending well out onto each lobe, the striations ± equally distinct over all three lower lobes, sometimes simple, sometimes branched; tube (5.0)6.4(8.0)mm long, abaxially and somewhat laterally broadened at about point of insertion of anterior filaments, which are (3.5)5.2(7.3)mm from base of corolla, externally glabrous at base and on abaxial side, on distal adaxial and lateral surfaces covered by moderately dense to dense, short to moderately long eglandular hairs, with dense patch of short glandular hairs about lateral clefts, internally except for glabrous basal 1mm and behind lower lip, covered by dense, very short to moderately long, downturned eglandular hairs extending to between bases of posterior filaments; hood (2.3)3.5(4.2)mm long, excluding lobes (2.5)3.0(3.5)mm broad, including lobes (6.0)7.7(10.5)mm broad, externally covered on midline and front by dense, short to moderately long eglandular hairs, sparser or absent from the sides, and sparse to dense, short glandular hairs on sides between sinus and lateral clefts, internally with very short to short glandular hairs, usually moderately dense to dense at sinus region or extending around margins, sometimes moderately dense over all hood, and dense, short to moderately long eglandular hairs at sinus; upper lobes almost in same plane, broadly obtuse, sometimes with short apiculation, to praemorse-truncate to shallowly emarginate, with cleft between (1.3)1.8(2.5)mm deep, with front surface and margins glabrous, with rear surface glabrous or bearing short to moderately long glandular hairs, sparse to dense and confined to base, or all over and dense at base, sparse distally; lower lip concave from above, downturned until almost parallel to upper side, (6.0)7.3(8.0)mm long, (9.6)13.0(15.5)mm broad, externally bearing sparse to moderately dense, short glandular hairs, sometimes mixed with sparse to moderately dense, short to moderately long eglandular hairs, either all over or confined to area behind lowest or lateral lobes, with margins and inner surface glabrous; lower lobes broadly obtuse to praemorse-truncate to emarginate, with clefts between (2.7)3.4(4.3)mm deep.

Stamens with filaments glabrous, the anterior pair (2.7)3.8(4.2)mm long, the posterior pair (1.1)1.9(2.4)mm long; anthers (1.1)1.4-1.9(2.2)mm long, (0.6)0.9-1.2(1.3)mm broad, with connectives glabrous, with slits lined by short to very short eglandular hairs, with posterior pair of awns (0.2)0.3-).4(0.5)mm long, usually longer than, occasionally ± equal to other three awn pairs.

Ovary in lateral view oblong to broad elliptic or broad oblong-ovate, slightly compressed laterally, in median view usually narrow ovate to ovate, sometimes elliptic, usually glabrous, sometimes with a few short setae at the apex, sometimes denser and extending 1/3 way down lines of dehiscence; apex in lateral view shallowly emarginate to truncate to obtuse, occasionally obliquely so; ovules (33)46(58).

Capsules (few seen) ca. 4.5-10.5mm long, slightly compressed laterally, in lateral view usually oblong-elliptic to elliptic or ovate-oblong, sometimes broadly so, ca. 2.4-3.7mm broad, in median view ± ovate, usually glabrous, occasionally with apex covered by short to moderately long setae; apex in lateral view broadly obtuse to truncate to emarginate, sometimes oblique; seeds ca. 7-33, usually ± ellipsoid to reniform, occasionally broadly so, (0.8)1.2-1.8(2.0)mm long, 0.5-0.9mm broad.

Chromosome number: n=c.20-30 (Barker 1060)

Plates: 5, 18

Figures: 13

TYPIFICATION:

1. E. striata R.Br.

Holotype: R.Brown 62, ii-iii.1804 [13.iii.1804]. In summitate Montis Tabularis prope fluv: Derwent. BM(p.p.). Isotypes: Brown s.n., s.dat. Table Mountain. K(p.p.), MEL41683.

Table Mountain is an old name for Mount Wellington which is about 7km west of Hobart. Many collections of E. striata have been made from this locality, where it is very common.

The exact date of collection of the type material was recorded in Brown's manuscript. Otherwise the data in the manuscript and on the collection itself are more or less identical.

It is clear that at some stage between the collection of the specimens initially named E. striata, and the publication of that name in the Prodromus (Brown 1810), Brown decided to call the species "E. picta". On the types in K and BM and in the manuscript Brown has crossed out E. striata and substituted the other name, while the MEL type bears both names. The epithet "picta" has since been used for a European species of Euphrasia.

The holotype which is mounted with a collection by Caley of E. gibbsiae is in good condition but for the loss of some inflorescences. It contains almost an entire plant with many floral branches, as well as three portions of plants, each bearing several branches. Du Rietz (1948a: pl.2) included a photograph of the holotype in his paper on the Tasmanian species of Euphrasia.

The K isotype is mounted with two other collections of E. striata from Mt. Wellington, the holotype of E. alpina var. humilis (see below) and Cunningham 50.

2. E. alpina R.Br. var. humilis Benth.

Holotype: R. Gunn 1221, s.dat. A small species very common to the extreme summit of Mt. Wellington. K(p.p.). Isotypes: [Gunn] $\frac{1221}{1842}$, 31.i.1840. Mt. Wellington. NSW10820, BISH; BM(n.v.: Du Rietz 1948a, p.103).

In addition to Gunn's label affixed to the holotype is another annotated by Bentham with "Euphrasia alpina βhumilis". In keeping with his recognition of the synonomy of the variety with E. striata (Bentham 1868), Bentham subsequently re-determined the collection as that species.

It should be noted that the date, 1844, stamped on Bentham's label on the holotype is not the date of the collection.

When Bentham (1846) initially described the taxon "E. alpina β humilis" he gave no indication of rank. However the varietal rank of the taxon is clearly indicated in the subsequent works of Hooker (1857) and Bentham (1868).

The holotype is in good condition with three portions of plants each bearing a number of floral branches, containing flowers but lacking mature fruits.

DISTRIBUTION (Fig. 13):

E. striata is confined to the mountain areas of central Tasmania. More specifically it occurs in the higher parts of the Central Plateau and the crescent of mountains (to its west and south) bounded by Cradle Mt. in the north and Mt. Wellington in the south. It has not been recorded from other mountain areas with subalpine zones in the south-west, extreme west (e.g. Mt. Murchison to Frenchmans Cap), and north-east (Ben Lomond), although the first two areas have been rather poorly botanised and one specimen (Comber 2167), only slightly atypical of E. striata (see Note 2) comes from Mt. Sedgwick in the West Coast Range.

The species is known from altitudes of between 1000m and 1370m.

The reported occurrences of E. striata on the south-west coast of Tasmania (Curtis 1967a, 1967b) are probably based upon plants of E. gibbsiae ssp. kingii wrongly ascribed to E. striata. It is also doubtful whether collections allegedly made by Milligan from such regions came from there (see Note 4).

ECOLOGY:

E. striata is confined to the subalpine and alpine zones, where it usually occurs in open areas with grasses or low woody perennials, often protected by low to tall heath, or simply by the terrain. It rarely occurs in dense tall heath or dense subalpine woodland (Barker 1185,1188), areas of "cushion plants", i.e. hard compact mats of Abrotanella, Phyllachne, Donatia etc. (Barker 1202, 1203,1208; Jackson HO) or clumps of Astelia alpina R.Br. (Barker 1074,1203,1213), each of which is a habitat often favoured by one or several other Euphrasia species. It appears to grow mainly on dolerite-based soils, although the collections, from the plateau immediately north of Cradle Mountain and nearby Mt. Campbell (Barker 1208,1209,1213,1215) are from apparently quartzitic soils.

It seems that flowering begins in late December and rarely continues long after the end of February. There is one record of flowering in April (Rodway 1411). Fruits are increasingly apparent from early February, but rarely develop fully while the inflorescence is still in flower.

NOTES:

1. All plants of the collection which Curtis (HO: 5.iii.1949) made from the Cradle Mountain plateau have upper internodes more or less equal in length to the upper leaves. In a random gathering from a normal population of E. striata most plants would bear longer upper internodes. In all other respects the plants agree with typical E. striata. Pollen from one of the plants was found to be almost entirely functional in appearance (Appendix 1: PS270), thus making a hybrid origin of the plants rather doubtful.

2. The collection Comber 2167 from Mt. Sedgwick at 2000 feet (610m) in the western mountains of Tasmania is allied to E. striata, but differs by its long-toothed leaves and rather short internodes. In these characters the plants tend to some extent to E. hookeri but the leaves are not sufficiently toothed nor are the recurved margins joined on the underside. The small corolla size as well as the confinement of the tiny glandular hairs to the inner surface of the calyces clearly link the collection to E. striata and distinguish it from the other species of Subsect. Striatae. There is no evidence that the specimens are hybrids; a study of pollen from one young flower was almost entirely functional in appearance (Appendix 1: PS271).

3. Occasional highly sterile hybrids between E. striata and E. collina ssp. diemenica are known in Tasmania from the Central Plateau and possibly also from Mt. Wellington (see Interspecific Hybrids).

4. The collections placed by Milligan under his number 766 come from several localities and include E. striata, E. hookeri and E. gibbsiae ssp. kingii. Herbarium sheets inscribed with this number often bear mixtures of these species and bear only the one locality label.

Collections of E. striata by Milligan (766: MEL41685, MEL 41451p.p., BMp.p.) are alleged to have come from Birchs Inlet, MacQuarie Harbour and questionably (see below) Kellys Basin, Port Davey. There are apparently no other herbarium collections of E. striata from the south-west of Tasmania. Accordingly, Milligan may have mixed his collections of E. striata from Mt. Wellington (MEL41694) with collections of E. gibbsiae ssp. kingii from the above localities. Nevertheless, E. striata may occur in the south-west of Tasmania providing suitable habitats are available. The climate seems sufficiently extreme to cater for an environment similar to the subalpine habitats in which it normally occurs. However, Jackson (1965) states that the moorland which E. striata characteristically inhabits occurs at altitudes above 2000 feet (600m) in the south. In the map accompanying his article moorland is not shown in the Port Davey and MacQuarie Harbour areas. Accordingly, if present there it must be limited in occurrence and extent as the map by necessity covers only the regions with extensive tracts of moorland.

Additional confusion concerning the true source of Milligan's collections of E. striata arises from the annotation "Kelly's Basin, McQur. Harbour" on MEL41685. Kellys Basin is an inlet of Port Davey which is at the very south-west corner of Tasmania, about 85km south of MacQuarie Harbour. Milligan apparently collected at both localities.

SPECIMENS EXAMINED:

Tasmania

Ainsworth per Barker 1, 28.i.1971. On Windemere track near Lake Holmes. Cradle Mt. - Lake St. Clair National Park. AD. -- Ainsworth per Barker 2, 28.i.1971. Cradle Cirque, Cradle Mt. - Lake St. Clair National Park. AD. -- Anon. s.n., 20.i.1960. Projection Bluff. HO. -- Anon. s.n., s.dat. Without locality. MEL 41536. -- Archer s.n., s.dat. Without locality. GH,NSW10821. -- Ashton s.n., -.ii.1960. Plateau Cradle Mt. MEL41696. -- Barker 994, 30.xi.1970. Ca. ½km south of Lake Augusta and ca. 4km south-west of the source of the River Ouse. AD. -- Barker 1004, 30.xi.1970. Beside Lakes Highway, near Pine Lake, which is ca. 5km north of Breona; near the second snow fence from the south. AD. -- Barker 1011, 3.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD. --

Barker 1016, 3.i.1971. As for Barker 1011. AD. —— Barker 1040(p.p.), 5.i.1971. Ca. 1km north-east of the westernmost causeway, just south of dunes on the southern side of Lake Augusta. AD(p.p.). —— Barker 1060, 7.i.1971. Lakes Highway at Doctors Creek, which is ca. 4km south of Breona. AD. —— Barker 1061, 7.i.1971. As for Barker 1060. AD. —— Barker 1066, 7.i.1971. Beside Lakes Highway, ca. 1½km north of Pine Lake, which is ca. 5km north of Breona; near the northernmost snow fence near Pine Lake. AD. —— Barker 1067, 7.i.1971. As for Barker 1066. AD. —— Barker 1069, 7.i.1971. As for Barker 1066. AD. —— Barker 1071, 7.i.1971. Beside Lakes Highway from east of Pine Lake to ca. 1km north of it. AD. —— Barker 1074, 8.i.1971. Lake MacKenzie; ca. 1½km west of dam site by main access road from the Mersey Valley, ca. 1km north of Fisher River. AD. —— Barker 1124, 15.i.1971. As for Barker 1011. AD. —— Barker 1151, 19.i.1971. Mt. Field Nat. Park; ca. 400m west of Ski Village, on track to Tarn Shelf and Mt. Field West. AD. —— Barker 1152, 19.i.1971. Mt. Field Nat. Park; ca. 800m west of Ski Village on track to Tarn Shelf and Mt. Field West. AD. —— Barker 1154, 19.i.1971. Mt. Field Nat. Park; on slopes overlooking Tarn Shelf and Lake Seal, on track to Mt. Field West, ca. 100m from turnoff to Tarn Shelf track. AD. —— Barker 1176, 19.i.1971. Mt. Field Nat. Park; Clemes Tarn area, from ca. 100m north-west of Tarn towards Mt. Field West to ca. 100m east towards K. Col. AD. —— Barker 1178B, 19.i.1971. Mt. Field Nat. Park; ca. 400m east of Clemes Tarn, on track from K. Col. to Mt. Field West. AD. —— Barker 1183, 21.i.1971. Mt. Field Nat. Park; summit of Mt. Field East, and 100m south-west of it. AD. —— Barker 1185, 21.i.1971. Mt. Field Nat. Park; on lower slopes of Mt. Field East immediately above Windy Moor, ca. ½km south-west of summit. AD. —— Barker 1186, 21.i.1971. Mt. Field Nat. Park; Windy Moor, along track to Lake Fenton between ca. ½ to 2km south-west of Mt. Field East summit. AD. —— Barker 1188, 21.i.1971. Mt. Field Nat. Park; on ridge between Lake Fenton and Windy Moor on track to Mt. Field East. AD. —— Barker 1201, 27.i.1971. Cradle Mt. - Lake St. Clair National Park; on the Lake Rodway - Waldheim track, ca. 0.5-1.2km from Scott-Kilvert (Rodway) Hut. AD. —— Barker 1202, 27.i.1971. Cradle Mt. - Lake St. Clair Nat. Park; ca. halfway between Lake Rodway and ranger hut at Twisted Lakes on the Waldheim - Lake Rodway track (ca. ½km from each). AD. —— Barker 1203, 27.i.1971. Cradle Mt. - Lake St. Clair Nat. Park; near ranger hut at Twisted Lakes, and at the junction of the track along the north face of Cradle Mt. and the Waldheim - Lake Rodway track. AD. —— Barker 1204, 28.i.1971. Cradle Mt. - Lake St.

Clair National Park; on north face of Cradle Mt. below saddle between Little Horn and Weindorfers Tower, on the track from Hanson's Peak to Kitchen Hut; at turnoff to Wilks Lake. AD. —— Barker 1208, 28.i.1971. On eastern edge of plateau on north side of Cradle Mt. near junction of tracks from Lake Wilks and from Little Horn. AD. —— Barker 1209, 28.i.1971. On eastern edge of plateau on north side of Cradle Mt. near junction of tracks from Lake Wilks and from Little Horn. AD. —— Barker 1210, 28.i.1971. Ca. ½km west of the eastern edge of plateau on north side of Cradle Mt. on track to Kitchen Hut from Little Horn. AD. —— Barker 1213, 28.i.1971. On plateau on north side of Cradle Mt., ca. 100m along track to Waldheim from Kitchen Hut. AD; pollen slide A.N.U.,AD. —— Barker 1224, 28.i.1971. Cradle Mt. On slopes below Little Horn. AD. —— Barker 1225, 29.i.1971. Cradle Mt. - Lake St. Clair National Park. On top of Mt. Campbell, which is north-east of Cradle Mt. AD. —— Barker 1228, 29.i.1971. North-east of Cradle Mt. at the junction of the Mt. Campbell, Waldheim and Lake Rodway tracks AD. —— Barker 1231, 30.i.1971. Cradle Mt. - Lake St. Clair National Park. On "shelf" on the east side of Mt. Rufus on the southern track to Mt. Rufus from Cynthia Bay (on Lake St. Clair), just prior to steep climb to summit region. (Mt. Rufus is ca. 150km north-west of Hobart). —— Barker 1232, 30.i.1971. Cradle Mt. - Lake St. Clair National Park. On southern track to Mt. Rufus from Cynthia Bay (on Lake St. Clair); on saddle between east peak and middle or north peak, on slope up to latter. AD; pollen sample A.N.U., AD. —— Barker 1233, 30.i.1971. As for Barker 1232. AD. —— Black 2, s.dat. Mt. Wellington. MEL. —— Black 3, 21.i. 1913. Mt. Wellington. MEL. —— Black 5, 7.ii.1922. Mt. Wellington. MEL. —— Blackwood s.n., 3.i.1930. Great Lake, N. End. HO. —— Brown 62, -.ii-iii.1804. In summitate Montis Tabularis prope fluv: Derwent. BM(p.p.:holotype of E. striata). —— Brown s.n., s.dat. Table Mountain. K, MEL41683(isotype of E. striata). —— Burbidge 3258, 22.i.1949. Lake Dobson, National Park. CANB,L. —— Canning 2262, 2.ii.1969. Mt. Field National Park. Lake Belcher track. CBG. —— Carolin 1607, 28.i.1960. Windy Moor, S.W. of Mt. Field East. SYD. —— Carolin 1735, 5.ii.1960. Mt. Wellington. SYD. —— Cleland s.n., 20.i.1949. N. of Breona, Gt. Lake. AD97304022. —— Cunningham 50, -.i.1819. Mount Wellington. K(p.p.). —— Curtis s.n., 5.iii.1949. Cradle Mountain plateau. HO. —— Davis s.n., 30.i.1937. Pinnacle, Mt. Wellington. NSW22283. —— Eichler 16483, 8.i.1960. Cradle Mountain National Park. Marion's Lookout (above Crater Lake). AD. —— Eichler 16594, 13.i.1960. Lake St. Clair National Park. On way to Mt. Rufus, above forest line. AD. —— Eichler 16723, 21.i.1960. Mount Field National Park. Between

Ski Hut and Clemes Tarn on track to Mt. Field West. AD. — Elliot s.n., -.9.1946. Mt. Rufus. HO. — Ewart s.n., -.ii.1927. Mt. Field. MEL41698. — Fenton & Rimmer per Barker 1, 21.i.1971. Mt. Field National Park. From McKenzie Tarn to Walker Tarn on Tarn Shelf. AD. — Fenton & Rimmer per Barker 2, 21.i.1971. Mt. Field National Park. Lake Newdegate to Twisted Tarn. AD. — Fenton & Rimmer per Barker 4, 21.i.1971. Mt. Field National Park. Far end of Lake Dobson (i.e. farthest from huts). AD. — Garden s.n., 28.i.1949. Cradle Mountain. NSW7295(?p.p.). — Gunn 1221, s.dat. Without locality. K(p.p.:holotype of E. alpina var. humilis). — [Gunn] 1221/1842, 31.i.1840. Mt. Wellington. NSW10820,BISH; (isotypes of E. alpina var. humilis). — Gunn s.n., s.dat. Without locality. NY(p.p.). — Gunn s.n., s.dat. V.D.L. NY(p.p.). — Gunn s.n., s.dat. Without locality. L. — Gunn s.n., s.dat. Without locality. GH(p.p.). — Helms s.n., 19.i.1902. Mt. Wellington. NSW10819,BISH. — Hooker s.n., s.dat. Without locality. GH(p.p.),MEL41689. — Ising s.n., 23.i.1928. Mt. Wellington near top. AD966020911. — Jackson s.n., 18.ii.1965. K Col. HO. — Long 1117, 17.i.1932. HO. — Maiden s.n., -.iii.1906. Mount Field East. NSW10818. — Milligan 766+, 27.ii.1849. Mount Wellington. Back summit. HO,MEL41694. — Milligan s.n., s.dat. Without locality. MEL41466(p.p.). — Moore s.n., 20.i.1949. Great Lake. CHR66804(p.p.). — Morris & Burbury s.n., -.ii.1945. Cradle Valley, Cradle Mt. MEL41695. — Mueller s.n., -.i.1869. On Mt. Field. MEL41692. — Mueller s.n., -.i.1869. Mount Field East. MEL41690. — Mueller s.n., s.dat. Without locality. MEL41691. — F.A. Rodway 1411, 12.iv.1931. Mt. Wellington. NSW22284. — F.A. Rodway s.n., -.i.1899. Summit Mt. Wellington. NSW22277. — F.A. Rodway s.n., -.xii.1899. Ironstone Mts. NSW22281 (p.p.),BISH. — F.A. Rodway s.n., -.xii.1900. Ironstone plateau. NSW22271. — F.A. Rodway s.n., -.xii.1917. Nr. L. St. Clair. NSW 22290. — L. Rodway s.n., -.xii.1908. Great Western Mts. HO(p.p.). — L. Rodway s.n., -.i.1913. Mt. Wellington. HO. — [Stuart] 324, -.i.1849. Summit of Quambys Bluff. MEL(p.p.). — [Stuart] 324, 21.i.-. Mountains 3-4000ft. MEL. — Stuart s.n., s.dat. V.D.L. HBG. — Telford per Canning 2211, 2.ii.1969. Mt. Field National Park (western slope of Rodway Range towards K Col. CBG. — Telford per Canning 2715, 14.ii.1969. Cradle Mt. National Park (plateau above Crater Lake). CBG. — Walter 2044, 15.i.1959. Bei Breona am Great Lake Road. B. — Webb 3375, -.ii.1957. Near Pine Lake. BRI.

Without locality

Gunn s.n., s.dat. MEL41693.

Locality doubtful

Tasmania

Anon. s.n., 20.i.1915. Fern Tree. AD97013005. — Milligan 766, s.dat. Birch's Inlet Mcquarie Hr. MEL(p.p.). — Milligan $\frac{766}{X}$, 1.viii.1846. Kelly's Basin Mcqur. Harbour. MEL. — Milligan 766, s.dat. Birch's Inlet Mcquarie Hb. BM(p.p.).

SPECIMENS WITH AFFINITIES TO E. STRIATA

Tasmania

Comber 2167, 28.ii.1930. Mt. Sedgewick. HO. — Curtis s.n., 5.iii.1949. Cradle Mountain plateau. HO.

9. <u>Euphrasia semipicta</u> Barker, species nova

<u>E. brownii</u> [auct. non FvM.,Fragm.Phyt.Austral.5(1865)89 (nom.illeg.)]: Somerville & Elliot,Tasm.Nat.N.S.1(1946)5

LATIN DESCRIPTION:

<u>Herba</u> perennis, (10)15–25(30)cm alta, caule solo erecto surculos axillares ramosque ascendentes in partibus aeriis infernis ferenti, post annum primum retro ad ramulos superos mortuo. <u>Caulis</u> inflorescentiam in anno primo ferens, usque ad basim huius (2) 5–11(15)cm altus, (20)35–60(80) pares foliorum ferens, plerumque ramosus ramis summis a (5)10–25(33) nodis infra inflorescentiam, raro simplex; <u>internodiis</u> inter (3)4–7(9) pares summas foliorum quam folios longioribus, internodio longissimo foliis summis (2)3–4(5)-plo longiore, in partibus infernis multo brevioribus; <u>axibus</u> porphyreis duos series distichos pilorum eglandulosorum brevium densorum inter bases foliorum decurrentes ferentibus. <u>Cotyledones</u> subcirculares, integrae, glabrae, caducae. <u>Folia</u>: <u>summa caulina</u> (si caulis florifer) (4.0)5.0–8.0(10.0)mm longo, in ambitu obovata usque obovato-oblonga vel ita late, virides, interdum partim rubra, glabra; <u>base</u> longe attenuata; dentibus (1)2(3) secus quemque marginem, plerumque acutis, interdum obtusis, ad $(\frac{1}{3})\frac{1}{2}(\frac{5}{8})$ distalem folii limitatis, dente longissimo (0.9)1.2–1.8(2.2)mm longo; <u>apice</u> acuto usque obtuso, (1.0)1.3–2.0(2.8)mm longo, 1.3–1.7(2.5)mm lato; <u>inferna</u> et <u>in ramis</u> similes sed parum parviores, in surculis multo parviores. <u>Inflorescentiae</u> racemosae, densae praeter 0–1(3) nodos infimos, caulina (8)10–18(24) flores ferens, interdum nodo infimo florem unum subtendenti, ramorum paulo flores pauciores ferentes; <u>rhachidi</u> axibus similari; <u>pedicellis</u> florum infimorum (0.5)0.7–2.7(3.0)mm longus, versus apicem brevioribus; <u>fasce apicali gemmarum</u> (gemmis ad nodos inferiores distantes exclusis) sphaerico usque late rotundato-

conico, primum 0.6-1.3mm longo, post anthesin florum ad (1)3(6) nodos primos a corollis supremis occulto. Bracteae foliis summis similares. Calyx (5.0)6.6(8.5)mm longus, extra glaber interdum praeter pilos glandulosus minutos, intra tubo glabro, dentibus pilos glandulosos eglandulososque ferentibus; dentibus acutis; rimis lateralibus (1.5)2.3(3.0)mm profundis, medianis (2.0)3.4(4.5)mm profundis. Corolla secus superficiem (7.3)8.7(10.5)mm longa, alba, macula lutea in labio infero, lobis lateralibus 3 strias purpureas ferentibus, lobo infimo labioque supero interdum subtiliter striatis; tubo (4.0)5.2(6.2)mm longo, extra pilis eglandulosis densis, longiusculis usque longis, saepe pilis glandulosis post rimas laterales, intra glabro praeter duas series de basibus filamentum decurrentas; labio supero (3.0)3.4(4.0)mm longo, (2.5)3.1(3.5)mm lato lobis exclusis, (3.9)5.3(6.2)mm lato lobis inclusis, extra pilis eglandulosis, interdum pilis glandulosis permixtis, intra in sinu piloso eglanduloso, alibi glabro; lobis superis in plus minusve eodem plano, plerumque non profunde emarginatis, interdum obtusis, glabris praeter pilos glandulosos breves in pagina postica, rima (1.2)1.9(2.3)mm profunda; labio infero superne viso concavo, de base deorsum curvato, (5.8)6.9(8.0)mm longo; (10.3)11.5(13.5)mm lato, extra glabro vel pilos eglandulosos, interdum pilis glandulosis permixtos, ferenti, intra glabro; lobiis inferis plerumque emarginatis usque truncatis, interdum obtusis, rimis (2.9)3.9(5.0)mm profundis. Stamina filamentis glabris, pari antico (3.0)3.9(4.5)mm longo, pari postico (1.4)1.9(2.5)mm longo; antheris (1.4)1.5(1.7)mm longis, 0.7-1.0mm latis, connectivis plerumque glabris, raro area parva pilorum eglanduloscrum densorum, longiusculorum usque longorum, rimis pilis eglandulosis densis, longiusculis usque longis, aristis paris postici (0.25)0.3(0.4)mm longis. Ovarium latere visum oblongum, ellipticum, ovato-ellipticumve, glabrum saepe praeter aliquot setas breves usque longiusculas circa apicem; apice plerumque latere viso obtuso, interdum lato obliquove acutove; ovulis (79)93(110). Capsulae (4.0)6.0-8.0(9.0)mm longae, latere visae obovatae usque oblongae ellipticaeve usque ovato-ellipticae, 2.2-3.0mm latae, glabrae interdum praeter ad apicem setas sparsas usque densas, breves; apice latere viso truncato usque late acuto, saepe obliquo; seminibus ca. 48-78, oblongo-ellipticis usque fere reniformis, (0.5)0.7-0.9(1.0)mm longis, (0.3)0.4(0.5)mm latis.

Holotypus (tab. 18): W.R. Barker 963, 14.xi.1970. Tasmania, South-east. Headland at the south end of Port Arthur, ca. 4½km south of Port Arthur settlement, and ca. 2km north-west of West Arthur Head. AD97112114. Isotypi: AD97112099, duo alii distribuendi.

DESCRIPTION:

Perennial herb, (10)15-25(30)cm tall, with single erect stem, bearing axillary shoots and ascending branches in lower aerial parts, dying back to ?uppermost branches after first year.

Stem bearing inflorescence in first year, (2)5-11(15)cm high to its base, bearing (20)35-60(80) pairs of leaves, usually branched with uppermost branches (5)10-25(33) nodes below inflorescence, rarely simple; internodes between uppermost (3)4-7(9) leaf pairs longer than leaves, the longest internode (2)3-4(5) times length of uppermost leaves, in lower parts much shorter than leaves; axes purple-brown, bearing two distichous rows of short dense eglandular hairs decurrent from between leaf bases, the rows sometimes divided by central glabrous band over part or all of internode.

Cotyledons ± circular, entire, glabrous caducous before stem flowers.

Leaves: uppermost leaves of flowering stem (4.0)5.0-8.0(10.0)mm long, in outline obovate to obovate-oblong or broadly so, green, sometimes reddened in parts, glabrous but for patches of sessile glands confined to distal $\frac{1}{2}(\frac{5}{8})$ of lower surface; base long attenuate; teeth (1)2(3) along each margin, usually sharply acute, sometimes bluntly obtuse, confined to distal $(\frac{1}{3})\frac{1}{2}(\frac{5}{8})$ of leaf, with longest tooth (0.9)1.2-1.8(2.2)mm long; apex usually sharply acute to obtuse, sometimes bluntly obtuse, (1.0) 1.3-2.0(2.8)mm long, 1.3-1.7(2.5)mm broad; leaves lower down and those on branches of similar shape but slightly smaller, much smaller on shoots.

Inflorescences but for lowermost 0-1(3) nodes dense racemes, that of stem bearing (8)10-18(24) flowers, with lowermost node sometimes bearing one flower, those of branches bearing somewhat fewer flowers; rachis as for axes; internodes not elongating after anthesis; pedicels of lowermost flowers (0.5) 0.7-2.7(3.0)mm long, shorter towards apex, i.e. 0.5-1.2(1.4)mm long, not elongating after anthesis; apical bud cluster excluding buds at widely-spaced lower nodes spherical to broadly rounded-conical, initially 0.6-1.3mm long, becoming hidden by corollas of uppermost flower pair after opening of flowers at first (1)3(6) nodes.

Bracts similar in shape and indumentum to uppermost leaves, but slightly broader.

Calyx (5.0)6.6(8.5)mm long, 4-ribbed, externally glabrous except sometimes for a few tiny glandular hairs, internally with tube glabrous, with teeth covered by very short to short eglandular hairs, sparse to dense in upper $\frac{1}{2}$-$\frac{2}{3}$, absent except on margins to sparser below, occasionally mixed with a few very short glandular hairs; teeth bluntly to sharply acute; lateral clefts (1.5)2.3(3.0)mm deep, shorter than median clefts, which are (2.0)3.4(4.5)mm deep.

Corolla (7.3)8.7(10.5)mm long along upper side, white with faint or distinctive yellow patch on lower side of mouth, each lateral lobe lined by 3 red-purple striations varying in distance reached from lobe apex, the basal lobe bearing 3 fine indigo striations or unmarked, the upper lip unmarked but for indistinct striations sometimes on hood; tube (4.0)5.2(6.2)mm long, abaxially and laterally broadened at about point of intersection of anterior filaments, which are (2.6)3.8(4.8)mm from base of corolla, externally on distal adaxial and lateral surfaces and sometimes behind lateral lobes covered by dense, moderately long to long eglandular hairs, often with dense patch of glandular hairs behind lateral clefts towards base of anterior filaments, glabrous at base and on most of or entire abaxial surface, internally glabrous but for two rows of dense short eglandular hairs decurrent from bases of filaments on either side of midline of corolla, sometimes with sparse eglandular hairs between; hood (3.0)3.4(4.0)mm long, excluding lobes (2.5)3.1(3.5)mm wide, including lobes (3.9)5.3(6.2)mm broad, externally covered by moderately long to long eglandular hairs, dense on midline and front, sparser or absent from sides, sometimes mixed with short glandular hairs, sparse to moderately dense on sides or at front, internally glabrous but for dense short to long eglandular hairs in region of sinus; upper lobes in ± same plane, usually shallowly emarginate, sometimes obtuse, glabrous but for sparse to moderately dense, short glandular hairs occasionally at base of or all over rear surface, with cleft between (1.2)1.9(2.3)mm deep; lower lip concave when viewed from above, down-turned from base, (5.8)6.9(8.0)mm long, (10.3)11.5(13.5)mm broad, externally glabrous or covered entirely or in part by sparse to dense moderately long to long eglandular hairs, sometimes mixed with sparse short glandular hairs, internally glabrous; lower lobes usually emarginate to truncate, sometimes obtuse, with clefts between (2.9)3.9(5.0)mm deep.

Stamens with filaments glabrous, the anterior pair (3.0)3.9(4.5)mm long, the posterior pair (1.4)1.9(2.5)mm long; anthers

(1.4)1.5(1.7)mm long, 0.7-1.0mm broad, with connectives usually glabrous rarely with a small patch of dense, moderately long to long flexuose eglandular hairs, with slits lined by dense, moderately long to long, flexuose eglandular hairs, with posterior pair of awns (0.25)0.3(0.4)mm long, longer than awns of other three pairs.

Ovary in lateral view oblong to elliptic or ovate-elliptic, slightly compressed laterally, in median view ovate, glabrous except often for a few, short to moderately long setae about apex; apex in lateral view usually obtuse, sometimes broadly or obliquely so or acute; ovules (79)93(110).

Capsules (4.0)6.0-8.0(9.0)mm long, only slightly compressed laterally, in lateral view obovate to oblong or elliptic to ovate-elliptic, 2.2-3.0mm broad, in median view ± ovate or ovate-acuminate, glabrous except sometimes for sparse to dense, short setae at very apex; apex in lateral view truncate to broadly acute, often obliquely so; seeds ca. 48-78, ± oblong-elliptic to almost reniform, often rather angular, (0.5)0.7-0.9(1.0)mm long, (0.3)0.4(0.5)mm broad.

Chromosome number: Unknown.

Plates: 5, 18

Figures: 13

TYPIFICATION:

Holotype (pl. 18): W.R.Barker 963, 14.xi.1970. Tasmania, South-east. Headland at the south end of Port Arthur, ca. 4½km south of Port Arthur settlement, and ca. 2km north-west of West Arthur Head. Low hilly coastal moorland at the top of a small hill. Fine grey organic sand. Altitude ca. 50m. Corollas white with a yellow spot in the mouth at the foot of the basal lobe, with 3 mauve striations on each lateral lobe, and with 3 fine indigo striations on the lower lobe. On additional label on holotype: This population ca. ½km from both 960-962 and 967 WRB, covering area over the small hill of ca. 50m x 15m. In 3 hours of sunny midday weather, no pollinators observed. AD97112114.

Isotypes: AD97112099, 2 other duplicates to be distributed.

Pollen slides: A.N.U., AD.

The type material is in very good condition with corolla striations clearly seen in many specimens. First-year plants, including seedlings, and later-year plants are represented in the collection, which comprises about 40 entire plants in all.

The type population is in little apparent danger of destruction.

DISTRIBUTION (Fig. 13):

E. semipicta is known from only two localities, near Port Arthur and near Eaglehawk Neck, on the Tasman Peninsula in the south-eastern corner of Tasmania. It appears to occur only very close to sea level, the sole records of altitude being about 50m (Barker 960-963, 967).

ECOLOGY:

At Port Arthur on the exposed promontory terminating in West Arthur Head *E. semipicta* occurs in an extensive area of dense coastal heath on sandy soil either on top of hillocks or in swales between (Barker 960-963, 967). At Eaglehawk Neck it is recorded from "dryer coastal heath on sandstone" (Hemsley 6580).

Flowering apparently begins in November or even earlier (plants in the collection, Anon. s.n., 11.ix.1951 HO, bear mainly mature fruits and few flowers). Since no material seems to have been collected later than November, it is difficult to estimate when flowering would be completed, but it is probably well before the end of January.

NOTES:

1. E. semipicta is very closely related to E. striata but distinct on the basis of a number of characters (for differences see key to the species of Sect. Striatae).

2. I am grateful to Mr. Arnold Himson of Buckland, Tasmania, for directing me to the populations of E. semipicta near West Arthur Head. Without his assistance the species would not have been recognised, as by other than my own collections it is very inadequately represented in herbaria.

SPECIMENS EXAMINED:

Tasmania

Anon. (ex Herb. Thomson) s.n., s.dat. Eaglehawk Neck. CHR146863. — Anon. (? Curtis) s.n., 11.ix.1951. Near Port Arthur. HO. — Barker 960, 13.xi.1970. Headland at the south end of Port Arthur, ca. 5km south of Port Arthur settlement, and ca. 1½km north-west of West Arthur Head. AD. — Barker 961, 13.xi.1970. Headland at the south end of Port Arthur, ca. 5km south of Port Arthur settlement, and ca. 1½km north-west of West Arthur Head. AD. — Barker 962, 13.xi.1970. As for Barker 961. AD. — Barker 963, 14.xi.1970. Headland at the south end of Port Arthur, ca. 4½km south of Port Arthur settlement, and ca. 2km north-west of West Arthur Head. AD (holotype). — Barker 967, 14.xi.1970. Headland at the south end of Port Arthur, ca. 4km south of Port Arthur settlement, and ca. 2km north-west of West Arthur Head. AD. — Black 1, s.dat. Locality unknown. MEL38917(p.p.). — Bufton 3, 1892. Port Arthur. MEL. — Bufton 13, 1892. Port Arthur. MEL. — Hemsley 6580, 27.ix.1969. 3 miles W. of Eaglehawk Neck, Tasman Peninsula. K. — Stuart 1744(p.p.), –.xi.1956. South Port. MEL(p.p.).

6. Euphrasia hookeri Wettst.,Monogr.Gatt.Euphrasia (1896)268, t.6 f.436-439,t.13 f.10(substitute name for E. cuspidata Hook.f.non Host); Du Rietz,Sv.Bot.Tidskr.25(1932)532,534, 42(1948)112,359; Curtis,Stud.Fl.Tasm.(1967)532; Harris, Alp.Pl.Austral.(1970)138

E.cuspidata Hook.f.,Fl.Tasm.1(1857)298, 2(1859)369; FvM., Fragm.Phyt.Austral.5(1865)90; Benth.,Fl.Austral.4(1868) 522; Spicer,Hdbk.Pl.Tasm.(1878)77,127; FvM.,Syst.Cens. Austral.Pl.1(1882)98; FvM.,Sec.Syst.Cens.Austral.Pl. 1(1889)165; Wettst.in Engler & Prantl,Nat.Pflfam.IV3b (1893)101; Rodway,Tasm.Fl.(1903)143: non Host,Fl.Austriaca 2(1831)186

DESCRIPTION:

Perennial herb, (2)5-12(15)cm tall, usually with simple erect stem, sometimes with 2(6) simple erect branches arising from very base of prominent (in first year plants) or reduced (in later year plants) stem.

Stem, or branches, if no flowering stem present, (1.0)4.0-8.5(11.0)cm long to base of inflorescence; internodes much shorter than leaves at least in lower parts, often ± equal up to $1\frac{1}{2}$(2) times length of upper leaves in region of upper (1)3(4) nodes below inflorescence; axes purple-brown, with two opposite rows of moderately dense, short to moderately long eglandular hairs decurrent from between bases of upper few pairs of leaves, glabrous or with very sparse eglandular hairs in lower parts.

Cotyledons usually broadly ovate to elliptic-ovate, sometimes triangular, acute or obtuse, entire, (0.5)0.8-1.2mm long, usually persistent, at least in first year plants, sometimes caducous before flowering.

Leaves: uppermost leaves in outline elliptic to obovate to very broadly so, (5.0)6.5-10.5(11.7)mm long, (4.2)5.5-10.0(11.5)mm broad, digitate, glabrous, lacking patches of sessile glands, green or partially reddened, with lamina obovate to broadly obovate; base narrow cuneate; teeth (3)4-5(7) along each margin, confined to and constituting almost entire distal half of leaf, linear, acuminate, often ± hooked, of ± equal length except sometimes for small outermost teeth, (1.9)2.5-4.5(5.1)mm long, with margins recurved greatly on underside such that coherent for whole length; apex identical to neighbouring teeth in shape, size and recurvature of margins, ca. 0.6-0.9mm broad; middle leaves similar to uppermost; lower leaves similar but smaller, fewer toothed, those at very base entire, subulate or with one tooth along each margin.

Inflorescences dense racemes, that of stem producing (6) 10-20(26) flowers, with lowest node occasionally bearing one flower, those of branches ± similar; rachis red-brown, covered by dense moderately long eglandular hairs, sometimes mixed with sparse, short to moderately long glandular hairs; internodes hardly elongating after anthesis; pedicels of lowermost flowers (1.2)2.6(4.0)mm long, shorter higher up; apical bud cluster initially spherical to very broadly ellipsoid, 0.8-1.5mm long, hidden by or hardly protruding from uppermost corollas after flowers at first 1-2 nodes have opened.

Bracts similar to uppermost leaves in shape and morphology, but somewhat larger and often more toothed, glabrous on inner surface, with outer surface covered by sparse to moderately dense, short to moderately long eglandular hairs, mixed with short to moderately long glandular hairs mainly confined to margin of blade.

Calyx (5.5)8.0(10.5)mm long, slightly 4-ribbed, externally with tube and lower part of teeth covered by moderately dense to dense, short to moderately long glandular hairs mixed with moderately dense to dense, short eglandular hairs, with upper part of teeth covered by dense short eglandular hairs, sometimes mixed with sparse short glandular hairs, internally with tube glabrous, with short glandular hairs, dense and mainly confined to lower part of teeth, with short eglandular hairs, dense and mainly confined to their upper half; teeth sharply acuminate, with margins in upper half recurved, coherent near apex; lateral clefts ca. 2.0-5.0mm deep, shorter than median clefts which are ca. 3.3-7.0mm deep.

Corolla (7.0)8.5(9.5)mm long along upper side, usually white, sometimes pink-purple (Barker 1222), with yellow blotches, often continuous, on lower side of mouth and deep in throat, with red-purple striations ca. 3 on each lobe, sometimes extending only short distance onto lobes; tube (4.8)5.7(6.7)mm long, laterally and abaxially broadened at about point of insertion of anterior filaments, which are (3.3)4.1(5.0)mm from base of corolla, externally glabrous but for most distal parts, on distal adaxial and lateral surfaces covered by dense moderately long eglandular hairs, with patch of dense short glandular hairs about lateral clefts, on distal abaxial surface covered by sparse to moderately dense short glandular hairs, sometimes mixed with sparse to dense, short to moderately long eglandular hairs, internally sometimes glabrous, sometimes with two rows of sparse to dense, short to moderately long downturned eglandular hairs decurrent from bases of filaments, rarely with hairs also extending across midline between filament bases; hood (2.2)2.8(3.5)mm long, excluding lobes c. 2.8-3.2mm broad, including lobes (4.0)5.0(5.8)mm broad, externally covered all over by dense, moderately long to long eglandular hairs, with moderately dense short glandular hairs on sides, sometimes with a few glandular hairs at front, internally with dense long eglandular hairs in region of sinus, elsewhere usually glabrous, rarely with line of moderately long eglandular hairs down midline; upper lobes almost coplanar or at broad angle to each other, usually emarginate to praemorse to truncate-obtuse, rarely obtuse and shortly apiculate, with cleft between (1.2)1.6(2.0)mm deep, with front surface and margins glabrous, with rear surface glabrous or covered by sparse short glandular hairs, sometimes mixed with sparse short eglandular hairs; lower lip concave from above, downturned until almost parallel to upper side, (4.3)5.9(6.8)mm long, (9.0)11.0(13.0)mm broad, externally bearing sparse to moderately dense, short glandular hairs, usually mixed with sparse to moderately dense, short to moderately long eglandular hairs, with margins and inner surface glabrous; lower lobes usually emarginate, sometimes truncate, with clefts between (3.0)3.6(4.3)mm deep.

Stamens with filaments glabrous, the anterior pair (1.7)3.2 (4.0)mm long, the posterior pair (0.9)1.4(1.7)mm long; anthers (1.1)1.3(1.5)mm long, (0.7)0.9(1.2)mm broad, tending to separate after anthesis, with connectives glabrous, with slits lined by sparse to dense, short to long eglandular hairs, with posterior pair of awns (0.15)0.2(0.3)mm long, longer than other three awn pairs.

Ovary in lateral view oblong to oblong-elliptic, hardly compressed laterally, in median view ovate to broadly ovate, glabrous but for sparse to moderately dense, short to long setae in region of apex; apex in lateral view, usually emarginate to truncate to broadly obtuse, sometimes obliquely so; ovules ca. 70-90.

Capsules (7.8)9.2(11.0)mm long, only slightly compressed laterally, in lateral view ovate-elliptic to elliptic or oblong-elliptic, 3.5-4.5(5.5)mm broad, in median view ± ovate to elliptic, glabrous but for very few to moderately dense, usually short, rarely long setae at very apex; apex in lateral view obtuse to truncate-obtuse; seeds (60)72(84), usually oblong-ellipsoid to obliquely ellipsoid to ± reniform, often broadly so, (0.9)1.1-1.4(1.5)mm long, (0.5)0.6-0.8(0.9)mm broad.

Chromosome number: n=c.25-30 (Barker 1212)

Plates: 1, 5

Figures: 13

TYPIFICATION:

E. cuspidata Hook.f. ≡ *E. hookeri* Wettst.

Lectotypus (tab. 19): Milligan 767, 15.i.1847. Mt. Sorell, McQuarie Harbour. Tasmania. K(p.p.). Isolectotypi: W104161(p.p.), MEL41521,HO,FI. Syntypus alius (tab. 19): Mr Archer s.n., 1839. W. (=Western) Mts., in moist places. K(p.p.).

Wettstein (1896) stated that his *E. hookeri* and *E. cuspidata* Hook.f. were identical, the name of the species having to be substituted because Hooker's name was predated by *E. cuspidata* Host. Accordingly the two names must be considered as nomenclatural synonyms, with the typification of *E. hookeri* identical to and determined by that of *E. cuspidata* Hook.f. Oldfield's collection (W), reputedly from Mt. Wellington, therefore has no type status even though it was the only specimen of the species, other than the isolectotype of *E. cuspidata* in FI, seen by Wettstein and cited in his initial description of *E. hookeri* (Wettstein 1896).

Each syntype is typical of *E. hookeri* and comprises several plants. The Milligan collection was chosen as lectotype because of the presence of mature fruits as well as flowers. Archer's collection has flowers but lacks fully-developed fruits. Of additional advantage in the making of this choice are the existence of several isolectotypes and the fact that one of these (in FI) was cited by Wettstein (1896) in his initial description of *E. hookeri* and bears his determinavit.

The two syntypes of E. cuspidata are mounted together on the same sheet from Herbarium Hookerianum. Also on the sheet is the collection by Oldfield from Mt. La Perouse which was cited as belonging to the species by Hooker (1859a) two years after the publication of the protologue (Hooker 1857).

It is not known whether the species still exists at the lectotype locality.

DISTRIBUTION (Fig. 13):

E. hookeri is confined to the mountains of west and south-west Tasmania. The species appears to be notably absent from the more central mountain areas of Tasmania, such as the Central Plateau, Mt. Field, and probably Mt. Wellington (although there is a doubtful record from there - see Note 3), as well as Ben Lomond in the north-east.

From localities known it probably occurs between altitudes of about 700m, which is the height of Mt. Zeehan, and 1300m, the height of localities around Cradle Mountain.

ECOLOGY:

From personal observation and the few records available E. hookeri mainly occurs in the dense hard mats of "cushion plants", called "blanket bog" by McVean (1969). A description of the community is given by Curtis (1969). Plants are occasionally found in low prostrate compact woody shrubs bordering these cushion plant areas where most of the population occurs (Barker 1212, 1214; Edwards AD 97121098). One plant of the population (Barker 1227) was found in clump of "pineapple grass" (Astelia sp.)

Flowering apparently occurs between December and late March. Mature fruits are found in collections made after mid-January.

NOTES:

1. The unique leaves of E. hookeri set it apart from the other species of Subsect. Striatae (pl. 1 and 5). Of these species it most closely approaches E. striata and E. semipicta by its small corollas and leaves. Both species can be distinguished not only on leaf characters but also by the absence of glandular hairs from the calyces, bracts and rachises. In addition, E. striata differs by its many decumbent branches and the absence of a flowering stem, while E. semipicta is clearly distinguished by the absence of purple striations from the upper and lowest lobes.

2. In the past E. hookeri has generally been considered an annual (Hooker 1857; Bentham 1868; Rodway 1903; Du Rietz 1948a,b; Curtis 1967; Harris 1970), despite the fact that its closest Australian relatives are perennials. Wettstein (1896) was not convinced that the species was an annual. However, he mistakenly considered that the specimens seen by him were broken-off branches. They were actually whole plants comprising either a single stem or a few branches. His basis for doubting that they were annual was that herbarium collections of the annual species of Euphrasia always consisted of whole plants. In addition he referred to the perennial nature and similarity of appearance of the closest related species.

It seems clear from my own field observations that E. hookeri is a perennial. Occasional plants can be found bearing dead grey-white remains of branches, sometimes with parts of the inflorescence still attached. Examples of such plants are found on the AD sheet of the collections Barker 1207, 1212, 1214 & 1222. Similar remnants of floral branches or stems are commonly found in all the Australian perennial species, but not in the annual species. Thus it appears that plants of E. hookeri perennate at least occasionally. It is difficult to estimate the frequency of perennation, as it is possible that plants in such extreme habitats, snow-covered in winter, and comprising so few axes may rarely retain remnants of the branches or stem of prior years. In addition, although the majority of plants in the dried collections still bear the cotyledons, this does not necessarily signify that these plants were in their first year of growth. Cotyledons of the Australian perennial species of *Euphrasia* are found occasionally in the young seedlings of a few species (e.g. *E. semipicta*), while they often persist in the annual species. However, one plant in Barker 1207 bearing a dead stem with the remains of a pedicel in the upper part still has a pair of green fleshy cotyledons. Thus the protection provided by the hard compacted leaves of the "cushion plants" in which *E. hookeri* grows may be sufficient to allow the cotyledons to survive into the second year. It is concluded that *E. hookeri* is a perennial, although further study is required to determine how often the species survives for more than one year.

3. The locality, "Summit of Mt. Wellington, Tasmania", attributed to a collection of *E. hookeri* by Oldfield (W) must be considered doubtful. The collection was originally mounted with plants of *E. striata* which is common at that locality (see Wettstein 1896: p.269). However, no authentic collections of *E. hookeri* have ever been made from Mt. Wellington, which is probably the most botanized alpine locality in Tasmania. In addition, except in the Cradle Mountain area well to the north, there are no records of *E. striata* and *E. hookeri* occurring in the same mountain range.

SPECIMENS EXAMINED:

Tasmania.

Ainsworth 3 per Barker, 28.i.1971. Cradle Cirque, Cradle Mt.-Lake St. Clair National Park. AD. — Archer s.n., s.dat. Without locality. NSW10815,BISH. — Archer s.n., 1839. W. Mts. K(p.p.)syntype. — Barker 1207, 28.i.1971. Cradle Mt.-Lake St.

Clair National Park; east edge of plateau below Weindorfer's Tower on track to Hanson's Peak. AD; pollen slide A.N.U.,AD. — Barker 1211, 28.i.1971. Ca. ½km west of the eastern edge of plateau on north side of Cradle Mt. on track to Kitchen Hut from Little Horn. AD. — Barker 1212, 28.i.1971. Ca. ½km east of Kitchen Hut on track along plateau on north side of Cradle Mt. to Little Horn. AD. — Barker 1214, 28.i.1971. On plateau on north side of Cradle Mt. ca. 100m along track to Waldheim from Kitchen Hut. AD. — Barker 1215, 28.i.1971. On plateau on north side of Cradle Mt., at junction of tracks to Marions Lookout, Crater Lake and Cradle Mt., ca. 150m from Kitchen Hut. AD. — Barker 1222, 28.i.1971. On plateau on north side of Cradle Mt., ca. 200m from Kitchen Hut on track to Little Horn. AD. — Barker 1227, 29.i.1971. Cradle Mt.-Lake St. Clair National Park. On top of Mt. Campbell, which is north-east of Cradle Mt. AD. — Edwards s.n., 5.xii.1970. Goon Moor, Federation Peak. AD97121098. — Fitzgerald s.n., 1894. Mt. Zeehan. MEL41739. — King s.n., iii-xi. 1954. Norold Mts. MEL41522. — Milligan 766, s.dat. Gordon R. NY(p.p.). — Milligan 767, 15.i.1847. Mt. Sorell McQuarie Harbour. K(p.p.) lectotype; W(p.p.),MEL,HO,FI. — Moore 12, 1892. Mt. Zeehan. MEL. — Moore s.n., 1893. Mt. Darwin. MEL41518. — Oldfield 13, s.dat. Nr. the summit of Mt. Laperouse. MEL41520,K(p.p.). — L.Rodway s.n., -.xii.1898. Mt. La Perouse. HO. — F.A. Rodway s.n., -.xii.1898. La Perouse. NSW22288. — Stuart 1863, 1.iii.1857. Mt. a la Perouse. MEL. — Peterson s.n., 21.iii.1965. La Perouse. HO.

Tasmania. Locality doubtful.

Oldfield s.n., s.dat. Summit of Mt. Wellington. W104161(p.p.).

Locality unknown.

Anon. s.n., s.dat. NSW10872(p.p.).

III. Sect. Lasiantherae Barker

For synonymy, Latin and English descriptions, typification and distribution, see Chapter 5; p. 146.

KEW TO THE SPECIES OF SECT. LASIANTHERAE:

1a. Perennial; flowering stem usually lacking, present at least sometimes in first-year plants, with branches ascending and produced only from ground level. Anthers (1.9)2.0-2.5(2.7)mm long; awns of posterior pair (0.4)0.5-0.7(0.8)mm long; area about connectives of anterior anthers ± equally as hairy as in posterior anthers. Anterior filaments 5.0-6.5(7.5)mm long. Ovary sparsely to densely setose in apical region; ovules (31)60(97). Capsule sparsely to densely setose over distal $\frac{1}{4}$; seeds (6)17-70, 0.9-1.4(1.5)mm long. [Corolla with two prominent yellow spots at base of anterior filaments, but lacking yellow blotch on lower lip. Uppermost leaves of floral branches crenate-serrate to serrate, with length : breadth ratio of (0.9)1.3(1.6) : 1, with (1)2-4(7) teeth along each margin.]

9. E. lasianthera

1b. Annual; flowering stem present, with branches ascending or erect, developing in a basipetal sequence, initially from upper parts of stem. Anthers 0.9-2.0(2.2)mm long; awns of posterior pair 0.1-0.4 (0.5)mm long; area about connectives of anterior anthers less hairy than in posterior anthers. Anterior filaments 2.2-5.0mm long. Ovary densely setose over distal $\frac{1}{3}$ - $\frac{2}{3}$; ovules 10-35(40). Capsules densely setose in upper $\frac{1}{3}$ - $\frac{3}{4}$; seeds ca. 4-15, 1.5-2.5mm long.

2a. Stem to base of inflorescence 1.3-5.0(6.0)cm long, bearing (1)3-4(5) pairs of leaves. Indumentum on calyces, bracts, rachis, axis and leaves ca. 0.1-0.3mm thick. Uppermost stem leaves pinnatifid to pinnatifid-serrate, with length : breadth ratio of (1.1)1.7(2.7) : 1, with (1)2(3) teeth along each margin. Corolla [with yellow blotch behind lobes on lower lip, extending to point of insertion of filaments], (5.5)7.0-9.0 (10.2)mm along upper side; hood 1.5-2.8mm long; cleft between upper lobes 0.8-2.2mm deep; lower lip (3.0)3.5-5.0(6.5)mm long, (6.5)7.5-12.0(12.7)mm broad; clefts between lower lobes 1.6-4.0mm deep; inner surface of tube glabrous. Anthers 0.9-1.3mm long; awns of posterior pair 0.1-0.2(0.25)mm long. Anterior filaments 2.2-2.9mm long. Ovules 10-12(15).

7. E. alsa

2b. Stem to base of inflorescence (2.5)5.0-11.0(14.0)cm long, bearing (5)6-8(12) pairs of leaves. Indumentum on calyces, bracts, rachis, axis and leaves (0.2)0.4-0.7(1.0)mm thick. Uppermost stem leaves serrate to serrate-crenate, with length : breadth ratio of (1.8)2.6(3.3) : 1, with (2)3-4(5) teeth along each margin. Corolla [?lacking yellow nectar guides], (6.5)8.2-11.5(13.0)mm long along upper side; hood (2.1)2.7-4.0(4.5)mm long; cleft between upper lobes (2.0)2.5-4.0(4.5)mm deep; lower lip (5.0)7.0(10.0)mm long, (11.0)14.0 (18.0)mm broad, clefts between lower lobes (3.0)4.0-6.0(7.8)mm deep; inner surface of tube densely eglandular hairy between bases and decurrent from them. Anthers (1.2)1.6-2.0(2.2)mm long; awns of posterior pair (0.25)0.3(0.5)mm long. Anterior filaments 3.5-5.0mm long. Ovules (20)30(40).

8. E. eichleri

7. Euphrasia alsa FvM.,Trans.Phil.Soc.Vict.1(1855)107; FvM.in Hook., J.Bot.Kew Gard.Misc.8(1856)203; Hook.f.,Fl.Tasm.1(1857)296; FvM.,Fragm.Phyt.Austral.5(1865)90; Wettst.,Monogr.Gatt. Euphrasia(1896)263,t.6 f.447-457,t.13 f.5; Du Rietz, Sv.Bot. Tidskr.42(1948)360

E. scabra R.Br. var. alsa (FvM.)Willis,Muelleria 1(1967)148, p.p.(as to Mueller's plants from the Munyang Mountains); Harris,Alp.Pl.Austral.(1970)138

[E. antarctica auct. non Benth.in DC.: Benth.,Fl.Austral.4 (1868)522; FvM.,Syst.Cens.Austral.Pl.1(1882)98; Moore, Cens.Pl.N.S.W.(1884)50; FvM.,Key Syst.Vict.Pl.2(1885)41, 1(1887-1888)392; FvM.,Sec.Syst.Cens.Austral.Pl.1(1889) 165; Moore & Betche,Hdbk.Fl.N.S.W.(1893)343; Wettst.in Engl.& Prantl,Nat.Pflfam.IV3b(1893)101,p.p.(as to Australian plants); Dixon,Pl.N.S.W.(1906)226; Maiden & Betche,Cens. N.S.W.Pl.(1916)184; Ewart,Fl.Vict.(1931)1024,p.p.(as to N.S.W.plants).]

[E. zelandica auct.non Wettst.: Ewart,Fl.Vict.(1931)1024, pro syn.--"E. zealandica".]

DESCRIPTION:

Annual herb, 2-6(7)cm tall, reaching ca. 12cm when fruiting, erect with vegetative parts as well as calyces, bracts and rachises often red-purple, greener in more luxuriant plants.

Stem to base of inflorescence 1.3-5.0(6.5)cm high, bearing (1)3-4(5) pairs of leaves, with branches in axils of cotyledons and leaves up to (1)2(3) nodes below inflorescence, the upper ones developing first; branches later-flowering, bearing 0-2 leaf pairs, sometimes themselves branched; axes with indumentum ca. 0.1-0.3mm thick, consisting of moderately dense, short to moderately long glandular hairs and two decussate broad bands of dense, short to moderately long eglandular hairs.

Cotyledons broad, ovate-elliptic to elliptic, 2-5mm long, entire, glabrous, persistent.

Leaves: uppermost stem leaves in outline usually obovate or elliptic, rarely broadly so, pinnatifid or pinnatifid-serrate, (4.0)6.0-10.0(15.0)mm long, (2.0)3.5-7.0(9.0)mm broad, with blade usually elliptic to elliptic-ovate or narrowly so, sometimes lanceolate with margins recurved, with upper surface and margin covered by sparse short glandular hairs mixed with eglandular hairs, moderately long, sparse and lax towards the base, short, dense, ± upturned and stiff towards apex, with lower surface covered by mixture of moderately dense, moderately long glandular hairs and sparse to moderately dense, short to moderately long eglandular hairs; base narrow cuneate to rounded-cuneate; teeth (1)2(3) along each margin, bluntly acute or obtuse, (0.7)1.2-2.5(3.5)mm long; apex blunt, usually acute, sometimes obtuse, (1.0)1.5-3.5(5.0)mm long; lower leaves near the cotyledons smaller, fewer-toothed, with a sparser shorter indumentum; leaves on branches similar to uppermost stem leaves, but rather smaller.

Inflorescences dense racemes; flowers of inflorescence terminating stem ca. 15-30, fewer on depauperate plants less than 3cm high and in inflorescences terminating branches; rachis with indumentum similar to axis; internodes elongating slightly after anthesis such that apices or capsules extend past bases of calyces above, with lowermost 1-2 internodes longer; pedicles 0.3-1.5(2.0)mm long; apical bud cluster hemispherical, extending (0.1)0.3-0.8mm above initial flower pair, hidden by or hardly emergent from uppermost corollas after flowers of first (0)2-3(6) pairs have opened.

Bracts of similar shape to the uppermost leaves but longer, broader, sometimes more toothed and with a denser similar indumentum.

Calyx (4.0)4.5-7.0(7.7)mm long, broadening as capsule forms.

with external indumentum 0.1-0.3(0.4)mm thick, consisting of a mixture of moderately dense to dense, short to moderately long glandular hairs and sparse, very short to short eglandular hairs, with inside of teeth bearing very sparse to dense, short to moderately long glandular hairs mixed with sparse short eglandular hairs behind the apex only or extending to bases of clefts, with margins lined with moderately dense, short eglandular hairs, with inner surface below teeth glabrous; teeth ± bluntly narrow acute, with margins not recurved; lateral clefts (1.7)2.0-3.2(3.6)mm deep, shorter than median clefts which are (2.0)2.3-4.0(4.5)mm deep.

Corolla white to lilac, with three red-purple striations on each lobe, those on upper lobes extending onto hood, with yellow blotch on lower lip behind lobes extending deep into throat to point of insertion of stamens, (5.5)7.0-9.0(10.2)mm long along upper side; tube (4.8)6.0(8.0)mm long, for initial (3.4)4.5(6.0)mm to base of anterior filaments narrow cylindrical, then expanded laterally and ventrally, externally glabrous but for short to moderately long, dense eglandular hairs on dorsal and lateral surfaces of distal half and small patch of dense, moderately long glandular hairs behind lateral clefts, internally glabrous; hood 1.5-2.8mm long, externally with dense, moderately long eglandular hairs on dorsal surface and sides, with sparse glandular hairs occasionally at base of lobes, rarely along middle of dorsal surface, internally with sparse to dense, very short to short glandular hairs above anthers mixed with moderately long, moderately dense eglandular hairs below sinus between lobes, with upper lobes ± coplanar, glabrous, usually emarginate or shallowly so, rarely ± obtuse, with cleft between 0.8-2.2mm deep; lower lip (3.0)3.5-5.0(6.5)mm long, (6.5)7.5-12.0(12.7)mm broad, concave from above, markedly downturned from tube, externally covered behind lobes by dense, moderately long eglandular hairs, sometimes mixed with sparse to moderately dense, moderately long glandular hairs, on middle lobe by sparse to moderately dense, moderately long eglandular hairs, rarely mixed with sparse short glandular hairs, with indumentum on lateral lobes similar to that of lower lobe but sparser, internally and on margins glabrous, with lower lobes, usually emarginate, sometimes broadly or deeply so, with clefts between 1.6-4.0mm deep.

Filaments of stamens glabrous, anterior pair 2.2-2.9mm long, posterior pair 0.7-1.2mm long; anthers 0.9-1.3mm long, 0.6-1.0mm wide, with connectives of anterior pair glabrous or surrounded by a few to sparse, short flexuose eglandular hairs, less hairy than those of posterior pair which are surrounded by sparse to dense, short to moderately long flexuose hairs, with awns of posterior pair 0.1-0.2(0.25)mm long, always longer than awns of other 3 pairs.

Ovary laterally compressed, in lateral view elliptic to oblong-elliptic, with upper $\frac{1}{3}$ covered by dense, moderately long to long setae; apex in lateral view usually broadly obtuse, sometimes truncate to slightly emarginate; ovules 10-12(15), equal in each cell of ovary or with one more in dorsal cell.

Capsules laterally compressed, in lateral view elliptic, 7.0-8.5mm long, ca. 4mm broad, usually shorter than calyx, sometimes slightly protruding with usually upper third, rarely upper half clothed with dense long setae; apex in lateral view broad, truncate to obtuse, sometimes shallowly emarginate; seeds (4)7-11(12), ± ellipsoid, 1.8-2.5mm long.

Chromosome number: n=27 (pollen mother cell meiosis; Barker 1696)

Plates: 6, 19

Figures: 14

TYPIFICATION:

Lectotypus (tab. 19): DM [F.Mueller] s.n., s.dat. Munyang Mountains 6000'. MEL41669. Syntypi alii (isolectotypi possibiles): MEL41665,MEL41668,MEL41670,NSW10876,MELU,FI,G, GH(two collections on one sheet). Syntypi probabiles (isolectotypi possibiles): F.Mueller s.n., 1855. Mt. Coskiusko/Kosciusko 6000'. MEL41666,NSW10875.

There are at least eleven herbarium sheets of E. alsa collected by Mueller from the "Munyang Mountains" area. Although the collections are very homogeneous overall and were apparently collected at a similar time (all are at a similar stage of development) it is impossible to determine whether they come from the one gathering or more as all but two specimens which are specifically noted as coming from Mt. Kosciusko bear locality annotations similar to or only slightly differing from the very general distribution cited in the protologue (Mueller 1855), viz "Gregarious on the highest stoney summits of the Munyang Mountains — (6000 feet)". Many of the syntypes have an extended altitudinal range of "5-6000 feet". Many also are identified as E. antarctica Benth. in keeping with Mueller's acceptance of the name after its publication in Bentham's Flora Australiensis (1868).

MEL41669 was chosen as the lectotype since it is the only syntype which bears all the following qualities:

1) A label in Mueller's handwriting worded the closest to the protologue.
2) Mueller's annotations "Euphrasia alsa Ferd. Muell." rather than E. antarctica Benth.
3) No other slightly discordant labels on the same sheet.
4) As good a sample of plants as occurs on the other syntypes.

The lectotype is in good condition and consists of ten plants some lacking the root system. All have young stem inflorescences with flowers as well as buds, but the branch inflorescences are still in bud. Two plants have almost mature capsules. The syntypes are in a similarly good condition.

The two Mt. Kosciusko collections are probably syntypes as the mountain lies in the Munyang Mountains as defined in Mueller's time (M. Willis 1949) and there is no reason to doubt that Mueller considered them typical of E. alsa (he has labelled the NSW specimen E. alsa and the MEL specimen E. antarctica, its synonym).

A syntype bearing copious information is MEL41665, the one specimen apparently seen by Bentham; on it Mueller has written:

"Euphrasia antarctica B. Munyang Mountains on wet gravelly irrigated by the melting snow Jan 55. Dr. Ferd Mueller".

Some of the syntypes have been dated January 1855 by Mueller. Willis has annotated other MEL type collections with this date. This does not appear to be justified as Mueller climbed the summit of Mt. Kosciusko or a neighbouring peak on New Year's Day, 1855 (M. Willis 1949). Since there is no reason to assume that all the syntypes come from the one gathering, it is possible that collections could have been made in late December, 1854.

The species is still widespread in the type area, which lies within the Kosciusko National Park.

DISTRIBUTION (Fig. 14):

E. alsa is endemic to the Snowy Mountains of south-eastern New South Wales. Most collections come from the Kosciusko region in the south of the distributional range. Not only may this be because of the higher mountains of this region, but it may also reflect its greater accessibility to collectors.

The species occurs at altitudes ranging from about 1700m to over 2100m.

ECOLOGY:

E. alsa tends to occupy small bare stony areas between shrubs of low heath (Barker 1696, 1707), tall alpine herbfield (Barker 1714), grassland (Barlow & James 1804) or fjaeldmark (Bryant NSW10131; Gray & Totterdell 6159, s.n.,17.ii.1967). It has also been recorded from "boggy grassland" (McVean CANB) and "sand among *Senecio pectinatus*" (Gray & Totterdell 6608).

Localities below about 1800m lie within the subalpine zone, where *E. alsa* may occur in pockets of vegetation characteristic of the alpine zone rather than subalpine types. This is evident at Spencer's Creek at about 5800 feet (1770m), where it occurs in low alpine heath (Barker 1696). Burbidge (6322) records it also from "alpine heath" at the even lower Piper's Gap (probably about 1730m). Costin (NSW10874) has recorded it from "subalpine and alpine" tracts of Mt. Kosciusko, but this probably refers to the general zonation of the region rather than to specific vegetation types.

Flowering of the main stem inflorescence begins between late December and late January or possibly even early February. Mature fruits are apparent from mid-January. Branch inflorescences are probably still to be found in early April as two of the few March collections, Costin & Skottsberg (NSW10873) and Gauba (GAUBA 7854, GAUBA7855) made on the 11th and 10th of March respectively, have young branch inflorescences.

NOTE:

E. alsa is most closely related to *E. eichleri*, the other annual of Sect. *Lasiantherae*, and *E. caudata* of Sect. *Scabrae*. The differences from *E. eichleri* and *E. lasianthera*, the other member of Sect. *Lasiantherae*, are detailed in the key to the species. *E. caudata* resembles *E. alsa* by its emarginate corolla lobes, laterally emarginate to broadly obtuse, densely setose capsules and its glandular indumentum, which is widespread over the vegetative parts, as well as the calyces, bracts and rachises. These characters set E. caudata apart from the rest of Sect. Scabrae and point to a close evolutionary relationship with E. alsa. However it is distinct from E. alsa not only in the character of corolla coloration,which distinguishes Sect. Scabrae and Sect. Lasiantherae, but also in its taller habit, more numerous stem nodes, longer glandular indumentum, different leaf shape, larger anthers with shorter awns, more numerous ovules and smaller seeds.

E. alsa has been confused by many authors with the small South American annual E. antarctica Benth., starting with Bentham (1868) himself. E. antarctica differs by the absence of a glandular indumentum, its trifid leaves, its free, completely glabrous anthers and its glabrous capsules.

Four New Zealand annual species of Sect. Novaezeelandiae might similarly be confused with E. alsa because of their small habit and short corollas. Ewart (1931) cited one of these, E. zelandica Wettst., as a synonym of the Australian species. These New Zealand annuals differ from E. alsa in their common attributes of glabrous-backed anthers and broadly obovate to obovate-cordate capsules (in lateral view) as well as their generally shorter-toothed leaves. In addition E. cheesemanii Wettst. and E. australis Petrie are distinguishable by their long-pedicellate flowers, E. cockayniana Petrie by its yellow corollas and E. zelandica by its entire corolla lobes and generally short corolla lips, absence of a widespread glandular indumentum on vegetative parts, and its often dense, short eglandular calyx indumentum.

SPECIMENS EXAMINED:

New South Wales

Baeuerlen 64, -.ii.1890. Mt. Kosciusko. MEL. -- Baeuerlen s.n., -.ii.1890. Mt. Kosciusko. NSW10871. -- Barker 1696, 26.i.1972. Kosciusko National Park. Ca. 50km N of bridge across Spencers Creek, on the Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1707, 27.i.1972. Kosciusko National Park. On top of Etheridge Range; ca. ½km W of Seamans Hut, ca. 1.km E of Mt. Kosciusko summit; above large quarry on Kosciusko Summit Road. AD. -- Barker 1714, 27.i.1972. Kosciusko National Park. Ca. 2km north of Seamans Hut along the snow pole line to Lake Albina; ca. 2½km NE of Mt. Kosciusko. AD. -- Barlow & James 1804, ii.1954. Cesjack Hut. COOMA. -- Beadle s.n., 4.ii.1952. Kosciusko. SYD. -- Briggs s.n., 31.i.1954. 1½ miles S.E. of Seamans Hut, Mt. Kosciusko. NE004507. -- Bryant s.n., 19.i.1967. Near Carruthers Peak, Kosciusko area. NSW101301,BISH. -- Burbidge 6316, 17.ii.1959. Carruthers Track. Mt. Kosciusko. CANB. -- Burbidge 6322, 17.ii.1959. Piper's Gap. Mt. Kosciusko. CANB. -- Carolin B76, 5.ii.1957. Above Club Lake. SYD. -- Costin s.n., -.iii.1949. Mt. Kosciusko. NSW10874. -- Costin & Skottsberg s.n., 11.iii.1949. Near Lake Albina. NSW10873. -- Eichler 13660, 5.ii.1957. Snowy Mountains. Great Dividing Range, between Mt. Lee and Carruthers Peak (ca. 4.5km NNE of Mt. Kosciusko). AD; pollen slides A.N.U.,AD. -- Gauba s.n., 10.iii.1953. Kosciusko. GAUBA7854,GAUBA7855. -- Gray & Totterdell 6159, 7.ii.1968. Ridge between Mt. Twynam and Carruthers, Kosciusko area. CANB. -- Gray & Totterdell 6608, ii/iii.1972. Snowy River bridge below Seaman's Hut, Kosciusko area. CANB. -- Gray & Totterdell s.n., 17.ii.1967. North-cote Pass, Kosciusko area. CANB(s.n.). -- Johnson & Constable s.n., 20.i.1951. Above Lake Albina. NSW15790. -- McLuckie s.n., -.i.1925. Kosciusko. SYD. -- McLuckie & Petrie s.n., -.i.1925. Bett's Camp. Kosciusko. SYD. -- McVean s.n., 28.i.1967. Between Seaman's Hut and Mt. Northcote, Kosciusko area. CANB(s.n.). -- Maiden s.n., 16.ii.1914. Betts Camp, Mt. Kosciusko. NSW10872(p.p.). -- F. Mueller s.n., -.-. 1855. Summit of the Munyang Mountains. MEL41669 (lectotype); MEL41665, MEL41668,MEL41670,NSW10876,MELU,FI,G,GH (other syntypes, possibly iso-lectotypes). -- F. Mueller s.n., 1855. Mount Kosciusko. MEL41666, NSW10875 (probable syntypes). -- M. Mueller 1804, -.ii.1954. Head-waters of Doubtful River. NSW60816. -- Phillips s.n., 29.i.1964. Near Carruthers Peak, Kosciusko National Park. CBG. -- Stead s.n., 5.i.1962. Lake Albina, Kosciusko area. NSW60817. -- Stead s.n., 22.i.1964. Spencer's Creek, Kosciusko area. NSW64339, BISH. -- Thompson 379, 22.i.1970. Spencers Creek. $\frac{1}{4}$ mile below road bridge. NSW89034. — Totterdell 55, 12.ii.1970. Mt. Northcotts, western spur above Lake Albina, Mt. Kosciusko area. CANB. — Totterdell 92, Carruthers Peak, Kosciusko area. CANB. — Wimbush s.n., 16.ii.1959. Gungartan peak. COOMA.

8. Euphrasia eichleri Barker, species nova

[E. antarctica auct. non Benth. in DC.: Ewart,Fl.Vict.(1931) 1024,p.p.(as to N.E. Victorian plants)]

[E. scabra R.Br. var. alsa (F.vM.)Willis,Muelleria 1(1967)148, p.p.(as to Willis MEL41664, Tadgell MEL41663); Willis, Hdbk.Pl.Vict. 2(1973)573]

[E. scabra R.Br. var. caudata Willis,Muelleria 1(1967)149,p.p. (as to Howitt 12)]

LATIN DESCRIPTION:

Herbe annua, (4.0)7.0-14.5(16.0)cm alta, ubi fructifera altier, erecta, interdum partibus herbaceis rubefactis. Caulis usque ad basim inflorescentiae (2.5)5.0-11.0(14.0)cm longus, (5)6-8(12) paria, foliorum ferens, ramis in axillis cotyledonum et omnium foliorum usque ad (1)2(3) nodos infra inflorescentiam, ramis superis primo evolutis; ramis postea florentibus, saltem superis (1)2-3(4) paria folium ferentibus, paribus interioribus surculos plerumque subtendentibus; axibus indumento infra cotyledones plerumque extenso, ex permixtione pilorum glandulosorum eglandulosorumque debilium, posteriorum interdum absentium brevi-orumve, constanti, in quattuor seriebus e basibus folium decussatis, densis longis, id est, (0.2)0.4-0.7(1.0)mm, et densiusculis, brevibus usque longis alternantibus, disposita. Cotyledones intergrae glabrae, spathulatae usque ellipticae, 2-5mm longae, ca. $1\frac{1}{2}$-2mm latae, plerumque persistentes. Folia caulina summa (8.0) 10.0-16.0(20.0)mm longa, (2.9)3.5-6.5(8.5)mm lata, serrata usque crenata-serrata, in ambitu plerumque elliptica, interdum ovata-elliptica obovata-ellipticave, glandulifera, marginibus scabris recurvatis; base plerumque rotundata-cuneata usque angusta-cuneata, interdum rotundata; dentibus (2)3-4(5) secus quoque marginem, acutis obtusisve, (0.5)1.5(2.5)mm longis; apice obtuso acutove, (2.0)2.5-4.0(6.5)mm longo. Inflorescentiae racemosae densae, illa caulis plerumque plus quam 15-flora procreantes; rhachide indumento axi simile sed densiore; pedicellis 0-1($2\frac{1}{2}$)mm longis; fasce apicali gemmarum hemisphaerico, super corollas paris primi florum vix emergenti. Bracteae foliorum summorum similes. Calyx (5.3)6.2-8.7(9.5)mm longus, indumento extra denso glanduloso, (0.3)0.4-0.6(1.0)mm longo, intra super rimas medianas denso, brevi usque longo glanduloso; dentibus linearibus-acutus caudatisve apicibus scabris pilosisve, marginibus in siccitate plus minusve recurvatis; rimis lateralibus (2.0)2.5-3.9(4.8)mm profundis, rimis medianis (3.0)3.5-5.0(5.8)mm profundis. Corolla alba usque lilacina, in quoque lobo 3-5 striis indicis usque profunde purpureis, illis in lobis summis in cucullum extensis, maculis luteis apparenter absentibus, secus superficiem (6.5)8.2-11.5(13.0)mm longa, extra in superficie et post labium interius pilos densos longiusculosque, in lobis internis pilos sparsiores, ferens, lobis superis glabris, intra in dimidio supero tubi et circa bases filamentorum eglandulosa; labio supero (2.1)2.7-4.0(4.5)mm longo; labio inferio (5.0)7.0(10.0)mm longo, (11.0)14.0(18.0)mm lato; lobis plerumque non profundis usque profundis emarginatis, lobis superis non profundioribus profunde praemorsis-truncatis; rima supera (2.0)2.5-4.0(4.5)mm profunda, rimis infernis (3.0)4.0-6.0(7.8)mm profundis. Filamenta staminum glabra, antica3.5-5.0mm longa, posticaque 1.5-2.5mm longa; antheris (1.2)1.6-2.0(2.2)mm longis, 0.8-1.1mm latis; connectivis paris anticae glabris vel pilos breves flexuosos eglandulosos, plerumque sparsos, raro densiusculos, sparsiores quam eos connectivorum paris posticae, ferentibus; aristis posticis (0.25)0.3(0.5)mm longis. Ovula (20)30(40). Capsula aspectu laterali obovata usque oblonga-ovata, saltem 7mm longa, in dimidio supero dense longa-setosa; apice aspectu laterali non profunde emarginato usque ?truncato; seminibus ca. 4-15, oblique ellipsoideis, quam 1.5mm longioribus.

Holotypus: Hj. Eichler 14825, 13.ii.1958. Victoria, Bogong High Plains. Surroundings of Mt. Nelse; ca. 1900m alt. AD 96105007. Isotypi: 3 distribuendi. (tab. 20).

DESCRIPTION:

Annual herb, (4.0)7.0-14.5(16.0)cm tall, higher when fruiting, erect, occasionally with herbaceous parts reddened.

Stem to base of inflorescence (2.5)5.0-11.0(14.0)cm long, bearing (5)6-8(12) pairs of leaves, with branches forming in axils of cotyledons (at least in the few sufficiently mature plants seen) and all leaf axils up to (1)2(3) nodes below inflorescence; branches later-flowering, with upper ones developing first, bearing (1)2-3(4) leaf pairs, the lower pairs themselves usually subtending shoots (fully developed lower branches not seen); axes with indumentum usually extending to below cotyledons, consisting of mixture of glandular hairs and lax eglandular hairs, arranged in four rows decussate from leaf bases, alternately dense, long, i.e. (0.2)0.4-0.7(1.0)mm, and moderately dense, short to long, the eglandular hairs sometimes lacking or shorter than the glandular hairs.

Cotyledons 2-5mm long, ca. 1½-2mm broad, spathulate to elliptic, entire, glabrous, usually persisting until after flowering time.

Leaves: uppermost stem leaves (8.0)10.0-16.0(20.0)mm long, (2.9)3.5-6.5(8.5)mm broad, serrate to crenate-serrate, usually elliptic, sometimes ovate-elliptic or obovate-elliptic in outline, with margins recurved, with upper surface covered by dense glandular hairs, short in apical half grading to moderately long towards base, mixed with short eglandular hairs, dense and ± scabrous in apical region, especially upon recurved margins, grading to sparse and lax towards base, with lower surface usually covered by sparse to moderately dense, moderately long glandular hairs, sometimes mixed with sparse to moderately dense, short to moderately long ± lax eglandular hairs; base usually rounded cuneate to narrow cuneate, sometimes rounded; teeth (2) 3-4(5) along each margin, bluntly acute or obtuse, (0.5)1.5(2.5)mm long; apex bluntly obtuse or acute, (2.0)2.5-4.0(6.5)mm long; leaves in middle of stem similar; lowest leaves smaller, fewer-toothed and with more attenuated bases, but with similar indumentum.

Inflorescences dense racemes, that of stem with usually more than 15 flowers; rachis with indumentum similar to axis but denser; internodes elongating somewhat after anthesis such that fruiting calyces extend past bases of calyces above, sometimes lower ones slightly longer; pedicels 0-1.0(2.5)mm long, hardly elongating after anthesis; apical bud cluster hemispherical, hardly extending above corollas of initial flower pair (i.e. extended less than 0.5cm).

Bracts similar to uppermost leaves or somewhat shorter, with longer, occasionally more numerous teeth and denser indumentum.

Calyx (5.3)6.2-8.7(9.5)mm long, externally bearing dense long glandular indumentum, (0.3)0.4-0.6(1.0)mm thick, with apices of teeth covered by short setose to moderately long lax, moderately dense to dense upturned eglandular hairs, internally with dense, short to long glandular hairs above median clefts mixed with short to moderately long eglandular hairs, usually confined to apices of teeth, sometimes over all teeth and onto tube; teeth ± sharp, linear, acute or caudate, with margins somewhat recurved at least when dried; lateral clefts (2.0)2.5–3.9(4.8)mm deep, shorter than median clefts which are (3.0)3.5–5.0(5.8)mm deep.

Corolla (6.5)8.2–11.5(13.0)mm long along upper side, white to lilac with 3–5 indigo to deep red-purple striations on each lobe, those on upper lobes extending onto hood, with yellow markings apparently lacking; tube (4.5)6.4(8.0)mm long, for initial (3.3)3.6(5.7)mm to base of anterior filaments narrow cylindrical, then expanded laterally and ventrally, externally glabrous or with dense, short to long downturned eglandular hairs on distal $\frac{1}{2}$–$\frac{1}{3}$ of adaxial and lateral surfaces, usually also with dense patch of short to moderately long glandular hairs behind lateral clefts, internally with dense, short to moderately long eglandular hairs on upper half of tube about bases of filaments and decurrent from them; hood (2.1)2.7–4.0(4.5)mm long, externally on top covered usually by dense long eglandular hairs, sometimes by dense, short to moderately long glandular hairs, on sides covered usually by dense long eglandular hairs, sometimes by moderately dense moderately long glandular hairs, internally bearing moderately dense to dense, short to moderately long glandular hairs above anthers, together with a dense patch of usually moderately long to long, occasionally short, flexuose eglandular hairs in area of sinus, sometimes also with sparse line of short eglandular hairs down middle of hood, with upper lobes ± coplanar, usually shallowly to deeply emarginate, sometimes praemorse-truncate, with front surface and margins glabrous, with rear surface usually glabrous, sometimes bearing sparse glandular hairs in proximal half, with cleft between (2.0)2.5–4.0(4.5)mm deep; lower lip (5.0)7.0(10.0)mm long, (11.0)14.0(18.0)mm broad, concave from above, curved downward from tube, externally covered behind lobes usually by sparse to dense mixture of moderately long glandular and eglandular hairs, sometimes by eglandular hairs alone, lobes usually bearing a sparser indumentum, sometimes glabrous, with margins and inner surface glabrous, with lower lobes usually emarginate or deeply so, rarely shallowly emarginate, with clefts between (3.0)4.0-6.0(7.8)mm deep.

Filaments of stamens usually glabrous, rarely with one or two short eglandular hairs, anterior pair 3.5-5.0mm long, posterior pair 1.5-2.5mm long; anthers (1.2)1.6-2.0(2.2)mm long, 0.8-1.1mm wide, with connectives of anterior pair glabrous or surrounded by usually sparse, rarely moderately dense, short flexuose eglandular hairs, less hairy than those of posterior pair, which are surrounded by very sparse to dense, short to moderately long flexuose hairs, with posterior pair of awns (0.25)0.3(0.5)mm long, always longer than other three awn pairs.

Ovary laterally compressed, in lateral view ovate to oblong-elliptic to oblong-obovate, with upper $\frac{1}{2}$-$\frac{2}{3}$ covered by dense, long to very long setae; apex in lateral view obtuse to truncate-obtuse; ovules (20)30(40), often with somewhat different number in each cell.

Immature capsules obovate to oblong-elliptic to oblong-ovate in lateral view, laterally compressed, attaining a length of 7mm and breadth of 4mm and then still shorter than calyx, with upper $\frac{1}{2}$-$\frac{3}{4}$ clothed by dense setae, short towards base, long at apex; apex in lateral view shallowly emarginate to truncate; immature seeds ca. 4-15, obliquely ellipsoid, 1.5-2.0mm long, 0.5-1.2mm broad.

Chromosome number: Unknown.

Plates: 6, 20

Figures: 14

TYPIFICATION:

Holotype (pl. 20): Hj. Eichler 14825, 13.ii.1958. Victoria, Bogong High Plains. Surroundings of Mt. Nelse; ca. 1900m alt. AD96105007.

Isotypes: 3 duplicates to be distributed. Pollen slide: A.N.U.,AD.

The type collection is well preserved and consists of about fifty plants. Plants mainly bear buds, mature flowers and sometimes young fruits. As in other collections of the species, mature fruits are lacking.

It is very likely that the type population still survives. Mt. Nelse lies in the Rocky Valley Reservoir catchment area which is protected by the State Electricity Commission of Victoria against despoliation. The continued grazing of cattle in the area may constitute some threat to the existence of the type population, but there appears to have been no decline in the number of incoming collections of the species from the Bogong High Plains over the past 30 years.

DISTRIBUTION (Fig. 14):

E. eichleri is confined to alpine and subalpine tracts of the Bogong and nearby Dargo High Plains of the Victorian Alps, probably at altitudes from 4500 feet (1370m) to over 6000 feet (1830m).

ECOLOGY:

Little is knownof the ecology of the species other than its occurrence above the snow-line. Willis (MEL41664) has recorded it "in sphagnum bogs". The type material lacks ecological annotation, but Eichler (pers.comm., 14.vi.1973) feels certain that the collection came from a grassland or low heath area. A State Electricity Commission of Victoria pamphlet (1967) describes "E. antarctica", which is presumably E. eichleri, as "scattered on High Plains".

Flowering apparently begins from the middle of January to early February. Only the type, which was collected in mid-February, bears capsules on the stem. The remaining collections were collected earlier. Flowering probably continues until at least April.

NOTES:

1. E. eichleri is intermediate morphologically between E. alsa and E. lasianthera, the two other species in Sect. Lasiantherae. It is nevertheless clearly distinct from each on a number of characters (for details see key to the species.

The "linear" morphological transition between E. lasianthera and E. caudata of Sect. Scabrae via E. eichleri and E. alsa may represent a line of evolution in past times. This is supported by the intermediate geographical position of E. eichleri between E. lasianthera and E. alsa (fig. 14 ; see Chapter 4: Evolution of Euphrasia in Australia).

2. Stead's specimen (NSW60818), alleged to have been collected from Charlotte's Pass near Mt. Kosciusko, New South Wales, is clearly E. eichleri. If genuine, this would be the sole record of the species, outside of its otherwise restricted range of distribution. Accordingly, the locality must be considered extremely doubtful, especially as she collected E. eichleri from the Bogong High Plains (NSW126394) a week earlier than the collection in question.

SPECIMENS EXAMINED:

Victoria

Beauglehole 15543, 26.i.1966. Bogong High Plains, N. side of Mt. Cope. BEAUGLEHOLE. -- Beauglehole 15616, 26.i.1966. Bogong High Plains, Watchbed Creek. BEAUGLEHOLE. -- Beauglehole 15818, 29.i.1966. Bogong High Plains, Cope Creek. BEAUGLEHOLE. -- Ducker s.n.,

-.i.1946. Bogong High Plains. MELU. -- Eichler 14825, 13.ii.1958. Bogong High Plains. Surroundings of Mt. Nelse. AD, holotype; pollen slide in ANU, AD. -- Howitt 12, 1883. Dargo High Plains. Gippsland. MEL. -- McVean s.n., 4.ii.1967. Near Mt. Cope, Victoria. CANB (s.n.). -- Stead s.n., 20.i.1962. Falls Creek, Victoria. NSW126394. -- Tadgell s.n., -.ii.1926. Mt. Fainter. MEL41663. -- Willis s.n., 15.i.1946. Pretty Valley, between Mt. Jim and Rocky Knobs, Bogong High Plains. MEL41664.

New South Wales. Locality very doubtful.

Stead s.n., 13.i.1962. Charlottes Pass, Kosciusko area. NSW60818.

9. Euphrasia lasianthera Barker, species nova

[E. gibbsiae f. comberi auct. non Du Rietz: Willis, Muelleria 1(1967)148(as to MEL41528); Harris, Alp.Pl.Austral.(1970) 138; Willis, Hdbk.Pl.Vict.2(1973)573]

LATIN DESCRIPTION:

Herba perennis, (10)16-30(35)cm alta ramis multis congestis, ascendentibus, ex caule reductissimo, in partibus prostratis non radicata. Caulis reductus; rami florales parte prostrata initio (0)4-18(25)cm longa, parte erecta integra (6)11-18(25)cm alta ad basim inflorescentiae; internodiis in partibus superis foliis summis (1)1½-2(3)-plo longioribus, in partibus infernis foliis brevioribus; axibus in partibus superis pilis glandulosis, plerumque densiusculis usque densis, raro sparsis, (0.2)0.4-0.5(0.6)mm longis, seriebus duobus quattuorve pilorum eglandulosorum, brevium usque longiusculorum, inter bases foliorum decurrentibus vestitis, in partibus infernis indumentum paullo sparsum breviusque ferentibus. Cotyledones non vidi. Folia: summa ramorum floralium plerumque late obovata usque late ovata, interdum circularia, serrata, (5)8-12(14)mm longa, (4)5-8(14)mm lata, viridia, raro rubella, marginibus recurvatis, glandibus sessilibus super fere integrum longitudinem folii distributis, pilis glandulosis, densiusculis usque densis, plerumque longis, raro brevibus, pilis eglandulosis sparsis brevibus permixtis superne infraque vestita; base rotundato-cuneata usque truncata, marginibus axem amplectentibus; dentibus (1)2-4(7) secus (½)¾(1) distale cuiusque marginis, plerumque acutis usque acuminatis, raro obtusis, 1.0-2.5(4.3)mm longis; apice plerumque acuto usque obtuso, interdum breve acuminato, (1.0)1.2-2.7(3.0)mm longo, (1.5)2.0-3.5(4.0)mm lato; inferna minora indumento sparsiore. Inflorescentiae racemosae speciosae, densae praeter nodos infimos, (14)20-26(30) flores ferentes; rhachide indumento plerumque axibus similari, interdum paullo longiore; pedicellis (0.5)1.5-5.5(7.0)mm longis, ad basem inflorescentiae longissimis; fasce apicali gemmarum (gemmis ad nodos inferiores distantes exclusis) cylindrico usque conico-cylindrico, rotundato, primum usque 1.5(1.8)cm longo, post anthesin florum ad 3-6 nodos primos plerumque a corollis supremis occulto, raro usque 1cm super corollas remanenti. Bracteae basibus attenuatioribus, alioquin foliis summis similares. Calyx (5.5)6.0-8.0(9.0)mm longus, extra indumento (0.1)0.2-0.3(0.4)mm lato, ex pilis glandulosis densiusculis usque densis, plerumque longiusculis usque longis, rare brevibus, interdum pilis eglándulosis sparsis usque densiusculis, brevibus usque longiusculis permixtis, constanti, intra plerumque indumento illi partis exterioris similari sed eidem breviorusculo, partibus distalibus restricto, raro glaber; dentibus acutis usque breve acuminatis; rimis lateralibus 2.0-5.0mm profundis, medianis 3.0-6.0mm profundis. Corolla secus superficiem (10)11-14(15)mm longa, alba usque lilacina usque erubescens, in quoque lobo 3-5 striis purpureis, plerumque conspicuis, raro tenuibus, ad basem utriusque filamenti anterioris macula flava parva conspicua; tubo 6-10mm longo, extra intraque dense piloso praeter ad basem; labio supero (3.0)3.5-5.0mm longo, extra ubique piloso, intra pilis glandulosis brevibus, sparsis usque densis, pilis eglandulosis, ad sinum densis longis usque longissimis, plerumque alibi absentibus, raro super antheras sparsis, longiusculis permixtis, vestito; lobis superis in eodem plano, obtusis usque praemorso-obtusis usque non profunde emarginatus, in pagina postica pilis glandulosis brevibus, pagina antica marginibusque glabris, rima (3.0)4.2(5.5)mm profunda; labio infero plerumque 3-lobato, interdum 5-7 lobato, superne viso concavo, de base deorsum curvato sed ad extremum prorsum curvato, (8)10-13(16)mm longo, (12)15-20(22)mm lato, extra pilis glandulosis eglandulosisque vestito, intra et in marginibus glabro; lobis inferis plerumque emarginatis usque praemorso-truncatis usque truncatis, interdum late obtusis, rimis (4.0) 5.0-7.0(8.5)mm profundis. Stamina filamentis glabris, pari antico 5.0-6.5(7.5)mm longo, pari postico 2.0-3.5(4.5)mm longo; antheris (1.9)2.0-2.5(2.7)mm longis, (1.2)1.3-1.6(1.7)mm latis, connectivis pilosis eglandulosis flexuosis densis longis circum-cinctis, aristis paris postici (0.4)0.5-0.7(0.8)mm longis. Ovarium latere visum ovatum usque oblongum glabrum plerumque praeter setis paucissimis usque densis, brevibus usque longis circa apicem; apice latere viso truncato usque obtuso, saepe obliquo; ovulis (31)60(97). Capsulae (7.5)8.0-10.0(13.0)mm longae, latere visae plerumque ovato- oblongae usque oblongo- ellipticae, interdum obovato-oblongae, (3.0)3.5-4.0(5.0)mm latae, setis paucis usque densiusculis, brevibus usque longis circa apicem; apice latere viso plerumque truncato usque late obtuso, raro acuto, saepe obliquo; seminibus (6)17-70, oblongis usque ellipsoideis, plerumque oblique, interdum late, 0.9-1.4(1.5)mm longis, 0.5-0.8(1.0)mm latis.

Holotypus(tab. 20): W.R. Barker 1498, 25.xii.1971. Victoria, Eastern Highlands. Ca. 2½km NW of Howitt Hut on the road to Macalister River headwaters, ca. 1km SE of turnoff to Macalister Springs. AD 97218059. Isotypi: 13 distribuendi.

DESCRIPTION:

Perennial herb, (10)16-30(35)cm tall with many densely crowded ascending branches arising from very reduced stem, lacking roots on prostrate parts.

Stem terminated just above ground; floral branches initially prostrate for length of (0)4-18(25)cm, abruptly or gradually erect, (6)11-18(25)cm high to base of inflorescence, branched in proximal prostrate parts, simple distally; internodes in upper parts (1)1½-2(3) times length of upper leaves, lower down shorter than leaves; vegetative branches shorter, either similarly robust with leaves of similar size often clustered towards apex or more slender with smaller leaves; axes in upper parts covered by usually moderately dense to dense, rarely sparse, long to very long glandular hairs [(0.2)0.4-0.5(0.6)mm long], mixed with short to moderately long eglandular hairs usually in four lines, sometimes in two rows decurrent from between leaf bases, the indumentum slightly sparser and shorter in lower parts.

Cotyledons not seen.

Leaves: uppermost leaves on floral branches usually broadly obovate to broadly ovate, sometimes circular, crenate-serrate to serrate, (5)8-12(14)mm long, (4)5-8(14)mm broad, light green, rarely reddened, with margins recurved and sessile gland patches distributed over almost entire length of underside, covered on both surfaces by moderately dense to dense, usually long, rarely short glandular hairs mixed with sparse short eglandular hairs, usually denser towards leaf base; base rounded cuneate to truncate, with margins clasping axis; teeth (1)2-4(7) along distal (½)¾(1) of each margin, usually bluntly acute to acuminate, rarely obtuse, 1.0-2.5(4.3)mm long; apex usually bluntly acute to obtuse, sometimes bluntly short acuminate, (1.0)1.2-2.7(3.0)mm long, (1.5)2.0-3.5(4.0)mm broad; leaves lower down smaller with sparser indumentum.

Inflorescences but for lowermost 1 to several pairs of flowers dense showy racemes bearing (14)20-26(30) or more flowers; rachis similar to axes but sometimes with slightly longer indumentum; internodes elongating after anthesis such that fruiting calyces extend to base of calyx above or past it; pedicels (0.5)1.5-

5.5(7.0)mm long, longest towards base of inflorescence; apical bud cluster (excluding buds at widely spaced lower nodes) cylindrical to conical-cylindrical, rounded, initially up to 1.5(1.8)cm long, after flowers of first 3-6 pairs have reached anthesis usually hidden by uppermost corollas, rarely remaining extended up to 1cm above corollas.

Bracts similar to uppermost leaves of floral branches but with bases more attenuated.

Calyx (5.5)6.0-8.0(9.0)mm long, externally with indumentum (0.1)0.2-0.3(0.4)mm thick comprising moderately dense to dense, usually moderately long to long, rarely short glandular hairs, sometimes mixed with sparse to moderately dense, short to moderately long eglandular hairs, internally with tube usually glabrous, sometimes bearing, mixture of glandular and eglandular hairs, with teeth usually with indumentum similar to but somewhat shorter than external surface, usually confined to distal part and margins or over whole length, rarely glabrous; teeth ± sharply acute to shortly acuminate; lateral clefts 2.0-5.0mm deep, shorter than median clefts which are 3.0-6.0mm deep and often somewhat unequal.

Corolla (10)11-14(15)mm long along upper side, white to pale lilac to deep pink, with 3-5 red-purple striations on each lobe, usually conspicuous, rarely faint, converging together deep in tube, often also with broad red-purple band lining base of lobes, especially lower ones, with small intense yellow blotch at base of each anterior filament; tube 6-10mm long, cylindrical for initial 3-5mm to base of anterior filaments, distally expanded laterally and ventrally, externally glabrous at base, distally on adaxial and lateral surfaces covered by dense long eglandular hairs sometimes mixed with sparse glandular hairs, with patch of moderately dense to dense short to long glandular hairs behind lateral clefts, on abaxial surface covered by mixture of glandular and eglandular hairs, internally glabrous at base, distally covered by dense, short to moderately long eglandular hairs below and between base of filaments sometimes mixed with a few glandular hairs; hood (3.0)3.5-5.0mm long, externally covered by moderately long to long eglandular hairs, dense on top, sparser on sides, mixed with short to moderately long glandular hairs, usually sparse or absent sometimes moderately dense on top, moderately dense to dense on sides, internally with short glandular hairs, usually moderately dense to dense, sometimes sparse above anthers, sparser or absent towards bases of filaments, mixed with eglandular hairs, dense, long to very long at sinus, usually lacking farther back, rarely sparse, moderately long above anthers; upper lobes coplanar, obtuse to praemorse-obtuse to shallowly emarginate, with rear surface covered by short glandular hairs, sparse to moderately dense towards base, sparse to absent distally with front surface and margins glabrous, with cleft betwen (3.0)4.2(5.5)mm deep; lower lip usually 3-lobed, sometimes 5-7 lobed by subdivision of lobes, concave from above, downturned from base but finally curved forward, (8)10-13(16)mm long, (12)15-20(22)mm broad, externally covered in proximal parts by a sparse to moderately dense mixture of glandular and eglandular hairs, distally with indumentum sparser, sometimes almost glabrous, internally and on margins glabrous; lower lobes usually emarginate to praemorse-truncate to truncate, sometimes broadly obtuse, with clefts between (4.0)5.0-7.0(8.5)mm deep.

Stamens with filaments glabrous, the anterior pair 5.0-6.5 (7.5)mm long, the posterior pair 2.0-3.5(4.5)mm long; anthers (1.9)2.0-2.5(2.7)mm long, (1.2)1.3-1.6(1.7)mm broad, with connectives surrounded by dense long flexuose eglandular hairs, the pilosity ± equal on each anther, with awns of posterior pair

(0.4)0.5-0.7(0.8)mm long, longer than anterior six awns.

Ovary in lateral view ovate to oblong, somewhat compressed laterally, in median view ovate, usually glabrous but for very few to dense, short to long setae in apical region, rarely glabrous all over; apex in lateral view truncate to obtuse, often oblique; ovules (31)60(97).

Capsules slightly to greatly exserted from calyx, slightly compressed laterally, (7.5)8.0-10.0(13.0)mm long, in lateral view usually ovate-oblong to oblong-elliptic, sometimes obovate-oblong (3.0)3.5-4.0(5.0)mm broad, in median view ovate to ovate-elliptic, with few to moderately dense, short to long setae confined to the upper ¼ or at the very apex; apex in lateral view usually truncate to broadly obtuse, rarely acute, often oblique; seeds (6)17-70, oblong to ellipsoid, usually obliquely so, sometimes broadly so, 0.9-1.4(1.5)mm long, 0.5-0.8(1.0)mm broad.

Chromosome number: n=c.45-60 (Barker 1536)

Plates: 6, 20

Figures: 14

TYPIFICATION:

Holotype (pl. 20): W.R. Barker 1498, 25.xii.1971. Victoria, Eastern Highlands. Ca. 2½km NW of Howitt Hut on the road to Macalister River headwaters, ca. 1km SE of turnoff to Macalister Springs. Roadside; cleared areas near semi-closed snowgum woodland or in the shade of the snowgums in low shrub stratum and grassy undergrowth. A large population; forming showy-flowered clumps with ascending stems branched at ground level. Corollas with variation of colour and depth of striations - white to pale lilac to pale pink, with reddish-purple striations 3-5 (the latter formed by the division of the two lateral striations) on all lobes, to occas. in some white flowers just faintly striated; sometimes the depth of colour of striations such that a broad red-purple band between mouth and halfway along lobes extends at right angles to striations. A yellow area at the point of insertion of each of the two lower (longer) filaments. Often corollas with an extra lobe. Insect pollinators collected; black and orange native bee as in WRB 1492 very common in the Euphrasia population; another native bee, completely black, seen rarely. AD97218059. Isotypes: 13 to be distributed.

The species occurs commonly in the type region near Macalister Springs. At the time of collection the type population was separated from the populations of *E. collina* which occurred nearby and there was no evidence of hybrids such as those occurring about 200m away (Barker 1507-1509).

The type collection is in good condition, with corolla striations prominent although colours have become more bluish with drying. Plants possess buds and copious flowers but only occasionally mature capsules. The collection probably totals about 14 more or less entire plants and the same number of fragments, normally each comprising several branches.

DISTRIBUTION (Fig. 14):

E. lasianthera occurs in the western part of Victoria's eastern highlands. It is endemic to a small dissected highland region of interconnected ranges and small plateaux reaching 1500m to 1800m and bounded to the west, north and south by Mts. Buller, Speculation and Arbuckle, respectively. Its apparent absence from high mountains to the immediate south is discussed in Note 2.

The recorded localities for the species range in altitude from about 1500m to 1800m.

ECOLOGY:

The species as far as is known, occurs on mountain sides, on plateau areas and on rocky summits. It occurs in dense local populations in grassy areas in a variety of habitats, namely "alpine herbfield" (Willis MEL41534, MEL41564), "alpine grassland" (Muir 965), alpine heathland (Barker 1535, 1536), subalpine snowgum (Eucalyptus pauciflora) woodland in openings or under overhanging trees (Barker 1498, 1502, 1503, 1506, 1518, 1519), and sclerophyll forest (Barker 1538).

It occasionally occupies disturbed situations. For example, the major portion of an extensive population in snowgum woodland near Macalister Springs occurs on a cleared grassy grazed roadside verge (Barker 1498, 1502, 1506).

Flowering apparently begins in late November and continues until early February. Mature capsules are increasingly apparent after the start of January.

NOTES:

1. E. lasianthera is unique among the Australian perennials by its combination of hairy anther backs and prominently striated corollas. It is also unique for the sharply demarcated yellow blotches, one at the base of each anterior filament, which form the centre point of the flower. These are highlighted by the convergent striations on the corolla lobes. Unlike the other Australian perennials with striated corollas a yellow blotch behind the lowest lobe is consistently absent.

The species is one of the three very distinct species which together form Sect. Lasiantherae. For details of diagnostic characters refer to the key to the species under the treatment of the Section.

2. The most southerly record of E. lasianthera is at Snowy Plains (Barker 1519; Beauglehole 40983) which is a few kilometres north of Mt. Arbuckle. Further south and more or less continuous with the Snowy Plains are Mts. Tamboritha and Wellington which are nearly 1600m high. Although access to these mountains has been improved only recently and it has been rather inadequately botanised in the past (the only collections of Euphrasia other than my own being those of Beauglehole et al, Carrick, Muir and Willis) collections are sufficiently numerous to have expected some record of E. lasianthera if it does occur there. In support of this, so many collections of E. collina ssp. paludosa have been made from sclerophyll forest to the highest summits in this region, that it would seem remarkable if E. lasianthera had been missed, especially as the two species are often sympatric further to the north. The generally lower altitude of the Mt. Wellington-Mt. Tamboritha region and the resultant restriction and disjunction of areas above 1500m, the lowest recorded occurrence of E. lasianthera, may have contributed to its absence from the area. In addition, the existence of a glandular form of E. collina in the Mt. Wellington region may relate to this apparent absence of E. lasianthera from the same area.

SPECIMENS EXAMINED:

Victoria

Allender s.n., 9.i.1969. Mt. Buller. MEL41791. — Barker 1498, 25.xii.1971. Eastern Highlands. Ca. $2\frac{1}{2}$km NW of Howitt Hut on the road to Macalister River headwaters, ca. 1km SE of turnoff to Macalister Springs. AD, holotype. — Barker 1502, 25.xii.1971. Eastern Highlands. Ca. 3km NW of Howitt Hut on the Macalister Headwaters road, ca. 100m SE of the turnoff to Macalister Springs. AD. — Barker 1503, 25.xii.1971. Eastern Highlands. Ca. 2km SE of the turnoff to Macalister Springs on the Howitt Road to Licola; ca. 1km NW of Howitt Hut. AD. — Barker 1506, 26.xii.1971. Eastern

Highlands. Ca. 3km NW of Howitt Hut on the Macalister Headwaters road, ca. 100m SE of the turnoff to Macalister Springs. AD. — Barker 1518, 26.xii.1971. Eastern Highlands. Ca. 50m below summit of Minogues Lookout, which is ca. 5km SSE of Howitt Hut on the Howitt Road between Mt. Arbuckle and the Macalister Headwaters at Mt. Howitt. AD. — Barker 1519, 26.xii.1971. Eastern Highlands. Ca. 1½km S of the Snowy Plains airstrip, on the Howitt Road between Mt. Arbuckle and the Macalister Headwaters at Mt. Howitt. AD. — Barker 1535, 28.xii.1971. Eastern Highlands. Ca. ½km ESE of Mt. Buller summit on track to Alpine Village. AD. — Barker 1536, 28.xii.1971. Eastern Highlands. Summit of Mt. Buller. AD. — Barker 1538, 28.xii.1971. Eastern Highlands. Between 15 & 20km by road from Mirimbah on the Mt. Stirling Circuit Road on the southern side of Mt. Stirling, between Howqua Gap & Stanley's Creek. AD. — Beauglehole 40774 & Chesterfield, 28.xii.1972. S16. Mt. Howitt - on top. BEAUGLEHOLE, AD. — Beauglehole 40983 & Chesterfield, 5.i.1973. S26. Snowy Range, Airstrip Plain; ± 12m N.N.W. of Mt. Wellington. BEAUGLEHOLE. — Beauglehole 41231 & Chesterfield, 18.i.1973. S15. Mt. McDonald. 12m S.W. of Mt. Howitt. BEAUGLEHOLE, AD. — Beauglehole 41237 & Chesterfield, 19.i.1973. S16. Mt. Clear, ± 7m S.W. of Mt. Howitt. BEAUGLEHOLE. — Beauglehole 41278 & Chesterfield, 21.i.1973. S16. Mt. Marjorie. Hells Window area. ± 1½km S.W. of Mt. Howitt. BEAUGLEHOLE, AD. — Muir 344, 29.i.1958. Mt. Buller. Rocky northern slopes of Baldy. MEL. — Muir 965, 28.xii.1959. The Bluff, 8 miles south-east of Mt. Buller. MEL. — Willis s.n., 2.i.1945. Summit of Mt. Speculation, Barry Mts. MEL41528. — Willis s.n., 6.xii.1970. Macalister Springs saddle on eastern declivities of Mt. Howitt. MEL41534. — Willis s.n., 6.xii.1970. Near summit of Mt. Howitt. MEL41564. — Willis s.n., 6.xii.1970. Macalister Springs saddle on eastern declivities of Mt. Howitt. MEL41535.

IV. Sect. Scabrae (Du Rietz)Barker

For synonymy, description, typification and distribution, see Chapter 5: p.148.

KEY TO THE SPECIES OF SECT. SCABRAE:

1a. Calyces externally scaberulous to shortly scabrous, sometimes also bearing a few tiny glandular hairs (less than 0.05mm long).

2a. Uppermost stem leaves with (2)3-4(5) teeth along each margin, the longest tooth (1.5)3.0(5.5)mm long. Lowermost calyces of stem inflorescence (5.3)6.3(8.2)mm long. [Corollas white to lilac to ?purple, at least sometimes with yellow patch on lower lip.]

E. arguta

2b. Uppermost stem leaves with (0)1(2) teeth along each margin, the longest tooth 0.05-1.5mm long. Lowermost calyces of stem inflorescence (2.8)3.5-5.4(6.0)mm long.

3a. Corollas blue to mauve with midline of lower lip at least sometimes yellow. Capsules usually with upper $\frac{1}{3}$ - $\frac{1}{2}$ covered by sparse to moderately dense setae less than 0.1mm long, sometimes glabrous. Seeds (0.9)1.0-1.2(1.4)mm long. Posterior anther awns (0.3)0.4-0.5(0.6)mm long.

E. ciliolata

3b. Corollas yellow. Capsules with upper $\frac{2}{3}$ - $\frac{3}{4}$ covered by dense setae more than 0.2mm long. Seeds (0.4)0.5-0.8(0.9)mm long. Posterior anther awns (0.1)0.2(0.3)mm long.

E. orthocheila

var. peraspera

1b. Calyces covered by prominent glandular hairs, moderately dense to dense at least on teeth, usually 0.1-1.0mm long, rarely subsessile (with large glands), mixed with very short to long, scabrous to lax eglandular hairs.

4a. Lower corolla lobes usually emarginate, rarely truncate, with glabrous margins. Seeds (0.9)1.2-2.0(2.5)mm long. Capsules porrect, with apices in lateral view shallowly emarginate-truncate to broadly obtuse. [Corollas usually violet to pink, sometimes paler or white, with yellow to red streak along midline of lower lip. Capsules with upper $\frac{1}{2}$ - $\frac{2}{3}$ covered by dense setae more than 0.3mm long. Glandular hairs dense over calyx, (0.1)0.2-0.4(0.6)mm long.]

E. caudata

4b. Lower corolla lobes usually obtuse to truncate and often shortly apiculate, sometimes shallowly emarginate, with margins sparsely to densely lined by short eglandular hairs or glabrous. Seeds (0.4)0.5-0.8(1.0)mm long. Capsules usually slightly downcurved, rarely porrect, with apices in lateral view acute to obtuse.

5a. Uppermost stem leaves (4)6-8(11)mm long, (0.5)1.2-2.0(2.5)mm broad, with 0-1(2) teeth along each margin, the longest lobe 0.05-0.5(0.6)mm long. Lowermost calyces of stem inflorescence infructescence (3.4)4.0-5.0mm long. [Corollas yellow.]

E. orthocheila

var. orthocheila

5b. Uppermost stem leaves (6)7½-14(20)mm long, (1.0)2.5-10.0 (13.0)mm broad, with (1)2-3(5) teeth along each margin, the longest tooth (0.4)0.7-4.0(5.5)mm long. Lowermost calyces of stem inflorescence (4.3)5.5-7.0(9.0)mm long. Lowermost capsules of stem infructescence (4.0)5.0-8.0 (9.3)mm long.

6a. Corollas yellow. Capsules with upper $\frac{3}{4}$ covered by dense setae more than 0.3mm long. Stem nodes (6)8-18(24). Glandular hairs on calyx prominent (ca.0.1-0.3mm long). Posterior anther awns (0.1)0.2(0.3)mm long.

<u>E. scabra</u>

6b. Corollas white to lilac to ?purple, at least sometimes with yellow blotch on lower lip. Capsules usually with upper $\frac{1}{4}$-$\frac{1}{2}$ covered by moderately dense to dense setae 0.1-0.3mm long, extending slightly further down lines of dehiscence, sometimes glabrous but for a few setae at very apex. Stem nodes (18)24(30). Glandular hairs on calyx tiny (less than 0.05mm long). Posterior anther awns (0.2)0.3-0.4(0.5)mm long.

<u>E. arguta</u>

10. Euphrasia caudata (Willis)Barker, comb. & stat. nov.

E. scabra R.Br. var. caudata Willis, Muelleria 1(1967)149, p.p. (as to holo- & iso-types, & paratypes excl. Howitt 12, Willis MEL41654) BASIONYM; Harris, Alp.Pl.Austral.(1970) 138; Nat.Pks.Assoc.A.C.T.& Dept.Int., Mount.Slopes Plains (1971)40; Willis, Hdbk.Pl.Vict.2(1973)573

[E. brownii FvM.(nom.illeg.) var. psilantherea FvM., Fragm.Phyt. Austral.5(1865)89, p.p.(as to syntype, Mueller MEL41653, but not lectotype - see under E. gibbsiae); Wettst., Monogr. Gatt.Euphrasia (1896)253; Du Rietz, Sv.Bot.Tidskr.25(1932) 532]

[E. arguta auct. non R.Br.: Benth., Fl.Austral.4(1868)522, p.p. (as to Mueller MEL41658)]

DESCRIPTION:

Erect annual herb, (7½)12-34(40)cm tall.

Stem to base of inflorescence (3½)7-24(30)cm high, bearing (5)8-14(17) pairs of leaves, with axillary branches developing from (1)2-6(10) nodes above cotyledons to (2)3-5 nodes below inflorescence, with length of stem between inflorescence and uppermost branches more than half length of entire stem to base of inflorescence; branches flowering later than stem and developing in a basipetal sequence, lower branches bearing up to ca. 4-10 leaf pairs, uppermost pair bearing (1)2-5(7) leaf pairs, with all but upper and occasionally lowermost leaf pairs subtending shoots; axes covered by moderately dense, moderately long to long glandular hairs over whole length, mixed with short to moderately long eglandular hairs, which are mainly confined in upper parts to two dense rows decurrent from between leaf bases or four dense lines decurrent from sides of each leaf, eglandular hairs sparse in between, more scattered and sparse to moderately dense lower down.

Cotyledons oblong to broad oblong, c. 1.0-2.5mm long, entire, glabrous, hardly persisting or deciduous at flowering.

Leaves: uppermost stem in outline ovate-elliptic, usually pinnatifid, sometimes serrate-crenate, (6)12-24(36)mm long, (1.7) 3.3-7.0(9.5)mm broad, with margins recurved, with blade (excluding teeth) lanceolate, covered by usually moderately dense to dense, rarely sparse, short to moderately long scabrous indumentum on upper surface and margin, often sparser on lower surface, usually mixed especially towards base with sparse to dense, moderately long to long glandular hairs; base rounded to rounded-cuneate; teeth 2-3(5) along each margin, usually bluntly or sharply acute, rarely obtuse, reaching (0.5)1.2-3.0(5.0)mm long; apex bluntly or sharply acute, (2.0)4.0-10.0(14.8)mm long; leaves lower down somewhat longer than uppermost leaves with shorter apex and teeth and with similar indumentum; those at very base much smaller; leaves of branches in similar positions similar in shape but somewhat smaller.

Inflorescences dense racemes, that of stem producing (10) 18-24(32) flowers, those of branches producing fewer, those of depauperate plants producing 10 or less flowers; rachis covered by dense rows of down-turned, moderately long to long eglandular hairs mixed with sparse, short to long glandular hairs decussate from between bracts, alternating with a mixture of sparse, short to long eglandular hairs and moderately dense, moderately long to long glandular hairs; internodes elongating after anthesis such that capsules are well below or just reach node above;

pedicels hardly elongating after anthesis, 0.2-0.9(1.5)mm long, those at lowermost 1-3 nodes longer; apical bud cluster rounded-conical, bracteose, extended ca. 0.5-2.0mm above initial flower pair, becoming hidden after 3-12 or more pairs of flowers have opened.

Bracts similar to uppermost leaves, somewhat shorter and broader, with similar indumentum.

Calyx (3.8)5.5-8.0(9.5)mm long, externally covered by a mixture of dense, usually moderately long to long, rarely short, (i.e. (0.1)0.2-0.4(0.6)mm long) glandular hairs and sparse to dense, short to long eglandular hairs, internally with teeth covered by moderately long to long glandular hairs, moderately dense to dense at apex, sparser or absent below mixed with short to long, upturned appressed eglandular hairs, usually sparse to dense or sometimes absent at base of teeth, sparser or absent towards apex, glabrous below teeth; teeth usually sharply, occasionally bluntly acute; lateral clefts (2.0)2.6-3.7(5.5)mm deep, shorter than the median clefts which are (2.3)3.2-4.5(6.2)mm deep.

Corolla (9.0)11.8-16.0(19.0)mm along upper side, usually violet, blue, dark blue-purple, purple, lilac, mauve or pink, rarely paler or white (Phillips CBG007717, Darbyshire 104), with broad groove extending from behind lower lobes to narrow part of tube, at least usually white with a usually yellow or orange to yellow-brown or orange-brown, rarely red (Hoogland 3158) streak down its midline; tube (6.3)8.2(10.0)mm long, laterally and somewhat medianally broadened at bases of anterior filaments, which are (4.2)5.4(6.8)mm from base of corolla, externally glabrous at base, distally except for proximal part of abaxial groove covered by moderately dense to dense, moderately long to long eglandular hairs, sometimes with dense patch of short to moderately long glandular hairs behind the lateral clefts, sometimes extending as far as base of anterior filaments, internally glabrous to summit of ovary, distally covered by moderately dense to dense, short to long eglandular hairs up to bases of posterior filaments; hood (3.4) 4.8(6.3)mm long, externally covered by moderately dense to dense, moderately long to long eglandular hairs, often mixed with short to moderately long glandular hairs, usually restricted to sides or front where sparse to moderately dense, occasionally dense all over, internally covered by moderately dense to dense, short to long eglandular hairs at the sinus, often extended to above anthers, usually lacking elsewhere, sometimes sparse along midline of hood, sometimes also with sparse short glandular hairs, with upper lobes usually emarginate or deeply or broadly so, sometimes shallowly emarginate or truncate, with rear surface usually glabrous, sometimes covered by sparse to dense short to moderately long glandular or eglandular hairs or both, with front surface and margins glabrous, with cleft between (1.0)1.8(2.6)mm deep; lower lip (5.0)8.0(11.0)mm long, (8.0)11.8(17.0)mm broad, ± flat cross-wise, initially porrect, often later bent downwards distally, probably after anthesis, always longer than upper lip, externally covered by sparse to dense, moderately long to long eglandular hairs, occasionally mixed with moderately dense to dense, short to moderately long glandular hairs, internally at base bordered by eglandular hairs of tube, otherwise glabrous, with margins glabrous or with one or two eglandular hairs towards base of clefts, with lower lobes usually emarginate or deeply so, rarely truncate, with clefts between (2.5)4.1(5.5)mm deep.

Filaments of stamens usually glabrous, rarely with dense eglandular hairs covering lower third of anterior filaments, anterior pair (4.0)6.0(8.6)mm long, posterior pair (2.0)3.1(5.2)mm long; anthers (1.2)1.7(2.1)mm long, (0.9)1.1(1.5)mm broad, with connectives of anterior pair surrounded by usually very few to moderately dense, long to very long, rarely dense or short downturned eglandular hairs, less hairy than or equally as hairy as those of posterior pair, which bear sparse to dense, long to very long eglandular hairs, with posterior pair of awns (0.2)0.3(0.4)mm long, longer than the anterior three pairs.

Ovary laterally compressed, in lateral view usually oblong-obovate to oblong-ovate, sometimes ovate or elliptic, with upper $\frac{1}{2}$-$\frac{2}{3}$ covered by dense upright setae, very long about apex, long lower down; apex usually obtuse or ± truncate, rarely broad acute; ovules (20)30-110.

Capsules slightly compressed laterally, in lateral view oblong-ovate to oblong-elliptic, (5.2)5.5-8.5(9.5)mm long, (3.0) 3.9(4.3)mm broad, with upper $\frac{1}{2}$-$\frac{2}{3}$ covered by dense, long upright setae, very long about apex; apex obtuse to truncate or even slightly emarginate; seeds 9-80, usually ± ellipsoid, sometimes angular-ellipsoid, (0.9)1.2-1.5(2.0)mm long, (0.5)0.6-0.9(1.0)mm broad.

Chromosome number: n=27,28,27II + 2I, 25II + 2III (Barker 1649)

Plates: 3, 6, 21

Figures: 14

TYPIFICATION:

Holotype (pl. 21): R.D.Hoogland 8481, 28.ii.1962. Australian Capital Territory. Snowy Flats (near Mt. Gingera); Cotter River District. On edges of swampy flat, partly under low Eucalyptus forest; alt.c. 5200 feet. Flowers purple. MEL41671 (p.p.).

Isotypes: MEL41671 (p.p.),CANB,AD,NSW,NE,L,BISH,G,A,B; and (n.v.) BM,K,BRI,BH,E,Z,UC,NY.

The type sheet consists of four plants and displays buds, mature flowers and mature fruits. Three specimens, less branched than normal for the species, were labelled as isotypes by Willis on 11.i.1966. The other specimen is more typical of the species and was designated as the holotype. One of the isotypes is also unusual in that the stem was apparently cut off near its base and the pair of branches in the axils of the uppermost of the remaining leaves developed equally in its place.

It is customary to designate as holotype an entire herbarium sheet of plants from a single collection. However, in this case the segregation of the specimens on the type sheet into a holotype and isotypes must be followed since Willis (1967) in the protologue of his ssp. caudata indicated that MEL possessed both holotype and isotype material. Unless another sheet of the type collection is found in MEL, it is clear that Willis desired his annotations on the type sheet to be followed.

The species still occurs at the type locality in the Brindabella Range near Canberra (pers. observ., 18.i.1972).

DISTRIBUTION (Fig. 14):

E. caudata is confined almost entirely to the Brindabella Range of New South Wales and the Australian Capital Territory and the Snowy Mountains of New South Wales and Victoria. The species has not been recorded from the Victorian alps west of Omeo except for an isolated collection from Mt. Wellington (see Note 2). The only other record outside of the above range of distribution is the collection made by Betche (NSW10868) from "Brown Mountains near Littleton", about 100km east of Mt. Kosciusko (see Note 3).

The species has been recorded from localities between 3500 feet (1070m) and 6500 feet (1980m).

ECOLOGY:

E. caudata occurs in the subalpine and alpine zones, each region being characterised by a separate subspecies. There is one record possibly from montane forest. (For details see under each subspecies.)

NOTES:

1. E. caudata is closely related to E. ciliolata, E. arguta and E. scabra. Differences are outlined in the key to the species of Sect. Scabrae. In addition, the differences between E. caudata and E. scabra are listed in Table 9 in a discussion of specimens intermediate between the two species (see E. scabra Intraspecific Variation).

E. caudata approaches E. alsa and E. eichleri of Sect. Lasiantherae by its emarginate corolla lobes, glandular indumentum, densely setose capsules with broadly obtuse to truncate or emarginate apices, and its large seeds. E. alsa, which also approaches E. caudata in leaf shape (pl. 6) differs by its smaller habit, fewer stem nodes, shorter indumentum, smaller striated corollas lacking a groove on the lower side and with a downturned lower lip and by its smaller anthers. Hybrids between E. alsa and E. caudata (q.v.) are rare and show a high degree of pollen sterility. E. eichleri differs by its serrate to crenate-serrate leaves (pl. 6) its fewer stem nodes, its shorter striated corollas lacking a groove on the lower side, with a downturned lower lip and with longer lobes, and its shorter filaments.

2. A single plant was collected by Mueller (MEL41653) in 1861 from Mt. Wellington, Victoria, far to the west of the main area of distribution of E. caudata. It is distinctive for its glabrous-backed anthers and its leaf apices and teeth which are rather blunter than

normal. Otherwise, however, the plant clearly resembles E. caudata ssp. caudata by its tall habit, its moderately long glandular and sparingly scabrous indumentum, its pinnatifid leaves, its large flowers with cleft corolla lobes, its large, laterally truncate-obtuse capsules which are densely covered by long setae, and its large seeds. Although the corollas have dried yellow and details of their colour are lacking from the specimen, it seems that the original colour was the purple or white of E. caudata. This is suggested not only by the brownish colour of the anthers, but also by the fact that Mueller (1865) placed the specimen (of his own collecting) under E. brownii, which he distinguished from E. scabra by its non-yellow corollas. Further collections are required to determine whether the plant represents a distinct subspecies of E. caudata

3. The collection from the "Brown Mountains near Littleton" (Betche NSW10868) is the sole record of E. caudata from the ranges east of the Snowy Mountains. The plants in this collection do not differ from normal specimens of E. caudata ssp. caudata from the Snowy Mountains and Brindabella Range. Except for the Tinderry Range about 100km to the north of Brown Mountain, none of the eastern mountains supports a subalpine zone (Costin 1954: vegetation map and text). Mr. L. Adams (pers. comm. 1972) has suggested that E. caudata may occur in subalpine bogs near the summits of the Tinderry Range. However, it is unclear as to where the species may occur further south in the much lower Brown Mountain area. Fens of the "Carex gaudichaudiana alliance" which occur throughout this region as well as in the subalpine and alpine zones of the Kosciusko region (Costin l.c.) may provide a suitable habitat. The fens of the eastern mountains contain supposed relicts of "Hierochloe redolens and Oreomyrrhis andicola, two predominantly

alpine and subalpine species of the Western Monaro" (Snowy Mountains region) (Costin l.c. p.236). Populations of <u>E. caudata</u> in the Brown Mountain region could similarly be considered as relicts of a past wider distribution of the species.

INTRASPECIFIC VARIATION:

Within <u>E. caudata</u> there is good evidence for the existence of a cline along an altitudinal gradient in the alpine and subalpine tracts of the Mt. Kosciusko area. Morphological differences are sufficiently clear cut and intermediates of such rarity that the formal distinction of the populations at either end of the cline as subspecies appears justified. Ssp <u>nana</u> is apparently confined to the higher parts of the Kosciusko massif above Charlotte's Pass, where the vegetation is predominantly alpine, while ssp. <u>caudata</u> is found below Charlotte's Pass in the subalpine zone in which it occurs throughout much of the Australian Alps. This latter subspecies has been recorded only once in alpine vegetation; Burbidge (3922) collected it from alpine heath at Guthega Dam, which is also in the Kosciusko region. This locality, however, is well below Charlotte's Pass at an altitude of about 5200 feet.

The collection, Stead 7, comprises plants which are intermediate between the two subspecies. It was possibly made near the point where Spencer's Creek crosses the Kosciusko summit road, which is well below the tree-line and at only a slightly lower altitude than Charlotte's Pass. The locality is somewhat intermediate between the habitats typical of both subspecies as, while it is surrounded by tree-covered slopes, there are also areas of tall alpine herbfield and low alpine heath. Like plants of both subspecies, plants of this intermediate population tested for possible evidence of hybridism bore a high percentage of apparently normal pollen (Appendix 1).

A comparison of the morphological variation in the two subspecies and the intermediate population as well as the possible differences in habitat are summarised in Table 8.

The differences between the two subspecies are all quantitative. However, the organs do not show correlated changes in all characters measured in them. Thus, although ssp. nana has leaves with on the average shorter teeth and apices than those of ssp. caudata, the leaf length and the number of leaf teeth are much the same. Similarly, the two subspecies are characterised by anthers of like size and show only slight differences in calyx size, even though their flowers show greater divergence in corolla size and the number of ovules.

In the absence of a combined ecological and genetical study of the two subspecies, it is impossible to determine whether their morphological differences reflect true genetical differences or alternatively, the different influences of their respective habitats upon very similar genotypes.

KEY TO THE INFRASPECIFIC TAXA OF E. CAUDATA:

A. Stem to the base of its inflorescence (7.3)11.0-24.0(30.0)cm high, bearing (8)10-14(17) pairs of leaves. Apices of uppermost leaves (2.0)5.3-10.0(14.8)mm long. Ovules (30)62(110).

a. ssp. caudata

A. Stem to the base of its inflorescence (3.5)6.7(11.0)cm high, bearing (5)6-8(9) pairs of leaves. Apices of uppermost leaves (3.2)4.0(5.2)mm long. Ovules (20)37(45).

b. ssp. nana

TABLE 8: A SUMMARY OF MORPHOLOGICAL VARIATION WITHIN *Euphrasia caudata* IN VARIOUS HABITATS IN THE KOSCIUSKO REGION OF THE AUSTRALIAN ALPS.

	ssp. nana
Known localities in Kosciusko area	Mt. Kosciusko 6500' Charlottes Pass The Chalet (at Charlottes Pass)
Estimated altitudinal range	1800-2000m
Probable general habitat	alpine vegetation
MORPHOLOGY	
HABIT	
Sample size	12
Plant height	(7.5)12.0(14.5)cm
Stem height to base of inflores-cence	(3.5)6.7(11.0)cm
No. of stem nodes	(5)6-8(9)
No. of nodes immed. below inforescence lacking branches	0-1(3)
No. of nodes on upper most branches	1-2(4)
UPPERMOST STEM LEAVES	
Sample size	6
Leaf length	(12.0)16.7(20.5)mm
Leaf breadth	(2.2)4.4(6.0)mm
Apex length	(3.2)4.0(5.2)mm
No. of teeth along each margin	2-3(4)
Length of longest tooth	(0.6)1.3(1.7)mm
STEM INFLORESCENCE	
Data correspond to lowest flowers; sample size follows measurements	
No. of flowers	(10)18(26) :10
Calyx length	(4.5)6.0(8.0)mm :19
Corolla length along upper side	(9.0)11.8(15.7)mm :16
Anther length	(1.4)1.6(2.0)mm :7fls.
Posterior awn length	(0.2)0.3(0.4)mm :7fls.
No. of ovules	(20)37(45) :7
Capsule length	(5.5)6.1(8.3)mm :c.20
No. of seeds	9-30 :6
Seed length	(0.9(1.2-1.5(1.9)mm :c.30

ssp. *nana* – *caudata*	ssp. *caudata*
Spencers Creek	Dead Horse Gap Thredbo River Gorge, Guthega Guthega Dam, Waste Point
1770m	1000-1600m (-1800m in Brindabella Ra.)
area supports alpine and subalpine vegetation	subalpine (?rarely alpine) vegetation
15	50
(13.5)18.6(26.0)cm	(10)15-34(40)cm
(10.0)13.5(17.5)cm 8-10(12)	(7.3)11.0-24.0(30.0)cm (8)10-14(17)
(1)2-3(4)	(1)2-4
c.2-3	(3)5(7)
7	66
(7.5)13.6(17.5)mm (2.2)3.3(5.1)mm (2.8)4.9(7.5)mm 2-3(5) (0.5)1.2(2.0)mm	(6)12-24(36)mm (1.7)3.5-7.0(9.5)mm (2.0)5.3-10.0(14.8)mm 2-3(4) (0.5)1.2-3.0(5.0)mm
(12)20(32) :11 (5.3)7.1(8.0)mm :11 Longer than 9-10mm(=length upper corollas) :7	(12)24(32) :50 (3.8)5.5-8.0(9.5)mm :59 (9.5)12.5-16.0(19.0)mm :56
(1.3)1.6(2.0)mm :7fls. (0.2)0.3(0.4)mm :6fls.	(1.2)1.7(2.1)mm :10fls. (0.2)0.3(0.4)mm :10fls. (30)62(110) :10
6.5-9.0mm :3 29,40 :2 (0.9)1.2-1.6(1.7)mm :c.20	(5.2)7.7(9.5)mm :c.25 (10)30-80 :8 (1.0)1.3-1.5(2.0)mm :c.50

a. ssp. caudata

E. scabra R.Br. ssp. caudata Willis, Muelleria 1(1967) 149, p.p. (excl. Howitt 12, Willis MEL41654) BASIONYM; other references as listed under E. caudata.

E. brownii FvM. (nom. illeg.) var. psilantherea FvM., Fragm. Phyt. Austral. 5(1865)89, p.p. (as to syntype, Mueller MEL41653, but not lectotype).

DESCRIPTION:

Plant (10)15-34(40)cm tall.

Stem to base of inflorescence (y.3)11.0-24.0(30.0)cm tall, bearing (8)10-14(17) pairs of leaves, except in simple-stemmed depauperate plants with axillary branches forming in the region from (1)2-6(10) nodes above cotyledons to (2)3-5 nodes below inflorescence; uppermost branches bearing (3)5(7) leaf pairs.

Uppermost stem leaves usually pinnatifid, rarely serrate-crenate, (6)12-24(36)mm long, (1.7)3.5-7.0(9.5)mm broad; apex (2.0)5.3-10.0(14.8)mm long; teeth 2-3(4) along each margin, the longest (0.5)1.2-3.0(5.0)mm long.

Stem inflorescence producing (12)24(32) flowers, that of depauperate plants producing ca. 4-8; pedicels 0.5-0.9(1.5)mm long, with those at lowermost 1-3 nodes longer, up to 4.0mm long; apical bud cluster rounded-conical, extended ca. 0.8-2.0mm above initial flower pair, becoming hidden after 3-12 or more pairs of flowers have opened.

Flowers with calyx (3.8)5.5-8.0(9.5)mm long; corolla (9.5)12.5-16.0(19.0)mm long along upper side; stamens with anthers (1.2)1.7(2.1)mm long, with posterior pair of awns (0.2)0.3(0.4)mm long; ovules (30)62(110).

Capsules (5.2)7.7(9.5)mm long; seeds (10)30-80, (1.0)1.3-1.5(2.0)mm long.

Plates: 3, 6, 21

Figures: 14

DISTRIBUTION (Fig. 14):

The geographical range of ssp. caudata is the same as that of the species.

It has been recorded from altitudes of between 3500 and 5900 feet (1070-1800m).

ECOLOGY:

The vast majority of collections of ssp. caudata come from the subalpine zone. Over half of the 37 collections bearing ecological annotations mention an association of the subspecies with sphagnum swamps, streams or damp situations. Many of these and others refer to its occurrence in grassy areas which are often open, sometimes under snowgum (Eucalyptus pauciflora) or within areas of shrubs.

Unusual localities are "Steep mountain side in fairly tall scrub in Eucalypt forest" (Ford NSW47104) and "alpine heath on roadside bank" (Burbidge 3922). The term "alpine" in the latter instance may have been correctly used, although there is some doubt about this as the site of the collection seems rather lower than normal for alpine vegetation in the Koscuisko region. Four other references to alpine situations clearly apply to subalpine communities. Two of these apply to the Brindabella Range from which Lang (1970) asserts that alpine vegetation is absent.

Flowering begins usually in January, rarely in early December. Stems finish flowering in the period from February to March, but primary and secondary branches may continue to flower well into April or May.

NOTES:

Depauperate plants such as those in Willis MEL41656 contribute entirely to the lowest values of the number of stem leaf pairs in ssp. caudata. These plants, which are very slender and bear a few small flowers, show no tendency to branch. Plants of ssp. nana, which have a similar number of stem nodes can be readily distinguished by their many branches.

SPECIMENS EXAMINED:

Australian Capital Territory

Adams 510, 6.i.1963. C. 1.5 miles S. of Mt. Franklin, Cotter River District. CANB,NSW,A,MEL,B,L,BISH. -- Adams 2564, 13.iii.1971. Snowy Flat, Mt. Gingera, Brindabella Range. CANB. -- Barker 1633, 18.i.1972. Brindabella Range. Ca. ½km E of Mt. Gingera. AB. -- Barker 1641, 18.i.1972. Brindabella Range. Beside road immediately E of the summit of Mt. Gingera. AD. -- Barker 1649, 19.i.1972. Smokers Flat, ca. 3km S of Smokers Gap, which is 7km ENE of the Corrin Dam on the road from Tharwa. AD. -- Brooker 997, 26.iv.1965. Sphagnum swamp near Mt. Gingera. GAUBA. -- Burbidge 1746, 8.iii.1947. Col Swamp - between Mt. Gingera and Mt. Ginini. CANB. -- Burbidge 4469, 17.i.1958. Mt. Ginini. CANB. -- Burbidge 5633, 21.iii.1958. Mt. Gingera. CANB. -- Burbidge 6943, 15.ii.1961. Murray's Gap. CANB,NSW57426. -- Burbidge 7629, 16.v.1966. Kangaroo Flats, near upper source of a tributary of Kangaroo Creek. CANB. -- Campbell 28, 22.iii.1959. Mt. Gingera. CANB. -- Constable s.n., 29.iv.1958. Mt. Gingera, Brindabella Ranges. NSW126392,AD97123084. -- Darbyshire 104, 10.i.1961. Ca. ¾-way up Mt. Gingera, on N.E. side. CANB. -- Gauba s.n., 14.ii.1950. Mt. Gingera. GAUBA7860, GAUBA 7861. -- Gauba s.n., 14.ii.1950. Mt. Gingera, Snowy Flat. GAUBA7862. -- Hoogland 3158, 5.iii.1953. Cotter River District, E. slope of Mt. Gingera near the summit. CANB. -- Hoogland 8481, 28.ii.1962. Snowy Flats (near Mt. Gingera); Cotter River District. MEL (holotype); CANB,AD,NSW57603,NE,L,BISH,B,A,G; (n.v.) BRI,BM,K,BH,E,Z,UC,NY. -- Ingmersen s.n., 27.i.1966. Lower slopes, Mt. Gingera. CBG016745. -- Moore 2284, 4.ii.1953. Mt. Gingera. CANB,NSW23421. -- Moore 2301, 9.ii.1953. Mt. Gingera. CANB,NSW23422. -- Moore 3351, 3.ii.1961. Mt. Gingera. CANB. -- Ollerenshaw 228 & McMillan, 27.iii.1973. 1 ml. S. of Mt. Franklin. CBG,AD. -- Ollerenshaw 238 & McMillan, 27.iii.1973. Alpine Botanic Hut near Snowy Flats. CBG,AD. -- Phillips s.n., 20.ii.1963. Mt. Gingera, A.C.T. Botanic Garden site. CBG007717. -- Phillips s.n., 4.iii.1965. Mt. Gingera, A.C.T. Botanic Garden site.

CBG012789, NSW126393. -- Schodde 1290, 8.ii.1961. Cotter River district, Ginini Flats, c. 1m. NE of Mt. Ginini, Brindabella Range. CANB,MEL,AD,BISH,G,L,K(n.v.). -- Williams 1410, 1.iv.1953. Mt. Gingera. CANB. -- Willis s.n., 14.i.1970. Leura Gap, on S.W. border of Australian Capital Territory between Mts. Gingera & Bimberi. MEL41652.

New South Wales

Althofer s.n., -.ii.1954. Tumut Ponds. NSW26689. -- Ashby 3145 per Stead, 8.ii.1970. Mt. Kosciusko National Park. White River hut. AD. -- Ashby 3166, 9.iii.1970. Ibis Hut. AD. -- Baeuerlen s.n., -.ii.1890. Snowy Mtns. NSW10867. -- Barlow & James 1820, -.ii.1954. [Snowy Mountains]. COOMA. -- Betche s.n., -.ii.1893. Brown Mountains near Littleton. NSW10868. -- Betche s.n., -.ii.1897. Kiandra distr. NSW10869,AD97013007. -- Burbidge 3922, 24.ii.1955. Guthega Dam. CANB. -- Burbidge 6377, 24.ii.1959. Murray's Gap (E. side). CANB. -- Carroll 433, 19.i.1966. O'Keefe's Hut, Grey Mare track. Kosciusko National Park. CBG. -- Eichler 17825, 25.i.1964. Snowy Mountains. Near the Crackenback River at Thredbo Village. AD. -- Filmer s.n., 1.iii.1957. Upper Tumut R. Gorge, near Junction Shaft. NSW126390. -- Johnson & Constable s.n., 19.i.1951. Thredbo River Gorge. Kosciusko. NSW15765. -- [P.S.L.] s.n., 18.xii.1960. Waste Point. COOMA. -- McLuckie s.n., -.ii.1928. Mt. Kosciusko. SYD. -- McLuckie s.n., -.ii.1932. Mt. Kosciusko. SYD. -- McVean s.n., -.i.1967. Guthega; Kosc. Region. CANB176396. -- MUE 598, 16.iv.1953. Tumut River Alluvium at Leach Creek junction. COOMA. -- F. Mueller s.n., -.i.1874. Munyang Mountains. MEL41659. -- M. Mueller s.n., -.ii.1954. Headwaters of Doubtful River. NSW 126391. -- Muir 3261, 13.ii.1964. Alpine Way near Crackenback River, 5 miles south of Mt. Kosciusko. MEL. -- Rodd 458, 26.iii.1967. Murray's Gap (western border of A.C.T.). NSW84959. -- Rupp s.n., -.xii.1912. Mt. Kosciukso. NSW10870. -- Salasoo 3568, 23.i.1969. On slopes, Dead Horse Gap, SW of Jindabyne. NSW103010. -- Stead 4, 12.i.1966. Dickey Cooper Bogong, Kosciusko area. MEL. -- Willis s.n., 3.ii.1946. Pilot tin mine huts at head of Ingeegoodbee River ± $4\frac{1}{2}$ miles N.E. of Mt. Pilot. MEL41674,AD96638068.

Victoria

Beauglehole 36702, 9.ii.1971. V52-5. East Gippsland. The Playground below Cobberas No. 1. BEAUGLEHOLE. -- Beauglehole 36809, 18.ii.1971. V51-1B. East Gippsland. Bentleys Plains Road. S. of Benambra-Wulgulmerang Road. BEAUGLEHOLE,AD. -- Beauglehole 35258 &

Finck, 19.i.1971. W7-2. East Gippsland. Forlorn Hope Plain. BEAUGLEHOLE,AD. -- Beauglehole 41490 & Rogers, 14.ii.1973. W7 East Gippsland. Nunniong Plateau. Forlorn Hope Plain. BEAUGLEHOLE,AD. -- Beauglehole 41555 & Rogers, 23.ii.1973. V33 N.E. Vic. Between Grid V42 & base of Mt. Gibbo. N. of Beumba Hut & Gap. BEAUGLEHOLE,AD. -- Beauglehole 41567 & Rogers, 24.ii 1973. V33 N.E. Vic. Mt. Anderson, 1m. E. of Mt. Gibbo. BEAUGLEHOLE,AD. -- Beauglehole 41578 & Rogers, 24.ii.1973. V34 N.E. Vic. Mt. Pinnibar. BEAUGLEHOLE,AD. -- Ford s.n., 10.i.1959. Below Sassafras Gap (ca. 15m. S. of Nariel). NSW47104. -- F. Mueller s.n., -.i.1854/ -.ii.1854. Mount Cobberas plains. MEL41658. -- F. Mueller s.n., -.iii.1861. Mount Wellington, Gippsland. MEL41653 (syntype of E. brownii var. psilantherea). -- Stirling 293, 20.i.1883. From flats near Cobberas Mountains - Native Dog Ck. MEL. -- Willis s.n., 8.ii.1946. Between Mack's Creek and the head of Buckwong River, - Davey's Plain region, Upper Murray. MEL41655. -- Willis s.n., 10.ii. 1946. Cobboras Mts., at source of Bullcock [?Bully] Creek. MEL41656.

Locality doubtful

Anon. s.n., s.dat. Mt. Alexander. (Western Highlands, Victoria). MEL41607 (p.p.).

Locality uncertain

Baeuerlen 532, -.iv.1887. Browns Camp. MEL41753. -- F. Mueller s.n., s.dat. Lower part of Australian Alps. MEL41682.

b. ssp. nana Barker, subspecies nova

DIAGNOSIS:

Subspecies nova prope ssp. caudata sed differt altitudine (7.5)12.0(14.5)cm; caule usque ad basim inflorescentiae (3.5)6.7 (11.0)cm longo, (5)6-8(9) paria foliorum ferenti, ramis axillaribus in regionem a 1-2(5) nodis supra cotyledones ad 1-2(4) nodos infra inflorescentias evolutis, ramis summis 1-2(4) paria foliorum ferentibus; foliis caulinis summis pinnatifidis-serratis, (12.0)16.7(20.5)mm longis, (2.2)4.4(6.0)mm latis, apice (3.2)4.0(5.2)mm longo, dentibus 2-3(4) secus quemque marginem, dente longissimo (0.6)1.3(1.7)mm longo; inflorescentia caulina (10)18(26) flores procreanti, pedicellis 0.2-0.5(0.7)mm longis, in floribus infimis longioribus, fasce apicali gemmarum rotundato-conico, supra flores primos primo exserto, post anthesin 4-8 parium florum super corollas paris summi florum vix emergenti; floribus calyce (4.5)6.0(8.0)mm longo, corolla (9.0)11.8(15.7)mm longa secus superficiem, staminibus antheris (1.4)1.6(2.0)mm longis, aristis posticus (0.2)0.3(0.4)mm longis, ovulis (20)37(45); capsula (5.5)6.1(8.3)mm longa, seminibus ca. 9-30, (0.9)1.2-1.5(1.9)mm longis.

Holotypus: Mrs. Thistle Y. Stead 8, 14.ii.1966. Charlotte Pass, Kosciusko Plateau, N.S.W. MEL41650. (Tab. 21).

DESCRIPTION:

Plant (7.5)12.0(14.5)cm tall.

Stem to base of inflorescence (3.5)6.7(11.0)cm high, bearing (5)6-8(9) pairs of leaves, with axillary branches forming in region from 1-2(5) nodes above cotyledons to 1-2(4) nodes below inflorescence; uppermost branches bearing 1-2(4) leaf pairs.

Uppermost stem leaves pinnatifid-serrate, (12.0)16.7(20.5)mm long, (2.2)4.4(6.0)mm broad; apex (3.2)4.0(5.2)mm long; teeth 2-3 (4) along each margin, the longest (0.6)1.3(1.7)mm long.

Stem inflorescence producing (10)18(26) flowers; pedicels 0.2-0.5(0.7)mm long, longer in lowermost flowers; apical bud cluster **rounded-conical, initially extended above first flowers, hardly extended above corollas of uppermost pair of flowers after 4-8 or more pairs of flowers have opened.**

Flowers with calyx (4.5)6.0(8.0)mm long; corolla (9.0) 11.8(15.7)mm long along upper side; stamens with anthers (1.4)1.6 (2.0)mm long, with posterior pair of awns (0.2)0.3(0.4)mm long; ovules (20)37(45).

Capsules (5.5)6.1(8.3)mm long; seeds 9-30, (0.9)1.2-1.5(1.9)mm long.

Plates: 21

Figures: 14

TYPIFICATION:

Holotype: Mrs. Thistle Y. Stead 8, 14.ii.1966. Charlotte Pass, Kosciusko Plateau, N.S.W. MEL41650. (Pl.21).

The holotype was amongst a group of eight collections of Euphrasia, collected in early 1966 by Mrs. Stead from the Australian Alps and sent subsequently to Mr. J.H. Willis of MEL for identification. In the accompanying letter, dated 24.v.1966 and mounted with the MEL specimen, Stead 7, Mrs. Stead has written that she has retained duplicates of all the specimens sent to MEL except her number 6. Therefore it is possible that she may still possess isotype material.

Willis identified (1.vi.1966) the above holotype as his var. caudata of E. scabra R.Br. which then was still unpublished.

The holotype consists of three well-preserved plants bearing buds, flowers and mature fruits. Topotype material should still be available as the type locality is in the Kosciusko National Park.

DISTRIBUTION (Fig. 14):

This subspecies is known at present only from Charlotte's Pass in the southern alps of New South Wales, a few miles east of Mt. Kosciusko. The Chalet, which is cited as the locality of the collection, Skottsberg & Costin NSW10865, is situated immediately below the Pass.

The altitude of Charlotte's Pass is about 6000 feet (1830m). Costin made one collection (602) from "Kosciusko at 6500" feet (1980m).

ECOLOGY:

The only information as to the ecology is the following: "alpine tracts" (Costin 602) and "alpine and subalpine tracts" (Costin NSW10866). The latter annotation was added to Costin's collection of E. alsa (NSW10874) made similarly in March 1949; this may have been used to cover collections and observations made over a wide range of localities.

From the condition of the few specimens seen, flowering seems to occur between January and April, continuing even longer on the branches of some plants.

SPECIMENS EXAMINED:

New South Wales

Costin 602, -.iii.1949. Alpine tracts, Kosciusko. COOMA. -- Costin s.n., -.iii.1949. Mt. Kosciusko. NSW10866. -- Skottsberg & Costin s.n., 12.iii.1949. The Chalet, Mt. Kosciusko. NSW10865. -- Stead 8, 14.ii.1966. Charlotte Pass, Kosciusko Plateau. MEL (holotype). -- Stead 7, 11.ii.1966. Spencer's Creek, Kosciusko area. MEL.

SPECIMEN INTERMEDIATE BETWEEN SSP. CAUDATA AND SSP NANA

New South Wales

Stead 7, 11.ii.1966. Spencer's Creek, Kosciusko area. MEL41651.

11. Euphrasia scabra R.Br.,Prodr.(1810)437; [R.Br.,Manuscript, unpubl.]; Sprengel,Linn.Syst.Veg.(ed.16)2(1825)777; Bartling in Lehm.,Pl.Preiss.1(1845)343; Benth.in DC., Prodr.10(1846)554,?p.p.(possibly excl. E.arguta: see Note 2 under that species); Hook.f.,Fl.Tasm.1(1857)297; FvM., Fragm.Phyt.Austral.5(1865)89; Benth.,Fl.Austral.4(1868)521, p.p.(as to all spec. excl. Stuart MEL41430, MEL41594, MEL 41598, MEL41599, Beckler MEL41595); FvM.,Fragm.Phyt.Austral. 9(1875)168,p.p.(as to Browne 45); Spicer,Hdbk.Pl.Tasm.(1878) 127; FvM.,Syst.Cens.Austral.Pl.1(1882)98,p.p.(excl. Qld. and possibly some N.S.W. occurrences); Moore,Cens.Pl.N.S.W. (1884)50,p.p.(excl. E. arguta); FvM.,Key Syst.Vict.Pl.2(1885) 41,1(1887-1888)392; FvM.,Sec.Syst.Cens.Austral.Pl.1(1889)165, p.p.(excl. Qld. and possibly some N.S.W. occurrences); Tate, Hdbk.Fl.Extratrop.S.Austral.(1890)153,253; Woolls,Pl.Indig. Nat.Neighb.Syd.(1891)38; Moore & Betche,Hdbk.Fl.N.S.W.(1893) 342; Wettst.in Engl.& Prantl,Nat.Pflfam.IV3b(1893)101; Wettst., Monogr.Gatt.Euphrasia (1896)260,t.6f.440-446,t.13f.4; Rodway, Tasm.Fl.(1903)143; Dixon,Pl.N.S.W.(1906)226; Maiden & Betche, Cens.N.S.W.Pl.(1916)184; Black,Fl.S.Austral.(ed.1)(1926)513; Ewart,Fl.Vict.(1931)1024; Gardner,Enum.Pl.Austral.Occid.(1931) 118; Du Rietz,Sv.Bot.Tidskr.25(1932)534, 42(1948)359; Galbraith, Wildfl.Vict.(1955)136,(1967)123; Robertson in Black,Fl.S.Austral. (ed.2)(1957)772; Beard,Descr.Cat.W.Austral.Pl.(1965)96,?p.p. (probably as to yellow-flowered forms),(1970)118,?p.p.(as before); Curtis,Stud.Fl.Tasm.(1967)531; Willis,Muelleria 1(1967)148, p.p.(as to typical form, i.e., excl. var. caudata and var. alsa); Harris,Alp.Pl.Austral.(1970)138,p.p.(as to creamy yellow-flowered forms, excl. var. alsa and var. caudata); Willis,Hdbk. Pl.Vict.2(1973)573,p.p.(as to yellow-flowered plants, excl. var. alsa and var. caudata)

?E. scabra R.Br. var. caudata Willis, Muelleria 1(1967)149, p.p. (as to Willis MEL41654 - see Intraspecific Variation)

DESCRIPTION:

Erect annual herb, becoming brittle, (8.5)15.0-35.0(50.0)cm tall.

Stem to base of inflorescence (7.5)11.0-25.0(45.0)cm high, bearing (6)8-18(24) pairs of leaves, usually with axillary branches forming in region from (1)2-7(14) nodes above cotyledons to 1-2(3) nodes below inflorescence, sometimes simple (mainly if plant depauperate), with length of stem between inflorescence and uppermost branches (0.03)0.21(0.48) length of entire stem to base of inflorescence; branches flowering later than stem and developing basipetally, lower ones bearing up to 7(9) nodes, upper ones bearing 1-3(5) nodes, with leaf pairs finally subtending shoots; axes reddish-brown to yellow-brown, usually covered by short white eglandular hairs, dense in upper parts but sparser or absent lower down, sometimes with short glandular hairs in upper parts, sparse and absent down stem, sometimes with moderately dense, short to moderately long glandular hairs on lower parts.

Cotyledons oblong, glabrous, sometimes persisting.

Leaves: uppermost stem leaves in outline usually ovate-elliptic to elliptic, rarely linear-lanceolate, pinnatifid to serrate-crenate, (6.0)7.5-14.0(20.0)mm long, (1.0)2.5-6.5(9.5)mm broad, covered by dense, short to moderately long scabrous indumentum, sometimes mixed with sparse, short glandular hairs, with margins recurved; base usually rounded cuneate, rarely truncate; lobes (1)2-3(5) along each margin, usually bluntly obtuse or acute, rarely acuminate, with longest lobe (0.4)0.7-2.6(4.0)mm long; apex usually bluntly obtuse or acute, rarely sharply acute, (1.8)3.0-6.0(9.0)mm long; leaves in middle of stem only slightly longer, sometimes with 1 more tooth along each margin, lacking glandular hairs; lowermost ones much shorter, with scabrous indumentum rarely mixed with sparse, short to moderately long glandular hairs; leaves in similar positions on branches similar but somewhat smaller.

Inflorescences dense racemes, that of stem producing (10) 14-32(54) flowers; rachis covered usually by a dense mixture of short to moderately long glandular and eglandular hairs, sometimes by dense eglandular hairs; internodes elongating variably, such that apices of capsules well below to well above node above; pedicels 0-0.3 (0.6)mm long, reaching 1.2(1.6)mm on lowest flowers; apical bud cluster rounded, cylindrical to conical, that of stem 0.3-1.9mm long, remaining extended above uppermost corollas until 2-11 or more pairs of flowers have reached anthesis.

Bracts like uppermost leaves, but somewhat shorter and broader, bearing densely scabrous indumentum often mixed with dense, short to moderately long glandular hairs, denser on underside.

Calyx (4.3)5.5-7.0(9.0)mm long, externally covered by dense, short to moderately long glandular hairs, mixed with dense, short to moderately long scabrous eglandular hairs, sparser on tube, internally covered on teeth by moderately dense to dense, subsessile to short glandular hairs, often also by moderately dense to dense, upturned appressed short eglandular hairs, elsewhere glabrous; teeth sharply acute to acuminate; lateral clefts 1.7-3.9mm deep, shorter than median clefts which are 2.2-5.6mm deep.

Corolla (8.0)9.0-12.0(14.0)mm long along upper side, with lower side broadly grooved, yellow, sometimes with 3 red-brown striations present (at least in dried material) on hood and lower lip behind each lobe; tube (6.0)7.0(8.3)mm long, broadened laterally and somewhat medianally at or below bases of anterior filaments, which are (4.0)5.0(5.9)mm from base of corolla, with basal part glabrous on inside and outside, with distal parts covered externally by dense, moderately long eglandular hairs sometimes mixed behind lateral clefts with sparse to dense, short glandular hairs, internally by eglandular hairs, sometimes sparse to dense, short to moderately long and confined to region between filaments, sometimes moderately dense to dense, short to moderately long around and below bases of filaments and behind lower lip; hood (3.3)4.4(5.5)mm long, externally covered by moderately long eglandular hairs, dense towards rear, sparser at front, mixed with short glandular hairs, dense in front half or only above sinus, absent towards rear, internally with moderately long to long eglandular hairs densely covering entire surface or restricted to area about sinus, sometimes with a patch of subsessile glandular hairs also at sinus, with upper lobes obtuse or acute, with front surface ± glabrous or covered by dense short eglandular hairs, with rear surface moderately densely to densely covered by short to moderately long glandular hairs or by short to moderately long eglandular hairs or by both, in which case former tend toward base, latter toward tip, with margins glabrous or lined with sparse to moderately dense, short eglandular hairs, with cleft between 0.4-1.0mm deep; lower lip (3.4)6.9(8.3)mm long, (4.9)8.0 (15.0)mm broad, porrect, externally covered by sparse to dense moderately long to long eglandular hairs, usually mixed with dense moderately long glandular hairs, sometimes with glandular hairs restricted to parts of lip or absent, internally ± glabrous or with dense short to moderately long eglandular hairs all over or confined to area behind lobes, with margins glabrous or lined with sparse to dense, short eglandular hairs, with lower lobes usually obtuse to truncate, often shortly apiculate, sometimes shallowly emarginate, with clefts between 1.0-3.0mm deep.

Filaments of stamens glabrous, anterior pair (4.2)4.8 (6.2)mm long, posterior pair (1.8)2.5(3.0)mm long; anthers (1.1)1.2-1.5(1.6)mm long, (0.7)0.8-1.0(1.1)mm broad, with connectives of anterior pair, glabrous or with sparse to dense, short to long eglandular hairs, less hairy than or as hairy as those of posterior pair which are usually surrounded by sparse to dense, short to long flexuose eglandular hairs, sometimes glabrous, with awns of posterior pair (0.1)0.2(0.3)mm long, usually longer than those of other three pairs, rarely ± equal to them.

Ovary laterally compressed, in lateral view elliptic to oblong-elliptic or ovate-elliptic, covered in upper $\frac{3}{4}$ by dense upturned setae, moderately long to long at base, long to very long at apex; apex in lateral view acute, often obliquely so, to obliquely obtuse; ovules (57)90(140).

Capsules in lateral view oblong-elliptic to ovate-elliptic, usually ± declinate, (5.0)6.7(9.3)mm long, (2.0)2.4(3.0)mm broad, in upper $\frac{3}{4}$ covered by dense long upturned setae; apex usually acute to obtuse, often obliquely so, rarely truncate; seeds (29)60-90, ± ellipsoid to oblong-ellipsoid, often somewhat angular, (0.4)0.5-0.8(1.0)mm long, (0.2)0.3(0.6)mm broad.

Chromosome number: Unknown.

Figures: 6, 22

Plates: 15

TYPIFICATION:

Lectotypus (tab. 22): R.Brown s.n., 1.i.1804. In campis depressis graminosis prope Lagoon beach & alibi in Port Dalrymple. BM(p.p.). Isolectotypi: K,MEL41633. Syntypus alter (tab.) R.Brown s.n., 24/25.i.1804. Port Phillip. In campis graminos [Harbor ad radium] Arthur's Seat. BM(p.p.).

Both type collections belong to E. scabra. Only material in BM was considered for lectotypification. Both the syntypes, which are mounted together on the one sheet, are damaged to some extent, with leaves being partly or entirely broken off and some young lateral inflorescences lost. Both have mainly fruits but also some flowers. Either specimen was eligible for selection as lectotype because,

1) both were collected by Brown and bear labels annotated by him,
2) the distribution cited for E. scabra in the protologue (Brown 1810) covers both type localities, and
3) both collections are in reasonable condition, although the Port Phillip specimen contains more material (3 whole plants and 2 large fragments) than the Port Dalrymple collection (2 whole plants).

The Port Dalrymple specimen was selected as lectotype for the following reasons:

1) There is some doubt as to whether Brown had, at least initially, considered the two collections to be conspecific. The Port Dalrymple material was initially called "Euphrasia lutea" by Brown in both his manuscript (Brown, unpubl.) and on the specimen itself. On the other hand he annotated the Port Phillip specimen, "Euphrasia lutea? an sp. divers?".
2) The Port Dalrymple material is alone cited as the basis for his extensive description of the species in his manuscript. The Port Phillip locality is not mentioned.
3) The Port Dalrymple collection was renamed "Euphrasia scabra" on both the specimen and in the manuscript. The Port Phillip material bears no such annotation. (Nor do any of the isolectotypes.)

The lectotype locality "Lagoon beach" is near a fresh-water lagoon 4km south-east of Low Head on the shores of Port Dalrymple. Its exact position is marked on a detailed map of Port Dalrymple accompanying Flinders' narrative of his voyage (Flinders 1814: pl. 6 "Sheet V"). This area is apparently still covered mainly by natural vegetation (Davies ed. 1965: pl. 15). However it may be in danger of being cleared as the neighbouring area near Low Head is a popular seaside resort. The other syntype was collected from the Melbourne suburb of Rosebud on the south-east shore of Port Phillip Harbour. It is hardly likely that E. scabra has survived there.

DISTRIBUTION (Fig. 15):

E. scabra occurs throughout most of temperate, non-arid Australia and Tasmania, reaching as far north as Sydney on the east coast, and extending into the south-west of Western Australia.

It ranges in altitude from sea level up to 1100m in Tasmania and about 1500m on the Australian mainland. The specimens from upper elevations on the Australian mainland are somewhat doubtfully attributed to E. scabra as they tend towards E. caudata (see Intraspecific Variation).

Although described in the last century as flourishing throughout extratropical Australia but not as abundantly as the sympatric perennial species (Mueller 1865, p.89), nowadays E. scabra appears to have become very rare. The majority of herbarium specimens were collected during the previous century. During the past 70 years the greatest number of collections has come from the vicinity of Hobart from the Waterworks, Mt. Nelson and Ridgeway, the latest collections being those of Carolin (1770) in 1960 and Ratkowsky (AD97349029) in 1973. Elsewhere in Tasmania it was found by Rees (110) in 1939 at St. Marys. The only mainland records during that period have been those of Willis (MEL41654) from Buckety Plain in the Victorian Alps in 1946, and Ashby (4354, 4928) near Lake Muir and at Yorn Creek in south-west Western Australia in 1971 and 1973. The huge contrast in numbers of collections from each century indicates that the species is threatened with extinction.

ECOLOGY:

E. scabra appears to occupy a wide range of habitats according to the occasional ecological annotations on specimens. There are relatively fewer references to bog, swamp or moist habitats than for the closely related E. caudata, E. ciliolata and probably E. orthocheila. However Miss A.M. Ashby (pers. comm. 13.xi.1973) made her recent collection 4928 from such a locality. The plants (with corollas a "cadmium lemon" colour) from Yorn Creek, Western Australia grew in open areas between dense heath in black soil on low-lying land inundated when particularly wet, but dry in summer. The plants from near Lake Muir, Western Australia (Ashby 4354) were found in a similar locality, the surrounding heath being much sparser. Other annotations referring to such habitats are "Moorboden" [= boggy soil: Behr MEL41580], "Edges of sphagnum bog" (Willis MEL41654), "In swamps..." (Maxwell MEL41629) and "Moist Flats" (Anon. MEL41576). In addition, the collection, Preiss 2337, was made "In solo sublimoso" (= in rather muddy soil: Bartling 1845, p.343). That the species commonly occurs in open grassy situations is supported by the following: "In campis depressis graminosis" (Brown, BM lectotype) and a similar reference on the other syntype, "on meadows" (Mueller MEL41680), "In grassland amongst Themeda australis" (Carolin 1770), "cleared land" (Comber 2045) and "In high elevated pastures" (Anon. 42). Its occurrence in taller vegetation is also recorded by the annotations, "Patch of heath ground" (Sullivan 4), "Dry heath.... sea level" (Hamilton 24), "Bush" (Oakden 83) and "Dry forest land" (Mueller MEL41759). It has also been found among sand dunes ("inter syrtes") along the south-east coast of South Australia by Mueller (MEL41575) and by Maxwell on the coast of Western Australia in "Sand hills" (MEL41626) and in "sandy flatts [sic] Salt Lagoons" (MEL41631). Rodway (1903) and Curtis (1967a) have described it as occurring "on dry hills" in Tasmania.

Flowering times seem to vary considerably throughout the range of the species. Plants begin flowering between early October and February. The main stem inflorescences cease bearing flowers by November to March, but those of the branches continue to produce them until early January to April or even longer. From the few records available, in the Australian Alps the flowering times are towards the latter part of the stated ranges of time. This is in keeping with the lateness of seasons in the high mountain regions.

NOTES:

1. E. scabra is closely related to all the species of Sect. Scabrae. Differences are shown in the key to the species. Characters distinguishing between E. caudata and E. scabra break down to some extent in the Australian Alps (see Intraspecific Variation).

2. On herbarium specimens the name "Euphrasia scabra R.Br. tenuis Ferd. Mueller" has been attributed to three unusually tall and slender plants of E. scabra from Tasmania. Apparently the name has never been used in publication. One of the plants was collected by Mueller (MEL41678 p.p.). The other two were collected by Stuart (MEL41654 p.p., MEL41570) and possibly come from the same population. Not only could the two localities cited, namely "Nr. Deloraine" and "Nr. Rio Mersey", cover a single locality, but Stuart also ascribed the same number, 426, to both collections.

There is little purpose giving these plants taxonomic status as they appear to be extremes of the range of variation in stem length in E. scabra, perhaps produced by a shaded position or by growth between tall grasses. One of the Stuart collections (MEL 41570) contains a specimen of normal habit as well as the slender plant. In addition, Mueller (MEL41573) collected a similarly slender plant from Bugle-range in South Australia.

3. Two old specimens with very inadequate locality annotations clearly belong to E. scabra but show some differences from typical forms of the species. The specimens are Anon., "N.Holl., E. arguta R.Br." from GH, and Anderson "Nouvelle-Hollande" from G annotated as E. scabra by Wettstein. Both are characterised by short but broad capsules, which are symmetrically ovate in lateral view. This shape is not found elsewhere in E. scabra. The G collection also tends slightly away from E. scabra by its shallowly emarginate lower corolla lobes, an attribute only occasionally found in the species. While there is little doubt that the G specimen had the yellow corollas (with reddish striations apparent) of E. scabra, the GH specimen has dried a colour atypical of herbarium material of the species. Although it has yellow anthers and this attribute is often found in plants with yellow corollas, the association is too loose in E. scabra to enable the corolla colour to be determined with any certainty. If it was originally a non-yellow colour, its affinities are uncertain and perhaps lie most with "E. arguta Wettst." (see notes under E. arguta). There is no evidence of hybridism being involved as a high percentage of pollen sampled appears normal (Appendix 1: PS132-134).

INTRASPECIFIC VARIATION:

In the Australian Alps between the Mt. Kosciusko region and the Bogong High Plains there is a breakdown of the many morphological differences between E. scabra and E. caudata. These differences are listed in Table 9.

The specimens intermediate between E. scabra and E. caudata all possess the yellow corollas of the former species, although this is difficult to determine in the dried state. Only in one of the collections (Willis MEL 41654) is this feature noted. Of the nine collections involved, seven are only slightly divergent from E. scabra

TABLE 9: A COMPARISON OF THE CHARACTERS DISTINGUISHING

E. caudata and E. scabra.

E. caudata	E. scabra
Corollas usually purplish to blue, rarely white	Corollas yellow
Lower corolla lobes usually emarginate, often deeply so, rarely truncate	Lower corolla lobes usually obtuse, often shortly apiculate, occasionally shallowly emarginate
Anthers (1.2)1.4-1.8(2.1)mm long, (0.9)1.0-1.3(1.5)mm broad	Anthers (1.1)1.2-1.5(1.6)mm long, (0.7)0.8-1.0(1.1)mm broad
Capsules densely setose in upper $\frac{1}{2}$-$\frac{2}{3}$, in lateral view porrect, with apex usually emarginate to broadly obtuse, rarely broadly acute	Capsules densely setose in upper $\frac{3}{4}$ or more, in lateral view down-curved or somewhat so, with apex asymmetrically narrow acute to obtuse, rarely broadly obtuse or $\pm$ symmetrical
Seeds (0.9)1.2-1.5(2.0)mm long	Seeds (0.4)0.5-0.8(1.0)mm long
Upper (1)2-4 stem nodes lacking braches and occupying more than half of stem	Upper 0-1(2) stem nodes lacking branches and occupying upper (0.03)0.21(0.48) of stem
Glandular indumentum all over vegetative parts, rachis, bracts and calyces, but sometimes sparse in middle section of stem or branches	Glandular indumentum usually confined to rachis, bracts and calyces, sometimes at base of plant or on axis for some distance below inflorescence, rarely on upper leaves
Glandular indumentum on above parts moderately long to very long, rarely short, e.g. on calyx (0.1)0.2-0.4(0.6)mm	Glandular indumentum on above parts usually short to moderately long, rarely long, e.g. on calyx (0.05)0.1-0.2(0.3)mm

while two are more or less intermediate between the two species.

The seven specimens only slightly atypical of E. scabra vary in the characters which are anomalous. The anomalies rarely occur elsewhere in lowland Australia, but their incidence is much more frequent in the region of the Australian Alps. The collections of Martin (MEL41660, MEL41614) and Findlay (MEL41661) differ from E. scabra only by their emarginate lower corolla lobes. Those in MEL41660 are very deeply incised. On the other hand, the collections, Baeuerlen NSW10885 and Howitt MEL41681, show a rather extensive cover of glandular hairs over the herbaceous parts, which is rarely found elsewhere in E. scabra. In addition they diverge slightly in the approximately symmetrical lateral view of the capsules, the rather large seeds (0.9-1.1mm long) and the rather large anthers (1.4-1.9mm long). Finally, there are two poor specimens which show characters somewhat atypical of E. scabra. Lower corolla lobes in Baeuerlen 57 are emarginate. Merrah MEL41352, which bears many capsules and no flowers, has a glandular indumentum extending farther down the stem than usual in E. scabra and capsules with broadly obtuse apices. In all other respects, except where a character cannot be observed because of the inadequacy of material, the above specimens are characteristic of E. scabra.

Perhaps of greatest importance are the two collections, Willis MEL41654 and Howitt 116. These specimens tend in many respects towards E. caudata. Thus, their lower corolla lobes are emarginate, branching begins at the second to as low as the sixth node below the main stem inflorescence at a point rarely less than halfway down the stem, the glandular hairs cover all herbaceous parts, although very sparsely in the upper middle regions, and the ovaries appear symmetrical in lateral view. However, bending in the ovary is more obvious in the capsule stage. In addition anthers are rather large for E. scabra (1.3-1.7mm long). The specimens approach E. scabra by their yellow corollas and short to moderately long eglandular hairs. Unfortunately, capsules and seed are absent.

There appears to be a correlation between the ranges of distribution of the atypical specimens of differing degrees of divergence from E. scabra and the respective ecological ranges of distribution of E. scabra and E. caudata. E. caudata is confined to the subalpine and alpine zone. Typical forms of E. scabra occur below these zones in montane or lowland habitats. The highest record appears to be Yarrangobilly Caves (Betche NSW10884) which is below the subalpine zone. The seven specimens which are only slightly divergent from E. scabra all appear to occur well below the subalpine zone, although the "Upper Murray" locality (Findlay MEL41661) is perhaps doubtful. They therefore are probably ecologically sympatric with typical populations of E. scabra. On the other hand the two collections intermediate between E. scabra and E. caudata occur in localities which are possibly both from the subalpine zone in which E. caudata abounds. The locality, altitude (1520m) and habitat (sphagnum bog) of the collection, Willis MEL41654, from the Bogong High Plains clearly indicate that it came from this zone. It should be noted that there is no authentic record of E. caudata from this much-botanised extensive alpine region of Victoria. The location of the Howitt (116) collection, however, is uncertain. If the locality cited "Nunionyong", to which I can find no reference, is identical to Nunniong, then a subalpine occurrence is also quite likely. Hogg (1970) refers to "large areas of open snowplain" on the Nunniong Plateau which is located in the Snowy Mountains of Victoria to the south of Mt. Kosciusko. E. caudata occurs in this region.

It is possible therefore that the two species, E. scabra and E. caudata, actually represent the extremes of a cline along an altitudinal gradient. The very few intermediates may be relicts of the evolution of the two species from a common ancestor (see chapter on Evolution of Euphrasia in Australia). An alternative explanation based on hybridism seems unlikely as there is no evidence that the two species overlap in distribution, and there seems little variation within a collection of the intermediates. In addition, pollen sterility tests show only a very low percentage of sterile pollen in all but one (Martin MEL41614) of the nine intermediate plants sampled (Appendix 1: PS127-131, 136-139).

SPECIMENS EXAMINED:

New South Wales

Anon. 236, September. Prunella (possibly a locality but more likely referring to the genus of the same name). MEL. -- Baeuerlen s.n., -.ii.1890. Woollandilly, Jindabyne. NSW10885. -- Betche s.n., -.ii.1897. Yarrogobilly [=Yarrangobilly] Caves. NSW10884,AD97013003; pollen slide A.N.U.,AD. -- Blakely s.n., -.xii.1899. Jenolan Caves. NSW10881,SYD. -- Bull s.n., s.dat. Tumbarumba, Upper Murray R. MEL41586. -- Clark s.n., 1887. Sources of the Genoa. MEL41618. -- Gaudichaud 144, s.dat. Port Jackson. G(2 spec.). -- [Mueller] s.n., s.dat. Lake George. MEL41647 (p.p.).

South Australia

Anon. s.n., 24.x.1885. Steep Hill, Belair. AD(Herb. Tate). -- Anon. s.n., s.dat. Without locality. AD97012202(p.p.). -- Behr s.n., Jan. Tanunda. MEL41579. -- Behr s.n., Dec. Barossa. MEL41580. -- Browne 45, 1874. Port Lincoln. MEL. -- [Mueller] s.n., 20.xii.1848. In montis ad fl. Onkapar[inga]. MEL41577. -- Mueller s.n., 22.xii.1848. Ad Hake's-place. MEL41574. -- [Mueller] s.n., -.ii.1849. Inter [syrtes] sinus Guichen Bay & pramontorii Jaffe [Cape Jaffa]. MEL41575. -- [Mueller] s.n., s.dat. St. Vincents Gulf. MEL41635. -- Mueller s.n., Init.xii.1848. Bugle-range. MEL41573.

Tasmania (Van Diemens Land)

Anon. s.n., s.dat. Mt. Arthur. FI(p.p.). -- Anon. s.n., s.dat. Mt. Arthur. PH. -- Anon. s.n., s.dat. Locality unknown. G. -- Archer s.n., s.dat. Locality unknown. NSW10889. -- Brown s.n., 1.i.1804. Prope Lagoon beach & alibi in Port Dalrymple. BM(p.p.) lectotype; K,MEL41633. -- Carolin 1770, 6.ii.1960. Mt. Nelson, near Signal Lookout. SYD. -- Coates & Sullivan 110, 1886. Mt. Arthur.

MEL. -- Comber 2045, Feb. Mt. Nelson. HO. -- Gunn s.n., s.dat. Locality unknown. L(p.p.). -- Gunn s.n., s.dat. Locality unknown L. -- Gunn s.n., s.dat. Locality unknown. GH. -- Hamilton 24, 18.iv.1932. Port Sorell. HO. -- Hooker s.n., s.dat. Locality unknown. MEL41637. -- Lucas s.n., -.xi.1923. Waterworks Hobart. NSW10890. -- Milligan 508, 9.ii.1842. Valley west of Rocky Cap. FI(2 spec.),HO,MEL41571. -- Mueller s.n., s.dat. Locality unknown. MEL41678(p.p.). -- Mueller s.n., s.dat. Locality unknown. MEL41678. -- Oakden 83, 21.xi.1887. Bush near Launceston. MEL. -- Olsen s.n., 27.i.1937. Waterworks, Hobart. HO. -- Ratkowsky s.n., 29.xi.1973. Mt. Wellington, nr. Ridgeway. AD97349029. -- Rees s.n., -.x.1929. St. Marys. HO. -- F.A.Rodway 6680, -.i.1918. Mt. Nelson. NSW22274. -- F.A.Rodway 14398, 30.i.1947. Ridge west of Mt. Nelson. NSW22275. -- L.Rodway s.n., -.ix.1899. Nr. Mt. Nelson. HO. -- L.Rodway s.n., -.xii.1892. Near Waterworks, Hobart. WELT(s.n.: p.p.). -- Rupp s.n., -.xi.1920. Mt. Nelson. MELU(p.p.). -- Rupp s.n., -.xi.1921. Punchbowl, Launceston. MELU(p.p.). -- Rupp s.n., xi-xii. 1921. Punchbowl, Co. Dorset. NSW10888. -- Simson s.n., 22.xii.1879. Harefield, St. Mary's MEL41569. -- Simson s.n., 1878. St. Mary's. HO. -- Story s.n., s.dat. Without locality. MEL41572. -- [Stuart] 426, -.i.1849. Nr. Deloraine. MEL. -- [Stuart] 426, Jan 8th. Nr. Rio Mersey. MEL(p.p.). -- [Stuart] s.n., s.dat. Nr. George Town. MEL41645(p.p.).

Victoria

Anon. s.n., s.dat. Mt. Alexander. MEL41607. -- Anon. (Herb. Walter) s.n., s.dat. Grampians. AD97331120. -- Anon. s.n., s.dat. Bonang. Snowy River. MEL41576. -- Anon. s.n., s.dat. Priest-point. Glenelg. MEL41608. -- Allitt s.n., s.dat. Mouth of the Glenelg. MEL41610. -- Baeuerlen 57, -.iii.1885. Genoa District. MEL. -- Brown s.n., 24/25.i.1804. Port Phillip.....Harbour. BM(p.p.) syntype. -- [Cloudunning] 61, s.dat. Ballarat. MEL. -- Cooper s.n., 1856. Pyrenean Mountains, Port Phillip. MEL41603. -- Findlay s.n., 1883. Upper Murray. MEL41661. -- Gargurevich s.n., 1874. Red Jacket Creek. MEL41647(p.p.). -- Harvey s.n., ix.xii.1854. Without locality. GH. -- Hildebrandt s.n., s.dat. Prope Port Melbourne. MEL41611. -- Howitt s.n., 1883. Gippsland. MEL41681. -- McCann 2, 1891. Ovens River. MEL. -- Martin s.n., 1887. Snowy Creek. MEL41614,MEL41660. -- Merrah s.n., 1887. Sources of Delegate-River. MEL41352. -- Moffat s.n., s.dat. Romsey. MEL41617. -- [Mueller] s.n., -.xii.1852. Dry forest land near Barker's Creek. MEL41609. -- Mueller s.n., 26.iii.1853. In lateribus montis Timbertop. MEL41680. -- Renfrey 36, Dec. Heywood.

MEL. -- Sullivan 4, -.ix.1876. Moyston. MEL. -- Treyvaud 2, 1894. Cudgewa, Upper Murray River. MEL. -- Whan 169, s.dat. Creswick. MEL. -- Williamson s.n., -.xii.1902. Curdie R. NSW10887. -- Wilson 29, ["ca. 1880" -scrips. J.H. Willis]. Near Geelong. MEL.

Western Australia

Anon. s.n., 20.xii.1859. Tone River. MEL41627. -- Ashby 4354, 22.x.1971. Between Lake Muir and Muir Bridge. AD. -- Ashby 4928, 17.x.1973. [Near the base of the Porongorups, near Western Yorn Creek ca. 6 miles east of the Chester Pass Road towards Narrikup.] AD. -- Cronin s.n., 1889. Sources of Blackwood River. MEL41747. -- Drummond 244, s.dat. Without locality. MEL41630. -- Drummond [442], s.dat. Swan-River. G. -- Drummond s.n., s.dat. Swan River. G. -- Helms s.n., -.x.1899. Mt. Barker. NSW126395. -- Lickin s.n., 1874. Freemantle. MEL41632. -- Logue s.n., 1889. Harvey River. MEL41766. -- McHard s.n., 1874. Blackwood. MEL41321. -- McHard s.n., 1875. Blackwood River. MEL41758,MEL41769. -- McHard s.n., -.iii.1885. Cape Leeuwin. MEL41724. -- Maiden s.n., -.xi.1909. Porongorups. NSW10886(n.v.),AD97123085,BISH; pollen sample A.N.U., AD. -- [Maxwell] s.n., s.dat. Cape Knobb. MEL41629. -- [Maxwell] s.n., s.dat. Esperance bay. MEL41631. -- Maxwell s.n., s.dat. Gales brook. MEL41626. -- Morrison s.n., 1.x.1902. Yetemerup. PERTH. -- Mueller s.n., 10.xii.1877. Blackwood- & Warren River. MEL41759. -- [Mueller] s.n., -.x.1867. Mt. Barker. MEL41621. -- Muir s.n., 1879. Near Mr. Lindsay. MEL41725. -- Muir s.n., s.dat. [King George] Sound. MEL41628. -- Oldfield s.n., s.dat. Harvey R. MEL41620. -- Oldfield 186, s.dat. Kalgan R. MEL41622. -- Oldfield 186b, s.dat. Blackwood. MEL. -- Oldfield s.n., s.dat. Blackwood R. MEL41624. -- Oldfield s.n. s.dat. Champion Bay. MEL41623,MELU. -- Preiss 2337, 30.x.1840. Prope Belgarup, Goderich. FI(p.p.),L,MEL.

Without specific locality

Anderson s.n., [prior to 1893]. Nouvelle-Hollande. G. -- Anon. 42, -.ii.1865. In high elevated pastures common in southern districts. MEL. -- Anon. s.n., s.dat. N. Holl. CH. -- Cunningham, or Anderson or others 429, s.dat. Australia. MEL(p.p.). -- [Mueller] s.n., s.dat. Nov. Holland. meridional. HBG,FI.

SPECIMENS INTERMEDIATE BETWEEN E. scabra and E. caudata:

Victoria

Howitt 116, 1884. Nunionyong [? =Nunniong]. MEL -- Willis s.n., 18.i.1947. Buckety Plain, Bogong High Plains. MEL41654.

12. Euphrasia orthocheila Barker, species nova

[E. scabra auct. non R.Br.: Bentham, Fl. Austral. 4(1868)521, p.p.(as to Stuart MEL41594, MEL41598, Beckler MEL41595); FvM., Fragm. Phyt. Austral. 9(1875)168, p.p.(as to Hartmann 59); FvM., Syst. Cens. Austral. Pl. 1(1882)97, p.p.(as to Qld. and possibly some N.S.W. occurrences); Bailey, Syn. Qld. Fl. (1883) 360; FvM., Sec. Syst. Cens. Austral. Pl. 1(1889)165, p.p. (as to Qld. and possibly some N.S.W. occurrences); Bailey, Cat. Indig. Nat. Pl. Qld. (1890)34; Bailey, Qld. Fl. 4(1901)1124; Bailey, Compr. Cat. Qld. Pl. (1913)363; Gray, Contr. N.S.W. Nat. Herb. 3(1961)63]

LATIN DESCRIPTION:

Herba annua erecta, mox fragilis, (18.5)20-43(60)cm alta. Caulis usque ad basim inflorescentiae (15)17.5-37(50)cm longus, (10)13-30(36) paria foliorum ferens, ramis axillaribus in regione a 0-1(6) nodis supra cotyledones ad (1)3(4) nodos infra inflorescentiam evolutis, interdum 1-5 ramis caulibus similibus ad 1-2 nodos basales si caulis absens; ramis post caulem florentibus, in ordine basipeto crescentibus, inferioribus usque ad 7(10) nodos superioribus ibusque 1-2 nodos ferentibus, pariis omnibus foliorum praeter paria summa surculos subtendibus; axibus pilos eglandulosos breves decurvatos, circa axem plus minusve aequaliter vel in quattuor seriebus, seriebus densibus sparsibusque alternantibus, distributos ferentibus. Cotyledones oblongae glabrae, interdum persistentes. Folia caulina summa plerumque angusto-linearis usque linearis, interdum oblongo-lanceolata, versus basim latissima, dense scaberula vel breve scabra, marginibus recurvatis, parce lobatis fissisve vel integris, (4)6-8 (11)mm longa, (0.5)1.2-2.0(2.5)mm lata; base rotundato-cuneata; lobis 0-1(2) secus quemque marginem, obtusis, 0.05-0.5(0.6)mm longis;

apice acuto, quum folium lobatum (2.3)2.5-5.0(5.5)mm longo; foliis inferis maioribus, crenatis 2-3(4) lobis secus quoque marginem et indumento scabro longiore.

Inflorescentiae racemosae subdenae, illa caulina (15)25-40 flores procreantes, floribus aliquis non fecundis; rhachide pilos eglandulosus densos decurvatos pilosve glandulosos modice densos usque densos, subsessiles usque breves ferenti; pedicellis ca. 0.1-0.8mm longis; fasce apicali gemmarum conico, illo caulino 0.3-1.3mm longo, post anthesin 7-12 parium florum super corollas paris summi florum etiamtum emergenti. Bracteae foliorum summorum similae, sed breviores, ad basim latiores, indumento denso, scaberulo usque breve scabro, interdum cum pilis glandulosis subsessilibus. Calyx (2.8)3.5-4.5(4.9)mm longus, extra dense scaberulus vel sic sparsim et cum pilis glandulosis modice densis usque densis, subsessilibus usque brevibus, intra super rimas pilos eglandulosos cum sineve glandulosos ferentem; dentibus acutis; rimis medianis 1.1-1.8mm profundis, rimis medianis (1.3)1.6-2.6mm profundis. Corolla secus superficiem (9.5)11.0-13.5(15.0)mm longa, inferne sulcum latum habens, lutea, interdum striis porphyreis (saltem in exsiccato) in cucullo labioque inferiore praesentibus; tubo 5.4-7.0(8.5)mm longo, ad infrave bases filamentorum anteriorum expanso, extra in regione proximale glabro, distalibus pilis eglandulosis densis, brevibus usque modice longis, cum pilis glandulosis, modice densis usque densis, brevibus post rimas laterales vestito, intra in regione distale pilis eglandulosis, modice densis usque densis, brevibus usque modice longis vestito; cucullo (3.8) 5.9(7.2)mm longo, extra pilis eglandulosis densis, brevibus usque modice longis, intra pilis eglandulosis, sparsis usque densis, modice longis usque longis, interdum solum secus medianum vel cum pilis glandulosis sparsis brevissimus vestito, lobis superis plerumque obtusis acutisve, interdum acuminatis, in fronte subglabris, in dorso glabris vel pilis eglandulosis glandulosisque vestitis, marginibus sparsissime usque dense ciliolatis, rima inter eos (0.4)0.8(1.5)mm profunda; labio infero (5.0)6.1(8.0)mm longo, (4.8)6.8(10.0)mm lato, porrecto, cucullum subaequanti, extra pilis eglandulosis densis, brevibus usque modice longis, interdum cum pilis glandulosis sparsis brevibus vestito, intra glabro praeter plerumque post lobos pilos eglandulosos sparsos usque densos, marginibus sparsissime usque dense ciliolatis, lobis inferis non profunde emarginatis usque truncatis obtusisve, interdum praemorsis breveve apiculatis, rimis inter eos (1.0)1.8(2.5)mm profundis.

Filamenta staminum plerumque glabra, interdum basi paris anticae pilis eglandulosis paucis vestita, pari antica (4.8)6.7(8.3)mm longa; antheris 1.2-1.5(1.6)mm longis, (0.6)0.7-1.0(1.1)mm latis, connectivis paris anticae interdum glabris plerumque pilos eglandulosos flexuosos, paucos usque densos, breves usque longos, pauciores pariterve quam eos connectivorum paris posticae, ferentibus, aristis posticis (0.1)0.2(0.3)mm longis, plerumque longioribus, interdum pariter quam aristas alteras. Ovarium in supero $\frac{2}{3} - \frac{3}{4}$ setis densis, modice longis, erectis vestitum; apice aspectu laterali plerumque acuto, interdum obtuso vel asymmetrice obtuso; ovulis ca. (20)45-100.

Capsula obovoideo-ellipsoidea usque ovoideo-ellipsoidea, parum decurvata, (3.4)4.0-5.0mm longa, (0.8)1.3-1.7mm lata; seminibus (4)15-40, plus minusve ellipsoideis oblongo-angularibusve, (0.4)0.5-0.8(0.9)mm longis, 0.3-0.4(0.5)mm latis.

Holotypus: Dr. Beckler s.n., s.dat. Mt. Mitchell. MEL41595. (Pl.22).

DESCRIPTION:

Erect annual herb, becoming brittle, (18.5)20-43(60)cm tall.

Stem to base of inflorescence (15)17.5-37(50)cm high, bearing (10)13-30(36) pairs of leaves, with axillary branches forming in region from 0-1(6) nodes above cotyledons to (1)3(4) nodes below inflorescence, sometimes with 1-5 stem-like branches developing at basal 1-2 nodes if stem growth suppressed; branches flowering later than stem and developing basipetally, lower ones bearing up to 7(10) nodes, upper ones bearing 1-2 nodes, with all leaf pairs except uppermost subtending shoots; axes reddish-brown to yellow-brown, covered by short down-turned white eglandular hairs, more or less evenly distributed about axis or in four rows, two dense alternating with two sparse, with sparse rows decussate from leaf bases.

Cotyledons oblong, glabrous, sometimes persisting.

Leaves: uppermost stem leaves usually narrow-linear to linear, sometimes oblong lanceolate, broadest towards base, densely scaberulous or shortly scabrous, often deeply reddened, with margins recurved, sparingly lobed or cleft, or entire, (4)6-8(11)mm long, (0.5)1.2-2.0(2.5)mm broad; base rounded cuneate; lobes 0-1(2) along each margin, obtuse, 0.05-0.5(0.6)mm long; apex usually sharply, rarely bluntly acute, when leaf lobed (2.3)2.5-5.0(5.5)mm long; lower leaves longer and broader, crenate with 2-3(4) lobes along each margin and with longer scabrous indumentum; leaves in similar positions on branches similar but somewhat smaller.

Inflorescences ± dense racemes, that of stem bearing (15)25-40 flowers, with some flowers not forming fruits; rachis bearing dense downturned eglandular hairs or moderately dense to dense, subsessile to short glandular hairs; internodes hardly elongating after anthesis such that apices of capsules reach or extend past node above except for lowermost 1-2 nodes; pedicels ca. 0.1-0.8mm long; apical bud cluster conical, that of stem 0.3-1.3mm long, remaining extended above the uppermost corollas after 7-12 pairs of flowers have reached anthesis.

Bracts like uppermost leaves, but shorter, broader at base, with dense, scaberulous or shortly scabrous indumentum, sometimes mixed with subsessile glandular hairs.

Calyx (2.8)3.5-4.5(4.9)mm long, externally densely scaberulous or only sparsely so and then mixed with moderately dense to dense, subsessile to short glandular hairs, internally glabrous well below clefts with region above usually covered by a mixture of short, sparse to dense, upturned appressed short eglandular hairs, and sparse to dense, subsessile glandular hairs, sometimes lacking glandular hairs; teeth usually sharply, rarely bluntly acute; lateral clefts 1.1-1.8mm deep, shorter than median clefts which are (1.3)1.6-2.6mm deep.

Corolla (9.5)11.0-13.5(15.0)mm long along upper side, with lower side broadly grooved, yellow, sometimes with 3 red-brown striations sometimes present (at least in dried material) on hood and lower lip behind each lobe; tube 5.4-7.0(8.5)mm long, broadened laterally and somewhat medianally at about or below bases of anterior filaments, which are (3.5)4.7(6.0)mm from base of corolla, with basal part glabrous, with distal parts covered externally by dense, short to moderately long eglandular hairs mixed behind lateral clefts with moderately dense to dense, short glandular hairs, internally by moderately dense to dense, short to moderately long, eglandular hairs; hood (3.8)5.9(7.2)mm long, covered externally by dense, short to moderately long eglandular hairs, internally by sparse to dense, moderately long to long flexuose eglandular hairs, all over or along midline only, sometimes mixed above anthers with sparse, very short glandular hairs, with upper lobes usually obtuse or acute, sometimes acuminate, with cleft between (0.4)0.8(1.5)mm deep, with front surface ± glabrous, with rear surface glabrous or proximally with a few very short glandular hairs and distally sometimes with sparse to dense short eglandular hairs, with margins lined densely or very sparingly with short eglandular hairs; lower lip (5.0) 6.1(8.0)mm long, (4.8)6.8(10.0)mm broad, porrect, somewhat shorter to somewhat longer than upper lip, covered externally by dense, short to moderately long eglandular hairs, sometimes mixed with sparse short glandular hairs, internally glabrous except usually for sparse to dense, eglandular hairs behind lobes, with margins very sparsely to densely lined with short eglandular hairs, with lower lobes shallowly emarginate to truncate or obtuse, sometimes praemorse or shortly apiculate, with clefts between (1.0)1.8(2.5)mm deep.

Filaments of stamens usually glabrous, sometimes with a few eglandular hairs at very base, anterior pair (4.8)6.7(8.2)mm long, posterior pair (2.7)3.8(5.0)mm long; anthers 1.2-1.5(1.6)mm long, (0.6)0.7-1.0(1.1)mm broad, with connectives of anterior pair usually surrounded by sparse to dense, short to long flexuose eglandular hairs, sometimes glabrous, less hairy than or as hairy as those of posterior pair which are surrounded by moderately dense to dense, moderately long to long downturned flexuose eglandular hairs, with awns of posterior pair (0.1)0.2(0.3)mm long, usually longer than those of anterior three pairs, sometimes equal to them.

Ovary laterally compressed, in lateral view usually ovate to ovate-elliptic, sometimes elliptic, covered in upper $\frac{2}{3}$ - $\frac{3}{4}$ by dense, moderately long, upturned setae; apex in lateral view usually acute, sometimes obtuse or obliquely so; ovules (20)45-100.

Capsules in lateral view obovate-elliptic to ovate-elliptic, usually with lower side straighter than upper, (3.4)4.0-5.0mm long, (0.8)1.3-1.7mm broad, with moderately long to long, dense setae over upper $\frac{2}{3}$ - $\frac{3}{4}$; apex acute or obtuse; seeds (4)15-40, $\pm$ ellipsoid or oblong-angular, (0.4)0.5-0.8(0.9)mm long, 0.3-0.4(0.5)mm broad.

Chromosome number: Unknown.

Figures: 16

Plates: 6, 22

TYPIFICATION:

Holotype (pl. 22): Dr Beckler s.n., s.dat. Mt Mitchell. MEL41595.

The holotype consists of three plants, one complete and the other two lacking only the lowermost parts; all are copiously branched. The collection, possessing buds, flowers and mature fruits, is in very good condition although a few lateral inflorescences and some leaves have been lost from one of the plants.

Mt. Mitchell is in the New England Tablelands, about 50km north of Armidale. The type collection was made prior to 1868 (it was cited in Bentham's Flora Australiensis of that date). As no material has been collected from the type locality since then and it is probable that the species is extinct, it is unlikely that topotype material still exists.

DISTRIBUTION (Fig. 16):

E. orthocheila is possibly extinct as it was last collected in 1917 (Boorman NSW10878). Collections mainly come from the Northern Tablelands region of New South Wales, as defined by Anderson (1961), and its northern extension into the very south of Queensland. The collection from the Clarence River (Wilcox MEL41718,MEL41589) probably comes from its headwaters in that region.

Although the evidence is poor, the species apparently occurred further south in the region of Sydney and the Blue Mountains (Central Coast and Central Tablelands regions of Anderson). Mueller's collection

(MEL41587) from Port Jackson provides the only apparent record from this area. The localities, Castlereagh and "Orange district" only, doubtfully apply to E. orthocheila (see Notes 4,5). Of the two varieties only var. orthocheila occurs in this area.

No altitudinal records exist. However, from the distributional range of the species, it possibly occurs between about 750m and 1100m in the Northern Tablelands and lower in the south of its range.

ECOLOGY:

The only ecological annotations pertaining to E. orthocheila are on the two Boorman collections. His specimens of var. orthocheila from Chandler's Peak (NSW10878) were found "... growing in a moist place at the foot of the Peak amongst grasses and sedges, generally". His collection of var. peraspera from Boonoo Boonoo (NSW10877) was annotated, "... growing in clumps in permanently moist situations."

From the few dated collections seen, it appears that flowering begins in November to December, although one specimen just beginning to flower (Porter MEL41644) is alleged to have been collected in March. The stem ceases flowering in about the February-March period. Plants with branches still flowering are recorded as late as May (Crawford 19).

NOTES:

1. The two varieties of E. orthocheila approach most closely different species of Sect. Scabrae. E. scabra is clearly allied to var. orthocheila by many characters including its yellow corollas and short glandular indumentum. E. ciliolata clearly resembles var. peraspera by its lack of glandular hairs from the calyces, bracts, rachises and at least upper vegetative parts, by its scaberulous calyces, and its few-, short-lobed leaves. E. ciliolata differs by its purplish corollas, its sparingly setose capsules, its larger

seeds and its rather large anthers with longer awns. It is probable that E. orthocheila and E. ciliolata terminate separate evolutionary lines derived from ancestral taxa related to E. caudata in the Australian Alps (see chapter 4: Evolution of Euphrasia in Australia). Accordingly, var. peraspera may represent a stabilised hybrid derived from ancestral forms similar to var. orthocheila and E. ciliolata.

For a detailed summary of the differences between E. orthocheila and the other species of Sect. Scabrae refer to the key to the species.

2. There are a number of examples in the collections of E. orthocheila of the apparent suppression of growth of the main stem apex with a consequent replacement by lateral growth alone. In some cases (Heron NSW10880, Boorman NSW10878, Stuart MEL41593) the stem is very reduced and is mounted by a number (2-5) of often equally-developed stem-like branches. In other cases (e.g. Stuart 49, Hartmann 59) it is the very upper part of the stem that has not properly developed. In these instances a short length of dead stem may still remain. One plant of the collection, Beckler MEL41595, is terminated by a dead main stem inflorescence which had apparently died before it could develop significantly despite concurrent or subsequent flowering on many branches. These phenomena may result from grazing.

3. It must be considered doubtful that the collection Smith HBG came from Launceston in Tasmania as alleged. The plants lack glandular hairs and instead are covered by the dense shortly scabrous indumentum of E. orthocheila var. peraspera. Accordingly they cannot be confused with the glandular E. scabra, which is the only annual occurring in Tasmania, although they tend somewhat towards it in calyx size (4.6-4.9mm on the stem, 3.7-4.7mm on the branches)

and capsule size (4.5-6.0mm long). The plants clearly belong to E. orthocheila by their short, few-toothed uppermost leaves and bracts. Furthermore, the collection was made in June with branches still in flower. Flowering at this time of the year is found in the annuals of northern New South Wales rather than the more southerly-occurring E. scabra, which has rarely been collected after March (although records are rather few).

An alternative explanation is that the plants represent an introduction of var. peraspera into Tasmania from their natural habitat in New South Wales. Sell & Yeo (1970) suggest that several of the European annuals have spread artificially into North America. However there is no evidence for similar introductions of any of the Australian species of Euphrasia. Furthermore, artificial spread of the Australian annuals is unlikely as several of them, including E. orthocheila, are possibly extinct or almost so, and this may have been caused by agricultural and pastoral use of their habitats. In contrast, the northern annuals are adapted to survive grazing and mowing (Yeo 1968; Sell & Yeo 1970).

It is unlikely that the plants are of hybrid origin as there is a very low percentage of sterile pollen (Appendix 1: PS111).

4. The specimen, Woolls 3, is placed under E. orthocheila var. orthocheila rather than E. scabra because of its small upper leaves, calyces and capsules. However, the fragmentary nature of the specimen and the uncertainty as to whether the branches present have arisen from a stem or a branch make this determination questionable. The specimen is also unusual for its extremely dense pubescence and the thickening of its leaf and bract margins.

5. The locality of Castlereagh, New South Wales, must be assigned with doubt to E. orthocheila. The herbarium sheet (Woolls MEL41489), which is annotated with this locality, comprises a mixture of two

species, namely E. orthocheila and E. collina ssp. paludosa. It is impossible to determine to how many and which specimens the label applies.

6. The epithet "orthocheila" refers to the porrect lower corolla lip found in this species. This is one of several characteristics which together describe corolla shape in E. orthocheila and its closest relatives in Sect. Scabrae. The corolla shape appears to be unique to these five species in the genus.

INTRASPECIFIC VARIATION:

Two varieties, distinguishable by the presence or absence of glandular hairs in the inflorescence, are apparent under E. orthocheila. Although many of the collections contain more than one plant, there is no instance of a mixing of the plants of the two varieties. It is therefore likely that they are confined to separate populations. No environmental correlation is apparent.

KEY TO THE INFRASPECIFIC TAXA OF E. ORTHOCHEILA:

A. The calyces, usually the rachis of the inflorescence, and occasionally the bracts bearing short to subsessile glandular hairs.

a. var. orthocheila

A. The calyces and bracts scaberulous or shortly scabrous; the rachis of the inflorescence covered by dense short eglandular hairs.

b. var. peraspera

a. var. orthocheila

DESCRIPTION:

Inflorescences with rachis usually bearing moderately dense to dense subsessile to short glandular hairs, rarely bearing dense down-turned eglandular hairs.

Bracts covered by a dense scaberulous to shortly scabrous indumentum, occasionally mixed with a few to moderately dense sub-sessile glandular hairs.

Calyx externally covered by short glandular hairs, dense at least on lobes, and short scabrous hairs, sparse or dense, mainly on lower part of tube.

Plates: 6, 22

Figures: 16

DISTRIBUTION (Fig. 16) & ECOLOGY:

See under the species.

SPECIMENS EXAMINED:

New South Wales

Anon. s.n., s.dat. Tenterfield. MEL41594(p.p.). -- Beckler s.n., s.dat. Mt Mitchell. MEL41595 (holotype). -- Beckler s.n., s.dat. Ben Lomond. New England. MEL41596(p.p.). -- Boorman s.n., -.iii.1917. Chandler's Peak. Guyra. NSW10878,SYD. -- Carter s.n., 1892. Baker's Creek, N.Engl. MEL41778. -- Collie s.n., -188[6]. New England. MEL41643. -- Crawford 19, -.v.1887. Moona, Walcha. MEL 41592. -- Crawford 475, -.ii.1885. Moona, Walcha. MEL. -- Mueller s.n., s.dat. Port Jackson. MEL41587. -- [Parsons] 103, s.dat. Armidale, N.Engl. MEL. -- Porter s.n., -.iii.1885. New England. MEL41644. -- [Stuart] 49, s.dat. Clifton. MEL41594(p.p.), MEL41598(p.p.). -- [Stuart] 394, February. Timbarra. MEL41599. -- Stuart s.n., December Timbarra. New England. MEL41593. -- Stuart s.n., s.dat. New England MEL41594(p.p.), MEL41598(p.p.). -- Stuart s.n., s.dat. Timbarra, New England. MEL41430. -- Woolls 3, s.dat. Orange district. MEL.

Queensland

Anon. s.n., s.dat. Warwick. MEL41596(p.p.). -- [Mr. B] s.n., s.dat. Stanthorpe. MEL41591. -- Hartmann 59, 1873. Severn MEL.

Without specific locality

Sieber 490, s.dat. Fl. Novae Holl. L.

Locality doubtful

Woolls s.n., s.dat. Castlereagh. MEL41489(p.p.).

b. var. peraspera Barker, varietas nova.

DIAGNOSIS:

Varietas nova prope var. orthocheila sed differt inflorescentiis rhachide pilos densos deflexos eglandulosos ferentibus, bracteis indumentum dense breveque scabrum ferentibus, calyceque extra dense scaberulo.

Holotypus (tab. 23): Wilcox s.n., -.xi.1875. Clarence River MEL41718.

Isotypus: MEL41589.

DESCRIPTION:

Bracts covered by dense, scaberulous to shortly scabrous indumentum.

Inflorescences with rachis bearing dense downturned eglandular hairs.

Calyx externally densely scaberulous.

Plates: 6, 23

Figures: 16

TYPIFICATION:

Holotype (pl. 23): Wilcox s.n., -.xi.1875. Clarence River. MEL41718. Isotype: MEL41589.

Although not ideal as a holotype because the plants are very young, the specimen selected is the best available. It is in good condition and consists of one complete plant, two plants lacking the lowermost part of the stem, one plant with the main inflorescence lost but for the two lowest flowers, and a stem lacking its base and inflorescence. The stems all bear vegetative shoots and the inflorescences contain buds and flowers; young or mature fruits are lacking. In addition a discordant fragment is mounted on the sheet. The isotype comprises a single complete plant with buds and flowers, and very young branches.

Judging by the distribution of the species, the type locality is probably nearer the source of the Clarence River, in the Northern Tablelands of New South Wales, rather than downstream near its mouth at Coff's Harbour. It is unknown whether the species still exists in the region of the Clarence River.

DISTRIBUTION (Fig. 16) & ECOLOGY:

See under the species.

SPECIMENS EXAMINED:

New South Wales

Boorman s.n., -.ii.1905. Boonoo Boonoo. NSW10877(n.v.), AD97123096, G(4 sheets),BISH. -- Deane s.n., -.iii.1907. Torrington near Deepwater. NSW10883,SYD. -- [Heron] s.n., -.xi.1910. Dorrigo. NSW10880. -- Hickey 11, 1885. Sources of the Dumaresq River. MEL. -- Maiden s.n., Bald Hills Station to Guy Fawkes, New England District. -- Wilcox s.n., -.xi.1875. Clarence River. MEL41718 (holotype); MEL41589.

Locality extremely doubtful

Smith s.n., -.vi.1902. Launceston - Tasmania. HBG.

13. Euphrasia arguta R.Br.,Prodr.(1810)437; [R.Br.,Manuscript, unpubl.]; Sprengel,Linn.Syst.Veg.(ed.16)2(1825)777; FvM., Fragm.Phyt.Austral.5(1865)90; Benth.,Fl.Austral.4(1868) 522,p.p.(as to N.S.W. specimens); Moore,Cens.Pl.N.S.W. (1884)50; FvM.,Sec.Syst.Cens.Austral.Pl.1(1889)163; Moore & Betche,Hdbk.Fl.N.S.W.(1893)342; Wettst.in Engl.& Prantl, Nat.Pflfam.IV3b(1893)101; Wettst.,Monogr.Gatt.Euphrasia (1896)262,t.6,f.453 (as to name only: see Note 2); Dixon, Pl.N.S.W.(1906)226; Maiden & Betche,Cens.N.S.W.Pl.(1916) 184; Gandoger,Bull.Soc.Bot.France 66(1919)217; Du Rietz, Sv.Bot.Tidskr.25(1932)534,48(1948)359

DESCRIPTION:

Erect brittle annual herb, (17)28(45)cm high.

Stem to base of inflorescence (12)22(33)cm tall, bearing (18)24(30) pairs of leaves, with axillary branches developing from (6)8(12) nodes above cotyledons to 1-2(5) nodes below inflorescence, sometimes with an extra shoot along underside of branch in axils of upper leaf pair; branches flowering later than stem, developing in basipetal sequence, lower branches bearing up to ca. 13 leaf pairs, uppermost pair bearing 0-1(4) leaf pairs, with all leaf pairs subtending shoots; axes in upper parts covered equally all around by dense to moderately dense, short to moderately long, downturned eglandular hairs, often very dense on young shoots, somewhat sparser to very sparse lower down stem.

Cotyledons caducous.

Leaves: uppermost stem leaves in outline ovate to elliptic, often broadly so, pinnatifid to deeply pinnatifid, (6.8)10.7(14.5)mm long, (3.5)8.3(13.0)mm broad, usually densely scaberulous, sometimes sparser on lower side or with a few tiny glandular hairs, rarely densely scabrous on upper surface and margins, with blade lanceolate to elliptic or narrowly so, with margins ± recurved; base rounded cuneate to narrow cuneate; teeth 2-3(4) along each margin, sharply acute to acuminate with longest (1.5)3.0(5.5)mm long; apex (2.5)4.5(7.5)mm long, sharply acute to long acuminate; lower leaves similar to upper leaves, but occasionally with somewhat longer scabridity or somewhat shorter teeth; leaves in similar positions on branches similar but somewhat smaller.

Inflorescences dense racemes with that of stem producing (30)50-90 or more flowers, those of branches somewhat fewer; rachis of same pilosity as upper stem; internodes hardly elongating after anthesis so that capsules usually extend well past or sometimes just reach node above; pedicels (0.2)0.3-0.5(1.1)mm long, remaining the same length after anthesis; apical bud cluster rounded, up to 1.5cm long, emergent above flowers even after inflorescence has produced many flowers.

Bracts similar in dimensions to uppermost leaves, but usually with broader blade, usually moderately densely to densely scaberulous, often also bearing a few tiny glandular hairs, rarely densely scabrous.

Calyx (5.3)6.3(8.2)mm long, externally usually densely scaberulous, usually also bearing very few to moderately dense tiny glandular hairs, rarely densely scabrous, internally bearing sparse to dense, very short to moderately long, appressed upturned eglandular hairs mixed with sparse to moderately dense, very short glandular hairs, the indumentum on the teeth shorter or sometimes lacking; teeth sharp-tipped usually very narrow acuminate, sometimes narrow acute; lateral clefts (2.0)3.0(4.0)mm deep, shorter than the median clefts which are (2.6)4.1(6.3)mm deep.

Corolla (10.0)11.6(14.0)mm long along upper side, white (Brown) to lilac (Musson) and, at least in plants seen by Brown, with yellow area on lower side of mouth, with lower side ± broadly grooved; tube (6.7)7.7(8.5)mm long, laterally and somewhat medianally narrowly broadened from below bases of anterior filaments, which are (4.0)5.0(6.0)mm from base of corolla, externally glabrous at base, distally covered by dense, moderately long to long eglandular hairs, usually with dense patch of short glandular hairs behind lateral cleft extended towards base of anterior filaments, internally glabrous to summit of ovary, distally covered by dense, short to long downturned eglandular hairs up to bases of posterior filaments; hood (3.0)4.1(5.5)mm long, covered externally by dense, moderately long to long eglandular hairs, sometimes mixed with dense, very short glandular hairs on sides, internally with moderately long to long flexuose eglandular hairs, dense at sinus, sparser above anthers and usually lacking proximally, mixed with very few to moderately dense, very short glandular hairs, with upper lobes, usually obtuse, occasionally acute or shortly apiculate, glabrous or covered by moderately dense to dense, very short to short eglandular hairs at front, usually covered by sparse to dense, short to long eglandular hairs, rarely glabrous at back, with margins lined by moderately dense to dense, short to moderately long eglandular hairs with cleft between (1.0)1.5(2.5)mm deep; lower lip (4.5)5.8(9.0)mm long, (8.2)9.6(13.0)mm broad, ± flat cross-wise, apparently distally bent downwards, always longer than upper lip, externally covered by dense, moderately long to long eglandular hairs, internally covered behind lobes by sparse to dense, short to moderately long eglandular hairs, on lobes usually sparser and shorter, sometimes lacking, with margins lined by moderately dense to dense, short to moderately long eglandular hairs, with lower lobes broadly obtuse, occasionally praemorse or slightly apiculate, with clefts between (2.0)2.7(5.0)mm deep.

Filaments of stamens glabrous but for sparse to dense, short to very long eglandular hairs on lower half or at base of anterior pair, anterior pair (4.0)5.1(6.3)mm long, posterior pair (1.7)2.4(3.6)mm long; anthers (0.9)1.3-1.5(1.7)mm long, (0.6)0.8-1.2mm broad, with connectives of anterior pair surrounded by sparse to dense, long flexuose eglandular hairs, less hairy or equally as hairy as those of posterior pair which bear dense long eglandular hairs, with posterior pair of awns (0.2)0.3-0.4(0.5)mm long, longer than anterior three pairs.

Ovary laterally compressed, in lateral view ovate-elliptic, elliptic or oblong-elliptic, glabrous but for dense upturned setae in apical $\frac{1}{8}$ - $\frac{1}{3}$, long at very apex, very short to short below; apex in lateral view usually acute or somewhat shortly acuminate, rarely obliquely obtuse; ovules ca. 35-80.

Capsule laterally compressed, in lateral view usually broadly elliptic and declinate, sometimes obovate-elliptic, rarely ovate-elliptic, (4.0)5.0-7.0(7.5)mm long, (1.8)2.1(3.2)mm broad, usually with short, dense to moderately dense setae over upper $\frac{1}{4}$-$\frac{1}{2}$ and dense setae along upper $\frac{1}{3}$ - $\frac{2}{3}$ of lines of dehiscence, short to long at apex, shorter lower down, occasionally glabrous but for a few setae at very apex; apex usually acute or obtuse, rarely acuminate; seeds (8)23(50), usually more or less oblong-ellipsoid, sometimes broadly so, (0.4)0.6-0.8(1.0)mm long, (0.3) 0.4-0.6(0.9)mm broad.

Chromosome number: Unknown.

Plates: 7, 23

Figures: 16

TYPIFICATION:

Holotype (pl. 23): R.Brown s.n. x.-xi.1804. In pascuus prope fluv: Patersons & Williams Rivers. BM.

In gauging the affinities of the type collection with certainty, the manuscript description (Brown, unpublished) had to be taken into account as the holotype is in very poor condition. None of the four plants which make up the holotype possess a whole flower or bract, while most branches are broken and many of the leaves, especially the upper ones, are lost or broken.

The locality cited under E. arguta in the manuscript is "In pratio prope ripas Paterson's River. inter Mt. Anna and Mt. Elizabeth. Oct. 1804. No. 58." Dr. L.A.S.Johnson and Mr. D.J.McGillivray of NSW (pers. comm. 19.vii.1973) were unable to locate the two mountains, but suggested that the locality would not be in highland areas, nor would it be near the headwaters of the two rivers as Brown "did not venture very far inland...and it is unlikely that he went north of 32°35'S." This information is sufficient to confine the locality to an area of about 15km square. Considering that the type locality lies in the closely-settled eastern coastal sector of New South Wales it is highly unlikely that the species still exists there, especially as it is possibly almost extinct.

DISTRIBUTION (Fig. 16):

It is probable that E. arguta is now exceedingly rare, if not extinct, as no collection has been made of it for 70 years. The species may have been rare even before white-man's arrival in Australia as hardly more than 13 collections (I have probably not seen all in existence) have ever been made of it. Mueller (1865) commented on its rarity in the last century; to that time he had only been sent the single specimen collected by Woolls from Mudgee (MEL41394).

E. arguta is recorded from a small area inland and to the north and east of Sydney. The area of distribution covers the Central Western Slopes and the Northern Tablelands, and partially the North Coast phyto-geographic divisions of New South Wales proposed by Anderson (1961).

ECOLOGY:

Nothing is known other than Brown's record of its occurrence in meadows near rivers ("pascuus prope fluv...").

Although data are poor, flowering plants are recorded from October to January, with one collection with branches still flowering in June.

NOTES:

1. E. arguta is one of the closely related species which together make up Sect. Scabrae (for differences see the key to the species of Sect. Scabrae).

2. I have seen neither the specimens which Bentham (1868) stated that he had misidentified as E. arguta in his (1846) monograph of Scrophulariaceae, nor material upon which Wettstein (1896) based his concept of E. arguta.

Wettstein described the species as having stems which bore glandular hairs mixed with lax eglandular hairs, leaves and calyces covered by a mixture of long glandular hairs and scabrous eglandular setae and bracts covered by a mixture of long glandular and eglandular hairs. His illustration of a fruiting calyx (t.6, fig. 453) shows exactly these attributes. This description of the length of the indumentum and density and size of the glandular hairs is in absolute discord with that of the same attributes in the true E. arguta. Thus the glandular hairs of E. arguta, if present on the leaves, bracts and calyces, are very sparse and extremely small, the stem never bears glandular hairs, and the uppermost leaves, bracts and calyces are usually densely scaberulous and only rarely densely scabrous.

Wettstein's description does not fit any species outlined in this work. It differs from E. scabra in the dull purple (when dried) corolla colour, the restriction of the capsule hairs to the apical region and the "obovate-cuneate" capsule shape. From E. caudata it differs in the integrity of the corolla lobes (unusual in E. caudata) and the restriction of the capsule setosity. While one of the two specimens cited by Wettstein with specific localities came from the "Alpes Australes" (Cunningham FI) and could possibly have been confused with E. caudata, another comes from the Blue Mountains (Lesson B), an area from which I have seen only one questionable record of an annual species (E. orthocheila: Note 5). The other two specimens cited by Wettstein under E. arguta (Huegel "Australia orientalis" W; Sieber 490 W,P) could have come from this latter region. The shape and indumentum of the capsule of the glandular forms of E. collina which occur in the Blue Mountains, is often similar to that described and illustrated by Wettstein for E. arguta. However, it is very doubtful that Wettstein would have mis-identified plants of this species as he saw much material of it and its habit is very different. It seems possible that Wettstein's E. arguta may represent an undescribed taxon intermediate between E. caudata and E. arguta both in morphology and geography.

3. The two specimens of E. arguta collected by Sieber under his number 490 which I have seen are obviously two different collections. The plants come from New South Wales as Sieber spent seven months

there during 1823 (Maiden 1908; Dietrich 1881). The NY specimen has a sparse external corolla indumentum but it is otherwise typical of E. arguta with its "purple" corollas, bracts and calyces with sharply acuminate teeth, dark-coloured anthers, and ovaries setose only at the apex. The herbaceous parts of the plant from L are densely scabrous. This is the only specimen seen with so long an indumentum. However, otherwise it clearly belongs to E. arguta, possessing all the species characters cited for the NY specimen.

4. One plant in the collection, Boorman NSW10934, is atypical of E. arguta by its glabrous leaves, bracts and calyces and its large seeds (1.2-1.4mm long). Pollen from a flower of this plant is almost entirely functional in appearance (Appendix 1; PS113). Of the other four plants, which appear to be typical of E. arguta, one also had a high percentage of normal pollen (PS112), but another had an estimated 54% sterile pollen (PS114). It is possible that the plants are of hybrid origin with E. arguta and possibly E. collina the parent species.

SPECIMENS EXAMINED:

New South Wales

Anon. s.n., s.dat. Barrangan beyond Mudgee. MEL41395. -- Anon. s.n., s.dat. New England. NSW10899. -- Boorman s.n., -.vi. 1904. Nundle. NSW10934. -- Brown s.n., x.-xi.1804. Prope fluv: Patersons & Williams Rivers. BM(holotype). -- Crawford 577, 1885. Moona, Walcha. MEL. -- Hamilton s.n., s.dat. Mudgee. MEL41398. -- Leichhardt s.n., s.dat. New England. MEL41393. -- Musson s.n., -.i.1890. Hanging Rock, Nundle. MEL41397. -- Sieber 490, s.dat. Fl. Novae Holl. L,NY. -- Stephenson s.n., -.xii.1856. Upper Hunter River. NSW10900. -- Taylor s.n., 1870. Mudgee. MEL41396. -- Woolls s.n., s.dat. Mudgee. MEL41394.

14. Euphrasia ciliolata Barker, species nova.

LATIN DESCRIPTION:

Herba annua erecta, (19)22-32(45)cm alta. Caulis usque ad basim inflorescentiae (11)16-23(25)cm longus, (10)13-16(19) paria foliorum ferens, plerumque ramis axillaribus in regione a (2)5(10) nodis supra cotyledones ad (1)3-4(7) nodos infra inflorescentiam evolutis, interdum etiam 1-2 ramis, caulibus similibus, in axillis 1-2 parium basalarum foliorum praecox evolutis, raro simplex; ramis post caulem florentibus, in ordine basipeto crescentibus, (3)5-8(10) paria foliorum, quorum multa surculos ramosve subtendent, ferentibus; axibus quattuor series pilorum eglandulorum brevium decurvatorum, seriebus densibus sparsibusque alternantibus, raro etiam in regionibus inferioribus pilos glandulosos breves usque longos, sparsos usque moderate densos ferentibus. Cotyledones ellipticae integrae, raro persistentes. Folia caulina summa (5.2)5.5-11.0(13.0)mm longa, (2.0)2.4-4.5(5.5)mm lata, crenata usque serrata, plerumque ovata usque elliptica, interdum oblonga-elliptica, plerumque glabra, raro scaberula, marginibus subrecurvatis; base plerumque rotundata-cuneata, interdum anguste cuneata; dentibus (1)2(3) secus quoque marginem, acutis obtusisve, 0.2-1.5mm longis; apice acuto obtusove, (1.4)2.8(4.5)mm longo; foliis inferis maioribus, crenatioribus, scabridis usque scaberulis, infimis interdum etiam pilos glandulosos sparsos, breves usque longos ferentibus. Inflorescentiae racemosae sublaxae, illa caulina (10)16-26(36) flores procreantes, floribus superioribus non fecundis; pedicellis 0.5-2.5mm longis; fasce apicali gemmarum ovoideo 0.8-1.7mm longo, post anthesin 3-7 parium florum super corollas paris summi florum vix emergenti. Bracteae foliorum summorum similae. Calyx (3.0)4.0-5.4(6.0)mm longus, extra dense scaberulus, intra pilosus glandulosus eglandulosusque;

dentibus acutis; rimis lateralibus (0.8)1.2-2.0mm profundis, rimis medianis (1.4)1.8-2.8mm profundis. Corolla secus superficiem (10.5)12.0-15.5(16.5)mm longa, caerulea, purpurea, profunde purpurea vel malvina, inferne, lobis exceptis, alba et sulcum latum habens, saltem interdum mediano labii inferior luteo; tubo (6.0) 8.0(9.8)mm longo, infra bases filamentorum anguste expanso, extra intraque in regionibus proximalibus glabro, distalibus pilis densis brevibus vestito; labio supero (4.0)5.3(6.5)mm longo, extra pilis densis brevibus, marginibus loborum superorum inclusis, intra infra rimam superam pilis densis, brevibus usque moderate longis, eglandulosis vestito, alibi plerumque glabro, interdum pilis brevibus densis eglandulosis glandulosisve vestito, lobis superis plerumque obtusis integrisque, raro acutis praemorsisve, rima inter eos (0.6)1.2(1.8)mm profunda; labio infero (4.2)5.9(7.2)mm longo, (6.0)7.9(12.0)mm lato, subrecto, labium superum subaequanti, extra pilis densis brevibus eglandulosis, saepe in mediano sparsioibus, ad margines pilis densis brevibus glandulosis mixtis, vestito, margine pilis eglandulosos similes ferenti, intra pilis densis bremibus eglandulosis, interdum post lobos laterales brevissimis regione post lobum medianum glabra, vestito, lobis inferis obtusis, plerumque breve apiculatis, rimis inter eos (0.8)1.9(3.0)mm profundis. Filamenta staminum plerumque glabra, interdum basi paris anticae pilis brevibus eglandulosis vestita, pari antica 6.0-9.0mm longa, pari postica 3.0-5.0mm longa; antheris (1.3)1.5-1.8(2.0)mm longis, 0.9-1.4mm latis, connectivis paris anticae glabris vel pilos paucos, breves usque longos, eglandulosos, pauciores quam eos connectivorum paris posticae, ferentibus, aristis posticis (0.3)0.4-0.5(0.6)mm longis, semper longioribus quam aristas alteras. Ovarium in apice vel in supero $\frac{1}{3}$ - $\frac{3}{4}$ setis densis, brevibus usque brevissimis, erectis vestitum; apice aspectu laterali obtuso acutove; ovulis ca. 30-75.

Capsula ellipsoidea usque obovoidea ovoideo-ellipsoideave, 4.0-6.8mm longa, 1.8-2.5(3.0)mm lata; seminibus (14)30(63), (0.9)1.0-1.2(1.4)mm longis, (0.4)0.5-0.6(0.8)mm latis, subellipsoideis.

Holotypus (tab. 24): J.Pulley 671, 10.ii.1971. Barrington Tops, N.S.W. Herb field near Polblue Creek 4,900'. CBG (s.n.). Isotypus: AD97346096.

DESCRIPTION:

Erect annual herb, (19)22-32(45)cm tall.

Stem to base of inflorescence (11)16-23(25)cm long, bearing (10)13-16(19) pairs of leaves, usually with axillary branches forming in region from (2)5(10) nodes above cotyledons to (1)3-4(7) nodes below inflorescence, sometimes also with 1-2 stem-like branches developing early in axils of basal 1-2 leaf pairs, rarely simple; branches flowering later than stem, developing basipetally, bearing (3)5-8(10) leaf pairs, many of these subtending shoots or branches; axes in upper parts bearing short down-turned white eglandular hairs in four rows, two of dense indumentum alternating with two of sparse indumentum, with sparse rows decussate from leaf bases, in lower parts with similar indumentum mixed rarely with short to long, sparse to moderately dense glandular hairs.

Cotyledons elliptic entire, rarely persisting.

Leaves: uppermost stem leaves (5.2)5.5-11.0(13.0)mm long, (2.0)2.4-4.5(5.5)mm broad, crenate to serrate, usually ovate to elliptic, sometimes oblong-elliptic, usually glabrous, rarely scaberulous, with somewhat recurved margins; base usually rounded cuneate, occasionally narrow cuneate; teeth (1)2(3) along each margin, usually bluntly, rarely sharply, acute or obtuse, 0.2-1.5mm long; apex usually sharply acute, sometimes bluntly acute or obtuse, (1.4)2.8(4.5)mm long; lower leaves larger, more toothed, scabrid to scaberulous, the lowermost ones occasionally also bearing short to long, sparse glandular hairs; leaves in similar positions on branches similar but somewhat smaller.

Inflorescences ± lax racemes, that of stem bearing (10) 16-26(36) flowers, the upper ones usually not forming fruits; rachis with indumentum similar to upper part of axis but denser; internodes elongating after anthesis such that apices of capsules do not reach node above; pedicels 0.5-2.5mm long, hardly elongating after anthesis; apical bud cluster rounded-conical 0.8-1.7mm long, hardly extended past corollas of uppermost pair of flowers after 3-7 pairs of flowers have reached anthesis.

Bracts like uppermost leaves.

Calyx (3.0)4.0-5.4(6.0)mm long, externally densely scaberulous, internally bearing sparse to dense, short to long upturned eglandular hairs mixed with sparse to dense, short glandular hairs extending to clefts or well below them; teeth sharply acute; lateral clefts (0.8)1.2-2.0mm deep, shorter than median clefts which are (1.4)1.8-2.8mm deep.

Corolla (10.5)12.0-15.5(16.5)mm long along upper side, blue, purple, deep purple or mauve, with lower side broadly grooved and white except on lobes, with mid-line of lower lip, at least occasionally (Pullen 3792, White 11596), yellow; tube (6.0)8.0(9.8)mm long, laterally and somewhat medianally narrowly broadened well below bases of anterior filaments, which are (3.5)4.2(5.8)mm from base of corolla, glabrous proximally, distally covered externally by dense short eglandular hairs, between bases of anterior filaments and lateral clefts mixed with dense short glandular hairs, internally by dense short eglandular hairs up to bases of posterior filaments; hood (4.0)5.3(6.5)mm long, covered externally by dense short eglandular hairs, mixed on sides with dense short glandular hairs, internally in area below upper cleft by dense, short to moderately long eglandular hairs, sometimes along midline of hood by dense short glandular hairs, or from base of filaments to the anthers, by dense short eglandular hairs, with upper lobes usually obtuse and entire, rarely acute or praemorse, with cleft between (0.6)1.2(1.8)mm deep, on front surface glabrous or covered by dense very short eglandular hairs, on rear surface covered proximally with dense short glandular hairs, distally with dense short eglandular hairs which also line margins; lower lip (4.2)5.9(7.2)mm long, (6.0) 7.9(12.0)mm broad; flat, directed ± straight out from tube, slightly shorter to slightly longer than upper lip, covered externally by dense short eglandular hairs, often sparser in middle, mixed towards margin with dense short glandular hairs, with margin lined with similar eglandular hairs, internally by dense eglandular hairs, usually short, sometimes very short behind lateral lobes with region behind middle lobe glabrous, with lower lobes obtuse, usually shortly apiculate, with clefts between (0.8)1.9(3.0)mm deep.

Filaments of stamens usually glabrous, sometimes with lower ½-1mm of anterior pair covered by short eglandular hairs, anterior pair 6.0-9.0mm long, posterior pair 3.0-5.0mm long; anthers (1.3) 1.5-1.8(2.0)mm long, 0.9-1.4mm broad, with connectives of anterior pair glabrous or with a few short to long eglandular hairs, less hairy than those of posterior pair which are surrounded by moderately dense to dense, moderately long to long downturned flexuose eglandular hairs, with posterior pair of awns (0.3)0.4-0.5(0.6)mm long, always longer than the anterior three awn pairs.

Ovary laterally compressed, usually ovate, sometimes elliptic-ovate, in lateral view, clothed by dense, very short to short, upturned setae in apical region only or in upper $\frac{1}{3}$ - $\frac{3}{4}$; apex in lateral view obtuse or acute; ovules ca. 30-75.

Capsule 4.0-6.8mm long hardly compressed laterally, in median view usually ovate, sometimes narrow ovate, porrect or slightly declinate, in lateral view ovate-elliptic to obovate-elliptic, 1.8-2.5(3.0)mm broad, usually covered in upper $\frac{1}{3}$ - $\frac{1}{2}$ by sparse to moderately dense, very short to short setae, occasionally glabrous; apex obtuse, usually obliquely so; seeds (14)30(63), (0.9)1.0-1.2(1.4)mm long, (0.4)0.5-0.6(0.8)mm broad, more or less ellipsoid, often angled.

Chromosome number: Unknown.

Figures: 16

Plates: 3, 7, 23

TYPIFICATION:

Holotype (pl. 23): J.Pulley 671, 10.ii.1971. Barrington Tops, N.S.W. Herb field near Polblue Creek 4,900'. CBG(s.n.).

Isotype: AD97346096.

The type collection is in very good condition, with all plants profusely branched and bearing flowers and mature fruits. The holotype consists of three plants, the isotype two plants.

As much material of the species has been collected from the Barrington Tops region, and because the collection was made very recently, it is probable that the population from which the collection was made still survives.

DISTRIBUTION (Fig. 16):

E. ciliolata is endemic to the geographic region of New South Wales called by Anderson (1961) the Northern Tablelands.

Collections are very few north of the Barrington Tops-Gloucester Tops area. This possibly reflects the greater frequency of botanical collecting in the southern areas.

The altitudinal range for the species at this stage of our knowledge is about 900m to 1550m, the altitudes above about 1000m being recorded from the southern localities.

ECOLOGY:

Data on specimen labels show that the species exists in a variety of habitats, with open grassy situations and a proximity to bogs or swamps often mentioned. Ecological records include: "In Eucalyptus pauciflora woodland (sparsely wooded), among grass and Lomandra longifolia on red soil over igneous rock" (Briggs NSW102586), "Only in swampy ground near river bank. Granite" (Constable NSW56101), "in E. obliqua-E.viminalis forest" (Floyd 5), "Grasslands on the plateau" (Lowery NSW55199), "Snow grass" (McDonald 8), "Margin of open boggy flat on gentle slope (Pullen 3792), "Herbfield" (Pulley 671), "Subalpine woodland" (Pulley 705), and "common on edge of swamps and on grassy slopes leading to them" (White 11596).

Plants begin flowering in early January, with branches still bearing flowers in May or even August.

NOTES:

1. E. ciliolata is most closely related to E. arguta by its purplish corollas and sparingly setose capsules and the general absence of glandular hairs. It is also closely related to var. peraspera of E. orthocheila (q.v.). Differences from these species and other species of Sect. Scabrae are detailed in the key to the species.

2. The collections Constable NSW56101 and Lowery NSW55199 comprise plants with scaberulous bracts and upper leaves. While tending

towards E. orthocheila in this character, the plants clearly belong to E. ciliolata because of their purplish flowers and subglabrous capsules. Plants from other collections of this species are more or less glabrous in these parts.

3. The collection Carolin 487 consists of plants which tend towards E. collina by their many-seeded, large capsules (7-9mm long) and long upper leaves and bracts with two teeth along each margin. The plants clearly belong to E. ciliolata by the pubescence of the calyces, corollas, and anther backs, the shape of the corolla, the presence of axillary branches on the erect stem, and the lack of evidence that the plants are perennial.

4. The specific epithet refers to the short eglandular hairs which densely line the margins of the corolla lobes in this species. Only in E. arguta does this pilosity occur with such density and consistency.

SPECIMENS EXAMINED:

New South Wales

Briggs s.n., 17.iv.1965. Gloucester Tops, 1 mile NW of Gloucester Fall. NSW102586,BISH. -- Carolin 487, 13.iv.1958. Carey's Peak. SYD. -- Carter s.n., 1887. Sources of the Hunter River. MEL41585. -- Constable s.n., 7.v.1961. Deepwater River, 3 miles east of Deepwater. NSW56101,NE,AD; pollen slide A.N.U., AD. -- Coveny s.n., 1.i.1966. Gloucester Tops. NSW126396. -- Coveny s.n., 24.iii.1967. Gloucester Tops. NSW98627,BISH. -- Floyd 5, 13.vii.1956. East of Yarrowitch (Walcha-Wauchope Rd.). NSW102587,BISH. -- Fraser & Vickery s.n., 7.i.1934. Barrington Tops. NSW10863,SYD. -- Fuller s.n., -.i.1928. Allyn R. to Barrington Tops. SYD. -- Lowery s.n., 13.v.1961. Barrington Tops. NSW55199. -- McDonald 8, s.dat. Polblue Swamps, Barrington Tops. NSW(s.n.). -- Munro s.n., -.i.1953. Barrington Tops. NSW22270. -- Pullen 3792, 3.ii.1963. CANB,NSW66531, L(n.v.), K(n.v.). -- Pulley 671, 10.ii.1971. Barrington Tops, near Polblue Creek. CBG(holotype); AD. -- Pulley 705, 11.ii.1971. Gloucester Tops. CBG. -- Reik 037, s.dat. Manning River (Barrington Tops Trip). CANB. -- Rupp s.n., -.i.1928. Barrington Tops. NSW10862. -- Rupp per Sivyer 3, -.i. 1925. Barrington Tops. MEL. -- White 11596, 28.viii.1938. Barrington Tops. BRI,NSW10864,GH. -- White-Haney s.n., 9.ii.1930. Glen Elgin. CANB7920.

V. Sect. <u>Australes</u> (Benth.)Joerg.

For synonymy, description, typification and distribution, see Chapter 5: p.150.

NOTES:

1. Sect. <u>Australes</u> consists of two species, <u>E. collina</u> and <u>E. bella</u>, and <u>E. crassiuscula</u>, which is probably a stabilized hybrid between Sect. <u>Australes</u> and Sect. <u>Striatae</u> Subsect. <u>Striatae</u> and has been placed in the section for convenience (see Note 2). All three species are very closely related. However, it has been considered advisable to distinguish them at the species level since they are clearly distinct from the large complex network of subspecies which together make up <u>E. collina</u>.

2. <u>E. crassiuscula</u> (q.v.: Intraspecific Variation) varies in the presence of striations on the corolla and the incidence of hairs on the anther backs, which are the major characters distinguishing Sect. <u>Australes</u> and Sect. <u>Striatae</u>, the sections to which it is most closely related. It is believed that the species originated from the hybridization of species in the two sections (see Chapter 4: Evolution of <u>Euphrasia</u> in Australia).

Among the present-day species of Sect. <u>Striatae</u> and Sect. <u>Australes</u>, <u>E. crassiuscula</u> is most closely related to the members of the latter section, particularly <u>E. collina</u> ssp. <u>paludosa</u>. For this reason Sect. <u>Australes</u> has been considered the most appropriate position for <u>E. crassiuscula</u> in the newly proposed infrageneric classification of <u>Euphrasia</u>. It seems possible that there was once also a now extinct group of taxa in Sect. <u>Striatae</u> which resembled <u>E. crassiuscula</u> ssp. <u>eglandulosa</u> (see also Chapter 4).

3. The specimen Weymouth MEL41765 from southern Tasmania has characters of both Sect. Australes and Sect. Striatae Subsect. Striatae. It resembles the former by its hairy-backed anthers and corollas which do not appear to be striated. However it resembles Subsect. Striatae by its very sharply acute, deeply toothed leaves, which are not found in any of the members of *E. collina* in Tasmania. The plant is also unusual in that it has leaves, bracts and flowers in whorls of three. It cannot be determined whether the plant is an extreme of *E. collina* or a hybrid between *E. collina* and a species of Subsect. Striatae. A pollen test (Appendix 1: PS355) shows the pollen to be almost entirely functional in appearance.

SPECIMEN EXAMINED:

W.A. Weymouth s.n., 11.ix.1889. Port Cygnet, Tasmania. MEL41765.

KEY TO THE SPECIES OF SECT. AUSTRALES:

1a. Calyx, bracts and at least upper leaves usually glandular hairy, rarely within populations glandular hairy, lined by dense eglandular hairs 0.3-0.8mm long.

17. *E. crassiuscula*

[see Sect. Australes: Note 2]

1b. Calyx, bracts and upper leaves glandular hairy, or if non-glandular, ~~glandular,~~ sometimes lined by usually sparse to moderately dense, rarely dense, eglandular hairs 0.1-0.2mm long.

2a. Uppermost leaves of main axis(es) with base narrow cuneate to truncate, opposite. Ovules [except in ssp. bowdeniae which has ca.20-40 ovules] (60)80-180(200).

15. *E. collina*

2b. Uppermost leaves of main axes with base narrow attenuate, usually opposite, sometimes alternate. Ovules ca. 60.

16. *E. bella*

15. Euphrasia collina R.Br.,Prodr.(1810)436. For full references to citation of this and other species names see under the various subspecies

E. tetragona R.Br.,l.c.436

E. paludosa R.Br.,l.c.436

E. speciosa R.Br.,l.c.437

E. diemenica Sprengel,Linn.Syst.Veg.(ed.16)2(1825)777(substitute name for E. alpina R.Br.non Lam.)

E. multicaulis Benth.in DC.,Prodr.10(1846)553

E. muelleri Wettst.,Monogr.Gatt.Euphrasia (1896)257

E. glacialis Wettst., l.c.259; Willis,Muelleria 1(1967)146,p.p.(excl. var. eglandulosa); Harris, Alp.Pl.Austral.(1970)138, p.p.(excl. var. eglandulosa); Willis,Hdbk.Pl.Vict.2(1973) 573,p.p.(excl. var. eglandulosa)

E. walteri Gandoger,Bull.Soc.Bot.France 66(1919)218

E. tasmanica Gandoger,l.c.218; Du Rietz,Sv.Bot.Tidskr.42(1948) 361; Briggs in McGillivray,Contr.N.S.W.Nat.Herb.4(1973)339

E. novae-cambriae Gandoger,l.c.218

E. deflexifolia Gandoger,l.c.218

E. trichocalycina Gandoger,l.c.218

E. maidenii Gandoger,l.c.218

[E. alpina R.Br.,Prodr.(1810)436(nom.illeg.)non Lam.,Encycl.meth. Bot.2(1786)400; Benth.in DC.,Prodr.10(1846)553,p.p.(excl. var. humilis)]

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.),p.p. (excl. "var. psilantherea"); Spicer,Hdbk.Pl.Tasm.(1878)77, 127,p.p.(excl. synonyms E. striata and E. alpina p.p. of Benth. and Hook.f.); FvM.,Syst.Cens.Austral.Pl.1(1882)97,p.p.(excl. some Tasm. occurrences of E. striata); FvM.,Sec.Syst.Cens. Austral.Pl.1(1889)165,p.p.(excl. Polynesian occurrence, later E. papuana Schlecht., and some Tasm. occurrences of E. striata);

Wettst.in Engler & Prantl,Nat.Pflfam.IV3b(1893)101,?p.p.; Rodway,Tasm.Fl.(1903)143,p.p.(excl. var. striata); Gandoger, Bull.Soc.Bot.France 66(1919)217; Du Rietz,Sv.Bot.Tidskr.25 (1932)528]

[E. striata auct. non R.Br.: FvM.,Fragm.Phyt.Austral.5(1865)89; Benth,Fl.Austral.4(1868)521,p.p.(as to Mueller MEL41545,MEL 41538)]

[?E. scabra auct. non R.Br.: Beard,Descr.Cat.W.Austral.Pl.(1965) 96,p.p.(as to "?white"-flowered form if true); Beard,Descr. Cat.W.Austral.Pl.(1970)118,p.p.(as in prior reference)]

[Calophrasia paludosa Presl ex Wettst.,Monogr.Gatt.Euphrasia (1896)256("in sched.")pro syn.]

[Cyanophrasia speciosa Presl ex Wettst.,l.c.259("in sched.")pro syn.]

DESCRIPTION:

Perennial herb or undershrub of variable habit.

Cotyledons ovate-elliptic to elliptic, ca. 6-12mm long, ca. 6mm broad, entire, glabrous, present only in seedlings.

Inflorescences racemes of varied nature.

Calyx with variable length and indumentum; teeth blunt or sharp, usually acute, sometimes obtuse; lateral clefts (0.2)1-3(4.5)mm deep, more shallow than median clefts which are (1.2)2.5-4(6.5)mm deep.

Corolla variable in size, colour and incidence of yellow blotches on lower lip and at point of insertion of anterior filaments, with lower side flattened or shallowly grooved; tube glabrous at base, distally with outer surface covered by short to long eglandular hairs, dense on the adaxial and lateral surface, sparse or absent on the abaxial surface, sometimes (in ssp. tetragona) completely lacking eglandular hairs, with sparse to dense patch of very short to short glandular hairs behind lateral cleft, with inner surface bearing moderately dense to dense, short to long eglandular hairs between and decurrent from base of filaments or all over, sometimes mixed with short to moderately long glandular hairs, sparse all over or confined to area between filaments; hood excluding lobes 4-6(6.5)mm broad, including lobes (5)5.5-9.5(12.5)mm broad, externally covered by dense short to long hairs often mixed with short to moderately long glandular hairs on front and sides or all over, the indumentum usually all over hood, but in ssp. tetragona sometimes confined to midline or absent, internally usually with long to very long eglandular hairs in dense patch in sinus region, sometimes extending over distal half, often with sparse to dense, very short to short glandular hairs, confined to sinus region, or extending along sides or over hood, or all over; lobes coplanar or almost so, with cleft between (1.5)2-4(5)mm deep; lower lip ± flattened crossways at base, initially porrect, distally spreading, (9)10-24(30)mm broad; lower lobes with clefts between 3.5-7.5(9)mm deep.

Stamens with filaments glabrous, the anterior pair (2.8)4.5-7.5(9.2)mm long, the posterior pair (1.3)2.5-4.5(5.5)mm long; anthers variable in length, (0.9)1.2-1.7(2.0)mm broad, with area about connectives with variable indumentum, rarely glabrous, with slits lined by dense moderately long to very long eglandular hairs, with posterior pair of awns variable in length, longer than other three pairs.

Ovary in lateral view ovate to elliptic or oblong, hardly compressed laterally; in median view ovate- to narrow ovate-caudate, glabrous or with sparse to dense, very short to moderately long setae confined to apex or distributed over distal $\frac{3}{4}$; apex in lateral view usually obtuse, sometimes acute or truncate-obtuse, rarely acuminate; ovules in ssp. bowdeniae (19)31(40) [4 counts], in remainder of species (60)80-180(200).

Capsules of variable shape and indumentum; seeds variable in number and size.

Chromosome number: n=c.28-30 (Barker 1374,1438,1439,1440, 1489), or c.45-60 (Barker 1504,1685)

Other characters very variable (habit, leaves, inflorescence, bracts, calyx length and indumentum, corolla size, colour indumentum and shape of lobes, anther length and indumentum, and length of posterior awns, capsule shape and indumentum, seed number and size): see descriptions of infraspecific taxa.

Plates: 4, 7-11, 24

Figures: 17-24

TYPIFICATION:

1. E. collina

Lectotypus (tab. 24): R. Brown 64, ii/iii/1804. Mscr: fluv. Derwent. In campis & collibus prope fluvium Derwent. BM (p.p., quoad duo specimina sinistra). Isolectotypi: R.Brown s.n., s.dat. Derwent. K (p.p., quoad specimina exteriora), MEL41468 (p.p., specimine sinistro et secundo a dextra excluso). Syntypus alter (tab. 24): R. Brown s.n., s.dat. Derwent. BM (p.p., quoad specimen dextrum). Isosyntypi alteri: R. Brown s.n., s.dat. Derwent. K (p.p., quoad duo specimina media), MEL41468 (p.p., quoad specimen sinistra et secunda a dextra).

The type collection consists of at least two elements, one of ssp. collina (equivalent to E. collina of current usage, e.g. in Curtis 1967a) and the other from the populations on the upper slopes of Mt. Wellington which connect ssp. collina and ssp. diemenica (which is equivalent to E. diemenica in recent works). All three sheets are in good condition except for the loss of some inflorescences. Material of the lectotype is in flower and fruit, while that of the other syntype is in bud and flower. The localities of Brown's collections are discussed later.

The choice of lectotype is supported on several grounds. By its oblong to narrow oblong leaves with a single tooth on each margin the lectotype fits the protologue (Brown 1810: "..foliis lineari-cuneatis obtuse tridendatis glabris") better than the other syntype, which has broader leaves, often with two teeth on each margin. Of the two syntypes the lectotype is also the more divergent from Brown's E. alpina (later called E. diemenica and now ssp. diemenica) which was described with E. collina in the protologue. The choice of lectotype also preserves current application of the name in Tasmania (Curtis 1967a) and therefore is in accordance with Recommendation 7B of the International Code of Botanical Nomenclature (Stafleu ed. 1972). Finally, it avoids the taxonomic difficulties of the lectotype coming from the intergradation between two subspecies (see also E. crassiuscula: Typification for similar example).

The lectotypification, although following Brown's concepts in the protologue, is contrary to those of E. collina in his manuscript (Brown, unpubl.). The two elements apparently correspond to the two collections upon which were based the two provisional names, "E. alba" and "E. collina", used in the manuscript. This is verified by several labels on the above types (including the two on the BM type) on which E. alba has been crossed out by Brown and replaced with E. collina.

Brown's "E. alba" clearly corresponds to the lectotype of E. collina as its leaves are described in the manuscript as follows:

> "Folia opposita [?....] cuneato-linearia [?patentes] glaberrima crassiuscula apice triloba lobulis obtusis [?...] majore supra [?....] apressa apice [?....] $3\frac{1}{2}$ lineas longe unam lineam late crassiuscula"

On the other hand "E. collina" of the manuscript was described as intermediate between "E. alba" and "E. speciosa", the name which Brown originally attributed to his E. alpina (see ssp. diemenica:

Typification). Brown gave the characters distinguishing it from "E. alba" as follows:

> "E. collina media inter Euphrasiam albam & speciosam / a priori differt / Caulibus undique tenuiforme pubescentibus / Foliis [?extra] medium 5-dentatis majoribus supra minus nitentibus saepius paulo / Pedunculis longioribus / Calycis laciniis acutioribus / Corollis purpureo-caeruleis / Antherarum superarum [lobo] superiore tantum mucrono manifesto reliquis brevioribus a pilis occultatis / Stigmato paullo longiore / Pubescentia corolla paullo longiore omnique simplici nec partim capitata".

From the leaf characters the manuscript "E. collina" clearly corresponds to the plants intermediate between ssp. collina and ssp. diemenica. This is verified by the labels on the BM specimen; Brown's collection of "E. alba" was numbered 64 in the manuscript which is identical to the number of the label closest to the lectotype.

The collections upon which Brown's manuscript species were based were given locality details more exact than those on the type specimens. The manuscript "E. collina" was based on a collection made in July 1804 "In collibus prope Risdon" which is a suburb of Hobart on the River Derwent. "E. alba" was described from a collection made in February 1804 "In pratis sterilioribus prope Frederic Henry Bay". There is some doubt as to what Brown meant by this latter locality, as Flinders, who led the expedition upon which Brown was botanist, was confused about its exact location.* However, if it is assumed

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* In his "Observations of the Coasts of Van Diemen's Land", Flinders (1801: p.4) stated:

> "It does not seem to be well determined which is the Frederick Henry or Hendricks Bay of Tasmania. In the chart I affix the name to the space which lies to the

(continuation next page)

that Brown's concept of Frederick Henry Bay was identical to that of Flinders at the time of his collection of "E. alba", then the collection must have come from either Marion Bay or the region including Storm Bay, Frederick Henry Bay and Norfolk Bay as portrayed in Davies (1965: map 25). Brown apparently confined most of his collecting activity to the mountains and lowland regions surrounding the mouth of the River Derwent (Stearn 1960). It therefore seems unlikely that the "Frederic Henry Bay" collection came from Marion Bay or Norfolk Bay, which are well to the east of the Derwent. Forms of E. collina related to both syntypes are known from the regions about Risdon Cove. However, the intergradation between ssp. collina and ssp. diemenica is apparently confined to subalpine areas and because the postulated locations of Frederick Henry Bay apparently lack such areas it is almost certain that the intergradation could not have come from there. It follows that the syntype belonging to the intergradation must have been "E. collina" of the manuscript collected from near Risdon, while the lectotype (belonging to ssp. collina) corresponds to

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> northward of, and between Cape Frederick Henry and Cape Basaltes; and I have extended it to those large pieces of water, on each side of Green Head, calling them the upper bay."

From Flinders's detailed description (l.c.: p.3) of the south coast of Tasmania his Cape Frederick Henry corresponds to Cape Queen Elizabeth on Bruny Island, and Cape Basaltes to Cape Raoul on Tasman Peninsula. The region thus defined encompasses Storm Bay, Frederick Henry Bay and Norfolk Bay of Davies (1965: map 25). However a different concept of the bay is shown in one of Flinders's charts (Flinders 1814: inset on pl. VI), published later than these observations but drawn earlier in 1798-9. It depicts "Fredk. Hendrik's Bay" on the east coast of Tasmania in what is currently known as Marion Bay.

"E. alba" from near "Frederic Henry Bay". This is in accordance with the conclusion on the postulated relationships of the two manuscript names to the syntypes based on the descriptions in the manuscript.

Therefore it seems certain that the lectotype was collected in February 1804 near Storm Bay, Frederick Henry Bay, Norfolk Bay or Marion Bay, and most likely in the region of the first two. I have not seen any collections of ssp. collina from these regions, other than those from near Nubeena (Barker 968) and at Eaglehawk Neck (Giblin s.n.) both of which are on the Tasman Peninsula. The other syntype probably came from the upper slopes of Mt. Wellington, where similar specimens still flourish.

2. E. tasmanica (see Note 2)

Holotype: Simson 58, 17.x.1875. Georges Bay. LY(Herb.Spicer).

The type is in good condition and consists of a single floral branch terminated by a young inflorescence of buds.

At least one population (Barker 892) flourishes in the Georges Bay region in an extensive native scrubland.

3. Typification of the other synonyms of E. collina

For	E. tetragona	see	ssp. tetragona
	E. paludosa		ssp. paludosa
	E. speciosa		ssp. speciosa
	E. diemenica		ssp. diemenica
	E. multicaulis		ssp. tetragona
	E. muelleri		ssp. muelleri
	E. glacialis		ssp. glacialis
	E. walteri		ssp. collina
	E. novae-cambriae		ssp. paludosa
	E. deflexifolia		ssp. deflexifolia
	E. trichocalycina		ssp. trichocalycina
	E. maidenii		ssp. glacialis
	E. alpina		ssp. diemenica

DISTRIBUTION (Figs. 17-29):

E. collina is the commonest and most widespread species of Euphrasia in Australia, being distributed throughout the temperate regions of the continent from sea level to the top of the highest summit, Mt. Kosciusko at 2230m altitude. Its 15 subspecies and several other variants possibly warranting taxonomic recognition have much more limited ranges of distribution. In many cases it is difficult to determine the true extent of the distribution because of doubtful records from areas disjunct from the main range of distribution. These are possibly caused by the mixing of material from different collections or, alternatively, they may be authentic records lacking verification because of the sparse collections which have been made from the region. Details of the ranges of distribution and any uncertainties in these are included under the respective subspecies or, in the case of undescribed variants, in the discussions of their affinities in the Notes under E. collina.

ECOLOGY:

The wide-ranging altitudinal and geographical distribution of E. collina is clearly the result of its ability to inhabit a correspondingly wide range of habitats. The various subspecies have more limited ecological preferences, and their range of distribution and commonness reflect the range of distribution and commonness of their habitats. Details are found in the Notes on Ecology under the treatments of the various subspecies. Evidence of the strong ecological limits on their ranges of distribution is seen when two or more occur in the same region. Such examples are described under E. collina: Intraspecific Variation. In addition to ecological differences between the subspecies, there are some subspecies which are wider in their ecological requirements than others and tend to have a corresponding inherent, often apparently clinal variation which can sometimes be related to the environmental differences between the habitats or regions occupied by the morphological extremes.

Flowering occurs in spring and summer except for occasional earlier or later records. It varies with the climatic region. In lowland stations the main flowering season begins in August and continues until January or February, although in particular localities the duration is almost certainly less than this (see treatments of Ecology under ssp. trichocalycina and ssp. paludosa). In alpine conditions flowering mainly occurs between December and March. For details see under the respective subspecies.

NOTES:

1. An apparently undescribed subspecies of E. collina exists in sand dunes on the central north coast and the upper west coast of Tasmania (fig. 25). It seems clearly distinct from the other subspecies which lack glandular hairs (including ssp. tetragona which also occurs in dunes of the same general region) by its small oblong to broad oblong bracts and uppermost leaves (ca. 5-7.5mm long, 2.2-4.5mm broad) with 1-2(3) short lobes (ca. 0.5-0.9mm long) along each margin confined to the distal half, its small lowermost calyces (ca. 3.7-5.5mm long), its small corollas (ca. 6.5-9mm long, although the lowermost ones, which are absent, are possibly slightly longer) and its small capsules (ca. 4.5-7mm long). In addition the lower corolla lobes are shallowly emarginate to emarginate, and are glabrous or bear short dense eglandular hairs all over the external surface; the capsules are glabrous or with short setae confined to the apex or spread over the upper half, and the seeds are small (ca. 0.7-0.8mm long) and numerous. The plants from the west coast (Barker 990, Jackson 293) have branching in the aerial parts (pl. 25) but it is difficult to gauge the habit of the plants from which the three Stuart fragments were taken. Before formal recognition can

be justified a study of the dune populations of E. collina in Tasmania (at present the species is only known from the dunes of the north-west) should be made to ascertain the degree of morphological variation within this apparently distinct taxon, to discover whether distinctions from ssp. tetragona, ssp. diemenica, ssp. collina and ssp. paludosa are maintained.

SPECIMENS EXAMINED:

Tasmania

Barker 990, 24.xi.1970. Ca. 1km from the Arthur River holiday resort on the Marrawah Road. AD;pollen slide A.N.U.,AD. -- Jackson 293, -.i.1954. Corinna. Poa Dunes. HO. -- [Stuart] 943, -.xi.1850. Nr. Badger Head. MEL. -- St[uart] 943, s.dat. Sand Hills on N.W. Coast. MEL.

2. Collections from the east coast of Tasmania (fig. 18) from St. Helens or George Bay, which include the holotype of E. tasmanica (Simson 58), and near Murdunna well to the south on the Forestier Peninsula belong to the group of glandular subspecies of E. collina branched in the upper parts and with few-toothed leaves. There are three subspecies recognised in this group. From ssp. trichocalycina these plants differ by their fewer-flowered inflorescences (ca. 20 flowers), shorter posterior anther awns (ca. 0.1mm), and the shorter apices and teeth of their uppermost leaves (see pl. 8: Barker 892). The plants differ from ssp. gunnii by their denser inflorescences, usually glabrous capsules, rarely sparingly setose at the apex, and the short glandular indumentum (ca. 0.1mm), if present, at the base of the plant. From ssp. deflexifolia, which also occurs on the east coast of Tasmania, the plants are distinguishable by their fewer-flowered inflorescences, subglabrous capsules and the short glandular indumentum (if present) at the base of the plant.

It is likely that these plants represent a distinct subspecies, but as only one "mass" collection (Barker 892) has been made from populations its formal taxonomic recognition is premature. Further collections from populations at other localities are required to determine the variability and diagnostic value of the characters outlined above. So far the plants have been recorded from "Eucalyptus spp. (mixed) low woodland. Prominent shrub stratum. Sandy loam soil" (Barker 892) and "heath" (Curtis AD 9712109).

A population of lilac-flowered individuals from a mud flat beside a swamp on the Freycinet Peninsula (Barker 969, Himson HOp.p.) differs significantly from this apparently distinct subspecies only in flower colour. However only two specimens exist in herbaria. My two visits to the area to study this population produced only a single specimen. Mr. A. Himson, who accompanied me on the second visit, considered that the extensive population which had occupied the mud flat during his visits in 1968 and 1969 may have been over-grazed by kangaroos. The single specimen in Barker 969 certainly appears to have been grazed.

The two plants are characterized by a short sparse glandular indumentum confined to the rachis, bracts and calyces, an inflorescence apparently moderately dense in flower, and ovaries which are either glabrous or with a few short setae at the very apex. There is no evidence that the two plants are hybrids between ssp. collina and the nearby populations of ssp. deflexifolia as postulated by Dr. W.M. Curtis in a letter mounted with Himson's collection in HO. Ssp. collina is unknown along the east coast of Tasmania, and the original population was apparently about 1km away from the nearest plants of ssp. deflexifolia (pers. observ.; and Himson, pers. comm. 17.xi.1970). In addition there was a low percentage of sterile pollen in the single anther tested from Barker 969 (Appendix 1: PS8).

SPECIMENS EXAMINED:

Tasmania

Anon. s.n., 25.viii.1938. St. Helens. HO. —— Barker 892, 3.xi.1970. The south-eastern side of George Bay, ca. 8km east of St. Helens, on the track to St. Helens Point. AD. —— Barker 969 & Himson, 17.xi.1970. Freycinet National Park: at the edge of swamp, ca. 100m west of the sand dunes bordering Wineglass Bay. AD. —— Curtis per Barker s.n., -.xi.1970. ½ mile past Murdunna on Eagle-hawk Neck Rd. AD. —— Himson s.n., 1968. Wineglass Bay on margin of swamps. HO(p.p.). —— Simson 58, 17.x.1875. Georges Bay. LY(holotype of E. tasmanica).

3. Ssp. paludosa, ssp. speciosa and ssp. diversicolor are the clearly distinguishable, most extreme and most widespread variants of a complex of E. collina encompassing the majority of populations in the highlands of the south-east of Australia. Only ssp. glacialis, ssp. lapidosa and ssp. bowdeniae are reasonably distinct in this region, but they are restricted to very localised habitats. At this stage four variants, which cover the majority of records of the forms intermediate between ssp. paludosa, ssp. speciosa and ssp. diversicolor, can be recognized; each is restricted geographically (fig.19,20) and ecologically and is apparently morphologically distinct in its own right. Two of these variants occur in the Wellington-Buller-Speculation mountain system in the eastern highlands of Victoria, one occurring in the Mt. Wellington region (Barker 1479-1481,1483,1484; Beauglehole 41150, Carrick 3149), the other on the summit of Mt. Howitt (Beauglehole 40773, Willis MEL41564). The relationships of these glandular variants to ssp. paludosa, which in this region lacks subsessile glands (see below and ssp. paludosa: Note 2) and to several collections from other localities in the region (Barker 1513; Beauglehole 40747,41223; Gates 32, Thorn MEL41390) will remain obscure until field studies are carried out. Another apparently restricted variant (referred to as "aff. ssp. diversicolor") is found in the subalpine areas on The Cobberas in eastern Victoria.

The fourth variant has a range of distribution similar to its close relative ssp. _speciosa_; it is confined to the montane and coastal areas of southern and central New South Wales. (This variant has been called "aff. ssp. _speciosa_").

Unless otherwise stated the variation within a variant or recognized subspecies can occur within populations. Ssp. _diversicolor_ and its closely related form from nearby Mt. Cobberas are somewhat separated from the rest by the large seeds and large anthers and the consistent presence of a yellow blotch on the lower corolla lip. The other three variants and ssp. _paludosa_ and ssp. _speciosa_ are very closely related.

One of the main distinguishing characters in the complex is variation in, and the length and distribution of, the glandular indumentum. From a microscopic examination there is a complete transition in the morphology of the glands from the subsessile type found in ssp. _paludosa_ with the gland raised from the epidermis by a single-celled stalk shorter than the head, through to the gland being borne on a stalk much longer than the gland and consisting of several elongated cells. The variation in the number of cells of the stalk has not been measured, but it is unlikely to prove of diagnostic value superior to the associated character involving the length of the glandular hairs. Unlike the subsessile glands of the subalpine population of ssp. _paludosa_ (q.v.: Note 2) which are not sufficiently consistent in their occurrence to form the basis of taxonomic recognition, the longer glandular hairs in other subspecies and all but one of the other variants are apparently present throughout populations. The one exception is in the variant from Mt. Wellington, Victoria. Non-glandular plants occur sporadically in populations which are in the main composed of plants with at least the outer surface of the calyx very sparsely to densely glandular. In addition collections (Barker 1513, Beauglehole 4074) from areas of subalpine tussock grassland between Mt. Wellington and Mt. Howitt apparently come from populations with a similar mixture of glandular and non-glandular individuals, but a contrastingly higher frequency of the latter. These plants tend more to ssp. paludosa in their leaf characters than to the Mt. Howitt or Mt. Wellington variants. It is impossible to gauge their significance in the complex on such little information.

The variants and subspecies have distinctive ranges of distribution and climatic preferences, but little is known of the degree to which their integrity is maintained when sympatric. Only on the Cobberas have sympatric members of the complex been closely observed. From personal observations and the limited herbarium material available it seems that ssp. paludosa (Barker 1612,1617,1625) and the variant related to ssp. diversicolor (Barker 1616,1626) occupy distinct populations within subalpine conditions. (The lack of intermediates in Beauglehole 36486 indicates that the plants of the subspecies and variant contained in this collection have probably come from distinct populations). In the Mt. Wellington region non-glandular populations of ssp. paludosa occur in the nearby areas of wet sclerophyll forest (Barker 1489) while the glandular "Mt. Wellington variant" occupies subalpine snowgum woodland and tussock grassland. Similarly the two collections of the "Mt. Howitt glandular variant" were apparently collected from the summit region above the tree-line. Within snow-gum woodland populations of non-glandular ssp. paludosa (Barker 1504,1505,1510, 1511) are prevalent. In montane and lowland habitats ssp. speciosa and ssp. paludosa and one of the variants occur together. Their relationship is discussed under ssp. speciosa (Note 1).

Pollen sterility tests (Appendix 1) have been made on plants from the Mt. Howitt glandular populations (PS302-304), the glandular (PS294-301) and non-glandular (PS42-44) plants of the Mt. Wellington populations, the related glandular (PS286) and non-glandular (PS287-288) plants from the region between Mt. Wellington and Mt. Howitt, and a plant (PS181) of the New South Wales variant related to ssp. speciosa. There is no evidence that any of these populations are hybrid swarms. (There were occasional plants with high sterility but this is probably caused by other factors unrelated to hybridism.) The variants and subspecies seen in the field are almost certainly genetically independent populations. However, whether these variants warrant formal taxonomic recognition must await a critical revision of the complex throughout its entire range. Such a study should embody a wide field knowledge of the geographical and ecological range and variability of each member of the complex. It should also include an examination of the relationships with the closely-related ssp. trichocalycina which contains forms in the eastern highlands with leaves tending more in shape to those of ssp. paludosa than to its more western populations (see ssp. trichocalycina: Typification). Whatever the degree of intergradation between the subspecies and variants in the complex it is considered advisable to retain at least the three subspecies recognised herein to partition the wide, regionally based variation which occurs in this widespread complex.

SPECIMENS EXAMINED:

(Those from The Cobberas, with affinities to ssp. diversicolor, and those from New South Wales, with affinities to ssp. speciosa, are listed under those subspecies.)

Victoria

Barker 1479 & 1479A, 24.xii.1971. Ca. 50m S of Mt. Wellington summit along track to Moroka Gap. AD(2 specimens). — Barker 1480, 24.xii.1971. As for Barker 1479. AD. — Barker 1481, 24.xii.1971. Ca. ½km S of Mt. Wellington summit on saddle leading to and ca. ½km NE of Moroka Gap. AD. — Barker 1483, 24.xii.1971. On the Moroka

Road, which is between Mt. Arbuckle and the Moroka River, at the beginning of the track to Mt. Wellington and Lake Tarli Karng. AD(2 specimens). -- Barker 1484 & 1484A, 24.xii.1971. As for Barker 1483. AD(2 specimens). -- Barker 1513, 26.xii.1971. Howitt Plains; ca. 50m S of Howitt Hut, on the Howitt Road between Mt. Arbuckle and the Macalister headwaters at Mt. Howitt. AD(2 specimens). Beauglehole 40747, 27.xii.1972. S26. Snowy Range. Holmes Plain ± 9m N.W. of Mt. Wellington. BEAUGLEHOLE,AD. -- Beauglehole 40773 & Chesterfield, 28.xii.1972. S16. Mt. Howitt - on top. BEAUGLEHOLE,AD. -- Beauglehole 41150 & Chesterfield, 8.i.1973. S36. Mt. Wellington - near summit. BEAUGLEHOLE. -- Beauglehole 41223 & Chesterfield, 17.i.1973. S15. ± 13m. S.W. of Mt. Howitt, ± 3m S.S.E. of Mt. McDonald. Extreme S.E. Corner of grid. BEAUGLEHOLE,AD. -- Carrick 3149, 20.i.1972. 73 m[ile] s[tone] north of Heyfield, ca. 39 miles north of Licola, beyond Trapyard Hill. AD. -- Gates 32, 1890. Upper Goulbourn River. Wood's Point. MEL. -- Thorn s.n., 1891. Delatite River. MEL41390. -- Willis s.n., 6.xii.1970. Near summit of Mt. Howitt. MEL41564.

4. The collection of Rupp (MEL41405) from the north coast of New South Wales is unusual in its calyx indumentum which is a mixture of eglandular hairs, ca. 0.05mm long, and similarly long glandular hairs. It is related to ssp. muelleri by these eglandular hairs on the calyx. However, it is also related to ssp. trichocalycina by the presence of the glandular indumentum and its confinement to the calyx, its branching apparently well above ground level and its small upper leaves (on rather depauperate branches) with only 1 pair of teeth. Good collections are required from the Bungwahl area to establish the true relationship of this specimen.

SPECIMEN EXAMINED:

New South Wales

Rupp 2, -.i.1924. Smith's Lake, Bungwahl. MEL41405.

5. A specimen from Tamworth, New South Wales, about 250km north of the Blue Mountains contains two large fragments of floral branches or stems which resemble both E. collina ssp. bowdeniae and E. bella by the very weak habit, deflexed leaves and long-pedicellate flowers

in lax sparse racemes, apparently lacking flowers in the distal parts. By its narrow sessile leaves it is more closely allied to ssp. _bowdeniae_ than to _E. bella_, which is distinguished from _E. collina_ by its petiolate leaves. The fragments differ from ssp. _bowdeniae_ by their uppermost leaves which bear two pairs of lobes, and by their densely hairy, ciliolate corolla lobes. They are also characterised by the presence of young shoots well up the axis to a few nodes below the inflorescence and by calyces which are glabrous but for the rare presence of glandular hairs and very short eglandular hairs on the inner surface of the lobes. A search of similar habitats to those occupied by ssp. _bowdeniae_ if they occur around Tamworth may help to locate the source of this material, which may prove to represent a distinct taxon.

SPECIMEN EXAMINED:

[Rupp] 2 or 1, -.ix.1904. Tamworth, N.S.W. MEL41404.

6. By their possession of a single erect stem some first year plants of ssp. _speciosa_ and ssp. _paludosa_ may be confused with the annuals of Sect. _Scabrae_. The perennials can easily be distinguished by the absence of branches from all but the lowest nodes. The annual species have branching in a more or less rigid basipetal sequence starting from a position one to a few nodes below the inflorescence and occurring in all lower nodes. Nevertheless, the similarity between these two subspecies of _E. collina_, especially ssp. _paludosa_, and the geographically sympatric annual, _E. ciliolata_, apparently reflects a close morphological and evolutionary relationship.

INTRASPECIFIC VARIATION:

1. _The nature of the variation in E. collina_

The variation of _E. collina_ to be discussed in this section involves that of the characters which have been found of diagnostic importance in separating the populations of the species. The variation in these characters within populations is always narrow relative to the variation found throughout E. collina, which indicates that there is a large genetic basis to their variation.

It has been possible to divide this extremely polymorphic species into fifteen closely-related subspecies. In addition, reference is made to a number of other variants, as yet inadequately known, which are possibly also distinct subspecies. Each subspecies or variant has a distinctive ecological and geographical range; these are detailed under the treatments of each subspecies or, in the cases of the undescribed variants, under the Notes following the treatment of the species itself. It is often clear from these that the morphological differences between the subspecies are linked in some way to the differences in their respective environments. Whether the characters are of direct adaptive significance to the plant in its habitat or are simply an outward expression of essential physiological differences is impossible to determine in most cases. However, speculation on the adaptive significance of some of the characters have been included in the treatment of Morphology (Chapter 3).

The degree of variability within the subspecies varies greatly. In the subspecies which are highly localised geographically because of their confinement to very restricted and specialised habitats variation from population to population is slight. Examples of this type are ssp. lapidosa and ssp. glacialis. On the other hand several subspecies are widespread and vary between populations apparently on geographical, ecotypic or climatic bases. Such variation is discussed under the Notes in the treatment of each subspecies. They include a geographical variation in leaf shape in ssp. collina (q.v.: Note 2) ecotypic differentiation in ssp. diemenica (q.v.: Note 1) probably warranting taxonomic recognition and involving characters of indumentum, flower and leaf size and the incidence of the yellow corolla blotch; geographical variation in habit and leaf shape and ecotypic differences in the degree of fleshiness of the plant in ssp. tetragona (q.v.: Notes 2 and 3, respectively); regional differences possibly warranting formal taxonomic recognition in ssp. trichocalycina (q.v.: Typification); altitudinal variation in indumentum and seed size and regional occurrences of different habit types in ssp. paludosa (q.v.: Notes 2 and 3, respectively); geographical variation in corolla colour and the incidence of the yellow blotch on the lower corolla lip in ssp. osbornii (q.v.: Note 1); and possible genetically based ecotypic divergence in flower and leaf size and flower production in ssp. diversicolor (q.v.: Note 3). In the majority of these cases it is probable that the morphological gradient is of a clinal nature.

The reality of the subspecies as distinct taxa or genetically independent assemblages of populations can best be gauged in the study of sympatric occurrences, whether in the geographical or ecological sense, if they occur. These give an insight into the degree of genetic distinction between the subspecies. Sympatric occurrences, which have been closely studied in the field, are described in detail in the section II. These have been confined largely to the alpine and subalpine situations. In section III is an indication of the occurrences of sympatry in the subspecies of E. collina in various geographical regions of Australia in the many cases which have not been studied critically in the field. They mainly occur in montane and lowland regions. Where there is some indication of the type of interaction between two subspecies, whether from the examination of herbarium material or a limited view of the subspecies in the field, this has been referred to in section IV.

II. Field studies of subspecies of E. collina geographically sympatric for at least part of their range.

a. Subspecies of E. collina geographically sympatric but ecologically allopatric with no apparent morphological intergradation.

Ssp. lapidosa, ssp. glacialis and ssp. diversicolor all occur in the alpine zone on mountains in the Kosciusko region of New South Wales. Each occupies a distinct vegetation type, ssp. lapidosa being restricted to fjaeld-mark of the exposed ridge-tops, ssp. glacialis to the areas of short alpine herbfield which border the streams of the valley floors and ssp. diversicolor to the tall alpine herbfield which clothes the slopes between. Ecotonal intergradation occurs between ssp. diversicolor and ssp. glacialis (see section IIb1). In contrast ssp. lapidosa apparently remains morphologically distinct from the other two subspecies with little evidence of overlap of populations. It was observed in two localities. The first of these was on the upper slopes of the Etheridge Range where populations of ssp. diversicolor (Barker 1704) occupying tall alpine herbfield were found near the stony fjaeldmark areas which house a population of ssp. lapidosa (Barker 1706). Both subspecies occupy their pure habitats, although a small outlier (Barker 1705) of the fjaeldmark population was found in a small stony patch apparently divergent from pure "windswept" fjaeldmark by the presence of a diverse range of prostrate plants. Otherwise in the broad grassy stony ecotone between neither subspecies was seen to occur. No morphologically intermediate plants were observed.

The second population of ssp. lapidosa (Barker 1710) was found in a small area of fjaeldmark-like vegetation (see ssp. lapidosa: Ecology) on top of a platform jutting out from the valley floor into a channel cut out by a stream (pl. 25). The locality is distinctive in that ssp. lapidosa, ssp. glacialis and ssp. diversicolor all occur within 1m of each other. The flat areas of sediment just above the level of the stream a little over 1m below the top of the platform are occupied by a community of short alpine herbfield containing a profusion of plants of ssp. glacialis (Barker 1712). The steep sides of the platform are covered by tall alpine herbfield in which many plants of ssp. diversicolor occur (Barker 1711); these are part of the populations of the subspecies which abound in the extensive surrounding areas of tall alpine herbfield (Barker 1713). Unlike the situation at the first locality the boundary between the tall alpine herbfield and fjaeldmark-like vegetation is very sharp. No plants intermediate between ssp. lapidosa and either of the other subspecies were observed. In fact, on a smaller similar platform a few metres away which differs from the other by its almost complete absence of plants, two plants (Barker 1712A) in a somewhat depauperate condition but otherwise typical of ssp. glacialis were discovered near a single plant clearly of ssp. lapidosa (unfortunately mixed with the specimens from the other platform under Barker 1710). This indicates that the differences between these two subspecies are almost certainly genetically based.

On the basis of the above observations there must clearly be some barriers to inter-breeding between ssp. lapidosa and ssp. diversicolor and ssp. glacialis. One of these may be the much earlier flowering period of ssp. lapidosa relative to the other two subspecies; this was observed in both localities and appears to be related to the different rates of thaw in their respective habitats (Mr. D.J. Wimbush; pers.comm.Jan. 1972). It is difficult on these observations to gauge how important phenological differences are in maintaining the genetic integrity of ssp. lapidosa. In the first locality studied, there was an almost clearcut difference in flowering time between ssp. lapidosa and ssp. diversicolor and a broad ecotone lacking plants of

Euphrasia was present between their respective habitats. In the second locality, where many plants of ssp. lapidosa still bore their last flowers while many of the plants of the other two subspecies were in full flower, such an ecotone is absent. Judging by the intergradation between ssp. glacialis and ssp. diversicolor (see section IIb1) intermediate plants may only be able to occupy intermediate habitats. It is possible that in a locality with both an ecotonal situation and a sufficient overlap in flowering time an intergradation between ssp. lapidosa and one of the other subspecies might occur. If this were the case it would indicate that the populations in the first locality studied have probably never overlapped significantly in flowering time.

b. Subspecies of E. collina geographically sympatric, but ecologically allopatric with morphological intergradation along an ecotone

1. In contrast to the apparent absence of intergradation with ssp. lapidosa which has been discussed in the previous section (IIa), the differences between ssp. diversicolor and ssp. glacialis of the Kosciusko region of southern New South Wales break down in ecotones between their respective habitats of tall alpine herbfield and short alpine herbfield. The graph (fig. 21) portrays the morphological intergradation between the two subspecies in a narrow ecotone between the habitats. In this particular locality (pl. 25) both the populations of ssp. glacialis in the short alpine herbfield beside the streams (Barker 1685) and those of ssp. diversicolor in the tall alpine herbfield on the surrounding slopes (Barker 1686, and higher up Barker 1684) flower simultaneously, while the intermediate plants on the steep sides of the channels cut out by the streams (Barker 1687,1688) flower later. There is some overlap in flowering period with the populations of the two subspecies,

although the intermediate plants were mainly in bud at the time of observation. On much broader ecotones between the two habitats on the wide alpine valleys, where the slope into the streams is very gradual, a transition from plants in full flower in tall alpine herbfield to plants mainly in bud in short alpine herbfield was observed. Collections from such an area had to be divided somewhat artificially. The limits of the short alpine herbfield were reasonably clear and the specimens collected from there (Barker 1708) were found to be typical of ssp. glacialis. However the limits of the ecotone into the tall alpine herbfield were obscure and collections clearly from both were combined under Barker 1709. Between the tall alpine herbfield populations (Barker 1713) and short alpine herbfield populations (Barker 1712) on the steep sides of the platform bearing ssp. lapidosa, mentioned in section IIa, occur some plants intermediate between ssp. glacialis and ssp. diversicolor and others clearly typical of the latter; all were collected under Barker 1711 as in the continuous intergradation it was again impossible to divide the specimens into plants from the pure subspecies and their ecotonal intermediates. Here also there were no clearcut differences in flowering time by which to divide the plants artificially. This variability in the flowering times of the plants of the two subspecies and those on the connecting ecotone is apparently caused by the difference in the rate of spring thaw on areas with different slopes and exposures, with snow lying longer in spring on the steeper banks of the streams (Mr. D.J. Wimbush, pers. comm. Jan. 1972).

The characters distinguishing the subspecies are clearly genetically based. For example plants of Barker 1711, including some definitely of ssp. diversicolor, and plants of ssp. glacialis (Barker 1712) were found in sphagnum next to each other. If the morphological distinctions between the subspecies are genetically based, strong selective forces must be acting to maintain their morphological and ecotypic differences in the face of apparent facility of interbreeding between them.

An attempt has been made to determine the nature of the intergradation between ssp. diversicolor and ssp. glacialis by testing the degree of sterility of pollen from the anthers of all plants of the collections Barker 1685-1688 used in the graph (fig. 21) referred to above. The results are detailed in Appendix 1 (PS54-71,337-354), and have been incorporated into the same graph. From the graph it is clear that in the two subspecies and the intergradation between them individuals with pollen almost entirely functional in appearance are common. However in both the subspecies and the intergradation there are some individuals with varying degrees of pollen sterility. There does not appear to be a greatly significant increase in the sterility of morphologically intermediate plants in comparison to plants of the two subspecies; this would have pointed to the intermediate forms being a hybrid swarm. There are similarly sporadic occurrences of plants with rather high degrees of pollen sterility (Appendix 1: PS72-78) apparently unrelated to the morphological transition between the tall alpine herbfield and sphagnum populations of ssp. diversicolor in the Spencers Creek area (see ssp. diversicolor: Note 3.) It therefore appears that this incidence of abnormal levels of pollen sterility in populations of ssp. diversicolor, ssp. glacialis and their ecotonal intermediates may be caused by environmental influence or genetic or chromosomal irregularities unrelated to hybridism between existing sympatric subspecies. It cannot be determined on the above evidence whether the intergradation between the two subspecies is clinal in nature or a hybrid swarm between two interfertile subspecies.

2. Although ssp. paludosa and ssp. diversicolor are geographically sympatric throughout the Snowy Mountains of southern New South Wales they occupy different habitats and only rarely do the populations of the two come into close contact with each other. Ssp. paludosa apparently extends only as high as the subalpine zone where it is particularly common. Ssp. diversicolor is most plentiful in the alpine regions, but extends into the subalpine zone where it is almost entirely confined to small populations on the surrounds of sphagnum bogs. In the several cases of contact between the two subspecies in the subalpine zone no intergradation was observed. The detection of plants of the two subspecies was greatly aided by the yellow blotch on the lower corolla lip being always absent from ssp. paludosa and consistently present, although rarely faint and detectable only in mature buds, in ssp. diversicolor, as well as by the usual earlier flowering of ssp. paludosa. In the Toolong Range ssp. diversicolor (Barker 1677) was found on the edge of a bog or occasionally in sphagnum, within 30m of, but quite distinct from, a large population of ssp. paludosa (Barker 1676). A similar occurrence of ssp. diversicolor in sphagnum bordering the creek (Barker 1694) and ssp. paludosa in grassy sparse low subalpine heath (Barker 1695) occurs at Perisher Valley. At Long Plain, the northern-most known occurrence of ssp. diversicolor, Barker 1663 occupies a broad hollow of dense tussock grasses, obviously somewhat moister than the surrounding areas because of the presence of occasional sedges; ssp. paludosa (Barker 1662) flourishes in the surrounding subalpine tussock grassland some distance away. In all these localities no intermediates were observed. The nearest that the populations of the two subspecies were observed to grow together was on a steep hillside covered by snow-gum woodland above Pipers Creek near The Smiggin Holes. Again no intergradation between the

two subspecies was observed even though plants of each subspecies occurred within a few metres of each other. Ssp. diversicolor was found in a sphagnum bog (Barker 1692) or in the dense shrubbery surrounding it (Barker 1691) while ssp. paludosa grew amongst the dense Poa tussocks, especially in the more open expanses of grassland. Although in all these cases the populations of ssp. paludosa had all but completed flowering while those of ssp. diversicolor were still in flower, there must have been some overlap in flowering time. These differences in flowering time may be caused by the delayed spring growth of plants in moister areas (see also ssp. diemenica: Note 1) relative to those on better-drained ground. Clearly whatever the extent to which phenological differences are involved, there must be some means by which the genetic integrity of the two subspecies is retained when in such close proximity.

In only two localities were subalpine populations of ssp. paludosa seen to approach alpine populations of ssp. diversicolor. In one at the Spencers Creek bridge on the Mt. Kosciusko summit road ssp. paludosa occupies a region of low subalpine heath in the valley (Barker 1700), while ssp. diversicolor occurs on the slopes in tall alpine herbfield (Barker 1703) or in sphagnum (Barker 1707) or its surrounds (Barker 1702) on the edge of the water. The populations are apparently over a 100m apart. However one plant (Barker 1699) which is typical of ssp. diversicolor occurred in tall alpine herb-field close to the population of ssp. paludosa. As its pollen was found to be almost entirely functional in appearance (Appendix 1: PS335) it was almost certainly an outlier of the main population of ssp. diversicolor.

On Mt. Jagungal, the other locality where ssp. paludosa approaches alpine stands of ssp. diversicolor, intergradation occurs. In the tall alpine herbfield on top of the southern spur of the mountain occurs typical ssp. diversicolor (Barker 1665,1668), glandular and with yellow-blotched corollas. On the slopes leading down from the summit and also on the upper slopes of the spur in what is either pure subalpine tussock grassland or an ecotone into the tall alpine herbfield occurs a large number of plants with (Barker 1667,1671) and without (Barker 1666,1670) yellow-blotched corollas. This was the only locality seen in the entire Snowy Mountains region where plants of the two corolla colorations grew side by side. It is now evident that this unique situation is actually a hybrid swarm between the two subspecies. Examination of plants collected from the location showed that there is considerable variation in the characters distinguishing the two subspecies, namely the leaf shape, the length of the glandular indumentum (all plants resembling ssp. paludosa bear subsessile glands), the length of the lower corolla lip, the incidence of the yellow corolla blotch, the size of the anthers and the posterior pair of awns, the shape and indumentum of the capsule and the seed size. Thirty plants, some resembling either subspecies, others the intermediates, were selected for pollen sterility tests (see Appendix 1: PS305-334). The characters of the length of the glandular indumentum on the calyx, length of the posterior pair of anther awns and the presence or absence of the yellow blotch on the corolla were recorded at the same time. The length of the posterior anther awns was often taken from the final bud of an inflorescence, but it was found that in plants of each subspecies the range in size was still to that found in lower flowers when describing the subspecies. On the other hand it was found that the other characters distinguishing the two subspecies had to be measured from mature fruiting material and the lowest corollas of the inflorescence and these stages were not available in every plant. The results are plotted in the graph of fig. 22. Clearly the intergradation is a hybrid swarm between populations of ssp. diversicolor and ssp.

paludosa typical of the region.

This hybrid swarm gives an insight into the nature of the differences between the two subspecies. Firstly, since both subspecies retained their morphological distinctions where growing side by side in apparently the same conditions with only sterile hybrids bridging these morphological differences, it seems certain that the differences between them are genetically based with little influence from the difference in the habitats. Furthermore, since this breakdown in morphological distinctions occurs apparently outside the typical habitats of either subspecies and because they are distinct ecotypes elsewhere, it appears that strong selective forces related to habitat differences are acting on the genes determining the morphological differences between the two subspecies.

3. On the upper slopes of Mt. Wellington, Tasmania, along the summit road between The Springs at about 700m and the tree-line at about 1100m occur populations of plants belonging to ssp. *collina* or ssp. *diemenica* or a transition between them. Ssp. *diemenica* is predominantly an alpine inhabitant in the region but a population (Barker 1141), which is typical of ssp. *diemenica* by its calyx indumentum of subsessile glands, broad upper leaves on the main floral axes (pl. 7) and decumbent branches simple above ground level, occurs in regenerating wet sclerophyll forest a little above The Springs. Ssp. *collina* in its typical form does not seem to occur in the region; in the lower montane regions surrounding Mt. Wellington it is characterized by a non-glandular indumentum, narrow upper leaves on the main floral axes (pl. 7) and its stem and main floral branches branched high above ground level. Populations intermediate between ssp. *collina* and ssp. *diemenica* in these characters occur in sclerophyll forest or woodland between The Springs and the tree-line (Barker 978,1138,1146,1147,1149). They resemble ssp. *collina* by their

narrow uppermost leaves (pl. 7: Barker 1138,1146,1147) and a usually non-glandular indumentum, although rarely (Barker 1149A) sparse glandular hairs may line the bracts and calyx teeth. These populations vary, however, in the extent of branching above ground level; often more or less decumbently branched plants, simple above ground level, are present. It is not known whether in this area plants are truly part of an intergradation between the two subspecies or whether the integrity of the two subspecies is maintained in the area, with the apparent breakdown in habit characteristics being caused by environmental factors or independent genetic variation. Pollen sterility tests (Appendix 1) on the intergrading populations (PS209-216,336) and ssp. diemenica in both the alpine zone (PS2117-225) and in the population (Barker 1141) much lower down the mountain (PS205-208) show little evidence for morphological intergradation caused by hybridization. Occasional individuals producing a high percentage of sterile pollen occur in both the pure populations of ssp. diemenica in the alpine zone and plants from the intermediate zone, but the majority of plants tested, including the narrow-leaved slightly glandular plant (Barker 1149A: PS336) mentioned above, show normal levels of pollen of functional appearance.

c. Subspecies of E. collina geographically and ecologically sympatric with little or no apparent intergradation

Ssp. collina and ssp. trichocalycina both occur in the Grampians of western Victoria where they are distinguished solely on the basis of their non-glandular and shortly glandular indumentum respectively. In all other respects, except perhaps the occasional presence of a yellow corolla-blotch only in ssp. collina, the plants of the two subspecies in the region seem morphologically indistinguishable. From the samples and observations made of populations of E. collina in the Grampians it is probable that the two subspecies are genetically independent and occupy distinct populations with similar ecological preferences. Of my nine collections of the two subspecies in the Grampians, five were purely of ssp. collina and totalled 28 plants, while three were of ssp. trichocalycina and contained 33 plants. In only one case (Barker 1439) was there a mixture with one plant of ssp. trichocalycina mixed with seven plants of ssp. collina, but this may have been caused by mixing of plants from different collections, as the samples from a number of populations were pressed at the same time. There is no evidence of mixing in any of the many other collections of E. collina from the Grampians. Further study is required of the morphological, genetic and ecological separation of the two subspecies throughout their common range to determine whether they are truly intersterile and identical in their ecological preferences.

III. Other cases of sympatry in the subspecies of E. collina in need of study.

In the above section have been discussed cases of sympatric subspecies which have been studied in the field. Because there is intergradation between sympatric subspecies in several of these cases, it would seem important to discover by critical field studies whether in the many other areas where geographically sympatric subspecies occur the subspecies remain in distinct populations or intergrade locally in a similar manner, perhaps along an ecotonal gradient.

Subalpine and alpine areas with sympatric taxa have been studied personally and have been discussed in the previous section. The sympatric subspecies in the various other regions are outlined as follows:

Tasmania:

There is much work to be done on E. collina in the lowland and montane regions of the north and east of the island. Collections are rather few, usually old and often contain few plants. Only in the

Hobart region is there a large number of collections, but even close to Hobart there is a subspecies (see ssp. gunnii: Distribution) which has only been collected once. In the region between the Midlands and the east coast occur ssp. collina, a variant closely related to ssp. diemenica (q.v.: Note 2), ssp. gunnii, ssp. deflexifolia and a possibly undescribed subspecies related to the last two subspecies (see E. collina: Note 2). The north and north-west of the island are inhabited by ssp. tetragona and plants possibly representing an undescribed subspecies (see E. collina: Note 1) both of which may be confined to coastal sand dunes, as well as ssp. diemenica and its closely related variant described above, which probably both occur in montane localities.

South Australia (excluding the Lower South-East):

Ssp. osbornii, ssp. muelleri and ssp. paludosa are known from the Mt. Lofty and Southern Flinders Ranges. The latter two have not been collected there for over a century. Ssp. tetragona, which is generally geographically separated from these subspecies, may also occur in these ranges in the regions of Mt. Kitchener and Mt. Remarkable (see ssp. tetragona: Note 4). It may also overlap with ssp. osbornii (q.v.: Note 1) in the Upper South-East with a possible introgression of characters.

Lower South-East of South Australia - Western Victoria:

The two subspecies of the Grampians ssp. collina and ssp. trichocalycina, the sympatry of which is discussed in Section IIc, apparently extend onto the surrounding plains; however ssp. trichocalycina may be rare on these plains as it is known only from one locality near the coast. The plains are also occupied by ssp. tetragona, ssp. muelleri and ssp. paludosa; no collections of the latter two have been made for many years. Ssp. collina and ssp. trichocalycina may be confined to swamps, at least in the southern lowland regions, while ssp. tetragona is probably restricted to sandy mallee heaths. There is evidence from a single specimen that ssp. paludosa and ssp. muelleri intergrade in the area (see Sect. IVa2).

Central Victoria:

Ssp. collina, ssp. trichocalycina (itself possibly containing two taxa: q.v. Typification), ssp. paludosa, ssp. muelleri and ssp. speciosa all occur in this region. The mass collections required to distinguish ssp. collina and ssp. paludosa with certainty are lacking from this region. However by grouping collections related to these subspecies on their likely affinities, it appears that outside the western part of the Eastern Highlands in the remainder of central Victoria the two subspecies occupy distinct ranges of distribution (see ssp. collina: Note 1, ssp. paludosa: Note 1). There is no evidence of intergradation between the subspecies. On the basis of data from other regions ecological preferences seem similar for ssp. collina, ssp. paludosa, ssp. trichocalycina and ssp. speciosa, while those of ssp. muelleri are little known. The only evidence of ecological distinction between sympatric subspecies in the region is found in Mueller's collections from Forest Creek. His specimen MEL41512 of ssp. trichocalycina came from "swamps" while that of ssp. muelleri (MEL41511) was gathered from "hills". A specimen (Mueller MEL41385 p.p.) apparently of ssp. collina was also collected there.

Eastern Coastal Plains and Wilson's Promontory, Victoria and the extreme South East of New South Wales:

Ssp. collina and ssp. paludosa occur in this area from which few collections of E. collina have been made. The former subspecies tends to occupy the coastal areas, while the latter may come from more montane regions. There is, however, one inland collection of ssp. collina from Tyers. The three collections from Wilson's Promontory each seem most closely allied to a different subspecies, namely the above two subspecies and apparently ssp. tetragona. The specimen allied to ssp. tetragona may represent an extreme variant of a population of one or other or a mixture of the other two subspecies, as the nearest known populations of ssp. tetragona are widely disjunct from this locality.

Central and Southern New South Wales:

Widespread in this region are ssp. paludosa, ssp. speciosa and a variant intermediate between them (see E. collina: Note 3), together with ssp. collina, which is confined to the south-east corner of the state, ssp. bowdeniae, which is apparently endemic to the Blue Mountains, and ssp. muelleri, which is represented by a few widespread collections and which may now be extinct. Ssp. bowdeniae (q.v.: Ecology) is apparently ecotypically distinct from ssp. paludosa. It is not known whether the variant intermediate between ssp. paludosa and ssp. speciosa represents part of a clinal or introgressive intergradation between the two subspecies or a distinct taxon (see E. collina: Note 3). However the two subspecies are apparently distinct morphologically and spatially in the Brindabella Range of the Australian Capital Territory (see Sect. IVb4).

Northern New South Wales:

Ssp. paludosa and ssp. muelleri, which is represented by only two records in the region, extend into this area from the south. Ssp. nandewarensis is known only from the Nandewar Range and the Warrumbungles which are two western offshoots of the Great Dividing Range. Two records of ssp. paludosa from the vicinity of the Warrumbungles indicate that at least this subspecies may also occur in these ranges.

IV. Indications of the kind of interaction between subspecies of limited field and herbarium observations

There are probably a number of undescribed taxa encompassed by the alpine and subalpine populations of ssp. diemenica. The nature of the variants seen in the field, and the kind of interactions which occur when sympatric are described in Note 1 of the treatment of ssp. diemenica.

a. Evidence for a possible intergradation between subspecies of E. collina

1. The specimen Phillips CBG015457 from the foot of the Great Western Tiers in northern Tasmania is intermediate between two subspecies which occur in the region, namely ssp. diemenica of the alpine and subalpine zones and ssp. gunnii, which occupies the montane and lowland zones. The plant is allied to both subspecies by its complete cover of glandular hairs, which are 0.1-0.2mm long on the calyx and 0.3mm long on the axes at the base of the plant, its upper leaves with 0-1 teeth on each side and with the sessile glands confined to the margins, its shallowly emarginate lower corolla lobes, which are externally hairy all over, and its capsules with a densely setose apex. It approaches ssp. diemenica and differs from ssp. gunnii by its many-flowered inflorescences (with ca. 20-35 flowers), large flowers (over 14mm long) and large seeds (1.3-1.7mm) long; in contrast it resembles ssp. gunnii and diverges from ssp. diemenica by the narrowness of its leaves and the presence of shoots above ground level, but confined to the lower third of the main branches.

It is probably that rather than being a unique extreme of either of the two subspecies, this plant comes from an intergradation between nearby alpine and subalpine populations of ssp. diemenica and montane and lowland stands of ssp. gunnii.

2. Two collections (Muir 2692,3108) from open grassy areas in light sclerophyll forest or snowgum woodland near Mt. Wellington in the eastern highlands of Victoria may come from an intergradation between ssp. paludosa, which is prevalent in the region, and ssp. muelleri which has not been recorded in the area and is little-recorded in south-eastern Victoria. The specimens, which probably come from four

plants in all, resemble both subspecies by the upper leaves with 2-3 teeth along the upper $\frac{1}{2}$-$\frac{3}{4}$ of each margin, and obtuse to emarginate corollas externally hairy all over, but diverge from the majority of members of either by the branching extending above ground level over the lower $\frac{1}{3}$ - $\frac{1}{2}$ of the main axes. The indumentum on the external surface of the calyx varies between the characteristics of both subspecies. That of one plant is almost glabrous and is therefore typical of ssp. paludosa, on another two is a densely scaberulous indumentum typical of ssp. muelleri, while the fourth is very sparsely scaberulous. A study of the area is required to determine whether these collections are extreme variants of ssp. paludosa or are truly an intergradation between the two subspecies.

The three floral branches which make up the collection Robertson NSW10938 from western Victoria point to a further example of intergradation between ssp. paludosa and ssp. muelleri. The branches clearly have come from the same population as they are almost identical in the stage of flowering, the shape of the apical bud cluster, and the size, the extent and number of teeth, and the distribution of the sessile gland patches of leaves in analogous positions. Two of the branches resemble ssp. paludosa by their externally glabrous calyces, while the calyces of the third bear a dense moderately long weak eglandular indumentum. A search of the remaining large areas of natural vegetation in the Casterton - Wando Vale region may reveal populations which provide a basis for an understanding of these species. Neither subspecies has been collected in the region for many years.

b. Evidence that subspecies of E. collina maintain their integrity when sympatric

1. Ssp. deflexifolia and a related possibly undescribed subspecies.

Populations of these are apparently ecologically separated (for details see under E. collina: Note 2).

2. Ssp. gunnii and a variant related to ssp. diemenica (q.v.: Note 2).

These (Barker 913 and 923 respectively) were observed to occupy distinct populations in montane forest near Launceston. However, the distance between the populations was several kilometres.

3. Ssp. paludosa and a related variant in The Cobberas.

Populations are apparently ecologically separated. For details see under E. collina: Note 3.

4. Ssp. paludosa and ssp. speciosa.

The one population of ssp. speciosa seen personally (Barker 1630) was found in the Brindabella Range of the Australian Capital Territory. There was no sign of plants of ssp. paludosa, which is prolific in the area, in the vicinity of this population. There is also no evidence of mixing of plants of either subspecies in herbarium material, even though they have similar ranges of distribution and ecological preferences.

5. Ssp. paludosa and ssp. bowdeniae.

These occur in apparently ecologically distinct populations with no intergradation. This is discussed under ssp. bowdeniae (Ecology and Notes).

SPECIMENS INTERMEDIATE BETWEEN SSP. DIVERSICOLOR AND SSP. GLACIALIS:

New South Wales

Barker 1687, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit on valley below and ca. 400m NW of Seamans Hut, on snowpole line to Lake Albina. AD. — Barker 1688, 25.i.1972. As for Barker 1687. AD. — Barker 1709(p.p.), 27.i.1972. Kosciusko National Park. Ca. 2km NE of Mt. Kosciusko summit; in the second valley ca. 1km NW of Seamans Hut along snowpole line to Lake Albina. AD(p.p.). — Barker 1711(p.p.), 27.i.1972. Kosciusko

National Park. Ca. 2km NE of Mt. Kosciusko summit; ca. 1km N of Seamans Hut along snowpole line to Lake Albina; at bottom of valley immediately S of Mt. Northcote. AD(p.p.). -- Gray & Totterdell 6518, 7.i.1972. Snowy R. bridge below Seaman's Hut, Kosciusko area. CANB. -- Gray & Totterdell 6630, 22.iii.1972. Near Lake Cootapatamba, Kosciusko area. CANB. -- McVean s.n., 9.ii.1967. Mt. Kosciusko. CANB.

SPECIMENS EXAMINED OF SSP. PALUDOSA X SSP. DIVERSICOLOR:

New South Wales: Kosciusko National Park. SE end of Toolong Range. Barker 1666(p.p.), 22.i.1972. On top of the southern ridge of Mt. Jagungal, ca. 50m below and ca. ½km S of summit. AD(p.p.). -- Barker 1667, 22.i.1972. As for Barker 1666. AD. -- Barker 1668(p.p.), 22.i.1972. As for Barker 1666, 1667, but ca. 20m away. AD. -- Barker 1670(p.p.), 22.i.1972. On top of southern ridge of Mt. Jagungal, ca. ¼km S of summit. AD. -- Barker 1671, 22.i.1972. As for Barker 1670. AD. -- Barker 1672, 22.i.1972. On top of southern ridge of Mt. Jagungal, ca. 1½km S of summit. AD.

SPECIMENS INTERMEDIATE BETWEEN SSP. COLLINA AND SSP. DIEMENICA:

Tasmania

Anon. s.n., s.dat. Without locality. GH(p.p.). -- Anon. s.n., s.dat. Without locality. G. -- Barker 978, 18.xi.1970. Mt. Wellington: below the Organ Pipes; 50-100 metres up road from sign re geology of the area, ca. 2.4km from The Springs on the road to the Pinnacle. AD. -- Barker 1138, 15.i.1971. Upper slopes of Mt. Wellington; below the Organ Pipes above the summit road opposite mile-post 4 miles (6.4km) from Fern Tree (same locality as Barker 978). AD(2 specimens). -- Barker 1146, 17.i.1971. As for Barker 1138. AD(2 specimens). -- Barker 1147 & 1147B, 17.i.1971. As for Barker 1138. AD(2 specimens). -- Barker 1149, 17.i.1971. Upper slopes of Mt. Wellington; ca. 2 miles (3.2km) from The Springs on the summit road. AD(2 specimens; pollen sample A.N.U.,AD.). -- [Black] s.n., s.dat. Garden Id. Creek. MEL38919. -- Brown s.n., s.dat. Derwent. BM(p.p.: syntype of E. collina); K(p.p.), MEL41468(p.p.). -- Caley s.n., s.dat. V.D.Land. G. -- [Cleland] s.n., 28.x.1939. Mt. Wellington, Hobart. AD97308390 . -- [Curtis] s.n., 6.i.1947. Mt. W[ellington]. Foot of Organ Pipes. HO. -- [Curtis] s.n., 14.xii. 1962. Near shelter hut, Mt. W[ellington]. HO.-- Hooker s.n., s.dat. Without locality. MEL41461. -- Ising s.n., 23.i.1928. Side of

Mt. Wellington. AD966020872. -- Long 365, 27.v.1931. Springs - Lenah Valley track. HO,CANB. -- Long 703, 10.x.1931. Mt. Wellington HO. -- Paton s.n., -.i.1953. Collin's Gap. HO(3 specimens). -- Phillips 733, 28.ii.1965. Mt. Wellington, at junction of main road and dolerite still. CBG. -- Ratkowsky s.n., 20.ix.1973. Mt. Wellington. AD97339098. -- Tindale s.n., 13.xii.1954. Mt. Wellington. NSW126372.

SPECIMENS INTERMEDIATE BETWEEN SSP. DIEMENICA AND SSP. GUNNII:

Tasmania

Phillips s.n., 6.xii.1965. 5 miles from Poatina towards Miena. GBG015457.

SPECIMENS INTERMEDIATE BETWEEN SSP. PALUDOSA AND SSP. MUELLERI:

Victoria

Muir 2962, 31.xii.1963. Hillside above Tali Karng, Gippsland. MEL. -- Muir 3108, 3.i.1964. Gippsland. About 2 miles south-west of Mt. Wellington on the Tali Karng track. MEL. -- Robertson s.n., s.dat. Wando Vale. NSW10938.

KEY TO THE INFRASPECIFIC TAXA OF E. COLLINA

Points to note:

1. It is stressed that to be certain of attaining an accurate determination a collection of at least about six or preferably more plants should be made from a single population and studied in its entirety for variations in the cited characters.

2. The unbracketed range of variation in quantitative characters is that common to ca. 80% of the plants in the taxon; in brackets are the extremes of variation.

3. Floral measurements all apply to the lowermost pair of flowers. However characters of indumentum and shape apply equally to flowers throughout an inflorescence except possibly the depauperate last-formed ones. The length of the posterior anther awns may apply more or less to higher flowers in the inflorescence.

4. Attention is drawn to the fact that the position of the uppermost

branches on the main axes used in leads 6 and 10 is gauged from the presence of not only mature branches but also the young shoots which may require a hand lens to be discerned.

1a. External surface of calyx glabrous (except for a small area below each cleft).

2a. Uppermost leaves of main floral axes with 4-6 pairs of teeth. Base of plant glandular. [Branching from ground level; lower corolla lobes obtuse to truncate, externally pilose.]

j. ssp. nandewarensis

2b. Uppermost leaves of main floral axes with (0)1-3(6) pairs of teeth. Base of plant usually non-glandular, rarely (in ssp. paludosa and ssp. diemenica) glandular.

3a. Ovules few, (ca. 19-40). Main axes weak, decumbent or procumbent. Leaves deflexed greatly, pliant when dried. Inflorescences weak. [Endemic to Blue Mountains, New South Wales].

i. ssp. bowdeniae

3b. Ovules many, (70)80-180(200). Main axes rigid, erect or decumbent. Leaves ascending or deflexed, rigid and often brittle when dried.

4a. Lowest node of main inflorescence with corollas 6.5-9(?10)mm long along upper side, capsules 4.5-7mm long.

?ssp. indescr. [see E. collina: Note 1]

4b. Lowest node of main inflorescence with corollas (7.3) 8.5-13.5mm long or longer along upper side, capsules (6)7-9.5mm long or more.

5a. Lower corolla lobes externally glabrous [usually emarginate or deeply so, rarely shallowly emarginate, with lower lip (5.2)6-10.5(13)mm long. Uppermost leaves of main axis with (0)1-2(4) pairs of teeth confined to distal (0)0.15-0.5(0.6) of leaf. Posterior pair of anther awns (0.1)0.2-0.5mm long. Seeds (0.5)0.6-0.9(1.0)mm long].

c. ssp. tetragona

5b. Lower corolla lobes externally usually pilose all over or along midline, rarely pilose at base only (best seen in mature buds).

6a. Main floral axes bearing branches or having shoots (sometimes very small) well above ground level, i.e. simple below inflorescence for (0.05)0.1-0.55(0.8) of the height of the inflorescence above ground level.

7a. Uppermost leaves of main axes (1.5)2.0-4.2(4.4)mm broad, with (0)1(2) pairs of teeth, confined to distal (0)0.15-0.35(0.45) of leaf. Lower corolla lobes usually emarginate to truncate, rarely obtuse. Posterior pair of anther awns (0.2)0.3-0.5(0.6)mm long.

a. ssp. collina

7b. Uppermost leaves of main axes (2.4)3.4-7.0(8.0)mm broad, with 1-3(6) pairs of teeth, confined to distal (0.2)0.3-0.65(0.85) of leaf. Lower corolla lobes usually obtuse or truncate, sometimes shallowly emarginate, rarely emarginate. Posterior pair of anther awns (0.15)0.2-0.3(0.4)mm long.

g. ssp. paludosa

6b. Main floral axes bearing branches or young shoots (sometimes very small) near ground level, i.e. simple below inflorescence for 0.8-1.0 of the height of the

8a. Uppermost leaves of main floral axes with lateral extensions of the marginal rows of sessile glands on the lower surface usually short, rarely extended past the distal side of the base of the nearest proximal tooth (if one is present); teeth confined to distal (0.1)0.2-0.45(0.55) of leaf; apex (0.6)0.8-1.8(2.5)mm long. Lower corolla lip (4.5)5-12(14)mm long, with lobes usually emarginate or deeply so, sometimes shallowly emarginate, rarely truncate. Posterior pair of anther awns (0.2)0.3-0.5(0.6)mm long. Seeds (0.9)1.1-1.9mm long.

b. ssp. diemenica

8b. Uppermost leaves of main floral axes with lateral extensions of the marginal rows of sessile glands on the lower surface usually long, often reaching past distal side of the base of the next proximal tooth (if one is present), rarely short; teeth confined to distal (0.2)0.3-0.65(0.85) of leaf; apex (1.1)1.3-2.8(4.3)mm long. Lower corolla lip (4)4.5-7(8.5)mm long, with lobes usually obtuse or truncate, sometimes shallowly emarginate, rarely emarginate. Posterior pair of anther awns (0.15)0.2-0.3(0.4)mm long. Seeds (0.5)0.7-1.3(1.5)mm long.

g. ssp. paludosa

1b. External surface of calyx hairy.

9a. Bracts and external surface of calyx covered by eglandular hairs. [Main floral axes with shoots or branches usually forming near ground level, rarely higher up.]

h. ssp. muelleri

9b. Bracts and external surface of calyx with glandular hairs, sometimes mixed with eglandular hairs.

10a. Main floral axes bearing branches or shoots (which may be very short) high above ground level, i.e. simple below inflorescence for (0.05)0.1-0.75(0.85) of the height of the inflorescence above ground level. [Yellow blotch usually absent from lower corolla lip, rarely (in some populations of ssp. osbornii: q.v. Note 1) present.]

11a. Uppermost leaves of main floral axis with (1)3-6(8) pairs of teeth distributed over distal (0.35)0.55-1.0 of leaf. Seeds 0.4-0.9(1.0)mm long. [Main inflorescences bearing (20)24-56(60) glowers. Glandular hairs on calyx 0.1-0.25(0.3)mm long. Posterior pair of anther awns (0.1)0.2-0.4mm long. Capsules with distal $(\frac{1}{4})\frac{1}{3} - \frac{1}{2}(\frac{2}{3})$ covered by moderately dense to dense setae. Uppermost leaves (3.0)3.5-9.0(11.0)mm broad, with apex (1.1)1.2-2.9(3.3)mm long and longest tooth (0.4)0.9-1.7(2.9)mm long.]

1. ssp. osbornii

11b. Uppermost leaves of main floral axes with (0)1-2(4) pairs of teeth distributed over distal (0.15)0.2-0.65 (0.7) of leaf. Seeds (0.5)0.7-1.1(1.5)mm long.

.... cont.

12a. Glandular hairs on calyx 0.05-0.1(0.2)mm long, those at base of plant, if present, up to 0.1mm long. Capsules glabrous or with few to moderately dense setae at apex.

13a. Main inflorescence with (14)20-40(48) flowers. Posterior anther awns (0.1)0.2-0.4(0.5)mm long. Uppermost leaves of main floral axis with apex (1.2)1.7-3.0(3.4)mm long, with longest tooth 0.8-2.0(2.4)mm long. Glandular indumentum rarely at base of plant.

d. ssp. trichocalycina

13b. Main inflorescences with fewer (ca. 20) flowers. Posterior anther awns ca. 0.1-?0.2mm long. Uppermost leaves of main floral axis with apex (0.8) 1.0-1.9mm long, with longest tooth 0.5-1.0(1.2)mm long. Glandular indumentum often at base of plant.

?ssp. indescr. [see E. collina: Note 2]

12b. Glandular hairs on calyx 0.1-0.3mm long or longer, those at base of plant, if present, 0.1-0.2(0.5)mm long. Capsules usually with dense setae over distal $(\frac{1}{2})\frac{1}{4}-\frac{1}{8}$ or less, sometimes (ssp. gunnii) with few setae at apex or glabrous.

14a. Uppermost leaves of main floral axis (1.9)2.1-3.2(4.2)mm broad, with 1(2) pairs of teeth. Main inflorescences with (10)12-24(28) flowers. Posterior pair of anther awns (0.1)0.2-0.3mm long.

e. ssp. gunnii

14b. Uppermost leaves of main floral axes (2.5)2.9-6.0 (7.4)mm broad, with 1-2(4) pairs of teeth. Main inflorescences with (16)18-40(46) flowers. Posterior pair of anther awns (0.1)0.15(0.3)mm long.

f. ssp. deflexifolia

10b. Main floral axes bearing branches or shoots (which may be very short) near ground level simple above or sometimes (in ssp. *speciosa*) branched some way up, i.e. simple below inflorescence for (0.5)0.7-1.0 of the height of the inflorescence above ground level.

15a. Glandular indumentum on external surface of calyx up to 0.1(0.15)mm throughout plants in population.

16a. Glands on external surface of calyx subsessile, 0.05mm long and less in plants of population.

g. ssp. *paludosa*

16b. Glands on external surface of calyx usually clearly stalked, 0.05-0.1(0.15)mm long in plants of population.

17a. Uppermost leaves of main floral axes with (0)1-2(4) pairs of teeth distributed over distal (0.1)0.2-0.45(0.55) of leaf. Lower corolla lobes usually emarginate or deeply so, sometimes shallowly emarginate, rarely truncate or praemorsely so. Seeds (0.9)1.1-1.9mm long.

b. ssp. *diemenica*

17b. Uppermost leaves of main floral axes with 2-4(6) pairs of teeth distributed over distal (0.35)0.5-0.9(0.95) of leaf. Lower corolla lobes usually obtuse, sometimes truncate, rarely emarginate. Seeds 0.6-1.2mm long. [Plants from Mt. Howitt-Mt. Wellington region of Victoria.]

.... cont.

[18a.] Glandular indumentum often on upper and lower parts of plant but absent in middle parts, sometimes all over or confined to inflorescence; on calyx sparse to dense, denser on teeth. Capsules glabrous or setose. [Variant from Mt. Wellington, Victoria.]

?ssp. indescr. [see E. collina: Note 3]

[18b.] Glandular indumentum distributed all over plant; on calyx dense all over. ?Capsules densely setose. [Variant from Mt. Howitt, Victoria.]

?ssp. indescr. [see E. collina: Note 3]

15b. Glandular indumentum on external surface of calyx (0.05) 0.1-0.2mm long or (in some taxa) longer in plants of population.

19a. Uppermost leaves of main floral axes with (0)1-2(4) pairs of teeth.

20a. Main inflorescences with (6)12-26(30) flowers. Main floral axes (5.5)7-17(25)cm high to base of inflorescence; the longest internode (1.3)2.5-5(6) times the length of upper leaves. Uppermost leaves obovate or subspathulate to elliptic or oblong; lateral extensions of the marginal rows of sessile glands on lower surface usually short, rarely long and extended past the distal side of the base of the next proximal tooth (if one is present); apex (0.6)0.8-1.8(2.5)mm long, (1.0)1.3-2.5(3.7)mm broad. Capsules usually sparsely to densely setose, rarely glabrous.

b. ssp. diemenica

...... cont.

20b. Main inflorescences with ca. 6-12 flowers. Main floral axes (2.5)3.5-9.5(13)cm high to base of inflorescence; the longest internode (0.9)1.7-3(3.5) times the length of upper leaves. Uppermost leaves obovate to ovate, often broadly so; lateral extensions of the marginal rows of sessile glands on lower surface usually long, often extended past the distal side of the base of the next proximal tooth (if one is present), rarely short; apex (0.9)1.2-2.5(3.5)mm long, (1.6)2.0-3.2(3.8)mm broad. Capsules subglabrous.

o. ssp. glacialis

19b. Uppermost leaves of main floral axes with (1)2-4(8) pairs of teeth.

21a. The number of upper internodes on main floral axes as long as or longer than upper leaves 0-3(4), the longest internode (0.3)0.5-1.8(2.1) times the length of upper leaves. [Glandular hairs on calyx (0.1)0.2-0.5mm long. Yellow blotch always present on lower corolla lip. Posterior pair of anther awns (0.25)0.3-0.5(0.6)mm long. Seeds (0.8)0.9-1.2(1.4)mm long.]

n. ssp. lapidosa

21b. The number of upper internodes on main floral axes as long as or longer than upper leaves (2)4-8(13), the longest internode (1.8)2.2-4.0 or more times the length of upper leaves.

...... cont.

22a. Seeds (0.9)1.1-1.7(1.9)mm long. Anthers (1.7) 1.8-2.6(3.0)mm long, with posterior pair of awns (0.25)0.3-0.5(0.6)mm long. Yellow blotch on lower corolla lip always present.

23a. Glandular hairs 0.1-0.3(0.5) long on calyx, usually confined to upper parts, sometimes over whole plant.

m. ssp. diversicolor

23b. Glandular hairs (0.05)0.1-0.2(0.4)mm long on calyx, distributed all over plant. [Variant from The Cobberas, Victoria.]

?ssp. indescr. [see E. collina: Note 3]

22b. Seeds 0.4-0.9(1.0)mm long. Anthers (1.3)1.4-1.9(2.2) mm long, with posterior pair of awns (0.1)0.2-0.3 (0.4)mm long. Yellow blotch on lower corolla lip ?absent.

24a. Populations with capsules with usually dense, rarely moderately dense setae over distal ($\frac{1}{4}$) $\frac{1}{3}-\frac{2}{3}$; glandular hairs on lower parts usually present, rarely lacking.

k. ssp. speciosa

24b. Populations with capsules glabrous or with moderately dense to dense, rarely sparse setae over apex to distal $\frac{1}{2}$($\frac{2}{3}$); glandular hairs on lower parts often lacking, sometimes present. [Variant from lowland and montane New South Wales.]

?ssp. indescr. [see E. collina: Note 3]

a. ssp. collina

E. collina R.Br.,Prodr.(1810)436; [R.Br., Manuscript (unpubl.) "E. alba"]; Sprengel,Linn.Syst.Veg.(ed.16) 2(1825)776; ?Hook.f.Fl.Tasm.(1857)296,p.p.(probably as to glabrous forms); Benth.,Fl.Austral.4(1868)520, p.p.(as to Brown's and probably Hooker's specimens from Tasmania, Mueller MEL41425 from N.S.Wales, and some Victorian and South Australian collections, and many specimens not cited); Ewart,Fl.Vict.(1931)1024,p.p.(at least as to some Grampians plants); Du Rietz,Sv.Bot. Tidskr.42(1948)348; Galbraith,Wildfl.Vict.(2nd.ed.) (1955)136,p.p.; Robertson in Black Fl.S.Austral.(2nd. ed.)(1957)772,p.p.(as to some plants lacking glandular hairs from South-East); Eichler,Suppl.Black's Fl.S. Austral.(2nd.ed.)(1965)282,p.p.; Curtis,Stud.Fl.Tasm. (1967)528,p.p.(excl.plants from at least "montane grass-lands", and synonym E. multicaulis Benth.); Galbraith, Wildfl.Vict.(3rd.ed.)(1967)123,p.p.; Willis,Hdbk.Pl. Vict.2(1973)574,p.p.(as to some glabrous forms from sections CDEGHJKMNPSTWXZ of Victoria, and some S.A.,Tas. and N.S.W. occurrences)

E. muelleri Wettst., Monogr.Gatt.Euphrasia (1896)257,p.p. (as to Wilhelmi W71487)

E. brownii FvM.var.collina (R.Br.)Maiden & Betche, Cens. N.S.W.Pl.(1916)184 (possibly as to name only)

E. walteri Gandoger,Bull.Soc.Bot.France 66(1919)218(as to lectotype only); Briggs in McGillivray,Contr.N.S.W. Nat.Herb.4(1973)339

E. gunnii Du Rietz,Sv.Bot.Tidskr.42(1948)355,p.p.(as to Gunn [Hb.Lindley] Kp.p.)

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.), p.p.(as to synonym E. collina R.Br.); Spicer,Hdbk.Pl. Tasm.(1878)127,p.p.(as to synonym E. collina of Benth., p.p.); FvM.,Syst.Cens.Austral.Pl.1(1882)98,p.p.(as to some Victorian, N.S.Wales, Tasmania and S.Australian occurrences); FvM.,Key Syst.Vict.Pl.2(1885)41,p.p.(as to some records from all parts of State except the north-east); 1(1887-1888) 392,p.p.; FvM.,Sec.Syst.Cens.Austral.Pl.1(1889)165,p.p.(as to some Victorian, N.S.Wales, Tasmanian and S. Australian occurrences); Rodway,Tasm.Fl.(1903)143,p.p.(as to some glabrous forms)]

[E. multicaulis auct.non Benth.: Wettst.,Monogr.Gatt.Euphrasia (1896)249,p.p.(as to Anderson FI)]

DESCRIPTION

Erect perennial herb or undershrub (19)25-60(80)cm tall, with many ascending or erect branches arising from single erect stem, flowering in first year, subsequently dying back to upper branches.

Stem or, after first year, main floral branches (14)18-50 (60)cm high to base of inflorescences, simple for 0-12(32) nodes below inflorescence, i.e. for (0)0.1-0.55(0.8) of height of inflorescence above ground level; upper (2)3-7(9) internodes as long as or longer than upper leaves, the longest internode (1.0) 1.5-5.0(7.5) times the length of upper leaves; axes in upper parts bearing two rows or four lines of sparse to dense, very short to moderately long eglandular hairs decurrent from between leaf bases, sometimes with sparse eglandular hairs between, in lower parts usually sparser and shorter, sometimes glabrous.

Leaves: uppermost leaves of stem or main floral branches (4.5)5-12(16.5)mm long, (1.5)2.0-4.2(4.4)mm broad, with sessile glands confined to distal (0.4)0.55-0.85(0.9) of undersurface, otherwise glabrous, but occasionally for a few eglandular hairs on margins near base, with blade ovate-elliptic to elliptic or oblong, often narrowly so; base rounded to narrow cuneate; teeth (0)1(2) along each margin, confined to distal (0)0.15-0.35(0.45) of leaf, bluntly or sharply acute or obtuse, the longest tooth (0.2)0.5-2.1(2.3)mm long; apex (0.6)1.1-3.5(4.0)mm long, (0.6)0.9-2.0(2.3)mm broad, sharply or bluntly acute or obtuse; leaves lower down glabrous.

Inflorescences racemes, except sometimes for widely-spaced 0-2(5) nodes usually dense, rarely moderately dense in bud, usually moderately dense to dense, rarely lax in flower and fruit, those of stem or main branches with (16)20-44(48) flowers; pedicels at lowest node (0.3)0.5-7.5(8.0)mm long, shorter higher up; rachis with indumentum similar to upper part of axis but denser and somewhat longer; internodes elongating prior to anthesis such that capsules well below node above or reach past it; apical bud cluster (excluding lower widely-spaced nodes) usually narrow cylindrical to narrow conical cylindrical, rarely ovoid, initially 1.2-4.0mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 4-15 or more nodes have reached anthesis.

Bracts glabrous, shorter than calyx, except sometimes for those at lower 3(4) nodes, sometimes all entire, sometimes all toothed, sometimes with proximal ones toothed and distal ones entire, those at lowest nodes similar in size and shape to uppermost leaves.

Calyx (3.9)5.0-6.7(7.0)mm long, externally glabrous, internally with moderately dense to dense, very short to moderately long eglandular hairs on distal part of tube and lobes.

Corolla (9.0)9.5-13.5(14.5)mm long along upper side, white, or pale or deep mauve, pink, purple, lilac, violet, lavender or blue but for either a white tube and mouth or white extremities, or coloured throughout, often with yellow blotch behind lowest lobe, sometimes with smaller blotch at base or each anterior filament, sometimes with blotch faint and apparent only in bud or lacking; tube (5.9)6-9.8(10.3)mm long; hood (2.9)3.2-4.2(5.0)mm long; upper lobes usually shallowly emarginate or truncate, rarely emarginate or obtuse, with rear surface bearing very short glandular hairs, usually moderately dense to dense all over, sometimes sparse or confined to base; lower lip (3.8)4.8-9.2(11.0)mm long; lower lobes usually emarginate to truncate, rarely obtuse, externally covered by very short to short glandular hairs, often mixed with short to moderately long eglandular hairs, the indumentum usually moderately dense to dense all over, rarely sparse or confined to proximal parts.

Stamens with anthers (1.5)1.6-2.3(2.4)mm long, with connectives surrounded by usually moderately dense to dense, rarely sparse, long to very long eglandular hairs, sometimes with indumentum sparser on anterior connectives; posterior pair of awns (0.2)0.3-0.5(0.6)mm long.

Capsules (6)7-9.5(10.5)mm long, in lateral view ovate to obovate, sometimes narrowly so or somewhat deflexed, 2.0-3.0(3.6)mm broad, in median view ovate to ovate- or elliptic-acuminate, sometimes narrowly so, glabrous or with few to moderately dense, very short to moderately long setae at very apex; apex in lateral view usually obtuse to truncate, sometimes acute, sometimes obliquely so; seeds (0)14-72(88), (0.7)0.8-1.2(1.3)mm long, (0.25)0.3-0.5(0.7)mm broad, ellipsoid, oblong or ovoid, sometimes broadly or obliquely so.

Plates: 7, 24

Figures: 17

TYPIFICATION

1. E. collina ---- see after description of species.

2. E. walteri

Lectotypus (tab. 25): Chas Walter s.n., 1902. Australia, Victoria. LY(p.p., quoad specimen secundum tertiumque a sinistra). Isolectotypus: BISH. Isolectotypus probabilis: Chas Walter s.n., -.ix.1898. Grampians. NSW10945,BISH. Syntypus alter (tab. 26): Chas Walter s.n., 1902. Australia, Victoria. LY (p.p., quoad specimen primum, quartum, quintumque a sinistra). Isosyntypi possibiles: C. Walter s.n., s.dat. Wimmera. G. Anon. [?C. Walter] s.n., s.dat. Wimmera. G,MEL 41309(p.p.),L908227137.

The specimen upon which Gandoger (1919) based the name E. walteri consists of a mixture of ssp. collina and ssp. muelleri. The diagnostic characters used by Gandoger in the protologue in a key to distinguish E. walteri from six other "new" species of Euphrasia in Australia were

"Calyx glaber....... Folia tridentata vel trilobata".

These characters do not apply to the material of ssp. muelleri on the type sheet, as the calyces are densely scaberulous and the leaves have two teeth along each margin (i.e. five-toothed in the sense of Gandoger, who included the apex as a tooth). In contrast, the specimens of ssp. collina with their glabrous calyces and leaves with usually one, rarely two, teeth along each margin, fit the protologue perfectly. The latter element has accordingly been chosen as lectotype.

This lectotype is in good condition. It consists of two floral branches, picked from their base and bearing old buds, flowers and a single capsule. The isolectotype consists of a vegetative branch and flower of E. collina. It has clearly been removed from the LY specimen and not the possible isolectotype discussed below as it is labelled "type specimen", bears locality data identical to the type, and has annotations referring to and paraphrasing Dr. B.G. Brigg's comments on the affinities of E. walteri which are affixed to the LY specimen. In addition material from the possible isolectotype is also in BISH.

Three pieces of evidence point to the Grampians, as the source of the lectotype material. In the first case, because the leaves have a long, narrow acute apex and teeth (the two specimens have uppermost leaves with the apex 1.9, 2.5mm long, 0.8, 0.8mm broad and teeth 0.8, 1.6mm long, respectively) it is highly probable that the lectotype came from western Victoria or, perhaps the western part of the eastern highlands of Victoria (see Note 2). Secondly Walter apparently only made the one collection of ssp. collina from the "Grampians" which are on the western extremity of the western highlands and house the extreme leaf shape of this type. The date "1902" on the type specimen does not refer to the date of collection, but possibly to the year in which the specimen was sent to Gandoger. In the paper enumerating Gandoger's Australian types in LY (McGillivray 1973) many of Walter's specimens, which come from all states of Australia, are dated 1902. As a third piece of evidence for the NSW collection being an isolectotype, the material of both collections is in similar condition and furthermore it appears that one of the branches of the NSW collection has been broken from a branch on the lectotype. It thus appears that the Grampians is the source of the lectotype collection. Many collections of ssp. collina have come from this region. The subspecies still flourishes there and is in no apparent danger as the area is a State Forest.

A similar procedure has been used to determine the isosyntype material. Walter's only collections of ssp. muelleri come from the

"Upper Yarra" and "Wimmera". The former material has narrow leaves with mainly one pair of teeth and therefore does not tally with the syntype. The latter collections however, bear broad leaves with two pairs of teeth, and, in so resembling the syntype, are possibly duplicates. The labels on the three specimens without indication of the collector are written in a hand which differs in some respects from the samples of Walter's handwriting which I have seen. Their status as isosyntypes is therefore doubtful.

DISTRIBUTION (Fig. 17):

E. collina ssp. collina is widespread throughout lowland eastern Tasmania (although collections from outside the Hobart area are very few) and occurs in Victoria in the southern lowland regions, the western highlands, and the south-western edge of the eastern highlands. The range of distribution just extends into the south-east corners of South Australia and New South Wales. There is one record from Queensland which is almost certainly incorrect (see Note 3).

The subspecies has been recorded at altitudes from near sea level to about 750m, although it probably occurs at higher elevations on Mt. William in the Grampians, Victoria (1670m high) and on Mt. Wellington in south-east Tasmania.

ECOLOGY:

In south east Tasmania and the Grampians of Victoria, the subspecies has been recorded from the dense shrub understory of sclerophyll forest (Barker 1119), sclerophyll forest lacking a well-developed shrub under-story (Barker 980,982,1443,1446), the heathy understory of Eucalyptus woodland (Barker 877,955,1431,1439,1441), and "damp heath" (Gauba 9426). A collection, Lam 7517, with affinities to ssp. collina from the western part of the eastern highlands of Victoria comes from "open heath country". In the coastal regions of Victoria and south-eastern New South Wales it occurs in an "open position in coastal heathland" (Muir 1840) and "on exposed headland" (Constable NSW126373). In the extreme west of its range of distribution in the lowland regions of south-western Victoria and south-eastern South Australia the only ecological records are from swamp areas, vic. "Euc[alyptus] camaldulensis swamp" (Beauglehole 38074), "On damp soil at edge of heathland swamp" (Aston 754), "swamp" (Anon. 5), "swampy ground" (Jackson 204).

In south-east Tasmania the subspecies has been recorded from mud-stone (Long 807,953), clayey soil (Barker 955), and doleritic loams (Barker 880,953). In the Grampians it occurs in sandy soil (Barker 1443) often where it is shallow on the sandstone ridges (Barker 1439,1440,1441; Willis MEL41469). Weber 1793 from "sandy soil" in south-eastern South Australia provides the only other record.

Flowering begins in August and is completed by mid-February, although there is one record of flowering material in April (Staer NSW10948). Capsules form from September.

NOTES:

1. Ssp. collina and ssp. paludosa both occur in the western part of the eastern highlands of Victoria. There is no evidence of a breakdown of their differences in the very few collections adequate for estimating variability in populations which have come from the area. In other parts of Victoria, along the southern slopes of the eastern highlands and between the Grampians and Melbourne, the two subspecies seem to occupy different areas of distribution, with ssp. collina mainly occurring in the western highlands and coastal regions, and ssp. paludosa being confined to the region of the basalt plains between Warrnambool and Port Phillip and to a possibly isolated occurrence in the region of Maryborough. However, these conclusions are only speculatory as they are partly based on a number of collections containing only one or two plants, which are clearly more

allied to ssp. collina by their uppermost leaves with a single pair of teeth, but which could be uncommon variants from populations of ssp. paludosa. These plants have been tentatively placed in ssp. collina.

2. Within ssp. collina there is a geographical variation in the shape of the uppermost leaves of the stem or main floral branches. The graph (fig. 23) portrays the variation in the length of the apex and teeth of the uppermost leaves in different geographical areas throughout the range of the subspecies. Samples of uppermost leaves of the Grampians region of western Victoria (Barker 1439, 1443,1446) and south-eastern Tasmania (Barker 953,955,968) are displaced in pl. 7. These leaves are typical of these areas and represent the extremes in variation. The leaf type with longer, more acute apices and teeth occurs in populations in the Grampians and nearby mountain areas such as at Ararat (Williamson NSW10936). Leaves tending to the other type with shorter, blunter leaf apices and teeth from south-east Tasmania are found along the Victorian coast extending eastwards from Anglesea into southern New South Wales. The whole range of variation in leaf shape is found in collections from the western plains of Victoria from the coast to north of the Grampians and in specimens from the western highlands (excluding the Grampians) and southern and western margins of the eastern highlands. Although the extreme types are apparently scattered throughout this area, within those collections containing several plants there is little variation. Further study is required to determine whether these differences are genetically determined or the response to different environmental factors acting on a common genotype.

3. The sheet MEL41774 bears a label annotated, "Johnson 1876 Cleveland Bay" with the determination "Vandellia" in F. von Mueller's

hand. This is almost certainly a misplaced label, as not only would the Cleveland Bay, Queensland, locality extend the distribution of the subspecies (and genus) well to the north of its most northerly known locality, but also it is extremely doubtful that Mueller would have made such a gross misidentification of the material which contains buds and flowers and belongs to a genus which he knew very well.

SPECIMENS EXAMINED:

New South Wales

Constable s.n., 10.x.1954. Green Cape. NSW126373. — [Mueller] s.n., –.ix.1860. Twofold Bay. MEL41425. — Rodway s.n., –.xii.1920. Green Cape. NSW22268. — Witheford s.n., 6–16.ix.1953. Womboyne–Nadgee area. NSW82350.

South Australia

Anon. [?S.W.L.D.] 5, Novbr. & Decbr. Swamp Guichenbay. MEL41407. — Hunt 2566, 3.xi.1965. Big Heath Reserve. AD. — Ising s.n., 29.x.1934. Lucindale. AD966050077. — Jackson 204, 13.xi.1959. North end of Lake Bonney. AD. — [Osswald] s.n., Sept. Reedy Creek. MEL41338. — Weber 1793, 5.xi.1969. Big Heath National Park, north-eastern part. (Big Heath is ca. 25km south-west of Naracoorte). AD. Wehl s.n., 1874. Lake Bonney. MEL41416. — Wehl s.n., 1882. Lake Bonney. MEL41780. — Well s.n., 1880. Near Mt. Gambier. MEL41737, MEL41714.

Tasmania

Atkinson 141, 24.x.1931. Ridgeway. HO. — Anderson [Herb. Spicer] s.n., s.dat. Browns River. FI. — Anon. s.n., 3.xi.1955. Kingston–Longley turnoff. HO. — Anon. s.n., s.dat. Without locality. L908227106. — Barker 877, 3.xi.1970. Fern Tree; ca. 1½km south-east of the Huon Highway on Summerleas Road. AD. — Barker 880, 3.xi.1970. Beneath transmission lines, ca. 1½km east of Summerleas Road, which connects Kingston and Fern Tree; ca. 6km south of Fern Tree. AD. — Barker 953, 11.xi.1970. Hillside immediately south of Chimney Pot Hill, at the west end of Hall Street, Ridgeway. AD (2 specimens). — Barker 955, 12.xi.1970. Ca ½km south of Taroona on the Kingston road. AD. — Barker 968, 14.xi.1970. On the road to Rearing Beach, ca. 1km west of the Nubeena–Premaydena road, across the bay from Nubeena. AD. — Barker 980, 20.xi.1970. Gerry's Hill;

on road connecting the Tunnack-Eldon Road to the Woodsdale-Levendale Road, ca. 3km from the former. AD. -- Barker 982, 20.xi.1970. As for Barker 980. AD. -- Barker 1119, 14.i.1971. At the turnoff to Ridgeway via Chimney Pot Hill, ca. 1½km east of Fern Tree, by the Huon Road. AD. -- Black 2, 10.xi.1913. Mt. Nelson. MEL. -- Black 3, 23.x.1920. Mt. Nelson, Hobart. MEL. -- Brown 64, ii/iii/1804. Prope fluvium Derwent. BM(p.p.: lectotype of E. collina); K(p.p.),MEL(p.p.). -- Bufton 26, 1892. Port Arthur. MEL. -- [Curtis] s.n., 15.i.1948. Chimney-pot Hill. HO. -- [Curtis] s.n., 28.iii.1959. Bonnet Hill, nr Taronga. HO. -- [Curtis] s.n., 9.x.1949. Longley. HO. -- [Curtis] s.n., 28.xii. 1949. Chimney Pot Hill. HO. -- C[urtis] s.n., 20.x.1957. Nr. Longley. HO. -- C[urtis] s.n., 20.x.1957. Nr. Longley. HO. -- Giblin 8, 21.x.1928. Ridgeway. HO,CANB,NSW10833. -- Giblin s.n., 21.x.1928. Ridgeway. HO,CANB7918. -- Giblin s.n., 23.x.1929. Eaglehawk Neck. HO(3 specimens), CANB7919,GH. -- Gunn 1219, 18.ix.1842. Penquite. NSW10835. -- Gunn [Herb. Lindley] s.n., s.dat. Van Diemen's Land. K(p.p.). -- Gunn s.n., s.dat. Vandiemans Land. NY(p.p.). -- Hickman s.n., s.dat. Mt. Wellington. HO. -- Hooker s.n., s.dat. Without locality. MEL41458. -- H[ooker] s.n., s.dat. Without locality. GH(p.p.). -- [Labillardiere] 43, s.dat. In terra van diemen. FI. -- Labill[ardiere] s.n., s.dat. Van Diemen. G. -- [Labillardiere] s.n., s.dat. C. v. Diemen. L908227161(p.p.). -- Lhotsky s.n., s.dat. Terre de van Diemen. G. -- Lindon per Lucas s.n., -.x.1924. Bellerive Hills. NSW10832. -- Long 807, 18.x.1931. Taroona. Browns River Road. HO. -- Long 871, 25.x.1931. Glenorchy, on Water Reserve. HO. -- Long 953, 2.xi.1931. Kingston Longley Road. HO. -- Long 1037, 21.xi.1931. Longley. Above Allens Rivulet. HO. -- Lucas s.n., -.x.1923. Waterworks Hobart. NSW10840. -- M[ueller] s.n., s.dat. Tasmaniae. HBG. -- Ratkowsky 598, 4.ix.1973. Mt. Nekon Ridge, above Cartwright Creek, Taroona. AD. -- E. Rodway 162, -.vii.1931. Mt. Nelson. HO,CANB. -- F.A. Rodway s.n., -.x.1898. Waterworks Hobart. NSW22278. -- F.A. Rodway s.n., -.i.1918. Mt. Nelson ra. NSW22279. -- L. Rodway s.n., -.xii.1895. Kingston. NSW 10834,BISH. -- R[upp] 3, -.x.1920. Mt. Nelson. MELU15990. -- Simson 1763(p.p.), -.ii.1880. Mt. Wellington. MEL(p.p.) -- S[omerville] s.n., 23.x.1945. Snug [to] Oyster Cove. HO. -- Somerville s.n., 15.x.1958. Chimney Pot Hill, near Huon Rd. HO(2 specimens). -- [Stuart] 671, Nov. Rocky hills nr. St. Pauls River. MEL41449. -- [Stuart] 671-672-717(p.p.), Novr. Nr. St. Pauls dome. MEL41437(p.p.). -- Stuart s.n., s.dat. Van Diemensland. MEL41455(p.p.). -- Stuart s.n., s.dat. Tasmaniae. MEL41446(p.p.). -- Story s.n., s.dat. Without locality. MEL41463(p.p.). -- Tenison-Woods s.n., s.dat.

Without locality. MEL41781(p.p.). -- Verreaux s.n., s.dat. Terre de Van Diemen. G.

Victoria

Anon. 3, s.dat. Portland Bay. MEL. -- Anon. s.n., 14.x.1907. Mount Birchet [?Birchip]. BISH. -- Anon. s.n., s.dat. Wimmera. MEL41309(p.p.). -- Aston 754, 22.x.1960. Along the Mt. Richmond to Greenwald road, and $1\frac{1}{2}$ miles north of the Surry River. MEL. -- Audas s.n., -.x.1923. Grampian Mts. NY. -- Barker 1431. 26.x.1971. Grampians. On the lower east slopes of the Serra Range near the road to Halls Gap, ca. 12m (20km) by road from Dunkeld. AD. -- Barker 1439(p.p.), 26.x.1971. Grampians. On the road to the Mt. William summit from the Dunkeld-Halls Gap road, at lookout ca. 1m (1.6km) by road down from the barrier and car park ca. 1km below the summit. AD. -- Barker 1440, 26.x.1971. As for Barker 1439. AD. -- Barker 1441, 26.x.1971. On the road to Mt. William summit from the Dunkeld - Halls Gap road, ca. 2m (3.2km) by road down from the barrier and car-park ca. 1km below the summit. AD. -- Barker 1443, 26.x.1971. Grampians. On the Lake Bellfield-Mt. Rosea-Halls Gap circuit road near Mt. Rosea; at the turnoff to Sundial. AD. -- Barker 1446, 26.x.1971. Grampians. On the Lake Bellfield-Mt. Rosea-Halls Gap circuit road, ca. 1km S of the Wartook-Halls Gap road. AD. -- Beauglehole 15878, 6.xi.1966. D17. Grampians. Victoria Range. E. side of Castle Rock - extreme upper reaches of Deep Creek. BEAUGLEHOLE. -- Beauglehole 17378 & Corrick, 1.x.1967. D17. Grampians. Victoria Gap. N. of Gap Track, N of Syphon Road. BEAUGLEHOLE -- Beauglehole 38074, 16.xii.1971. Glenelgshire, D20. $3\frac{1}{4}$ m[iles] S. W. of Dergholm P.O. BEAUGLEHOLE. -- Beauglehole 40703, 25.xi.1972. D26. Grampians. Victoria Range. Victoria Range Road, ± 3m. N.E. of the Chimney Pot - along top of range. BEAUGLEHOLE. -- Beauglehole 40738, E1. Lower Glenelg River area. W of Glenelg River mouth, Nelson. BEAUGLEHOLE. -- Beauglehole 40739, -.x.1946. E12. Portland, Gorae West. BEAUGLEHOLE. -- Bullock s.n., 1886. Wimmera. MEL41700. -- Cowle per Walter s.n., -.x.1904. Grampians. MEL41328. -- Curdie s.n., s.dat. Donald. MEL41376(p.p.). -- Dall[achy] s.n., s.dat. Wimmera. MEL41331(p.p.),MEL41310,MEL41330. -- Eckert 70, 1891. Lower Glenelg River. MEL41367. -- Galbraith s.n., -.x.1925. Tyers. CANB190468(p.p.). -- Gauba s.n., 23.ii.1953. Grampians. GAUBA9246. -- Hess s.n., -.x.1944. Grampian Mtns. PH820888. -- Ingmerson s.n., 11.ii.1965. Mt. William. Grampians. Summit. CBG011501. -- Matthews 54, 1893. Wimmera. MEL41699. -- [Mueller] s.n., s.dat. On the Glenelg River. MEL41317. -- [Mueller] s.n., s.dat. Glenelg

River. MEL41318. -- [Mueller] s.n., s.dat. Grampians. MEL 41326. -- Mueller s.n., s.dat. Port Phillip. L908227953. -- Mueller s.n., s.dat. Australia felix. MEL41708,W,L908227951. -- Th. Mueller s.n., Wimera. L908227175. -- Muir 868, 27.ix. 1959. Grampians Mountains. Dunkeld Rd., 16km (10miles) south of Hall's Gap. MEL,AD; pollen slide A.N.U.,AD. -- Muir 1840, 23.xi.1960. About 4 miles south-west of Mallacoota. MEL. -- Muir 2697, 4.xi.1962. Grampians Mountains. Grampians Lookout, in Mt. Difficult Range 2 miles north-west of Hall's Gap. -- O'Grady s.n., -.xi.1957. Portland. NSW102602. -- Perrin per R[upp] 2 (p.p.), -.x.1922. Grampians, MELU(p.p.). -- Phillips 225, 30.x.1960. Mt. Difficult Road, Grampians. CBG. -- Phillips 242A, 27.x.1971. Loch Ard Gorge, Port Campbell National Park. CBG. -- Phillips 243, 14.x.1966. Jimmy's Creek Road, Grampians. 1 mile from Dunkeld-Hall's Gap road. CBG. -- Phillips 510, 4.xi.1971. Sundial track, Grampians. CBG. -- Reader s.n., 15.ix.1907. Between Portland & Heywood. G. -- Robbins s.n., -.ix.1932. Grampians. BEAUGLEHOLE 16830. -- Staer s.n., -.iv.1911. Anglesea. NSW10948. -- Stewart s.n., s.dat. St. Arnaud. Wimmera District. MEL41333, MEL41332. -- Symon 187, 10.xi.1959. 35m from Dunkeld on the Victoria Valley Rd from Halls Gap. ADW. -- Tilden 770, -.x/xi.1912. Point Lonsdale. G.K.BISH,GH(p.p.). -- Walter s.n., -.ix.1898. Grampians. NSW 10945(probable isolectotype of E. walteri); BISH. -- Walter s.n., 1902. Without locality. LY(lectotype of E. walteri); BISH. -- Warcup s.n., 7.ix.1961. Dunkeld Road past Fyans Creek, Grampians. ADW24206,NE. -- Whaite 1518, 27.x.1953. On Paddys Castle, Grampians. NSW102601. -- Wilhelmi s.n., -.xii.1856. Banks of the Wannon. GH(p.p.). -- Williamson s.n., -.ix.1899. Ararat. NSW10936,BISH. -- Willis s.n., 9.xi.1963. Mt. Difficult Range, above camping ground and lookout, Grampians. MEL41469. -- Wrigley 7979, 1.xii.1968. Mt. Difficult road, Grampians, 3 miles from main road. CBG.

Australia. Without locality

Labillardiere 29, s.dat. N.Holl. L. -- Labillardiere s.n., s.dat. Nova Hollandia. NY(p.p.),MEL41443. -- Labillardiere s.n., s.dat. Nova Hollandia et terra Diemen. FI. -- Verreaux 50, 1845. Nouvelle Hollande. Cote orientale. G.

Without locality

Gunn s.n., s.dat. MEL41467(p.p.). -- [Labillardiere] s.n., s.dat. FI. -- Lhotsky s.n., s.dat. G. -- [Stuart] 672, Nov. MEL. --

Sullivan 56, s.dat. MEL41710.

Locality doubtful

Johnson s.n., 1876. Cleveland Bay. MEL41774.

SPECIMENS WITH AFFINITIES TO SSP. COLLINA:

Victoria

Anon. s.n., s.dat. Forest Creek. MEL41385(p.p.). -- Anon. 151, s.dat. Creswick Diggings. MEL. -- Anon. s.n., Novr. McIvor. MEL41384(p.p.). -- Anon. s.n., s.dat. Gippsland. L908227127. -- French s.n., -.x.1897. Without locality. G(p.p.). -- Gargurevich s.n., 1873. Red Jacket Creek, Victorian Alps. MEL41372,MEL41374. -- Lam 7517, 4.ix.1954. Upper Beaconsfield. L,A. -- Lucas s.n., 1883. Myrtleford. MEL41356. -- Musgrave s.n., s.dat. Wilsons Promontory. MEL41345. Thorn 27, 1883. Lower Loddon. MEL. -- Tisdale 10, s.dat. Walhalla. MEL. -- Wawra 534, s.dat. Dandenong. W(2 specimens). -- Weindorfer 77(p.p.), -.ix.1902. Dandenong Rgs. W(p.p.). -- W[ilhelmi] s.n., s.dat. McIvor Ranges. W71487(syntype of E. muelleri).

b. ssp. diemenica (Sprengel)Barker, comb. et stat. nov.

E. diemenica Sprengel,Linn. Syst. Veget.(1825)777(substitute name for E. alpina R.Br. non Lam.) BASIONYM; Wettst., Monogr.Gatt.Euphrasia(1896)250,t.5 f.389-394,t.13 f.7; Du Rietz,Sv.Bot.Tidskr.42(4)(1948)357,f.f; Curtis,Stud. Fl.Tasm.(1967)528,f.117; Harris,Alp.Pl.Austral.(1970)137

[E. alpina R.Br.,Prodr.(1810)436(nom.illeg.)non Lam., Encycl. meth.Bot.2(1786)400; [R.Br.,Manuscript,unpubl.(under "E. grandiflora")]; Benth. in DC.,Prodr.10(1846)553,p.p. (excl.var.humilis; affinities of var. angustifolia not known); Hook.f.,Fl.Tasm. 1(1857)296,p.p.(excl. var. humilis; affinities of var. angustifolia not known); 2 (1859)369; Benth.,Fl.Austral.4(1868)521,p.p.(at least as to Brown 2722 but excl. N.S.Wales, Victorian and probably some Tasmanian specimens); Willis,Muelleria 1(1967)148 ("probably no more than a glabrescent alpine form of E.

gibbsiae")]

E. brownii FvM. var. alpina (R.Br.)Rodway,Tasm.Fl.(1903)143

E. collina R.Br.: Curtis, Stud.Fl.Tasm.(1967)527,p.p.(as to plants from "montane habitats")

[?E. multicaulis auct. non Benth.: Hook.f.,Fl.Tasm.1(1857) 297,p.p.(probably as to some of Gunn's specimens, n.v., but excl. Gunn 863); Wettst.,Monogr.Gatt.Euphrasia (1896)249,p.p.(at least as to t.5 f.383-388)]

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.),p.p. (as to synonyms E. alpina R.Br., E. diemenica Sprengel); Spicer,Hdbk.Pl.Tasm.(1878)77,127,p.p.(partly as to synonym E. alpina of Benth. and Hook.f.); FvM.,Syst.Cens.Austral. Pl.1(1882)98,p.p.(as to some Tasmanian occurrences); FvM., Sec.Syst.Cens.Austral.Pl.1(1889)165,p.p.(as to some Tasmanian occurrences)]

DESCRIPTION:

Erect perennial herb, (7)11-26(35)cm tall, with few to many ascending branches arising from a reduced stem.

Main floral branches (5.5)7-17(25)cm high to base of inflorescence, simple for (3)8-32(50) nodes below inflorescence, i.e. for (0.85)1.00 of distance from inflorescence to ground level; upper (3)4-7(9) internodes as long as or longer than upper leaves, the longest internode (1.3)2.5-5(6) times length of upper leaves, those lower down much shorter; axes in upper parts bearing two rows or four lines of moderately dense to dense, short to moderately long eglandular hairs decurrent from between leaf bases, sometimes with sparser eglandular hairs between, sometimes mixed with sparse to dense, short to long glandular hairs, lower down with eglandular indumentum sparser and shorter, with glandular hairs usually absent, sometimes sparse to dense and short at ground level.

Leaves: uppermost leaves of main floral branches (3.5)5.5-12.5(16)mm long, (1.4)2.5-6.5(9.4)mm broad, in outline usually obovate sometimes subspathulate, oblong or elliptic, crenate to crenate-serrate, with sessile gland patches extended over distal (0.4)0.55-0.8(0.95) of undersurface, sometimes glabrous or with moderately dense to dense, short eglandular hairs on margins and upper surface, sometimes also bearing usually very short to moderately long, rarely long glandular hairs, sparse and confined to margins to dense all over; base usually narrow cuneate, sometimes cuneate; teeth (0)1-2(4) along each margin, confined to distal (0.1)0.2-0.45(0.55) of leaf, blunt, usually obtuse, sometimes acute, the longest tooth (0.1)0.3-1.6(2.3)mm long; apex (0.6)0.8-1.8(2.5)mm long, (1.0)1.3-2.5(3.7)mm broad, usually blunt, rarely sharp, usually obtuse, sometimes truncate, acute or shortly broad acuminate; leaves lower down usually glabrous, rarely with a similar but sparser glandular indumentum; lowest leaves usually glabrous, sometimes with sparse to dense very short to short glandular hairs.

Inflorescences racemes, except for lowest 0-2(3) nodes, dense in bud, usually dense, sometimes moderately dense in flower and fruit, with (6)12-26(30) flowers, sometimes with lowest node bearing a single flower or none at all, pedicels at lowest node (0.7)0.8-5.5(5.8)mm long, shorter higher up; internodes elongating prior to anthesis and sometimes continuing after; rachis as for upper part of axis but sometimes with sparse glandular hairs when lacking from axis; apical bud cluster narrow ovoid to spherical, initially ca. 1-3.5cm long, hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 1-10 nodes have reached anthesis.

Bracts at lowest nodes like uppermost leaves in size, shape and indumentum, although glandular hairs sometimes denser or present when absent from leaves, shorter higher up, shorter than calyx, except rarely for those at lowest node, those at lowest 1-10 or more nodes toothed, distal ones entire.

Calyx (3.2)4.5-7.5(7.7)mm long, externally glabrous except for eglandular hairs decurrent from base of clefts or bearing very sparse to dense, very short to long glandular hairs sometimes with short eglandular hairs or a mixture of both, internally on teeth and distal part of tube covered by dense short to very long straight upturned eglandular hairs.

Corolla (7.3)8.5-14.5(15.2)mm long along upper side, white or coloured palely to deeply in blue, violet, lilac, purple, mauve or pink, with colour sometimes confined to lobes and tube with broad white area behind lower lobes, sometimes all over, with yellow area at point of insertion of each anterior filament, with a yellow blotch on lower lip behind lobes, sometimes present and distinct from or continuous with spots at base of filaments, sometimes absent; tube (4.5)6-9(10)mm long; hood (2.6)3-6(6.5)mm long; upper lobes usually emarginate or shallowly so, rarely entire, with rear surface glabrous or bearing sparse to moderately dense, short to long eglandular hairs; lower lip (4.5)5-12(14)mm long; lower lobes usually emarginate or deeply so, sometimes shallowly emarginate rarely truncate or praemorsely so, externally covered by a moderately dense to dense indumentum, short to long eglandular hairs or glandular hairs or a mixture of both, sometimes all over, sometimes along middle of lobes.

Stamens with anthers (1.2)1.4-2.0(2.2)mm long, with connectives usually surrounded by moderately dense to dense, usually long to very long, rarely short eglandular hairs, rarely glabrous; posterior pair of awns (0.2)0.3-0.5(0.6)mm long.

Capsules 6.8-10mm long, in lateral view ovate to elliptic or oblong, sometimes broadly so, 2.4-4.0mm broad, in median view narrow ovate-caudate or elliptic-acuminate, usually covered by very few to dense, short to long setae on apex only to on distal $\frac{1}{2}(\frac{2}{3})$, rarely completely glabrous; apex in lateral view usually obtuse to truncate, sometimes acute or obliquely so; seeds (7)25(69), (0.9)1.1-1.9mm long, 0.4-0.8(0.9)mm broad, obliquely ovoid, oblong or ellipsoid, sometimes broadly so.

Plates:

Figures: 17

TYPIFICATION:

E. alpina R.Br. = E. diemenica Sprengel

Holotype: R.Brown 63/2722, ii/iii.1804. In summitate Montis Tabularis prope fluv: Derwent. BM. Isotype: R.Brown s.n., 1802-5. Table Mtn. MEL41304.

The holotype comprises five fragments consisting of one to many entire floral branches. Unfortunately the inflorescences have been lost apparently because of insect damage. The branches and leaves are well preserved. The MEL specimen is clearly an isotype and consists of a number of fragments, one a complete branch with an inflorescence with buds and flowers, the other four consisting of floral branches but lacking the inflorescences.

Brown gave two names to this species before deciding to call it E. alpina in publication (Brown 1810). On the holotype and initially in his manuscript description (based on the collection "No. 63. In summitate Montis Tabularis versus fluvium Derwent. Feb: - Mar: 1804" which clearly corresponds to the holotype label) he called the species "E. speciosa", a name which he finally used for a New South Wales species. In the manuscript he crossed out "speciosa" and replaced it with the epithet "grandiflora" a name which he apparently never used in publication.

The type collection clearly belongs with the much-collected populations on the summit of Mt. Wellington, called Table Mountain at the time of Brown's visit (Flinders 1814: pl.6). They do not come from the populations intermediate between ssp. collina and ssp. diemenica on the slopes of the mountain (see E. collina: Intraspecific Variation). The summit populations of ssp. diemenica are prolific and do not appear endangered.

DISTRIBUTION (Fig. 17):

E. collina ssp. diemenica is endemic to Tasmania, where it is restricted to the subalpine and alpine zones of the isolated north-east mountains, the Central Plateau, the south-central mountain systems of Mt. Field and Mt. Wellington, and the Cradle Mountain-Hampshire Hills region which forms the northern most extension of the Western Mountains. There is one collection from the mid-west of the island from Mt. King William (F.A. Rodway NSW22287) at the southern end of the Western Mountains, and another from Port Davey in the extreme south-west (Long HO) which is somewhat atypical of the subspecies (see Note 3). These records should be considered doubtful until verified. However, the south-west is poorly botanized because of its inaccessibility. Forms closely allied to ssp. diemenica but diverging from it in some characters occur in north-east and north-west lowland and montane Tasmania (see Note 2).

The subspecies apparently occurs at altitudes between 850 and 1400m (2800-4600 feet). The Port Davey specimen could have come from sea level as conditions are very harsh in this area.

ECOLOGY:

Ssp. diemenica occurs in the alpine zones of Mt. Wellington, Ben Lomond and Mt. Barrow in more or less dense to open heathland in flat areas or amongst screes. There is one authentic record from the montane zone "in burnt area among regenerating Eucalyptus (3-6m high) of wet sclerophyll forest" (Barker 1141) but most records are from subalpine tussock grassland, such as on the highest parts of the

Central Plateau (Barker 1068, 1070, 1073) or in dense open areas of subalpine heath (moorland on my labels), which are also on the Central Plateau. The collections from the Cradle Mountain-Hampshire Hills region come from "Plains" (Anderson 3), "subalpine herbfield" (Canning 2740) and "Margins of beech forest" (Carolin 1222). Barker 999 and 1058 come from "open summer pasture, grassy with Helichrysums, Plantains and Ranunculus sp." The subspecies appears to occupy mainly doleritic areas although rocks of this type may be absent from the Cradle Mountain-Hampshire Hills and Port Davey regions (Banks 1965: Map 4). The allied lowland and montane variant has been collected from "Eucalyptus wet to dry sclerophyll forest; in a small population occurring only in a very grassy area of felled trees..." (Barker 923) and "tall forest & 'white grass plain'" (Phillips CBG015462).

Flowering occurs mainly between November and March, starting later at higher altitudes; there is one early October record (Gunn 863 or 1220?). Fruits begin forming in early December in some populations but apparently are mainly produced from January.

NOTES:

1. Although the members of ssp. diemenica form a natural assemblage by their characteristic leaf shape, their ascending branches, simple above ground level, and their emarginate externally hairy lower corolla lobes, the subspecies is itself polymorphic. The variation involves the characters of the presence or absence, distribution, length and density of the glandular indumentum on the calyces, bracts, rachises, leaves and axes, the size of the corollas, calyces and upper leaves and the extent and density of the setae on the capsules. It was considered inadvisable to produce a classification of the variants in the absence of field studies from a wider range of localities.

On the north-west edge of the Great Western Tiers near Lake MacKenzie two ecotypes were found growing side by side with no intermediates. One (Barker 1078), characterised by white corollas always with a yellow blotch lower lip and lacking glandular hairs from all parts bar the corolla, was found as a small population growing in a moist hollow on the open hill-side. The surrounding open grassy subalpine heath was occupied by an extensive population of plants (Barker 1079,1080) apparently with somewhat smaller flowers with a sparse to dense, short glandular indumentum on the calyces, bracts, rachises and upper leaves and with white to lilac corollas varying in the incidence of the yellow blotch on the lower lip. The two populations were separable also by their different flowering times, the glandular plants of the heath having flowered much earlier. The probable retention of water in the hollow described above may prolong growth well into the summer and produce a delay in flowering time. It could also provide an environmental basis for the somewhat larger flower size in the population growing in the hollow. Although there was some spatial overlap of the two populations, the correlation between differences in indumentum and the stage of flowering was apparently without exception. A study of the pollen from plants of both populations showed some incidence of higher pollen sterility (Appendix 1: PS196-204). One high sterility count (PS202) may have resulted from the pollen coming from one of the final flowers produced by the plant. The other count (PS198) came from a young flower of a plant of Barker 1078 at an early stage of flowering. The significance of this high sterility count cannot be determined without a cytogenetical study.

Elsewhere in the Tasmanian highlands indumentum characters and flower and leaf size separate populations on a regional or local basis. Although treated separately in this account, differences in flower and leaf size may be produced by environmental differences; the larger-flowered larger-leaved forms tend to occupy wetter or higher, more exposed situations. Such forms are found near Pine Lake near the summit of the Great Western Tiers in subalpine grassland (Barker 1068,1070), in a marshy area of subalpine grassland on a hill overlooking Lake Augusta (Barker 1073), and on the alpine heath on the upper slopes and summit of Mt. Wellington.

Among the small-flowered, small-leaved variants extensive populations of a form with white corollas with yellow areas always in the throat, but varying in their presence on the lower lip, and a short, sparse to dense glandular indumentum, at least on the upper parts, and sometimes extending onto the basal parts abound on the alpine heath beside Lake Augusta on the Central Plateau (Barker 1020, 1023,1041,1042,1045,1047,1049-1051,1053). The Cradle Mountain-Hampshire Hills region is occupied by a form lacking glandular hairs, except rarely at the base of the plant (Eichler 16567), and with usually white, sometimes lilac or purple corollas; the incidence of the yellow blotches is unknown. Another related variant occurs beside the Lakes Highway west of Great Lake in grazed subalpine pasture (Barker 999,1058). It is characterised by lilac corollas always with yellow blotches on the lower lip and deep in the throat, an absence of glandular hairs in the upper parts, but often a short glandular indumentum on the leaves and axes of the lower parts.

The only known instance of a breakdown of the character of the presence or absence of glandular hairs on the upper parts of the floral branches in the smaller-flowered, smaller-leaved forms of ssp. diemenica is found at Doctors Creek near Great Lake (Barker 1000-1003,1062,1064). In this population the yellow spot on the lower corolla lip was sometimes lacking. Unfortunately, the variation in indumentum could not be accurately observed in the field and collections were combined of plants occurring in the grassy, subalpine heath on the banks of the stream and those occupying the more open areas at stream level. It is therefore not known whether there was any correlation between ecology and indumentum characters. Pollen sterility tests (Appendix 1: PS236-252) covering both indumentum types consist mostly of counts of low sterility. However in about a quarter of the counts only 50-80% of the pollen was functional in appearance, while one plant produced a very low proportion of such pollen (PS236). Whether these rather high sterility counts reflect a hybrid situation or have resulted from a possible breakdown in the production of functional pollen in a pure population, is unknown.

The larger-flowered, larger-leaved forms of ssp. diemenica have complexities in indumentum similar to those found in the smaller forms. They seem always to have yellow blotch on the lower lip which is often continuous with that in the throat, and is rarely indistinct. On the Central Plateau occur populations of plants solely glandular in the upper parts (Barker 1073), while others contain only non-glandular plants (Barker 1068,1070,1078). However populations on Mt. Wellington (Barker 1015,1122,1141) contain a small proportion of non-glandular plants as well as occasional individuals with only very few glandular hairs on the calyces, bracts or rachises. The majority of the plants bear a sparse to dense glandular indumentum. It is uncertain whether these non-glandular plants are extremes of variation of pure populations of ssp. diemenica on Mt. Wellington or the product of an introgression of genes determining this character from the sympatric ssp. collina into populations of a purely glandular form ssp. diemenica (see E. collina: Intraspecific Variation).

In alpine heath on the summit of the Ben Lomond massif and Mt. Barrow, which form part of an isolated mountain system in north-east Tasmania, occur populations (Barker 1095,1097,1098,1105,1107), which are divergent from members of ssp. diemenica on the mountains of the centre, south and west of the island by their densely setose capsules, and by their longer glandular indumentum (ca. 0.1-0.3(0.4) mm long on the calyx) usually confined to the upper parts, rarely also at the base of the plant or almost absent. Elsewhere in ssp. diemenica the capsules are often glabrous or sparsely setose at the apex, and the glandular hairs are short (0.05-0.1(0.2)mm long on the calyx) and similarly distributed.

On the edge of the Ben Lomond plateau in grassy areas sheltered by large shrubs and dolerite boulders occurs a complex situation involving variation in indumentum and flower and leaf size. In the field the plants were separated into two collections, one of large-flowered plants just beginning to flower (Barker 1113), the other of small-flowered individuals, many of which were bearing mature capsules (Barker 1112). The former collection resembled the populations from the plateau itself (Barker 1105) in size and the presence of a glandular indumentum of varying density in the upper parts but differs by the shortness of the glandular hairs (ca. 0.1mm on the calyx) and the presence of one plant with subglabrous capsules. The other collection (Barker 1112) contains a mixture of non-glandular and sparsely to densely shortly glandular plants with usually moderately densely to densely setose capsules; one plant has subglabrous capsules. Pollen from the majority of plants was examined to determine the proportion of sterile pollen. The results are tabulated in Table 10. Most sterility counts show a very high incidence of apparently functional pollen. Although few, the counts showing percentages of apparently functional pollen of below 80% are concentrated in a particular range of character combinations. It is possible that these plants are partially sterile hybrids and that this locality is a point of overlap of two independent populations, one identical to those on the plateau itself (Barker 1105) comprising large glandular plants with densely setose capsules, the other, previously uncollected (except

TABLE 10: Morphological variation in the two collections, Barker 1112 and 1113, from a single population on the edge of the Ben Lomond plateau, Tasmania, with corresponding estimates of the percentage of pollen functional in appearance from a single flower, with only one estimate, as far as can be determined, coming from a single plant. The counts below 80% are underlined.

Capsule indumentum	Indumentum on calyces, bracts and rachis: Non-glandular Count	Voucher slide	Sparsely glandular Count	Voucher slide	Moderately densely glandular Count	Voucher slide	Densely glandular Count	Voucher slide
Densely setose	1112		1112		1113		1112	
	100% :	PS187	60% :	PS278	99% :	PS191	94% :	PS185
	57% :	PS188			95% :	PS193	95% :	PS276
	95% :	PS190	1113				1113	
	99% :	PS279	45% :	PS275			73% :	PS192
	100% :	PS280					Upper plateau	
	99% :	PS282					1105	
	97% :	PS283					100%:	PS253
							100%:	PS254
Moderately densely setose or setose at very apex	1112		1112		1112			
	100% :	PS194	93% :	PS183	5% :	PS189		
	98% :	PS195	5% :	PS186	1113			
	99% :	PS277			65% :	PS274		
	95% :	PS281						
	93% :	PS284						
Subglabrous	1112		1113				1112	
	95% :	PS285	100% :	PS182			75% :	PS184

possibly for a single plant Olsen 169), consisting of smaller non-glandular plants with capsules probably moderately densely to densely setose.

Ecological and cytogenetical studies of ssp. diemenica throughout its range of distribution may be required before it can be determined whether a classification involving the recognition of its main variants either as distinct subspecies or as infrasubspecific taxa is justifiable. Any attempt to classify these closely related variants should at the least be ased on the critical study of populations over a much wider range of localities than has been observed in this revision. In particular, evidence of clinal intergradation should be looked for and sympatric variants closely studied.

2. The collections from lowland and montane north-eastern and north-western Tasmania (fig. 17) resemble the alpine and subalpine populations by their branching being confined to ground level, their non-glandular indumentum, usually emarginate, rarely obtuse (Phillips CBG015462) corollas lobes, externally usually hairy all over, rarely (Gunn 200p.p.) subglabrous, their posterior pair of anther awns (0.2)0.35-0.4mm long, and their uppermost leaves with sessile glands on the lower surface confined mainly to marginal rows, with lateral extensions usually very short, rarely long, with 1-2(3) teeth confined to the distal half of the leaf. They diverge in the narrowness of their upper-most leaves and size of the leaf apices, which are 1.2-1.8mm long, and (0.8)1.1-1.7mm broad. Although these still lie in the common range of variation of ssp. diemenica, populations in alpine and subalpine zones appear to always contain plants with much shorter apices. Furthermore the only seeds seen (those of Phillips CBG015462) were smaller than normal for the subspecies (0.7mm long). Further collections are required to determine whether these data truly reflect the range of variation in these

characters in the populations throughout montane and lowland northern Tasmania. If these are truly representative then the collections probably represent an undescribed subspecies closely related to ssp. diemenica.

3. The specimens collected by Long (HO) from Port Davey is the only collection of E. collina from the south-west of Tasmania. They have been placed under ssp. diemenica although there is insufficient material (3 floral branches probably from the one plant) to gauge the variation of the populations in the area. In addition, possibly because of the rather depauperate condition of the specimens, they diverge to some extent from normal ranges of variation to ssp. diemenica by their obtuse lower corolla lobes and rather short posterior pair of anther awns (0.25mm long). They resemble ssp. diemenica by the confinement of branches to near ground level, the non-glandular indumentum, the broad upper leaves on the main branches with one pair of short teeth (0.5mm long) close to the small apex (1.1mm long, 1.5mm broad) and the externally pilose lower corolla lobes. A study of populations of E. collina in the south-west of Tasmania are required to assess not only whether this collection truly belongs to ssp. diemenica but also variation and ecological preferences of the species in this extremely wet and cold region.

4. Occasionally higher sterile hybrids between E. collina ssp. diemenica and E. striata are known from the Central Plateau of Tasmania and possibly also from Mt. Wellington (see Interspecific Hybrids).

SPECIMENS EXAMINED:

Tasmania

Anderson 3, 2.xii.1931. Mt. Cradle. HO. — Anon. s.n., 27.xii.1959. Mt. Barrow. HO. — Anon. s.n., 20.i.1960. Projection Bluff. HO. — Anon. (Herb. Archer) s.n., s.dat. Without locality. NSW10837,BISH. — Archer s.n., s.dat. Without locality. G. —

Barker 999, 30.xi.1970. Beside Lakes Highway, at turnoff to Liawenee and Lake Augusta. AD. -- Barker 1000, 30.xi.1970. On east side of Lakes Highway at Doctors Creek c. 4km south of Breona. AD. -- Barker 1001, 30.xi.1970. As for Barker 1000. AD. -- Barker 1002, 30.xi.1970. As for Barker 1000. AD. -- Barker 1003, 30.xi.1970. As for Barker 1000. AD. -- Barker 1015, 3.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD. -- Barker 1020, 5.i.1971. Ca ½km south of Carters Lake on the south side of Lake Augusta. AD. -- Barker 1023, 5.i.1971. At the western end of Lake Augusta, on hillside. AD. -- Barker 1041, 5.i.1971. Ca. 1km north-east of the westernmost causeway, just south of dunes on the southern side of Lake Augusta. AD. -- Barker 1042, 5.i.1971. As for Barker 1041. AD. -- Barker 1045(1) & (2), 6.i.1971. Ca. ½km south of Lake Augusta, by track ca. 4km south-west of the source of the River Ouse. AD; pollen sample A.N.U.,AD. -- Barker 1046, 6.i.1971. As for Barker 1045. AD. -- Barker 1047, 6.i.1971. As for Barker 1045. AD. -- Barker 1049(1) & (2), 6.i.1971. As for Barker 1045. AD. -- Barker 1050, 6.i.1971. As for Barker 1045. AD. -- Barker 1051(1) & (2), 6.i.1971. Ca. 5km west-south-west of the source of the River Ouse at Lake Augusta, on hill ca. ½km from the edge of the Lake. AD. -- Barker 1053(1) & (2), 7.i.1971. Ca. ½km east of the road from Lakes Highway to Lake Augusta, and ca. 1½km south of the River Ouse at Lake Augusta. AD. -- Barker 1058, 7.i.1971. Lakes Highway, ca. ½km south of the turnoff to Lake Augusta. AD. -- Barker 1062, 7.i.1971. Lakes Highway at Doctors Creek, which is ca. 4km south of Breona. AD. -- Barker 1064, 7.i.1971. As for Barker 1062. AD. -- Barker 1068, 7.i.1971. Beside Lakes Highway ca. 1½km north of Pine Lake, which is ca. 5km north of Breona; near the northernmost snow fence near Pine Lake. AD. -- Barker 1070, 7.i.1971. Beside Lakes Highway from east of Pine Lake to ca. 1km north of it. AD. -- Barker 1073, 7.i.1971. Ca. 1km east of road from Lakes Highway to Lake Augusta, and ca. 2km south of the River Ouse at Lake Augusta. AD. -- Barker 1078, 8.i.1971. Hillside opposite foot track to "Devil's Gullet" and north of road to Mersey valley, ca. 5km west of Lake MacKenzie dam site. AD. -- Barker 1079, 8.i.1971. As for Barker 1078. AD. -- Barker 1080, 8.i.1971. As for Barker 1078. AD. -- Barker 1095, 10.i.1971. Mt. Barrow; near car-park on east side of summit plateau. AD. -- Barker 1097, 10.i.1971. Mt. Barrow; near radio towers on south-east end of summit plateau. AD. -- Barker 1098, 10.i.1971. Mt. Barrow; near road on summit plateau, ca. 200m west of lookout and ca. 1km north of end of road on south-east end of plateau. AD. —— Barker 1105, 12.i.1971. Northern end of Ben Lomond Nat. Park; on slopes within ski village. AD; pollen sample A.N.U., AD. —— Barker 1107, 12.i.1971. As for Barker 1105. AD. —— Barker 1112, 13.i.1971. Northern end of Ben Lomond Nat. Park; at the top of Jacob's Ladder, the face of the Ben Lomond mesa down which the road from the ski village winds. AD. —— Barker 1113, 13.i.1971. As for Barker 1112. AD. —— Barker 1122, 15.i.1971. Summit of Mt. Wellington; moorland west of The Pinnacle. AD; pollen sample A.N.U.,AD. —— Barker 1128, 15.i.1971. Upper slopes of Mt. Wellington; on road from The Pinnacle, near 6-mile post to Fern Tree. AD. —— Barker 1137, 15.i.1971. Upper slopes of Mt. Wellington; on road from The Pinnacle to Fern Tree, ca. 400m south-east of the turnoff of the track to Collins Cap. AD(2 specimens). —— Barker 1141, 17.i.1971. Upper slopes of Mt. Wellington; ca. 1250m from The Springs on the summit road. AD. —— Belcher 1339, 6.ii.1968. Mt. Barrow, E. of Launceston. AD,G,MEL. —— [Black] 1, s.dat. Without locality. MEL. —— Black 2, 27.i.1914. Mt. Wellington. MEL. —— Black 3, 4.iii.1917. Collins Cap. Bismarck. MEL. —— Blackwood s.n., 3.i.1930. N. End of Great Lake. HO. —— Brown 63/2722, ii/iii.1804. In summitate Montis Tabularis prope fluv: Derwent. BM(holotype of E. alpina R.Br.). —— Brown s.n., 1802-5. Table Mtn. MEL41304(isotype of E. alpina R.Br.). —— Burbidge 3016, 9.i.1949. Slopes of Mt. Barrow CANB,HO. —— Burbidge 3205, 19.i.1949. Near summit of Mt. Wellington. CANB(2 specimens). —— Burns 214A, 27.xii.1959. Mt. Barrow Grid Ref.: 5302/9013. MEL,NSW56033. —— Canning 2634, 13.ii.1969. Mt. Barrow (near radio station). CBG. —— Canning 2740, 15.ii.1969. Iris River crossing on Wilmot-Cradle Mtn. road. CBG. —— Carolin 1222, 10.i.1960. Pencil Pine Creek. Boundary of Mt. Cradle Nat. Park. SYD. —— Carolin 1736, 5.ii.1960. Mt. Wellington. SYD. —— Cheel s.n., -.iii.1910. Mt. Wellington. NSW10817. —— Court 1220, 21.ii.1958. On southern slopes of Mt. Wellington (near road to summit). A. —— Cunningham 1836, 8.i.1819. On the extreme summit of Mt. Wellington, at the back or to the westwd. of Hobart Town. K(p.p.). —— [Curtis] s.n., 30.xii.1952. Nr. [The] Springs. HO. —— Curtis s.n., 30.xii.1952. Mt. Wellington. HO. —— [Curtis] s.n., 30.xii.1952. Mt. W[ellington] at bend. HO. —— C[urtis] & Nordenskiold s.n., 5.xii.1957. Mt. W[ellington]. HO. —— Davis 80, 1.i.1946. Mt. Wellington. AD. —— Eichler 16567, 10.i.1960. North of Cradle Mountain. Near road to Waldheim at Pencil Pine Creek. AD. —— Eichler 16877, 1.ii.1960. Mount Wellington. Near the road on the high plains below the summit (in the saddle). AD. —— Gauba TAS444, 4.iii.1951. Mt. Wellington.

GAUBA. -- Gauba s.n., 5.iii.1951. Mt. Field, National Park. GAUBA1883. -- G[ordon] s.n., 27.ii.1941. Mt. W[ellington]. HO. -- Gulliver 22, s.dat. Mt. Wellington. MEL. -- Gulliver s.n., 1872. Mt. Wellington. MEL41440. -- Gunn ?200 (p.p.), s.dat. VDL. K(p.p.). -- Gunn $\frac{267}{1842}$ (p.p.), 31.i.1840. Without locality. NSW10836. -- [Gunn] $\frac{863 \text{ or } 1220?}{1842}$, 5.x.1839. New Norfolk. K(p.p.). -- Gunn s.n., 31.i.1840. Mt. Wellington. BISH. -- Gunn s.n., s. dat. V.D.L. GH(2 specimens, one p.p.),NY(p.p.). -- Gunn s.n., s.dat. Without locality. L908227165,L908227141(p.p.),NY(3 specimens, one p.p.). -- Helms s.n., 19.i.1902. Mt. Wellington. NSW10822. -- Hooker s.n., s.dat. Without locality. MEL41459,GH(p.p.). -- Hooker s.n., s.dat. Without locality. MEL41462. -- Jacobs 28, 1960. Mt. Barrow. MEL. -- Kayser s.n., 1884. Mt. Bis[c]hoff. MEL41762. -- Long 1098, 17.i.1932. Mt. Wellington. HO,CANB. -- Maiden s.n., -.i.1902. Mt. Wellington. G. -- Milligan 16, s.dat. Hampshire Hills. MEL(2 specimens). -- [Milligan] 1178, 27.ii.1849. Summit Mt. Wellington. MEL,NY. -- Millig[an] 1178, s.dat. Top of Mt. Wellington. MEL,FI. -- [Milligan] 1178, s.dat. Mt. Wellington. GH. -- Milligan s.n., s.dat. Without locality. MEL41466(p.p.). -- Mueller s.n., -.i.1869. Mt. Field East. MEL41537(p.p.). -- Olsen 169, 31.i.1967. Northern slopes of Ben Lomond. NSW95468. -- Phillips 174, 13.xi.1965. C. 6+ miles from Cradle Mountain, towards Wilmot, at old camp. CBG. -- Phillips s.n., 13.xi.1965. 11.5 miles from Cradle Mountain, towards Wilmot. CBG. -- F.A. Rodway s.n., -.i.1899. Summit Mt. Wellington. NSW22276. -- F.A. Rodway s.n., -.xii.1899. Ironstone Mts. NSW22281(p.p.). -- F.A. Rodway s.n., -.xii.1900. L. Balmoral (Ironstone Ranges). NSW22273. -- F.A. Rodway s.n., -.xii.1915. Cradle Mt. NSW22289. -- F.A. Rodway s.n., -.xii.1917. Mt. King William. NSW22287. -- L. Rodway s.n., -.xii. 1908. Great Western Mts [? = Tiers]. HO. -- L. Rodway s.n., -.i.1913. Mt. Wellington. HO(2 specimens). -- R[upp] s.n., -.i.1922. The Plateau, Mt. Barrow. MEL41305. -- Scott s.n., s.dat. Without locality. MEL41785,MEL41787. -- Simson 1763(p.p.), -.ii.1880. Mt. Wellington. MEL. -- Somerville s.n., -.i.1960. Cradle Mt. area. HO. -- [Stuart] 428, 21.i.-. V.D.L. MEL. -- [Stuart] 428, -.i.1849. Western Mts [= Great Western Tiers]. MEL. -- Stuart s.n., s.dat. Without locality. MEL41455(p.p.). -- Sullivan & Coates 67, 1886. Mt. Barrow. MEL(p.p.). -- Telford per Canning 2593, 11.ii.1969. Ben Lomond National Park (ski village site) CBG. -- Thomson s.n., s.dat. Mt. Wellington. CHR114731. -- Walter 2005, 15.i.1959. Sudlich von Beaconsfield beim Pine Lake in ca. 1300m Hohe. B. --

Whaite 2173, 4.i.1962. On slopes Mt. Wellington below the Gap. NSW61049.

SPECIMENS WITH AFFINITIES TO SSP. DIEMENICA:

Tasmania

Barker 923, 7.xi.1970. Prossers Forest Road, ca. 10½km south-east of the turnoff from the Lilydale-Launceston road. AD. -- Gunn 200, s.dat. Without locality. NSW10839. -- F.H. Long s.n., -.ii.1929. Port Davey. HO. -- Phillips s.n., 18.xi.1965. 4 miles from Parrawe, towards Waratah. CBG015462. -- Rees s.n., -.xi.1929. St. Marys. HO. -- Stuart 671-672-717, Novr. W. St. Paul's Dome. MEL(p.p.). -- [Stuart] 717, Oct. South Esk. MEL. -- Stuart per Mueller s.n., s.dat. Without locality. MEL41446(p.p.).

c. ssp. tetragona (R.Br.)Barker, comb. et stat. nov.

E. tetragona R.Br.,Prodr.(1810)436 BASIONYM; [R.Br., Manuscript(unpubl.)"Euphrasioides tetragona"]; Spreng., Linn.Syst.Veg.(ed.16)2(1825)777(see Note 6); Bartling in Lehm.,Pl.Preiss.1(1845)343; Benth. in DC.,Prodr.10 (1846)553; Du Rietz,Sv.Bot.Tidskr.42(4)(1948)352,f.2

E. multicaulis Benth.in DC.,Prodr.10(1846)553; Hook.f.,Fl. Tasm.1(1857)297,p.p.(as to Gunn 863, 200 and probably as to "South-western Australia?" occurrence); ?Wettst., Monogr.Gatt.Euphrasia(1896)249,p.p.(as to some Gunn collections,n.v.)

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.),p.p. (as to syn. E. tetragona); FvM.,Fragm.Phyt.Austral.9 (1875)168,p.p.(as to Sullivan MEL41413); FvM.,Syst.Cens. Austral.Pl.1(1882)97,p.p.(as to W.A. and some S.A. and Vict. occurrences); FvM.,Key Syst.Vict.Pl.2(1885)41,p.p.(as to some N.W. and S.W. occurrences): 1(1887-1888)392; FvM., Sec.Syst.Cens.Austral.Pl.(1889)165,p.p.(as to W.A. and some S.A. and Vict. occurrences); Tate,Hdbk.Fl.Extratrop.S. Austral.(1890)253]

[E. collina auct. non R.Br.: Benth., Fl. Austral. 4(1868)520, p.p. (as to syn. E. tetragona: i.e., Preiss 2338; Brown, King George's Sound and Memory Cove; Maxwell MEL41432, MEL41434, MEL41436; Mueller MEL41420 and others); Black, Fl. S. Austral. (ed. 1)(1926)513, p.p.; Gardner, Enum. Pl. Austral. Occid. (1931)118; Ewart, Fl. Vict. (1931)1024, p.p.; Galbraith, Wildfl. Vict. (ed. 2)(1955)136, p.p.; Robertson in Black, Fl. S. Austral. (ed. 2)(1965)772, p.p.; Galbraith, Wildfl. Vict. (ed. 3)(1967)123, p.p.; Beek & Foster, Wild Fl. S. Austral. (1972) t. col.; Willis, Hdbk. Pl. Vict. 2(1973)574, p.p. (as to W.A. and some S.A. and Vict. occurrences)]

[E. paludosa auct. non R.Br.: Wettst., Monogr. Gatt. Euphrasia (1896)255, p.p. (as to Huegel "Australasia"W, "King George Sound"W; Preiss 2338)]

[?E. scabra auct. non R.Br.: Beard, Descr. Cat. W. Austral. Pl. (1965)96, p.p. (as to "?white" - flowered form if true); Beard, Descr. Cat. W. Austral. Pl. (1970)118, p.p. (as in previous reference)]

DESCRIPTION:

Erect perennial herb or undershrub (14.5)17-46(47)cm tall, with many ascending or erect branches arising from a single erect stem, flowering in first year, subsequently dying back to upper branches.

Stem or, after first year, main floral branches (10)12-37 (41)cm high to base of inflorescence, simple for (0.2)0.25-0.95 of height of inflorescence from ground level; upper (0)2-8(9) internodes as long as or longer than upper leaves, the longest internode (0.75)1.3-4.1(4.3) times length of upper leaves; axes in upper parts bearing two rows or four lines of sparse to dense, very short to moderately long eglandular hairs decurrent from between leaf bases, sometimes with sparse eglandular hairs between, in lower parts usually sparser and shorter, often glabrous.

Leaves: uppermost leaves of stem or main floral branches (4.6)5.5-13.8(14.3)mm long, 1.8-6.0(9.6)mm broad, with sessile glands confined to distal (0.35)0.4-0.85 of undersurface, otherwise glabrous, except sometimes for sparse to dense, short eglandular hairs on upper surface, with blade ovate-elliptic, obovate-elliptic, sometimes narrowly or broadly so; base narrow cuneate to rounded; lobes (0)1-2(4) along each margin, confined to distal (0)0.15-0.5 (0.6) of leaf, usually bluntly obtuse or acute, rarely sharply acute, the longest tooth (0.1)0.2-1.5(2.4)mm long; apex (0.2)1.3-3.5(3.8)mm long, (0.8)1.0-3.1(5.2)mm broad, usually bluntly acute or obtuse, rarely truncate; leaves lower down glabrous.

Inflorescences racemes, except sometimes for widely-spaced lower 1-2 nodes, dense, sometimes moderately dense, rarely lax in flower and fruit, with (12)18-52(80) flowers, with lowest node sometimes bearing a single flower; pedicels at lowest node (0.6)0.7-5.0(7.0)mm long, shorter higher up; rachis with indumentum similar to part of axis, but sometimes denser; internodes elongating prior to anthesis such that capsules usually reach past, sometimes well below base of calyx above; apical bud cluster usually narrow-cylindrical to narrow conical-cylindrical, sometimes ovoid, initially 1.0-4.0mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 5-29 nodes have reached anthesis.

Bracts glabrous, except often for eglandular hairs on upper surface, shorter than calyx, except sometimes for those at lowest 2(4) nodes, usually those at lower 2-11(23)nodes toothed with distal ones entire, rarely all entire, those at lowest nodes similar to upper leaves in shape and size.

Calyx (4.7)4.9-9.3(10.0)mm long, externally glabrous or with a small patch of eglandular hairs decurrent from base of median clefts, internally with moderately dense to dense, short to moderately long eglandular hairs on distal part of tube and lobes.

Corolla (9)11-16(17)mm long along upper side, white or pale to deep mauve, pink, purple, lilac, violet, lavender or blue, with yellow to orange blotch behind lowest lobe, usually also with smaller blotch at base of each anterior filament, sometimes with blotches in the two areas coextensive; tube (6.2)7-10(12)mm long; hood (2.6)3.5-6(6.8)mm long; upper lobes emarginate or shallowly so, with rear surface glabrous; lower lip (5.2)6-10.5(13)mm long; lower lobes usually emarginate or deeply so, rarely shallowly emarginate, externally glabrous.

Stamens with anthers (1.5)1.7-2.5(3.0)mm long, with connectives surrounded by usually dense, sometimes moderately dense, rarely sparse, long to very long eglandular hairs; posterior pair of awns (0.1)0.2-0.5mm long.

Capsules 7.5-12mm long, in lateral view elliptic to ovate-caudate, 2.5-3.0mm broad, in median view narrow ovate- acuminate, glabrous or with a few short setae at very apex; apex in lateral view obtuse to truncate-obtuse, sometimes obliquely so; seeds (7)55-105, (0.5)0.6-0.9(1.0)mm long, 0.3-0.4mm broad, ellipsoid, oblong or ovoid, often obliquely so.

Plates: 4, 8

Figures: 17

TYPIFICATION:

1. E. tetragona

Probable holotype: R.Brown 2720, s.dat. [Dec. 1803] "In collibus prope Bald Head" King Georges Sound. BM(p.p.).

Although the BM specimen seen and cited above is undoubtedly part of the type collection described in Brown's manuscript (unpubl.) and the protologue (Brown 1810), there are grounds for doubting that the specimen is the same as that designated and described by Du Rietz (1948b) as the "holotype". Du Rietz makes no mention of Brown's collection of E. tetragona from Memory Cove, South Australia, which is mounted with the above collection. In fact, he considered that E. tetragona was a "geographically very isolated member of the collina-paludosa group (which does not seem to be represented at all in South Australia)". It is likely that the collections were mounted together on the one sheet before Du Rietz's visit to BM in 1930-1931 as photographs of Brown's holotypes of E. collina and E. striata show that the specimens are arranged identically to their present state. Several explanations for this anomaly come to mind, the first being that he saw a duplicate of this sheet. The existence of a duplicate may be indicated also by the fact that unlike all Brown's other holotype sheets of Euphrasia, this one lacks locality annotations in Brown's handwriting. Alternatively however this may be the sheet seen by Du Rietz; either he may have considered that the Memory Cove collection belonged to "E. tetragona" and did not know that Memory Cove was in South Australia, or he may well have considered that it belonged to E. collina (sensu Brown 1810). In support of the latter, Brown had annotated the Memory Cove collection "Euphrasia cfr. collinam" and Du Rietz may have followed this.

The type specimen described above bears many mature capsules and comprises one apparently almost entire plant, lacking the root system, and two separate smaller floral branches. Some leaves have been lost. The pencil line separating the two collections seems to have been correctly placed.

It is not known if populations of ssp. tetragona still exist in the region of the type locality. The last collection from the Albany area was made by Preiss in 1838. However, this is no reason to consider that the populations at Albany are extinct. A number of collections of the species from the south coast of Western Australia have been made recently after no collections had been made there for more than a century.

2. E. multicaulis

Lectotypus: Gunn $\frac{863}{1837}$, 25.x.1836 (p.p.). Circular Head 25/10/36 Woolnorth. This very beautiful species is very common in the sandhills, &c. in the neighbourhood of the sea at Circular Head and Woolnorth, flowering during the latter part of October and early in Novb. In my earlier collections I am afraid I have sadly confounded different species of Euphrasia, and to commence clearing up matters, I give this a new number to begin with. K(p.p.). ?Isolectotypus: BM(n.v.). Syntypi alteri: Baxter s.n., K G [King George's] Sound N. Holl. K(p.p.). -- "Specimina a Labillardiere in ore meridionali Australiae..... lecta" (n.v.).

Gunn's collection from Herbarium Hookerianum is the obvious choice as lectotype since it forms the basis of the initial diagnosis (Bentham 1846). The other two syntypes were described as hardly differing from the species as described. The Baxter collection although almost vegetative clearly belongs to ssp. tetragona. From the locality cited it is probable that the other syntype also belongs to this subspecies.

The lectotype is apparently a combined collection from Circular Head and Woolnorth, two localities on the north-west corner of Tasmania. There seems little point in attempting to separate the three specimens which are included in the collection at this stage as together they form a homogeneous collection, although the two smaller plants may have come from one locality and the larger from the other. All three plants are almost entire, lacking only the root system, are in very good condition and bear buds and flowers.

The collection is mounted with the collection Gunn $\frac{863 \text{ or } 1220?}{1842}$ of ssp. diemenica from New Norfolk.

It is probable that BM also has an isolectotype as Du Rietz (1948b, p.354) discussed the K lectotype specimen, strangely without mention that it was a type of E. multicaulis, and noted that the collection was also represented in BM.

The region about Circular Head (the present site of Stanley) was searched in vain in 1970 for evidence of Euphrasia. The sand dunes in the area appear to be covered almost exclusively with Marram-grass (Ammophila arenaria(L.)Link), which was introduced by the Van Diemen's Land Co. in the early or mid-1800s to stabilise dune areas (Mr. D. Steane, Lands & Surveys Dept., Tasmania: pers. comm. 12.i.1971). For this reason Euphrasia may not now exist in the areas of Stanley and Woolnorth.

DISTRIBUTION (Fig. 17):

E. collina ssp. tetragona is restricted mainly to the coastal regions of south-west Western Australia and South Australia with an inland extension into the sandy-mallee heaths of the 90-Mile Desert in South Australia and the Little Desert and Big Desert of western Victoria. A few old collections come from Tasmania, the only specific localities being at Wodnorth and Circular Head (or Stanley) on the north-east coast. In South Australia, there are three isolated, possibly relict occurrences at Mt. Kitchener in the Mt. Lofty Ranges, Mt. Remarkable in the southern Flinders Ranges and in the Gawler Ranges (see Note 4). All of these are represented by one or two old collections. The area of distribution seems to lie within the areas receiving an annual rainfall of more than 35cm.

The subspecies apparently occurs from altitudes between sea level and about 150m. There is no evidence that the isolated inland populations came from above this altitude even though each mountain area exceeds 450m.

ECOLOGY:

The subspecies occurs in the mallee-heaths of the inland plains of eastern South Australia and western Victoria (Anway 364, Barker 1450, Specht & Rayson 66, Williams AD97336002), from coastal cliff-top heathland on southern Yorke Peninsula (Barker 1365, 1366), in sand dune vegetation in north-eastern Tasmania (Gunn 863), South Australia, where it may occur upon the dunes (Barker 1375) or in the swales between (Symon 8497) and Western Australia (Brown 2720, Orchard 1485). All of these vegetation types occupy sandy soil. On Kangaroo Island Jackson has made several collections from sandy soil (397) or sand on limestone (907, 910, 940, 954). Several of these came from limestone cliffs. It is probable that other collections recorded from limestone or limestone cliffs and hills on Kangaroo Island (Jackson 691) and in Western Australia, (Maxwell MEL41432, MEL41434, MEL41436; Preiss 2338) inhabited sand. The population on West Cape, southern Yorke Peninsula, (Barker 1374) grows in very limited soil amongst cracks in the limestone cliff top. Atypical records of habitat are "Lateritic soils. E[ucalyptus] cladocalyx dominant" (D. Smith 309A) and "Granite rock" (Lullfitz 3558).

Flowering occurs between August and February, with a single record of March (Staer NSW10949). Capsules begin to form from September.

NOTES:

1. The collection Muir 1783 from Wilsons Promontory in Victoria (fig. 17) has been tentatively placed under ssp. tetragona, even though it forms the most easterly locality of the subspecies and is disjunct from the nearest known occurrence of the subspecies

in the Little Desert of western Victoria. The collections contains a single plant typical of ssp. tetragona by its emarginate, externally glabrous corolla lobes, uppermost leaves with one or two teeth along each margin, and branching well up the main suberect branches. It is possible however that it is an extreme variant of populations related to ssp. paludosa and ssp. collina which occur on Wilsons Promontory. A study of populations in the region as part of a general revision of the lowland Victorian members of E. collina is recuired to clarify the situation.

2. Within ssp. tetragona there is geographical variation in leaf shape and the extent of branching in to the upper parts of the stem and main floral branches.

This variation is illustrated in the graph (fig.24) of the length : breadth ratio of the upper leaves of the main axes plotted against the proportion simple of the height of the inflorescence on the main axis above ground level. It should be noted that the selection of specimens in some cases is neither complete nor random, but has been based on an attempt to obtain the whole range of variation. The Kangaroo Island populations are represented by all entire plants in the available herbarium material. In addition, although incomplete, the only plants from the northern side of the island (Ashby 1400) are included, as they appear to relate more to the mainland populations than those from the southern coast of the island.

The graph demonstrates that except for the inland collections, which are apparently relict (see Note 4), a very [x]atypical

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[x]Decayed branches from the previous year indicate that the branching may have been much lower then, with the proportion of the height of the inflorescence above ground level simple about 0.60. This may point to some unusual environmental effect.

collection (Eichler 14044) from Corny Point and the collection Mueller MEL41408 from the extreme east of the mainland occurrences of ssp. tetragona (but see Note 1), the south coast Kangaroo Island populations differ from the mainland populations by their extremely high aerial branching on the main floral axes. They also have a tendency to have broader leaves than their counterparts on the neighbouring peninsulas, although the differences may not prove statistically significant (pl. 8: Eichler 15384, Barker 1355). However, it is clear that plants from the sandy-mallee heaths of the 90-Mile Desert, the Little Desert and the Big Desert in the eastern part of the mainland range of distribution, diverge from populations to the west by their narrower upper leaves (pl. 8, Barker 1450). These leaves are very similar in shape and size to those found in ssp. collina in the adjacent areas of inland western Victoria (pl. 7: Barker 1439,1443,1446), and reflect the close taxonomic affinities of the two subspecies.

3. Growing on the extreme tip of West Cape on the south-west corner of Yorke Peninsula occurs a population of ssp. tetragona (Barker 1374: pl. 26) unique for its large broad, very fleshy leaves (pl. 8) calyces and bracts and short floral branches. The plants grow with other succulent plants in very exposed conditions in sparse soil in crevices of the limestone which tops the promontory. Plants (Barker 1375) typical of coastal populations of southern Yorke Peninsula occur behind the headland in the more protected slopes of sand dunes. The increased fleshiness in the cliff-top plants is probably because of the greater exposure to sea-spray, a response often exhibited by plants in such areas (Specht 1973). Plants on less-exposed cliffs such as those near Corny Point are typical of the subspecies. Whether there is any genetic basis to these differences is not known.

4. The occurrence of ssp. tetragona in each of three disjunct mountain areas in South Australia must be open to some doubt as the individual records are based on possibly single old collections.

The Gawler Ranges, where the collections Sullivan MEL41413 and its possible duplicate Anon. MEL41752 were allegedly made, are on the northern perimeter of Eyre Peninsula. Because of the possible inadequacies in botanical collecting on Eyre Peninsula it is impossible to estimate whether this record, if authentic, represents a northernmost extension of populations in the areas between the Gawler Ranges and the known populations on the coast, or whether it is a relict occurrence in a mountain-area surrounded by lowlands with a climate too inhospitable for the subspecies to survive.

Kaiserstuhl (now known as Mt. Kitchener) in the Barossa Range, from which [x]Mueller MEL41488 is alleged to have come, and Mt. Remarkable in the southern Flinders Ranges, where Mueller HBG (p.p.) was apparently collected, are two of a line of disjunct mountain refuges between the Mt. Lofty Ranges and the Flinders Ranges (Kraehenbuehl unpublished) on which isolated extensions of the ranges of distribution of plant species widespread in the Flinders Ranges, Mt. Lofty Ranges, or the similarly moist or wetter climatic regions of Victoria and New South Wales occur. Boomsma (1972) has illustrated a number of patterns of distribution which seem to fit the refugial nature of these areas in particular (e.g. Acacia melanoxylon, Banksia marginata, Eucalyptus goniocalyx, E. macrorhyncha). A number of other examples are cited by Boomsma which demonstrate the refugial nature of extensions of these areas into the Mt. Lofty Ranges to the

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[x]The appearance of the specimen Mueller MEL41513, dated 1851, is so similar to that on this Kaiserstuhl collection that it seems likely that it comes from the same gathering.

south and the northern Flinders Ranges (see also Crocker & Wood 1947, Parsons 1973).

It is clear that these isolated occurrences must be verified, as evidence is based on only single collections. Should they prove authentic the pattern of distribution then portrayed by ssp. tetragona would seem to be unusual. I have not been able to discover other examples of a sandy mallee-heath plant with isolated occurrences in what are basically refuges for montane sclerophyll forest or woodland taxa.

5. The material of ssp. tetragona and the label "Woolls Parramatta" on MEL41424 must be very doubtfully associated. The deeply emarginate, glabrous corolla lobes clearly ally the specimen with ssp. tetragona. The leaves with 1-2 teeth along each margin also resemble these. Unfortunately only the upper parts have been collected and the habit cannot be determined. Other material collected by Woolls from Parramatta near Sydney clearly belongs to either ssp. speciosa or ssp. paludosa (q.v.)

6. The statement by Sprengel (1825) that "E. tetragona" (now E. collina ssp. tetragona) was restricted to Tasmania ("Terra Diemen") is clearly an error as the remainder of the text on E. tetragona and the other five species confined to Australia is a straight copy with some rearrangement of Brown's (1810) descriptions of each. Either Sprengel mistakenly substituted "Terra Diemen" for the southern coast of Australia ("Ora Meridionalis") cited by Brown for the species, or he intended to extend the distribution of the species into Tasmania and omitted reference to those localities already known.

SPECIMENS EXAMINED:

South Australia

Alcock 1648, 1.x.1967. West Point, Lincoln National Park, Eyre Peninsula. AD,ADW. -- Anon. [Herb. Black] s.n., 10.x.1918. S. of Lameroo. AD97331118. -- Anon. s.n., 25.x.-. Lake Koorong. MEL41415. -- Anon. [?Osswald] s.n., s.dat. Guichen Bay. MEL41410(p.p.). -- Anon. [Herb. Tate] s.n., s.dat. Seacliffs D'Estree Bay. AD97412387(p.p.). -- Anon. [Herb. Tate] s.n., s.dat. Lake George. AD97412387(p.p.). -- Anon. s.n., s.dat. Coffins Bay. MEL41712. -- Anon. s.n., s.dat. Gawler's Range. MEL41752. -- Ashby 1400, -.x.1905. Middle River. N.W. Kangaroo Island. NSW10950. -- Barker 1355 & Short, 25.ix.1971. Yorke Peninsula. Coastal cliff-top track to Gleesons's Landing, ca. 4km SSW of the Corny Point lighthouse. AD. -- Barker 1366, 25.ix.1971. Yorke Peninsula. Ca. 6km SSW of the Corny Point lighthouse, on coastal cliff-top track to Gleeson's Landing. AD. -- Barker 1374, 25.ix.1971. South-west tip of Yorke Peninsula. On the very edge and top of West Cape. AD. -- Barker 1375, 25.ix.1971. South-west tip of Yorke Peninsula. West Cape: ca. 200m E of the edge of the cape on north-facing slope of sand-dune ca. 50m W of westernmost extent of track from the Pondalowie Bay - Stenhouse Bay road. AD. -- Blaylock 42, 10.x.1965. Pondalowie Bay, Southern Yorke Peninsula. AD. -- Blaylock 216, 9.x.1966. Pondalowie Bay. AD. -- Blaylock 327, 11.x.1966. 8km SSW Corny Point Lighthouse. AD. -- Brown 2719, s.dat. Memory Cove. BM(p.p.). -- Browne 73, 1875. Port Lincoln. MEL. -- Browne 119, 187[4]. Port Lincoln. MEL. -- Brown[e] s.n., 1873. Port Lincoln. MEL41414. -- Carroll 555, 21.ix.1965. 5.5miles from Memory Cove, Cape Catastrophe, Eyre Penin., towards Port Lincoln. CBG,AD. -- Carter s.n., 31.x.1960. Daniel, Sect. 78 Hd of Coonarie, Co. Fergusson, Lower Yorke Peninsula ± 11m S.S.W. of Warooka. ADW24769. -- Cleland s.n., 6.iii. 1926. Pennington Bay, KI. AD97119092. -- Cleland s.n., 1929. K.I. Kangaroo Island. AD97119088. -- Cleland s.n., 4.xii.1934. Road to C. de Couedic KI. AD97119096. -- Cleland s.n., 31.i.1940. Mouth of Rocky R., KI. AD97119095. -- Cleland s.n., 19.ix.1953. 13m S. of Meningie. AD97119080. -- Cleland s.n., 27.x.1967. C. de Couedic, FC [Flinder's Chase]. AD96830268. -- Cooper s.n., 13.xii.1964. K Id. South Coast near Pelican Lag[oon]. AD96501008. -- Crocker s.n., 3.ix.1943. N.W. of Keith. CANB11673. -- Dixon s.n., -.x.1883. Port Lincoln. AD97412387(p.p.). -- Donner 155, 24.viii.1961. Hundred of Makin - ca. 23km north-east of Keith. AD. -- Donner 186, 25.viii. 1961. 7km north of Shipley Hill. Shipley Hill is ca. 26km north-east of Keith. AD. -- Eichler 14044, 27.ix.1957. Seacoast ca. 4km south of Corny Point. AD,L; P(n.v.). -- Eichler 15384, 11.xi.1958. Cape du Couedic (near the lighthouse). AD. -- Follett s.n., 25.x.1937. Coomandook. ADW3784. -- Hunt 213, 14.x.1961. Roadside between The Gap and Western Flat. AD. -- Hunt 1208, 6.x.1962. Bordertown-Naracoorte Rd. AD. -- Jackson 397, 1.xi.1964. Pennington Bay, Kangaroo Island. AD. -- Jackson 691, 11.x.1970. Track to Seal Bay. AD. -- Jackson 907, 28.xii.1971. Pennington Bay, K.I. AD. -- Jackson 908A, 28.xii.1971. As for 907. AD. -- Jackson 909A, 28.xii.1971. As for 907. AD. -- Jackson 910, 28.xii.1971. Eastern end Pennington Bay, K.I. AD. -- Jackson 932, s.dat. Kangaroo Island. "Probably from Baile's Beach near Seal Bay". AD. -- Jackson 940. 5.xi.1972. Bales Beach K.I. AD. -- Jackson 941, 5.xi.1972. As for 940. AD. -- Jackson 954, 7.xii.1972. Eastern end of D'Estrees Bay, K.I. AD. -- Kraehenbuehl 138, 28.xii.1959. Cape De Couedie, south-west corner of Kangaroo Island. AD. -- Kraehenbuehl 1260, 7.xi.1964. In cleared land near Pigsty Soak. Section 15. Hd. of Senior. County Buckingham. AD,CANB,CHR,; LE,RSA(n.v.). -- Mueller s.n., s.dat. Nov. Holl. austr. Kaiserstuhl. MEL41488. -- Mueller s.n., s.dat. Mount Gambir. Nov. Holl. austr. MEL41408. -- Mueller s.n., s.dat. Mount Remarkable Nov. Holl. austr. HBG(p.p.). -- Nash s.n., 27.ix.1964. Ca 10km south of Corny Point (south-west point of Y.P.). AD96450179. -- Orchard s.n., 9.viii.1965. Keith. AD966050189. -- Phillips 366, 18.x.1966. 31 miles from Yorketown, towards Marion Bay. CBG. -- Phillips 419, 18.x.1966. 24½ miles from Yorketown, towards Foul Bay. CBG. -- Richards s.n., 1883. Fowler's Bay. MEL 41745. -- Richards s.n., 188[3]. Between Port Lincoln and Streaky Bay. MEL41768. -- Rogers s.n., -.i.1907. Cape Couedie. Kangaroo Island. NSW24519. -- Rogers s.n., -.ix.1907. Marion Bay. NSW10952, BISH. -- Sharrad 1045, 27.viii.1961. Near Kangaringa Homestead, 60km south of Pinnaroo in the Hundred of Shaugh. AD. -- Sharrad 1060, 28.viii.1961. North of Bunn's Bore on Bordertown-Pinnaroo road. AD. -- Sharrad 1096, 29.viii.1961. 30 miles south of Pinnaroo on Bordertown road. AD. -- D. Smith 309A, -.ix.1956. Eyre Peninsula. Yallu[n]da Flat. MEL. -- T. Smith 770, 25.x.1967. On coastal cliffs approx. 1 mile south of Corny Point lighthouse. AD. -- Specht & Rayson 66, -.x.1950. Dark Island heath, 9mls. N.E. Keith. AD. -- Staer s.n., -.iii.1911. Kangaroo Island. NSW10949. -- Sullivan s.n., s.dat. Gawler Ranges. MEL41413. -- Symon 13, 9.iv.1957. Meningie. ADW. -- Symon 8497, 27.i.1973. Kangaroo Island, ... behind Pennington Bay. ADW. -- [Tate] s.n., 1882. Kangaroo Island. MEL41726. -- Warburton s.n., s.dat. Streaky Bay. MEL41418. -- White s.n., -.iv.1916. Pt.

Yorke, Y.P. AD97331119. –– Williams per Barker s.n., 1.ix.1973. Ca. 4km east of Meningie township on the main Coonalpyn road. AD97336002. –– Wilson 345, 9.x.1958. Near Memory Cove, 3km north of Cape Catastrophe, 29km south south east of Port Lincoln. AD. –– Wilson 901, 13.xi.1958. Pennington Bay, nr. Mt. Thisby, c. 24km south-south-east of Kingscote. AD. –– Wilson 1970, 25.viii.1961. Ca. 28km north-east of Keith in Hd. Makin. AD. –– Wilson 2090, 29.viii.1961. Ca. 65km north of Bordertown on Pinnaroo-Bordertown road. AD. –– Wrigley 7650, 20.xi.1968. Memory Cove, Eyre Peninsula. CBG.

Tasmania

Anon. s.n., s.dat. Terre de van Diemen. G. –– Gunn ?200 (p.p.), s.dat. VDL. K(p.p.). –– Gunn $\frac{863}{1837}$, 25.x.1836(p.p.). Circular Head & Woolnorth. K(p.p.: lectotype of E. multicaulis). –– Gunn s.n., s.dat. Without locality. GH,NY(p.p.).

Victoria

Ackland 31, 28.ix.1963. 20 miles S of Nhill, 2 miles W of Nhill-Gymbowen Road. Ca. 3-5 miles NNW of Murcoung. MEL. –– Allender s.n., 3.ix.1970. Little Desert, between The [Crater] and Broughton's Waterhole. MEL41792. –– Allitt s.n., s.dat. Mouth of the Glenelg River..MEL41366. –– Anon. s.n., s.dat. Wimmera. MEL41312. –– Anon. s.n., s.dat. Glenelg [River]. MEL41702. –– Anway 364, 10.ix.1965. Ca 6 miles south of Kiata, in the "Little Desert". PERTH,AD. –– Aston 1020, 30.ix.1963. Big Desert, 8 miles east of the South Australian border, and 22 miles north of the Western Highway. MEL. –– Barker 1450, 27.x.1971. Little Desert. Ca. 22km NNE of Gymbowen on the road to Nhill. AD. –– Beauglehole 18999, 5.ix.1962. Little Desert. 14m S of Kiata near Salt Lake. BEAUGLEHOLE. –– Beauglehole 40740, -.x.1949. Big Desert. N. of Yanac. BEAUGLEHOLE. –– Beauglehole 40741, -.x.1949. Little Desert. S. of Kaniva. BEAUGLEHOLE. –– Dall[achy] s.n., s.dat. Wimmera. MEL41331(p.p.). –– Davies s.n., 30.viii.1954. Little Desert. MELU 15986. –– Mueller s.n., s.dat. Austr[alia] felix. MEL41319(p.p.). –– Muir s.n., -.x.1947. Little Desert. S of Kiata. BEAUGLEHOLE40742. –– Phillips 94, 17.x.1963. Little Desert, beyond salt lake from Kiata. CBG. –– Phillips 435, 2.xi.1971. 16 miles S of Nhill, towards Goroke. CBG. –– Phillips 597, 23.x.1966. 6 miles from Winniam, towards Goroke. CBG. –– Walter s.n., s.dat. Wimmera. MEL41334. –– Wrigley 7913, 30.xi.1968. 17 miles from Nhill, towards Goroke. CBG038385.

Western Australia

Andrews 83, -.x.1903. Esperance. PERTH. -- Baxter s.n., s.dat. K G [King George's] Sound N. Holl. K(p.p.: syntype of E. multicaulis). -- Boyd 32, early 1971. Peaceful Bay. PERTH. -- Brown 2720, s.dat. Prope Bald Head, King Georges Sound. BM(p.p.: probable holotype). -- Dempster s.n., 1871. Between Esperance Bay and Russell Range. MEL41435. -- Huegel s.n., s.dat. King George Sound. W. -- Lullfitz 3558, 23.viii.1964. Cape Le Grande. PERTH. -- Maxwell s.n., s.dat. Esps [Esperance] bay. MEL41432. -- Maxwell s.n., s.dat. From Stokes inlet to Cape Le Grand. MEL41434. -- Maxwell s.n., s.dat. Esps (Esperance] Bay. MEL41436. -- Orchard 1485, 12.x.1969. Shire of Oldfield. Coastal sand dunes, ca. 14 km east of the mouth of the Oldfield river. AD,PERTH. -- Preiss 2338, 1.xii.1840. Princess Royal Harbour. MEL,HBG,L,W. -- Royce 8748, 22.x.1969. Cape Le Grand National Park. E. of Esperance. PERTH. -- Wrigley 5256, 31.x.1968. Twilight Cove, Esperance. CBG, BRI.

Australia. Without locality or locality unknown

Mueller s.n., 1851. MEL41513. -- Mueller s.n., s.dat. Nov. Holl. austr. Devils country. MEL41409. -- Mueller s.n., s.dat. Nov. Holland. meridional. W.

Without locality

Anon. [Herb. Black] s.n., s.dat. AD97331125. -- Huegel s.n., s.dat. Australasia. W.

Locality doubtful

Anon. s.n., s.dat. N.S.Wales. AD97012201(p.p.). -- Mueller s.n., various dates. Any one of three possible localities: Bethanien [Bethany]. s.dat. / Apud pag[um] german[um] [Probably Bethany]. -.ix.1848. / In montibus Flinders range. -.x.1851. MEL41484(p.p.). -- Woolls s.n., s.dat. Par[r]amatta. MEL41424.

SPECIMEN WITH AFFINITIES TO SSP. TETRAGONA:

Victoria

Muir 1783, 8.xi.1960. Wilson Promontory. On the Lighthouse track, 2 miles south of Fraser's Creek. MEL41796.

d. ssp. trichocalycina (Gandoger)Barker, comb. et stat. nov.

E. trichocalycina Gandoger,Bull.Soc.Bot.France 66(1919)218 BASIONYM; Briggs in McGillivray,Contr.N.S.W.Nat. Herb.4(1973)339

E. muelleri Wettst.,Monogr.Gatt.Euphrasia(1896)257,p.p. (as to Walter W3912p.p.)

E. collina R.Br.: Ewart,Fl.Vict.(1931)1024,p.p.(at least as to some Grampians occurrences); Willis,Hdbk.Pl.Vict. 2(1973)574,p.p.(as to some occurrences in regions C,D, H,J,M,N of Victoria)

[?E. collina auct. non R.Br.: Hook.f.,Fl.Tasm.1(1857)296, p.p.(possibly as to Robertson's Victorian collection, but not seen)]

DESCRIPTION:

Erect perennial herb or undershrub (15)26-50(62)cm high, with branches erect or rapidly ascending, arising from a single erect stem, terminated by an inflorescence in first year and then dying back to upper branches.

Stem or, after first year, main floral branches (13)22-43(55)cm high to base of inflorescence, simple for (0.05)0.1-0.45(0.75) of height from ground level to inflorescence; upper (1)4-9(10) internodes as long as or longer than upper leaves, the longest internode (1.0)2.2-4.2(7.0) times length of upper leaves; axes in upper parts covered by two rows or four lines of dense, short to moderately long eglandular hairs decurrent from between leaf bases, rarely with sparser eglandular hairs between, sometimes mixed with usually sparse, rarely dense, very short to moderately long glandular hairs all around, lower down with similar eglandular indumentum rarely with dense, short glandular hairs all around.

Leaves: uppermost leaves of stem or main floral branches

(5)7-14(15.8)mm long, (1.7)2.3-4.4(5.4)mm broad, with blade linear or narrow ovate-oblong to obovate-oblong, with sessile gland patches confined to distal (0.5)0.55-0.7(0.75) of lower surface, otherwise usually glabrous, sometimes covered by sparse to moderately dense, very short to short glandular hairs; base rounded or narrow cuneate; teeth (0)1(2) along each margin, confined to distal (0.15)0.25-0.45(0.5) of leaf, usually sharp, sometimes blunt, usually acute, rarely obtuse, the longest tooth 0.8-2.0(2.4)mm long; apex (1.2)1.7-3.0(3.4)mm long, (0.8)1.0-1.9(2.3)mm long, usually blunt, rarely sharp, acute or obtuse; leaves lower down glabrous but rarely for leaves near base which bear very sparse, short glandular hairs.

Inflorescences racemes, except for widely-spaced lower (0)1-3(5) nodes, dense in bud, moderately dense to dense in flower and fruit, with (14)20-40(48) flowers, rarely with lowest node bearing a single flower; pedicels at lowest node (0.5)1.0-3.7(7.5)mm long; rachis with eglandular indumentum similar to uppermost part of axis, but sometimes denser or slightly longer, sometimes with sparse to dense, very short to moderately long glandular hairs all around; internodes elongating prior to anthesis such that, except at widely spaced lower nodes, capsules usually reach or extend past node above, sometimes just below it; apical bud cluster, except for widely-spaced lower nodes, narrow cylindrical or narrow conical to ovoid, initially (1.5)2-3(4)mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after flowers at lower (4)6 or more nodes have reached anthesis.

Bracts similar to uppermost leaves in size and shape, usually bearing sparse to very dense, very short to short glandular hairs, rarely glabrous, those at all but the lower (2)3-6(9) nodes entire, those at all but the lower 0-4(5) nodes shorter than or equal to calyx.

Calyx (3.5)4.4-6.0(7.8)mm long, externally covered by very sparse to dense, usually very short to short, rarely moderately long glandular hairs densest on teeth, extending on to side of teeth, with short eglandular hairs on inside of teeth, rarely extending onto outer surface.

Corolla (9)9.5-12.5(14.5)mm long along upper side, white, or lavender to lilac with white lobes, or lavender to lilac and whitish behind lobes, with yellow blotch lacking; tube (5.5)6-9.5(10)mm long; upper lobes obtuse or shallowly emarginate with rear surface bearing moderately dense to dense, very short glandular hairs, sometimes all over, sometimes confined to base; lower lip (3.9)4.3-7.5(8.0)mm long, with moderately dense to dense, short glandular hairs, sometimes mixed with sparse to moderately dense, short eglandular hairs, the indumentum usually all over, sometimes only at base; lower lobes usually emarginate to shallow emarginate, sometimes praemorse obtuse.

Stamens with anthers (1.4)1.5-1.9(2.2)mm long, with connectives surrounded by dense long to very long eglandular hairs, the area about front ones sometimes somewhat sparser; posterior pair of awns (0.1)0.2-0.4(0.5)mm long.

Capsules (6.5)6.9-8.7(9.2)mm long, in lateral view usually elliptic to oblong-elliptic, sometimes narrowly so or obovate or somewhat caudate and slightly deflexed, (1.8)1.9-2.6mm broad, in median view ovate- to elliptic-acuminate, usually glabrous, sometimes with a few to moderately dense, short to long setae confined to apex; apex in lateral view acute to truncate-obtuse, sometimes obliquely so; seeds (23)55(123), (0.5)0.7-1.0(1.3)mm long, (0.2)0.3-0.5(0.6)mm broad, ellipsoid, oblong, ovoid or reniform, often obliquely so, sometimes broadly so.

Plates: 8

Figures: 18

TYPIFICATION:

Holotype: C. Walter s.n., 1902. Australia, Victoria. LY.

Isotype: BISH.

The holotype is in good condition and consists of two floral branches, one picked from its base, the other from probably half its length. Buds and flowers, but no fruits, are present. As well as the annotation "E. trichocalycina Gdgr!", Gandoger has written "Euphrasia Brownii f. pubicalyx"; this latter name and taxonomic concept was apparently superseded prior to the publication of the protologue (Gandoger 1919). The isotype consists of two flowers with bracts and a young shoot apparently removed from the holotype.

The type diverges somewhat from the other representatives of the subspecies by its elliptic upper leaves with short teeth extended almost into the basal half and its lax habit. However the short glandular indumentum restricted to the upper parts, the short posterior anther awns (0.2mm) and the subglabrous capsules ally the specimen with the other members of the subspecies sufficiently to warrant its inclusion in the subspecies at this stage.

Mueller MEL41512 from "Swamps about Forest Creek" and Thorn MEL41391 from "Upper Goulbourn River" contain single specimens which like the holotype are related to the major portion of ssp. trichocalycina by their glandular indumentum, their branching above ground level, their posterior anther awns 0.2-0.3mm long and their subglabrous capsules, but diverge from them by their upper leaves with 2-3 teeth along each margin. The glandular indumentum (ca. 0.5mm on calyx and leaves, 0.2mm on rachis and axis) of the former is unusual in that it is very sparse on the calyx but moderately dense on the bracts, rachis, leaves and axis almost to ground level; the upper leaves bear 3 teeth extended well down each margin. The Thorn specimen bears glandular hairs (0.2mm long on the calyx) confined to the upper parts and has upper leaves with 2 pairs of teeth restricted to the distal half. It seems probable that the type came from the western part of the eastern highlands of Victoria where these two related collections were made. Further collections of the subspecies are required outside the Grampians to determine whether the holotype and its two related specimens represent extremes in variation of the subspecies or a distinct taxon.

DISTRIBUTION (Fig. 18):

E. collina ssp. *trichocalycina* is confined mainly to central and western Victoria. It is also known in the South East of South Australia from Ewens Ponds near Port MacDonnell.

It has been recorded from altitudes between sea level and almost 800m.

ECOLOGY:

Mostly details of the Grampians habitats of ssp. tricho-calycina have been recorded. On the lower slopes of these sandstone ranges populations occur in sandy soil "in open areas of heath ... in low *Eucalyptus* forest/woodland, with a dense low shrub stratum of *Casuarina*, *Banksia*, *Hakea*, *Xanthorrhoea* etc." (Barker 1432) while on the higher slopes they inhabit low *Eucalyptus* scrub with a dense shrub understory in shallow sand between the exposed bedrock (Barker 1438,1439p.p.), an area of tall dense shrubs ca. 1½m high at the edge of tall Eucalyptus forest (Barker 1442), or a "heathy flat" (Symon 263). Barker 1439p.p. and 1442 were collected within shrubbery which had regenerated after roadworks. In central Victoria the subspecies has been recorded from "Steep slopes in *Eucalyptus goniocalyx*-*E. dives* forest" (Willis MEL41472) and "swamps" (Mueller MEL41512). The one South Australian collection also came from "In swamps" (Cleland AD.).

Flowering apparently begins between probably as early as August and early November and continues possibly into January. Copiously fruiting plants have been recorded in September. Flowering period is affected greatly by altitude since towards the end of October the population seen on the lower slopes had all but finished flowering (Barker 1432) while those on the slopes above 500m had hardly begun to flower (Barker 1438,1439p.p.,1442).

SPECIMENS EXAMINED:

South Australia

[Cleland] s.n., 30.x.1941. Near Ewens Ponds, Pt. MacDonnell. AD97119091,AD966060109.

Victoria

Audas s.n., 6.ix.1924. Ringwood. MEL41380. — Barker 1432, 26.x.1971. Grampians. On the lower east slopes of the Serra Range near the road to Halls Gap, ca. 12mi (20km) by road from Dunkeld. AD. — Barker 1438, 26.x.1971. Grampians. On the road to the Mt. William summit from the Dunkeld-Halls Gap road, ca. 2½-3mi (4.0-4.8km) by road down from the barrier and car park ca. 1km below the summit. AD. — Barker 1439(p.p.), 26.x.1971. Grampians. On the road to the Mt. William summit from the Dunkeld-Halls Gap road, at lookout ca. 1mi (1.6km) by road down from the barrier and car park ca. 1km below the summit. AD(p.p.). — Barker 1442, 26.x.1971. Grampians. On the road to the Mt. William summit from the Dunkeld-Halls Gap road, ca. 3mi (4.8km) by road down from the barrier and car park ca. 1km below the summit. AD. — Dale 189, 29.x.1950. C.l. Grampians. Hall's Gap. BEAUGLEHOLE. — Fiddian s.n., 1891. Grampians. MEL41327. — French s.n., s.dat. Upper Yarra. GH(p.p.), CANB209718(p.p.). — Lothian s.n., -.ix.1935. Heathmont. GH(p.p.). — Morrison s.n., 20.ix.1889. Ringwood, Port Philip. B. — [Mueller] s.n., s.dat. Swamps about Forest Creek. MEL41512. — Perrin per R[upp] 2(p.p.), -.x.1922. Grampians. MELU(p.p.). — Phillips 219, 21.x.1963. Mt. Difficult road, Grampians, 6 miles in from main road. CBG. — Renner s.n., -.xii.1889. Near tunnel Tarrawarra. MEL41346,MEL41347. — Rowan s.n., 1886. Without locality. MEL41789. — Symon 263, 12.xi.1959. On the upper ridge of Mt. Rosea, Grampians. ADW. — Thorn s.n., 1890. Upper Goulbourne River. MEL41391. — Walter s.n. 1902. Without locality. LY(holotype of E. trichocalycina); BISH.

—— Walter s.n., s.dat. Upper Yarra. W3912(p.p.; syntype of E. muelleri). —— Weindorfer 77(p.p.), —.ix.1902. Dandenong Rgs. W(p.p.). —— Willis s.n., 13.x.1963. Lerderderg River Gorge, on rocky spur north of Hogan's Flat (and opposite Mt. Blackwood). MEL41472.

e. ssp. gunnii (Du Rietz)Barker, comb. et stat. nov.

E. gunnii Du Rietz,Sv.Bot.Tidskr.42(4)(1948)355,f.3,pl.6, p.p.(excl. Gunn K ex Herb. Lindley) BASIONYM: Curtis, Stud.Fl.Tasm.(1967)528,p.p.(as to occurrences in north and partly east of state)

[E. gunnii Du Rietz,Sv.Bot.Tidskr.42(2)(1948)113, nomen nudum]

E. collina R.Br.: Benth.,Fl.Austral.4(1868)520,p.p.(as to Hooker's 778 and other Tasm. collections seen by me but not specifically cited)

[E. collina auct. non R.Br.: Benth.in DC.,Prodr.10(1846)553 (at least as to Gunn 1220, Scott K); Hook.f.,Fl.Tasm. 1(1857)296,p.p.(as to Gunn 1220, Hooker MEL41460); Benth., Fl.Austral.4(1868)520,?p.p.(as to Tasmanian collections incl. Hooker 778, Gunn 1220); Wettst.,Monogr.Gatt.Euphrasia (1896)254,p.p.(as to pl.5 f.404-409, Gunn 1220, Cunningham G, and probably other specimens cited except Labillardiere G)]

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom. illeg.), p.p.(as to synonym E. collina Benth. et Hook.f.); Spicer, Hdbk.Pl.Tasm.(1878)127,p.p.(as to synonym E. collina of Benth.p.p., and Hook.f.; as to Simson 58); FvM.,Syst. Cens.Austral.Pl.1(1882)98,p.p.(as to some Tasmanian occurrences); FvM.,Sec.Syst.Cens.Austral.Pl.(1889)165, p.p.(as to some Tasmanian occurrences); Rodway,Tasm.Fl. (1903)143,p.p.(as to synonym,E. collina Hook.[f.])]

DESCRIPTION:

Erect perennial herb or undershrub (19)24-43(45)cm tall, with branches erect or rapidly ascending, arising from a single erect stem, terminated by inflorescence in first year, then dying back to upper branches.

Stem or, after first year, main floral branches (12)17-30 (36)cm high, to base of inflorescence, simple for (1)2-9(22) nodes below inflorescence, i.e. for 0.2-0.6(0.7) of height from ground level to inflorescence; upper (2)3-12(20) internodes longer than or as long as uppermost leaves, the longest internode (2.0)2.5-5.0(6.0) times length of upper leaves, those lower down shorter than leaves; axes in upper parts bearing two rows of dense, usually short to moderately long, rarely long eglandular hairs decurrent from between leaf bases rarely with sparse eglandular hairs between, mixed all around with sparse to dense, short to long glandular hairs, lower down with eglandular indumentum similarly distributed but shorter, with glandular hairs lacking or sparse to moderately dense, short to long all around, in lowest parts with sparse to dense, very short to very long eglandular hairs often mixed with sparse to dense, moderately long to very long glandular hairs.

Leaves: uppermost leaves of stem or main floral branches (4.2)4.9-10.0(11.3)mm long, (1.9)2.1-3.2(4.2)mm broad, narrow oblong to oblong or elliptic in outline, with sessile gland patches extended over distal (0.6)0.7-0.8(0.9) of lower surface, covered by sparse to dense, short to long glandular hairs, sometimes mixed with sparse to moderately dense, very short to moderately long eglandular hairs; base narrow cuneate to rounded cuneate; lobes 1(2) along each margin, confined to distal (0.15)0.2-0.5(0.6) of leaf, usually blunt, rarely sharp, acute or obtuse, the longest lobe 0.6-1.1(1.5)mm long; apex usually blunt, rarely sharp, acute or obtuse, (0.9)1.1-2.0(2.6)mm long, (0.8)0.9-1.4(1.8)mm broad; leaves lower down glabrous or covered by sparse to moderately dense, short to long glandular hairs, sometimes mixed with moderately dense, short scabrous eglandular hairs; lowest leaves usually covered by sparse to dense, very short to moderately long glandular hairs, sometimes with sparse to dense short scabrous eglandular hairs along margins, sometimes glabrous.

Inflorescences racemes, usually dense, sometimes moderately dense in bud, lax to moderately dense in flower, with (10)12-24(28) flowers, sometimes with lower 1(4) nodes bearing a single flower or none at all; pedicels at lowest node (0)1.5-6(7.5)mm long, shorter higher up; rachis with eglandular hairs usually as for upper parts of axis, sometimes denser, with moderately dense to dense, moderately long to very long glandular hairs all around; internodes elongating prior to anthesis and sometimes greatly after, such that capsules well below node above; apical bud cluster narrow cylindrical to conical or conical-ovoid, initially ca. 1.0-2.2mm long, hidden by or hardly emergent from corollas of uppermost flower pair after flowers at initial 3-6 nodes have reached anthesis.

Bracts covered by moderately dense to dense, short to long glandular hairs, sometimes mixed with sparse to moderately dense, short to moderately long eglandular hairs, those at lowest nodes similar in size and shape to uppermost leaves, shorter higher up, all bracts, except rarely for lower 1-2 pairs, shorter than or equal to calyx, those at lower 3-6 or more nodes toothed, distally entire.

Calyx (3.2)3.5-5.5(6.3)mm long, externally covered by usually moderately dense to dense, rarely sparse, short to long glandular hairs, densest on teeth, sometimes extending onto inner surface of teeth where mixed with short to moderately long, eglandular hairs.

Corolla (8.0)9-12(12.5)mm long along upper side, white or white with pink or lilac extremities, lacking yellow blotch; tube (5.0)6-8.5(9.3)mm long; hood (2.2)2.8-4.0(5.0)mm long; upper lobes usually obtuse or shallowly emarginate, sometimes emarginate, with rear surface usually $\pm$ glabrous, sometimes covered by sparse to dense, very short eglandular hairs or glandular hairs; lower lip (4.0)5.3-9(11.0)mm long; lower lobes usually emarginate or shallowly so, sometimes truncate or obtuse and then often praemorse, externally usually bearing sparse to dense, very short to moderately long eglandular hairs, often mixed with sparse to moderately dense, very short to short glandular hairs, sometimes $\pm$ glabrous.

Stamens with anthers (1.2)1.4-1.9(2.1)mm long, with connectives of posterior pair surrounded by usually dense, sometimes moderately dense, long to very long eglandular hairs, those of anterior pair with indumentum sometimes similar, sometimes very sparse to sparse; posterior pair of awns (0.1)0.2-0.3(0.4)mm long.

Capsules (6.5)7-8(10)mm long, in lateral view usually obovate or elliptic, sometimes obliquely so or shortly caudate, 2.1-3.2mm broad, in median view elliptic-acuminate, usually with dense setae, 0.1-0.2mm long, in upper $\frac{1}{3}$ - $\frac{1}{8}$, sometimes with a few at apex, rarely glabrous; apex in lateral view usually obtuse to truncate, sometimes obliquely so, rarely shortly broad acuminate; seeds (41 in one capsule of Tenison-Woods MEL) 0.8-1.0mm long, 0.35-0.6(0.7)mm broad, oblong, ellipsoid, ovoid or reniform, usually obliquely so.

Plates: 8

Figures: 18

TYPIFICATION:

Holotype: Gunn $\frac{1220}{1842}$, 20.ix.1841 & 1842. Launceston. This is the commonest species about Launceston flowering in early spring - Septbr. The specimens sent under this number from New Norfolk seem more nearly allied to 863 which they may prove to be. K(p.p.).

Paratype, but possibly also isotype in part (as to 1842 collection): R. Gunn $\frac{1220}{1842}$, 18.ix.1841,1842 & 1843. Launceston. BM(p.p.). Possible isotype: R. Gunn $\frac{1220}{1842}$, 24.xii.1842. 10 miles N. of Launceston road to Pipers. NSW10830.

The holotype chosen by Du Rietz (1948) to typify his new species clearly contains at least two different collections. However, together the specimens make up an homogeneous group, and satisfy the requirements for a holotype under Article 7 of The International Code of Botanical Nomenclature (Stafleu ed. 1972). Gunn's practice of combining collections of his concept of a species under the one "species number" (see Burns & Skemp 1961) makes the recognition of isotypes difficult. The only specimens seen which could possibly be isotypes are cited above.

The holotype is in good condition, and is mounted on the same sheet as a collection by Hooker (778) of the subspecies. Although the delimitation of Hooker's and Gunn's collections is not obvious, it is almost certain that Hooker's collection only consists of the right-hand specimen on the sheet, while Gunn's collections comprise the other three specimens. This is deduced from the fact that the initials "JDH" are placed next to the right hand specimen well apart from the other three specimens. This specimen bears mainly buds and a few flowers. The other three specimens have had "VDL Gunn" written next to them on the left of the sheet well apart from the other specimen. They bear mainly fruits and flowers with only the last-formed buds present. Mr. P.S. Green (pers. comm. 14.iii.1973) has indicated that the association of labels and annotations with specimens on Kew collections of the past is usually reliable, especially when supported by the appearance of the specimens. On the basis of a photograph of the specimen he came tentatively to the same conclusion as above, pending a knowledge of the condition of the inflorescences, which had been omitted from the print.

The three specimens constituting the holotype as defined above, are in good condition and are almost entire plants bearing mainly flowers and fruits, but only a few old buds. The possible isotypes are in a similar state of development, the BM specimen comprising four whole plants with some loss of inflorescences and upper parts of branches, and the NSW collection consisting of two whole plants in flower and fruit, also with much loss of the distal parts of branches and inflorescences.

The NSW specimen provides the most precise locality information among the type material. It is probable however that Gunn made collections from a number of places about Launceston. Although he described the plant as common in the region, only one collection (Barker 913) has been made from the area in the last fifty years (I was directed to the locality by Mr. H.J. King of Launceston). As much natural vegetation still exists near Launceston this absence of collections probably reflects a decline in collecting activity rather than a present day rarity of populations.

DISTRIBUTION (Fig. 38):

E. collina ssp. gunnii is apparently restricted to Tasmania, where it is known at present only from the region of Launceston, where collections are reasonably plentiful but mainly old (for further discussion see Typification), and about 180km to the south from Grass Tree Hill on the northern outskirts of Hobart on the east bank of the River Derwent, where it is represented by a single collection Hooker 778. There is no reason to doubt the authenticity of Hooker's record even though it is the only one outside the Launceston area. Hooker collected outside the known area of distribution of ssp. gunnii and the related ssp. deflexifolia and yet made collections of both. It seems that the lack of other records from the south-east Tasmanian lowlands reflects the absence of significant collecting activity in the area.

There are no altitudinal records but it is likely that the subspecies occurs between near sea level (Penquite and other Launceston localities) and 500m (the height of Grass Tree Hill).

ECOLOGY:

The subspecies has only been recorded "On cleared land of Eucalyptus dry sclerophyll forest - either on grassy roadside, or inside fence where trees felled. Growing in litter in dark brown loam on dolerite and ironstone" (Barker 913).

Flowering occurs between late August and the end of December.

NOTE:

The basic colour of the corolla is white in ssp. gunnii. The yellow colour attributed to this subspecies by Wettstein (1896: under E. collina) and Du Rietz (1948a,b: under E. gunnii) has clearly been determined from the colour of the dried flowers, as no herbarium specimens have been annotated with flower colour. Curtis (1967a) described "E. gunnii" as having "usually creamy-white or yellow" corollas. Her reference to the yellow colour seems to be based on Du Rietz's observation rather than field experience.

SPECIMENS EXAMINED:

Tasmania

Anon. (Herb. Archer) s.n., s.dat. Without locality. NSW 10829. -- Anon. s.n., s.dat. Launceston. MEL41447. -- Archer s.n., s.dat. Near Launceston. BISH31520. -- Barker 913, 6.xi.1970. Prossers Forest Road, ca. $1\frac{1}{2}$km east of the turnoff from the Lilydale-Launceston road. AD; pollen slide A.N.U.,AD. -- Cunningham s.n., s.dat. Van Diemen's Land. G. -- Gunn 1219(p.p.), Penquite. NSW 10827(ex NSW10835),BISH. -- Gunn $\frac{1220}{1842}$, 20.ix.1841 & 1842. Launceston. K(p.p.)(holotype). -- Gunn $\frac{1220}{1842}$, 18.ix.1841.2 & 3. Launceston. BM (p.p.)(possible isotype p.p.). -- Gunn $\frac{1220}{1842}$, 24.xii.1842. 10 miles N. of Launceston road to Pipers. NSW10830(possible isotype). -- Gunn 1220, 1844. Launceston. K. -- Gunn s.n., 1835. Van Diemen's Land.

K(p.p.). — Gunn s.n., s.dat. Van Diemen's Land. L90910466,NY. — Gunn s.n., s.dat. V.D.L. GH(p.p.). — Gunn s.n., s.dat. Without locality. L908227141(p.p.),NY. — Gunn s.n., s.dat. Without locality. MEL41467(p.p.). — [Hooker] 778, 29.viii.1840. Grass tree hill. K(p.p.). — Hooker s.n., s.dat. Without locality. MEL41460. — R[upp] 4, -.x.1921. Near Launceston. MELU15991(p.p.). — Scott s.n., s.dat. Van Diemen's Isle. K. — Tenison-Woods s.n., s.dat. Without locality. MEL41781(p.p.).

f. ssp. deflexifolia (Gandoger)Barker, comb. et stat. nov.

E. deflexifolia Gandoger,Bull.Soc.Bot.France 66(1919)218 BASIONYM; Du Rietz,Sv.Bot.Tidskr.42(1948)361; Briggs in McGillivray,Contr.N.S.W.Nat.Herb.4(1973)339

E. collina R.Br.: Benth.,Fl.Austral.4(1868)520,p.p.(as to Story MEL41463 p.p.,MEL41464, seen by Bentham but not cited)

[E. collina auct. non R.Br.: Hook.f.,Fl.Tasm.1(1857)296 (as to Hooker GH p.p.)]

[E. brownii auct. non FvM.; Spicer,Hdbk.Pl.Tasm.(1878)127, p.p.(as to Simson 105,402)]

[E. gunnii auct. non. Du Rietz: Curtis,Stud.Fl.Tasm.(1967) 528,p.p.(as to some occurrences from "east of the State" i.e. Somerville HO, Himson HO p.p.)]

DESCRIPTION:

Erect perennial herb or undershrub, (25)26-51(76)cm high, with branches erect or rapidly ascending, arising from a single erect stem, terminated by inflorescence in first year, dying back to upper branches in subsequent years.

Stem or, after first year, main floral branches (19)20-41(68)cm high to base of inflorescence, simple for (1)3-15(22) nodes below inflorescence, i.e. for (0.1)0.2-0.55(0.6) of height from ground level to inflorescence; upper (0)3-9(17) internodes longer than or as long as upper leaves, the longest internode (0.75)1.8-5.0(6.0) times length of upper leaves, those lower down shorter than leaves; axes in upper parts with two rows of moderately dense to dense, short eglandular hairs decurrent from between leaf bases, sometimes with sparse eglandular hairs between, mixed all around with sparse to dense, short to very long glandular hairs, lower parts with eglandular indumentum shorter and slightly sparser, with glandular hairs usually lacking or sparse, sometimes similarly dense and long, in lowermost parts with eglandular hairs often long, sometimes similar to middle parts, with glandular hairs usually moderately dense, moderately long to long, sometimes absent.

Leaves: uppermost leaves of stem or main floral branches (4.0)5.6-10.0(12.5)mm long, (2.5)2.9-6.0(7.4)mm broad, crenate-serrate, oblong to oblong-elliptic to obovate in outline, with sessile gland patches extended over distal (0.5)0.55-0.8(0.85) of undersurface usually covered by sparse to dense, short to long glandular hairs, mixed rarely with sparse short eglandular hairs, rarely glabrous; base rounded to rounded-cuneate; lobes 1-2(4) along each margin, confined to distal (0.15)0.3-0.65(0.7) of leaf, sharply or bluntly acute to obtuse, the longest lobe (0.2)0.9-1.5(1.9)mm long; apex (0.5)1.1-2.1(2.6)mm long, 1.1-2.1(2.4)mm broad, bluntly or sharply truncate-obtuse to acute; leaves lower down with sparser, shorter indumentum or glabrous; lowermost leaves usually covered by sparse, short to moderately long glandular hairs, sometimes bearing sparse to dense short eglandular hairs or glabrous.

Inflorescence racemes, dense in bud, moderately dense to dense in flower, those of stem or main branches with (16)18-40(46) flowers, with usually two flowers at each node, rarely a single flower only at lowest node; pedicels at lowest node (0.5)1.0-3.0mm long, shorter higher up; rachis as for upper parts of axes, but indumentum denser and slightly longer; internodes elongating slightly or greatly before and possibly after anthesis, such that capsules well below or reach past node above; apical bud cluster narrow cylindrical to ovate-cylindrical or broad ovate-elliptic, initially 1.0-2.0mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair, after first 5-14 pairs of flowers have reached anthesis.

Bracts at lowermost nodes similar in shape and indumentum to uppermost leaves, shorter higher up, never extending past calyx, those at lower 6-14 or more nodes toothed, distal ones entire.

Calyx (3.8)4.3-6.5(7.8)mm long, externally covered by dense, short to very long glandular hairs, with short to long setose eglandular hairs on inside of teeth.

Corolla (9.4)11-13(14)mm long along upper side, white or white with pinkish extremities, lacking yellow blotch; tube (6)7-8.5(9)mm long; hood (3.0)3.5-5(5.3)mm long; upper lobes, obtuse or praemorse-obtuse to emarginate, with rear surface usually covered by sparse to dense, very short to short glandular hairs, sometimes all over by moderately dense to dense, short eglandular hairs or a mixture of both, the indumentum usually all over, rarely confined to base; lower lip (5.0)6-10(11)mm long; lower lobes usually emarginate to shallow emarginate, sometimes truncate or almost obtuse, externally covered all over by a moderately dense to dense indumentum of short to moderately long glandular hairs or short to long eglandular hairs or a mixture of both.

Stamens with anthers 1.4-2.1(2.5)mm long with connectives surrounded by usually dense, rarely moderately dense, long to very long eglandular hairs; posterior pair of awns (0.1)0.15(0.3)mm long.

Capsules (6.0)7.0-9.0(9.5)mm long, in lateral view obovate to ovate, (2.0)2.3-3.4(3.5)mm broad, in median view ovate to elliptic, sometimes narrowly so, usually acuminate, with distal $(\frac{1}{2})\frac{1}{4}-\frac{1}{8}$ or less covered by dense setae, 0.1-0.2(0.3)mm long, apex in lateral view truncate to obtuse; seeds (3)39(82), (0.6)0.8-1.1(1.5)mm long, (0.3)0.4-0.6(0.9)mm broad, obliquely ellipsoid, ovoid, oblong or reniform, sometimes broadly or narrowly so.

Plates: 8

Figures: 18

TYPIFICATION:

Holotype: A. Simson 402, -.xi.1876. Coast Road nr. Scamander River. LY(Herb.Spicer). Isotype: BISH.

The holotype is in excellent condition and consists of two main branches or stems picked from near their base and each terminated by a young inflorescence with the lower nodes bearing mature flowers. The left-hand specimen is atypical only in that its about 30 nodes do not subtend shoots. However, the second node below the inflorescence on the other specimen and several nodes lower down subtend shoots. The material in BISH consists of a flower, bract and two leaves segregated from the holotype specimen.

No collections other than the type have come from near the mouth of the Scamander River. Much natural vegetation still exists in the area and populations of Euphrasia probably still occur there.

DISTRIBUTION (Fig. 18):

E. collina ssp. deflexifolia is known only from the east coast of Tasmania from the region of the mouth of the Scamander River, and about 80km to the south on the Freycinet Peninsula. However, J.D. Hooker's collection of the subspecies (GHp.p.) must have come from outside this area of distribution, for he and Dr. Lyall collected only "in the Derwent, and in the Lake District of Tasmania, and at Port Arthur" (Hooker 1859b, p. cxvii).

It has been found at altitudes from sea level to about 200m.

ECOLOGY:

The subspecies has been recorded from heath (Barker 975, Somerville HO) and dry sclerophyll (Eucalyptus) forest or woodland with a dense low heath understory (Barker 939, 940, 942, 945-47, 977). It occupies sand or sandy loam (Barker ibid.). Except for the collection Barker 977, the subspecies was seen on the granite outcrops of the Freycinet Peninsula. It is possible that it prefers such granite-based soils. The collections from the mouth of the Scamander River and Falmouth could also have come from populations growing in similar soils, as extensive areas of granite of a similar geological age occur a few kilometres to the north and south of these localities (Banks 1965: Map 4).

From the condition of herbarium specimens, all collected in November, flowering begins in October to November, and continues to December and possibly early January.

NOTE:

Some plants in the collection Barker 977 appear depauperate, with weak floral branches bearing few flowers. From the stems which appear to have been chewed off a few centimetres from the ground, these are possibly plants which have had their main axes grazed and which have subsequently developed via the lower younger and weaker lateral shoots. Nevertheless the leaf sample displayed in Plate 8 includes most of these poorly developed plants and it is noteworthy that the leaf characters used to distinguish the subspecies from its closest relatives are retained.

SPECIMENS EXAMINED:

Tasmania

Barker 939, 9.xi.1970. Freycinet National Park: on the track across The Hazards from Coles Bay to Wineglass Bay, ca. 15m down the southern side of the saddle. AD. — Barker 940, 9.xi.1970. Locality as for Barker 939. AD(2 specimens). — Barker 942, 9.xi.1970. Freycinet National Park: on the track across The Hazards from Coles Bay to Wineglass Bay, ca. 50m down the southern side of the saddle. AD. — Barker 945, 9.xi.1970. Freycinet National Park: on the track across The Hazards from Coles Bay to Wineglass Bay, ca. halfway down the southern side of the saddle. AD; pollen slide A.N.U.,AD. — Barker 946, 9.xi.1970. Freycinet National Park: on the track across The Hazards from Coles Bay to Wineglass Bay, ca. 100m up the southern side of the saddle. AD. — Barker 947, 9.xi.1970. Locality as for Barker 946. AD. — Barker 975, 17.xi.1970. At the end of the track from Coles Bay, on the hill above Sleepy Bay, ca. 3km south-east of Coles Bay. AD. — Barker 977, 17.xi.1970. Ca. 4km north-west of Coles Bay on the road to Bicheno. AD. — Himson s.n., 1968. Wineglass Bay on margin of swamps. HO(p.p.). — H[ooker] s.n., s.dat. Without locality. GH(p.p.). — Simson 105, -.xii.1875. Falmouth. FI. — Simson 402, -.xi.1876. Coast Road nr. Scamander River. LY(holotype);BISH. — Somerville s.n., 16.ix.1959. Sleepy Bay, Freycinet Penin. HO. — Story s.n., s.dat. Without locality. MEL41463(p.p.),MEL41464.

g. ssp. paludosa (R.Br.)Barker, stat. nov.

E. paludosa R.Br.,Prodr.(1810)436 BASIONYM; [R.Br.,Manuscript (unpubl.)]; Sprengel,Linn.Syst.Veget.(ed.16)2(1825)776; Benth.in DC.,Prodr.10(1846)554,p.p.(?excl. "β pedicularoides Cunn.,mss."); Wettst.,Monogr.Gatt.Euphrasia (1896)255, p.p.(excl. Preiss 2338,Huegel W from King Georges Sound, ?as well as β pedicularioides Cunn.ex Benth.in DC.); Gandoger,Bull.Soc.Bot.France 66(1919)217; Du Rietz,Sv. Bot.Tidskr.42(4)(1948)351,f.2a; Eichler,Suppl.Black's

Fl.S.Austral.(2nd.ed.)(1965)282(as to name only)

E. collina R.Br. var. paludosa (R.Br.)Benth.,Fl.Austral. 4(1868)520,p.p.(excl. yellow-flowered and glandular-pubescent forms and at least S. Australian specimens; incl. probably Beckler MEL41427,MEL41477 and Stuart 199 placed under E. collina)

E. brownii FvM. var. paludosa (R.Br.)Maiden & Betche,Cens. N.S.W.Pl.(1916)184

E. collina R.Br.: Bailey,Syn.Qld.Fl.(1883)360; Moore,Cens. Pl.N.S.W.(1884)50; Bailey,Catal.Indig.Natural,Pl.Qld. (1890)34; Woolls,Pl.Indig.Natural.Neighb.Syd.(1891)38; Bailey,Qld.Fl.(1901)1124; Bailey,Compr.Catal.Qld.Pl. (1913)363; ?Ewart,Fl.Vict.(1931)1024,p.p.; ?Galbraith, Wildfl.Vict.(ed.2)(1955)136,p.p.; ?Galbraith,Wildfl. Vict.(ed.3)(1967)123,p.p.; Harris,Alp.Pl.Austral.(1970) 137,p.p.(as to some N.S.W. and Vict. occurrences); Willis, Hdbk.Pl.Vict.2(1973)574,p.p.(as to localities in JKNPRSTVWZ)

E. novae-cambriae Gandoger,Bull.Soc.Bot.France 66(1919)218

E. glacialis Wettst.var.eglandulosa Willis,Muelleria 1(1967) 146,p.p.(as to Darbyshire 73)

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.), p.p.(as to synonym,E. paludosa); FvM.,Fragm.Phyt.Austral. 9(1875)168,p.p.(as to Hartmann 10,11); FvM.,Syst.Cens. Austral.Pl.1(1882)98,p.p.(as to Qld. and some N.S.W. and Vict. occurrences); FvM.,Key Syst.Vict.Pl.2(1885)41, p.p.: 1(1887-1888)392,p.p.; FvM.,Sec.Syst.Cens.Austral. Pl.1(1889),p.p.(as to Qld. and some N.S.W. and Vict. occurrences); Moore & Betche,Hdbk.Fl.N.S.W.(1893)342,p.p. (at least as to synonym, E. collina); Dixon,Pl.N.S.W. (1906)226,p.p.]

[E. speciosa auct. non R.Br.: Evans in Beadle,Evans & Carolin,Hdbk.Vasc.Pl.Syd.Distr.Blue Mts.(1963)410, p.p.; Evans in Beadle,Evans & Carolin,Fl.Syd.Reg. (1972)500,p.p.; Briggs in McGillivray,Contr.N.S.W.Nat. Herb.4(1973)339]

[Calophrasia paludosa Presl ex Wettst.,Monogr.Gatt. Euphrasia(1896)256("in sched."), pro syn.]

["E. aff. paludosa R.Br.": Burbidge & Gray,Fl.A.C.T.(1970) 328]

["E. aff. glacialis Wettst.": Burbidge & Gray,l.c.328]

["E. aff. glacialis Wettst. var. eglandulosa J.H. Willis": Burbidge & Gray,l.c.329]

DESCRIPTION:

Erect perennial herb, (10)18-45(56)cm tall, usually with few to many ascending branches, arising from lower part of stem or prostrate parts of other branches, with stem sometimes in first year bearing inflorescence, subsequently dying back to near ground level, sometimes reduced and never extending above branches near ground level.

Stem or, if reduced, main floral branches (7)10-26(50)cm high to base of inflorescence, simple for (1)4-21(31) nodes below inflorescence, i.e. for (0.35)0.8-1.0 of distance from inflorescence to ground level; upper (2)4-8(12) internodes as long as or longer than upper leaves, the longest (1.3)2.0-4.0(4.5) times length of upper leaves, those lower down much shorter; axes in upper parts bearing two rows of dense short to moderately long eglandular hairs decurrent from between leaf bases, sometimes with somewhat sparser eglandular hairs between, sometimes glabrous between, sometimes (in plants of subalpine grasslands) mixed with sparse to dense tiny subsessile glands, with indumentum in lower parts sometimes similar, sometimes sparser and shorter or even lacking.

Leaves: uppermost leaves of stem or main floral branches (5.6)7.4-13.5(23.0)mm long, (2.4)3.4-7.0(8.0)mm broad, in outline usually elliptic or oblong-elliptic, sometimes ovate or obovate, serrate to crenate-serrate, with sessile gland patches extended over distal (0.6)0.7-0.85(0.9) of undersurface, sometimes glabrous, sometimes with margins lined with sparse to dense, very short to short, hard eglandular protuberances or sparse to moderately dense, short to moderately long eglandular hairs, sometimes (in plants of subalpine grasslands) also bearing very sparse to dense, tiny sessile glands; base usually rounded to rounded-cuneate, sometimes narrow cuneate; teeth 1-3(6) along each margin, confined to distal (0.2)0.3-0.65(0.85) of leaf, usually blunt, rarely sharp, usually acute, sometimes obtuse, the longest tooth (0.5)0.7-2.0(2.8)mm long; apex (1.1)1.3-2.8(4.3)mm long, (0.9)1.4-2.5(5.1)mm broad, usually bluntly acute, sometimes sharp or obtuse, rarely shortly acuminate; leaves lower down with similar indumentum.

Inflorescences racemes, dense (except for more widely spaced lower (0)1-3(5) nodes), in bud, moderately dense to dense in flower and fruit with (14)20-40(55) flowers, sometimes with lowest node bearing a single flower; pedicels at lowest node (0.6)1.3-5.5(9.2)mm long, shorter higher up; internodes elongating prior to anthesis; rachis as for upper part of axis; apical bud cluster cylindrical to conical or ovoid, usually narrowly so, with apex ± acute, initially (1.3)2.0-3.0(5.0)cm long, hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 3-23 nodes have reached anthesis.

Bracts at lowest nodes like uppermost leaves in size, shape and indumentum, shorter higher up, those at lower 0-5(20) nodes, extended past calyx, distal ones shorter, those at lower (2)4-9 (rarely all) nodes toothed, distal ones entire.

Calyx (3.8)4.4-7.0(9.0)mm long, usually glabrous but for sparse to dense, very short to moderately long lax to scabrous eglandular hairs on inner surface and margins of teeth, sometimes (in plants of subalpine grasslands) also with sparse to dense tiny subsessile glands on outer surface.

Corolla (8.5)9.5-13.5(15)mm long along upper side, white, or coloured palely or deeply in blue, lavender, violet, lilac, purple, mauve or pink, with colour sometimes confined to tube and veins, sometimes on lobes and tube with broad white area behind lower lobes, sometimes all over but often paler behind lower lobes, with yellow blotch sometimes present on lower lip behind lobes, rarely also at point of insertion of filaments, sometimes absent; tube (6)7-10(11)mm long; hood (2.5)3.2-4.0(4.5)mm long; upper lobes usually obtuse, sometimes truncate to shallowly emarginate, rarely emarginate, with rear surface usually bearing sparse to dense, very short to short glandular hairs, sometimes confined to base of lobes, sometimes mixed with moderately dense to dense short eglandular hairs, sometimes glabrous; lower lip (4)4.5-7(8.5)mm long; lower lobes usually obtuse to truncate, sometimes shallowly emarginate, rarely emarginate, covered by usually moderately dense to dense, rarely sparse indumentum of short to moderately long glandular or eglandular hairs or both, rarely confined to proximal parts.

Stamens with anthers (1.3)1.6-1.9(2.1)mm long; posterior pair of awns (0.15)0.2-0.3(0.4)mm long.

Capsules (7.2)7.5-10.5(11.3)mm long, in lateral view (1.8)2.0-2.9(3.2)mm broad, usually elliptic or oblong, sometimes ovate or obovate or somewhat deflexed, rarely linear, in median view ovate-caudate to elliptic-acuminate, sometimes narrowly so, glabrous or bearing very sparse to dense, very short setae at apex only; apex in lateral view usually obtuse, sometimes truncate or acute, rarely shallowly emarginate-truncate, sometimes obliquely so; seeds (5)26-58(93), oblong to ellipsoid, sometimes obliquely so, (0.5)0.7-1.3(1.5)mm long, (0.2)0.3-0.5(0.7)mm broad.

Plates:

Figures: 18

TYPIFICATION:

1. E. paludosa R.Br.

Lectotypus: R. Brown 2721, s.dat. Port Jackson. BM. Syntypus alter: R.Brown s.n., s.dat.[24.vi.1803]. In paludibus versus Botany Bay. K. Illustration of lectotype: Du Rietz (1948b) fig. 2a.

Two collections, one in K, the other in BM, are identified in Brown's handwriting as E. paludosa and are clearly the material upon which Brown (1810) based his description of the species. The two syntypes belong to the same subspecies of E. collina.

Both collections qualify for being chosen as lectotype, as they fit the protologue in morphology and distribution (the distribution designation "J" in the protologue was used by Brown to denote the area of his Sydney-based collections). The K specimen was described in Brown's manuscript (unpubl.). Although there is no reference to the BM specimen in the manuscript this should not necessarily be used as a basis for lectotypification especially as his description is much shorter than normal in the manuscript for a distinct species of Euphrasia. The Botany Bay specimen may simply have been the first of the two specimens collected and the protologue may have been based on both.

It has seemed preferable to base the selection of the lectotype upon the quality of the syntypes. The Port Jackson specimen contains not only a larger quantity of material (7 floral branches or stems picked from above ground level but sufficiently low down to show branching, which in two cases is some distance up the axis) but also a wider range of floral material (buds, flowers and mature fruits). The Botany Bay specimen consists of two simple long floral branches picked above ground level and a further badly insect-damaged inflorescence; they contain buds and flowers. The latter syntype has suffered more greatly from the loss of leaves. On these grounds the Port Jackson specimen is clearly the better choice as lectotype. This specimen is conveniently housed in BM, where Brown worked.

It is extremely doubtful whether populations still occur in the Botany Bay-Port Jackson region, as this is the site of the city of Sydney. Since no collection has apparently been made of the species from the region since 1900 (Camfield NSW10895: Rose Bay) it seems unlikely that it still occurs in the remnants of natural vegetation.

2. E. novae-cambriae Gandoger

Holotype: R.T. Baker s.n., 14.ix.1896. Sydney. LY. Isotype: BISH.

The holotype comprises six single stems or branches, each picked above ground level and terminated by an inflorescence. Buds and mature flowers are present, but fruits are lacking. The material is in good condition although some leaves are lost. The isotype consists of a flower, leaf and an apical bud cluster apparently segregated from the holotype.

Like the type collection of E. paludosa this collection probably came from an area now mainly devoid of its indigenous vegetation.

DISTRIBUTION (Fig. 18):

E. collina ssp. paludosa is known from between the Mt. Lofty Ranges of South Australia and New England area of New South Wales and its northern extension into the very south of Queensland. There is one doubtful record from Hobart, Tasmania (see Note 4).

The subspecies is mainly restricted to highland regions; it is most common in the montane and subalpine regions of eastern Victoria and New South Wales. In southern Queensland it is known from only two collections (see Note 5). In South Australia the subspecies is confined to the Mt. Lofty Ranges which is a noted refuge area for plant species common in the wetter climates of south-eastern Australia, and apparently more widespread in previous cooler and wetter times (e.g. Parson 1973). It also occurs in the regions of Victoria between Port Phillip and Warrnambool and probably near Maryborough (see Note 1) and in the coastal regions of New South Wales, north of Botany Bay.

The subspecies has been recorded at altitudes between near sea level and 1900m (6200 ft).

ECOLOGY:

Ssp. paludosa occupies a wide range of habitats. In the subalpine zone of eastern Victoria and the southern tablelands of New South Wales it is common in sparse to dense snowgum (Eucalyptus pauciflora) woodland and sod-tussock grassland. It has also been recorded from "snowgum forest" on the Barrington Tops (Sutton NSW 26673) at the southern edge of the northern tablelands of New South Wales. It sometimes also occurs in heath (Barker 1680, Hoogland & Schodde 8457) or areas of shrubs in sparse snowgum woodland (Barker 1511,1634,1635,1644,1689,1690,1693,1700). On the summit of Mt. Speculation in Victoria it occupies "tall alpine herbfield-heath" (Barker 1543). Although it has been found near the Cobberas in "swampy areas" (Barker 1628) and in boggy areas near the Bogong High Plains, the record from a "sphagnum bog" (Packe MELU15985) in the Brindabella Ranges is doubtful as it has only otherwise been observed in grassy areas near bogs (Barker pers. observ.; Pullen 2478). In mountain regions extending south from Mt. Werong in the central tablelands of New South Wales into eastern Victoria, records are common from wet or dry sclerophyll forest or grassy clearings between. Further north in the northern tablelands ecological information is sparse. Johnson NSW2180 was collected "on acid granite on dry hillside", while Williams made collections from "saturated, rather peaty soil in sedge swamp over granite" (NE 31.vii.1966; also Williams & Winterhalder 649, NE -.iv.1958) and "peaty, light soil in swamp. Wet heath with fen patches" (Williams NE 16.xii.1967). The subspecies has been recorded in the Blue Mountains "In damp heath" (Burgess CBG023203) and "in marshy ground" (Chippendale NSW21811), in coastal regions from heath (Lithgow 183, McKee 5768) and "wet heath at edge of swamp..." (Boyd & McGillivray 1844), while in the Sydney region it has been recorded from swamps (Bauer W., R.Brown Kp.p., Forsyth NSW10897: "in the swamps...Cyperaceous plants"). The most westerly Victorian collection of ssp. paludosa from Mt. Emu Creek (Mueller MEL41379p.p.) was apparently collected from wet places near the creek ("in locis udis ad amnem"). Finally there is one record (Anon. 44) from a "sand hill" apparently near Walmer ("Wolmar") in the south-western plains of New South Wales. There are no data concerning the South Australian localities.

The subspecies has been recorded commonly on granite, but there are references to "shale" (Ludbrook CANB7921), "sandstone" (Darbyshire 73), "sedimentary rocks" (Moore 2334), sandy soil (Lithgow 183, McKee 5768, Sydney University Expd. SYD) and clayey soil (Briggs NSW72743).

The time of flowering varies with the climatic zone. In lowland and montaine regions it occurs mainly between the beginning of August and the start of December. The specimens collected by Brown (K) at the end of June from Botany Bay had begun to flower. In subalpine regions flowering often is later; it occurs mainly between late September and early February, with one record (Gray 5087) of plants flowering in mid-March. The earlier times are apparently from areas in the lower limits of the snow-gum woodland, while later-flowering may occur on the sparsely wooded high summit region.

NOTES:

1. In the western part of the eastern Victorian highlands, where ssp. paludosa and ssp. collina occur together, there is as yet no evidence in existing herbarium material of a breakdown of their differences. An extensive study of populations in the area must be made to determine whether they truly remain distinct, as there are few adequate collections for gauging the variability of populations. Except for possibly on Wilsons Promontory (see E. collina: Intraspecific Variation) ssp. paludosa does not appear to occur in other areas of Victoria occupied by ssp. collina (fig. 18). Collections (Ducker MELU15984, Johnstone 7, Mueller MEL41379p.p.) clearly belonging to ssp. paludosa came from the region between Port Phillip Bay and Warrnambool, where no collections of ssp. collina have been made. Similarly, two separate fragmentary collections (Maplestone MEL41371, Mueller MEL41342) more allied to ssp. paludosa than ssp. collina by their uppermost leaves bearing two or three pairs of teeth come from the Maryborough region a little to the north of the known localities of ssp. collina in the western highlands. However, collections are too few to be certain that the two subspecies have distinct distribution patterns in central and western Victoria. A number of the records of ssp. collina from central Victoria may actually represent extreme variants of normal populations of ssp. paludosa (see ssp. collina: Note 1).

2. In ssp. paludosa there are variations in characters of indumentum and seed size which are apparently related to altitudinal variation.

In the subalpine tussock grasslands of the southern tablelands of New South Wales, plants commonly bear tiny subsessile globular glands over the external surface of the plant. These subsessile glandular hairs are different from the sessile glands which occur in patches on the underside of all leaves of Euphrasia by their more sparse and wider distribution and by the presence of a short stalk, less than the diameter of the gland; in addition the sessile gland patches appear to be sunk into the leaf. They are similar to the subsessile glandular hairs which commonly occur throughout Euphrasia on the veins of the upper side of the leaves and bracts and at the base of the clefts between the leaf and calyx teeth. Plants with a dense cover of subsessile glandular hairs occur in the higher parts of the Mt. Kosciusko region near Charlottes Pass (e.g. Barker 1700, Johnson & Constable NSW15760). In lower subalpine areas, both in the Mt. Kosciusko region (e.g. Barker 1689,1690,1693,1695), and in the extensive tussock grasslands to the north (e.g. Barker: collections of ssp. paludosa between 1695 & 1682,1719-1719), the subsessile glandular hairs are much sparser or are sometimes lacking completely. Occurrences of these hairs outside the Snowy Mountains seem limited to two localities. Specimens in the subalpine woodland of the Brindabella Range (e.g. Barker 1644) bear subsessile glandular hairs mainly on the calyx. In other localities, both above the below the snow-line, only non-glandular plants seem to occur. Two plants in the collection Barker 1542 from the summit of Mt. Speculation have subsessile glandular hairs mainly confined to the lower leaves. The majority of the plants collected from the area lacked these glands (Barker 1542p.p.,1543). Thus subsessile glandular hairs are apparently confined to ssp. paludosa growing at higher altitudes. These scattered subsessile glandular hairs are compared with the somewhat longer glandular hairs in variants closely related to ssp. paludosa in the eastern highlands of Victoria under E. collina: Note 3.

The seeds are generally larger in plants of ssp. paludosa in the Kosciusko region (usually 1.0-1.4mm long), where sparse to dense indumentum of subsessile glandular hairs occurs exclusively. This however seems to be an independent altitudinal phenomenon as elsewhere populations with subsessile glandular hairs have the more normal smaller seeds (usually 0.6-1.1mm long). Similar reduction in seed size with lower altitude is seen in other taxa and groups of taxa in the genus in Australia[n] (see Chapter 3 on Morphology).

The number of populations with only a partial incidence of the scattered subsessile glandular hairs and the lack of a strong correlation of their presence with other character differences indicates that formal taxonomic recognition above the level of forma is unwarranted.

3. In ssp. paludosa branching is restricted to the regions of the axes at or near ground level throughout most subalpine and montane areas. However specimens with branches or shoots occurring well up the main axes are rather common in the montaine regions of northern New South Wales (Beckler MEL41427,MEL41477; Boorman NSW 10921, Johnson NSW21810, Stuart MEL41421,MEL41516) and constitute the only collections (Hartmann 10,11) of the species from southern Queensland. This type of habit also predominates in the collections from the coastal areas of New South Wales north of Newcastle (Boorman NSW10934, W27532; Boyd & McGillivray 1844, E.Brown NSW 10932, Burgess 90, Fawcett 99, Ingram NE011832, Lithgow 183, McKee 5768p.p., Sydney Univ. Expd. SYD). Similarly, specimens with branching occurring somewhat higher up the axes than usual occur in Victoria at Mt. Stanley (McBarron NSW10941, Canning 364) and Mt. Granya (Walter MEL41306,NSW10942 which are isolated mountains in the region of the River Murray. Sayer MEL41323 and MEL41324 are the only examples of this kind from East Gippsland, Victoria. In the Dandenong Ranges and other more westerly montane and lowland areas on the edge of the

eastern highlands of Victoria, populations with plants of a similar habit also occur (Gargurevich MEL41373, Walter NSW10944, Walter AK30649). Other specimens from this region with upper leaves with a single pair of teeth have apparently come from populations of ssp. collina (see Note 1).

4. The record of ssp. paludosa from Hobart is doubtful as it is represented by only a single collection (Caley MEL41441). Since Caley collected in the Sydney region, where in his time, ssp. paludosa was apparently prevalent, the specimens could have come from there. However, the possible occurrence in south-east Tasmania cannot be ruled out completely as the surroundings of Hobart, especially on the east side of the Derwent, do not appear to have been extensively botanised (see E. collina ssp. gunnii: Distribution).

5. The two specimens collected by Hartmann (10, 11) from Southern Queensland are from the Condamine River (Mueller 1875) rather than Condamine, 150km west of Brisbane, as might be interpreted from the labels.

SPECIMENS EXAMINED:

Australian Capital Territory

Adams 1645, 29.xi.1966. Mt. Gingera, Cotter River District. CANB,MEL,NSW84502,L; (n.v.)A,E,K,US,B. — Barker 1631, 18.i.1972. Brindabella Range. On the track to Moonlight Hollow, ca. 2km by road from the Bull's Head-Mt. Franklin road. AD. — Barker 1632, 18.i.1972. Brindabella Range. Ca. 5km S of Bulls Head on the road to Mt. Franklin along the top of the Brindabella Range. AD. — Barker 1634, 18.i.1972. Brindabella Range. C. ½km E. of Mt. Gingera. AD. — Barker 1635, 18.i.1972. As for Barker 1634. AD. — Barker 1640, 18.i.1972. Brindabella Range. Ca. 30m below the summit of Mt. Gingera on the eastern slopes. AD. — Barker 1643, 18.i.1972. Brindabella Range. Snowy Flat, which is ca. 1km NNE of the summit of Mt. Gingera. AD. — Barker 1644, 18.i.1972. As for Barker 1643. AD. — Barker 1648, 19.i.1972. On fire access raod to Smokers Flat ca.

1-2km S of Smokers Gap, which is ca. 7km ENE of the Corrin Dam and on the main road from Tharwa. AD. -- Barker 1650, 19.i.1972. Near Smokers Flat, ca. 3km S of Smokers Gap, which is ca. 7km ENE of the Corrin Dam on the main road to Tharwa. AD. -- Belcher 971, 17.xii.1967. Brindabella Range between Picadilly Circus and Mt. Franklin, WSW of Canberra. MEL,AD,GH; (n.v.)K,F. -- Belcher 998, 17.xii.1967. Ski slope, Mt. Franklin, Brindabella Range. PERTH,CANB,GH,BRI,MICH,US,NY. -- Burbidge 6717, 15.xi.1960. Mt. Coronet. Upper Cotter Valley. CANB,BISH,NSW63917. -- Burbidge 7717, 21.i.1969. Ginini Swamp. CANB. -- Canning 1304, 28.xi.1968. Brindabella Range, 3.6 ml. from Picadilly Circus toward Mt. Franklin. AD; (n.v.)CBG. -- Canning 3097, 11.ii.1970. 5.0 ml. from Orroral gate, up Orroral River Valley (taking R.H. fork just inside gate). CBG. (n.v.); AD. -- Constable s.n., 29.iv.1958. Mt. Gingera. NSW126476. -- Darbyshire 73, 20.xii.1960. Ca. 1 mile north of Snowy Flats, Bimberi Range. CANB,MEL,B,G,NSW 57604,L. -- Gauba s.n., 2.xi.1949. Mt. Franklin. GAUBA9247. -- Gauba s.n., 17.ii.1950. Mt. Gingera. GAUBA7857,GAUBA7858. -- Gauba s.n., 21.i.1953. Tidbinbilla. GAUBA9232. -- Gray 4379, 6.xi.1957. Mt. Ginini. CANB. -- Gray 5087, 17.iii.1960. Mt. Bimberi, near summit. CANB. -- Gray 6060, 20.xi.1967. Bull's Head to Mt. Franklin. CANB. -- Gray 6061, 20.xi.1967. As for Gray 6060. CANB. -- McKee 7627, 23.xi.1960. Mt. Franklin. NY,NSW102597,BISH; CANB(n.v.). -- McNeur s.n., -.x.1950. Mt. Gingera. CHR72922. -- Moore 2269, 4.ii.1953. Mt. Gingera. CANB,NSW23420,BISH. -- Moore 2286, 4.ii.1953. Mt. Gingera. CANB. -- Moore 2334, 11.ii.1953. Mt. Franklin Rd., 10 miles below Chalet. CANB,NSW23419. -- Moore 2346, 11.ii.1953. Mt. Franklin Road, 7 miles below Mt. Franklin. NSW23841. -- Moore 3027, 1.xii.1954. Naas-Shannon's Flat. 18 m. from Tharwa. CANB. -- Packe s.n., 16.i.1954. Mt. Gingera Excursion. MELU15985. -- Pullen 112, 15.iii.1957. Mt. Franklin, Brindabella Ra. CANB. -- Pullen 2327, 4.xi.1960. At head of the Orroral valley, upper Sawpit Creek just east of the Cotter Gap, Tennent District. CANB(2 specimens),L,NSW66536. -- Pullen 2478, 19.xii.1960. Snowy Flats near Mt. Gingera, Bimberi Range. CANB,NSW66537,BISH; (n.v.)K,BH. -- Pullen 2949, 15.xi.1961. Two Sticks Road between Picadilly Circus and Mt. Coree. CANB,AD, MEL,A,NSW102599,BISH,L,BRI; (n.v.)K,BH,US,Z,NE. -- Yapp 13, 1.xi.1961. Gudgenby District. CANB,AD; (n.v.)NSW57591,PERTH.

New South Wales

Althofer s.n., -.ix.1951. Kyber. (Current Mt. Gap). NSW 21812. -- Anderson s.n., 1832. Port Jackson (nouvelle Hollande).

G. -- Anon. 4, s.dat. Bett's Camp. MEL. -- Anon. 44, 18.ix.1860. Wolmar [?Walmer]. MEL(p.p.). -- Anon. 49, ?1822. P[ort] Jackson. W. -- Anon. s.n., -.xi.1894. Tumut. NSW10927. -- Anon. s.n., -.vii.1897. Port Jackson District. GH. -- Anon. s.n., -.viii. 1900. Port Jackson District. G. -- Anon. s.n., -.xi.1900. Near Tumbarumba.NY. -- Anon. s.n., -.xi.1900. Tumbarumba. PERTH. -- Anon. s.n., s.dat. Ben Lomond New England. MEL41483. -- Anon. s.n., s.dat. New England. MEL41502. -- Anon. s.n., s.dat. Beyond Bathurst. MEL41504. -- Anon. s.n., s.dat. Jenolan Caves. W1224. -- Armstrong s.n., s.dat. Sydney. K(p.p.). -- Ashford s.n., 1968. Near Growee Gulph, E of Ryleston. NSW85516. -- Atkinson 15, Octr. Oldbury and Bundanoon Creek. MEL. -- Baeuerlen 511, -.v.1887. Tinkirinki [?Tingiringi] Mountain. MEL. -- Baker s.n., -.x.1893. Rylstone. NSW10923. -- Baker s.n., 14.ix.1896. Sydney. LY (holotype of E. novae-cambriae); BISH. -- Barker 1659, 21.i.1972. Kosciusko National Park. The Fiery Range; Peppercorn Flat, ca. 3km NE of Peppper-corn Hill, which is ca. 40km NNE of Kiandra. AD. -- Barker 1662, 21.i.1972. Kosciusko National Park. Long Plain, which is along the east side of The Fiery Range; ca. 20km NNE of Rules Point. AD.-- Barker 1664, 21.i.1972. Kosciusko National Park. Long Plain which is along the E side of The Fiery Range; ca. 10km NNE of Rules Point. AD. -- Barker 1666(p.p.), 22.i.1972. Kosciusko National Park. SE end of Toolong Range; on top of southern ridge of Mt. Jagungal, ca. 50m below and ca. ½km S of summit. AD(2 specimens). -- Barker 1670 (p.p.), 22.i.1972. Kosciusko National Park. SE end of Toolong Range; on top of southern ridge of Mt. Jagungal, ca. ¼km S of summit. AD. -- Barker 1675, 22.i.1972. Kosciusko National Park. Toolong Range; on the Grey Mare Trail between Round Mt. and Mt. Jagungal, ca. 2km NW of the intersection with the track from Happy Jacks. AD. -- Barker 1676, 22.i.1972. Kosciusko National Park. Toolong Range; on the Grey Mare Trail between Round Mt. and Mt. Jagungal, ca. 3km NW of the intersection with the track to Happy Jacks. AD. -- Barker 1678, 22.i.1972. Kosciusko National Park. Toolong Range; on the Grey Mare Trail between Round Mt. and Mt. Jagungal, ca. 8km NNW of the intersection with the track to Happy Jacks. AD. -- Barker 1680, 23.i.1972. Kosciusko National Park. Three Mile Creek; ca. 5km SW of Kiandra; near the road to Cabramurra. AD. -- Barker 1682, 23.i.1972. Kosciusko National Park. At the start of the Grey Mare Trail from the main Cabramurra-Khancoban road; ca. 2km NE of Round Mountain. AD. -- Barker 1689, 26.i.1972. Kosciusko National Park. Dainers Gap, which is ca. 5km NE of the Smiggin Holes; ca. 100m S of the Kosciusko Summit Road, along old fence line. AD. —— Barker 1690, 26.i.1972. Kosciusko National Park. Ca. ½km E of The Smiggin Holes, ca. 50m S of bridge across Pipers Creek. AD. —— Barker 1693, 26.i.1972. Kosciusko National Park. Ca. ½km E of The Smiggin Holes, ca. 100m S and ca. 30m above bridge across Pipers Creek. AD. —— Barker 1695, 26.i.1972. Kosciusko National Park. Perisher Valley; on slopes of hill to E of bridge across Perisher Creek on North Perisher Road. AD. —— Barker 1700, 26.i. 1972. Kosciusko National Park. Ca. 50m NW of bridge across Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. —— Barker 1716, 28.i.1972. Kosciusko National Park. On the Happy Jacks Road, ca. 100m N of Barne's Creek crossing. AD. —— Barker 1717, 28.i.1972. Kosciusko National Park. On the Happy Jack's Road, ca. 100m W of Henderson's Creek. AD. —— Barker 1718, 28.i.1972. Kosciusko National Park. On the Happy Jacks Road, between Henderson's Creek and Tibardo Creek. AD. —— Barker 1719, 28.i.1972. Kosciusko National Park. On the Happy Jacks Road, at junction with the Grey Mare Trail. AD. —— Bate s.n., –.ix.1882. Tilba Tilba. MEL41735. —— Bauer s.n., s.dat. Prope Port Jackson. W. —— Beckler s.n., s.dat. Hastings River. MEL41427,MEL41477. —— Betche s.n., –.ii.1897. Kiandra distr. Top of Mt. Table-top. NSW10954. —— Blakely & Ludowici s.n., 26.x.1940. Mt. Werong. NSW 10909. —— Boden s.n., 8.xii.1966. Above Cooleman Creek. CBG. —— Boorman s.n., –.viii.1909. Smoky Cape. NSW10934. —— Boorman s.n., –.ix.1911. Port Stephens. W27532. —— Boorman s.n., –.x.1911. Torrington. NSW10921,BISH. —— Bowden s.n., 3.x.1966. Westworth Falls, Blue Mountains (Blaxland Rd nr golflinks N of the town). NSW93932. —— Bowden s.n., 5.x.1966. Wentworth Falls. NSW84071. —— Bowden s.n., 5.x.1966. Wentworth Falls. NSW84072,BISH. —— Bowden s.n., 5.x.1966. Wentworth Falls. NSW84073. —— Bowden s.n., 7.x.1966. Medlow Bath. NSW84074,BISH. —— Boyd & McGillivray 1844, 8.vi.1966. Ca. 2 miles North-West of Point Plomer (10 miles North of Port Macquarie). NSW(s.n.). —— Briggs 2566, 10.xi.1969. Ogilvies Creek, 3 miles E.N.E. of Tooma Reservoir on Tooma-Cabramurra road. AD. —— Briggs s.n., 1.i.1964. 10 miles SW of Cabramurra. NSW102595. —— E. Brown s.n., –.ii.1897. Port Macquarie. NSW10932,BISH. —— R. Brown 2721, s.dat. Port Jackson. BM(lectotype). —— R.Brown s.n., s. dat. [24.vi.1803]. Botany Bay. K(p.p.; syntype). —— Burbidge 3948, 24.ii.1955. Piper's Creek, below Smiggin's Hole. CANB. —— Burbidge 5239, 7.i.1959. Perisher's Gap. CANB. —— C.Burgess s.n., 2.x.1968. Mt. Hay Road, Leura. CBG023203,AD97345099. —— P.Burgess 90, 20.x.1961. Near Forster. NSW102593. -- Burrows 016, -.x.1918. State Forest Bundulla, Warrumbungle Rges. NSW10925. -- Calvert s.n., s.dat. Trap formation nr. Berrima. MEL41508. -- Cambage s.n., -.x.1899. Orange. NSW10922. -- Cambage s.n., -.vii.1907. Stannum. AD97123092,BISH;NSW10919(n.v.). -- Camfield s.n., -.viii. 1900. Rose Bay. NSW10895,SYD. -- Campbell s.n., -.xi.1899. Callaghan Swamp, Walcha. NSW10924.-- Carroll 10, 15.i.1966. Happy Jacks's Plain, Snowy Mountains. East Bolton Hill trig Point 2. CBG. -- Carroll 205, 17.i.1966. Happy Jack's Plain, Snowy Mountains, at Boobee Hut. CBG. -- Carroll 260, 19.i.1966. Happy Jacks's Plain, Snowy Mountains. At Tibaude's Hut (7.7 miles from Happy Jack's Road along Grey Mare Track). CBG. -- Carroll 412, 20.i.1966. Happy Jack's Plain, Snowy Mountains. Along Beacon Hill Track. CBG. -- Carter s.n., 1883. Moonan Brook, near Scone. MEL41749. -- Chinnock 296, 29.iv.1973. Southern Tablelands, Roadside between Adaminaby and Kiandra. AD. -- Chippendale s.n., 10.x. 1951. Bell. NSW21811. -- Cleland s.n., 10.xii.1910. Mt. Kosciusko. AD97013004. -- Constable 4078, 26.xi.1962. Mt. Werong. Werong Range, 25 miles (40km) S. of Oberon. AD,NSW66829(n.v.)(pollen sample A.N.U., AD.). -- Curran s.n., -.x.188[2]. Upper Macquarie River. MEL41743. -- Fagg s.n., 20.i.1963. Mt. Kosciusko District. AD96321132. -- Filmer s.n., 20.ii.1957. Upper Tumut R. Gorge near Junction Shaft. MEL126375. -- Fletcher s.n., 18.viii.1888. Botany. NSW10896,BISH. -- Fletcher s.n., 13.ix.1890. W.F. [Wentworth Falls]. NSW10916. -- Fletcher s.n., -.x.1892. Mt. Victoria. NSW10911. -- Forsyth s.n., 10.vii.1897. La Perouse. NSW10897,BISH,SYD. -- Forsyth s.n., -.xi. 1900. Between Germanton & Tumbarumba. NSW10943. -- Forsyth s.n., -.xii.1901. Kiandra District. B(p.p.),G(2 specimens, one p.p.). -- Garden s.n., 12.xi.1952. Edith to Jenolan. NSW21814,CHR91283. -- Gauba s.n., 29.xi.1955. Near Alpine Creek. GAUBA9244. -- Green 2642, 17.xi.1960. Bell. NE. -- Hamilton s.n., -.ix.1914. Leura. Mt. Hay Rd. NSW10910. -- Harrison s.n., -.i.1925. Barrington Tops. NSW10935. -- Hoogland & Schodde 8457, 13.xii.1961. Daners Gap (between Hotel Kosciusko and The Smiggin Holes); Snowy Mountains area. CANB,NSW57585,L. -- Hoogland 10026, 27.i.1965. Brumby Flats on Western slopes of Mt. Gingera, Brindabella Range. (A.C.T.-N.S.W. border). CANB. -- Ingram s.n., 30.viii.1943. S.W. Rocks. NE011832. -- Johnson s.n., 5.xi.1951. Silent Grove to Torrington. NSW21810, BISH. -- Johnson & Briggs 1059, 29.xi.1966. Mt. Werong, c. 15 miles (24km) S. of Jenolan Caves. AD.,BISH; NSW98616(n.v.). -- Johnson & Constable s.n.(p.p.), 18.i.1951. Charlotte Pass. Kosciusko.

NSW15760,CHR72349(p.p.),G(p.p.). — Johnson & Constable s.n., 23.x.1951. Ruby Creek. Mt. Werong. NSW18442,CHR91281. — [Knoetzsch] s.n., 1884. Boonoo-Boonoo, New England. MEL41711,MEL41740. — Law s.n., s.dat. New England. Q.L. [Queensland]. MEL41777. — Lawson s.n., 26.vi.1925. Barrington Tops. SYD,NSW22485. — Lithgow 183, 12.viii.1965. Nelson Bay. NSW102591,BISH. — Lynch 4, -.x.1913. Tungsten via Deepwater. NSW10918. — McBarron 7273, 6.i.1963. Sue City-Cabramurra Rd., Snowy Mts. NSW. — McBarron 7277, 6.i.1963. Sue City-Cabramurra Rd., Snowy Mts. NSW(s.n.). — McKee 5768, 9.viii.1957. Bonny Hills (Pt. Macquarie to Laurieton). NSW102592,SYD.BISH. — McKee s.n., 22.ix.1952. Currant Mt. Gap. NSW21815. — McLuckie s.n., 30.ix.1921. Blue Mountains. SYD. — McMutt 66, -.viii.1913. Bismuth via Deepwater. NSW10920. — Maiden & Cambage s.n., -.x.1904. Cox's River. NSW10917. — Maiden & Forsyth s.n., -.i.1899. Pretty Point. Mt. Kosciusko. NSW10953. — Malthorne s.n., -.x.1898. Jenolan Caves. G.AD97013009. — Martensz 455, 25.i.1972. Fiery Range. West on "Long Plain Hut" Kosciusko National Park. AD. — Martensz 456, 25.i.1972. Fiery Range. West of "Long Plain Hut". Kosciusko National Park. AD. — Morris 1839, 29.ix.1927. Bell. NSW10915,ADW(2 specimens). — Mueller s.n., s.dat. Mount Coskiusko. Munyang Mountains. MEL41428. — MM 599, 19.xii. 1952. Above Eucumbene Portal. COOMA. — MM 2333 & 2333A, 8.xii.1954. Ogilvie's Creek. COOMA. — MM 3040, 25.xi.1955. T2 track. COOMA. — Newman 80, 1.i.1953. Doubtful R., near Faom Ridge. NSW21816. — Nolan s.n., s.dat. Coonabarabran. AK93121. — Oldfield s.n., s.dat. Cook's River, nr. Sydney. W36923. — Perrott s.n., s.dat. Armidale. MEL41422. — Phillips 7, 13.i.1965. 3 miles from Eucumbene Portal towards Eucumbene Dam, Snowy Mountains. CBG. — MEP [?Phillips] 2375, 20.xii.1954. Hill near Happy Jack's River. COOMA. — Porter 20, 1885. Tamworth New England. MEL. — Rodd 462, 26.iii.1967. C. ½mile N. of Murray's Gap. AD,NSW84960(n.v.). — Rodd 1608, 7.i.1971. Little R., 9.8 km NNE of Jenolan Caves. AD,NSW(n.v.). — Rowan s.n., s.dat. Port Jackson. MEL41729. — Simmonds s.n., -.xii.1961. Threadbo river valley between Threadbo and Jindabyne. BRI034799. — Simson 8, -.ix.1956. Forster. NSW126371. — Stead 1, 19.i.1966. Blue Lake, Kosciusko Plateau. MEL. — Stephenson s.n., 1844/5 & 6. Within 125 miles of Sydney. NY(p.p.). — Stuart 199, s.dat. Clifton. New England. MEL41642,MEL41641p.p. — Stuart 949, Septr. Tenterfield. MEL. — [Stuart] s.n., Oct. Tenterfield. MEL41516. — [Stuart] s.n., s.dat. New England. MEL41421. — Stuart s.n., s.dat. New England. MEL41505. — Sulman s.n., s.dat. Blackheath. Hat Hill. NSW10913. — Sutton s.n., 6.xii.1953. Barrington Tops. NSW26673. — Swain 12, -.xi.1914. Th. Terrergee. Co. Courallie. Moree district. NSW10928. — Sydney University Exped. s.n., 29.viii.1934. Myall Lakes to Bulladelah. SYD. — Thompson 27, 17.i.1958. Happy Jacks Plain, headwaters of the H.J. river, ca. 15m S of Kiandra. NSW126374. — Thompson s.n., 18.i.1958. Happy Jacks Plain, headwaters of the H.J. River, ca. 15 miles S. of Kiandra. NSW102596,BISH. — Vickery s.n., 24.iv.1962. Near Mt. Werong. NSW126377. — H. & E. Walter 3188(p.p.), 3.i.1959. Mt. Kosciusko, Snowy Mountains. Tal oberhalb "The Chalet". B. — Williams s.n., 31.vii.1966. Gibraltar Range Nat. Park, ca. 41 miles NE of Glen Innes. NE. — Williams s.n., 16.xii.1967. Barren Mountain, west of Dorrigo. NE(2 specimens). — Williams & Winterhalder 649, -.x.1958. Gibraltar Range. NE. — Williams & Winterhalder s.n., -.iv.1958. Gibraltar Range, ca. 40 miles NE of Glen Innes. NE. — W[imbush] s.n., 29. xi.1962. Thredbo River. Left bank near [The] Creel. COOMA. — Woolls s.n., s.dat. Blackheath. MEL41497. — Woolls s.n., s.dat. Castlereagh. MEL41489(p.p.).

Queensland

Hartmann 10, 1874. Condamine [River]. MEL(p.p.). — Hartmann 11, 1874. Condamine [River]. MEL(p.p.).

South Australia

Blandowsky 87, 22.ix.1849. Zwischen Adelaide u[nd] Hahnendorf. MEL. — Kinginsland s.n., s.dat. Without locality. HBG. — Mueller s.n., -.ix.1848. In M[ount] Barkeri districtus. MEL41487.

Victoria

Ackland 189, 25.xii.1964. Omeo-Corryong Highway, 3.2 road miles S. of Sassafras Gap. About 23 miles N. of Benambra. MEL. — Anon. s.n., -.xii.1862. Mount Useful. MEL41703. — Barker 1489, 24.xii.1971. Ca. 3km along the Moroka Road towards Mt. Arbuckle from the start of the Mt. Wellington and Tarli Karng track. AD. — Barker 1490, 25.xii.1971. On the Moroka Road, ca. 200m W of Forestry Camp and ca. 2½km E of the junction of the Howitt and Licola Roads. AD. — Barker 1492, 25.xii.1971. Ca. 3km along the Howitt Road from the junction of the Moroka Road and the road to Licola at Mt. Arbuckle; Holmes Plain. AD. — Barker 1495, 25.xii. 1971. Bryce's Plains, which is on the Howitt Road ca. 15km NNW of the junction of the Howitt Road, Moroka Road and the road to Licola.

AD. -- Barker 1497, 25.xii.1971. Ca. 1½km from Minogue's Lookout on the Howitt road towards Bryce's Plain and Mt. Arbuckle. AD. -- Barker 1504, 26.xii.1971. Opposite the Macalister Springs turnoff on the Howitt Road to Licola. Ca. 3km NW of Howitt Hut. AD. -- Barker 1505, 26.xii.1971. Ca. 3km NW of Howitt Hut on the Macalister Headwaters road, ca. 100m SE of the turnoff to Macalister Springs. AD. -- Barker 1509, 26.xii.1971. As for Barker 1505. AD. -- Barker 1510, 26.xii.1971. As for Barker 1505. AD. -- Barker 1511, 26.xii.1971. Ca. 2km NW of Howitt Hut on the Macalister Headwaters road, ca. 1km SE of the turnoff to Macalister Springs. AD. -- Barker 1517, 26.xii.1971. On the Howitt Road between Mt. Arbuckle and the Macalister headwaters at Mt. Howitt; ca. 1km S of Howitt Hut. AD. -- Barker 1521, 26.xii.1971. Lost Plain; ca. 3km SW of the junction of the Licola, Howitt and Moroka roads near Mt. Arbuckle; on the Licola Road. AD. -- Barker 1525, 27.xii.1971. South-east part of Bennison Plains, which is ca. 2km E of Mt. Tamboritha and ca. ½km N of the Licola-Snowy Plains road. AD. -- Barker 1528, 27.xii.1971. On the Licola-Mt. Skene road, ca. 7km NW of Connor(s) Plain. AD. -- Barker 1534, 27.xii.1971. On the north-west end of the summit ridge of Mt. Skene, which is between Licola and Jamieson. AD. -- Barker 1540, 29.xii.1971. On the Speculation Road ca. 28 miles (45km) by road from Mirimbah ca. 4km S of Mt. Cobbler. AD. -- Barker 1541, 29.xii.1971. On the Speculation Road ca. 32 miles (50km) by road from Mirimbah ca. 2km N of Mt. Koonika; Mustering Flat. AD. -- Barker 1542, 29.xii.1971. On the summit of Mt. Speculation which is at the W end of the Barry Mountains. AD. -- Barker 1543, 29.xii.1971. From ca. 50-150m NE of the summit of Mt. Speculation which is at the W end of the Barry Mountains. AD. -- Barker 1565, 6.i.1972. On the eastern slopes of The Twins, which is at the E end of the Barry Mountains, ca. 6km SW of Mt. Hotham. AD. -- Barker 1585, 7.i.1972. Bogong High Plains; between Mt. Cope and Cope Hut, ca. ½km and ca. 1km NNE of Mt. Cope. AD. -- Barker 1603, 10.i.1972. Bogong High Plains. Bucketty Plain; in boggy creek by Omeo-Falls Creek road; ca. 5km ESE of Mt. Cope. AD. -- Barker 1606, 10.i.1972. Ca. 3km E of Bucketty Plain and ca. 8km ESE of Mt. Cope, on the road to Omeo from the Bogong High Plains. AD. -- Barker 1611, 11.i.1972. Ca. 200m W of the turnoff of the Tin Mine Trail on the Benambra-Cobberas-Wulgulmerang road, ca. 30km ENE of Benambra. AD. -- Barker 1612, 12.i.1972. Cobberas Mountains. Ca. ½km E of the bridge on the Tin Mine Trail across Bully Creek; on Spur up to Moscow Peak. AD. -- Barker 1617, 12.i.1972. Cobberas

Mountains. On top of the saddle between Moscow Peak and Mt. Cobberas No. 1. AD. -- Barker 1625, 12.i.1972. Cobberas Mountains. Ca. 100m W of and 15-30m below the saddle between Middle Peak and Mt. Cobberas No. 1 summit. AD. -- Barker 1628, 13.i.1972. Rocky Plains between Big Hill and Mt. Wombargo; ca. 40km E on Benambra on the Benambra-Wulgulmerang road. AD. -- Beauglehole 15733, 28.i.1966. Bogong High Plains. Buckety Plain. BEAUGLEHOLE. -- Beauglehole 36486(p.p.) & Finck, 25.i.1971. V52-6. East Gippsland. Cobberas No. 1. BEAUGLEHOLE. -- Beauglehole 36547 & Rogers, 26.i.1971. V44-1. East Gippsland. Cowombat (Flat) Plain. Between Cobberas & N.S.W. Border. BEAUGLEHOLE. -- Beauglehole 37444, 17.iii.1971. W12-1. East Gippsland. Mt. Phipps Road. Great Dividing Road. BEAUGLEHOLE. -- Beauglehole 40831, 30.xii.1973. S35. Lake Tarli Karng area. Gillio's Track N.E. of Lake. BEAUGLEHOLE, AD. -- Beauglehole 40865 & Chesterfield, 31.xii.1972. S17. Snowy Range. Bryce Plain, W side of road ± 10m S.E. of Mt. Howitt. BEAUGLEHOLE,AD. -- Beauglehole 40892, 1.i.1973. S17. Snowy Range. Howitt Plain ± 2½m S.S.E. of Mt. Howitt. BEAUGLEHOLE,AD. -- Beauglehole 40991 & Chesterfield, 6.i.1973. S17-S26(Grid border). Snowy Range. Caledonia Swamp. Upper reaches of East Caledonia River ± 13m N.N.W. of Mt. Wellington. BEAUGLEHOLE. -- Beauglehole 41127 & Chesterfield, 8.i.1973. S35. Gable End. ± 2½m S.W. of Mt. Wellington. BEAUGLEHOLE. -- Beauglehole 41130 & Chesterfield, 11.i.1973. S17. Snowy Range. Pieman Creek area ± 10m S.E. of Mt. Howitt. BEAUGLEHOLE,AD. -- Beauglehole 41441, 11.ii.1973. W7. East Gippsland. Nunniong Plateau. Billy Plain. Diggers Hole Track. BEAUGLEHOLE,AD. -- Beauglehole 41489 & Rogers, 14.ii.1973. W7. East Gippsland. Nunniong Plateau. Forlorn Hope Plain. BEAUGLEHOLE. -- Beauglehole 41509, 15.ii.1973. W6. East Gippsland. Nunniong Plateau. Upper Reaches of Blue Shirt Creek ½m S. of Jam Tin Flat. BEAUGLEHOLE. -- Beauglehole 41643, 22.iii.1973. W1. Dargo High Plains. Lankeys Plain. BEAUGLEHOLE. -- Beauglehole 41720, 29.iii.1973. W22. Mt. Baldhead, ± 20m S. of Omeo. BEAUGLEHOLE. -- Briggs s.n., 28.xii.1964. 19 miles S of Mt. Hotham on Dargo Road. NSW72464,BISH. -- Briggs s.n., 28.xii.1964. 10miles N of Dargo near Mt Ewen on Mt. Hotham-Dargo Rd. NSW27243,BISH. -- Canning 364, 29.x.1967. 5.3ml. from Stanley, toward Mt. Stanley (just below the summit). CBG. -- Cravan 1706, 24.xii.1969. About 17 miles from Whitfield on the Mansfield-Whitfield road. CANB. -- Czornij 391, 6.xii.1971. Ca. 6km west of Hotham Heights. AD. -- Ducker s.n., 16.xii.1956. Little River. MELU15984. -- Gargurevich s.n., 1874. Red Jacket Creek. MEL41373. -- Henshall s.n., 4.i.1967. Bogong High Plains. NSW102600. -- Hill 1298, 1.i.1964. Bogong High Plains, Falls Creek Area - 120km east of Melbourne. AD. -- Howitt 52, 188[2]. [Tucker] Creek, Gippsland. MEL. -- Howitt 535, 188[2]. Upper Delegate River. MEL. -- Howitt 578, 188[2]. Delegate Hill. MEL. -- Howitt 593, 1882. Nunnyong. Gippsland. MEL. -- Jephcott s.n., 1883. Hume [Murray] River. MEL41358. -- Johnstone 7, 1883. Meredith. MEL. -- Ludbrook s.n., 24.xi.1940. Alpine Highway between Harrietville and Hotham Hts. CANB7921. -- McBarron 2944, 3.i.1949. Mt. Stanley (N.E. Victoria). NSW10941. -- McDonnell 468, 19.xi.1970. Bennison Plains, E. of Licola. AD,CBG(n.v.). -- Martin s.n., 1887. Snowy Creek. MEL41308. -- Merrall s.n., -.iv.1887. Head of the Delegate River. MEL41355. -- Merrall s.n., 1887. Coombimbah [?Combienbar] Valley, E. Gippsland. MEL41369. -- Merrall s.n., 1887. Sources of Delegate River. MEL41353. -- Merrall s.n., 1887. Delegate R. MEL 41354. -- [Mueller] s.n., -.iii.1853. Top of the Buffalo Ranges. MEL41550. -- M[ueller] s.n., -.xi.1853. Mt. Emu Creek. MEL41379 (p.p.). -- Muir 1086, 15.i.1960. Upper slopes of Mt. Delusion, 17 miles south-west of Omeo. MEL. -- M.U.M.C. s.n., 30.xii.1964. Mount Nelse, Bogong High Plains. On Duane track between Big River & Nelse Summit. CBG011570. -- R[upp] 1, -.x.1897. Ringwood. MELU. -- Sayer, s.n., 1887. Cann Valley. E. Gippsland. MEL41323. -- Sayer s.n., 1887. Between Bemm & Coombimbah [?Combienbar] Rivers. E. Gippsland. MEL41324. -- Thorn s.n., 1891. Delatite River. MEL41387,MEL41388. -- Thorn s.n., 1890. Delatite River. MEL41389. -- Walter s.n., -.x.1891. Mount Granya. MEL41306,NSW10942. -- Walter s.n., 1891. Upper Yarra River. AK30649. -- Walter s.n., s.dat. Dandenong. NSW10944,GH(p.p.). -- Ware s.n., 1884. Mt. Gibbo Range. MEL41364. -- Willis s.n., 15.i.1946. Head of Pretty Valley near Mt. Cope, Bogong High Plains. MEL41553(p.p.). -- Willis s.n., 5.xii.1970. Lost Plain near Mt. Arbuckle, against forest road between Mts. Tamboritha and Wellington. MEL41517.

Australia. Without locality or locality unknown

Anon. s.n., s.dat. AD97012203. -- Caley s.n., s.dat. Nova Hollandia. W. -- Dall[achy] s.n., s.dat. Murray-[Desert]. MEL41381 (p.p.). -- Lhotsky s.n., s.dat. In nova Hollandia. L908227163, W191151. -- Mueller s.n., s.dat. [Mt. Alex]. NY. -- Sieber 182, s.dat. Fl. Novae Holl. G(3 sheets),L908227182,L908227153,W(2 sheets), W300451,NY,MEL41316,MEL41315(p.p.).

Without locality

Anon. 294, s.dat. Australasia. W. -- Anon. s.n., s.dat. W. -- Huegel s.n., s.dat. Australasia orient. W. -- Sieber 629 (p.p.), s.dat. MEL41315(p.p.),MEL41500,MEL41499(p.p.).

Locality doubtful

Caley s.n., 1799-1810. Hobart. MEL41441.

SPECIMENS WITH AFFINITIES TO SSP. PALUDOSA

Victoria

Anon. s.n., s.dat. East Gippsland. MEL41322. -- Audas s.n., -.x.1915. Ringwood. MELU15944. -- Groves s.n., -.ix.1962. Barry's Ck. Wilson's Prom. MELU15992. -- Maplestone s.n., 1874. August to November. Maryborough. MEL41371. -- Mueller s.n., s.dat. Tar[r]angower. MEL41342.

h. ssp. muelleri (Wettst.)Barker, comb. et stat. nov.

E. muelleri Wettst.,Monogr.Gatt.Euphrasia (1896)257,t.6 f.416-423 BASIONYM; Du Rietz,Sv.Bot.Tidskr.42(1948) 359; Eichler,Suppl.Black's Fl.S.Austral.(2nd.ed.) (1965)282

E. collina R.Br.: Benth.,Fl.Austral.4(1868)520,p.p.(as to Wilhelmi MEL41377 and a number of other specimens from S.Austral. and Vict. seen by Bentham, labelled "collina", but not specifically cited); Ewart,Fl.Vict.(1931)1024,p.p.; Willis,Hdbk.Pl.Vict.2(1973)574,p.p.(as to some occurrences in probably CDHJMNQRSUV)

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.), p.p.; FvM.,Key Syst.Vict.Pl.2(1885)41,p.p.(as to some occurrences throughout Vict.,excl. "E."): 1(1887-1888) 392,p.p.; FvM.,Sec.Syst.Cens.Austral.Pl.1(1889)165,p.p. (as to some Vict., S.Austral. and N.S.Wales occurrences)]

[E. speciosa auct.non R.Br.: Benth.,Fl.Austral.4(1868)520, p.p.(as to Mueller MEL41510)]

DESCRIPTION:

Erect perennial herb (9.5)21-33(41)cm tall, with several to many erect or ascending annual branches usually arising from perennating base, or somewhat higher up from other branches.

Stem reduced [?always]; main floral branches (7.0)13.5-27(29)cm high to base of inflorescence, simple for (6)7-26(42) nodes below inflorescence, i.e. for (0.55)0.75-1.0 of height of inflorescence above ground level; upper (0)3-7(8) internodes as long as or longer than upper leaves, the longest internode (0.8)2.3-3.3(4.5) times the length of upper leaves, those lower down shorter than leaves; axes in upper parts bearing two rows of dense, short to moderately long eglandular hairs decurrent from between leaf bases, often with sparser eglandular hairs between, lower down with eglandular indumentum usually sparser and shorter or absent, rarely (Mueller MEL41511) dense and long and mixed with dense, short to long glandular hairs.

Leaves: uppermost leaves of main floral branches (5.9)6.5-11.5(14)mm long, (1.8)3.0-5.7(7.6)mm broad, serrate to pinnatifid-serrate, with sessile gland patches confined to distal (0.35)0.55-0.9(0.95) of leaf, otherwise usually moderately densely to densely scabrous or scaberulous all over, rarely sparsely so, or glabrous; base rounded-cuneate to narrow-cuneate; teeth (1)2-3(4) along each margin, confined to distal (0.25)0.35-0.65(0.75) of leaf, blunt or sharp, usually acute, rarely obtuse, the longest tooth (0.5)0.7-1.8(2.1)mm long; apex (0.9)1.2-2.8(3.2)mm long, (0.8)1.0-1.7(2.0)mm broad, usually blunt, sometimes sharp, usually acute, rarely obtuse; middle leaves like upper leaves but usually with shorter scabridity or glabrous; lowermost leaves sometimes glabrous, sometimes scabrous or scaberulous, sometimes bearing moderately dense to dense very short (subsessile) to moderately long glandular hairs, rarely with a mixture of both.

Inflorescences racemes, excluding widely-spaced flowers at lowest (0)1-2(5) nodes dense in bud, usually moderately dense to dense, rarely sparse in flower and fruit, with (22)26-46(50) flowers, sometimes with lowest node supporting a single flower; lowermost pedicels (0.7)1.0-3.7(4.7)mm long; rachis as for upper parts of axis; apical bud cluster usually narrow cylindrical to narrow ovoid- or conical-cylindrical, rarely broadly ovoid, initially ca. 1.5-4mm long, hidden by or hardly emergent from corollas of uppermost flower pair after first (3)5-15 pairs of flowers have reached anthesis.

Bracts similar in size and shape to uppermost leaves, usually moderately densely to densely scabrous or scaberulous all over, rarely sparsely so, those at lower (5)9-15 or more nodes toothed, distal ones entire, with all bracts, except sometimes for those at lower 2-5(7) nodes shorter than or equal to calyx.

Calyx (3.5)3.6-6.5(6.7)mm long, with external surface covered by moderately dense to dense, very short to long, usually stiff, rarely lax eglandular hairs, sometimes with indumentum denser on teeth, sparser towards base.

Corolla (9.4)9.8-13.5(14.8)mm long along upper side, apparently (from dried material) purplish or lilac sometimes with a paler tube and lower lip behind lower lobes, with incidence of yellow blotch on lower lip unknown; tube 6-8.5(10)mm long; hood 3-5(6.5)mm long; upper lobes usually shallowly emarginate, sometimes truncate or obtuse or praemorse, rarely emarginate, with rear surface covered by moderately dense, very short glandular hairs, or moderately dense to dense, very short to moderately long eglandular hairs, or a mixture of both; lower lip (4.5)6-10.5(12)mm long; lower lobes usually emarginate or deeply so, rarely shallowly emarginate or praemorsely obtuse, externally covered by a dense indumentum usually of very short to long eglandular hairs, rarely of very short glandular hairs or a mixture of both.

Stamens with anthers (1.4)1.5-1.8(1.9)mm long, with connectives surrounded by dense, long to very long eglandular hairs; posterior pair of anther awns 0.15-0.3(0.35)mm long.

Capsules ca. 6.5-8mm long, in lateral view ovate-elliptic to obovate, often narrowly so, or ± caudate, 1.5-2.5mm broad, in median view narrow ovate-caudate to narrow elliptic-acuminate, usually with dense, very short to moderately long setae over distal $(\frac{2}{3})\frac{1}{3}$ or less, sometimes sparsely setose at apex only, or glabrous; apex in lateral view acute, obtuse or truncate, often obliquely so; seeds ca. 19-96, (0.35)0.4-0.8mm long, 0.2-0.4(0.5)mm broad, ellipsoid, oblong, ovoid or reniform, often obliquely or broadly so.

Plates: 27

Figures: 18

TYPIFICATION:

Lectotypus (tab. 27): Carl Wilhelmi s.n., s.dat. Lofty ranges [? etc.], S.A[ustralia]. W. Isolectotypus: HBG. Syntypi alteri: F.Mueller s.n., s.dat. Nov. Holl. meridional. Plantae Muellerianae. W. -- F. Mueller s.n., s.dat. Austr[alia] felix. W;LE(n.v.). -- C. Walter s.n., 22.ix.1882. Upper Yarra. W776,WU,FI;B(n.v.). -- C. Walter s.n., s.dat. Upper Yarra, Vic. W3912. -- C. Wilh[elmi] s.n., s.dat. McIvor Ranges. W51090,W71487. Syntypi alteri non visi: Anon., Mt. Eliza. LE. -- C. Walter. Dandenong. B.
Illustration: Wettstein (1896)t.6 f.416-423 (Walter: Upper Yarra).

Wettstein (1896) combined plants of three subspecies of E. collina under his new species E. muelleri. It is clear from the protologue, including the key and the illustration, that the species was characterised by "Bracteae et tubus calycis setis minutis dense obsiti". Neither Wilhelmi W71487, which is related to ssp. collina, nor one fragment of ssp. trichocalycina in Walter W3912, have eglandular hairs on the bracts and the outer surface of the calyx. All the other syntypes seen were considered for lectotypification as each has this indumentum, although sometimes it diverges slightly from the protologue by being sparse on the bracts and tube.

The choice of lectotype was based primarily on the quality of the material. The specimen chosen contains a single entire plant with many floral branches bearing flowers and fruits, while the isolectotype has three separate full length floral branches in a similar condition to the lectotype. The specimen from "Australia felix" contains a whole plant with many floral branches in flower and fruit, but in the absence of knowledge of the existence, identity and quality of the possible duplicate material in B it was not considered a good choice for lectotype. The syntype Wilhelmi W51090 also contains a single entire plant with an inflorescence at an early stage of flowering, but the absence of duplicate material and the fact that only one entire floral branch was present while two others had lost inflorescences also made it a poor choice for lectotype. The Walter specimens from the Upper Yarra would also have qualified for lectotype but for the absence of an entire plant. Material from this collection formed the basis of the illustrations of the corolla, leaves, bracts and capsule in the protologue. In the three specimens six floral branches, mainly with buds and flowers, but with one specimen (WU) with young fruits, are present. The Mueller collection from "Nov. Holl. meridional." (South Australia) contains a single branch with mature capsules and a single flower but most leaves have been lost.

It is doubtful whether populations of ssp. muelleri still occur in the Mt. Lofty Ranges in South Australia, the source of the lectotype, as no herbarium collections of the subspecies have apparently been made there for over 80 years.

DISTRIBUTION (Fig. 18):

Old collections of E. collina ssp. muelleri indicate that the subspecies was widely distributed on the mainland of Australia from northern New South Wales near the Queensland border throughout south-eastern Australia, and westwards as far as the Mt. Lofty and Southern Flinders Ranges of South Australia. There is also one possible record (Stuart MEL41509) from Tasmania; this is doubtful, however, as the specimen of ssp. muelleri is mounted with material of ssp. osbornii and the accompanying label is annotated with a South Australian locality in a region where both are known to have occurred (see also ssp. osbornii: Note 2).

There are many more collections from central and western Victoria than from New South Wales and South Australia. Judging by the number of collections made of Euphrasia in the respective areas in the 19th century this indicates the subspecies was rare outside these parts of Victoria. The reason for this is not apparent. The subspecies is possibly now extinct as only two collections have been made since 1907; they came from Frankston, a Melbourne suburb on the western side of Port Phillip Bay in 1947 and 1949. Only an active search for material of this subspecies will indicate whether it is truly extinct or not.

Altitudinal data are lacking. However, it seems certain that it occupies lowland and at least low mountain habitats.

ECOLOGY:

There is insufficient ecological information on herbarium labels to gain a picture of the range of habitats which have been occupied by ssp. muelleri. The only two labels clearly referring to material of the subspecies indicate an open meadow habitat, viz.

"Common in open pasture lands" (Stirling 166) and "in pratis siccis" (Mueller MEL41378). On the labels on two mixed herbarium sheets are annotations possibly also pertaining to ssp. muelleri. These are "In locis udis ad amnem" (in wet places near stream: on Mueller MEL41379) and "kommt am haeufigsten auf [nassem] Boden vor" (occurring abundantly on wet soil: on Anon. MEL41410).

Flowering material has been collected mainly between August to November, with capsules being present from September. One collection from northern New South Wales (Boorman G) was collected in July and bears buds, flowers and fruits.

NOTE:

There are a few collections divergent in the indumentum of the calyces, bracts and upper leaves typical of ssp. muelleri. Several collections from western Victoria (Anon. GHp.p., Crouch MEL41431, Eckert 29, Reader 9, Sullivan 43, Whan NSW10940) bear sparse to dense glandular hairs, 0.05-0.1mm long, mixed with the moderately densely to densely eglandular scabrous or scaberulous indumentum characteristic of ssp. muelleri. Still other forms apparently confined to the Southern and Central Tablelands and South-western Slopes regions of New South Wales (Anderson 1961) and possibly in Victoria near the Snowy Mountains bear woolly eglandular hairs 0.2-0.5mm long on the upper parts, with the indumentum shorter lower down (Bull MEL41486, Rawes 34, Curran MEL41719). There are two similar specimens mounted with a densely glandular plant related to ssp. speciosa in the collection Anon. MEL41503 from the same region of New South Wales; these specimens bear dense woolly eglandular hairs ca. 0.2mm long mixed with very short glandular hairs on the bracts and rachis, and also differ from typical ssp. muelleri by their very elongated inflorescences with long pedicels and long narrow leaves with 1-2 pairs of teeth.

It seems that the long woolly eglandular variants lacking glandular hairs may be extremes of variation in normal populations of ssp. muelleri; Mueller MEL41375 and French MEL41718 contain some plants with the scabrous indumentum typical of the subspecies, and others with a longer, more lax indumentum in the upper parts. It is impossible to speculate on whether the glandular-scabrous variants of ssp. muelleri represent a distinct taxon or they are extreme variants of populations. To establish the true relationships between ssp. muelleri and these variants it is imperative that any surviving members of each be found.

SPECIMENS EXAMINED:

New South Wales

Boorman s.n., -.vii.1904. Dorrigo. G. -- Butler s.n., -.x.1887. Upper Macintyre River. MEL41763. -- French s.n., 1886. Upper Murray. MEL41748. -- Garland 66, 1887. Cootamundra. MEL. -- Jephcott s.n., 1883. Hume [Murray] River. MEL41359.

South Australia

Anon. [?Osswald] s.n., s.dat. Guichen Bay. MEL41410 (p.p.). -- Anon. per Pamplin s.n., s.dat. Port Adelaide. K(p.p.). -- Blandowsky 86(p.p.), s.dat. Gegend von Macclesfield. MEL(p.p.). -- Mueller s.n., -.x.1850 [?]. Montem M. Remarkable versus. MEL41490. -- Mueller s.n., s.dat. Mount Remarkable. HBG(p.p.). -- [Mueller] s.n., s.dat. Mt. Remarkable in interiore. MEL41485. -- Mueller s.n., s.dat. Nov. Holl. meridional. Tanunda. HBG(p.p.). -- Mueller s.n., s.dat. Without locality. MEL41515(p.p.). -- Mueller s.n., s.dat. Nov. Holland. meridional. W(syntype of E. muelleri). -- Wilhelmi s.n., s.dat. Lofty ranges. W(lectotype of E. muelleri).

Victoria

Anon. s.n., 1847. Port Phillip. MEL41382. -- Anon. 37, s.dat. Station Peak. MEL41307. -- Anon. s.n., Novr. McIvor. MEL41384(p.p.). -- Anon. [?Mueller] s.n., s.dat. Cape Otway. MEL41386. -- Anon. [?Walter] s.n., s.dat. Wimmera. MEL41309(p.p.), L908227137,G(possible isosyntypes of E. walteri). -- Anon. s.n., s.dat. Austr[alia] felix. MEL41705. -- Anon. [?Mueller] s.n., s.dat. Forest Creek. MEL41385(p.p.). -- Bertho[n]d 22, s.dat. Campaspe. MEL41336. -- Clifford 11, -.xi.1947. Frankston. PERTH. -- Curdie s.n., s.dat. Donald. MEL41376(p.p.). -- French s.n., s.dat. Upper Yarra. W138022,CANB209718(p.p.). -- Fullagar s.n., s.dat. Werribee. L908277107. -- Green 93, s.dat. Near Ararat. MEL. -- Green 136, s.dat. Near Ararat. MEL41341(p.p.). -- Green 150, s.dat. Near Ararat. MEL41341(p.p.). -- Guerard s.n. s.dat. Dandenong Ranges. W. -- Hardy s.n., 1882. Woods Point. MEL41350. -- Harvey s.n., ix.xii.1854. Without locality. GH. -- Morrison s.n., 13.ix.1891. Frankston. AD96412154,PERTH,BRI; pollen sample A.N.U.,AD. -- [Mueller] s.n., -.xi.1853. In pratis siccis prope Station Peak. MEL41378. -- M[ueller] s.n., -.xi.1953. Ad amnem Mt. Emu Creek. MEL41379(p.p.). -- Mueller s.n., s.dat. Mount Corong [?Kerang]. MEL41375. -- [Mueller] s.n., s.dat. Wimmera. MEL41311. -- Mueller s.n., s.dat. Austr[alia] felix. W(syntype of E. muelleri). -- [Mueller] s.n., s.dat. Austr[alia] felix. MEL41319(p.p.),MEL41706(p.p.),MEL41709. -- Mueller s.n., s.dat. Forest Creek. K(p.p.),MEL41510. -- [Mueller] s.n., s.dat. Hills about Forest Creek. MEL41511. -- O'Rourke per Howitt 48, 1883. Gippsland. Wulgul[merang]. MEL41370. -- Stirling 166, s.dat. Round Omeo. MEL41361. -- Stirling s.n., s.dat. Wilson's Promontory. MEL41363. -- Tovey s.n., 15.ix.1907. Mentone. G(3 specimens),L9102013598,L910236333. -- Walter s.n., 22.ix.1882. Upper Yarra. WU,W776(syntype of E. muelleri). -- Walter s.n., 1902. Without locality. LY(p.p.)(syntype of E. walteri). -- Walter s.n., s.dat. Upper Yarra. W3912(p.p.)(syntype of E. muelleri). -- Weindorfer 77(p.p.), -.ix.1902. Dandenong Rgs. W9930(p.p.). -- Wilhelmi s.n., 27.xii.1856. Top of Mount Rous. MEL41377. -- Wilh[elmi] s.n., s.dat. McIvor Ranges. W51090(syntype of E. muelleri). -- Williamson s.n., -.ix.1899. Ararat. BISH. -- W[in]kworth s.n., 24.viii.1949. Frankston. MELU15987.

Without locality

Anon. 110, s.dat. MEL41588(p.p.). -- French s.n., -.x.1897. G(p.p.).

Locality doubtful

Mueller s.n., various dates. One of three possible localities. Bethanien [Bethany]. s.dat./ Apud pag[um] german[um] [Probably Bethany]. -.ix.1848./ In montibus Flinders range. Nov. Holl. austral. -.x.1851. MEL41484(p.p.). -- Stuart s.n. Either of two localities. Ad fluv. Torrens. Octobr./ Nov. Holl. austr.

1847. V.D.L. MEL41509(p.p.).

SPECIMENS WITH AFFINITIES TO SSP. MUELLERI:

New South Wales

Anon. s.n., s.dat. Murrumbidgee. MEL41503(p.p.). -- Bull s.n., s.dat. Tumberumba. MEL41486. -- Crouch s.n., 1873. Brookong, Wagga Wagga. MEL41431. -- Curran s.n., -.x.188[2]. Upper Macquarie River. MEL41719. -- Rawes 34, 1888. Upper Murray River. MEL41351.

Victoria

Eckert 29, 1890. Wimmera. MEL41329. -- [Mueller] s.n., s.dat. Austr[alia] felix. GH(p.p.). -- Reader 9, 1893. Wimmera. Between Coromby and Murtoa. MEL41313. -- Whan s.n., 1860. Streatham. NSW10940.

Without locality

Sullivan 43, s.dat. MEL41704.

i. ssp. bowdeniae Barker, subspecies nova

LATIN DIAGNOSIS:

Subspecies nova Euphrasiae collinae differt a subspeciebus ceteris ovulis paucis, axibus principalibus inflorescentiisque infirmis, foliisque multum reflexis, in siccitate flexibilis.

Holotypus (tab. 27): R.G. Coveny s.n., 16.x.1966. Blackheath, between Govett's Leap and Pulpit Rock, N.S.W. NSW98623.

DESCRIPTION:

Perennial herb, 7-17cm high or higher (to 30cm: annotations on Bowden NSW84075), with many crowded ascending, **or de-**cumbent branches arising from very short stem or prostrate parts of other branches, or possibly (from position of vegetative buds on Bowden NSW84075) on erect parts of branches while flowering.

Stem apparently reduced; floral branches 4-19cm or more high to base of inflorescence, simple for 0-4(24) nodes below inflorescence, i.e. for much of height above ground level; upper 0-2 internodes as long as or longer than uppermost leaves, the longest $\frac{3}{4}$-$1\frac{3}{4}$ times length of upper leaves, shorter than leaves lower down; axis in upper parts covered by two rows of moderately dense to dense, short stiff downturned eglandular hairs decurrent from between leaf bases, sometimes with sparse similar hairs between, in lower parts similar or somewhat sparser and shorter.

Leaves: uppermost leaves of floral branches elliptic to obovate-elliptic, sometimes narrowly so, 5.8-7.5mm long, 1.2-3.0mm broad, "lax" (Bowden NSW84075), pliant when dried, deflexed, often greatly, glabrous, with sessile gland patches in distal $\frac{1}{2}$-$\frac{7}{8}$ length of leaf; base narrow cuneate, sometimes obliquely so; teeth (0)1 along each margin, bluntly obtuse, 0.1-0.5mm long; apex bluntly acute or obtuse, 1.8-2.8mm long, 1.0-2.2mm broad; leaves lower down similar to uppermost leaves.

Inflorescences racemes, sparse at least at base, with 4-20 flowers, the lowermost 1-5 nodes usually subtending a single flower only; pedicels at lowermost node 1.2-4.0mm long, shorter higher up; rachis similar to upper parts of axis, or covered all around by moderately dense to dense, short eglandular hairs; internodes long, in lowermost parts equalling almost length of pedicel and calyx combined; apical bud cluster somewhat loose, conical, ca. 1cm long, becoming hidden by or hardly emergent from uppermost corollas after flowers at first 1-4 nodes have reached anthesis.

Bracts similar to uppermost leaves.

Calyx 3.3-6.0mm long, externally and internally glabrous, except sometimes for a few very short to short glandular hairs on margins of teeth.

Corolla 7.0-10.5mm long along upper side, "delicate mauve-blue" (Bowden NSW84075) or "violet" (Currie NSW126387), with presence of yellow spots and shape of lower side unknown; tube 5.5-8.0mm long, cylindrical for 2.2-4.5mm to base of anterior filaments, then broadened laterally and abaxially, externally glabrous on narrow part of tube, on broad part of tube covered by sparse to dense, short glandular hairs, sometimes mixed with sparse to dense, short to long eglandular hairs, internally with moderately dense to dense, short to moderately long eglandular hairs, decurrent from bases of filaments, somewhat sparser or completely absent between; hood 1.5-2.8mm long, 4.0-4.5mm broad excluding lobes, 5.0-6.5mm broad including lobes, externally covered by sparse to dense, short glandular hairs, sometimes mixed with moderately dense to dense, short to long eglandular hairs confined to proximal parts or along midline, internally glabrous or with a few short eglandular hairs towards sinus; upper lobes ? ± coplanar usually obtuse, sometimes somewhat praemorse or shallowly emarginate, with front surface and margins glabrous, with rear surface covered by sparse to moderately dense, short glandular hairs, with cleft between 1.7-3.5mm deep; lower lip 5.5-9.0mm long, 9.0-13.0mm broad, [shape unknown], externally covered by sparse to moderately dense, short glandular hairs, internally glabrous; lower lobes usually obtuse, sometimes somewhat praemorse or shallowly emarginate, with clefts between 3.7-4.0mm long.

Stamens with filaments glabrous, but sometimes for short eglandular hairs at base of anterior filaments, the anterior filaments 3.8-5.0mm long, the posterior 1.2-2.3mm long; anthers 1.3-1.7mm long, 0.9-1.3mm broad, with connectives and slits covered by dense, long to very long eglandular hairs; awns tiny, those of posterior pair 0.05-0.2mm long, usually longer than, sometimes equal to those of other six pairs.

Ovary in lateral view obovate-elliptic to narrow ovate-elliptic, apparently laterally compressed, in lateral view narrow ovate, glabrous except sometimes for very few, short setae at very apex; apex in lateral view obtuse to narrow acuminate; ovules 19-40.

Capsule (2 seen) ca. 4mm long, in lateral view elliptic or ovate, ca. 2mm broad, laterally compressed, ovate-acuminate in median view, glabrous; apex acute or truncate-obtuse in lateral view; seeds (from 1 capsule only) 3, oblong-elliptic, 1.2-1.5mm long, 0.6-0.8mm broad.

Plates: 9, 27

Figures: 19

TYPIFICATION:

Holotype (pl. 27): R.G.Coveny s.n., 16.x.1966. Blackheath, between Govett's Leap and Pulpit Rock, N.S.W. Herb-like shrub in damp soil near rock face. NSW98623.

The holotype is somewhat fragmentary but otherwise in good condition and clearly the best collection available of this subspecies. It contains six inflorescences each bearing buds and mature flowers. Mature fruits are lacking. The collection apparently contains plants of a height (ca. 17cm) more typical of the subspecies than of the other collections seen. (From annotations on Bowden NSW84075 plants are "10-30cm" high.)

Topotype material should still be available as the type locality lies within the Blue Mountains National Park.

DISTRIBUTION (Fig. 19):

E. collina ssp. bowdeniae is endemic to the higher parts of the Blue Mountains in the Central Tablelands (Anderson 1961) of New South Wales where it is currently known only from four localities all within an area a few kilometres square. As yet, collections from Mt. Boyce, where according to Dr. B.G. Briggs (pers. comm., 2.iii.1973) Miss I. Bowden has made a close study of the subspecies, are apparently not available in herbaria. Dr. Briggs (l.c.) stated that her "impression is certainly that ...... further searching in the particular habitat favoured by the small form [ssp. bowdeniae] would also show up further localities in this same general region ....".

The subspecies apparently occurs above about 850m altitude and may extend almost to 1200m.

ECOLOGY:

The ecological preferences of this subspecies appear to be quite narrow and are distinct from the geographically sympatric ssp. paludosa. This has been summarised by Dr. B.G. Briggs of NSW (pers. comm., 2.iii.1973) presumably from discussions with Miss I. Bowden who has closely observed plants growing in the field:

> "The small plants [of ssp. bowdeniae] are found on very shallow soil on rocky ledges and sometimes trailing over steep rock exposures, whereas the larger ones [ssp. paludosa] are away from the cliff tops. This distribution for the small plants is constant at Wentworth Falls and at Mount Boyce. At the latter location both occur in quite close proximity (probably only a few yards, but I have not actually observed the site) and appeared distinct to a well-informed amateur collector (Miss Bowden) who observed them in both sites."

These impressions are confirmed by annotations on the specimens seen of ssp. bowdeniae. The plant in Bowden NSW84075 was found "Growing among dry sclerophyll plants near the cliff edge. A few plants seen to occur in this type of vegetation but I have observed most of these small plants growing on the cliff." The same collection has been further annotated with: "habitat similar to that of Epacris reclinata" which is described by

Beadle, Evans & Carolin (1972) as occupying "Higher parts of Blue Mts. on sheltered rocks in gullies". Coveny NSW98623 likewise comes from a rocky locality, viz. "damp soil near rock face".

All collections seen are in flower and were gathered in the months of September and October.

NOTES:

1. Unfortunately I have had no opportunity to see plants of this taxon in the field. From the few mainly fragmentary collections available it seems definite that subspecific status is justified. Furthermore, its apparently often procumbent habit, weak inflorescences, leaves and pedicels, few ovules and small capsules seem to set the taxon well apart from E. collina. However, any move to upgrade it to a distinct species should include a consideration of whether these characters are actually a result of growth on the rocky cliff faces. A thorough investigation is required involving the study of a wide range of populations in the field and from herbarium material, possibly supplemented by anatomical investigations if the laxness of the leaves, stems and pedicels is found not to be produced by wilting.

At the same time the variation of the sympatric ssp. paludosa in the area in any habitats found tending towards those occupied by ssp. bowdeniae should be noted.

2. The subspecies has been named after Miss I. Bowden of Woodford, New South Wales, who from her copiously annotated collection, NSW84075, considered it to be taxonomically distinct from ssp. paludosa (which she called "E. speciosa"), possibly at the species level. From annotations on the collection (NSW93932) of ssp. paludosa and her observations at Mt. Boyce (ex Dr. B.G. Briggs pers. comm. 2.iii.1973) the two subspecies are ecotypically distinct and "no intermediates between the two types have been seen".

Miss Bowden distinguished the subspecies from ssp. paludosa not only on its smaller size and smaller, fewer-toothed leaves, but also by its paler, shorter corollas, its long pedicels and its lax leaves

SPECIMENS EXAMINED:

New South Wales. Blue Mountains

Bowden s.n., 5.x.1966. Wentworth Falls. NSW84075,BISH. — Coveny s.n., 16.x.1966. Blackheath, between Govett's Leap and Pulpit Rock. NSW98623(holotype). — Currie s.n., -.ix.1954. Korall [Korowall] Buttress, S. of Mt. Colitary. NSW126387. — Fletcher s.n., s.dat. [prior to 24.xi.1924]. Wentworth Falls. NSW10933.

j. ssp. nandewarensis Barker, subspecies nova

LATIN DIAGNOSIS:

Subspecies nova Euphrasiae collinae prope ssp. paludosam et ssp. diemenicam indumento non-gladuloso in calyce ramisque simplibus super terram, sed differt a duabus foliis multidentatis indumentoque glanduloso semper in partibus inferis, etiam a ssp. diemenica lobis corollae plerumque obtusis usque truncatus, interdum ita praemorse, foliis summis apice acuto usque subcaudato et dentibus secus multum longitudinis distributis, seminibusque brevioribus.

Holotypus (tab. 28): C.W. Frazier s.n., -.x.1967. Mt. Kaputar. Growing at 4,500 ft. NE(s.n.).

DESCRIPTION:

Erect perennial herb, ca. 30-50cm tall, with ascending branches arising from stem near ground level or prostrate parts of other branches (stem reduced in plants seen).

Main floral branches ca. 20-35cm high to base of inflorescence, simple for 15-70 nodes below inflorescence, i.e. for 0.85-

1.0 of distance from inflorescence to ground level; upper 0-11 internodes longer than or as long as upper leaves, the longest internode ca. 1.0-2.5 times length of upper leaves, those lower down shorter; axes in upper parts bearing very short to short eglandular hairs, sparse to dense in two rows or four lines decurrent from between leaf bases, sparser in between, or dense all around, in lower parts with similar eglandular indumentum, but in lower $\frac{1}{6}$-$\frac{1}{2}$ also bearing short to long glandular hairs, which are moderately dense to dense near base.

Leaves: uppermost leaves of main floral branches ca. 9-17mm long, 4.85mm broad, elliptic to ovate in outline, serrate, sometimes deeply so, with sessile glands on undersurface extending over distal 0.65-1.0 of leaf, with margins lined by dense, very short, scabrous white eglandular protruberances, often also on upper surface and veins of lower side; base rounded-cuneate to cuneate; teeth 4-6 along each margin, confined to distal 0.65-0.85 of leaf, sharp or blunt, usually acute to caudate, rarely obtuse, the longest tooth ca. 0.9-3.5mm long; apex ca. 1.8-3.2mm long, 0.7-2.5mm broad, usually blunt, rarely sharp, usually acute, sometimes almost caudate; leaves lower down with similar eglandular indumentum, on leaves of basal $\frac{1}{5}$ - $\frac{3}{5}$ of axes, bearing very short to moderately long glandular hairs, moderately dense to dense at base, grading to very sparse distally.

Inflorescences racemes, dense in bud, usually moderately dense to dense, rarely sparse in flower and fruit, with ca. 35-50 flowers, with basal node sometimes bearing only one flower; pedicels at lowest node ca. 0.4-3.0mm long, shorter higher up; rachis as for upper parts of axis; internodes elongating prior to anthesis; apical bud cluster narrow cylindrical to ovoid, long (ca. 3.5cm), with apex rounded or acute, becoming hidden by or hardly emergent from corollas of uppermost flower pair after first ca. 14 or more flowers have reached anthesis.

Bracts at lowest nodes similar in shape and indumentum to uppermost leaves, shorter higher up, extending past calyces at lowest 1-8 nodes, shorter higher up, with all bracts toothed.

Calyx ca. 5-7.5mm long, externally glabrous often except for eglandular protuberances, similar to those on leaves, lining margins.

Corolla (the lowermost corollas of main inflorescences not seen) similar in size to ssp. paludosa, white, very pale lilac or "white, becoming pink on drying" (Johnson & Constable), (presence of yellow blotch on lower side not known); lobes obtuse to truncate, sometimes praemorse, with rear of upper lobes ± glabrous, or covered by sparse, very short glandular hairs, with external surface of lower lobes covered by sparse to dense, moderately long to long eglandular hairs, sometimes mixed with a few short to moderately long glandular hairs.

Stamens with anthers ca. 1.5-2.3mm long; posterior pair of awns ca. 0.2mm long.

Capsules ca. 7.5-14.5mm long, in lateral view ca. 2.9-3.8mm broad, ± elliptic, sometimes obliquely so, in median view elliptic-acuminate to ovate-caudate, glabrous except sometimes for very short to short setae, very sparse and confined to apex, or moderately dense along lines of dehiscence of distal $\frac{1}{3}$; apex in lateral view usually obtuse, sometimes narrow acuminate; seeds ca. 12-60, ca. (0.5)0.6-0.9mm long, 0.3-0.6mm broad, ellipsoid to reniform ellipsoid, sometimes broadly so.

Plates: 9, 28

Figures: 19

TYPIFICATION:

Holotype (pl. 28): C.W. Frazier s.n., -.x.1967. Mt. Kaputar. Growing at 4,500 ft. Flowers white. NE(s.n.)

The specimen selected as holotype was the best available for the purpose. It consists of a single entire plant with buds, flowers and fruits and is in good condition.

The populations on Mt. Kaputar appear not to be endangered as the mountain lies within a National Park.

DISTRIBUTION (Fig. 19):

E. collina ssp. nandewarensis is apparently confined to the Nandewar and Warrumbungle Ranges, two mountain ranges about 80km apart and to the west of the main part of the Great Dividing Range.

The only altitudinal records come from Mt. Kaputar and towards Coryah Gap from between 1370m (4500ft.) and 1490m (4900ft.). The Warrumbungles, however, only attain heights of about 1200m (4000ft.).

ECOLOGY:

Ecological information on specimen labels is as follows: "Among grass in Eucalyptus pauciflora woodland" (Briggs); "Common on basalt ridges" (Johnson & Constable); "Sandstone or trachyte" (Winterhalder).

It is possible that the subspecies is confined to snowgum (Eucalyptus pauciflora) woodland which occurs on the summits of the Warrumbungles (Morcombe 1969) as well as the Nandewar Range. Both ranges are apparently of very similar origin, being composed of the remains of volcanoes which became active in the late Tertiary (Morcombe l.c.) and the endemism of the subspecies to these two ranges may reflect unique soil preference.

Flowering occurs between October and January, although one plant (Briggs NSW) with a few flowering branches amongst fruiting ones, was collected in April from high up Mt. Kaputar. Fruits begin to form between about October and January and possibly later.

SPECIMENS EXAMINED:

New South Wales

Briggs s.n., 2.iv.1961. Mt. Kaputar, Nandewar Range. NSW(s.n.). — Crawford s.n., 2.i.1964. Mt. Kaputar, Nandewar Range, near Narrabri. CBG007720. — Frazier s.n., -.x.1967. Mt. Kaputar. NE(s.n.: holotype). — Johnson & Constable s.n., 6.xi.1954. Coryah Gap to Mt. Kaputar, Nandewar Rngs. NSW30524, BISH. — [Rupp] 1, -.x.1912. Mt. Lindsay, Nandewar Range. MEL. — Rupp 22, -.ix.1912. Mt. Lindsay, Nandewar Ranges. NSW10926. — Winterhalder s.n., 10.i.1961. Warrumbungles. NE(s.n.)

k. ssp. speciosa (R.Br.)Barker, comb. et stat. nov.

E. speciosa R.Br., Prodr.(1810)437 BASIONYM; [R.Br., Manuscript (unpubl.) initially as "E. decussata", finally as "E. coerulea"]; Sprengel, Linn.Syst.Veget.(ed.16) 2(1825)777; Benth.in DC.,Prodr.10(1846)554; Benth.,Fl. Austral.4(1868)519,p.p.(as to Brown "Port Jackson"); Moore,Cens.Pl.N.S.W.(1884)50; Woolls,Pl.Indig.Natural. Neighb.Syd.(1891)38; Wettst.,Monogr.Gatt.Euphrasia (1896)258,t.6 f.424-429,t.13 f.1,p.p.(excl. Osswald FI and probably Behr, "Sud-Australien Hb.Boiss", n.v., and Mossman "Twofold Bay Hb.Berl.", n.v.); Gandoger, Bull.Soc.Bot.France 66(1919)217; Du Rietz,Sv.Bot.Tidskr. 25(1932)533; Blake,Qld.Nat.12(1945)90; Du Rietz,Sv. Bot.Tidskr.42(1948)113,351; Evans in Beadle,Evans & Carolin,Hdbk.Vasc.Pl.Syd.Distr.Blue Mts.(1963)410,p.p.; Eichler,Suppl.Black's Fl.S.Austral.(2nd.ed.)(1965)282 (as to name only); Evans in Beadle, Evans & Carolin, Fl. Syd. Reg. (1972) 500, p.p.

E. collina R.Br.: Benth., Fl. Austral. 4 (1868) 520, p.p. (as to Sieber 183507, possibly referable to his var. paludosa, and also other specimens seen by him but not specifically cited)

E. brownii FvM. var. speciosa (R.Br.) Maiden & Betche, Cens. N.S.W. Pl. (1916) 184

[E. brownii FvM., Fragm. Phyt. Austral. 5 (1865) 88 (nom. illeg.), p.p. (as to synonym, E. speciosa); FvM., Syst. Cens. Austral. Pl. 1 (1882) 98, p.p. (as to some N.S.W. and possibly some Vict. occurrences); ?FvM., Sec. Syst. Vict. Pl. 2 (1885) 41, p.p.: 1 (1887-1888) 392, p.p.; FvM., Sec. Syst. Cens. Austral. Pl. 1 (1889) 165, p.p. (as to some N.S.W. and possibly some Vict. occurrences); Moore & Betche, Hdbk. Fl. N.S.W. (1893) 342, p.p. (as to synonym E. speciosa); Dixon, Pl. N.S.W. (1906) 226, p.p.]

[E. paludosa auct. non R.Br.: Benth., Fl. Austral. 4 (1868) 520, p.p. (as to Sieber 183,507)]

[Cyanophrasia speciosa Presl ex Wettst., Monogr. Gatt. Euphrasia (1896) 259 ("in sched.") pro syn.]

["E. sp.": Burbidge & Gray, Fl. A.C.T. (1970) 328]

DESCRIPTION:

Erect perennial herb, often woody at base, (15)26-40(50) cm high, with branches either ascending, arising from near ground from reduced stem, or prostrate parts of other branches, or rapidly ascending and arising from lower nodes of single erect stem flowering in first year, then dying back to near ground level, and lower parts of other branches.

Stem or, if stem reduced, main floral branches (12)15-30(35) cm high to base of inflorescence, simple for (4)5-32(53) nodes below inflorescence, i.e. for (0.5)0.7-1.0 of height from ground level to inflorescence; upper (2)4-8 internodes longer than or as long as leaves, the longest internode (1.8)2.3-6.0(7.0) times length of upper leaves, those lower down shorter than leaves; axes in upper parts with usually two rows, sometimes four lines of sparse to dense, short to moderately long eglandular hairs decurrent from between leaf bases, sometimes with sparser eglandular hairs between, mixed all around with usually moderately dense to dense, sometimes sparse, moderately long to very long glandular hairs, lower down with glandular indumentum almost always extending to very base of plant, often denser, rarely sparser, rarely absent from lower parts, with eglandular hairs somewhat sparser and shorter.

Leaves: uppermost leaves of stem or main floral branches (4.8)[illegible].4-16.0(17.0)mm long, (2.6)3.0-8.0(100)mm broad, usually ovate or broadly so to ovate-elliptic, sometimes obovate-elliptic, serrate or crenate, with sessile gland patches on undersurface, covered by usually dense, rarely very sparse (Baeuerlen 215) or absent (Fletcher NSW10907), usually short to moderately long, rarely long glandular hairs, with margins lined by dense, short, white scabrous eglandular hairs, with upper surface covered by similar, but sometimes sparser and somewhat more lax eglandular hairs; base usually broadly rounded to rounded-cuneate, sometimes cuneate; teeth 2-5(8) along each margin, spread over distal (0.45)0.55-0.9, usually bluntly acute, sometimes sharp or obtuse, the longest tooth (0.6)0.7-2.5(3.3)mm long; apex (1.0)1.3-3.4(4.0)mm long, (0.9)1.1-2.5(3.5)mm broad, usually blunt, sometimes sharp, acute or obtuse; leaves lower down with glandular indumentum usually continuing to very base of plant, where often dense, rarely very sparse, rarely absent from lowest leaves, with eglandular indumentum similar to uppermost leaves.

Inflorescences racemes dense in bud, usually sparse to moderately dense, rarely dense in flower and fruit, those of stem or main floral branches with (20)22-40(56) flowers, with usually two flowers at each node, rarely only one at lowest node; pedicels at lowest node (0.5)0.7-4.0(5.5)mm long, shorter higher up; rachis as for upper parts of axis, but indumentum slightly denser and longer; internodes elongating prior to anthesis; apical bud cluster usually ovoid conical or cylindrical, or narrowly so, usually with apex rounded, rarely acute, initially ca. 2.5-3.5(6.5)mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after first (4)7-14 or more flowers have reached anthesis.

Bracts at lowest nodes similar in shape and indumentum to uppermost leaves, shorter higher up, rarely extending past calyx and then only at lowest 1-2 nodes, with all toothed.

Calyx (3.2)4.2-7.8(8.5)mm long, externally covered by dense, usually short to moderately long, sometimes long, glandular hairs, often mixed on margins with dense moderately long eglandular hairs sometimes extending over outer surface, internally with sparser similar glandular hairs towards tooth apices, with sparse to dense eglandular hairs towards base of teeth and in distal part of tube.

Corolla (9)11-15.5mm long along upper side, "violacea immaculata... faux media immaculata" (Brown, Manuscript, unpubl.: under "E. coerulea"), "violet" (Rodway 893), "bluish" (Evans SYD.), "purple" (Anon. 66), "pale purple, paler on the lobes, interior ... streaked deeper purple" (Pullen 3861), "mauve" (Canning 3084), often with broad whitish patch (drying yellowish) behind lower lobes apparent in dried specimens (e.g. Woolls MEL41494); tube (5)7-9.5(11.5)mm long; hood (2.3)2.8-5.0(6.5)mm long; upper lobes usually obtuse, sometimes truncate or praemorse, with rear surface sometimes with sparse to dense, usually short, rarely long glandular hairs, sometimes with sparse to dense, very short to moderately long eglandular hairs, the indumentum sometimes confined to proximal parts, rarely ± glabrous; lower lip (4)6-10(11)mm long; lower lobes usually obtuse or truncate, sometimes emarginate and then usually shallowly so, externally bearing usually moderately dense to dense, rarely sparse, indumentum of very short to moderately long glandular or eglandular hairs or both.

Stamens with anthers (1.3)1.5-1.9(2.2)mm long; posterior pair of awns (0.1)0.2-0.3(0.4)mm long.

Capsules 5.5-9(13)mm long, in lateral view usually ovate to obovate-elliptic, sometimes narrowly so, rarely ± linear, 2.0-3.3mm broad, in median view ovate to ovate-caudate, sometimes narrowly so, with usually dense, rarely moderately dense setae, 0.1-0.2(0.25)mm long, covering distal $(\frac{1}{4})\frac{1}{3}-\frac{2}{3}$; apex in lateral view acute, obtuse or truncate, sometimes obliquely so; seeds (0)35-80(140); 0.4-0.9(1.0)mm long, 0.2-0.4(0.5)mm broad, ovoid to ellipsoid or oblong, often obliquely so.

Plates: 9

Figures: 19

TYPIFICATION:

Holotype: R.Brown 2724, s.dat. Without locality details. BM. Isotype: R. Brown s.n., s.dat. P[ort] Jackson [inlet]: prope Sydney. frequens. K.

The holotype is in good condition and contains four flowering specimens picked from ground level, with one an entire plant and another comprising many floral branches. Buds, flowers and fruits are present. The isotype consists of three specimens, of which two show branching at ground level. It is in much poorer condition with many leaves lost and only three calyces remaining of what originally must have been three or four complete inflorescences.

The BM specimen is clearly the holotype as it bears the species name in Brown's handwriting, and agrees with the protologue (Brown 1810) in morphology. There seems to be little reason to doubt that the K specimen is isotypic and that Brown's (unpubl.) manuscript description of "E. coerulea" is the basis for the initial diagnostic description (Brown 1810) of E. speciosa. The manuscript description of "E. coerulea" was based on plants collection by Brown at Port Jackson on 14th May 1802. It clearly agrees with the K and BM specimens cited above as well as the protologue of E. speciosa. That it was based on the holotype of the species seems certain as the other seven species described with E. speciosa in Brown's Prodromus (l.c.) had a matching description of type material in the manuscript. This is the only description in the manuscript that could correspond to E. speciosa, as defined by the holotype. If this is so, the K specimen is definitely an isotype, as not only does it come from the locality cited in the manuscript and protologue, but it also was identified by Brown as "E. decussata", a name which Brown initially used in the above manuscript description, but which he subsequently crossed out and replaced with "E. coerulea".

It seems unlikely that the subspecies still survives in the region of Sydney Harbour, the type locality.

DISTRIBUTION (Fig. 19):

E. collina ssp. speciosa is at present known in New South Wales from the Central and Southern Tablelands of Anderson (1961), including the Australian Capital Territory, from the coastal areas between Bulladelah and Jervis Bay, and from the eastern part of the Central Western Slopes (Anderson l.c.) in the region of Mudgee. In Victoria it is represented by several old collections from the eastern part of the western highlands between Ballarat and Heathcote.

The subspecies has been reorded at altitudes from near sea level to 1370m (4500 ft.).

The collections of plants allied to ssp. speciosa (see Note 1) are apparently confined to New South Wales where they occupy a similar range of distribution.

ECOLOGY:

Ssp. speciosa seems to be restricted to montane and lowland habitats. It has been recorded from open Eucalyptus sclerophyll forest or woodland (Barker 1630, Pullen 3861), swampy areas (Barnard 57, Boorman NSW10937) and a "rocky bank above creek" (Constable NSW48942) in montane areas. In the coastal region near Sydney it has been recorded "In sandy soil; rather moist open situation. Geological Form. Hawkesbury Series [? = sandstone]" (Evans SYD). There are no data concerning the Victorian occurrences.

The form related to ssp. speciosa (see Note 1) occupies similar areas. Holford 246 came from "dry sclerophyll forest", while Holford 246, Constable NSW126378 and G. Rodway NSW22269 refer to swampy areas. Briggs NSW65619 and Constable NSW26183 were found on exposed sandstone ridges or hillsides. In coastal areas it occurs in heath (Blaxell & Coveny 593; Gauba 9245,7859). There are several references to soil conditions of sand or sandstone.

Flowering occurs between August and December, although the holotype, collected in May (Brown unpubl.), contains flowers and young fruits. Capsules form from September.

NOTES:

1. Ssp. speciosa is an extreme variant of the polymorphic complex which also encompasses ssp. paludosa and ssp. diversicolor (see E. collina: Note 3). In New South Wales, between the Lithgow area of the Blue Mountains and Jervis Bay, occur plants partially

linking ssp. *speciosa* with ssp. *paludosa*. The most extreme variants in collections of these plants are characterised by glandular hairy upper parts and non-glandular lower parts, subglabrous capsules, and leaves resembling ssp. *paludosa* by their narrower width and usual confinement of teeth to the distal half. Collections of plants such as these may also contain intermediate individuals, some with glandular hairs extending down to the very base, but with subglabrous capsules, others with capsules densely setose in the distal $\frac{1}{3}$ - $\frac{1}{2}$, but with glandular hairs confined to the upper parts. Two collections (Gauba 7859,9245; Constable NSW126378) contain plants resembling ssp. *speciosa* in addition to others with glabrous capsules and a limited glandular indumentum.

The significance of these collections which form a partial intergradation between ssp. *speciosa* and ssp. *paludosa* is indefinite. Further study may show them to be the componenents closest to ssp. *speciosa* of a cline between the two subspecies. As such they may be remnants of an evolutionary link between them. Alternatively they may result from an introgression of characters of ssp. *paludosa* into populations of ssp. *speciosa*. This could explain the apparent lack of a full intergradation between the two subspecies. Pollen sterility tests (Appendix 1: PS181) show no high incidence of sterility in the intermediates. On the other hand the populations from which the collections came may have a stabilised inherent variation in the above characters, and, whatever the past origin of this variation, may now be spatially and genetically independent of populations of ssp. *speciosa* and ssp. *paludosa* to maintain this variation. If further study shows this to be the case, it is suggested that they be recognised as a distinct subspecies of *E. collina*. For this reason they have been included in the key to the subspecies of *E. collina*.

2. The reference to the yellow corolla on a label on the sheet

Anon. 67 in MEL clearly refers to the single fragment of an annual species, possibly E. scabra. Mueller has written a note in disagreement with the yellow colour of the plants of ssp. speciosa constituting the bulk of the collection, saying: "That the flowers are partially purplish is still visible on the dry plant...".

SPECIMENS EXAMINED:

Australian Capital Territory

Barker 1630, 18.i.1972. Brindabella Range. On the Bull's Head-Bendora Dam road, ca. 8km by road from Warks Camp. AD. -- Cambage 3040, 7.xi.1911. Tidbinbilla Queanbeyan. SYD,G(ex NSW). -- Canning 3084, 16.xii.1969. Tidbinbilla Flora & Fauna Reserve. (Lyrebird fire trail, Tidbinbilla Ridge). AD;CBG(n.v.). -- Pullen 3861, 3.x.1963. Between Bulls Head and Bendora Dam, Cotter River District. CANB,NSW102598,BISH,L,A; (n.v.)K,BH,G.

New South Wales

Anderson s.n., 1832. Port Jackson (Nouvelle Hollande). G. -- Anon. 51, s.dat. Without locality. NY. -- Anon. 66, s.dat. Berrima. MEL. -- Anon. 67, s.dat. Berrima. MEL(p.p.). -- Anon. 1[illegible]2, s.dat. Mudgee. MEL. -- Anon. (Voyage du capitaine Baudin) s.n., 1801. Port Jackson. GH(p.p.: ex P). -- Anon. s.n., -.x.1894. Major's Creek. Braidwood. NSW10902. -- Anon. s.n., 3.viii.1953. Port Woolstoncraft, L. Macquarie. NE. -- Anon. s.n., s.dat. Sydney. NY. -- Anon. s.n., s.dat. Sydney. GH(p.p.). -- Anon. s.n., s.dat. P[ort] Jackson. L908227949(ex P). -- Anon. s.n., s.dat. Mudgee. MEL41482. -- Anon. s.n., s.dat. Bathurst. MEL41423. -- Anon. s.n., s.dat. Paramatta. MEL41584. -- Anon. s.n., s.dat. Mudgee. MEL41320. -- Anon. s.n., s.dat. Port Jackson. MEL41429. -- Anon. (U.S. Exploring Exped. under Capt. Wilkes) s.n., s.dat. Without locality. NY. -- Anon. s.n., s.dat. Without locality. AD97012201(p.p.). -- Baeuerlen 215, -.xii.1884. Braidwood District. MEL. -- Barnard 57, -.ix.1941. Sublime Pt. CANB. -- Boorman s.n., -.ix.1899. Barbers Ck. NSW10903. -- Boorman s.n., -.x.1914. Morts Gully Lithgow. NSW10937. -- Bouton s.n., 1890. Lachlan's River. MEL41716. -- Brown 2724, [14.v.1802]. P[ort] Jackson. [Inlet]: prope Sydney. BM(holotype); K. -- Caley s.n., 1799-1810. Sydney. MEL41501,NSW126380. -- Cambage 1363, 1.x.1905. Taralga Road Wombeyan. NSW10905. -- Cleland s.n., -.ix.1911. Bulli Pass. AD97013010. -- Constable s.n., 26.x.1959. Mullions Range State

Forest, 16 miles north of Orange. NSW48942,CHR133331,AK91798. — Cross s.n., 31.viii.1945. Helensburgh. NSW2225. — Evans s.n., -.ix.1925. Engadine, National Park. SYD. — Fletcher s.n., 1.viii. 1888. Waterfall Rd. NSW10908. — Fletcher s.n., 22.ix.1888. Heathcote. NSW10907,BISH. — Fuller 312, -.ix.1926. Engadine. CANB. — Helms s.n., -.x.1900. Blue Mountains. NSW10901(n.v.); AD97123087,L953295334, AD42679,CHR91282; pollen sample A.N.U.,AD. — Ingram s.n., 17.x.1959. Palmers Oakey, NE of Bathurst. NE011828. — Jacobs s.n., 1.x.1949. Lithgow. NSW10936. — Lauterer s.n., -.ix.1885. Hill-End. MEL41767. — McLuckie s.n., -.x.1933. Near Bulli Pass. SYD. — Maiden s.n., 13.viii.1914. National Park. NSW10906. — F.A. Rodway 893, 25.ix.1932. Flats on Naval College Rd. Jervis Bay. NSW22265. — Stephenson s.n., 1844/5 & 6. Within 125 miles of Sydney. G,NY(p.p.). — Woolls s.n., s.dat. Lachlan. MEL41583. — Woolls s.n., s.dat. Mudgee. MEL41493, MEL41492(p.p.). — Woolls s.n., s.dat. Castlereagh. MEL41494. — Woolls s.n., s.dat. North shore Sydney. MEL41582. — Woolls s.n., s.dat. Paramatta. MEL41492(p.p.).

Victoria

Anon. 133, Octob. 7. Mt. Ida. MEL. — Anon. 138, 15.x.1892. Kyneton. MEL. — Anon. s.n., Novr. Mount McIvor. MEL41605. — Clendinning 62, s.dat. Ballarat. MEL. — [Mueller] s.n., s.dat. Austr[alia] felix, MEL41706(p.p.).

Australia: Without specific locality

Anderson 25, s.dat. New Holld. MEL(p.p.). — Caley s.n., s.dat. Nouvelle-Hollande. G. — Cunningham, Anderson and others 27, s.dat. NY,MEL(p.p.). — Graham s.n., s.dat. New Holland. NY. — Hooker s.n., s.dat. N. Holld. NY. — Huegel s.n., s.dat. Australasia subtropics. GH. — [Sieber] 183, 1826. Fl. Novae Holl. MEL,L908227952(p.p.), L908227956,L908227950,G(2 specimens),BM(p.p.). — [Sieber] 507, s.dat. Fl. Novae Holl. L. — Verreaux 50, 1845. Nouvelle Hollande. Cote orientale. L(ex P),G(2 specimens).

Without locality

Anon. 110, s.dat. MEL(p.p.).

SPECIMENS WITH AFFINITIES TO SSP. SPECIOSA:

New South Wales

Anon. s.n., s.dat. Murrumbidgee. MEL41503(p.p.). — Blaxell & Coveny 593, 25.ix.1968. C. 1 mile north of Budgewoi turnoff near Doyalson on Pacific Highway (10 miles NE of Wyong). NSW87001,BISH. — Briggs s.n., 29.viii.1964. 11 miles NNE of Clarence near Natural Bridge. NSW65619. — Cambage s.n., 4.xi.1908. Kybean. AD97123091; NSW10904(n.v.); pollen slide A.N.U.,AD. — Constable s.n., 26.viii.1953. East of Lithgow Railway Waterworks. Newnes Jct. NSW26183. — Constable s.n., 29.vii.1960. Junction of 9 mile Pine Plantation and Bird's Rock Trig roads, Newnes State Forest, ca. 6 miles north-north-east of Lithgow. NSW26378. — Fawcett 55, 1884. Bulladelah. MEL. — Gauba s.n., 19.ix.1956. Jervis Bay, near lighthouse. GAUBA9245,GAUBA7859. — Hamilton s.n., –.ix.1914. Bell. BISH. — Holford 246, 12.ix.1957. Wingello. NSW126379. — Leader s.n., 2.x.1950. Mt. Victoria – Bell. NSW21813. — McGillivray 1, 19.ix.1965. Between Budgewoi and Doyalson. NSW89409. — Maiden s.n., –.ix.1898. Clarence Siding. NSW10912. — G. Rodway s.n., 11.viii.1926. Loddon Falls. S. of Sydney. Head of Cataract River. NSW22269. — F.A. Rodway s.n., 4.ix.1927. Flat to Pacific City. Jervis Bay. NSW22267. — F.A. Rodway s.n., 4.ix.1927. Jervis Bay. K.

1. ssp. osbornii Barker, subspecies nova

[E. osbornii Du Rietz,Sv.Bot.Tidskr.42(1948)359, nom.illeg. (without Latin description and possibly a provisional name); Eichler,Suppl.Black's Fl.S.Austral.(2nd.ed.)(1965)282]

E. collina R.Br.: Benth.,Fl.Austral.4(1868)520,p.p.(as to Mueller MEL41706p.p.,MEL41484p.p.); Black,Fl.S.Austral.(1926)513,p.p.(as to individuals granular [?glandular] hairy on calyx); Robertson in Black,Fl.S.Austral.(2nd.ed.)(1957)772,p.p.(as to individuals granular [?glandular] hairy on calyx and f.1089a,b;?c,d); Eichler,Suppl.Black's Fl.S.Austral.(2nd.ed.)(1965)282,p.p.

[E. brownii FvM.,Fragm.Phyt.Austral.5(1865)88(nom.illeg.), p.p.(as to some S.Austral. occurrences); FvM.,Sec.Syst. Cens.Austral.Pl.1(1889)165,p.p.(as to some S.Austral. occurrences); Tate,Hdbk.Fl.Extratrop.S.Austral.(1890) 153,253,p.p.]

[E. speciosa auct.non R.Br.: Wettst.,Monogr.Gatt.Euphrasia (1896)258,p.p.(as to Osswald FI and probably Behr "Sued-Australien" ?G n.v.); Eichler,Suppl.Black's Fl.S.Austral. (2nd.ed.)(1965)282(as to name only)]

LATIN DIAGNOSIS:

Subspecies nova Euphrasiae collinae, proxima ssp. speciosam indumento glandulosos, capsula dense setosa, foliisque summis multidentatis in axe principali florali, sed differt ramis surculisve semper super terram, plerumque sic multum, pilisque glandulosis a basi plantae saepe absentibus; etiam ssp. trichocalycinae, ssp. gunnii, ssp. deflexifoliaeque similaris indumento glandulosos habituque, sed differt dentibus multis secus multum longitudinis foliorum, seminibus minoribus, corollis maioribus.

Holotypus (tab. 28): W.R. Barker 1346 & R. Short, 12.ix.1971. South Australia. Yorke Peninsula. Ca. 0.8km west of the main Ardrossan-Port Vincent road on track to Curramulka immediately south of and approximately parallel to Mickey Flat Road. AD97138333. Isotypi: 7 distribuendi. Topotypi: W.R. Barker 1729, 15.ix.1972. AD97311321, duobus specimenibus distribuendis. — W.R. Barker 1800, 13.iv.1974. AD97416076.

DESCRIPTION:

Erect perennial herb, woody at base, (13)25-47(60)cm high, with branches erect or rapidly ascending, arising from single erect stem, terminated by inflorescence in first year, dying back to upper branches in subsequent years.

Stem or after first year, main floral branches (8.5) 15-35(45)cm high to base of inflorescence, simple for (1)3-14(32) nodes below inflorescence, i.e. for (0.15)0.3-0.75(0.85) of height from ground level to inflorescence; upper (3)4-7(10) internodes longer than or as long as leaves, the longest internode (1.5)2.0-3.2(4.1) times length of upper leaves, those lower down shorter than leaves; axes in uppermost parts with two rows of dense, eglandular hairs (0.1)0.2(0.3)mm long decurrent between leaf bases, with usually only slightly sparser, rarely sparse eglandular hairs between, mixed all around with usually moderately dense to dense, sometimes sparse glandular hairs (0.1)0.2-0.3(0.45)mm long, with glandular hairs becoming sparser from point (0.15)0.2-0.55(0.95) of the distance from base of inflorescence to ground, absent from point (0.15)0.4-1.0 of same distance below inflorescence, usually absent or very sparse, subsessile to moderately long (0.05-0.2mm), rarely dense or long (0.3mm long) at base of plant, with eglandular hairs sparser and shorter lower down, dense to ± absent, usually very short (0.1mm) at base.

Leaves: Uppermost leaves of stem and main floral branches (5.5)6.5-12.0(21.0)mm long, (3.0)3.5-9.0(11.0)mm broad, ovate or broadly ovate in outline, serrate with sessile gland patches on undersurface often obscure, but when apparent extended over distal 0.8 to entire length of leaf surface, covered by usually dense, rarely moderately dense glandular hairs, 0.1-0.2(0.5)mm long, sometimes mixed with sparse to moderately dense, very short to short scabrous eglandular hairs confined to margins and upper surface base truncate or broadly rounded; teeth (1)3-6(8) along each margin, spread over distal (0.35)0.55-1.0 of leaf, usually blunt, sometimes sharp, usually acute, rarely obtuse, the longest tooth (0.4)0.9-1.7(2.9)mm long; apex (1.1)1.2-2.9(3.3)mm long, (0.8)1.0-1.8(2.3)mm broad, usually blunt, rarely sharp, usually acute, rarely obtuse;

leaves lower down with glandular indumentum sparser from point (0.15)0.25–0.6(0.8) of distance from base of inflorescence to ground, absent from point (0.25)0.6–0.9(1.0) of same distance below inflorescence, with glandular hairs on lowest leaves usually very sparse or absent, rarely dense, 0.1mm long or less, with eglandular hairs usually absent from lower leaves, rarely dense to moderately dense, very short.

Inflorescences racemes, dense in bud, moderately dense to dense in flower and fruit, sometimes with lowest 1–2 nodes more widely spaced, those of stem or main branches with (20)24–56(60) flowers, with usually two flowers at each node, sometimes only one at lowest node; pedicels at lowest node (0.7)1.0–2.7(4.8)mm long, shorter higher up; rachis as for upper parts of axes, but indumentum slightly denser and slightly longer; internodes elongating prior to anthesis but very little after, such that capsules reach up to or past base of calyx above; apical bud cluster usually ovoid to ovoid-cylindrical or narrowly so with rounded apex, rarely conical-cylindrical with acute apex, initially ca. 2.5–3.5mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after first 9–12 or more pairs of flowers have reached anthesis.

Bracts at lowest nodes similar in shape and indumentum to uppermost leaves, shorter higher up, rarely extending past calyx and then only at lower 1–2 nodes, with all rarely except for the very distal ones toothed.

Calyx (4.0)4.6–7.0(7.5)mm long, externally covered by glandular hairs, 0.1–0.25(0.3)mm long, dense on teeth and distal part of tube, often sparse towards base, with eglandular hairs lacking except towards base of tube, internally with similar but sparser glandular indumentum on teeth, often mixed with very short to short eglandular hairs, sparse on teeth, denser on distal part of tube.

Corolla (9.2)13-17.5mm long along upper side, white or pink, purple or lavender, with colour sometimes only on veins and base of tube with rest white, sometimes on lobes and tube with broad white area behind lower lobes, sometimes all over, occasionally also with yellow blotch behind lower lobe; tube (6)9-13mm long; hood 3-5mm long; upper lobes acute, obtuse or shallowly emarginate, with rare surface usually covered by very short to short glandular hairs, very sparse to dense at base, sparser or absent distally, rarely mixed with moderately dense short eglandular hairs; lower lip (4.8)7-10.5(16)mm long; lower lobes usually emarginate or shallowly so, sometimes truncate or obtuse, externally usually bearing short glandular hairs, very sparse, dense in proximal parts, sparser or absent distally, sometimes mixed with short eglandular hairs, rarely with eglandular hairs only.

Stamens with anthers (1.5)1.7-2.2mm long; posterior pair of awns (0.1)0.2-0.4mm long.

Capsules (5.2)6.0-8.0mm long, in lateral view ovate to ovate-elliptic, often obliquely so, sometimes narrowly so, 1.6-2.9mm broad, in median view ovate-caudate, with distal $(\frac{1}{4})\frac{1}{3}$-$\frac{1}{2}(\frac{2}{3})$ covered by dense setae 0.1-0.3mm long, often extending almost to base along lines of dehiscence; apex in lateral view truncate, obtuse or acute, usually obliquely so; seeds (22)66(112), 0.5-0.7 (0.8)mm long, (0.3)0.4-0.5(0.6)mm broad, usually obliquely ellipsoid or broad oblong, sometimes almost spherical.

Plates: 4, 9, 28

Figures: 19

TYPIFICATION:

Holotype (pl. 28): W.R. Barker 1346 & R. Short, 12.ix.1971. South Australia. Yorke Peninsula. Ca. 0.8km west of the main

Ardrossan-Port Vincent road on track to Curramulka immediately south of and approximately parallel to Mickey Flat Road. Red-brown clayey loam with limestone outcropping nearby. In a local but very large population in open flat areas amongst low bushes and shrubs and between mallees of mallee-broombush (*Melaleuca* sp.) community. Corolla lobes white to lilac to lavender to purple; lower side of mouth to deep in throat white but occasionally off-white to yellowish possibly from pollen. Insect pollinator collection from this population in alcohol on previous day (sunny). AD97138333. Isotypes: 7 to be distributed. Topotypes: W.R. Barker 1729, 16.ix.1972. AD97311321; 2 duplicate sheets to be distributed. -- W.R. Barker 1800, 13.iv.1974. AD97416076.

The holotype, isotypes and topotype collection are in excellent condition and consist of buds and flowers but only immature fruits. The holotype and isotypes together contain twenty whole individuals, while the topotype Barker 1729 contains sixteen plants of a somewhat young age. The other topotype contains young seedlings and plants showing regrowth after late summer rains.

The type locality is on private property in several acres of natural scrub surrounded by cleared farming land. There is always a danger that it may be cleared although from the agricultural viewpoint the closeness of the limestone bedrock to the soil surface makes this economically impractical at the present time.

DISTRIBUTION (Fig. 19):

E. collina ssp. *osbornii* is confined to South Australia in the Upper South-East, Fleurieu, Yorke and Eyre Peninsulas and the Flinders Ranges, apparently south of Burra in the Mid-North. Records are notably absent from Kangaroo Island and the southern portions of

Yorke and Eyre Peninsulas even though apparently favourable habitats occur there. There are two doubtful records from Tasmania which are in need of verification (see Note 2).

The subspecies occurs at altitudes from near sea level to 600m.

ECOLOGY:

Ssp. osbornii has been recorded mainly from the mallee (Eucalyptus) scrublands common throughout most of its area of distribution. In the higher parts of the Mount Lofty Ranges it occurs in open areas of heathy shrubs in wet sclerophyll forest (Mr. D.J.E. Whibley, pers. comm. 22.iv.1974). An apparently unique location is at Square Waterhole near Mt. Compass where "plants [are] scattered through ..... a Calorophus swamp" (Chinnock 1342). These plants are apparently an extension of the populations of the "dry stony hills adjoining the swamp" (Tepper 48).

Flowering usually begins in August or October, although June (Eichler 13872) and March (Kaspiew 66) collections of plants beginning to flower have been made. Fruits first appear in October to November.

NOTES:

1. Within ssp. osbornii there is a geographical variation in the colour and coloration of the corolla. Mt. Lofty Range populations are predominantly off-white, although pink tinting sometimes occurs in buds or in the veins of the lobes and at the base of the tube of open corollas. In addition senescent corollas may also deepen in colour. References to pink flowers (Anon. AD97331115, Hunt 3314) probably refer to the colour of the veins described above. Hunt 3280 with "flowers pale heliotrope" may be the only true record of a markedly non-white corolla in the Mt. Lofty Ranges.

In the remainder of the area of distribution of the subspecies on either side of the Mt. Lofty Ranges, corollas are coloured in lilac or mauve or similar shades, with only the lower side of the mouth white. Predominantly white corollas are rare in populations.

The incidence of the yellow nectar guide behind the lowest corolla lobe is also apparently geographically demarcated. In the white-flowered populations of the Mt. Lofty Ranges yellow blotches seem to occur only in the Square Waterhole populations near Mt. Compass (Chinnock 1342; Tepper 48,49) where it apparently occurs in all individuals (Mr. R.J. Chinnock, pers. comm. 9.iv.1974). Among the purplish-flowered populations of the lowland areas, yellow blotches have been recorded only from the eastern plains near Yumali in the Upper South-East of South Australia (Barker 1464; Gooden AD97147041) in a population in which plants with corollas lacking the yellow spots were far more frequent. The occasional slight yellowing of the white patch on the lower side of the corolla in populations near Curramulka on Yorke Peninsula is probably caused by scattered pollen (Barker 1346).

On these bases there is perhaps some justification for recognising several taxa within ssp. osbornii as circumscribed in the current revision. However, because no supporting characters are apparent and since data on corolla colour and the incidence of the yellow nectar guide are generally absent (it is especially difficult to discern the latter from dried specimens), this has not been considered advisable.

The apparent confinement of populations with an incidence of the yellow spot to the eastern side of the Mt. Lofty Ranges may be related to the partial overlap in geographical distribution of at least the more easterly populations with those of ssp. collina, plants of which apparently always possess the yellow blotch in this region. The occurrence of the yellow blotch in these populations may be produced by the introgression into ssp. osbornii of the genes in ssp. collina determining this character or, it may be a product of convergent evolution, perhaps under competition for a common pollinator. There is apparently no breakdown in the other character differences, although there may be an unusually high frequency of many-toothed leaves in populations of ssp. collina in the region.

2. A fragment on Stuart MEL41509 and the specimen Stuart HBG provide the only indication that the subspecies may occur in Tasmania. The former record is doubtful as not only is the specimen mounted with a plant of E. collina ssp. muelleri but there is also on the same lable as the reference to "V.D.L." an additional locality "Ad fluv. Torrens", referring to the River Torrens on which Adelaide, South Australia lies. The known distribution of ssp. muelleri does not help resolve the situation as it is similarly well-represented in South Australia (including the Mt. Lofty Ranges in which the River Torrens rises) and has not been recorded in Tasmania. Whether either taxon occurs in Tasmania must await verification.

3. Two specimens collected by Mueller (MEL41506,MEL41507) from the Lefevre Peninsula, which is the location of Port Adelaide, are of historical interest as they were apparently collected on the day after his arrival in Australia. A collection of a Helichrysum species was also made on that day (M. Willis 1949). However to a specimen of Stenopetalum lineare R.Br. ex DC. goes the distinction of being the first collection made by Mueller on Australian soil (Shaw 1972).

SPECIMENS EXAMINED:

South Australia

Anon. [Herb. J.M.Black] s.n., 10.xi.1879. Hope Valley Scrub. AD97331122. -- Anon. [Herb. Tate] s.n., -.ix.1880. Uley Scrub. AD97119189. -- Anon. [Herb. Tate] s.n., ?1882. Square Waterhole.

AD97119190. -- Anon. s.n., 9.x.1883. Brighton cliffs. AD97119187. Anon. [Herb. J.M.Black] s.n., 1.x.1904. Mt. George nr. Bridgewater. AD97331117(p.p.). -- Anon. [Herb. J.M.Black] s.n., 16.x.1904. Mt. Lofty. AD97331117(p.p.). -- Anon. [Herb J.M. Black] s.n., 6.iii.1907. In gully near Mt. Lofty Rly. Statn. AD97331117(p.p.). -- Anon. [Herb. J.M.Black] s.n., 10.xi.1907. Kangarilla. AD97331115. -- Anon. [Herb. J.M.Black] s.n., -.i.1924. Encounter Bay. AD97331142. -- Anon. [Herb. J.M.Black] s.n., 15.x.1925. Myponga. AD97331131. -- Anon. [Herb. J.M.Black] s.n., 22.xi.1925. Sevenhills. AD97331147, AD97331130. -- Anon. s.n., -.xi.1938. Mt. Compass. A. -- Anon. [Herb. J.M.Black] s.n., Oct. Williamstown. AD97331146. -- Anon. per Pamplin s.n., s.dat. Port Adelaide. K(p.p.). -- Anon. s.n., s.dat. Port Adelaide. K(p.p.). -- Anon. [Herb. Schomburgk] s.n., s.dat. Without locality. AD97012202(p.p.). -- Barker 853, 12.x.1970. Yorke Peninsula. Private land, by a secondary road ca. 1 mile east of the Curramulka-Port Vincent road, ca. 9km south-east of Curramulka. AD. -- Barker 854, 12.x.1970. Locality as for Barker 853. AD; pollen sample A.N.U.,AD. -- Barker 858, 19.x.1970. Range Road, opposite the Parawa No. 2 Fire Depot, ca. 23 miles by road west of Victor Harbour. AD. -- Barker 861, 19.x.1970. On Tunkalilla Road, ca. ½ mile south of Range Road; ca. 24 miles by road west of Victor Harbour. AD. -- Barker 862, 19.x.1970. Locality as for Barker 861. AD. -- Barker 863, 19.x.1970. On Tunkalilla Road, ca. ¾ mile south of Range Road; ca. 24 miles by road west of Victor Harbour. AD. -- Barker 864, 19.x.1970. Locality as for Barker 863. AD. -- Barker 869, 19.x.1970. On Tunkalilla Road, ca. 1¼ miles south of Range Road; ca. 24 miles by road west of Victor Harbour. AD. -- Barker 873, 19.x.1970. On Tunkalilla Road, ca. 1½ miles south of Range Road; ca 24 miles by road west of Victor Harbour. AD. -- Barker 1346 and Short, 12.ix.1971. Ca. 0.8km west of the main Ardrossan-Port Vincent road on track to Curramulka immediately south and approximately parallel to Mickey Flat Road. AD(holotype). -- Barker 1463, 21.xi. 1971. Upper South East: Ca. 12km W of Yumali on the Yumali-Meningie road; extensive scrub back from the road, surrounding the Wakefields' home. AD. -- Barker 1464, 21.xi.1971. Locality as for Barker 1463. AD. -- Barker 1729, 16.ix.1972. Locality as for Barker 1346. AD (topotype). -- Barker 1800, 13.iv.1974. Locality as for Barker 1346. AD(topotype). -- Behr s.n., Dec. Without locality. MEL41581. -- Beythien 107, 24.viii.1888. Moonta. MEL41722. -- Blandowsky 86, 1850. In via a Port Adelaide ad Hahnendorf. MEL41411. -- Blandowsky 86, mis. 1850. Carromondal [Coromandel] Valley an der Sturdt [Sturt].

MEL41639. -- Blandowsky 86, mis. 1850. Gegend von Macclesfield. MEL41640(p.p.). -- Blaylock 277, 8.x.1966. Section 141, Hundred of Ramsay. AD. -- Blaylock 1629, 10.x.1970. Hundred of Ramsay, Section 176 (Hundred of Ramsay is ca. 15km east-south-east of Minlaton). AD. -- Brummitt s.n., 4.xi.1892. Clare. AD95811014. -- Chinnock 1342, 13.x.1973. Square Water Hole, 3km south of Mt. Compass. AD. -- Cleland s.n., 1898. Near Adelaide. NSW10891. -- Cleland s.n., 30.x.1921. Mt. Compass AD97119077. -- Cleland s.n., 3.xi.1923. Encounter Bay. AD97119094. -- Cleland s.n., -.i.1924. Hills above Upper Hindmarsh. Encounter Bay. AD97119094. -- Cleland s.n., 28.x.1934. Back Valley near Encounter Bay (South Coast). AD97119079. -- Cleland s.n., 26.x.1946. Uraidla. AD97119078. -- Cleland s.n., 9.xi.1967. Eric Bonython Wildlife Reserve (near Tunkalilla Beach). AD96830269. -- Cleland s.n., 1923. Without locality. AD97119076. -- Cooper s.n., 11.x.1942. 4 miles S.E. of Mt. Compass. AD966030406. -- Cooper s.n., 3.x.1943. Taperoo. AD966081262. -- Cooper s.n., 11.x.1943. 5 miles North of Tunkalilla. AD966081313. -- Copley 4150, 6.x.1973. At north end of Voigt's Road, S.E. of Minlaton. AD. -- Eichler 13872, 30.vi.1957. Square Waterhole (ca. 2.5km south of Mt. Compass). AD. -- Eichler 14452, 16.xi.1957. Between Cape Jervis and Victor Harbour. Near Tunkalilla Road, ca. 3$\frac{3}{4}$ km north of the sea coast on roadside on ridge running from SW to NE. AD. -- Fowler s.n., s.dat. Yorke's Peninsula. MEL41480. -- Gemmell 78, 28.ix.1967. Macclesfield cemetery. AD. -- Gemmell 241, 20.x.1971. Macclesfield cemetery. AD. -- Gill 116, -.ix.1890. Near Kapunda. MEL. -- Gill s.n., 1900. Ranges nr Clarendon. NSW10894. -- Gooden s.n., Early Nov. 1971. Yumali-Meningie Rd., 35 miles S. of Tailem Bend. AD97147040,AD97147041. -- G[riffith] s.n., 23.xii.1906. Port Victor [Victor Harbour]. AD97331116. -- G[riffith] s.n., 11.ix.1907. Goolwa. AD97331117(p.p.). -- Hilton 413, 25.xi.1953. Hillside above Tunkalilla Creek (Southern Adelaide Hills). ADW. -- Hilton 952, 9.x. 1954. Square Water Hole, near Mt. Compass, Adelaide Hills. ADW. -- [Hinteraecker] 5, s.dat. Burra Burra. MEL. -- Howard s.n., 12.x.1959. Between Heathfield and Upper Stuart. AD966061295. -- Hunt 2449, 7.ix.1965. In swamp near Mt. Compass. AD. -- Hunt 3011, 4.ix.1969. Range Rd. 10 miles from Victor Harbour. AD. -- Hunt 3058, 11.x.1969. In scrub at Nangkita. AD. -- Hunt 3280, 25.ix.1970. Along 2-3 miles Tunkalilla Rd. AD. -- Hunt 3314, 21.x.1970. Range Rd. 2 miles S. of Tunkalilla. AD. -- Hunt 3315, 21.x.1970. Range Rd., 2 miles S. of Tunkalilla turn-off. AD. -- Hussey s.n., 1893. Port Elliot. MEL 41738. -- Ising s.n., 26.x.1960. Heather Rd., Mt. Lofty. AD96220070.

-- Kaspiew 40, 5.ix.-. Adelaide. NY. -- Kaspiew 66, 20.iii.-. Mt. Compass. NY. -- Lea s.n., 29.ix.-. Mount Lofty. BM(p.p.). -- Lothian 991, 9.x.1961. Stansbury scrub, Minlaton Road-turn, 10 miles north of Stansbury. AD. -- McDonald 19, s.dat. Crafers. MEL. -- Maiden s.n., -.i.1907. Aldgate. NSW24518. -- [Malpas] per Blandowsky 88, mis 1850. Port Adelaide ad Rapide Bay. MEL. -- Menzel s.n., -.ix.1896. Mt. Lofty Ranges. AD97119191. -- M[ueller] s.n., 16.xii.1847. In paeninsula Levevre. MEL41506. -- M[ueller] s.n., -.xii.1847. In peninsula Levevre. MEL41507. -- [Mueller] s.n., 2.iii.1848. Mt. Lofty Range. MEL41496. -- Mueller s.n., 1854. Nov. Holl. meridional. Murray. G. -- Mueller s.n., s.dat. Nov. Holl. meridional. Fiedler's Section. FI. -- Mueller s.n., s.dat. Tanunda. HBG(p.p.). -- Mueller s.n., s.dat. Without locality. MEL41515(p.p.). -- Osswald s.n., 1848. Tanunda. FI. -- Quinn s.n., c. 6.x.1969. Stansbury Scrub, ca. 10km east-south-east of Minlaton. AD96942021. -- Quinn s.n., 12.x.1969. Stansbury Scrub, ca. 10km east of Minlaton, ca. 1km south of main Minlaton [road] on back track. AD96950035,L (n.v.). -- Short, Short & Grubb 2, 17.xi.1970. 4mi S.E. of Curramulka off the Curramulka-Port Vincent road on a N.S. running road about 1mi. AD. -- Staer s.n., -.iii.1911. Aldgate. NSW10892. -- Tepper 48, 6/7.i.1882. Square Waterhole. MEL. -- Tepper 49, 6/7.i.1882. Square Waterhole. MEL41772(p.p.). -- Tepper 61, 1881. Near Mt. Lofty. MEL. -- Tepper 10[6], 1879. Yorke Peninsula. MEL. -- Tepper 374, 1879. Yorke Peninsula. MEL. -- Tepper 1150, 2.xi.1883. Magill, Mt. Lofty. MEL. -- T[epper] s.n., -.xi.1879. Ardrossan. AD97331123 [Herb. J.M. Black]. -- T[epper] s.n., -.xi.1879. Ardrossan. AD97331123. -- Tepper s.n., 1879. Yorke Peninsula. MEL41716. -- Tepper s.n., 1882. Clarendon. MEL41770. -- Tepper s.n., s.dat. Clarendon. MEL41772(p.p.). -- Todd s.n., -.xi.1902. Blackwood, Mt. Lofty Range. NSW10893,BISH. -- C.D.U. s.n., 16.x.1929. Mt. Compass. ADW1909. -- Warburton s.n., 1859. Venus Bay. MEL41406. -- Whibley 1278, 13.x.1963. Ca. 20km towards Victor Harbour, from Cape Jervis turnoff. AD. -- Whibley 1507, 20.x.1964. Scott's Creek. AD. -- Whibley 1559, 1.xii.1964. Uraidla. AD. -- Whibley 4155, 11.x.1973. Ca. 1km south-east of Uraidla on road to Carey's Gully. (Same locality as Whibley 1559). AD. -- Whittaker s.n., s.dat. Encounter Bay. K. -- Wilhelmi s.n., s.dat. Lofty ranges. HBG.

Australia. Without locality or locality unknown

Cunningham or Anderson and others 400, s.dat. MEL41676 (p.p.).

Without locality

Anon. [Herb. Tate] s.n., 1870. AD97119188. —— Anon. [Herb. J.M. Black] s.n., -.x.1882. AD97331124(p.p.). —— Anon. s.n., s.dat. AD97012218. —— Anon. [Herb. Buek] s.n., s.dat. HBG. —— Anon. [Herb. J.M.Black] s.n., s.dat. AD97331124.

Locality doubtful

Mueller s.n. Any one of three possible localities: Bethanien [Bethany]. s.dat. / Apud pag[um] german[um] [Probably Bethany]. -.ix.1848. In montibus Flinders range. -.x.1851. MEL 41484(p.p.). —— Stuart s.n., Either of two localities: Ad fluv. Torrens. Octobr.....?1847. / V.D.L. [Van Diemens Land]. ?1847. MEL41509(p.p.). —— Stuart s.n., s.dat. Vandimensland. HBG.

m. ssp. diversicolor Barker, subspecies nova

E. collina R.Br.: Costin & Wimbush in Murray,Alp.Fl.Kosc. State Park(1962)t.11(col.)

?E. brownii FvM. var. alpina (R.Br.)Maiden & Betche,Cens. N.S.W.Pl.(1916)184

[E. glacialis auct. non Wettst.: Ashby,S.Austral.Mus.Ser. (?1964)Card 57(t.col.,based on Ashby 858); Mass,Austral. Wildfl.Magic (1967)276,277(t.)p.p.(as to plate and text, but excl. "snowpatch form"); Willis,Muelleria 1(1967) 147,p.p.(as to "typical form" of species on Kosciusko Plateau, excl. var. eglandulosa); Child,Austral.Alp.Life (1969)41,p.p.(as to "large clumps over a foot high in fertile meadows"); Harris,Alp.Pl.Austral.(1970)138,t. col.,p.p.(as to some N.S.W. occurrences and plate, but excl. var. eglandulosa); Morcombe & Morcombe,Wildfl. East Coast (1970)64,p.p.(as to colour plate and text, but excl. "rather stunted" form)]

?E. striata auct. non R.Br.: FvM.,Fragm.Phyt.Austral.5(1865) 89,p.p.(as to Mueller MEL41538); Benth.,Fl.Austral.4(1868) 521,p.p.(as to Mueller MEL41538)

?[E. alpina auct. non R.Br.: Benth., Fl. Austral. 4(1868) 521, p.p. (as to Mueller MEL41546)

LATIN DIAGNOSIS:

Subspecies nova Euphrasiae collinae proxima ssp. speciosam et ssp. lapidosam indumento glanduloso longo in partibus superis, ramificatione solum prope terram, foliisque plerumque multi-dentatis, sed a duabus differt seminibus maioribus antherisque maioribus; etiam differt a ssp. speciosa aristis postremis antherarum longioribus, partibus inferis saepe non-glandulosis, capsulisque interdum glabris, et a ssp. lapidosa internodiis longioribus in partibus superis, quorum internodium longissimum bis longitudine foliorum maius est, altitudine maiore, basique foliorum latiore.

Holotypus (tab. 29): W.R. Barker 1684, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit; on slope below and ca. 50m N of Seamans Hut, along snowpole line to Lake Albina. AD97221170. Isotypi: 6 distribuendi.

DESCRIPTION:

Erect perennial herb, (10)15-30(45)cm tall, with stem reduced, or erect or ascending and flowering in first year, then dying back to ground, with many densely crowded ascending branches arising from base of stem or prostrate parts of other branches, rarely (except when in sphagnum bogs) rooting in proximal regions of prostrate parts.

Stem, if erect and flowering, or main floral branches (8)12-25(30)cm high to base of inflorescence, simple above ground level, i.e. for (11)13-28(33) nodes below inflorescence; upper (2)4-8(13) internodes longer than or as long as upper leaves, the longest internode (1.8)2.2-4.0(4.3) times length of upper leaves; axes in upper parts bearing two rows or four lines of dense, short to long eglandular hairs, sometimes with sparse eglandular hairs between, usually mixed all around with sparse to dense, short to very long glandular hairs, lower down with sparser, shorter eglandular hairs, with glandular hairs lacking.

Leaves: uppermost leaves of stem or main floral branches (5)8-12(17)mm long, (3.5)5-10(13)mm broad, usually ovate-elliptic to obovate-elliptic, usually broadly so, sometimes ovate or broadly ovate, with sessile glands confined to distal (0.55)0.75-0.95 of lower side, with marginal rows of glands along either side of apex and proximal side of each tooth with lateral branches which are finally directed towards leaf base and usually reach level of upper side of base of tooth below, otherwise usually covered by usually moderately dense to dense, sometimes sparse, short to moderately long glandular hairs, with margins and upper surface, sometimes also lower surface, covered by sparse to dense, short to long woolly eglandular hairs, sometimes ± glabrous; base usually rounded, sometimes truncate or rounded-cuneate, rarely cuneate; teeth (1)2-4(6) along each margin, confined to distal (0.25)0.4-0.8(0.85) of leaf, the longest tooth (0.9)1.1-2.4(3.0)mm long, usually bluntly or sharply acuminate or acute, rarely bluntly obtuse; apex (1.3)2.0-4.0(6.0)mm long, (1.4)2.5-4.0(6.5)mm broad, usually blunt, rarely sharp, usually acuminate or broadly so, to acute, sometimes obtuse or broadly so; leaves lower down with sparser shorter indumentum, at base usually glabrous, rarely with sparse short woolly eglandular hairs lining margins.

Inflorescences racemes, dense in bud flower and fruit, except sometimes for wider-spaced lower 1(3) nodes, with (6)12-22(26) flowers; pedicels at lowest node (1.4)1.5-3.0(6.2)mm long, shorter higher up; rachis with indumentum similar to uppermost parts of axis or slightly denser, longer; internodes elongating prior to anthesis such that capsules reach to or past base of calyx above; apical bud cluster ± spherical to conical-ovoid, sometimes broadly so, initially ca. 1.0-2.5mm long, becoming hidden by or hardly emergent from corollas of uppermost flower pair after flowers at first 1-4(6) nodes have reached anthesis.

Bracts covered by dense mixture of glandular and woolly eglandular hairs, at lower nodes similar in shape, size and indumentum to uppermost leaves, shorter than or equal to calyx except rarely at lowest node, toothed at all nodes.

Calyx (5.8)6.0-9.8(12.0)mm long, externally covered by dense, usually moderately long, sometimes short, long or very long glandular hairs, extending also onto inner surface of teeth, mixed with long to very long, woolly eglandular hairs, dense on margins and inner surface of teeth, sparse to dense and often shorter on outer surface.

Corolla (9)11-16(17)mm long along upper side, white or "pale" (Burbidge 3938,3945), or purple-violet, mauve, pink or lilac often with colour confined to lobes, with tube and area behind lower lobes white, with yellow blotch behind lowest lobe, often large and extending behind lateral lobes and coextensive with yellow blotches in tube at base of anterior filaments; tube (6.5)7.5-11(12)mm long; hood (3.0)3.5-5.3(5.5)mm long; upper lobes usually obtuse, sometimes truncate, rarely shallowly emarginate, often praemorsely so, with rear surface ± glabrous but for short, moderately dense glandular hairs at base; lower lip (7)8-12(13)mm long, externally covered by a mixture of short glandular and short to moderately long eglandular hairs, extending well out onto lobes, denser or lateral ones; lower lobes usually truncate to shallowly emarginate, sometimes obtuse or emarginate.

Stamens with anthers (1.7)2.0-2.6(3.0)mm long with connectives surrounded by usually dense, rarely moderately long to very long flexuose eglandular hairs; posterior pair of awns (0.25)0.3-0.5(0.6)mm long.

Capsules (6.3)7.5-10.5(13.3)mm long, in lateral view elliptic to ovate-elliptic, sometimes broadly so or somewhat caudate, (2.6)3.0-4.0mm broad, in median view ovate- to elliptic-acuminate, sometimes narrowly so, glabrous or with a few to moderately dense setae, 0.1-0.2mm long or less, confined to apex or upper $\frac{1}{4}$; apex in lateral view usually shallowly emarginate or truncate to obtuse, sometimes obliquely so, rarely acuminate; seeds (18)41(71), (0.9)1.1-1.7(1.9)mm long, 0.5-0.8(1.1)mm broad, obliquely ovoid to ellipsoid or oblong, sometimes flattened or broadly so.

Plates: 4, 10, 29

Figures: 20

TYPIFICATION:

Holotype (pl. 29): W.R. Barker 1684, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit; on slope below and ca. 50m N of Seamans Hut, along snowpole line to Lake Albina. Tall alpine herbfield; Euphrasia-Celmisia-Poa (tussock grass) -dominated. Altitude ca. 6600 feet (2000m). Corollas large, white to lilac to deep lilac with white mouth; with yellow areas on lower side of mouth, often very broad and extending behind lateral lobes, and deep in throat about the join of the filaments where often very prominent and joined with the former areas. Very widespread and prolific population. AD97221170. Isotypes: 6 duplicates to be distributed.

The type collection is in good condition and consists of nine more or less entire plants, seven groups of floral branches picked from ground level and a few smaller fragments. Flowers and buds predominate, but nearly mature capsules are also present mostly on the holotype sheet.

The subspecies flourishes in the type locality and is in little danger as it lies within a National Park.

DISTRIBUTION (Fig. 20):

E. collina ssp. diversicolor is endemic to the alpine and subalpine zones of the Snowy Mountains of south-eastern New South Wales. The subspecies is apparently absent from the subalpine zone on the summitt of the Brindabella Range even though it occurs on the lower-lying northward extension of the Snowy Mountains which reaches the base of these mountains (see Note 4). The absence of typical forms of ssp. diversicolor from the Gibbo-Pinnibar-Pilot-Cobberas mountain system has probably stemmed from the lack of botanical collecting in the area although a closely-related but divergent form from the Cobberas indicates that it is possibly absent from at least some alpine areas in the region (see Note 2).

The subspecies has been recorded from altitudes of about 1370m up to the summit of Mt. Kosciusko at 2230m.

ECOLOGY:

The subspecies is very common in alpine regions, where it abounds in the "*Celmisia longifolia-**Poa caespitosa alliance" or "tall alpine herbifield" of Costin (1954). It apparently does not occur in the "**Poa caespitosa-Danthonia nudiflora alliance" or "sod tussock grassland" (Costin 1954) of the Kosciusko region. References to "alpine grassland" on Burbidge 3929,3934 of "grassy slopes" on Burbidge 3944 probably refer to tall alpine herbfield. The subspecies is also found where tall alpine herbfield occurs

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* Given (1969) places the Snowy Mountains populations in Celmisia asteliifolia Hook.f.

** "Poa caespitosa" is now recognised to encompass many distinct, but closely related species, of which several occur in the Australian Alps (Vickery 1970).

below the tree-line, for example at the Spencers Creek crossing on the Kosciusko summit road (Barker 1703). Other alpine records from probably distinct vegetation types are "Grassland and Phebalium shrub area" (McVean CANB), "Damp water course with low shrubs, sphagnum etc." (Burbidge 3935,3938).

In subalpine regions ssp. diversicolor is less common and is generally found associated with the surrounds of sphagnum bogs (Barker 1677,1679,1683,1691,1692,1694,1698,1701,1702). Populations from bogs at higher elevations show some morphological divergence from the tall alpine herbfield forms (see Note 3). Barker 1663, the northernmost record of the subspecies, was found growing in a small distinctive area of herbfield within the surrounding sod tussock grasslands of its subalpine locality. The subspecies seems to be completely absent from the wide-spread sod tussock grasslands which are the principal subalpine habitat of ssp. paludosa in the Snowy Mountains.

Flowering occurs mainly between the start of December and the middle of February, although flowering specimens have been collected as early as September 1st (Stead NSW64341) and as late as the end of March (Wimbush COOMA). Mature fruits are evident at the start of January.

NOTES:

1. Ssp diversicolor is sympatric with ssp. glacialis, ssp. lapidosa and ssp. paludosa in parts of its range. It retains its morphological and ecological differences, except in the case of ecotonal intergradation into ssp. glacialis and a single instance of hybridization with ssp. paludosa (see E. collina: Intraspecific Variation).

2. Ssp. diversicolor is an extreme of a polymorphic complex which encompasses ssp. paludosa and ssp. speciosa. The overall complex

is discussed under E. collina: Note 3.

Plants of this complex collected from The Cobberas, which lies immediately south of the range of distribution of ssp. diversicolor, are clearly allied with the subspecies by their broad leaves with truncate to rounded leaf bases (see pl. 10) their extensive glandular indumentum, their basally branched habit, their subglabrous capsules and their yellow-blotched corollas. However they diverge from ssp. diversicolor by the shorter glandular indumentum, 0.05-0.1(0.2)mm long, which seems to extend always to the base of the plant, and the usual absence of long woolly eglandular hairs lining the bracts, leaves and calyces. The Colleras populations have been recorded only from subalpine snow-gum woodland, a habitat from which ssp. diversicolor is not known.

It is probable that populations related to either or both ssp. diversicolor and The Cobberas plants occur elsewhere in the Gibbo-Pinnibar-Pilot-Cobberas mountain system. In this region only The Cobberas appear to have been significantly botanised, and these mountains have a very limited alpine zone (Costin 1957b). Wider expanses of alpine herbfield, which are potential habitats for ssp. diversicolor, occur on Mt. Pinnibar (Costin 1957a) and apparently The Pilot (Costin 1954: from fig. 31). Until extensive collections are made in these regions it is not clear whether The Cobberas populations belong to a distinct subspecies or represent a sub-alpine extension of the typically alpine ssp. diversicolor with morphological differences mainly induced by the different environment.

3. Populations from tall alpine herbfields in the Kosciusko area and the higher mountains to the north are characterized by large, broad leaves, often broadest near the base and often with bluntish-tipped teeth and apices (pl.   : Barker 1684,1703,1704), long calyces and long corollas with long broad lower lips.

Plants found growing in sphagnum bogs in the higher areas about Kosciusko have smaller leaves with typical teeth and apices but with less truncate bases (pl. 10 : Barker 1701) and flowers which tend to be smaller with narrower lower corolla lobes. The plants often set less fruit, and the roots and lower branches, which are encased in sphagnum, are very slender. Such bogs occur at Spencers Creek near the Mt. Kosciusko road. The plants growing in the bog area but not within the sphagnum itself (Barker 1702: pl. 10) have uppermost leaves more similar to those of plants within the sphagnum (Barker 1701: pl. 10) than those of plants within the close-by tall alpine herbfield (pl. 10 : Barker 1703). However their root system and leafy lower parts of branches resemble the latter.

In the watersheds of the lower altitudes to the north where tussock grasslands mainly replace the herbfields of the higher regions, plants of ssp. diversicolor are usually associated with sphagnum bogs, although they do not grow within the sphagnum. These plants (e.g. Barker 1677: pl. 10) tend to be intermediate between the sphagnum and herbfield forms of the Kosciusko region in leaf and floral characters. Further study is required to determine the nature of this variation. It is likely that the plants growing in sphagnum are depauperate members of the herbfield populations.

4. Whereas the absence of ssp. diversicolor from the Gibbo-Pinnibar-Pilot-Cobberas mountains immediately south of its known area of distribution may result from the general lack of collections from the area (see Note 2), its absence from the much-botanised Brindabella Range on the north-east perimeter of the range of distribution is probably real. The Brindabella Range rises to an altitude of about 1900m, which is well above the elevations of the nearest population of ssp. diversicolor (Barker 1663) occurring

in subalpine herbfield (see Ecology) at about 1370m altitude and about 15km west of Mt. Bimberi and 7km from the nearest spurs of the range. The range lacks a true alpine zone (Lang 1970: fig. 5) but is topped by extensive areas of subalpine snowgum woodland in which some sphagnum bogs occur. That ssp. diversicolor has never been recorded from these bogs, while it occurs predominantly in such habitats on the subalpine plains below and to the south and east, can possibly be explained by any of the following hypotheses.

a. The bogs of the Brindabella Range are unsuitable for colonisation by ssp. diversicolor. (This could be tested by transplant experiments.)

b. The bogs are not extensive enough to have housed with certainty relict populations of the subspecies which may have been widespread in the area during Pleistocene glaciations.

c. Such subalpine bog populations in order to survive, require replenishment of seed (via the watershed) from self-sufficient alpine populations, which do not exist in the Brindabella Range.

d. Seed cannot be dispersed against gravity from the populations on the plains below up the mountain slopes across the presumably effective migratory barriers of montane forest and subalpine woodland.

5. The sheet MEL41549 bears three specimens of ssp. diversicolor mounted together with Mueller's label "Mount Hotham". Mueller's Mount Hotham is apparently the present-day Mt. Feathertop (Carr 1962). The subspecies has not been recorded west of The Cobberas and, unless verified by new collections, its presence in the Bogong-Feathertop area of the Victorian Alps must be considered unlikely.

6. The specimen Mueller MEL41419, alleged to have come from St. Vincents Gulf in South Australia, clearly belongs to ssp. diversicolor and cannot be confused with any of the South Australian taxa. The locality information is undoubtedly incorrect.

SPECIMENS EXAMINED:

New South Wales

Anon. s.n., s.dat. Sum[mi]t Kos[ciusko]. MEL41542(p.p.). -- Anon. (Herb. Tate) s.n., s.dat. On summit of Mt. Kosciusko. AD97119192. -- Ashby 858, 14.i.1964. Charlotte Pass, near Mt. Kosciusko. AD. -- Ashby 3757, 16.ii.1971. Mt. Kosciusko, on north-eastern slope. AD. -- Ashby 4424, 1.xii.1971. Boggy Plain which is east of Tantangara Mt., which is near Kiandra. AD. -- [Baeuerlen] s.n., -.ii.1890. Mnt. Kosciusko. NSW10858. -- Barker 1663, 21.i.1972. Kosciusko National Park. Long Plain, which is along the E side of The Fiery Range, ca. 16km NNE of Rules Point. AD. -- Barker 1665, 22.i.1972. Kosciusko National Park. SE end of Toolong Range; on the southern side of Mt. Jagungal, ca. 70m below and ca. ½km S of the summit. AD. -- Barker 1668(p.p.), 22.i.1972. Kosciusko National Park. SE end of Toolong Range; on top of southern ridge of Mt. Jagungal, ca. 50m below and ca. ½km S of summit. AD. -- Barker 1677, 22.i.1972. Kosciusko National Park. Toolong Range; on the Grey Mare Trail between Round Mt. & Mt. Jagungal, ca. 3km NW of the intersection with the track to Happy Jacks. AD. -- Barker 1679, 23.i.1972. Kosciusko National Park. Beside Kiandra Creek, ca. 8km N of Kiandra. AD. -- Barker 1683, 24.i.1972. Kosciusko National Park. Ca. 100m E of the top of Dead Horse Gap at the headwaters of the Crackenback River. AD. -- Barker 1684, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit; on slope below and ca. 50m N of Seamans Hut, along snowpole line to Lake Albina. AD(holotype). -- Barker 1686, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit; on valley below and ca. 400m NW of Seamans Hut, along snowpole line to Lake Albina. AD. -- Barker 1691, 26.i.1972. Kosciusko National Park. Ca. ½km E of The Smiggin Holes, ca. 50m S of bridge acorss Pipers Creek. AD. -- Barker 1692, 26.i.1972. Kosciusko National Park. Ca. ½km E of The Smiggin Holes, ca. 100m S and ca. 30m above bridge across Pipers Creek. AD. -- Barker 1694, 26.i.1972. Kosciusko National Park. Perisher Valley; near the bridge acorss Perisher Creek on the North Perisher Road. AD. -- Barker 1698, 26.i.1972. Kosciusko National Park. Ca. 50m N of bridge across Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1699, 26.i.1972. Kosciusko National Park. Ca. 50m NW of bridge acorss Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1701, Kosciusko National Park. Ca. 50m S of bridge across Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1702, 27.i.1972. Kosciusko National Park. Ca. 50m S of bridge acorss Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1703, 27.i.1972. Kosciusko National Park. Ca. 50m S of bridge acorss Spencers Creek on Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Barker 1704, 27.i.1972. Kosciusko National Park. On top of Etheridge Range, ca. ½km W of Seamans Hut, ca. 1½km E of Mt. Kosciusko summit; above large quarry by Kosciusko Summit Road. AD. -- Barker 1709(p.p.), 27.i.1972. Kosciusko National Park. Ca. 2km NE of Mt. Kosciusko summit; in the second valley ca. 1km NW of Seamans Hut along snowpole line to Lake Albina. AD(p.p.). -- Barker 1711(p.p.), 27.i.1972. Kosciusko National Park. Ca. 2km NE of Mt. Kosciusko summit; ca. 1km N of Seamans Hut along snowpole line to Lake Albina; at bottom of valley immediately [illegible] of Mt. Northcote. AD(p.p.). -- Barker 1713, 27.i.1972. As for Barker 1711. AD. -- Barker 1715, 27.i.1972. Kosciusko National Park. Ca. 2km N of Seamans Hut along the snowpole line to Lake Albina; ca. 2½km NE of Mt. Kosciusko summit. AD. -- Beadle & Smith-White s.n., -.i.1942. Kosciusko. SYD(p.p.). -- Belcher 1043, 20.xii.1967. Charlottes Pass, six metres from summit of Mt. Kosciusko. MEL. -- Boyce s.n., 30.i.195-. Mt. Kosciusko (summit). AD97123082. NSW10850(n.v.). -- Brooker B1067, 12.ii.1966. Summit. Mt. Kosciusko. GAUBA. -- Brough s.n., -.ii.1927. Kosciusko. SYD. -- Brough 2737, -.i.1928. Kosciusko. CANB. -- Burbidge 3929, 24.ii.1955. Snowy River corssing, Mt. Kosciusko. CANB. -- Burbidge 3934, 24.ii.1955. Mt. Kosciusko, near summit. CANB. -- Burbidge 3935, 24.ii.1955. Mt. Kosciusko, near summit. CANB. -- Burbidge 3938, 24.ii.1955. Mt. Kosciusko, near summit. CANB. -- Burbidge 3944, 24.ii.1955. Near col below Mt. Kosciusko summit. CANB. -- Burbidge 3945, 24.ii.1955. Above Mt. Charlotte Pass. CANB. -- Burbidge 3946, 24.ii.1955. Piper's Gap. Mt. Kosciusko. CANB. -- Burbidge 6302, 17.ii.1959. Piper's Gap. CANB. -- Burbidge 6310, 17.ii.1959. Carruthers Track, Mt. Kosciusko. CANB. -- Carroll 154, 17.i.1966. Happy Jack's Plain, Snowy Mountains. 2 miles along Happy Jacks Road from Grey Mare Track. CBG. -- Collins s.n., 1915. Mt. Kosciusko. CANB. -- Collins s.n., 1952. Kosciusko District.

NSW21819. -- Eichler 13462, 24.i.1957. Near Bett's Creek south of The Paralyser. AD. -- Eichler 17839, 26.i.1964. Ramshead Range; above Chair Lift north-west of Thredbo Village; upper part of Merrit's Spur. AD. -- Forsyth s.n., 23.i.1899. Mt. Kosciusko. NSW10860. -- Forsyth s.n., -.xii.1901. Kiandra District. B(p.p.), G(p.p.). -- Gauba & Pryor s.n., 8.i.1950. Mt. Kosciusko. GAUBA. -- Gittins 433, -.i.1962. The Kerries. NSW102594. Gray & Totterdell 6098, 16.i.1968. Mt. Kosciusko-Lake Albina track. CANB. -- Gray & Totterdell 6190, 13.ii.1968. Mt. Kosciusko. Below summit. CANB. -- Gray & Totterdell 6330, 20.ii.1969. Mt. Kosciusko-Lake Albina track. CANB. -- Gray & Totterdell 6339, 19.ii.1969. Near Kangaroo Range, between Snowy R. and summit road, Mt. Kosciusko. CANB. -- Gray & Totterdell 6393, 6.iii.1969. Mt. Kosciusko. CANB. -- Gray & Totterdell 6522, 7.i.1972. Rawson Pass, Kosciusko area. CANB. -- Gray & Totterdell 6558, 27.i.1972. Mt. Etheridge, Kosciusko area. CANB. -- Gray & Todderdell 6570, 19.ii.1972. Near Lake Cootapatamba, Mt. Kosciusko. CANB. -- Harris 36, -.i.1930. Mt. Kosciusko. NSW10849. -- Helms 50, -.xi.1901. Pretty Point, Mt. Kosciusko. NSW10848. -- Johnson & Constable s.n.(p.p.), 18.i.1951. Charlotte Pass. Kosciusko. NSW15760(n.v.);CHR72349(p.p.),G(p.p.). -- Johnson & Constable s.n., 20.i.1951. Mt. Kosciusko (below summit). NSW15736,G.CHR72346. -- Johnson & Constable s.n., 20.i.1951. Club Lake, Mt. Kosciusko. -- Kaspiew 1365, 23.xii.1953. Mt. Kosciusko. B. -- Kaspiew 1366, 23.xii.1953. Mt. Kosciusko. B. -- Lawson s.n., 15.ii.1924. Kosciusko. SYD. -- Lindenfeld s.n., -.i.1885. Mt. Kosciusko. MEL41733. -- McLuckie & Petrie s.n., -.i.1925. Mt. Kosciusko. SYD. -- McVean s.n., -.xii.1966. Mueller's Peak, Kosciusko area. CANB. -- Maiden s.n., -.i.1898. Mt. Kosciusko. NSW10859. -- Maiden s.n., 16.ii.1914. Betts Camp to Mt. Kosciusko. NSW10856. -- Maiden & Forsyth s.n., -.i.1899. Summit, Mt. Kosciusko. NSW10857. -- ?Maiden & Forsyth s.n., -.i.1899. Mt. Kosciusko. NSW10851(p.p.),NSW10855(p.p.). -- ?Maiden & Forsyth s.n., -.i.1900. Mt. Kosciusko. NSW10851(p.p.). -- MM 600, 30.i.1953. Kosciusko summit. COOMA. -- MM 601, 26.ii.1952. Manyang. COOMA, -- Moore s.n., 7.ii.1959. Merrits Creek, Kosciusko area. CANB94801. -- Phillips 55, 26.i.1965. Happy Jack's Plain, Snowy Mountains. Between Happy Jacks Creek and Happy Jacks Road. CBG. -- Phillips 72, 29.i.1964. Near Lake Albina, Kosciusko State Park. CBG007706. -- Phillips s.n., 9.ii.1966. Kangaroo Range, near Mt. Kosciusko. CBG020745. -- Rodd 708, 28.xii.1968. Grey Mare Range, about 1 mile NE of The Grey

Mare. NSW. -- R[upp] 2, -.i.1913. Pretty Point, Kosciusko. MEL. -- Salasoo 3575, 23.i.1969. SE slope of Mt. Guthrie, NE of Mt. Kosciusko. NSW103008. -- Stead 2, 13.i.1966. Lake Cootapatamba, Kosciusko Plateau. MEL. -- Stead 5, 13.i.1966. Shore of Lake Cootapatamba, Kosciusko Plateau. MEL. -- Stead 9, 11.ii.1966. Lake Cootapatamba, Kosciusko Plateau. MEL. -- Stead s.n., 1.ix.1964. Charlottes Pass, Kosciusko. NSW64341, BISH. -- Stead s.n., 10.i.1964. Lake Cootapatamba, Kosciusko area. NSW64343(p.p.),BISH(p.p.). -- S[tirling] 5, 1.i.1884. Summit of Mt. Kosciusko. MEL. -- Totterdell 148, 22.ii.1970. Carruthers Peak, west face, Kosciusko area. CANB. -- Totterdell 212, 4.iii.1971. Kangaroo Range, summit road approx. 4 miles from Mt. Kosciusko summit. CANB. -- C.W.T. s.n., 1954. Right at top of Kosciusko. MEL41566. -- C.W.T. s.n., 1954. Mt. Kosciusko. MEL41565. -- Walker ANU970, -.xii.1962. Mt. Kosciusko. Charlotte Pass. CANB; pollen sample A.N.U.,AD. -- H. & E. Walter 3188(p.p.), 3.i.1959. Mt. Kosciusko, Snowy Mountains. Tal oberhalb "The Chalet". B(p.p.). -- Willis s.n., 5.ii.1946. Hedley Tarn, below the Blue Lake, Kosciusko Plateau. MEL41541. -- Wimbush s.n., 22.iii.1957. Mt. Carruthers. COOMA.

Locality doubtful

Victoria

[Mueller] s.n., s.dat. Mount Hotham [now Mt. Feathertop]. MEL41549.

Locality incorrect

South Australia

Mueller s.n., s.dat. St. Vincents Gulf. MEL41419.

SPECIMENS WITH AFFINITIES TO SSP. DIVERSICOLOR

Victoria

Allen s.n., -.ix.1920. Cobberas. ADW11843. -- Barker 1616, 12.i.1972. Cobberas Mountains. On top and on the S side of the WSW ridge leading from the summit of Moscow Peak; ca. ½km WSW of the summit. AD. -- Barker 1626, 12.i.1972. Cobberas Mountains. Ca. 200m NW of and ca. 50m below Middle Peak, which is ca. 1km N of Mt. Cobberas No. 1 summit. AD. -- Beauglehole 36486(p.p.) & Finck, 25.i.1971. Cobberas No. 1. BEAUGLEHOLE. -- Beauglehole 36615 & Finck, 28.i.1971. Cobberas No. 1. BEAUGLEHOLE. -- Mueller s.n., s.dat. Cobbaras mountains. MEL41538. — [Mueller] s.n., s.dat. Summits of the Cobboras Mountains. Mount Cobra[s]. MEL41546.

n. ssp. lapidosa Barker, subspecies nova

[E. glacialis auct. non Wettst.: Child, Austral. Alp. Life (1969) 41, p.p. (as to "rather stunted plants found in gravelly sites"); Morcombe & Morcombe, Wildfl. East Coast (1970) 64, p.p. (as to "rather stunted" form)]

LATIN DIAGNOSIS:

Subspecies nova Euphrasiae collinae proxima ssp. diversicolor et ssp. speciosam indumento glanduloso longo in partibus superis, ramificatione solum prope terram, foliisque plerumque multi-dentatibus, sed a duabus differt internodiis brevioribus in partibus superis, quorum internodium longissimum bis longitudine foliorum minus est, et altitudine breviore; etiam differt a ssp. speciosa, partibus inferis non-glandulosis, floribus paucioribus, aristis postremis antherarum longioribus, capsulis saepe glabris, seminibus maioribus, et a ssp. diversicolor basi foliorum summorum angustiore, antheris brevioribus seminibus minoribus.

Holotypus (tab. 29): W.R. Barker 1706, 27.i.1972. Kosciusko National Park. On top of Etheridge Range, ca. ½km W of Seamans Hut, ca. 1½ km E of Mt. Kosciusko summit; above large quarry by the Kosciusko Summit Road. AD97221206. Isotypi: Duo distribuendi.

DESCRIPTION:

Erect perennial herb, (3)5-9(11)cm tall, with stem reduced or decumbent and flowering in first year, then dying back to ground, with few to many decumbent branches arising from base of stem or prostrate parts of other branches, often rooting in prostrate parts of branches.

Stem, if flowering, or main floral branches (1.2)1.5-6.5(7.5)cm high to base of inflorescence, simple above ground level, i.e. for (5)10-30(33) nodes below inflorescence; upper 0-3(4) internodes as long as or longer than upper leaves, the longest internode (0.3)0.5-1.8(2.1) times length of upper leaves; axes in upper parts with two rows or four lines of dense, short to very long eglandular hairs decurrent from between leaf bases, sometimes with sparse eglandular hairs between, mixed all around with moderately dense to dense, short to very long glandular hairs, lower down with glandular hairs absent and eglandular hairs sometimes shorter and sparser, sometimes absent on prostrate parts.

Leaves: uppermost leaves of stem or main floral branches (4.5)6.5-10.5(12.5)mm long, (3)4.5-7(9)mm broad, elliptic to obovate, sometimes broadly so, with sessile gland patches extended over distal (0.6)0.65-0.75 of lower side, otherwise covered by very sparse to dense, short to very long glandular hairs, sparser or lacking towards apex, often with short lax eglandular hairs on margins, sometimes extended onto upper side; base usually narrow-cuneate, shortly attenuate or attenuate, sometimes rounded or cuneate; teeth 2-3(4) along each margin, confined to distal (0.45)0.5-0.6(0.65) of leaf, usually sharp, rarely blunt, usually acute, sometimes acuminate, the longest tooth (1.0)1.3-2.0(2.5)mm long; apex (1.0)1.2-2.0(2.6)mm long, (1.2)1.6-2.5(3.2)mm broad, usually sharp, sometimes blunt, usually acuminate, sometimes broadly so or acute, rarely obtuse; leaves lower down glabrous.

Inflorescences racemes, dense in bud, flower and fruit, with (6)10-16 flowers; pedicels at lowest node (0.1)0.2-2(4)mm long; rachis with indumentum similar to uppermost part of axis, but sometimes denser; internodes elongating prior to anthesis such that capsule extends past base of calyx above; apical bud cluster very broadly ovoid, initially ca. 1.5cm long, hidden by or hardly emergent from corollas of uppermost flowers after corollas of first 1-2 flowers have reached anthesis.

Bracts covered by dense, short to long mixture of glandular and lax eglandular hairs, at lowest node similar in shape and size to uppermost leaves, shorter than or equal to calyx except rarely at lowest node, toothed at all nodes.

Calyx (5.5)6.2-8.0(9.0)mm long, externally covered by dense, usually moderately long to very long, rarely short, glandular hairs, extending to inner surface of teeth, mixed with short to long woolly eglandular hairs, dense on margins and inner surface of teeth, sparser or absent on outer surface.

Corolla (8.5)9.5-13(14)mm long along upper side, pale to deep lilac or mauve-pink, with tube and area behind lower lobes white, with yellow blotch behind lowest lobe, and two smaller blotches in tube at base of anterior filaments; tube (6.5)7-9(9.5)mm long; hood (2.6)3-4.5(5)mm long; upper lobes usually emarginate to truncate or praemorse-obtuse, rarely obtuse, with rear surface usually glabrous, except sometimes for sparse to dense very short to short glandular hairs at base, rarely with sparse mixture of very short glandular and eglandular hairs all over; lower lip (5.4)7.5-9.5(10)mm long, externally covered by sparse to dense, short to long eglandular hairs, sometimes mixed with sparse short glandular hairs, the indumentum often restricted to base of lobes, sometimes all over; lower lobes usually emarginate or shallowly so, sometimes praemorsely truncate, rarely obtuse.

Stamens with anthers (1.5)1.6-1.9(2.0)mm long, with connectives usually bearing very sparse to moderately dense, short to long eglandular hairs, sometimes glabrous; posterior pair of awns (0.25)0.3-5(0.6)mm long.

Capsules (7.0)7.3-12(13.5)mm long, in lateral view ovate-elliptic to obovate-elliptic, 2.8-4.8mm broad, in median view elliptic acuminate, sometimes narrowly so, glabrous or with very sparse to moderately dense, short to moderately long setae at very apex; apex emarginate to obtuse, sometimes obliquely so; seeds (18)32(48), (0.8)0.9-1.2(1.4)mm long, 0.4-0.6mm broad, oblong to ellipsoid, often obliquely so.

Plates: 10, 29

Figures: 20

TYPIFICATION:

Holotype (pl. 20): W.R. Barker 1706, 27.i.1972. Kosciusko National Park. On top of Etheridge Range, ca. ½km W of Seamans Hut, ca. 1½km E of Mt. Kosciusko summit; above large quarry by the Kosciusko Summit Road. In pure fjaeldmark on slight slope; growing usually amongst the extremities of prostrate woody bushes or occasionally in the stone chips between. Altitude ca. 6950 feet (2120m). Confined to fjaeldmark. The nearest plants of Euphrasia sp. (resembling WRB1704), prolifically in flower, occurred in low alpine heath-land grading into tall alpine herbfield, where the tussock grass (Poa sp.) begins and the stones are covered. There is a distinct difference in flowering time between the two taxa, as few plants of this fjaeldmark form bore flowers and no plant bore more than one or two flowers or buds. Ca. 100m west of a single plant (WRB1705) of same taxon. Corollas pale to deep lilac, white in mouth and throat, with yellow areas on lower side of mouth and deep in throat. AD97221206. Isotypes: 2 to be distributed.

The type collection consists of about twenty specimens, of which many are entire plants and some are single floral branches picked from their base. It is in good condition and contains flowers and fruits, but few buds.

The type population is in little danger of decimation as it occurs in a National Park.

DISTRIBUTION (Fig. 20):

E. collina ssp. lapidosa is known only from the alpine zone in the Kosciusko region of the Snowy Mountains in south-eastern New South Wales, between altitudes of 1920m (6300 feet) and about 2130m (7000 feet).

ECOLOGY:

The subspecies is apparently confined to areas of fjaeldmark, a sparsely vegetated community of prostrate woody shrubs on stony wind-exposed ridges above 6500 feet (1980m: Barrow, Costin & Lake 1968). All herbarium labels bear annotations referring either specifically to fjaeldmark or to slate chips and pebbles characteristic of this community. It is perhaps noteworthy in light of the semi-parasitic nature of Euphrasia that grasses or small sedges, common in Australian localities where plants of the genus grow, are apparently completely lacking.

The record from the lower altitude (Barker 1710) is of a small population occupying "two small fjaeldmark-like stony areas, on top of small elevated platforms cut out by intersecting streams" from a broad valley floor. The stony area is covered by apparently the same Epacris species that occurs throughout the fjaeldmark on the ridges (Barrow et al ibid.), but its codominant in those localities, Pygmaea densifolia, is absent. Around these platforms, within a few metres, occur the other two alpine subspecies of E. collina, ssp. glacialis and ssp. diversicolor, but morphological and ecological differences seem to be retained (see E. collina: Intraspecific Variation).

Flowering begins in December and is probably completed by early February. From personal observation (see E. collina: Intraspecific Variation) it flowers earlier than the other two alpine subspecies of E. collina in a given locality. This is apparently related to an earlier thaw on the fjaeldmark areas than in the less exposed surrounding herbfields (Mr. D.J. Wimbush pers. comm. Jan.1972).

NOTE:

I wish to record my thanks to Mr. Max Gray (CANB) for informing me of the presence of this distinct subspecies. His copious collections of the three alpine subspecies of E. collina, which he had recognised to be distinct taxa, have been of great assistance in this revision, and provided an excellent preview of the Kosciusko situation for my own field work in the area.

SPECIMENS EXAMINED:

New South Wales: Southern Tablelands

Barker 1705, 27.i.1972. On top of Etheridge Range, ca. ½km W of Seamans Hut, ca. 1½km E of Mt. Kosciusko summit, above large quarry by Kosciusko Summit Road. AD. -- Barker 1706, 27.i.1972. Same locality as Barker 1705, but ca. 100m west of it. AD9holotype). -- Barker 1710, 27.i.1972. Kosciusko National Park. Ca. 2km NE of Mt. Kosciusko summit; ca. 1km N of Seamans Hut along snowpole line to Lake Albina; at bottom valley immediately S of Mt. Northcote. AD. -- Beadle & Smith-White s.n., -.i.1952. Kosciusko. SYD(p.p.). -- Gray & Totterdell 6524, 7.i.1972. Rawson's Pass, Kosciusko area. CANB. -- Gray & Totterdell 6525, 7.i.1972. Rawson's Pass, Kosciusko area. CANB. -- Johnson & Constable s.n., 20.i.1951. Near Club Lake, Mt. Kosciusko. NSW21817. -- Johnson & Constable s.n., 20.i.1951. Above Club Lake. Mt. Kosciusko. AD97123083(?NSW n.v.). -- McVean s.n., -.xii.1966. Albina Pass moraine, Kosciusko area. CANB(s.n.). -- McVean s.n., 28.i.1967. Mt. Northcote pass feldmark, Kosciusko area. CANB(s.n.). -- Totterdell 27, 3.iii.1970. Mt. Twynam saddle, near Mt. Kosciusko. CANB(s.n.). -- Totterdell 270, 14.xii.1971. Etheridge feldmark, Kosciusko area. CANB(s.n.).

o. ssp. glacialis (Wettst.)Barker, comb. et stat. nov.

E. glacialis Wettst.,Monogr.Gatt.Euphrasia (1896)259,t. 13 f.8 BASIONYM; Du Rietz,Sv.Bot.Tidskr.42(1948) 112,359; Mass,Austral.Wildfl.Magic(1967)276,294,p.p. (as to "snowpatch form"; excl. text and plate on p.277); Harris,Alp.Pl.Austral.(1970)138,p.p.(as to some N.S. Wales occurrences, excl. plate and var. eglandulosa); Briggs in McGillivray,Contr.N.S.W.Nat.Herb.4(1973)339, t.30,p.p.(as to var. glacialis)

E. maidenii Gandoger,Bull.Soc.Bot.France 66(1919)218

[E. striata auct. non R.Br.: FvM.,Fragm.Phyt.Austral.5 (1865)89,p.p.(as to Mueller MEL41545); Benth.,Fl. Austral.4(1868)521,p.p.(as to Mueller MEL41545)]

[E. alpina R.Br. var. nivalis FvM. ex Wettst.,loc.cit.260 ("in sched": on syntypes of E. glacialis) pro syn.]

DESCRIPTION:

Erect perennial herb, (3.5)7-12(18)cm tall, with stem reduced, or decumbent and flowering in first year, then dying back to ground, with few to many ascending branches arising from base of stem or prostrate parts of other branches, in larger plants often rooting along prostrate parts.

Stem, if flowering, or main floral branches (2.5)3.5-9.5(13)cm high to base of inflorescence, simple above ground level, i.e. for (5)13-22(25) nodes below inflorescence; upper (0)3-6 internodes as long as or longer than upper leaves, the longest internode (0.9)1.7-3.0(3.5) times length of upper leaves; axes in upper parts with two rows or four lines of dense, short to long eglandular hairs decurrent from between leaf bases, sometimes with sparser eglandular hairs between, usually mixed with sparse to dense, short to very long glandular hairs, lower down with eglandular hairs sparser and shorter, often absent at base, with glandular hairs absent.

Leaves: uppermost leaves of stem or floral branches (3.5) 5.5-9(11)mm long, (2)4-6(8)mm broad, usually elliptic, sometimes obovate, ovate or oblong, often broadly so, with sessile gland patches extended over distal (0.6)0.7-0.85(0.9) of lower side, with marginal rows of glands along either side of apex and proximal side of each tooth with lateral branches which are finally directed towards leaf base and usually reach level of upper side of base of tooth below, otherwise usually bearing very sparse to dense, short glandular hairs, with sparse to dense short woolly eglandular hairs on margins, often also on upper side, rarely on lower side, the indumentum sparser towards apex, often absent; base usually rounded to rounded-cuneate, sometimes very shortly attenuate, rarely truncate; teeth (0)1-2(3) along each margin, confined to distal (0)0.25-0.6(0.75) of leaf, usually sharp, sometimes blunt, usually acute, sometimes acuminate, rarely obtuse, the longest tooth (0.2)0.9-1.5(2.0)mm long; apex (0.9)1.2-2.5(3.5)mm long, (1.6)2.0-3.2(3.8)mm broad, usually blunt sometimes sharp, usually acuminate, sometimes broadly so or acute, rarely obtuse; leaves lower down glabrous.

Inflorescences racemes, dense in bud, flower and fruit, sometimes except for lowest node, with ca. 6-12 flowers; pedicels at lowest node (0.1)0.3-2.0(2.5)mm long, shorter higher up; rachis with indumentum similar to highest parts of axis; internodes apparently elongating prior to anthesis such that capsules reach past base of calyx above; apical bud cluster spherical to very broadly ovoid, initially ca. 1.0cm long, hidden by or hardly emergent from uppermost corollas after flowers at first node have reached anthesis.

Bracts at lowest node similar in shape and size to uppermost leaves, but covered by dense, short to long mixture of glandular and woolly eglandular hairs, shorter than or equal to calyx except rarely at lowest node, apparently toothed at all nodes except when leaves rarely entire or bear one very short tooth.

Calyx (3.5)5-7.5(9)mm long, externally covered by dense, short to long glandular hairs, extending onto inner surface of teeth, mixed with short to long woolly eglandular hairs, dense on margins and inner surface of teeth, on outer surface sometimes sparser and often shorter, sometimes absent.

Corolla (8.5)10-12(13.5)mm long along upper side, usually white, rarely lilac in bud and becoming white as it opens, with yellow blotch on lower lip behind middle lobe, sometimes extending to behind lateral lobes, often continuous with two small yellow blotches at base of anterior filaments; tube (6.0)7.6(10.0)mm long; hood (2.5)3.6(5.0)mm long; upper lobes usually emarginate, often shallowly so, rarely obtuse, with rear surface usually glabrous, sometimes with very short glandular hairs at very base; lower lip (5.6)8.4(13.0)mm long; lower lobes usually emarginate, sometimes shallowly so, usually with very sparse to moderately dense, short to long eglandular hairs confined to base, rarely extending all over, sometimes mixed with sparse to moderately dense, short glandular hairs.

Stamens with anthers 1.4-2.0mm long, with connectives surrounded by sparse to dense, usually short to long, rarely very long eglandular hairs, with posterior pair of awns (0.3)0.4-0.5 (0.65)mm long.

Immature capsules 6.5-8.0mm long, in lateral view obovate to elliptic 2.5-4.0mm broad, ± glabrous; apex in lateral view usually truncate to shallowly emarginate, sometimes obtuse; young

<u>seeds</u> ca. 12-40, ca. 1.1-2.0mm long.

<u>Plates</u>: 10

<u>Figures</u>: 20

TYPIFICATION:

1. <u>E. glacialis</u>

<u>Lectotypus</u>: <u>Dr. Ferd. Mueller s.n.</u>, s.dat. Highest mountains: Sources of the Murray. FI. <u>Isolectotypus</u>: MEL41543. <u>Syntypus alter</u> (<u>isolectotypus probabilis</u>): <u>Dr. Mueller s.n.</u>, s.dat. Summit of the Munyang mountains. W71501. <u>Isosyntypi</u> (<u>isolecto-typi probabilis</u>): G,MEL41544; MEL41545 (<u>Dr. M[ueller] s.n.</u>, -.i.1855. In glaciosis nive dissolvente humi....per montes Munyang Mountains).

The whole type collection is in excellent condition and comprises about thirty specimens, which appear to have come from a single homogeneous collection. All specimens consist of one to four floral branches in full flower; very few branches have lost the inflorescence.

The selection of lectotype from the two syntypes, each of which bear Wettstein's determinavit slip, is based on quantity of material present. The FI specimen contains five separate branches, each with an inflorescence, while the W sheet bears a single specimen with three branches, from which the inflorescence of one has been lost.

All type specimens are labelled "<u>E. alpina</u> R.Br. var. <u>nivalis</u> F.Muell" by Mueller, but Mueller apparently never published this name.

The MEL types each contain far more material than those from the three European herbaria. The isosyntype MEL41545 not only bears the additional information quoted above, but also appears to be the only type seen by Bentham (each of the three labels bear his initial). Mueller annotated one label "Euphrasia striata Br e Benth. Austral alps", clearly having Bentham's (1846) treatment of Euphrasia in mind. Both he (Mueller 1865) and Bentham (1868) published accounts of Euphrasia in Australia in which they confused the specimen with E. striata.

The Munyang Mountains was the general term for the Kosciusko region of the Snowy Mountains in Mueller's time (M. Willis 1949). The type material therefore comes from within the recognized range of distribution of ssp. glacialis. The subspecies is prolific in this region, which lies entirely within a National Park.

2. E. maidenii

Holotype: J.H. Maiden & W. Forsyth s.n., -.i.1899. Mount Kosciusko (Tree line to 7,000 ft.). LY. Possible isotypes: J.H. Maiden & W. Forsyth s.n., -.i.1899. Mt. Kosciusko. NSW10855p.p., NSW10851p.p.,BISH. Photograph of holotype: Briggs in McGillivray (1973) pl.30.

The holotype is in good condition and consists of six floral branches in full flower, and another with the inflorescence lost. The NSW material comprises a number of similar floral branches loose in folders, while the BISH sheet contains a single specimen with two floral branches.

The holotype of E. maidenii, the BISH specimen, and much of the material on the NSW specimens clearly belong to ssp. glacialis and could represent a single collection of the subspecies. However, in both NSW specimens one or two specimens of ssp. diversicolor are present. The occurrence of a discordant label (Maiden & Forsyth s.n., -.i.1900. Mount Kosciusko) on NSW10851 indicates that different collections have been mixed. NSW10855 is clearly a segregate from this sheet as it bears an official label of recent origin and a note by Dr. B.G. Briggs stating that "remainder of material on loan to BISH". Accordingly the BISH material was probably separated from

NSW10851. It follows that the NSW and BISH material of ssp. glacialis could have been collected in January 1900 and that these specimens should be considered as only doubtful isotypes.

DISTRIBUTION (Fig. 20):

E. collina ssp. glacialis is confined to the alpine zone of the Snowy Mountains in south-eastern New South Wales in the region of Mt. Kosciusko at altitudes of above 1920m (6300 feet).

ECOLOGY:

On the track between Seamans Hut and Lake Albina the subspecies is apparently restricted (Barker 1685,1708,1712) to a very low mat-like community occupying moist flat sedimentary areas beside streams, called "short alpine herbfield" by Costin (1954) and probably equivalent to McVean's (1969) Plantago muelleri - Conostomum curvirostre association. The single exception was two plants (Barker 1712A) growing "on top of a small elevated platform" well above the level of the surrounding streams and devoid of accompanying plants. These plants were growing beside an outlier of a nearby population of ssp. lapidosa. The significance of this unusual situation is discussed under E. collina: Intraspecific Variation.

That the subspecies may inhabit other vegetation types seems apparent from the following records: "Wet areas of sod tussock grassland incl[uding] Ranunculus millanii depressions" (Gray & Totterdell 6520,6521,6524,6526), "Oreobolus flat" (McVean CANB -.xii.1966), "Wet snow bed" (McVean CANB 17.i.1961), "marshy" (Calvert CANB7914).

Flowering occurs between mid December and late February.

NOTE:

The subspecies is clearly distinct morphologically and ecologically from the sympatric ssp. diversicolor and ssp. lapidosa. Ecotonal intergradation into ssp. diversicolor is discussed under E. collina: Intraspecific Variation.

SPECIMENS EXAMINED:

New South Wales: Southern Tablelands

Barker 1685, 25.i.1972. Kosciusko National Park. Ca. 2km ENE of Mt. Kosciusko summit; on valley below and ca. 400m NW of Seamans Hut, along snowpole line to Lake Albina. AD. -- Barker 1708, 27.i.1972. Kosciusko National Park. C. 2km NE of Mt. Kosciusko summit, in the second valley ca. 1km NW of Seamans Hut, along the snowpole line to Lake Albina. AD. -- Barker 1712 & 1712A, 27.i.1972. Kosciusko National Park. C. 2km NE of Mt. Kosciusko summit; ca. 1km N of Seamans Hut along snow-pole line to Lake Albina; at bottom of valley immediately south of Mt. Northcote. AD. -- Beadle s.n., 5.ii.1952. Kosciusko. NE011821. -- Briggs s.n., 2.i.1965. Merritt's Creek, Kosciusko area. NSW80689. -- Burbidge 5939, 24.ii.1955. Near col. below Mt. Kosciusko summit. CANB. -- Calvert s.n., 20.xii.1930. Kosciusko - nr. summit. CANB7914. -- Eichler 17840, 26.i.1964. Snowy Mountains. Ramshead Range; above Chair Lift north-west of Thredbo Village; upper part of Merritt's spur. AD. -- Finley s.n., 1885. Mt. Kosciusko. MEL41715. -- Gray & Totterdell 6392, 6.iii.1969. Lake Cootapatamba, Mt. Kosciusko. CANB. -- Gray & Totterdell 6519, 7.i.1972. Snowy River bridge to Seaman's Hut, Kosciusko area. CANB. -- Gray & Totterdell 6520, 7.i.1972. Seaman's Hut to Snowy R. bridge, Kosciusko area. CANB. -- Gray & Totterdell 6521, 7.i.1972. Near bridge acorss Snowy River, towards Seaman's Hut, Kosciusko area. CANB. -- Gray & Totterdell 6526, 7.i.1972. Seaman's Hut to Snowy River bridge, Kosciusko area. CANB. -- Gray & Totterdell 6542, 27.i.1972. Seaman's Hut to Snowy River crossing, Kosciusko area. CANB. -- Gray & Totterdell 6571, 9.ii.1972. Near Lake Cootapatamba, Mt. Kosciusko. CANB. -- Kretschman s.n., -.xii.1892. Mt. Kosciusko. NSW10854. -- McVean s.n., -.xii.1966. Kangaroo Range, Kosciusko area. CANB(s.n.). -- McVean s.n., 17.i.1967. Mt. Tate, Kosciusko area. CANB(s.n.). -- Maiden & Forsyth s.n., -.i.1899. Mt. Kosciusko.

LY(holotype of E. maidenii); NSW10851(p.p.),NSW10855(p.p.), BISH. —— ?Maiden & Forsyth s.n., –.i.1900. Mt. Kosciusko. NSW10851(p.p.). —— M[ueller] s.n., –.i.1855. Per montes Munyang Mountains. MEL41545(isosyntype of E. glacialis). —— Mueller s.n., s.dat. Summit of the Munyang Mountains. W71501(syntype of E. glacialis); MEL41544,G. —— Mueller s.n., s.dat. Highest mountains; Sources of the Murray. FI(lectotype of E. glacialis); MEL41543. —— Phillips s.n., 29.i.1964. On Blue Lake Track above Lake Albina, Kosciusko State Park. CBG007705. —— Stead s.n., 10.i.1964. Lake Cootapatamba, Kosciusko area. NSW64343(p.p.),BISH(p.p.). —— Totterdell 165, 8.i.1971. Summit road near Snowy River bridge, Mt. Kosciusko area. CANB. —— Totterdell 304, 17.iii.1972. Near Carruthers Creek below Soil Conservation Hut, Kosciusko area. CANB. —— Walker AN 978, –.xii.1962. Kosciusko. Summit road, above Snowy River bridge. CANB. —— Walter 3158, 2.i.1959. Mt. Kosciusko, Snowy Mountains. B.

SPECIMENS INADEQUATE FOR INFRASPECIFIC DETERMINATION:

South Australia

Blackburn s.n., 23.vi.1959. Bool Lagoon. ADW22139. —— Cleland s.n., 20.i.19[illegible]. Black Swamp nr. Finniss. [illegible]97119093. —— [Mueller] s.n., s.dat. Spencers Gulf. MEL41420.

Tasmania

Gunn s.n., s.dat. V.D.L. NY(p.p.). —— Gunn s.n., s.dat. Without locality. NY. —— Gunn s.n., s.dat. Without locality. G(p.p.). —— [Stuart] 1744(p.p.), –.xi.1856. South Port. MEL(p.p.).

Victoria

Green 21, s.dat. Ararat Plains. MEL. —— [Mueller] s.n., –.x.1851. Swamps near the Glenelg. MEL41314. —— M[ueller] s.n., 4.iii.1853. In montib[us] altioribus.....Buffaloe Range. MEL41365. —— Robbins s.n., –.i.1940. J.10. Wannon River sources in Gramp[ians]. BEAUGLEHOLE16831.

Without locality

Anon. 110, s.dat. MEL41588(p.p.). —— Eckert 124, 1891. MEL.

16. Euphrasia bella Blake, Qld. Nat. 12(1945)88, pl. 5

DESCRIPTION:

Perennial herb, 9-30cm high, with many ascending branches, arising from reduced stem or both prostrate and erect parts of other branches.

Stem reduced; floral branches with distal suberect parts 2-10cm long to base of inflorescence; internodes as long as or longer than upper leaves over the upper 0-4(7) nodes, the longest internode $\frac{1}{3}$ - $1\frac{3}{4}$ times length of upper leaves, shorter lower down; axis covered all round by moderately dense short eglandular (? or decapitated glandular) hairs usually also with very rare to moderately dense, long to very long glandular hairs on younger parts of floral branch well below inflorescence.

Cotyledons not seen.

Leaves usually opposite, sometimes alternate: uppermost leaves of floral branches elliptic to obovate-spatulate in outline, 8.5-12.5mm long, 3.4-5.4mm broad, shortly subpetiolate, serrate-crenate, with upper surface glabrous or bearing sparse, long to very long glandular hairs, lower surface covered by sparse to moderately dense, long to very long glandular hairs, with sessile gland patches extensive on margins and between veins, extending over distal $\frac{3}{4}$ of leaf, with margins recurved, often shortly scaberulous; base narrow attenuate; teeth 2(3) along each margin, bluntly or sharply acute or obtuse, distributed over distal $\frac{1}{2}$, the longest 0.6-1.4mm long; apex bluntly or sharply obtuse or broad acute, 1.9-2.6mm long, 2.1-3.0mm broad; leaves lower down somewhat larger with a similar indumentum, sometimes with extra pair of teeth.

Inflorescences lax racemes with (6)12-36 flowers, usually opposite with flowers at the lowermost (0)1-5(7) nodes single, sometimes alternate; <u>pedicels</u> long, the lowermost ones (3.0) 4–8(9.2)mm long; <u>rachis</u> similar to upper parts of axis; <u>internodes</u> long, equalling the pedicel or pedicel and calyx combined; <u>apical bud cluster</u> loose, foliose, ca. 1–2cm long becoming hidden by or hardly emergent from uppermost corollas after flowers at first 1–9 nodes have reached anthesis.

<u>Bracts</u> similar to uppermost leaves.

<u>Calyx</u> 5–8mm long, externally usually glabrous but for a very few short glandular hairs below median clefts sometimes covered in distal half by sparse to moderately dense, short to moderately long glandular hairs, internally glabrous but for short glandular hairs, mainly confined to margins towards base of teeth; <u>teeth</u> bluntly or sharply obtuse; <u>lateral clefts</u> 0.8–2.5mm deep, shorter than <u>median clefts</u>, which are 2.1–4.3mm deep.

<u>Corolla</u> 9–15mm long along upper side, "blue" (Blake 14629), "light slightly lavender blue" (Blake 14652, 15417, 15456), "light mauve" (Blake 15923) or "deep blue" (Smith BRI144796), at least usually lighter behind lobes, with yellow blotch on lower lip (in all Blake specimens) apparently behind lowest lobe, with lower side apparently flattened, possibly grooved; <u>tube</u> 6–10mm long, narrow cylindrical for 3.2–5.2mm to base of anterior filaments, distally broadened laterally and somewhat medianally, externally glabrous at base and on abaxial surface, distally covered by moderately dense to dense, short to long eglandular hairs, mixed with sparse short glandular hairs which are sometimes confined to area behind lateral clefts, internally bearing moderately dense, short to long, setose eglandular hairs all around tube at and below bases of filaments; <u>hood</u> 2.8–5.0mm long, breadth uncertain, externally covered by moderately dense to dense, short to long eglandular hairs and sparse short glandular hairs, internally with dense long eglandular hairs at front near sinus, and sparse short

glandular hairs above and in front of anthers; upper lobes usually obtuse, sometimes very shallowly emarginate, with front surface glabrous, with rear surface covered by sparse to dense, short to long eglandular hairs, sometimes mixed with sparse short glandular hairs with margins lined sparsely to densely with short eglandular hairs, with cleft between 1.7-3.7mm deep; lower lip 5.0-10.2mm long, ca. 10-18mm broad, initially porrect, down-turned from about base of lobes, externally covered by sparse to dense, short to long eglandular hairs, sometimes mixed with sparse short glandular hairs, with margins lined sparsely to densely with short eglandular hairs, internally glabrous; lower lobes usually obtuse or slightly truncate, sometimes shallowly emarginate, with cleft between 2.7-5.5mm deep.

Stamens with filaments glabrous, anterior pair 4.5-6.3mm long, posterior pair 2.3-3.8mm long; anthers 1.6-1.9mm long, 1.0-1.4mm broad, with connectives of posterior pair surrounded by dense, long to very long eglandular hairs, with beard usually dense or more extensive than, rarely similar to, that of posterior pair, which are surrounded by sparse to dense, short to long eglandular hairs, with slits lined by dense, very long eglandular hairs; posterior pair of awns 0.3-0.4mm long, longer than other 3 pairs.

Ovary (only two seen) ovate or elliptic in lateral view, laterally compressed, glabrous; apex obtuse or obliquely truncate in lateral view; ovules ca. 60.

Capsules (Smith BRI144796) 6.5-8.2mm long, in lateral view ovate-elliptic to elliptic, sometimes obliquely so, 2.3-3.2mm broad, slightly compressed laterally, glabrous; apex obliquely truncate in lateral view; seeds 14 (in the one capsule dissected), obliquely narrow ellipsoid 0.7-1.0mm long, 0.3-0.4mm broad.

Chromosome number: Unknown.

Plates: 11, 30

Figures: 19

TYPIFICATION:

Holotype (pl. 30): S.T. Blake 14652, 4.x.1942. Queensland. Moreton District: - Mt. Merino, McPherson Range, near exposed edge of cliff, 3650ft. Shortly bushy shrub of about 1 ft.; leaves rather pale green; corolla light slightly lavender blue with pale throat with yellow mark on lower part.

BRI. Isotypes: MEL,GH.

The type collection comes from a single plant (Blake 1945) and is well-preserved. The holotype consists of three large fragments which show the pattern of branching and bear buds and flowers but lack mature fruits. The MEL and GH isotypes each bear two fragments, those of the latter being rather small; each contains several flowers.

The species is apparently exceedingly rare in the type locality since only three (or possibly four) plants have been seen by collectors of the species from Mt. Merino. Although the latest gathering was in 1951, the species probably still survives as Mt. Merino is within Lamington National Park.

DISTRIBUTION (Fig. 19):

E. bella is known only from four or five plants which occur on and near Mt. Merino in the McPherson Range in Queensland close by the New South Wales border. The higher parts of the range are apparently accessible only by long walking tracks (Morecombe 1969) and it seems likely that the species occurs on other similar peaks in the range.

It has been recorded from altitudes ranging between 1000 and 1200m (3500-3800 feet).

ECOLOGY:

So far E. bella has been found mainly on cliffs apparently in exposed positions. Blake 14629 was found "close to exposed edge of cliff at edge of Nothofagus forest"; Blake 14417, 14456 & 14652 from the same plant are similarly annotated: "near edge of exposed cliff". Blake 15923 was collected "at upper edge of precipitous cliff among moss", and Johnson NSW22291 came from "top of scarp under Nothofagus". Smith BRI144796 is described as growing "on bank of track".

Flowering apparently occurs between late August and December. In the December collection (Smith BRI144796) capsules are predominant.

SPECIMENS EXAMINED:

Queensland: Lamington National Park

Blake 14629, 15.viii.1942. McPherson Range: near top of Mt. Merino. BRI. -- Blake 14652, 4.x.1942. Mt. Merino, McPherson Range. BRI (holotype); MEL,GH. -- Blake 15417, 7.x.1944. Mt. Merino, McPherson Range. Specimen from same plant as no. 14652. BRI. -- Blake 15456, 19.xi.1944. Mt. Merino, McPherson Range. From same plant as 14652, 15417. BRI,NY. -- Blake 15923, 25.viii. 1945. Mt. Merino, McPherson Range. BRI. -- Johnson s.n., 21.v. 1951. Mt. Merino, McPherson Range. NSW22291. -- D.A. & L.S. Smith s.n., -.xii.1942. Between Echo Pt. & Main Border Track. BRI144796.

17. Euphrasia crassiuscula Gandoger, Bull. Soc. Bot. France 66(1919) 218; Briggs in McGillivray, Contr. N.S.W. Nat. Herb. 4(1973) 339.

E. glacialis Wettst. var. eglandulosa Willis, Muelleria 1(1967)146, p.p. (excl. Darbyshire 73); Cochrane, Fuhrer, Rothertham & Willis, Fl. Pl. Vict. (1968) t. 497; Harris, Alp. Pl. Austral. (1970) 138; Willis, Hdbk. Pl. Vict. 2(1973) 573

DESCRIPTION:

Perennial herb (6)10-20(30)cm tall, with many crowded ascending branches arising from reduced stem or prostrate parts of other branches, with proximal prostrate parts sometimes rooting.

Stem reduced; floral branches with distal erect parts simple, (4)9-18(23)cm high to base of inflorescence; internodes in upper parts usually longer than or as long as upper leaves, the longest internode ($\frac{3}{4}$)1-2($3\frac{1}{2}$) times length of upper leaves, in lower parts shorter than leaves; axis often reddened, in upper parts bearing four lines of dense short eglandular hairs decurrent from between leaf bases, sparser in lower parts, sometimes also with glandular hairs, dense in lower parts, sparse or lacking in upper parts.

Cotyledons not seen.

Leaves often reddened, cleft or serrate: uppermost leaves of floral branches usually ovate-elliptic to elliptic, rarely obovate-elliptic, (7)8-13(16)mm long, (4)5-8(10)mm broad, glabrous except for sessile gland patches which are confined to distal (0.7)0.8(1.0) of lower side and the usually dense, short to long woolly eglandular hairs lining margins; base usually rounded-cuneate, sometimes truncate or shortly attenuate; teeth 1-3(5) along each margin, usually confined to distal $\frac{1}{4}$-$\frac{2}{3}$, rarely over entire length, bluntly or sharply subacuminate to acute to obtuse, (0.2)0.3-1.2(1.7)mm long; apex broad, usually obtuse to shortly acuminate, sometimes acute, blunt or sharp at very tip, (0.5)1.0-3.0(3.7)mm long, (1.7)2.1-4.2(5.2)mm broad; leaves lower down floral branches and those on young shoots smaller, with eglandular hairs on margins sparse to dense or absent, sometimes bearing glandular hairs.

Inflorescences racemes, dense but for widely spaced lower 1-3 nodes; flowers ca. 20-40; rachis similar to upper axis; internodes elongating only slightly after anthesis such that (except for lower widely spaced nodes) top of calyces level with node above; pedicels of upper flowers $\frac{1}{2}$-2mm long, those of lowermost flowers longer; apical bud cluster conical, ± acute, initially (0.5)1.5(3.0)cm long, hidden by or hardly emergent from uppermost corollas after first 4-6 pairs of flowers have reached anthesis.

Bracts similar to uppermost leaves, with margins lined by dense long woolly eglandular hairs, sometimes mixed with glandular hairs.

Calyx 5.0-8.5mm long, glabrous but for dense long woolly eglandular hairs on margins and inner surface of distal part of teeth, rarely also with glandular hairs on margins; teeth bluntly or sharply acute; lateral clefts 2-4mm deep, usually shorter than, sometimes equal to median clefts which are 2.5-5mm deep.

Corolla (9)10-14.5(16)mm long along upper side, white to pale or deep lilac or purple, with yellow blotch on lower lip behind lowest lobe, sometimes flanked by two smaller ones, with two smaller blotches in tube at base of anterior filaments, with purple striations lacking or faint and confined to tube and hood or distinct and extending well out onto all lobes; tube 5-9mm long, for initial 3-6mm to base of anterior filaments narrow-cylindrical, then expanded laterally and ventrally, externally glabrous on abaxial side and elsewhere almost up to anterior filaments, distally on adaxial and lateral surfaces covered by dense, short to long downturned eglandular hairs, with a small patch of short glandular hairs behind lateral cleft, internally glabrous or with short to moderately long eglandular hairs, very sparse about bases of filaments or dense and decurrent from them to top of ovary; hood ca. 3.2-5.2mm long, 6.7-9.5mm wide (including lobes), 3.5-4.2mm wide (excluding lobes), externally on top and front covered by dense, moderately long to long, downturned eglandular hairs, on sides mixed with dense short glandular hairs, internally with dense long flexuose eglandular hairs behind sinus, and sparse to moderately dense short glandular hairs above anthers or all over; upper lobes coplanar or almost so, obtuse to praemorse-truncate to emarginate, with rear surface covered by glandular hairs, dense near base, sparser to glabrous distally, with margins usually glabrous, sometimes lined by short eglandular hairs near base, with front surface glabrous, with cleft between lobes (2.1)2.7(3.3)mm deep; lower lip concave from above, downcurved at anthesis such that ± perpendicular to upper side, (6.0)8.2(10.0)mm long, (12.7)16.3 (19.5)mm broad, externally usually glabrous, sometimes bearing very few eglandular hairs, internally usually glabrous, rarely with patch of eglandular hairs behind lateral lobes; lower lobes obtuse or praemorse-obtuse to emarginate, usually shallowly so, with clefts between (4.2)4.9(6.4)mm deep.

Stamens with filaments glabrous, the anterior pair 4.2-6.5mm long, the posterior pair 2.0-3.5mm long; anthers (1.5)1.8-2.5mm long, (0.9)1.0-1.5(1.6)mm broad, with connectives glabrous or surrounded by sparse to dense, long flexuose eglandular hairs, with awns of posterior pair (0.3)0.4-0.5(0.6)mm long, longer than those of anterior 3 pairs.

Ovary slightly compressed laterally, in lateral view ovate-oblong to elliptic-oblong or oblong, in median view ovate to elliptic-ovate, usually glabrous, sometimes with short to long, sparse to moderately dense setae at very apex and extended slightly down lines of dehiscence; apex in lateral view truncate to obtuse often obliquely so; ovules 40-100.

Capsules slightly compressed laterally, (5.0)6.0-8.5(9.5)mm long, in lateral view ovate-elliptic or ovate-oblong to obovate-elliptic or obovate-oblong, (1.8)2.0-3.2(3.5)mm broad, in median view usually ovate, sometimes narrow ovate or elliptic, usually glabrous, rarely setose at apex; apex in lateral view usually obtuse to truncate, sometimes shallowly emarginate, often oblique; seeds (3)10-40(62), ellipsoid or oblong to obovoid, usually obliquely so, (0.8)1.0-1.7(1.8)mm long, (0.3)0.5-0.8(0.9)mm broad.

Chromosome number: n=c.28-33 (Barker 1590)

n=c.28 (Barker 1593)

Plates: 11, 30

Figures: 20, 25, 26

TYPIFICATION:

Holotype (pl. 30): C.Walter s.n., 1902. Australia, Victoria. LY. Probable isotypes: BISH (2 specimens); ?NSW (n.v.).

The holotype consists of a single branch broken off from about ground level and terminated by an inflorescence containing buds, flowers and very young capsules. A number of leaves are missing, but otherwise the specimen is in good condition. A discordant fragment, definitely not *Euphrasia*, is also mounted on the sheet. There seems no reason to doubt that material in BISH is isotypic, as it is similarly annotated and bears material of similar age. One herbarium sheet bears a branch with only flowers apparent in the inflorescence; all leaves are present, but the upper ones have been insect-eaten, probably prior to collection. The other sheet contains the fragments of two flowers, a bract and a young capsule. Like the other material of Euphrasia from Australia in BISH, the former isotype has almost certainly been separated from a collection in NSW. However the presence of an isotype in NSW was not indicated in the recent paper on the LY types of Gandoger (Briggs in McGillivray 1973).

While there is no doubt about the affinities at the species level of the type material it cannot be placed with great certainty into one or other of the two subspecies lacking glandular hairs from the vegetative parts which are recognised under E. crassiuscula (see Intraspecific Variation). The holotype has white corollas with lobes not distinctly striated and sparsely hairy anther backs. This combination of characters is not common in either subspecies, and occurs more frequently in the rarer populations which are intermediate between them.

The type has not been placed with the intermediate populations for two reasons. Firstly, there is only a low probability that Walter by chance made his collection from such populations. Secondly, if the two taxonomically determined subspecies were erected excluding the holotype, a ssp. crassiuscula including the holotype would still have to be established for nomenclatural reasons (Stafleu (ed.)1972: Art. 26); this would produce a taxonomically unnatural classification.

It seems equally possible that the holotype came from either of the two subspecies lacking glandular hairs from the vegetative parts recognised under E. crassiuscula; the relative frequency of incidence of the characters of the holotype in each subspecies are as follows:

Ssp. 1. White corollas without prominently striated lobes occasional; sparsely haired anther backs occasional.

Ssp. 2. White corollas without prominently striated lobes common; sparsely haired anther backs rare.

As a consequence it is necessary to base the selection of the type subspecies upon the characteristics of the collections in BISH as well as the holotype. The corollas of the BISH material are similar to those on the holotype in being white and lacking striations. However, while on the sheet consisting only of fragments the anther backs are similarly sparsely hairy, on the other sheet they are more densely hairy. The branch on this latter sheet appears to have come from a different plant as the internodes are shorter than those of the holotype and the inflorescence is denser. It is more probable that two white-flowered plants, lacking prominent corolla striations and with anther backs sparse in one and dense in the other, came from a population of the subspecies, ssp. 1. Accordingly, ssp. 1 has been made the type subspecies. The NSW isotype, if found, should be studied to determine whether a correct decision has been made.

DISTRIBUTION (Figs. 20, 25):

E. crassiuscula is confined to two neighbouring mountain areas in the Victorian Alps. It is most diverse in the region bound to the south by the extensive Bogong High Plains and the higher regions of the Dargo High Plains, to the north-east by Mt. Bogong, which is the highest mountain in Victoria, and to the west by the Mt. Feathertop-Mt. Hotham-The Twins ridge. One of the subspecies also occurs on the isolated granitic Mt. Buffalo Plateau which is north-west of the "main divide" of the Alps.

The species is recorded from altitudes between 1200m and 2000m.

ECOLOGY:

E. crassiuscula occurs in dense local populations from above the snow-line to the highest summits. It has been recorded from subalpine snowgum (Eucalyptus pauciflora) woodland, where it favours the more open areas, alpine heath, especially in areas of low shrubs, although it is sometimes found in tall dense stands, and tall alpine herbfield. It appears to be absent from the subalpine tussock grasslands in the Mt. Cope-Pretty Valley area of the Bogong High Plains.

Flowering mainly occurs between mid-December and late February, with mature capsules being produced from early to mid-January and onwards.

NOTE:

E. crassiuscula is distinguished from all other Australian species of Euphrasia by its long woolly eglandular indumentum which lines the leaves, bracts and calyces, combined with its broad, shortly lobed leaves.

It is remarkable in that it varies in the presence of hairs on the anther backs and the presence of striations on the corolla, the very characters which distinguish Sect. Australes and Sect. Striatae, the two sections with which it has closest affinities. The species may have originated from the hybridization of species of either section, but only one of the possible parents, E. collina ssp. paludosa, survives today (see Chapter 4: p.108). Because it is only distantly related to the present-day members of Sect. Striatae and is very close morphologically to E. collina, it has been placed in Sect. Australes.

INTRASPECIFIC VARIATION:

A. The pure populations of the taxa.

The three subspecies recognised under E. crassiuscula show different, but overlapping altitudinal preferences (fig. 26) and areas of distribution (fig. 25). The map in fig. 25 portrays the known distribution of the three taxa concerned, and their intermediates. In addition it shows the variation in the diagnostically important characters of anther pilosity, corolla colour, and vegetation indumentum in often extensive population samples covering much of the range of the species.

It can be seen that of the three subspecies ssp. eglandulosa has the highest altitudinal range and that it mainly occupies localities east of the western edge of the Bogong High Plains. The only populations west of these plains occur on the summit of Mt. Feathertop, the highest point on the Feathertop-Hotham-Twins ridge (although the population on the ridge connecting Mt. Loch and Mt. Hotham could be referred to this subspecies rather than an intermediate type).

The distribution and altitudinal range of pure populations of ssp. glandulifera are very similar to ssp. eglandulosa. Although ssp. glandulifera differs in not being recorded from Mt. Bogong, it should not be concluded that it is absent from there; on the Bogong High Plains its populations are much rarer than those of ssp. eglandulosa and collections of E. crassiuscula from Mt. Bogong are as yet very few.

In contrast to the other two subspecies, ssp. crassiuscula occupies a lower altitudinal range. Furthermore, it is apparently located entirely west of the Bogong High Plains.

There is little apparent difference in the ecological preferences of ssp. eglandulosa and ssp. crassiuscula. Both occur in alpine heath and subalpine woodland. Ssp. glandulifera however was not seen personally in snowgum woodland communities, nor has it been recorded from them. Collections from near the Bogong High Plains (Eichler 14696, M.U.M.C. CBG011562), which lack ecological annotations, may have come from such a habitat.

B. Intergradation between the taxa.

The two similarly distributed taxa, ssp. eglandulosa and ssp. glandulifera apparently remain completely distinct from each other. On Mt. Nelse they are found as easily distinguishable populations with no detectable intergradation (Barker 1595, 1596). Willis (MEL41551, MEL41555) noted the two "forms growing in close proximity" on Mt. Nelse. Plants of the two taxa grow side by side on Mt. Feathertop (Barker 1573, 1574) but no intermediates could be found.

Populations intermediate between each of these taxa and the generally allopatric ssp. crassiuscula occur in the Feathertop-Hotham area. Except for possibly one case (Barker 1561 - see below) pure populations of the two eastern taxa apparently never occur beside populations of ssp. crassiuscula.

Ssp. crassiuscula and ssp. glandulifera intergrade in alpine and subalpine localities on "The Razorback" between Mts. Hotham and Feathertop (Barker 1579) and on the slopes of Mt. Feathertop itself (Barker 1575). In addition, it is unclear whether the two subspecies remain as distinct populations or are intermixed near the summit of Mt. Loch. Collections from two distinct localities about 100m apart have been mixed under the one number (Barker 1561). Briggs NSW126383 from the same area also contains a mixture of the two subspecies.

The differences between ssp. eglandulosa and ssp. crassiuscula break down to some extent on the rounded summit area of

Mt. Hotham (Barker 1551, 1553/4) and on the saddle between Mt. Hotham and Mt. Loch (Barker 1563)[x]. Populations (Barker 1553/4, 1563) consisting entirely of plants with white corollas lined with purple striations (typical of ssp. eglandulosa) possessed not only glabrous or very sparsely haired anther backs, but also a high proportion of densely bearded anther backs (typical of ssp. crassiuscula) even in the more extensively striated flowers. Another white-flowered population (Barker 1551) showed similar variation in anther hairiness, but the beards on the most hairy anthers were not as dense. Partially overlapping this population and flowering simultaneously was a population of ssp. crassiuscula (Barker 1549) easily distinguishable by its variation in corolla colour from white to varying shades of lilac or purple. Only a very small proportion of the plants sampled had sparsely hairy anther backs; anther backs of the remainder had the dense pilosity typical of the subspecies. Three plants of the white-flowered population (Barker 1551) were sampled from the area of overlap. Anther backs were glabrous in two, but sparsely hairy in the other. Taken overall, extremes of variation in the characters involved in separating ssp. crassiuscula and ssp. eglandulosa do not appear to be correlated with any obvious topographical or ecological gradient as can be observed in the other Australian species of Euphrasia (e.g. E. gibbsiae, E. collina, E. caudata -- q.v.). In fact, extremes in one diagnostic character were seen associated with either extreme of another in

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[x] The single collection (Robbins 145) of plants intermediate between ssp. eglandulosa and ssp. crassiuscula allegedly comes from Mt. St. Bernard. This record is in need of verification as Mt. St. Bernard at about 1500m high is much lower than the other known occurrences of such intermediates (ca. 1800-1860m). In addition it is about 8km from the nearest of these occurrences in an area where only ssp. crassiuscula has been found.

neighbouring plants. On this basis it seems that the characters of anther pilosity, corolla colour and extent of corolla striations are controlled by separate genes and the extremes of variation in each are real genetic differences rather than environment effects. In addition, because ssp. crassiuscula apparently retains its integrity when the populations of plants intermediate between the two subspecies occur sympatrically and flower simultaneously, some barrier to interbreeding must be involved.

It is impossible without experimentation to determine the true nature of the populations intermediate between ssp. crassiuscula and ssp. eglandulosa. Possibly they are relicts of an ancestral population from which either or both of the two present-day non-glandular subspecies of E. crassiuscula evolved. On the other hand they may be of hybrid origin. Originally discreet intersterile populations of ssp. crassiuscula and ssp. eglandulosa may have occurred in the Hotham-Loch region. The intermediate populations may have resulted from a unilateral breakdown of sterility barriers in the populations of the former. In such a case the lack of lilac or lilac-tinted corollas in the intermediate populations may reflect an epistatic dominance of the gene determining white corolla colour in ssp. eglandulosa over the white/lilac "locus" of ssp. crassiuscula.

The possibility that the extensive grazing and erosion which have occurred over the past century in these areas (Costin 1957a, 1962; Carr & Turner 1959) may have caused a breakdown of ecological barriers should also be considered.

To understand more fully the nature of this particular situation and the intraspecific variation which occurs in E. crassiuscula in general, studies at the genecological level are required. Such a study would have even wider taxonomic implications, because two of the characters involved in the variation (extent of corolla striations and anther hairiness) are those that distinguish the two sections with which E. crassiuscula has the closest affinities.

SPECIMENS INTERMEDIATE BETWEEN ssp. crassiuscula and ssp. glandulifera:

Victoria

Barker 1561, 3.i.1972. From ca. 20-30m below and from ca. 200-400m S of the summit of Mt. Loch, which is ca. 3km NE of Mt. Hotham. AD. -- Barker 1575, e.i.1972. Ca. 1km SW of and ca. 400-500feet (120-150m) below the summit of Mt. Feathertop on the saddle across to Mt. Little Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1579, 4.i.1972. Ca. 2km S of the Twin Knobs by the track along the Razorback; ca. 4½km N of Mt. Hotham. AD. -- Briggs s.n., 31.xii.1952. Mt. Loch near Mt. Hotham. AD97123081,NE004731,NSW126383(n.v.).

SPECIMENS INTERMEDIATE BETWEEN ssp. crassiuscula and ssp. eglandulosa:

Victoria

Barker 1551 & 1551A, 2.i.1972. From ca. ½-1km ENE of the summit of Mt. Hotham above the Alpine road. AD. -- Barker 1553 & 1553A, 2.i.1972. Ca. ½km W of the summit of Mt. Hotham, ca. ½km E of Diamantina Hut. AD. -- Barker 1554, 2.i.1972. Ca. ½km W of the summit of Mt. Hotham, ca. ½km E of Diamantina Hut. AD. -- Barker 1563 & 1563A, 3.i.1972. On N-facing slope overlooking Derrick Col, halfway between carpark by the Alpine Road at Mt. Hotham and the summit of Mt. Loch. AD. -- Whaite 1978, 25.i.1960. Mt. Hotham. NSW(s.n.).

Victoria: Locality doubtful

Robbins 145, ca. 1950. Mt. St. Bernard. BEAUGLEHOLE.

KEY TO THE INFRASPECIFIC TAXA OF E. crassiuscula:

1a. Anther backs usually glabrous, sometimes with a few hairs about each connective. Corollas white, with purple striations usually on tube and hood, often extending onto lobes, sometimes lacking.

c. ssp. eglandulosa

1b. Anther backs usually densely hairy, sometimes sparsely hairy about each connective. Corollas white, lilac with white mouth and tube or deep lilac or purple, with purple striations on tube and hood or completely absent.

2a. Glandular hairs absent except on corolla. Corollas white to deep lilac or purple.

a. ssp. crassiuscula

2b. Glandular hairs present on lower vegetative parts, sometimes extending onto upper leaves, bracts, calyx margins and rachises. Corollas pale to deep lilac or purple.

b. ssp. glandulifera

a. ssp. crassiuscula

E. glacialis Wettst. var. eglandulosa Willis, Muelleria 1(1967) 146, p.p. (as to Tadgell MEL41547, Willis MEL41552, MEL41555, MEL41554).

DESCRIPTIONS:

Plant lacking glandular hairs on vegetative parts, rachis, bracts and at least outer surface of calyces.

Corolla white or pale lilac with white mouth and tube with purple striations present or absent on tube and hood, or deep lilac or purple and lacking striations; tube covered by moderately dense to dense eglandular hairs below and between bases of filaments.

Anthers with connectives surrounded by usually dense, sometimes sparse, long eglandular hairs below and between bases of filaments.

Plates: 11

Figures: 20, 25, 26

DISTRIBUTION (Figs. 20, 25):

Ssp. crassiuscula mainly occupies the Mt. Feathertop-Mt. Hotham-The Twins ridge, with an outlying occurrence on the southern (highest) part of the Mt. Buffalo plateau, which lies about 50km to the north-west. No collection has been made east of the east branch of the Kiewa River, where the majority of populations of ssp. eglandulosa and ssp. glandulifera occur.

In the Hotham region ssp. crassiuscula has been found between altitudes of 1350m and 1900m, although the locality of Barker 1583 may have been as low as 1200m. It has been recorded above 1200m on the Mount Buffalo Plateau.

ECOLOGY:

Ssp. crassiuscula mainly inhabits subalpine localities, especially grassy areas, often between shrubs, in or near snowgum woodland (Barker 1545, 1546, 1558, 1559, 1571, 1578, 1581, 1583, 1601). The form also occurs in low alpine (or ?subalpine) heath (Barker 1547, 1548, 1549, 1550, 1560, 1580) which occurs above the snowgums.

NOTE:

To this subspecies belong the Mt. Buffalo populations which are characterised by elongated branch and inflorescence internodes and white flowers. Willis (1967) has described them as "an outlying, more elongated form" of his var. eglandulosa (= E. crassiuscula); more recently (1973a) he stated. "Plants on Mt. Buffalo have more elongated inflorescences and may represent a different, possibly undescribed taxon."

I feel that these plants do not warrant such separate taxonomic distinction. While ssp. crassiuscula in the Bogong-Hotham mountains differs in its greater variability, all populations there contain plants with similarly elongated internodes or white flowers or both. In fact, at the lowest altitudes plants with such internodes are very common (e.g. Barker 1581, 1583). The Mt. Buffalo plants would appear to be a very homogeneous extreme of an elsewhere more variable subspecies.

SPECIMENS EXAMINED:

Victoria

Barker 1545, 31.xii.1971. Mt. Buffalo Plateau; beside the road to the Horn; ca. ½km S of the Tatra Inn. AD. -- Barker 1546, 2.i.1972. Ca. 50m below the summit of C.R.B. Hill, above the Mt. Hotham Alpine Road, ca. 5km SW of Mt. Hotham. AD. -- Barker 1547, 2.i.1972. On Little Blowhard, which is on the southern slopes of Mt. Blowhard, ca. 3km SW of Mt. Hotham; ca. 20m above the Alpine Road. AD. -- Barker 1548, 2.i.1972. On the upper slopes of Mt. Little Baldy, which is ca. 1km NE of Blowhard Hut and ca. 2km SW of Mt. Hotham summit. AD. -- Barker 1549, 2.i.1972. Ca. 200m NW to N of the summit of Mt. Hotham above the Alpine Road. AD. -- Barker 1550 & 1550A, 2.i.1972. Ca. ½km S of the summit of Mt. Hotham. AD. -- Barker 1558, 3.i.1972. By Alpine Road on top of saddle between Mt. Higginbottom and Mt. Little Higginbottom, ca. 3km SE of Mt. Hotham. AD. -- Barker 1559, 3.i.1972. On the upper ESE slopes of Mt. Higginbottom, which is ca. 3km SE of Mt. Hotham. AD. -- Barker 1560, 3.i.1972. On the W end of the summit of Mt. Higginbottom, near water tanks; ca. 3km SE of Mt. Hotham. AD. -- Barker 1564, 3.i.1972. Ca. 20m W of the cairn on the NW end of the summit of The Twins, which is at the E end of the Barry Mountains, ca. 6km SW of Mt. Hotham. AD. -- Barker 1571, 3.i.1972. On the southern slopes of Mt. St. Bernard beside the track to The Twins, which is at the E end of the Barry Mts., ca. 6km SW of Mt. Hotham. AD. -- Barker 1578, 4.i.1972. On the W slopes of Mt. Little Feathertop; ca. 8km N of Mt. Hotham. AD. -- Barker 1580, 4.i.1972. Near the summit of one of the peaks of The Razorback, ca. 3km S of the Twin Knobs; ca. 3km N of Mt. Hotham. AD. -- Barker 1581, 5.i.1972. On the Dargo Road, ca. 8km from the turnoff from the Harrietville-Mt. Hotham road. AD. -- Barker 1583, 5.i.1972. On the Dargo road, ca. 10km from the Harrietville-Mt. Hotham Alpine Road. AD. -- Barker 1601, 9.i.1972. Ca. 50m E of and ca. 15m below summit of Mt. Niggerhead. AD. -- Cambage 3707, 17.i.1913. Summit of Mt. Hotham. NSW10842. -- Ford s.n., 13.i.1959. Below the Horn, Mt. Buffalo. NSW102588,BISH. -- Hill 1286, 31.xii.1963. Mt. Buffalo Plateau. AD. -- Hill 1337, 2.i.1964. Mt. Hotham area. AD. -- Tadgell s.n., -.xii.1914. Razor Back, Feathertop ... towards Mt. Hotham. MEL41547. -- Tadgell A, -.xii.1914. Towards Mt. Hotham. NSW10846. -- Tadgell B, -.xii.1917. Mt. Feathertop (North of Mt. Hotham). NSW10843. -- Tadgell C, -.xii.1917. Mt. Feathertop (North of Mt. Hotham). NSW10844. -- Walter s.n., 1902. Victoria. LY (holotype); BISH(2 spec.),?NSW(n.v.). -- Willis s.n., 18.ii.1963. Mt. Buffalo National Park. Along southern foot of The Bluff (S.W. portion of plateau). MEL41552.

b. ssp. glandulifera Barker, subspecies nova

E. glacialis Wettst. var. eglandulosa Willis, Muelleria 1(1967) 146, p.p.(as to Willis MEL41555, MEL41554).

LATIN DIAGNOSIS:

Subspecies nova prope ssp. crassiusculam eglandulosamque sed differt indumento glanduloso, breve usque longo, parco usque denso, plerumque in foliis humilissimis, foliis surculorum regionibusque humilissimis axium, interdum in ramis foliisque totis, marginibus bracteum calyciumque, rhachidibusque; corollis lilacinis purpureisve, pallidis usque profundis, interdum albis post lobos inferos et in tubo; connectivis antherarum pilis eglandulosis, plerumque densis, raro parcis circumcinctis.

Holotypus (tab. 31): W.R.Barker 1596, 8.i.1972. Victoria

Eastern Highlands. Bogong High Plains; from ca. 30-60m below & ca. 100-150m S of Mt. Nelse summit (southern peak); near snow-pole line. Isotypi: duo distribuendi.

DESCRIPTION:

Plant with short to long, sparse to dense glandular hairs, usually on lowermost leaves, leaves of young shoots and lower parts of axes, sometimes extending over all vegetative parts as well as bracts, calyx margins and rachises.

Corollas pale to deep lilac or purple, sometimes white behind lower lobes and on tube; tube densely hairy between and below bases of filaments.

Anthers with connectives surrounded by long eglandular hairs, usually dense, rarely sparse.

Plates: 11, 31

Figures: 20, 25, 26

TYPIFICATION:

Holotype (pl. 31): W.R.Barker 1596, 8.i.1972. Victoria, Eastern Highlands. Bogong High Plains; from ca. 30-60m below and ca. 100-150m S of Mt. Nelse summit (southern peak); near snowpole-line. Alpine moorland (dominated by Orites sp. and silver daisy - Celmisia sp.) growing into tall alpine herbfield lower down. Altitude ca. 6000ft (1830m). Sparse population over area of ca. 100m square. No connection observed with Euphrasia population on north side of summit from where W.R. Barker 1594 and 1595 collected. Corollas lilac with white mouth to deep lilac; with yellow areas on lower side of mouth and deep in throat; some veins purple on upper side of corolla tube. Anthers hairy about connective. AD97220027. Isotypes: 2 sheets to be distributed.

The holotype consists of large portions of three different plants, each with several floral branches, as well as two other single floral branches broken from the base. The isotypes contain three large portions of plants each with a number of floral branches and two other specimens with one or two floral branches. The material is in good condition and bears buds and flowers but lacks fruits.

The type population probably still survives. The collections Willis MEL41554 and MEL41555 are almost certainly topotypes.

DISTRIBUTION (Figs. 20, 25):

Ssp. glandulifera occurs in distinct populations on the higher summit areas of the Bogong-Hotham mountain system. The subspecies has not been found on Mt. Bogong itself, but collections of E. crassiuscula from this apparently little botanised mountain are too few to make any conclusions about its presence there.

Ssp. glandulifera has been recorded from altitudes between 1650m and 1950m.

ECOLOGY:

The subspecies has been recorded from alpine heath grading into tall alpine herbfield (Barker 1596). Most other collections come from tall alpine herbfield (Barker 1574, 1576) which is probably equivalent to the "alpine meadow" of Craven (1607, 1608). It has also been recorded from open grassy situations by Ford (NSW102589), Muir (1039) and Willis (MEL41554, MEL41555). A stony terrain is referred to in Muir 1039 and Willis MEL41555. The subspecies does not appear to occur below the tree-line.

NOTE:

That Willis overlooked the glandular indumentum which is distinctive of this subspecies is clear both from his published work (Willis 1967, 1973) where he has outlined the features of his var. eglandulosa (= E. crassiuscula) and from his annotations of his collections of ssp. glandulifera (MEL41555 -- on label, MEL41554 -- on outer folder). He has described both his varieties and the specimens of ssp. glandulifera as "non-glandular".

It it equally clear however, that on his 1947 visit to Mt. Nelse he recognised the distinctiveness of populations of ssp. eglandulosa and ssp. glandulifera. On the label of his collections of the former (the type) he has noted:

> "....Flowers very congested, white; anthers smooth except for some hair near the tail-like points. Growing in close proximity to another form with larger purplish flowers and copious white-woolly hairs on stems, edges of leaves, calyx-lobes and anthers."

The distinct form referred to is clearly ssp. glandulifera. That he considered it a form in the taxonomic sense is substantiated by his annotation, "E. glacialis Wettst. var. eglandulosa J.H. Willis (July 1967) forma", on MEL41554 and by his further reference to this in his (1967) enumeration of specimens of his var. eglandulosa.

It is true that the indumentum on the calyx and bract margins, as well as on the corollas, can be very dense in plants of this variety. This is seen in plants not only from Mt. Nelse but also from Rocky Knobs. These features however, are by no means characteristic of the subspecies as delimited herein, nor are they confined to it. Plants of ssp. glandulifera from more western localities (Barker 1574, 1576) have a less prominent indumentum more typical of ssp. eglandulosa and most collections of ssp. crassiuscula, while similarly dense indumentums are common in one population of ssp. crassiuscula (Barker 1601) from near the western edge of the Bogong High Plains. The significance of the fact that all populations of both ssp. glandulifera and ssp. crassiuscula on the Bogong High Plains exhibit a denser indumentum is unclear. If it is not a purely environmental effect, this common attribute may reflect a close phylogenetic relationship between the eastern populations of the two subspecies.

SPECIMENS EXAMINED:

Victoria

Barker 1574, 4.i.1972. Ca. 100m SW of and ca. 50feet (15m) below the summit of Mt. Feathertop on the track to Little Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1576, 4.i.1972. Ca. ½km NE of and ca. 150feet (50m) below the summit to Mt. Feathertop, on the lowest part of the saddle across to Mt. Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1596, 8.i.1972. Bogong High Plains; from ca. 30-60m below and ca. 100-150m S of Mt. Nelse summit (southern peak); near snowpole-line. AD(holotype). -- Craven 1607, 22.xii.1969. Summit area of Mt. Feathertop. CANB. -- Craven 1608, 22.xii.1969. Summit area of Mt. Feathertop. CANB. -- Eichler 14696, 3.ii.1958. Bogong High Plains. Rocky Knobs. AD; pollen slide A.N.U.,AD. -- Ford s.n. Below Mt. Loch (ca. N.E. of Mt. Hotham). NSW102589,BISH. -- M.U.M.C. s.n. Above Cope Hut, Bogong High Plains. CBG011562,AD97345098. -- Muir 1039, 11.i.1960. Bogong High Plains. Summit of Mt. Nelson. MEL,AD. -- Willis s.n., 12.i.1946. Summit of Mt. Nelse (Nelson), Bogong High Plains. MEL41555. -- Willis s.n., 15.i.1947. N.W. slopes of Mt. Nelse ("Nelson"), Bogong High Plains. At source of the Big River. MEL41554.

c. ssp. eglandulosa (Willis)Barker, comb. & stat. nov.

E. glacialis Wettst. var. eglandulosa Willis,Muelleria 1(1967) 146,p.p.(as to holotype and isotypes, and Willis MEL41553, p.p.)BASIONYM.

DESCRIPTION:

Plant with glandular hairs usually absent, rarely (Barker 1572) present sparsely on lower vegetative parts.

Corolla white, with purple striations usually on tube and hood, often extending well out onto lobes, rarely absent; tube with eglandular hairs about base of each filament and decurrent from it, rarely sparsely hairy between.

Anthers usually glabrous on back, sometimes with a few hairs about each connective.

Plates: 11

Figures: 20, 25, 26

TYPIFICATION:

Holotype: J.H.Willis s.n. 12.i.1946. Summit of Mt. Nelse ("Nelson"), Bogong High Plains, N.E. alps, Victoria. Stony terrain in open grassland at ± 1900m. (= 6200ft.) alt., flowers very congested, white; anthers smooth except for some hair near the tail-like points. Growing in close proximity to another form with larger purplish flowers and copious white-woolly hairs on stems, edges of leaves, calyx-lobes and anthers. MEL41551(p.p.). Isotypes: MEL41551(p.p.), NSW94625; K(n.v.).

The type collections are in good condition and contain buds and flowers, but only very immature capsules. The MEL holotype and isotypes referred to by Willis (1967) in the protologue, are mounted on a single sheet. The holotype comprises two entire floral branches, while the isotype material contains five single floral branches, broken off at ground level and a larger specimen with 2 floral branches and one vegetative branch.

Populations of ssp. eglandulosa in the type locality are still prevalent (Barker 1593, 1594, 1595).

DISTRIBUTION (Figs. 20, 25):

Except for occurrences on Mt. Feathertop, the highest mountain west of the Kiewa River, ssp. eglandulosa is confined to regions east of the Kiewa River between the Bogong High Plains and Mt. Bogong.

The altitudes recorded for the subspecies are between 1650m and 2000m. However, the collection, Barker 1605, may have come from as low as 1500m.

ECOLOGY:

Ssp. eglandulosa has mainly been recorded from low alpine heath (Barker 1593, 1594, 1595, 1597, 1599) and tall alpine herbfield (Barker 1572, 1573, 1577; Willis MEL41556). Most of these collections came from grassy areas. Several collections have been made from stony tracts (Aston 247B, Barker 1594, Willis MEL41551). Craven (1609, 1822) found it in "alpine meadow", while Willis (MEL41551) recorded it in "open grassland"; these probably refer to the heath or herbfield associations mentioned above. Occasionally the subspecies has been collected from within areas of shrubs in sparse snowgum (Eucalyptus pauciflora) woodland (Barker 1588, 1590, 1605) or in wide areas of heathland between snowgums (Barker 1591). Only a single plant (Barker 1605) has been found in dense woodland.

NOTES:

1. In the collection Barker 1572 a few plants bear glandular hairs on the lower vegetative parts. There is no reason to give

such plants formal taxonomic recognition as was done in distinguishing ssp. *glandulifera* from ssp. *crassiuscula* as they occur very rarely and, more importantly, separate glandular and non-glandular populations have not been discovered.

2. The specimen Galbraith CANB190468 contains two elements, a single flowering specimen of ssp. *eglandulosa* and many flowering fragments of *E. collina* ssp. *collina*. From the locality (far from the known area of distribution of ssp. *eglandulosa* and at a much lower altitude), the flower colour (the common name provided is "Purple Eyebright") and date of collection (October), the label clearly fits the latter element. The specimen of ssp. *eglandulosa* is considered without doubt to be discordant, but for easy reference is cited under Galbraith CANB190468 in the specimen index.

SPECIMENS EXAMINED:

Victoria

Aston 247B, 30.xii.1958. Mount Bogong, 20 yards north of Summit Hut. MEL. -- Barker 1572, 4.i.1972. Ca. 20m E of cairn on the summit of Mt. Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1573, 4.i.1972. Ca. 100m SW of and ca. 50 feet (15m) below the summit of Mt. Feathertop on the track to Little Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1577, 4.i.1972. Ca. ½km NE of and ca. 150 feet (50m) below the summit of Mt. Little Feathertop, on the lowest part of the saddle across to Mt. Feathertop; ca. 9km N of Mt. Hotham. AD. -- Barker 1588 & 1588A, 7.i.1972. Bogong High Plains; on the upper E slopes of Mt. Cope, ca. 10-50m below the summit. AD. -- Barker 1590, 7.i.1972. Bogong High Plains; on the upper W slopes of Mt. McKay, ca. 30m W of the road to the summit. AD. -- Barker 1591 & 1591A, 7.i.1972. Bogong High Plains; beside road along N edge of Rocky Valley Reservoir, ca. ½-1km E of causeway. AD. -- Barker 1593 & 1593A, 8.i.1972. Bogong High Plains; on top of Bakers Spur, which is a ridge WNW of Mt. Nelse summit leading to Spion Kopje; ca. 1km W of Mt. Nelse North. AD. -- Barker 1594 & 1594A, 8.i.1972. On pole line between summits of Mt. Nelse North and Mt. Nelse (southern peak), ca. 100m S of Mt. Nelse North. AD. -- Barker 1595, 8.i.1972. On the lowest part of the pole line between Mt. Nelse North and Mt. Nelse (southern peak) and ca. ½km from each; ca. 100m W of and 15m below the eastern peak of Mt. Nelse summit region. AD. -- Barker 1597, 8.i.1972. Ca. 300m N of turnoff to Kelly's Hut along track to Mt. Nelse. AD. -- Barker 1599, 8.i.1972. On the Mt. Nelse track from the E end of Rocky Valley Reservoir, ca. 150m W of the turnoff to Kelly's Hut. AD. -- Barker 1602, 10.i.1972. Strawberry Saddle, which is on the Falls Creek-Omeo road, ca. 5km ESE of Mt. Cope. AD. -- Barker 1605, 10.i.1972. Ca. 200m SE of Bucketty Plain on the Falls Creek - Omeo road; ca. 5km ESE of Mt. Cope. AD. -- Beauglehole 15542, 26.i.1966. Bogong High Plains, N side of Mt. Cope. BEAUGLEHOLE. -- Beauglehole 22305, 23.i.1967. Bogong High Plains, Spion Kopje. BEAUGLEHOLE. -- Clifford s.n., 15.i.1948. Bogong High Plains, Mt. Cope. MELU. -- Craven 1609, 22.xii.1969. Summit area of Mt. Feathertop. CANB. -- Craven 1822, 24.i.1970. Summit area of Mt. Cope, Bogong High Plains. CANB. -- Eichler 14692, 3.ii.1958. Bogong High Plains. North slope of Rocky Knobs (south of western creek in Rocky Valley). AD; pollen slide A.N.U., AD. -- Eichler 14856, 13.ii.1958. Surroundings of Mt. Nelse. AD. -- Kaspiew 700, 29.xii.1955. Mt. Hotham. B. -- Maiden s.n., -.i. 1900. Mt. Hotham. NSW10841. -- MUMC s.n., 28.xii.1964. Quartz Nob, Mount Bogong. CBG008908. -- MUMC s.n., 28.xii.1964. Mt. Bogong. T-spur track. CBG008909. -- Rodd 402, 31.xii.1966. Mt. Bogong, ... on steep NW face of spur but not on crest of spur about ½mile NE of summit. NSW102590,BISH. -- Skewes s.n., -.i.1953. Bogong High Plains. NE(s.n.). -- Stead s.n., 18.i.1962. Falls Creek. NSW126384/6,NSW126383/5. -- Willis s.n., 11.i.1946. Bogong High Plains, at a head of Middle Creek above Rover Scout Hut. MEL41556. -- Willis s.n., 12.i.1946. Summit of Mt. Nelse ("Nelson"), Bogong High Plains. MEL41551 (holotype); NSW94625; K(n.v.). -- Willis s.n., 15.i.1946. Head of Pretty Valley near Mt. Cope, Bogong High Plains. MEL41553(p.p.).

Victoria: Locality extremely doubtful

Galbraith s.n., -.x.1925. Tyers. CANB190468(p.p.).

SPECIMENS INADEQUATE FOR INFRASPECIFIC DETERMINATION:

Victoria

Beauglehole 41694, 27.iii.1973. V46. N.E. Vic., Hotham Heights. BEAUGLEHOLE. -- Beauglehole s.n., 27.iii.1973. W1. N.E. Vic. Mt. St. Bernard. BEAUGLEHOLE(s.n.). -- Stead s.n., 21.i.1964.

Mt. Hotham. NSW64344. -- *Walter s.n.*, -.i.1899. The Twins Summit. MEL41548. -- *Walter s.n.*, -.i.1899. Twins Mountains. NSW10847.

INTERSPECIFIC HYBRIDS

Hybridization between the Australian species of Euphrasia is rare. Only four cases have been found, three of these have been recognized from field study, and clearly indicate that the barriers to interspecific hybridization are very great. Hybrids in each case are scarce in comparison with the prolific population(s) of the parent species, and show reduced pollen fertility. It seems significant that the only hybrids so far detected have arisen from the crossing of species from different sections. This is possibly a reflection of the fact that in at least the areas visited, there is always an ecological separation between sympatric species of the same section. However, unlike several cases of ecotonal intergradation of a possible hybrid (as opposed to clinal) nature between infraspecific taxa, there is little evidence of such intergradation between related species (but see E. scabra: Intraspecific Variation).

In spite of this it seems that interspecific hybrids have in the past given rise to stabilized intermediate populations. E. orthocheila var. peraspera and E. crassiuscula appear to have originated in this way (see Chapter 4: Evolution of Euphrasia in Australia).

4 x 15b. E. striata x E. collina ssp. diemenica

Populations of E. striata (Sect. Striatae) and E. collina ssp. diemenica (Sect. Australes) grow together on the Central Plateau and Mt. Wellington in Tasmania. They represent the only cases of overlap of taxa from Sect. Striatae and Sect. Australes.

On the Central Plateau in an extensive area of alpine heath near Lake Augusta, sporadic hybrids occur among abundant populations of the two species. The two species differ in flowering time, with E. striata flowering earlier. The hybridization between them is probably effected mainly by the native bees which were seen visiting flowers of both species and the hybrids. The hybrid individuals were intermediate in the characters separating the two species, namely the presence of striations on the corolla, the presence of hairs on the anther backs, the bluntness of the leaf teeth, the overall leaf shape, and the incidence of a glandular indumentum on the upper and/or lower parts. The hybrids were mainly detected in the field by their only partially striated corollas. Pollen tests (Appendix 1: PS28,29,226-227, 229-230,261-265) showed the hybrids to be highly sterile. E. striata (PS18,26,27,228,258-260,269) and in general E. collina ssp. diemenica (q.v.: Note 1) show pollen which is mainly functional in appearance.

Hybrids have been collected also on the Central Plateau from the Ironstone Mountains (Rodway NSW22281p.p.) and near Breona (Barker 1065). In both instances pollen from the hybrid was highly sterile (PS231,267).

A putative hybrid from Mt. Wellington was not tested for pollen sterility because of the paucity of flowers. The fact that no other examples of possible hybridism are known from this much-botanized mountain suggests that there is a barrier to interbreeding between the species, which is more efficient than on the Central Plateau.

SPECIMENS EXAMINED:

Tasmania

Barker 996, 30.xi.1970. Ca. ½km south of Lake Augusta and ca. south-west of the source of the River Ouse, by track. AD. -- Barker 1021, 5.i.1971. Ca. ½km south of Carters Lake on the south side of Lake Augusta. AD. -- Barker 1040(p.p.), 5.i.1971. Ca. 1km north-east of the westernmost causeway just south of the dunes on the southern side of Lake Augusta. AD(p.p.). -- Barker 1044, 6.i.1971. Ca. ½km south of Lake Augusta, by track ca. 4km south-west of the source of the River Ouse. AD. -- Barker 1048, 6.i.1971. As for Barker 1044. AD. -- Barker 1052, 6.i.1971. Ca. 5km west-south-west of the source of the River Ouse at Lake Augusta, on hill ca. ½km from the edge of the lake. AD. -- Barker 1065, 7.i.1971. Lakes Highway at Doctor's Creek, which is ca. 4km south of Breona. AD. -- F.A. Rodway s.n., -.xii.1899. Ironstone Mts. NSW22281(p.p.). -- F.A. Rodway s.n., -.xii.1900. Wild Dog Plains. Ironstone Range. NSW22272.

PUTATIVE HYBRID:

Tasmania

L. Rodway s.n., -.i.1914. Mt. Wellington. HO.

9 x 15g. E. lasianthera x E. collina ssp. paludosa

E. lasianthera (Sect. Lasiantherae) and E. collina ssp. paludosa (Sect. Australes) hybridize near the headwaters of the Macalister River in the eastern highlands of Victoria. Prolific populations of both species grow in close proximity on a flat ridge-top covered by snowgum (Eucalyptus pauciflora) woodland. On the cleared grassy roadside verge on the summit of the ridge plants of the two species were commonly found within twenty metres of each other, and cases of plants of either species growing side by side were not uncommon. The two species were flowering simultaneously (although E. lasianthera was at a more advanced stage), and native bees similar to those observed visiting flowers of E. collina ssp. paludosa (Barker 1492, 1495) several kilometres away were seen among the flowers of E. lasianthera (pl. 12). With the plants of the two species clearly distinguishable on the characters of corolla coloration (the plants of E. collina in this region all bore a yellow blotch on the lower corolla lip) and indumentum, numerous plants of both populations were studied for evidence of hybridism. Only three plants (Barker 1507,1508,1512) were discovered which had a mixture of characters of both species. Three of these proved to be certain hybrids as their anthers contained an abnormally low percentage of functional pollen (Appendix 1: PS30,31,35,46). The pollen of the sympatric populations of E. collina ssp. paludosa is mainly functional in appearance (Appendix 1: PS32,38-41,45,

Clearly there must be some almost impenetrable barriers to interbreeding between the species. It seems possible that the two species have only come together in the disturbed roadside situation which provides an intermediate habitat between the open tussock grasslands in which E. collina was observed to abound, and the snowgum woodlands where E. lasianthera was generally seen. A study of populations surrounding the locality studied is required to determine whether this is true.

SPECIMENS EXAMINED:

Victoria: Eastern Highlands

Barker 1507, 26.xii.1971. Ca. 3km NW of Howitt Hut on the Macalister Headwaters road, ca. 100m SE of the turnoff to Macalister Springs. AD. -- Barker 1508, 26.xii.1971. As for Barker 1507. AD. -- Barker 1512, 26.xii.1971. Ca. 2km NW of Howitt Hut on the Macalister Headwaters road, ca. 1km SE of the turnoff to Macalister Springs. AD.

PUTATIVE HYBRID:

Barker 1505A, 26.xii.1971. As for Barker 1507. AD.

7 x 10a. E. alsa x E. caudata

These hybrids are known to occur only at Spencer's Creek, near Mt. Kosciusko (fig. 14). Several collections of E. alsa (Barker 1696; Thompson 379; Stead NSW64339) have been made there, but only one collection (Stead 7) of E. caudata (q.v.: Intraspecific Variation). Thompson has stated that the plants of her collection were growing "with two other species of Euphrasia". One of these species may have been E. caudata, although from personal experience, two subspecies of E. collina are prevalent in the area.

All hybrids show a high degree of pollen sterility (Appendix 1: PS49,50,86-91,93-94). On the other hand, E. alsa and E. caudata show a high percentage of normal pollen (PS48,51-53,82-85,92,97,104).

The hybrid collection (Barker 1697: pl. 31) was made at the edge of a population of E. alsa in low heath beside the river bank. The plants were very distinctive by their larger habit and more faintly striated corollas. They were found clustered together at the edge of a shallow hollow, about 8-15cm deep, between shrubs. This situation was typical of the occurrences of E. alsa in the area. There were no observable ecological differences between the localities of hybrids and E. alsa. The restriction of the hybrids to one small stand suggests that:

1. hybridization is rare between the two species,
2. the population found is an F2 or back-cross generation, the product of a lone F1 hybrid plant which was either self-fertilised or fertilised by pollen from one or other of the species, and
3. seed was spread about the parent plant and no further.

SPECIMENS EXAMINED:

New South Wales

Barker 1697, 26.i.1972. Kosciusko National Park. Ca. 50m N of bridge across Spencers Creek, on the Kosciusko Summit Road, ca. 3km ENE of Charlottes Pass. AD. -- Stead 3, 13.i.1966. Spencer's Creek, Kosciusko area. MEL. -- Stead s.n., 22.i.1964. Spencer's Creek, Kosciusko. NSW64342.

12a x ?15g. *E. orthocheila* var. *orthocheila* x ?*E. collina* ssp. *paludosa*

The three plants making up the collection Cambage 1594 resemble *E. orthocheila* var. *orthocheila* (Sect. *Scabrae*) by their yellow corollas, small capsules, branching apparently well up the stem, the high degree of secondary branching, and the glandular-scabrous indumentum of the herbaceous parts of the inflorescence. They tend, however, towards Sect. *Australes* mainly in the shape and indumentum of the corollas. The corollas possess lower lips which are large and apparently downcurved, while their pilosity is much sparser and less extensive than is typical in *E. orthocheila*.

In addition, two of the plants are abnormal in other characters. One plant, the only one which still retains a good set of leaves, has leaves uppermost on the main axes rather larger than normal for *E. orthocheila*, and these bear two teeth along each margin. The capsules are typical of *E. orthocheila* in indumentum and shape, while the seeds are rather large at ca. 0.9mm long. This plant has mainly functional pollen (Appendix 1: PS110,123). The capsules of a second plant (with the best display of fruits but lacking in leaves) are very long (ca. 5.8mm) for ones occurring on branches, have obtuse apices, and have a moderately dense cover of setae over only the upper half. The seed size is also large (ca. 1.0mm). In all these capsule characters it diverges from E. orthocheila. The pollen sterility estimates for this plant are abnormally high at 46-51% (l.c.: PS109,124). The third plant resembles E. orthocheila but for the unusual corollas mentioned above. The pollen appears almost entirely functional (l.c.: PS108, 125).

On the basis of the above evidence it is very probably that these plants are hybrid in origin. One parent taxon is clearly E. orthocheila var. orthocheila. The sympatric E. collina ssp. paludosa (Sect. Australes) may be the other parent.

SPECIMEN EXAMINED:

New South Wales

Cambage 1594, 8.vii.1907. Stannum. NSW10882.

APPENDIX I

POLLEN STERILITY TESTS

The technique used for the tests for pollen sterility is identical to that proposed by Owczarzak (1952). Dried herbarium material was used exclusively. Pollen was taken from mature buds or young flowers prior to anthesis. The grains were mounted on a microscope slide in a medium of glycerol jelly containing phloxine, which stains the contents of the pollen, and methyl green, which stains the pollen wall.

It is stressed that the technique does not measure pollen fertility. The estimate of the proportion of grains of "functional" appearance is an approximation to this, as some of the grains may be incapable of fertilization. It is also pointed out that high pollen sterility need not be caused by hybridization. Abnormal environmental conditions and genetic aberrations in pure populations may also affect pollen development. However, if high pollen sterility occurs in plants which are intermediate between taxa which themselves produce mainly functional pollen, then this can be taken as good evidence that the intermediates are of hybrid origin. Finally, it is emphasized that hybrids may show no loss in pollen fertility.

The estimates of the percentage of functionally appearing pollen should be treated as approximations only. Although differences in the rate of spread of the small light sterile grains and the large full functional grains to the edge of the slide when the cover-slip is positioned is reduced by the viscosity of the mounting medium, the distribution of the two types of grain is not completely random. The counts, nevertheless, indicate whether pollen development in the anther has been normal (functional pollen more than c.90% of total) or greatly impaired (functional pollen less than c.70%). Counts in between these two values should be treated with caution.

Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet		Taxon (see index page 652)
8	100	120	Barker	969	15N2
12	98	100	"	1187	3 aff.g
13	87	103	"	1187	3 aff.g
15	90	100	"	1187	3 aff.g
16	95	100	"	1187	3 aff.g
18	96	115	"	1188	4
26	100	148	"	1233	4
27	100	115	"	1233	4
28	2	52	"	1048B	4 x 15b
29	0	56	"	1048E	4 x 15b
30	42	101	"	1507	9 x 15g
31	23	119	"	1507	9 x 15g
32	87	107	"	1505	15g
35	11	100	"	1508	9 x 15g
36	11	88	"	1508	9 x 15g
38	82	114	"	1504	15g
39	67	100	"	1510	15g
40	96	100	"	1510	15g
41	91	109	"	1510	15g
42	100	130	"	1509	15g
43	12	100	"	1512	9 x 15g
44	77	100	"	1483A	15N3
45	99	100	"	1484A	15N3
46	100	61	"	1484A	15N3
48	90	61	"	1696	7
49	50	63	"	1697	7 x 10
50	20	102	"	1697	7 x 10
51	95	268	"	1649	10a
52	little pollen		"	1696	7
53	90	61	"	1696	7
54	99	145	"	1686	15m
55	97	210	"	1686	15m
56	100	208	"	1685	15o
57	97	341	"	1685	15m-o
58	33	412	"	1688	15m-o
59	58	81	"	1668	15m-o
60	100	103	"	1687	15m-o
61	100	108	"	1687	15m-o

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
62	99	110	Barker 1687	15m-o
63	97	120	" 1688	15m-o
64	96	100	" 1688	15m-o
65	97	104	" 1688	15m-o
66	92	101	" 1688	15m-o
67	30	95	" 1688	15m-o
68	100	110	" 1687	15m-o
69	26	78	" 1685	15o
70	99	120	" 1685	15o
71	58	85	" 1685	15o
72	55	113	" 1702	15m
73	51	77	" 1702	15m
74	96	248	" 1702	15m
75	81	307	" 1701	15m
76	95	387	" 1701	15m
77	78	379	" 1703	15m
78	83	283	" 1703	15m
79	87	199	" 1553A	17a-c
80	84	49	" 1553A	17a-c
81	95	188	" 1553A	17a-c
82	99	167	" 1696	7
83	100	96	" 1696	7
84	96	127	" 1696	7
85	95	61	" 1707	7
86	23	313	" 1697	7 x 10
87	14	269	" 1697	7 x 10
88	73	125	" 1697	7 x 10
89	21	131	" 1697	7 x 10
90	32	145	" 1697	7 x 10
91	16	207	" 1697	7 x 10
92	96	147	Costin 602	10b
93	51	361	Stead NSW64342	7 x 10
94	48	209	Stead NSW64342	7 x 10
95	23	254	Barker 1697	7 x 10
96	20	120	" 1697	7 x 10
97	98	114	" 1714	7
98	100	125	Skottsberg NSW10865	10b

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
99	95	124	Skottsberg NSW10865	10b
100	97	146	Skottsberg NSW10865	10b
101	97	152	Costin NSW10866	10b
102	96	183	" NSW10866	10b
103	97	183	" NSW10866	10b
104	97	91	Stead NSW64339	7
105	97	18	Constable NSW56101	14
106	96	334	" NSW56101	14
107	98	146	Carolin s.n.	14
108	100	73	Cambage 1594	12a x ?15g
109	51	84	" 1594	12a x ?15g
110	100	84	" 1594	12a x ?15g
111	100	105	Smith HBG	12b
112	87	69	Boorman NSW10934	aff.13
113	98	62	" NSW10934	aff.13
114	46	140	" NSW10934	aff.13
115	56	91	Stead 7	10a-b
116	100	80	" 7	10a-b
117	91	55	" 7	10a-b
118	100	105	" 7	10a-b
119	100	100	" 7	10a-b
120	100	105	" 7	10a-b
121	98	110	" 3	7 x 10
122	98	93	" 3	7 x 10
123	100	97	Cambage 1594	12a x ?15g
124	70	110	" 1594	12a x ?15g
125	99	100	" 1594	12a x ?15g
126	95	102	Woolls 3	12a
127	66	100	Martin MEL41614	11
128	98	100	Howitt MEL41681	11
129	100	100	Baeverlen NSW10885	11
130	100	100	Howitt 116	11
131	91	100	Findlay MEL41661	11
132	100	100	Anderson G	11
133	99	100	"	11
134	100	100	Anon. GH	11
135	95	100	Gaudichaud 144	11

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652
136	100	100	Martin MEL41660	11
137	100	100	Willis MEL41654	10-11
138	100	100	" MEL41654	10-11
139	99	100	Betche NSW10884	11
140	100	100	Ashby 4354	13
141	100	100	Barker 1174(1)	3a-d
142	94	100	" 1174(1)	3a-d
143	88	100	" 1175	3a-d
144	100	138	" 1175	3a-d
145	90	107	" 1175	3a-d
146	96	26	Wilhelmi W	15h
147	100	103	Mueller MEL41490	15h
148	95	100	Morrison BRI144805	15h
149	90	79	Barker 1174(2)	3a-d
150	little pollen		" 1174(2)	3a-d
151	67	106	" 1174(2)	3a-d
152	99	116	" 1174(2)	3a-d
153	42	103	" 1174(2)	3a-d
154	100	130	" 1174(2)	3a-d
155	little pollen		" 1174(1)	3a-d
156	72	55	" 1174(1)	3a-d
157	100	108	" 1173	3a-d
158	86	14	" 1173	3a-d
159	78	133	Edwards AD97347079	3d-e
160	100	106	" AD97347079	3d-e
161	100	118	" AD97347079	3d-e
162	57	175	" AD97347079	3d-e
163	99	109	Barker 1174(2)	3a-d
164	90	114	" 1174(2)	3a-d
165	98	124	Edwards AD97347079	3d-e
166	84	105	" AD97347079	3d-e
167	86	124	" AD97347079	3d-e
168	91	68	Stuart 1744	IIN3
169	53	109	Barker 1703A	15m
170	100	150	" 1640	15g
171	100	150	" 1640	15g

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Voucher slide no. (PS--)	Estimated per-centage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
172	100	120	Barker 1695	15g
173	100	150	" 1695	15g
174	100	107	" 1690	15g
175	100	110	" 1690	15g
176	100	130	" 1565	15g
177	100	115	" 1542	15g
178	100	160	" 1542	15g
179	100	140	" 1528	15g
180	95	110	" 1528	15g
181	100	132	Maiden NSW10912	15 aff.k
182	100	100	Barker 1113	15b
183	93	100	" 1112	15b
184	75	100	" 1112	15b
185	94	100	" 1112	15b
186	5	100	" 1112	15b
187	100	112	" 1112	15b
188	57	105	" 1112	15b
189	5	100	" 1112	15b
190	95	100	" 1112	15b
191	99	100	" 1113	15b
192	73	216	" 1113	15b
193	95	100	" 1113	15b
194	100	100	" 1112	15b
195	98	100	" 1112	15b
196	84	123	" 1078	15b
197	72	100	" 1113	15b
198	33	100	" 1078	15b
199	91	100	" 1078C	15b
200	100	100	" 1078D	15b
201	100	40	" 1079	15b
202	79	100	" 1079	15b
203	100	100	" 1080C	15b
204	98	100	" 1080	15b

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
205	100	100	Barker 1141	15b
206	90	100	" 1141	15b
207	85	100	" 1141	15b
208	96	100	" 1141	15b
209	81	100	" 978A	15a-b
210	69	100	" 978B	15a-b
211	56	103	" 978C	15a-b
212	98	123	" 1138	15a-b
213	100	125	" 1138	15a-b
214	78	103	" 1138	15a-b
215	51	101	" 1149	15a-b
216	92	105	" 1149	15a-b
217	100	106	" 1128	15b
218	56	117	" 1128	15b
219	98	126	" 1128	15b
220	100	130	" 1137	15b
221	15	121	" 1137	15b
222	96	109	" 1122	15b
223	100	119	" 1122	15b
224	100	115	" 1122	15b
225	100	127	" 1122	15b
226	2	102	" 1040(p.p.)	4 x 15b
227	13	105	" 1040(p.p.)	4 x 15b
228	97	115	" 1040(p.p.)	4
229	6	71	" 1048	4 x 15b
230	0	111	" 995B	4 x 15b
231	1	103	" 1065	4 x 15b
232	97	109	" 1042	15b
233	100	142	" 1049(1)	15b
234	25	100	" 1049(2)	15b
235	72	118	" 1049(3)	15b
236	12	121	" 1062	15b
237	94	119	" 1062I	15b

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
238	44	128	Barker 1062	15b
239	97	117	" 1062	15b
240	100	110	" 1062	15b
241	75	139	" 1002C	15b
242	75	132	" 1002	15b
243	98	129	" 1002A	15b
244	96	107	" 1001B	15b
245	97	102	" 1001A	15b
246	90	113	" 1001C	15b
247	75	102	" 1001C	15b
248	81	113	" 1000A	15b
249	87	96	" 1000E	15b
250	81	94	" 1003A	15b
251	100	110	" 1003D	15b
252	93	110	" 1003B	15b
253	100	100	" 1105	15b
254	100	100	" 1105	15b
255	100	105	" 1061A	4
256	99	99	" 1061D	4
257	88	95	" 1061B	4
258	85	98	" 994	4
259	98	102	" 994	4
260	100	120	" 994	4
261	3	117	" 1052B	4 x 15b
262	0	105	" 1052A	4 x 15b
263	75	100	" 1021	4 x 15b
264	15	100	" 1044	4 x 15b
265	4	97	" 1044A	4 x 15b
266	99	100	Phillips CBG015462	15 aff.b
267	0	108	Rodway NSW22281	4 x 15b
268	90	115	Rodway NSW22281	4
269	97	100	Rodway NSW22281	4
270	99	100	Curtis 5.iii.1949	4

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
271	97	109	Comber 2167	aff.4
272	97	99	Rodway NSW22280(p.p.)	IIN2
273	90	99	Stuart 1744	IIN3
274	65	130	Barker 1113	15b
275	45	100	" 1112	15b
276	95	100	" 1112	15b
277	99	100	" 1112	15b
278	74	82	" 1112	15b
279	99	100	" 1112	15b
280	100	100	" 1112	15b
281	95	100	" 1112	15b
282	99	100	" 1112	15b
283	97	100	" 1112	15b
284	93	100	" 1112	15b
285	95	100	" 1112	15b
286	95	100	" 1513A	15N3
287	99	100	" 1513	15N3
288	98	100	" 1513	15N3
289	98	100	" 1479	15N3
290	98	100	" 1479	15N3
291	3	100	" 1479	15N3
292	77	120	" 1479	15N3
293	99	100	" 1479	15N3
294	100	100	" 1480	15N3
295	100	100	" 1480	15N3
296	100	122	" 1480	15N3
297	96	115	" 1483A	15N3
298	98	98	" 1483	15N3
299	67	102	" 1484	15N3
300	84	118	" 1484	15N3
301	94	104	" 1484	15N3
302	97	104	Beauglehole 40773	15N3
303	100	113	Willis MEL41564	15N3

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Voucher slide no. (PS--)	Estimated per-centage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
304	96	114	Willis MEL41564	15N3
305	96	111	Barker 1665	15m
306	93	109	" 1665	15m
307	100	113	" 1665	15m
308	96	109	" 1665	15m
309	98	98	" 1665	15m
310	98	100	" 1665	15m
311	57	53	" 1672	15g x m
312	24	254	" 1666(p.p.)	15g x m
313	86	111	" 1666(p.p.)	15g
314	44	73	" 1666(p.p.)	15g x m
315	52	97	" 1667	15g x m
316	35	105	" 1667	15g x m
317	0	101	" 1667	15g x m
318	27	121	" 1667	15g x m
319	28	100	" 1668(p.p.)	15g x m
320	43	156	" 1668(p.p.)	15g x m
321	97	107	" 1668(p.p.)	15g
322	85	102	" 1668(p.p.)	15g
323	97	139	" 1670(p.p.)	15g
324	95	99	" 1670(p.p.)	15g
325	93	96	" 1670(p.p.)	15g
326	16	121	" 1670(p.p.)	15g x m
327	4	104	" 1671	15g x m
328	28	101	" 1671	15g x m
329	no pollen		" 1671	15g x m
330	18	218	" 1671	15g x m
331	75	104	" 1666(p.p.)	15g x m
332	96	111	" 1666(p.p.)	15g
333	91	108	" 1666(p.p.)	15g
334	100	120	" 1666(p.p.)	15g
335	100	70	" 1699	15m
336	92	103	" 1149A	15a-b

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Voucher slide no. (PS--)	Estimated percentage of functional pollen	Sample size	Herbarium sheet	Taxon (see index page 652)
337	87	106	Barker 1168	3i
338	100	109	" 1684	15m(T)
339	86	100	" 1685	15o
340	96	104	" 1685	15o
341	56	116	" 1685	15o
342	82	97	" 1685	15o
343	68	103	" 1685	15o
344	70	101	" 1685	15o
345	81	102	" 1685	15o
346	96	114	" 1685	15o
347	100	104	" 1685	15o
348	100	118	" 1685	15o
349	100	111	" 1687	15m-o
350	91	98	" 1687	15m-o
351	97	98	" 1687	15m-o
352	100	120	" 1686	15m
353	100	99	" 1686	15m
354	97	116	" 1688	15m-o
355	100	64	Weymouth MEL41765	VN3

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INDEX TO NUMBERED COLLECTIONS

Included in this index are those (unnumbered) collections of Ferdinand von Mueller, which bear dates. This may prove useful as a source of information on the exact itinerary of this important Australian botanist.

The first-cited number is the collectors number (or date in the case of F. Mueller).

The second designation is the code of the taxon to which the collection belongs (see Index to the Main Treatments of the Australian Taxa of *Euphrasia*). Where the collection is referred to only in a Note under a particular taxon, the code of the taxon symbol N (=Note) and note number are given in the order. Type specimens (excluding paratypes) are designated by (T). Hybrids are designated with "x" between the pertinent taxa. Intermediates between taxa are designated "-" between the pertinent taxa. Where a collection is inadequate for determination to a lower rank than that shown this is designated by Q (=Questionable).

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Kaspiew 40/151, 66/151, 700/17c, 1365/15m, 1366/15m; Kraehenbuehl 138/15c, 1260/15c.

Labillardiere 29/15a, 43/15a; Lam 7517/15aff.a; Lawrence 213/3c; Lithgow 183/15g; Long 365/15a-b, 703/15a-b, 807/15a, 871/15a, 953/15a, 1037/15a, 1098/15b, 1117/4; Lothian 991/151; Lullfitz 3558/15c; Lynch 4/15g.

McBarron 2944/15g, 7273/15g, 7277/15g; McCann 2/11; McDonald 8/14, 19/151; McDonnell 468/15g; McGillivray 1/15aff.k; McKee 5768/15g, 7627/15g; McKie 2308/1; McMutt 66/15g; Malpas per Blandowsky 88/151; Martensz 455/15g, 456/15g;

Matthews 54/15a; Milligan 16(p.p.)/3b, 16(p.p.)/15b, 371/3e, 508/11, 766/3e, 766/4, 766/6, $\frac{766}{x}$/4, $\frac{766}{+}$/4, 767/6(T), 1178/15b; MM 599/15g, 600/15m, 601/15m, 2333/15g, 2333A/15g, 3040/15g; Moore 2269/15g, 2284/10a, 2286/15g, 2301/10a, 2334/15g, 2346/15g, 3027/15g, 3351/10a; J.B. Moore 12/6; Morris 1839/15g; Mue? 598/10a; F. Mueller 16.xii.1847/15l, -.xii.1847/15l, 2.iii.1848/15l, -.ix.1848/15g, 20.xii.1848/11, 22.xii.1848/11, -.xii.1848/11, -.ii.1849/11, -.x.1850/15h, 1851/15c, -.xii.1852/11, 26.iii.1853/11, -.iii.1853/15g, -.xi.1853/15g, -.xi.1853/15h, -.i.1854/-.ii.1854/10a, 1854/15l, -.i.1855/7(T), -.i.1855/7(T), -.i.1855/15o(T), 1855/7(?T), -.ix.1860/15a, -.xii.1860/3g, -.iii.1861/10a(T), -.x.1867/11, -.i.1869/15b, -.i.1869/3a, -.i.1869/4, -.i.1874/10a, 10.xii.1877/11; M. Mueller 1804/7, 1820/10a; Muir 344/9, 868/15a, 965/9, 1039/17b, 1086/15g, 1783/15c, 1840/15a, 2962/15g-h, 2697/15a, 3108/15g-h, 3261/10a.

Newman 80/15g.

Oakden 220/3c; Oldfield 13/6, 186/11, 186b/11; Ollerenshaw 228/10a, 238/10a; Olsen 39/3aff.h, 65/3aff.h, 169/15b; Orchard 1485/15c; O'Rourke per Howitt 48/15h.

Parsons 103/12a; Perrin per Rupp 2 (p.p.)/15a, 2 (p.p.)/15a, 15d; Phillips 7/15g, 55/15m, 79/15m, 87/3f(T), 94/15c, 174/15b, 219/15d, 225/15a, 242A/15a, 243/15a, 366/15c, 419/15c, 435/15c, 510/15a, 597/15c, 733/15a-b, 878/3a, 2375/15g; Porter 20/15g; Preiss 2337/11, 2338/15c; Pullen 92/10a, 112/15g, 2327/15g, 2478/15g, 2949/15g, 3792/14, 3861/15k; Pulley 671/14(T), 705/14.

Ratkowsky 598/15a; Rawes 34/15aff.h; Reader 9/15aff.h; Reik 037/14; Renfrey 36/11; Robbins 145/17a-c; Rodd 402/17c, 458/10a, 462/15g, 708/15m, 1608/15g; E. Rodway 162/15a; F.A. Rodway 893/15k, 1411/5, 6680/11, 14398/11; Rupp 2 or 1/15N5, 1/15j, 1/15g, 2/15m, 3/15a, 4/15e, 22/15j, Rupp per Sivyer 3/14; Royce 8748/15c.

Salasoo 3568/10a, 3575/15m; Schodde 1290/10a; Sharrad 1045/15c, 1060/15c, 1096/15c; Short, Short & Grubb 2/151; Sieber 182/15g, 183/15k, 490/12a, 507/15k, 629(p.p.)/15g, 629(p.p.)/15k; A. Simson 58/15N2(T), 105/15f, 402/15f(T), 1763(p.p.)/15a, 1763(p.p.)/15b; J.N. Simson 8/15g; D.T. Smith 309A/15c, T. Smith 770/15c; Specht & Rayson 66/15c; Stead 1/15g, 2/15m, 3/7 x 10, 4/10a, 5/15m, 7/10a-b, 8/10b(T), 9/15m; Stirling 5/15m, 166/15h, 293/10a; Stuart 49/12a, 83/3q, 199/15g, 324/4, 394/12a, 426/11, 428/15b, 671-672-717(p.p.)/15a, 671-672-717(p.p.)/15aff.b, 671/15a, 672/15a, 717/15aff.b, 943/15N1, 949/15g, 1744(p.p.)/IIN3, 1744(p.p.)/15Q 1745/3b(T), 1863/6; Sullivan 4/11, 43/15aff.h, 56/15a, Sullivan & Coates 67/15b; Swain 12/15g; Symon 13/15c, 187/15a, 263/15d, 8497/15c.

Tadgell A/17a, B/17a, C/17a; Telford 2196/3a, Telford per Canning 211/4, 2233/3a-d, 2408/3d, 2481/3aff.h, 2593/15b, 2715/4; Tepper 48/151, 49/151, 61/151, 106/151, 374/151, 1150/151; Thompson 27/15g, 379/7; Thorn 27/15aff.a; Tilden 770/15a; Tisdale 10/15aff.a; Totterdell 27/15n, 55/7, 92/7, 148/15m, 165/15o, 212/15m, 270/15n, 304/15c; Treyvaud 2/11.

Verreaux 50/15k, 50/15a.

Walker ANU970/15m, ANU978/15o; Walter 2005/15b, 2044/4, 3158/15o, 3188/15g, 15m; Wawra 534/15aff.a; Webb 3375/4; Weber 1793/15a; Weindorfer 77(p.p.)/15aff.a, 77(p.p.)/15d, 77(p.p.)/15h; Whaite 1518/15a, 1978/17a-c, 2173/15b, 2257/3aff.h, 2262/3aff.h, 2267/3aff.h, 3232/3g; Whan 169/11; Whibley 1278/151, 1507/151, 1559/151, 4155/151; White 11596/14; B. Williams 1410/10a; J.B. Williams & Winterhalder 649/15g; P.Wilson 345/15c, 901/15c, 1970/15c, 2090/15c; W.B. Wilson 29/11; Woolls 3/12a; Wrigley 5256/15c, 7650/15c, 7913/15c, 7979/15a.

Yapp 13/15g.

INDEX TO SCIENTIFIC PLANT NAMES

NAMES:

The single underlining of a name of Euphrasia indicates that it is accepted in this treatment.

The absence of underlining of a name indicates that it is not accepted.

The genera are listed in alphabetical order.

Names of infrageneric taxa are listed in capitals in alphabetical order immediately after the genus.

Specific epithets are listed alphabetically under the genus and are preceded by "--".

Infraspecific taxa are listed alphabetically under the species and are preceded by "x".

! indicates a new taxon, new name, new combination or new status.

PAGE NUMBERS:

Double underlining indicates the location of the main taxonomic treatment.

Single underlining indicates a location in a key.

Rounded brackets indicate that the name has been treated as a synonym or misapplied name.

Square brackets indicate that the name is non-validly published (i.e. manuscript names, nomina nuda, etc.).

INDEX TO THE MAIN TREATMENT OF THE AUSTRALIAN TAXA OF *EUPHRASIA*

FIGURE 10

Distribution of the three species of Sect. Cuneatae

E. cuneata

(after Ashwin 1961) ——

E. durietziana ●

E. phragmostoma ▲

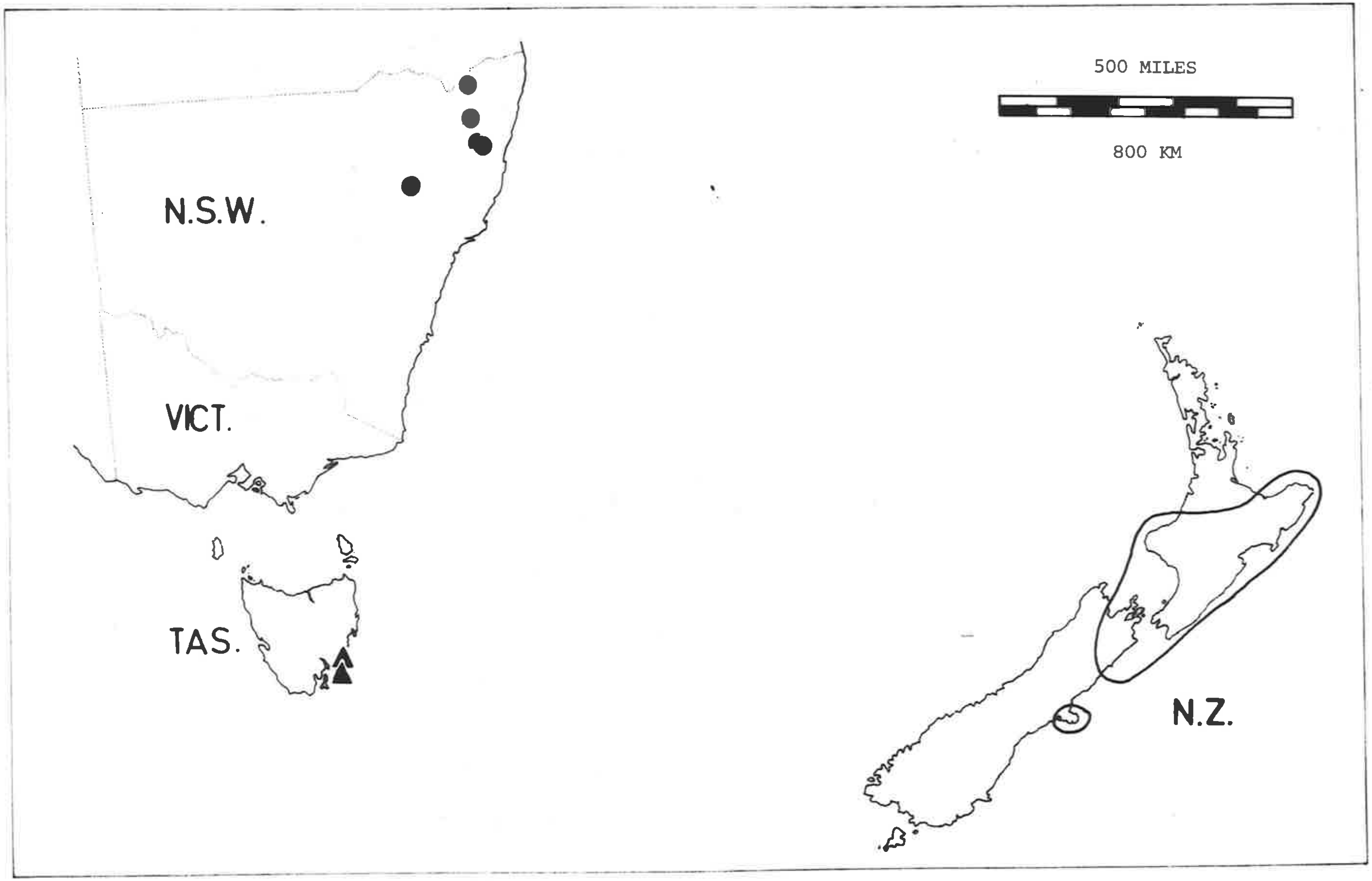

500 MILES
800 KM
N.S.W.
VICT.
TAS.
N.Z.

FIGURE 11

Distribution of taxa in Sect. *Striatae* Subsect. *Striatae*

UPPER

E. gibbsiae	
ssp. *gibbsiae*	▲
ssp. *psilanthera*	■
ssp. *wellingtonensis*	●
Doubtful locality of ssp. *wellingtonensis*	×
3000 feet (910m) contour	—

LOWER

E. gibbsiae	
ssp. *gibbsiae* - ssp. *comberi*	+
ssp. *comberi*	▲
ssp. *comberi* - ssp. *kingii*	×
ssp. *kingii*	●
ssp. *microdonta*	■
3000 feet (910m) contour	—

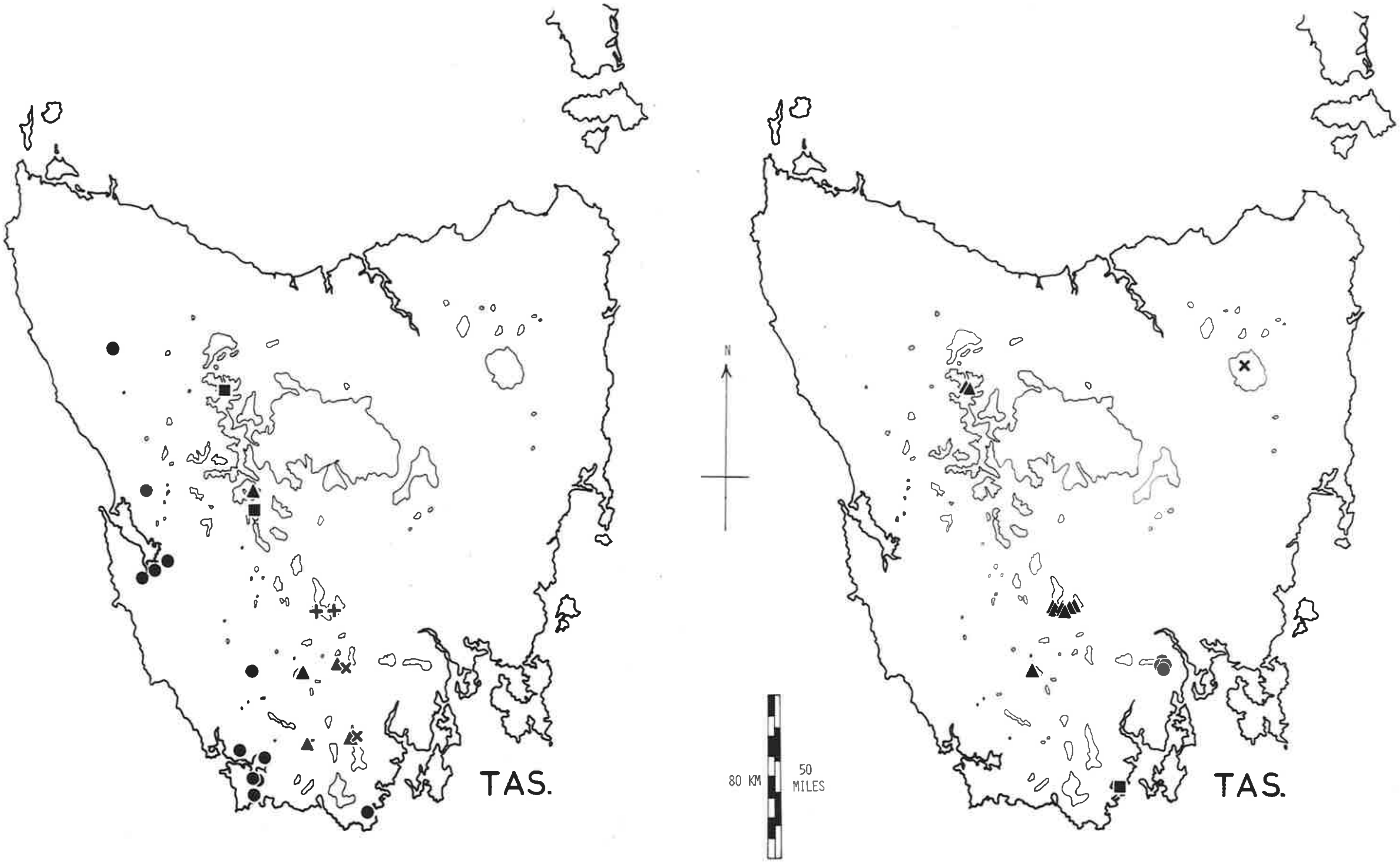
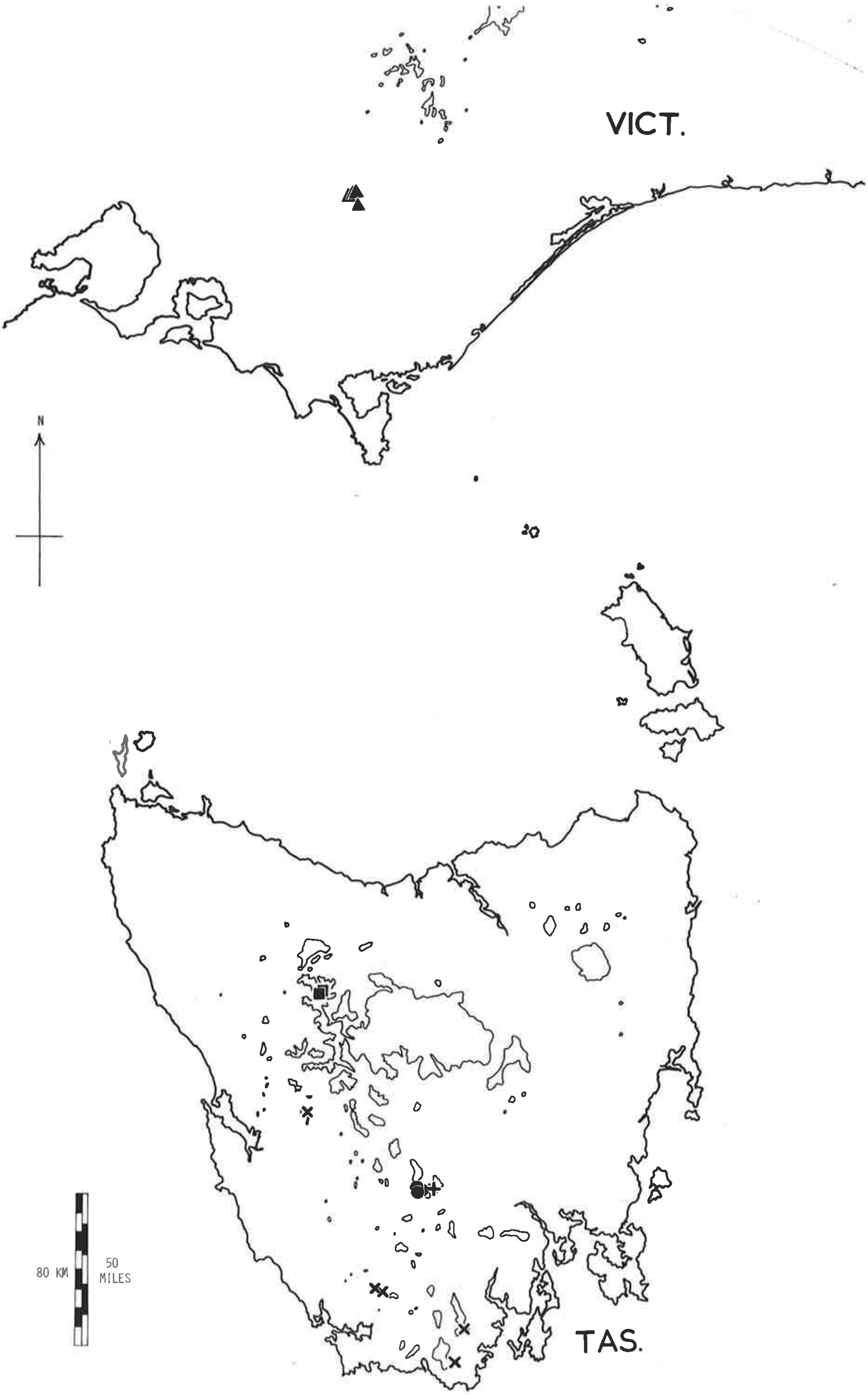

TAS.
N
80 KM
50
MILES
TAS.

FIGURE 12

Distribution of taxa in Sect. *Striatae* Subsect. *Striatae*

E. gibbsiae	
ssp. *subglabrifolia*	▲
aff. ssp. *subglabrifolia*	+
ssp. *discolor*	■
aff. ssp. *discolor*	×
ssp. *pulvinestris*	●
3000 feet (910m) contour (Tas.) 5000 feet (1520m) contour (Vict.)	—



VICT.
N
80 KM
50
MILES
TAS.

FIGURE 13

Distribution of taxa in Sect. *Striatae* Subsect. *Striatae*

UPPER

E. striata	▲
E. striata x *E. collina* ssp. *diemenica*	✕
3000 feet (910m) contour	—

LOWER

E. semipicta	●
E. ?sp. indescr. [see Sect. *Striatae*: Note 2]	■
E. hookeri	▲
Doubtful locality of *E. hookeri*	✚
E. sp. aff. *E. hookeri* [see Sect. *Striatae*: Note 1]	✕
3000 feet (910m) contour	—

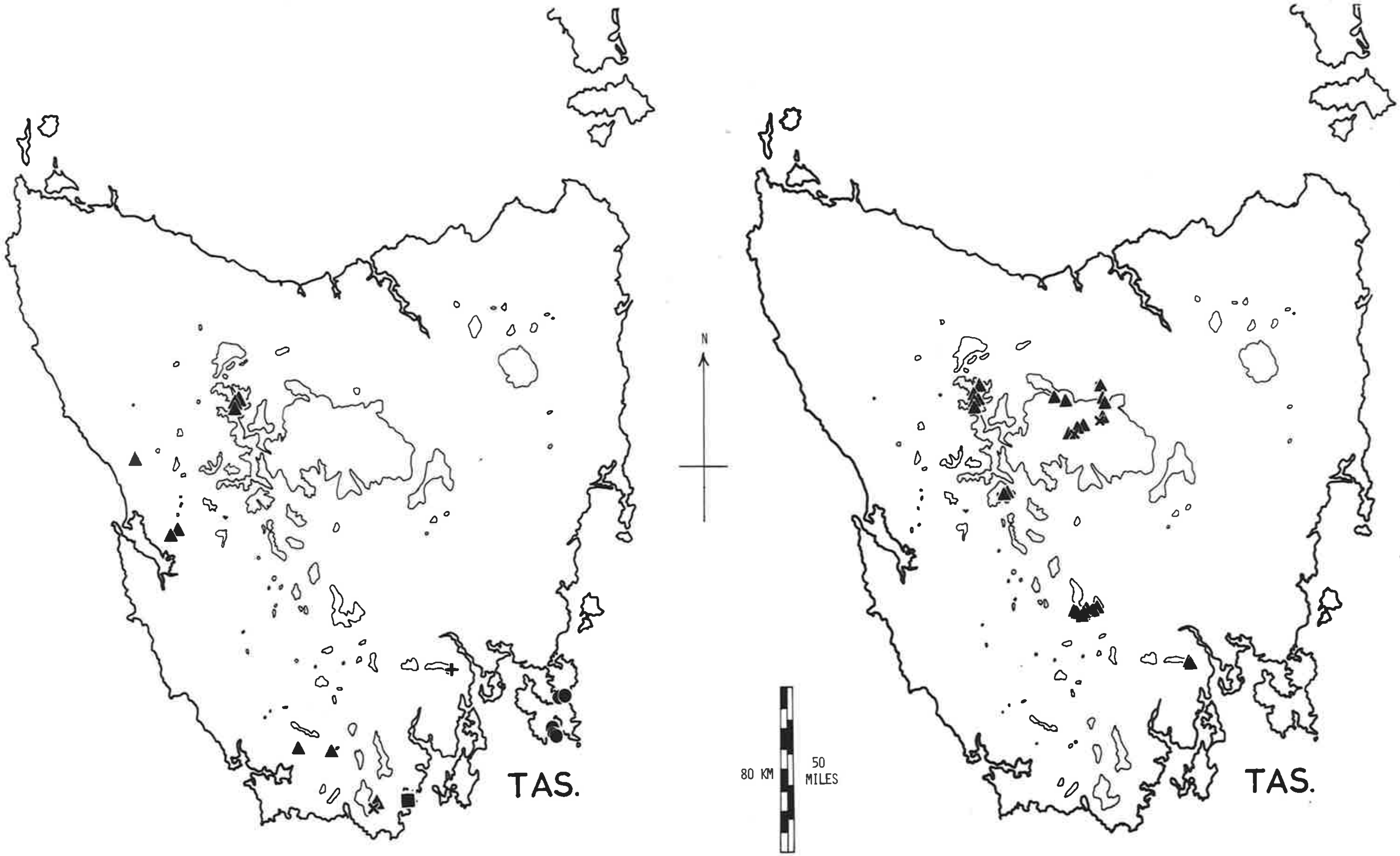

TAS.
N
80 KM
50
MILES
TAS.

FIGURE 14

UPPER

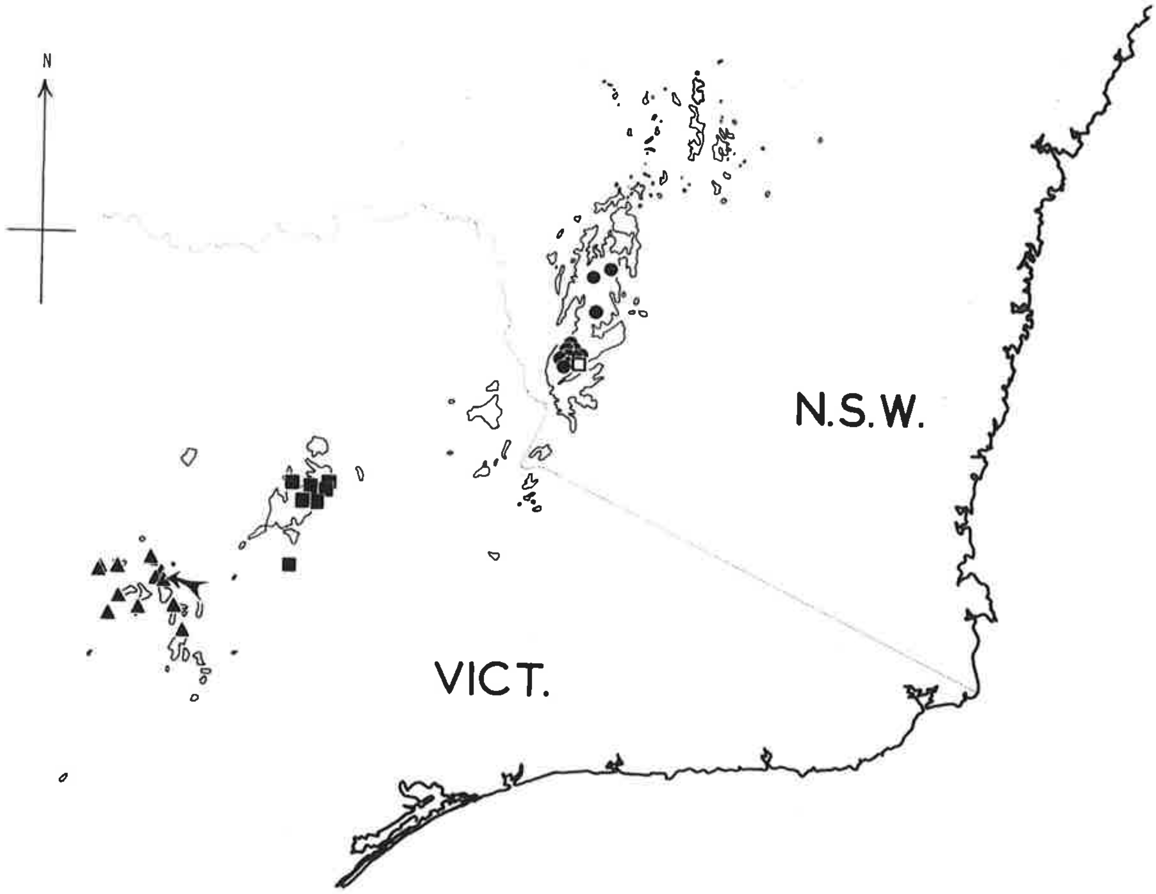
Distribution of the three species of Sect. *Lasiantherae*

E. alsa	●
E. alsa x *E. caudata* ssp. *caudata*	□
E. eichleri	■
Doubtful locality of *E. eichleri*	◘
E. lasianthera	▲
E. lasianthera x *E. collina* ssp. *paludosa*	
5000 feet (1520m) contour	—

LOWER

Distribution of taxa in Sect. *Scabrae*

E. caudata	
ssp. *nana*	△
ssp. *caudata*	▲
ssp. *nana* - ssp. *caudata*	
5000 feet (1520m) contour	—


N
N.S.W.
VICT.

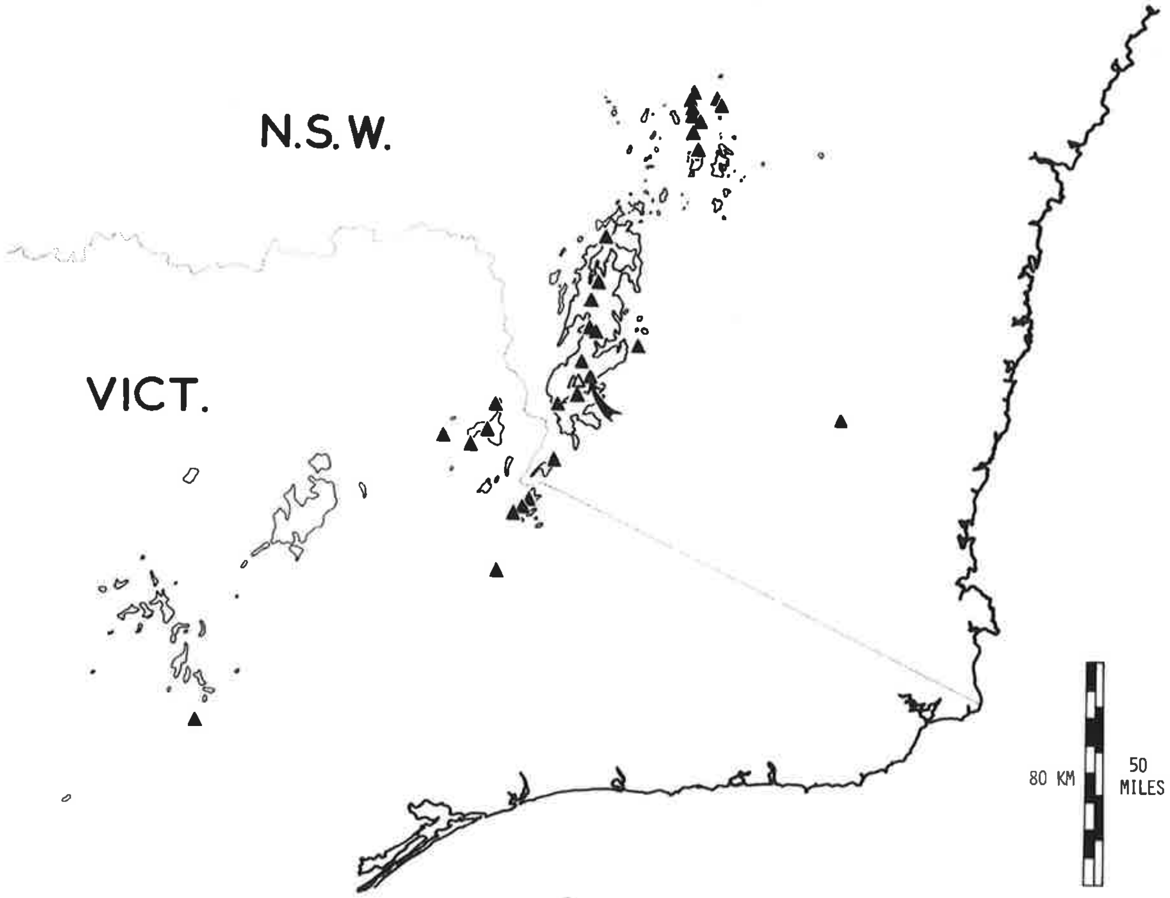

N.S.W.
VICT.
80 KM
50
MILES

FIGURE 15

Distribution of taxa in Sect. Scabrae

E. scabra	▲
Specimens of E. scabra approaching E. caudata	+

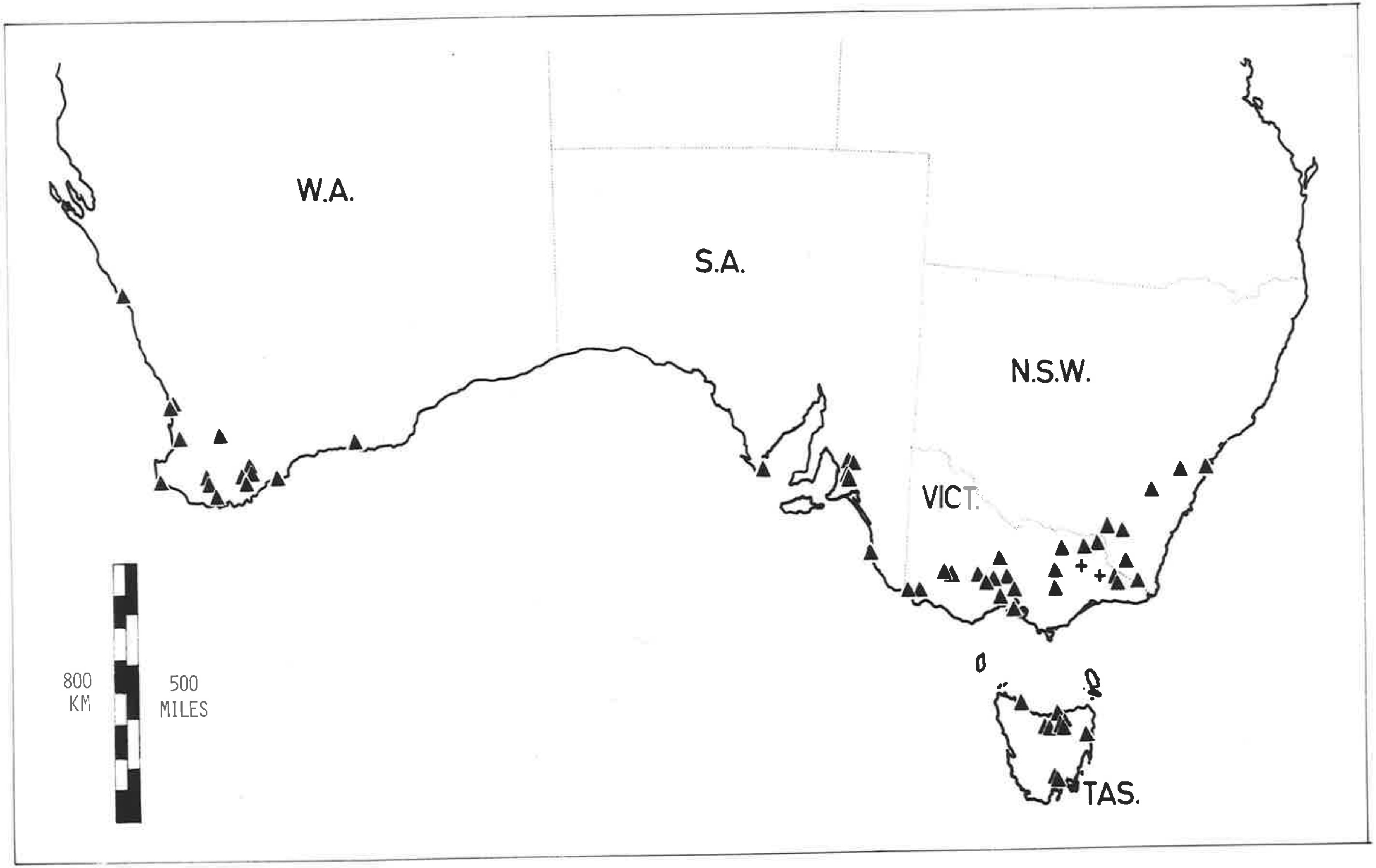

W.A.
S.A.
N.S.W.
VICT.
TAS.
800
KM
500
MILES

FIGURE 16

Distribution of taxa in Sect. *Scabrae*

E. scabra - northernmost locality	■
E. orthocheila	
var. *orthocheila*	▲
var. *peraspera*	△
Doubtful Castlereagh locality of var. *orthocheila*	A
Doubtful Orange locality of var. *orthocheila*	B
E. orthocheila var. *orthocheila* x ?*E. collina* ssp. *paludosa*	←
E. arguta	×
E. ciliolata	●
3000 feet (910m) contour	—


QLD.
N.S.W.
N
B
A
80 KM
50
MILES

FIGURE 17

Distribution of taxa in Sect. *Australes*

UPPER

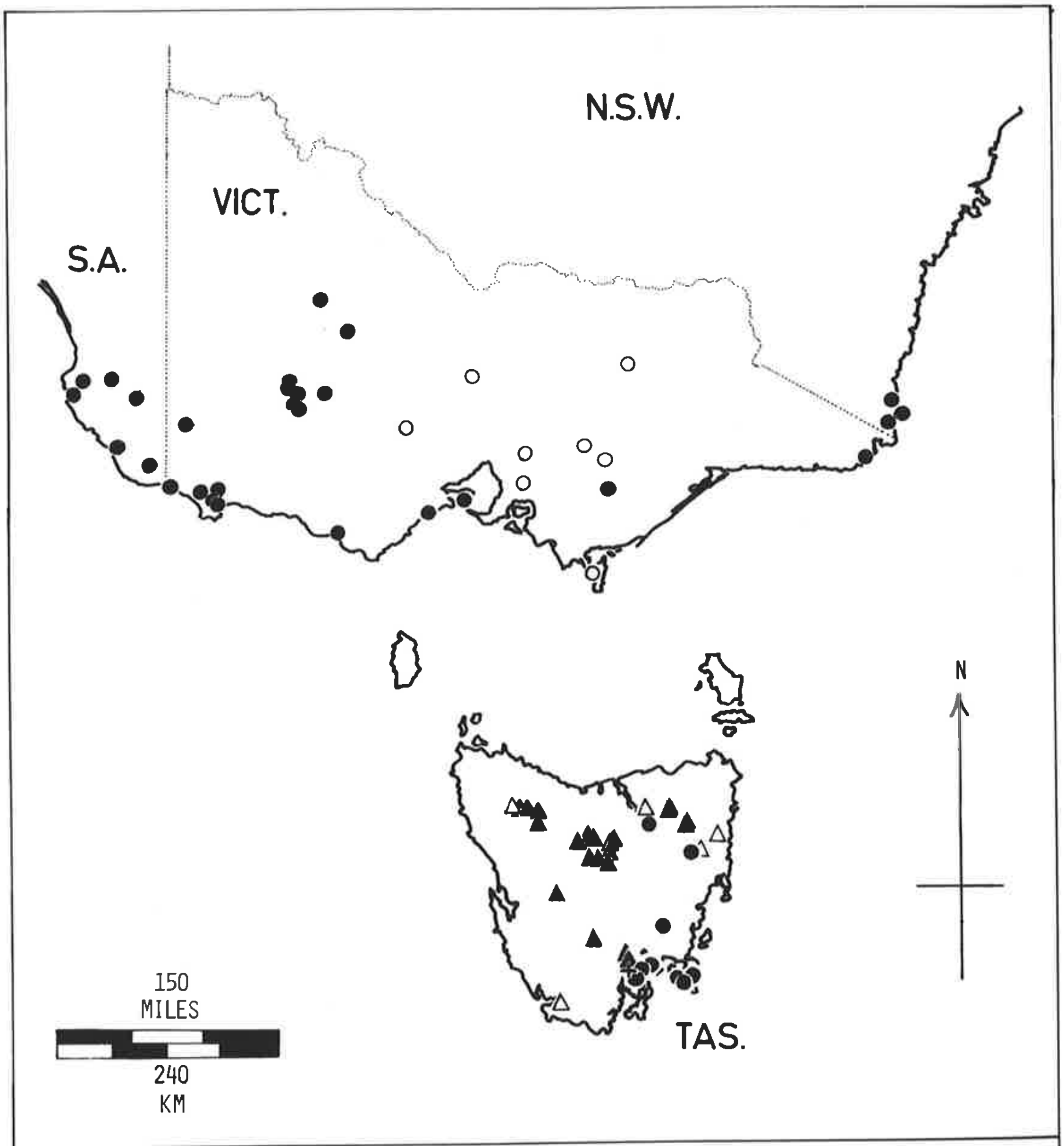
E. collina

ssp. *collina*	●
aff. ssp. *collina*	○
ssp. *diemenica*	▲
aff. ssp. *diemenica*	△
ssp. *collina* - ssp. *diemenica*	+

LOWER

E. collina

ssp. *tetragona*	●
Possible relict occurrences of ssp. *tetragona*	○
Doubtful Wilsons Promontory locality of ssp. *tetragona*	+
Doubtful Parramatta locality of ssp. *tetragona*	×
?ssp. indescr. [see *E. collina*: Note 1]	▲


N.S.W.
VICT.
S.A.
N
150
MILES
240
KM
TAS.

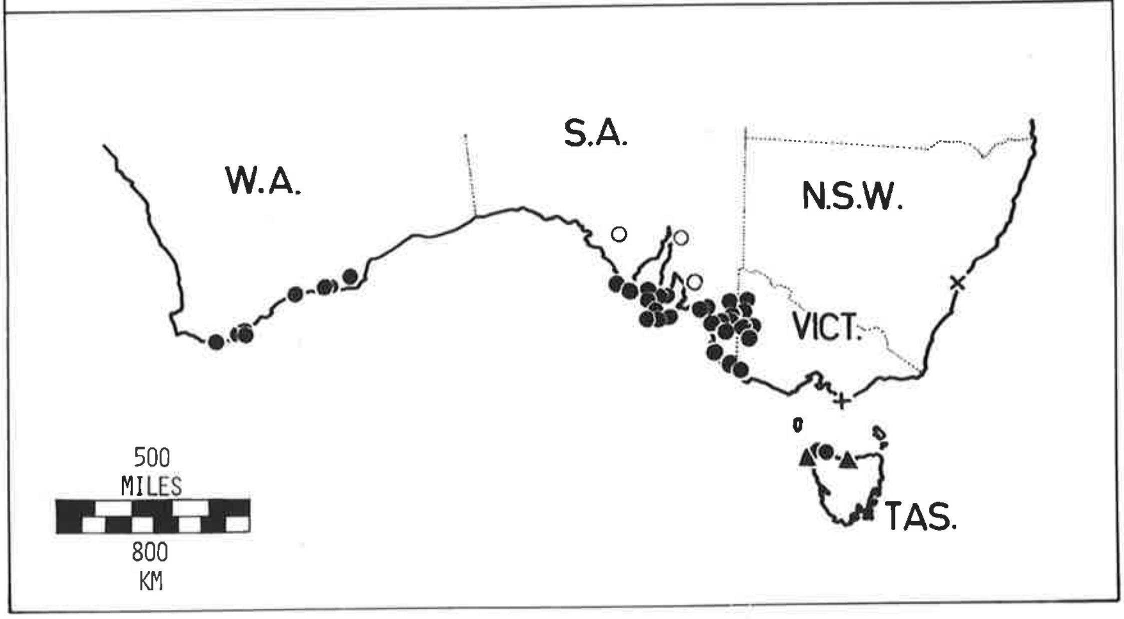

S.A.
W.A.
N.S.W.
VICT.
TAS.
500
MILES
800
KM

FIGURE 18

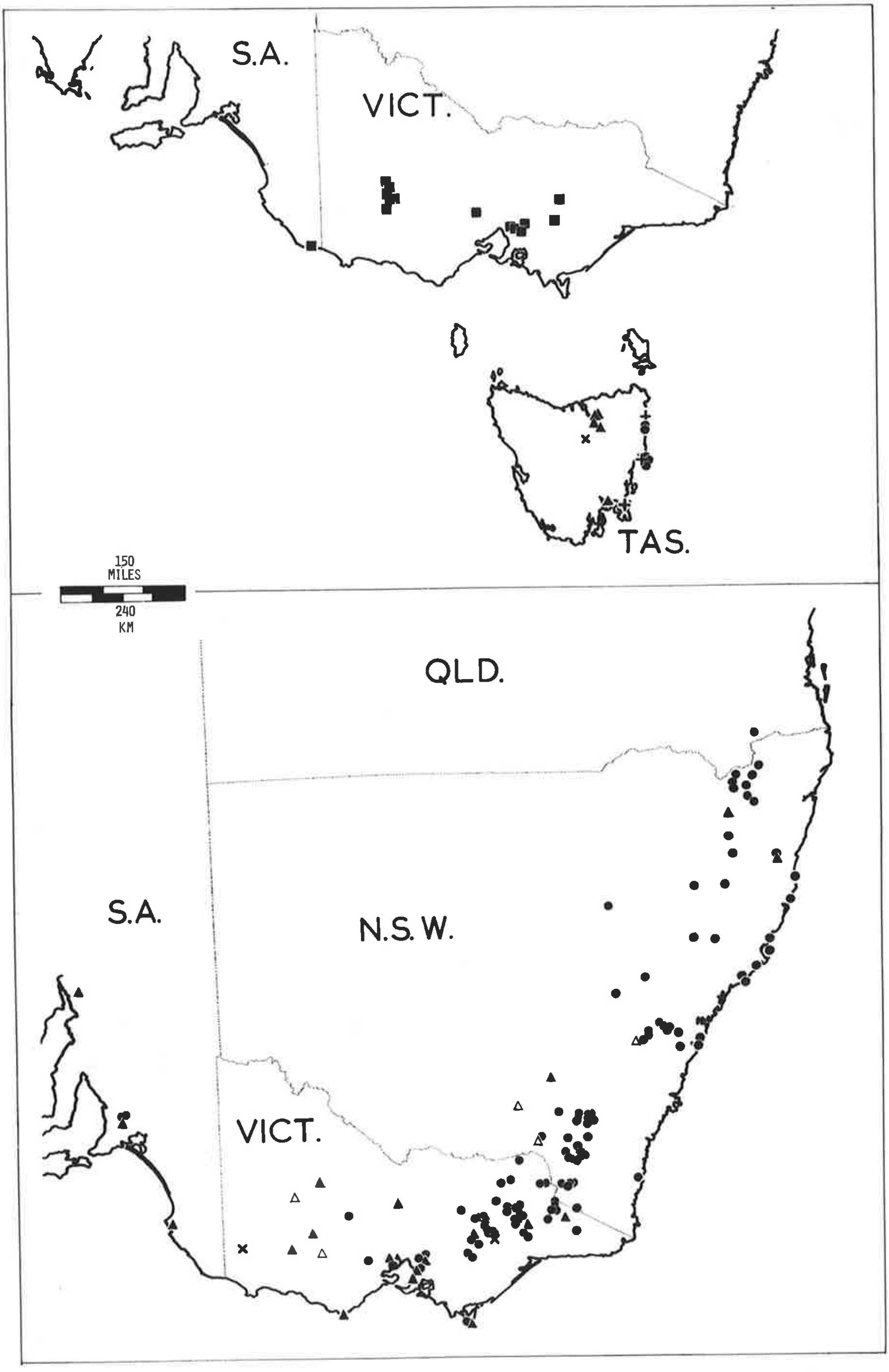
Distribution of taxa in Sect. *Australes*

UPPER

E. collina	
ssp. *trichocalycina*	■
ssp. *gunnii*	▲
ssp. *gunnii* - ssp. *diemenica*	×
ssp. *deflexifolia*	●
?ssp. indescr. [see *E. collina*: Note 2]	+

LOWER

E. collina	
ssp. *paludosa*	●
Doubtful locality of ssp. *paludosa*	+
ssp. *paludosa* - ssp. *muelleri*	×
ssp. *muelleri*	▲
aff. ssp. *muelleri*	△



S.A.
VICT.
TAS.
150
MILES
240
KM
QLD.
S.A.
N.S.W.
VICT.

FIGURE 19

Distribution of taxa in Sect. *Australes*

UPPER

E. collina	
ssp. *bowdeniae*	■
?ssp. indescr. [see *E. collina*: Note 5]	▲
ssp. *nandewarensis*	●
E. bella	□

LOWER

E. collina	
ssp. *speciosa*	▲
aff. ssp. *speciosa*	△
ssp. *osbornii*	●

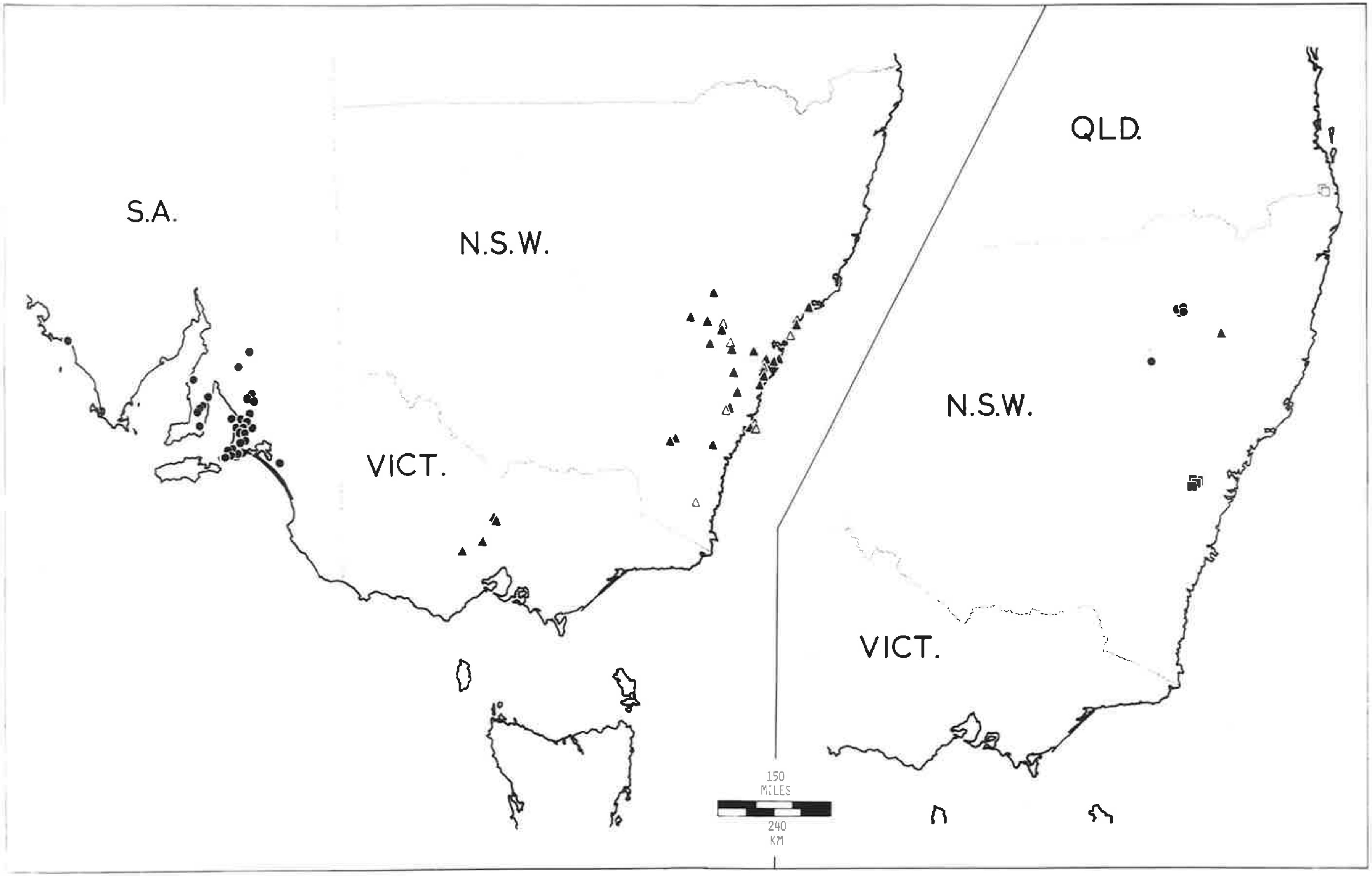

S.A.
N.S.W.
VICT.
QLD.
N.S.W.
VICT.
150
MILES
240
KM

FIGURE 20

Distribution of taxa in Sect. Australes

E. collina	
?ssp. indescr. on Mt. Wellington-Mt. Howitt [see E. collina: Note 3]	+
ssp. diversicolor	■
aff. ssp. diversicolor	×
Doubtful locality of ssp. diversicolor	←
ssp. lapidosa	▲
ssp. glacialis	●
E. crassiuscula	
ssp. crassiuscula	△
ssp. glandulifera	□
ssp. eglandulosa	○
5000 feet (1520m) contour	—

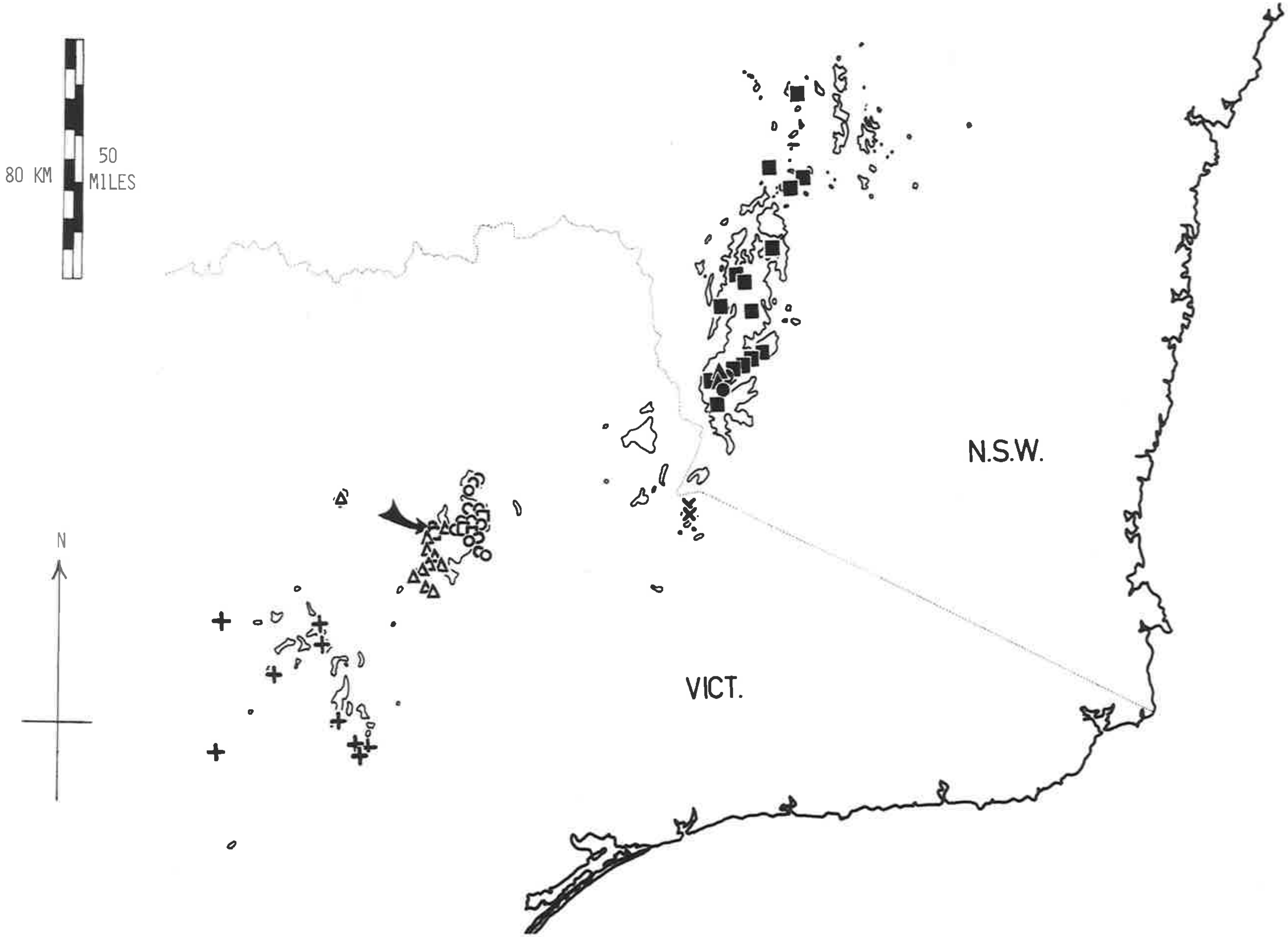
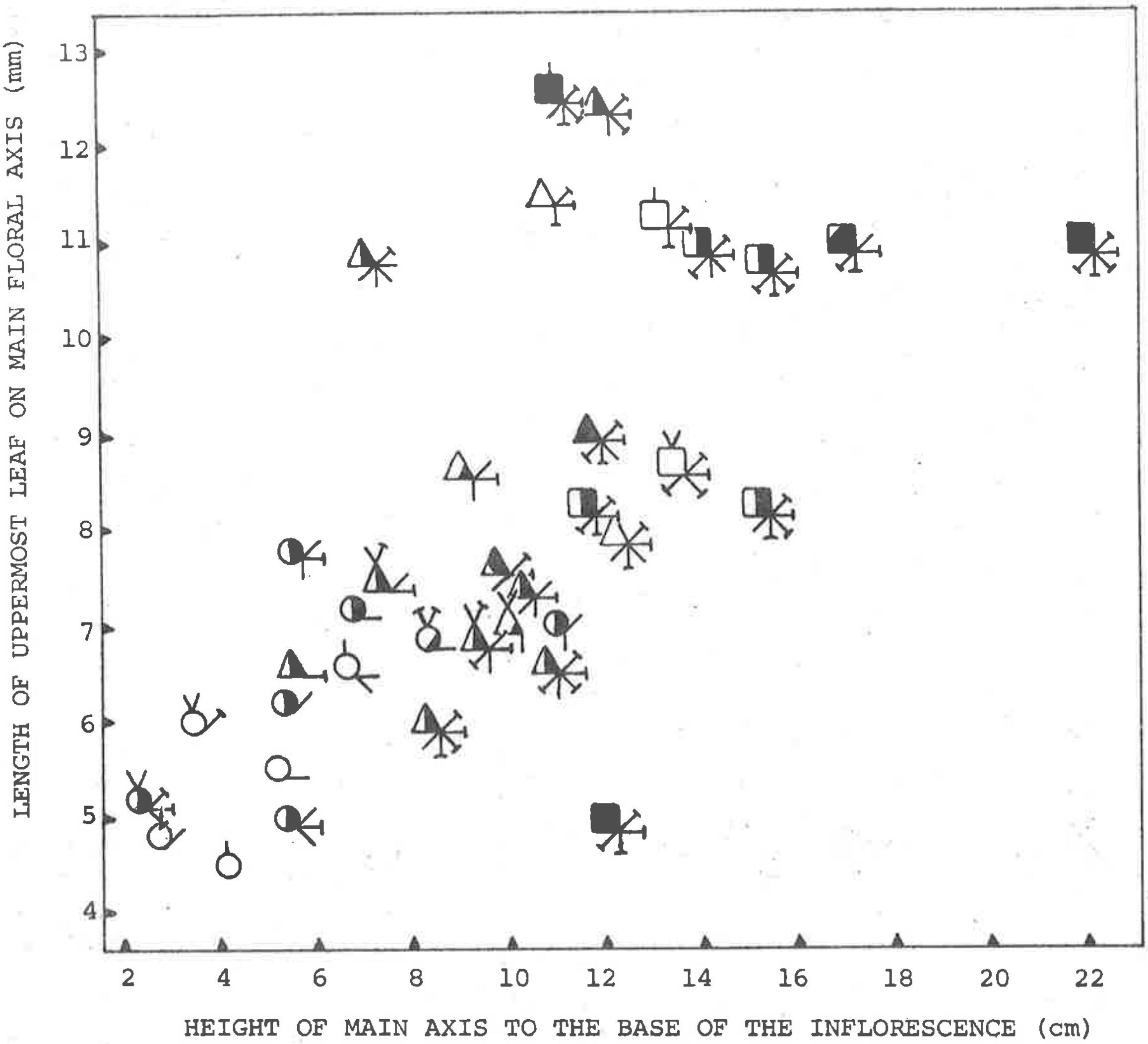

80 KM
50
MILES
N.S.W.
VICT.
N

FIGURE 21

Graph portraying the morphological intergradation between a population of *E. collina* ssp. *diversicolor* in tall alpine herbfield and a neighbouring population of ssp. *glacialis* in short alpine herbfield along an ecotone between the two habitats near the summit of Mt. Kosciusko. Each point represents a single individual.



EXPLANATION OF SYMBOLS

Location of plant

- Short alpine hbfld. (Barker 1685)
- Tall alpine hbfld. (Barker 1684, 1686)
- Ecotone (Barker 1687, 1688)

No. of teeth on uppermost leaves

1/1 1/2 2/2 2/3 3/3 or more

Corolla colour (from dried material)

white very pale lilac lilac

Length of anterior anthers (mm)

- 1.79 1.8 - 2.19 2.2 -

No. of hairs on anther backs

- 9 10 - 19 20 - ∞

Length of hairs on anther backs (mm)

-0.19 0.2 - 0.29 0.3 -

Indumentum of capsule apex

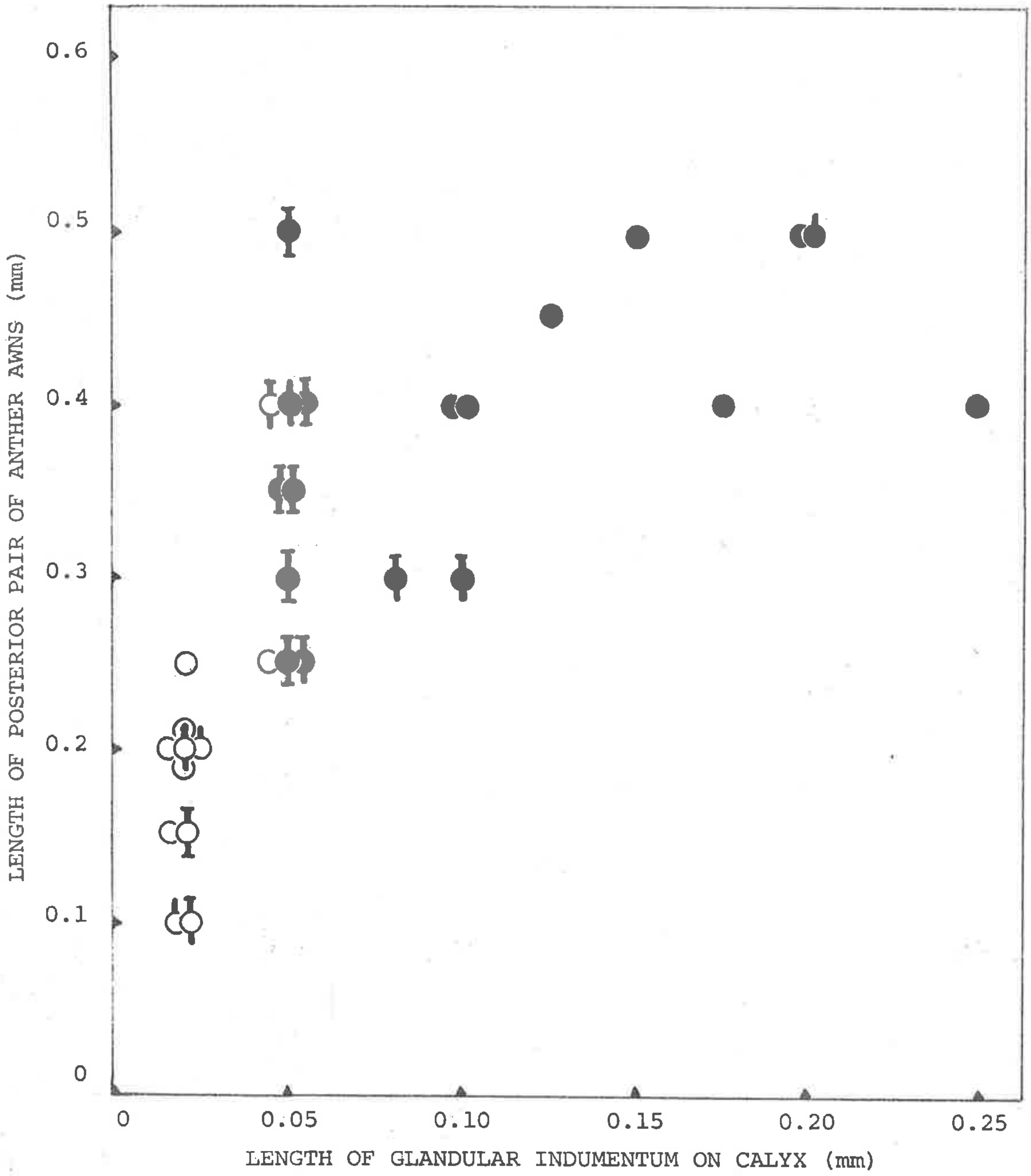
glabrous 1/2 setae mod. densely to densely setose

% pollen functional in appearance

90 - 100 %
70 - 89 %
50 - 69 %
30 - 49 %
0 - 29 %

FIGURE 22

Graph illustrating the variation in morphology and pollen sterility in a hybrid swarm between two subspecies, ssp. paludosa and ssp. diversicolor, of E. collina on the summit region of Mt. Jagungal. Each point on the graph represents a single individual.



EXPLANATION OF SYMBOLS

Yellow blotch on lower corolla lip

Present

Absent

Percentage of pollen functional in appearance

90 - 100%

70 - 89%

50 - 69%

30 - 49%

0 - 29%

FIGURE 23

Graph showing the variation in the lengths of the apex and longest tooth of the uppermost leaves of the main floral axis of <u>E. collina</u> ssp. <u>collina</u> in different geographical regions throughout its range of distribution.

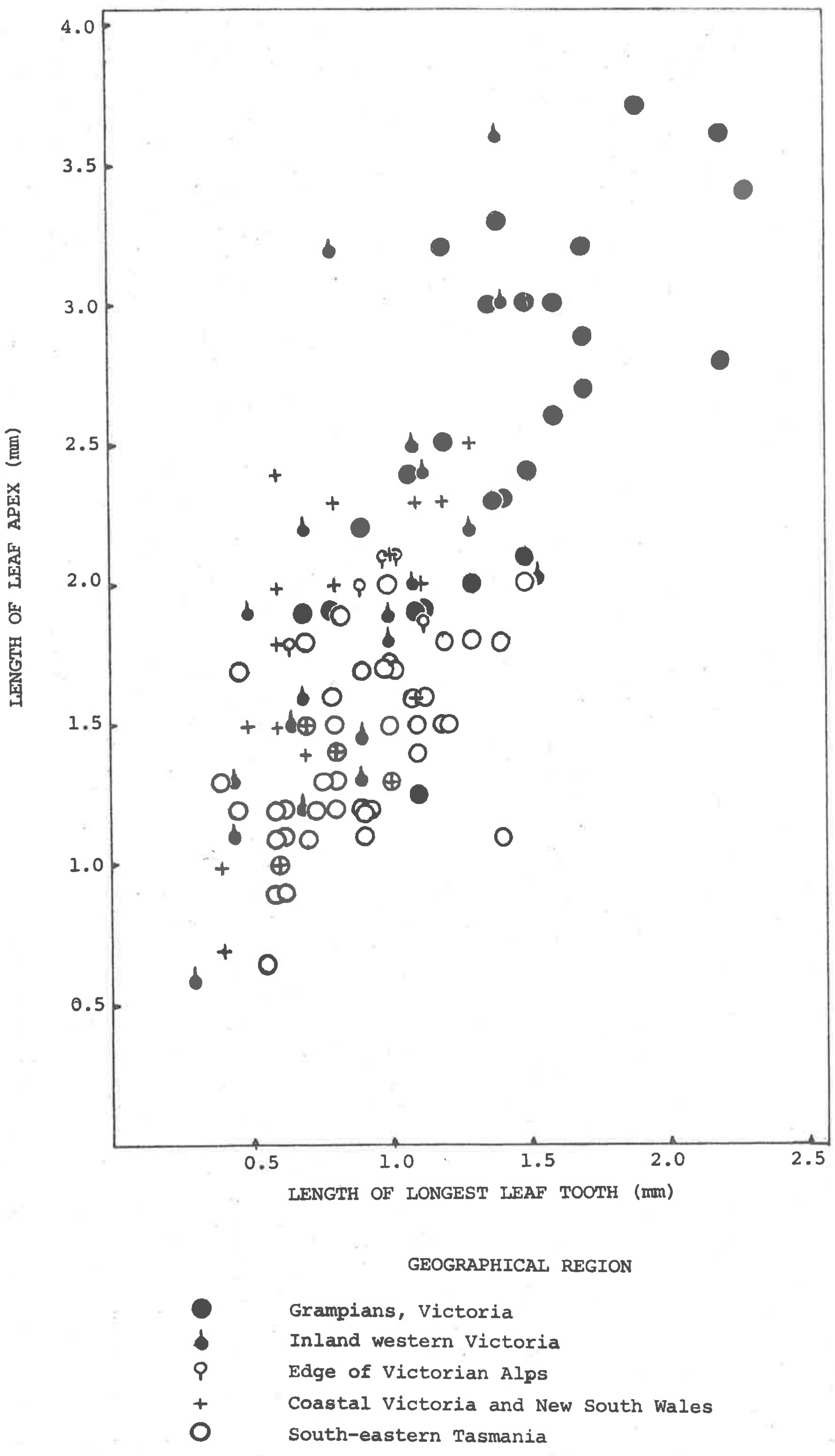
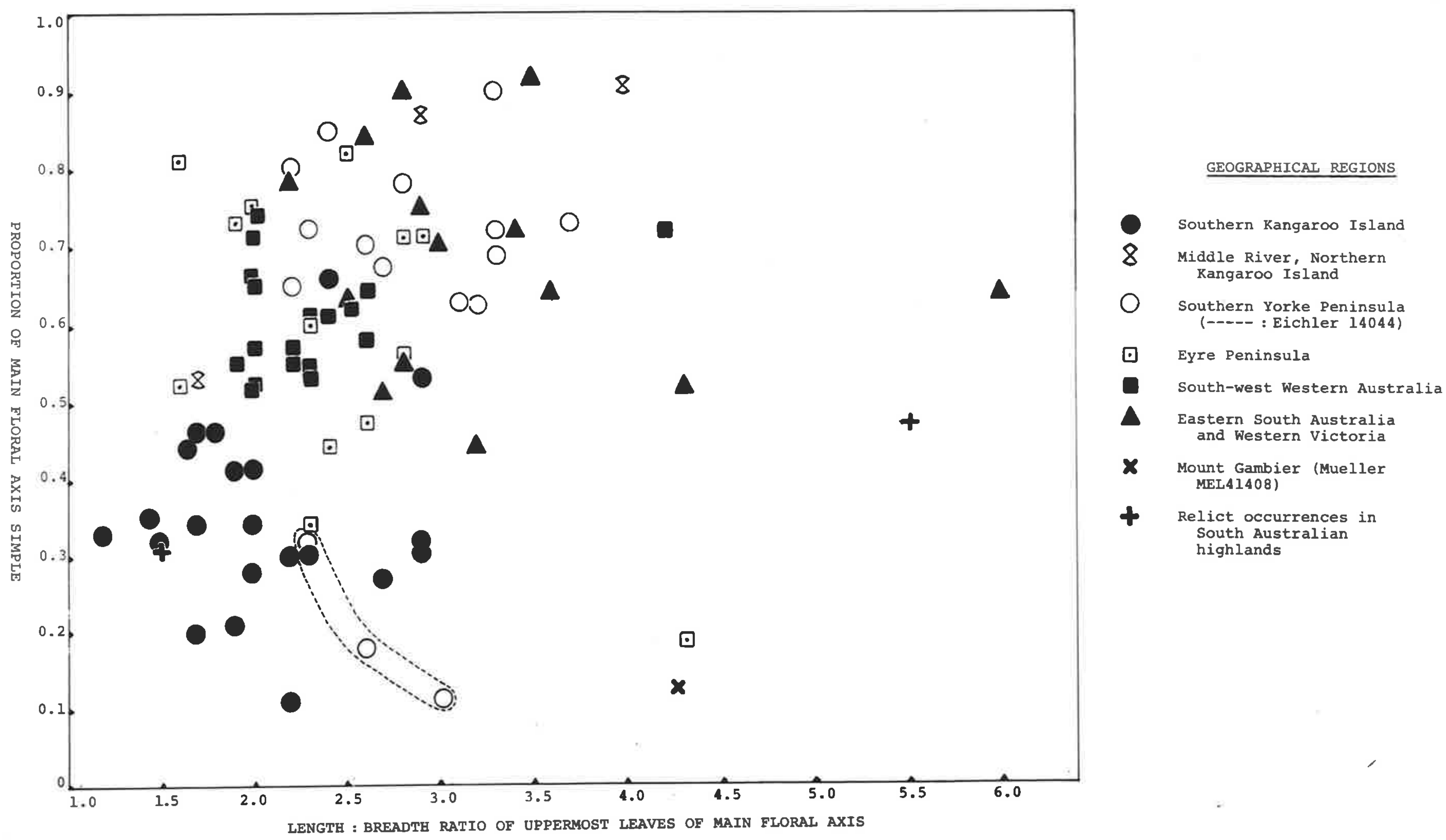

4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
LENGTH OF LEAF APEX (mm)
0.5
1.0
1.5
2.0
2.5
LENGTH OF LONGEST LEAF TOOTH (mm)
GEOGRAPHICAL REGION
Grampians, Victoria
Inland western Victoria
Edge of Victorian Alps
Coastal Victoria and New South Wales
South-eastern Tasmania

FIGURE 24

Graph portraying the variation in the shape of the uppermost leaves of the main floral axes (measured by the ratio of length : breadth) and the extent of branching above ground level on the main axes (measured by the proportion of the axis between ground level and the base of the inflorescence which is simple) in E. collina ssp. tetragona in different geographical regions of mainland Australia.

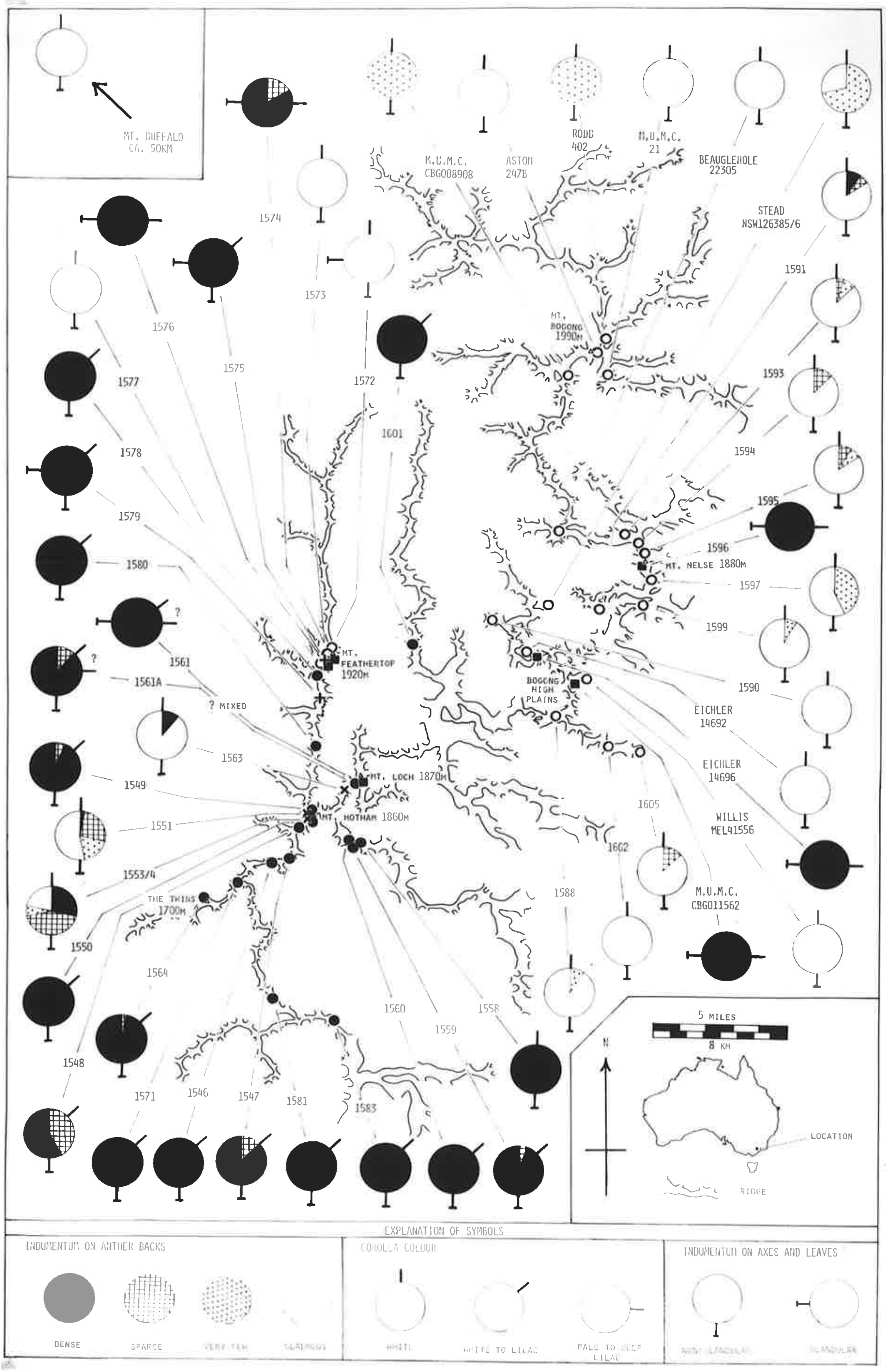


PROPORTION OF MAIN FLORAL AXIS SIMPLE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
LENGTH : BREADTH RATIO OF UPPERMOST LEAVES OF MAIN FLORAL AXIS
GEOGRAPHICAL REGIONS
Southern Kangaroo Island
Middle River, Northern Kangaroo Island
Southern Yorke Peninsula (----- : Eichler 14044)
Eyre Peninsula
South-west Western Australia
Eastern South Australia and Western Victoria
Mount Gambier (Mueller MEL41408)
Relict occurrences in South Australian highlands

FIGURE 25

Variation in diagnostic characters separating the three subspecies of *E. crassiuscula* in the eastern highlands of Victoria.

ssp. *crassiuscula*	●
ssp. *crassiuscula* - ssp. *eglandulosa*	×
ssp. *crassiuscula* - ssp. *glandulifera*	+
ssp. *glandulifera*	■
ssp. *eglandulosa*	o



MT. BUFFALO
CA. 50KM
M.U.M.C.
CBG008908
ASTON
247B
RODD
402
M.U.M.C.
21
BEAUGLEHOLE
22305
STEAD
NSW126385/6
MT.
BOGONG
1990M
MT. NELSE 1880M
MT.
FEATHERTOP
1920M
BOGONG
HIGH
PLAINS
? MIXED
MT. LOCH 1870M
MT. HOTHAM 1860M
THE TWINS
1700M
EICHLER
14692
EICHLER
14696
WILLIS
MEL41556
M.U.M.C.
CBG011562
1574
1573
1572
1576
1575
1577
1578
1579
1580
1561
1561A
1563
1549
1551
1553/4
1550
1564
1548
1571
1546
1547
1581
1583
1560
1559
1558
1601
1591
1593
1594
1595
1596
1597
1599
1590
1605
1602
1588
5 MILES
8 KM
N
LOCATION
RIDGE
EXPLANATION OF SYMBOLS
INDUMENTUM ON ANTHER BACKS
DENSE
SPARSE
VERY FEW
COROLLA COLOUR
WHITE
WHITE TO LILAC
PALE TO DEEP
LILAC
INDUMENTUM ON AXES AND LEAVES

FIGURE 26

The altitudinal range of the subspecies of *E. crassiuscula* and their intermediates, from data on herbarium labels.

●	Collections from the Bogong-Hotham mountain system
▲	Collections from Mt. Buffalo

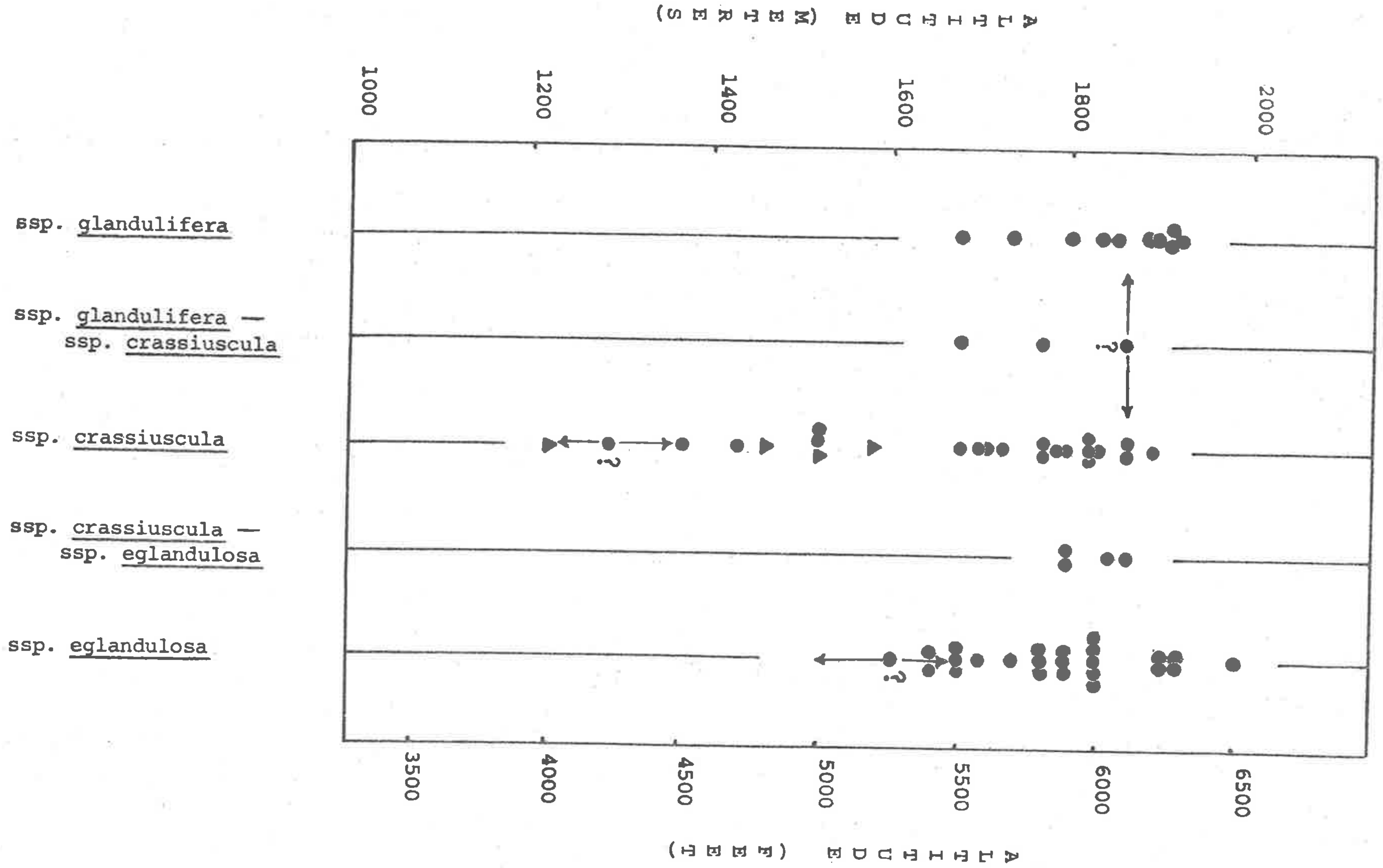

ALTITUDE (METRES)
1000
1200
1400
1600
1800
2000
ssp. glandulifera
ssp. glandulifera — ssp. crassiuscula
ssp. crassiuscula
ssp. crassiuscula — ssp. eglandulosa
ssp. eglandulosa
?
3500
4000
4500
5000
5500
6000
6500
ALTITUDE (FEET)

PLATE 1

Sect. *Striatae* Subsect. *Striatae*

A. Front view of corolla, with androecium. (y = yellow blotch).

B. Side view of flower.

C. Dorsal view of corolla, with stigma.

D. Ventral view of corolla, with lowest lobe removed.

E. External view of the anthers on one side of flower, with an anterior anther on left and posterior anther on right.

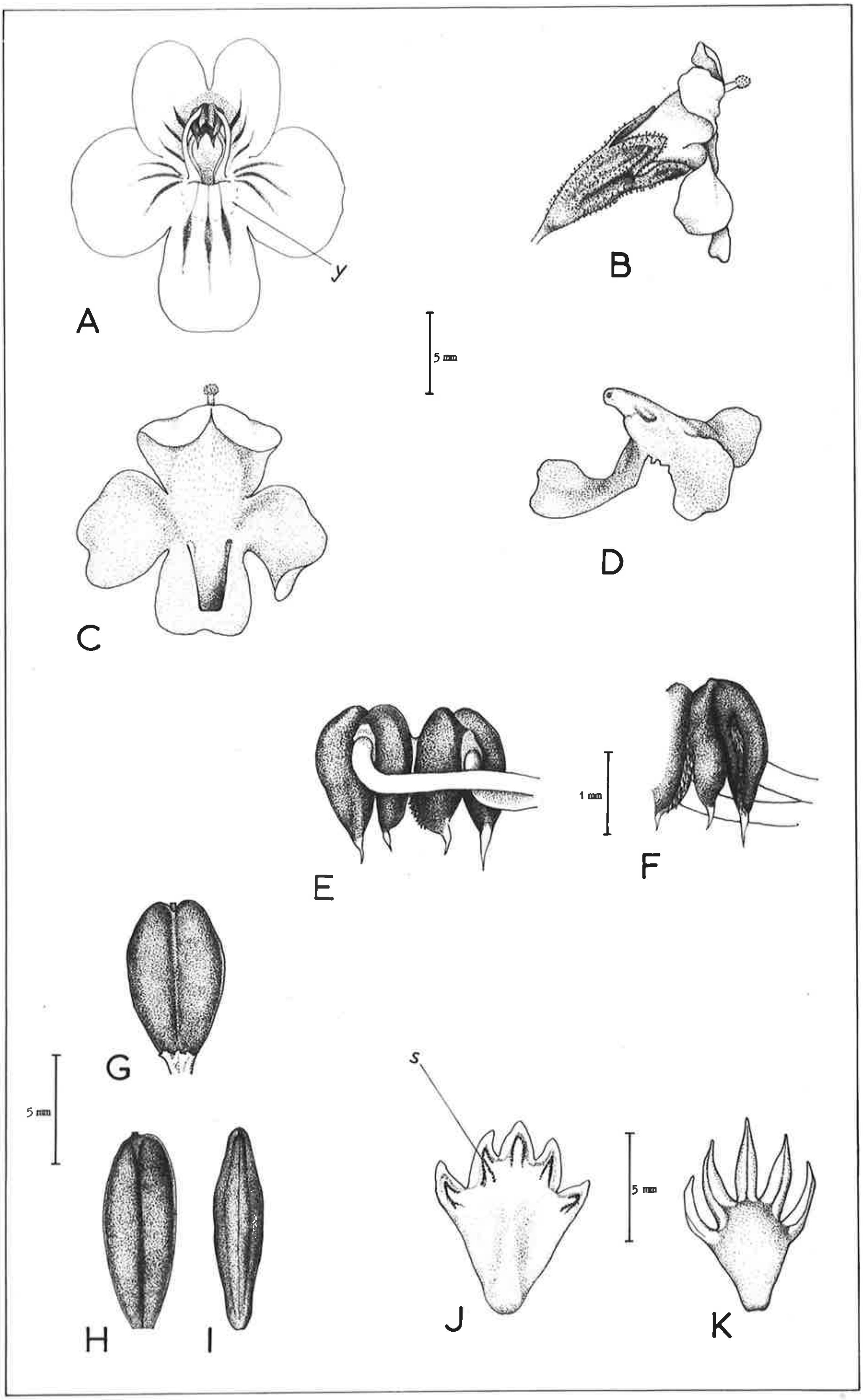
F. Internal view of a posterior anther (on right) and part of an anterior anther.

G,H. Lateral view of capsule.

I. Median view of capsule.

J,K. Abaxial view of uppermost leaf of main floral axis. (s = sessile gland patch).

A,E,F: *E. gibbsiae* ssp. *subglabrifolia* (Barker 1466). -- B-D: *E. gibbsiae* ssp. *subglabrifolia* (Beauglehole 41292). -- G: *E. gibbsiae* ssp. *gibbsiae* (Barker 1164). -- H,I: *E. gibbsiae* ssp. *kingii* (Barker 992). -- J: *E. gibbsiae* ssp. *pulvinestris* (Barker 1170). -- K: *E. hookeri* (Barker 1214).



A
y
B
5 mm
C
D
E
1 mm
F
G
5 mm
s
H
I
J
5 mm
K

PLATE 2

Sect. Lasiantherae

A. Front view of flower. (y = yellow blotch).

B. Side view of flower.

C. Dorsal view of corolla, with stigma.

D. Oblique ventral view of corolla.

E. External view of the anthers on one side of flower, with an anterior anther on left and a posterior anther on right.

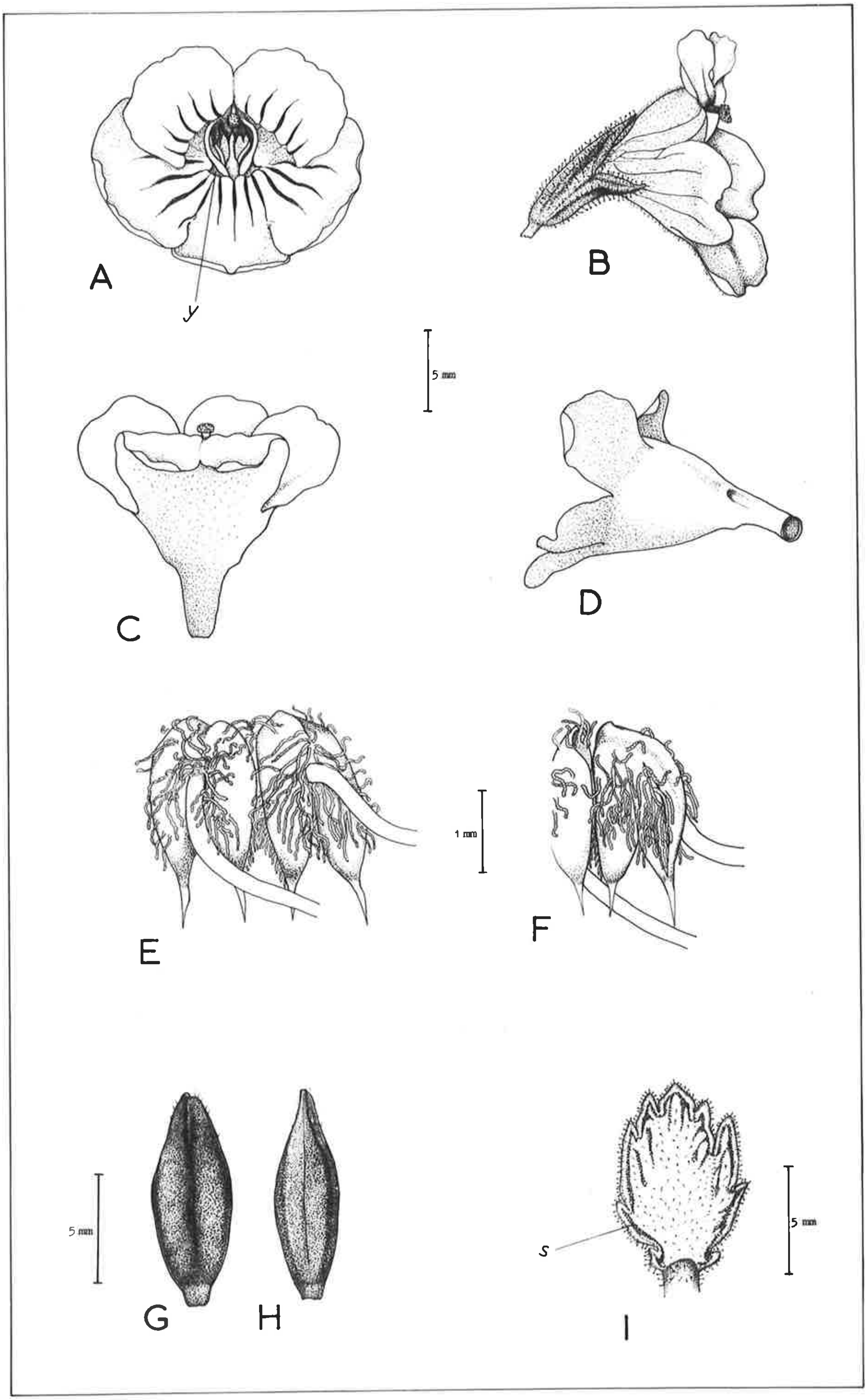
F. Internal view of a posterior anther (on right) and part of an anterior anther.

G. Lateral view of capsule.

H. Median view of capsule

I. Abaxial view of an uppermost leaf on a main floral axis. (s = sessile gland patch).

A-F,I: E. lasianthera (Barker 1498). -- G,H: E. lasianthera (Beauglehole 40774).



A
y
B
5 mm
C
D
E
1 mm
F
5 mm
G
H
s
5 mm
I

PLATE 3

Sect. Scabrae

A. Front view of flower.

B. Side view of flower.

C. Dorsal view of corolla.

D. Ventral view of corolla.

E,F. External view of the anthers on one side of flower, with an anterior anther on the left and a posterior anther on the right.

G. Internal view of a posterior anther (on right) and part of an anterior anther on left.

H. Lateral view of capsule.

I. Median view of capsule.

J. Abaxial view of an uppermost leaf on the main floral axis. (s = sessile gland patch).

A-D,F,G,J: E. caudata ssp. caudata (Barker 1649). -- E: E. ciliolata (Pullen 3792). -- H,I: E. caudata ssp. caudata (Hoogland 8481).

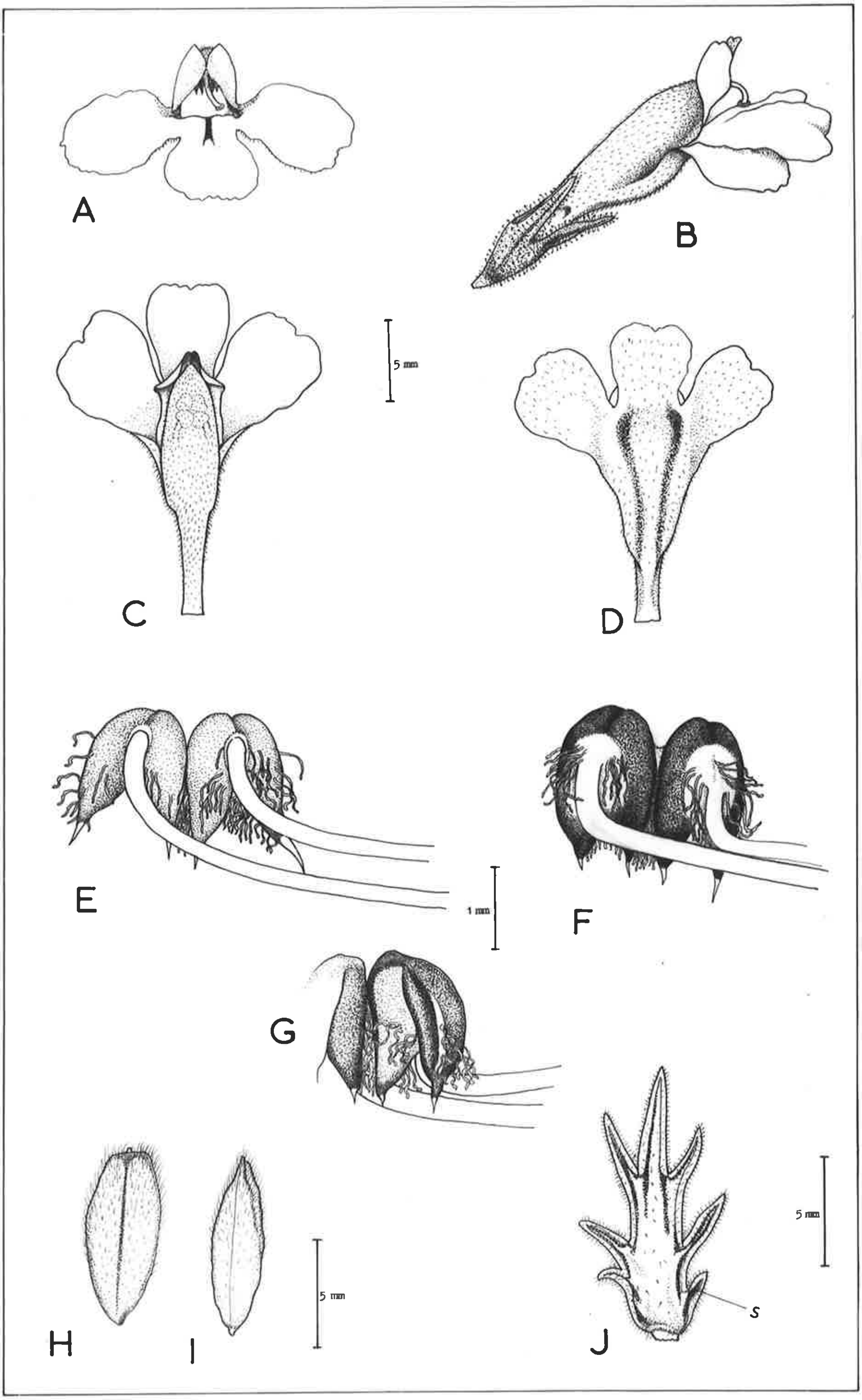

A
B
C
5 mm
D
E
1 mm
F
G
H
I
5 mm
J
s
5 mm

PLATE 4

Sect. Australes

A. Front view of corolla, with androecium.

B. Dorsal view of corolla.

C. Oblique ventral view of corolla.

D,E. Abaxial view of an uppermost leaf on a main floral axis. (s = sessile gland patch).

F. Lateral view of capsule.

G. Median view of capsule.

Sect. Cuneatae

H. External view of the anthers on one side of flower, with an anterior anther on the left and a posterior anther on the right.

I. Abaxial view of an uppermost leaf on a main floral axis. (s = sessile gland patch).

A-C: *E. collina* ssp. *osbornii* (Barker 854). -- D: *E. collina* ssp. *diversicolor* (Barker 1686). -- E: *E. collina* ssp. *diemenica* (Barker 1105). -- F,G: *E. collina* ssp. *tetragona* (Barker 1355). -- H: *E. phragmostoma* (Bufton 8). -- I: *E. phragmostoma* (Bufton 7).

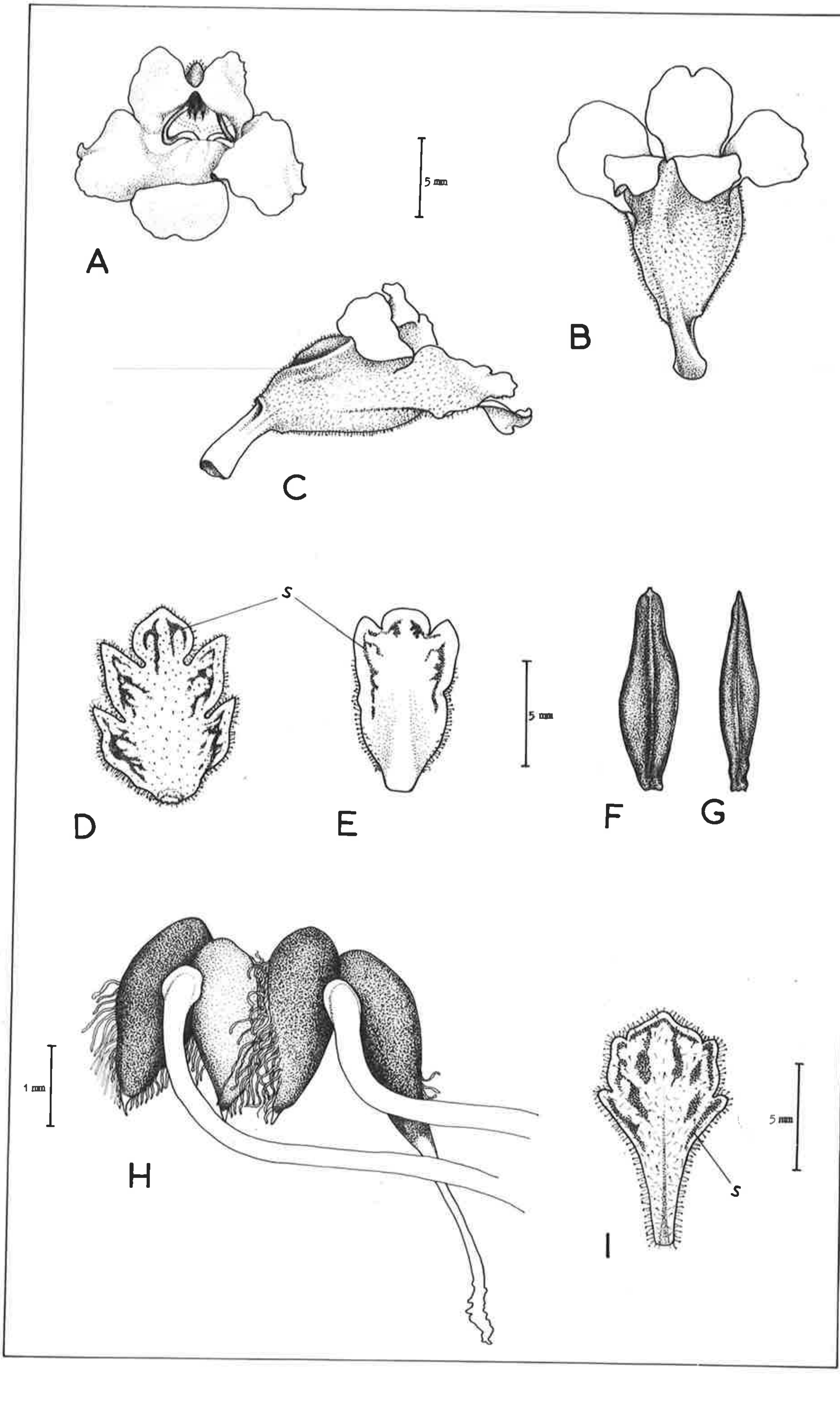
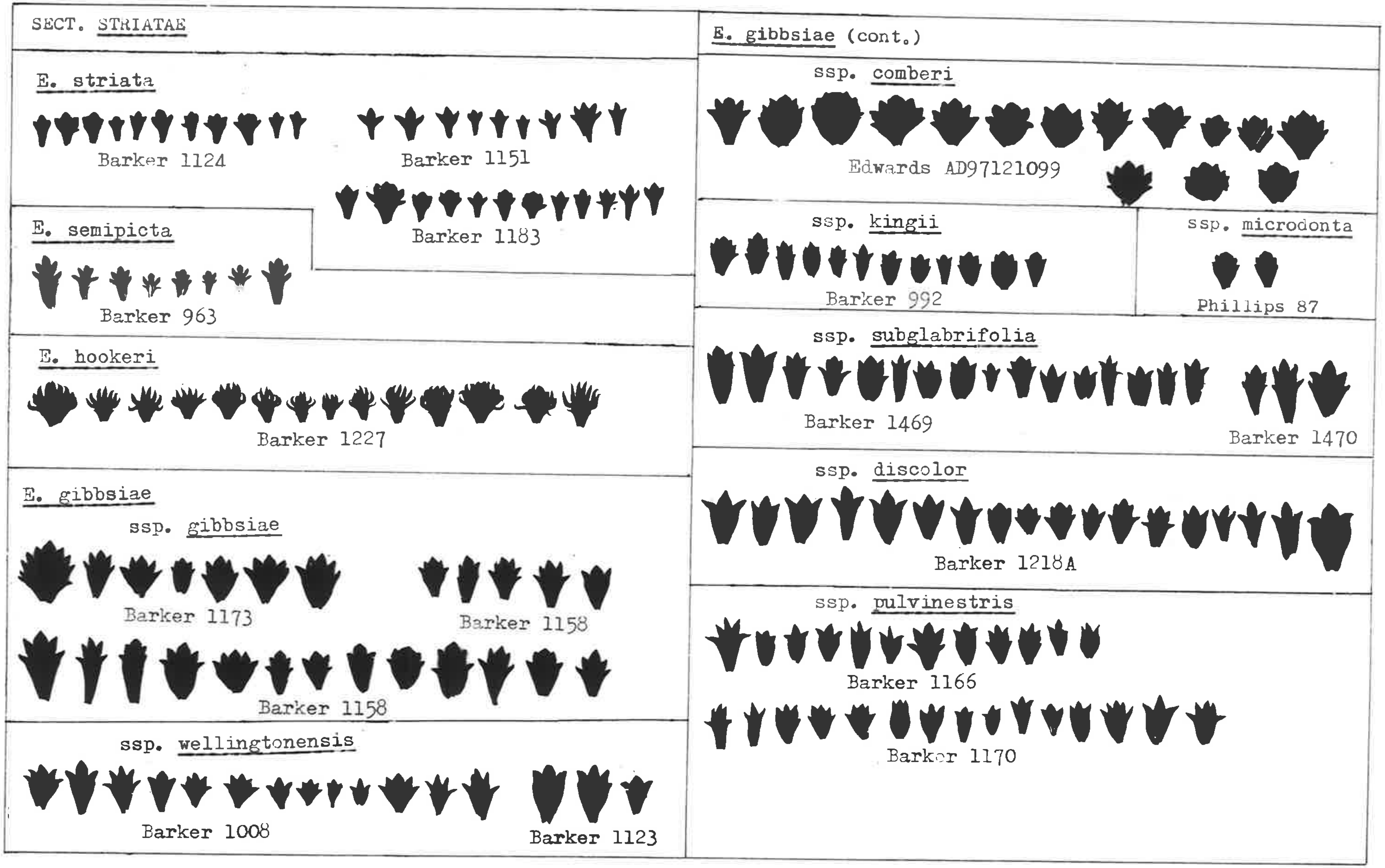

A
B
C
D
E
F
G
H
I
s
5 mm
1 mm

PLATE 5

The uppermost leaves of the main floral axis(es) of taxa in Sect. <u>Striatae</u> Subsect. <u>Striatae</u>.



SECT. STRIATAE
E. striata
Barker 1124
Barker 1151
Barker 1183
E. semipicta
Barker 963
E. hookeri
Barker 1227
E. gibbsiae
ssp. gibbsiae
Barker 1173
Barker 1158
Barker 1158
ssp. wellingtonensis
Barker 1008
Barker 1123
E. gibbsiae (cont.)
ssp. comberi
Edwards AD97121099
ssp. kingii
Barker 992
ssp. microdonta
Phillips 87
ssp. subglabrifolia
Barker 1469
Barker 1470
ssp. discolor
Barker 1218A
ssp. pulvinestris
Barker 1166
Barker 1170

PLATE 6

The uppermost leaves of the main floral axis(es) of taxa in Sect. Lasiantherae and Sect. Scabrae.

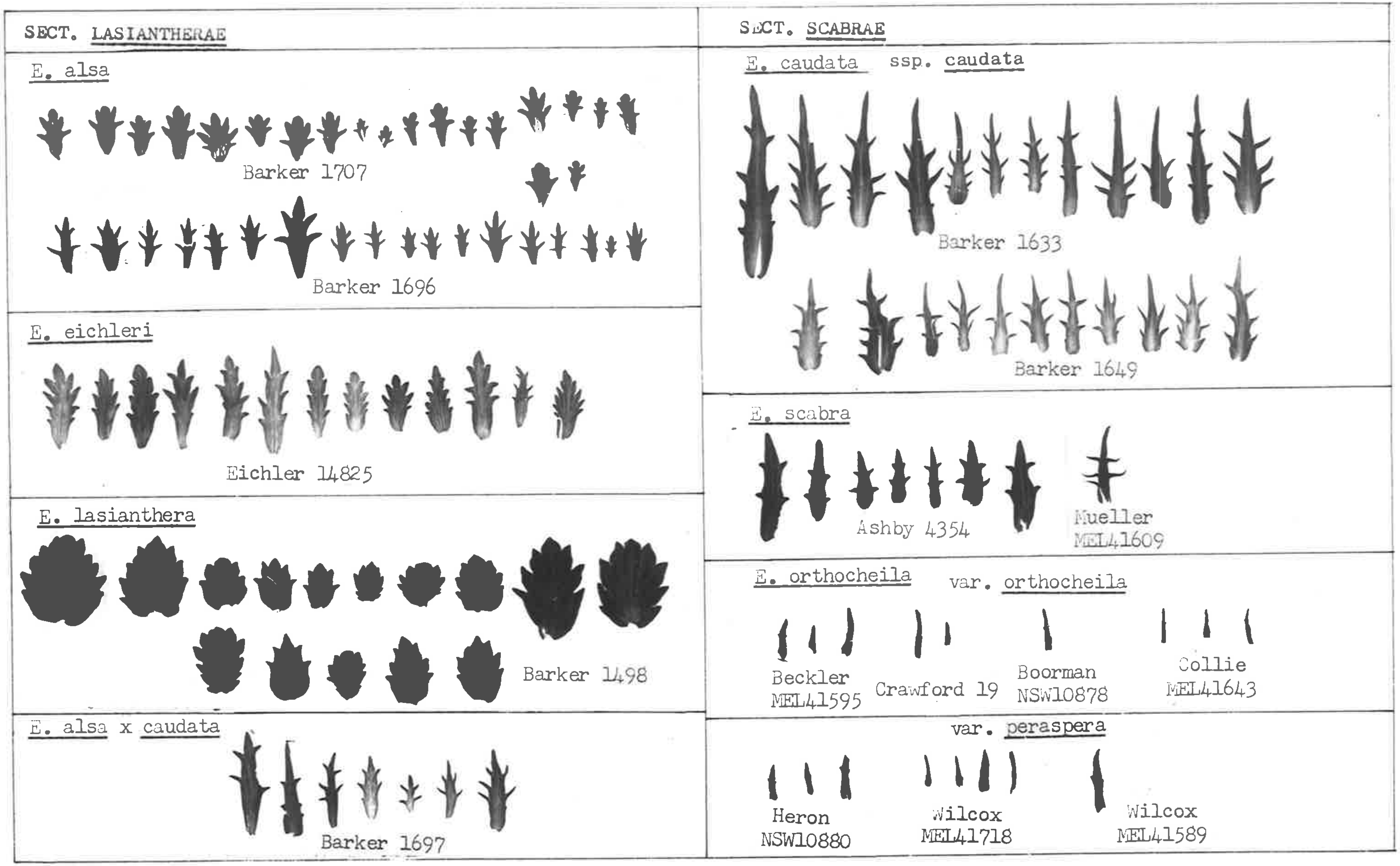

SECT. LASIANTHERAE
E. alsa
Barker 1707
Barker 1696
E. eichleri
Eichler 14825
E. lasianthera
Barker 1498
E. alsa x caudata
Barker 1697
SECT. SCABRAE
E. caudata ssp. caudata
Barker 1633
Barker 1649
E. scabra
Ashby 4354
Mueller
MEL41609
E. orthocheila var. orthocheila
Beckler
MEL41595
Crawford 19
Boorman
NSW10878
Collie
MEL41643
var. peraspera
Heron
NSW10880
Wilcox
MEL41718
Wilcox
MEL41589

PLATE 7

The uppermost leaves of the main floral axis(es) of taxa in Sect. Scabrae (continued) and Sect. Australes.

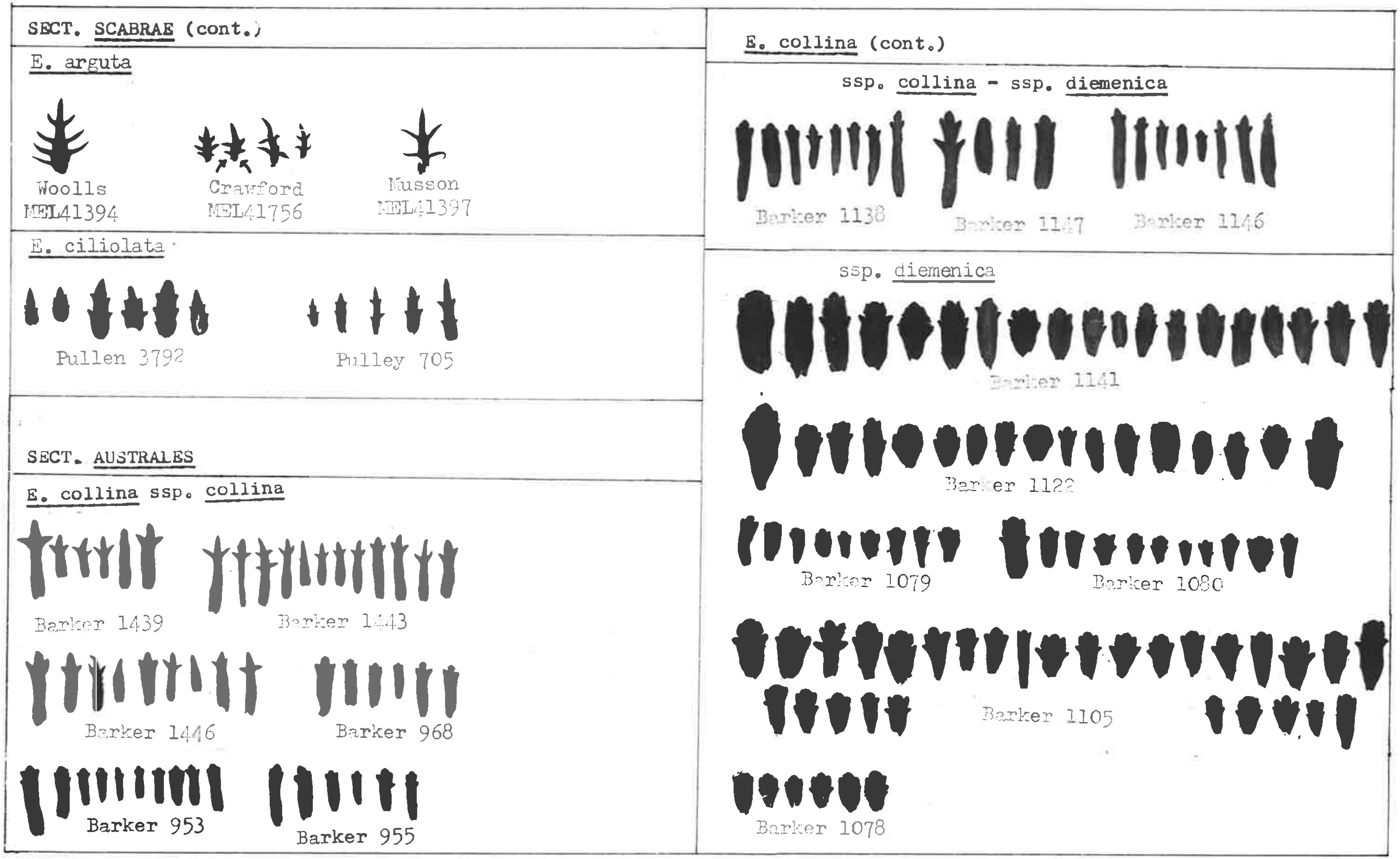

SECT. SCABRAE (cont.)
E. arguta
Woolls MEL41394
Crawford MEL41756
Musson MEL41397
E. ciliolata
Pullen 3792
Pulley 705
SECT. AUSTRALES
E. collina ssp. collina
Barker 1439
Barker 1443
Barker 1446
Barker 968
Barker 953
Barker 955
E. collina (cont.)
ssp. collina - ssp. diemenica
Barker 1138
Barker 1147
Barker 1146
ssp. diemenica
Barker 1141
Barker 1122
Barker 1079
Barker 1080
Barker 1105
Barker 1078

PLATE 8

The uppermost leaves of the main floral axis(es) of taxa in Sect. Australes (continued).

SECT. AUSTRALES (cont.) E. collina (cont.)
ssp. tetragona
Barker 1450
Donner 186
Barker 1355
Barker 1374
Eichler 15384
ssp. trichocalycina
Barker 1432
Barker 1438
Barker 1442
ssp. gunnii
Barker 913
Possibly undescribed subspecies
Barker 892
E. collina (cont.)
ssp. deflexifolia
Barker 940
Barker 942
Barker 975
Barker 977
ssp. paludosa
Barker 1565
Barker 1585
Barker 1603
Barker 1681
Barker 1640
Burgess CBG023203

PLATE 9

The uppermost leaves of the main floral axis(es) of taxa in Sect. Australes (continued).

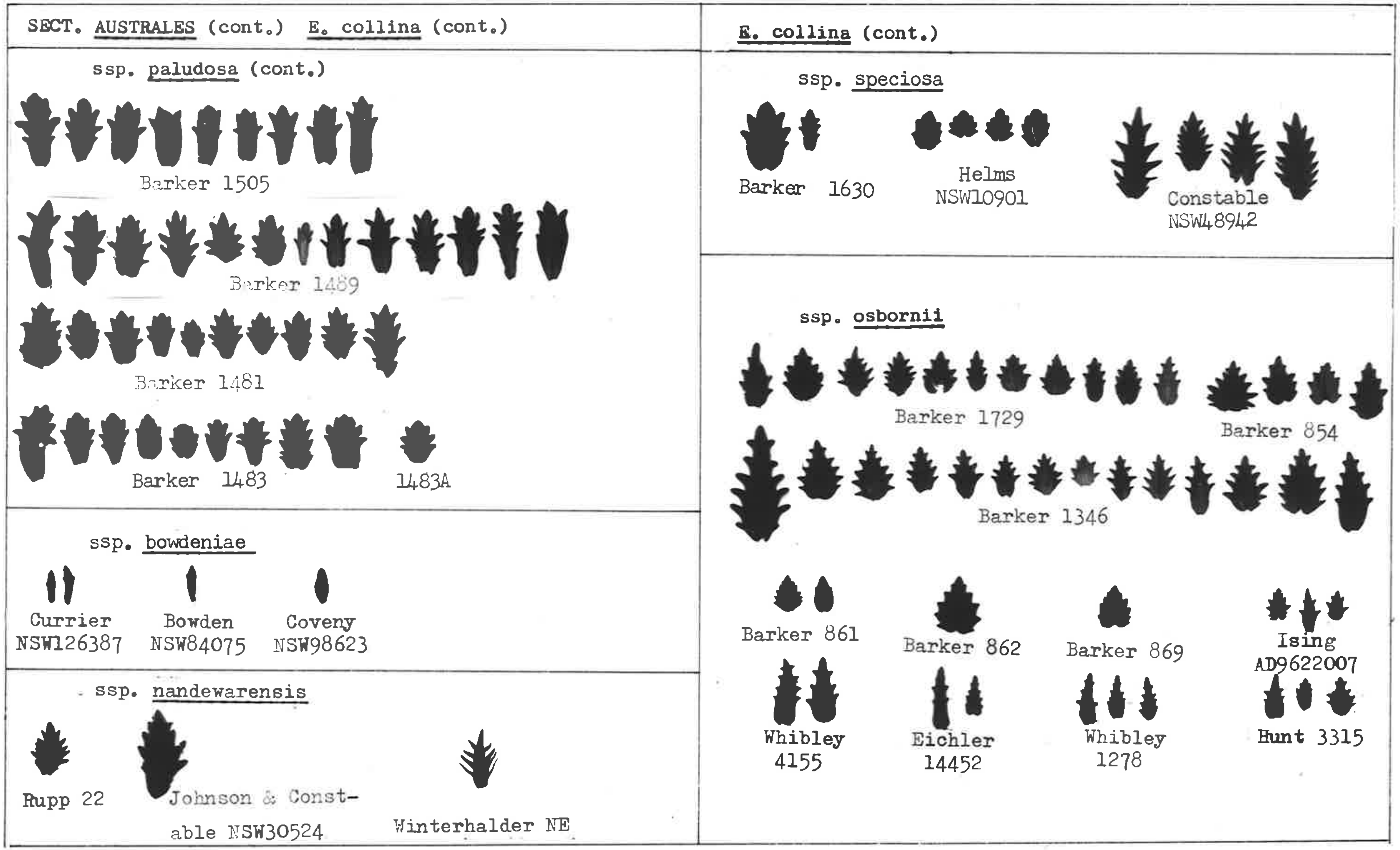

SECT. AUSTRALES (cont.) E. collina (cont.)
ssp. paludosa (cont.)
Barker 1505
Barker 1489
Barker 1481
Barker 1483
1483A
ssp. bowdeniae
Currier NSW126387
Bowden NSW84075
Coveny NSW98623
ssp. nandewarensis
Rupp 22
Johnson & Constable NSW30524
Winterhalder NE
E. collina (cont.)
ssp. speciosa
Barker 1630
Helms NSW10901
Constable NSW48942
ssp. osbornii
Barker 1729
Barker 854
Barker 1346
Barker 861
Barker 862
Barker 869
Ising AD9622007
Whibley 4155
Eichler 14452
Whibley 1278
Hunt 3315

PLATE 10

The uppermost leaves of the main floral axis(es) of taxa in Sect. Australes (continued).

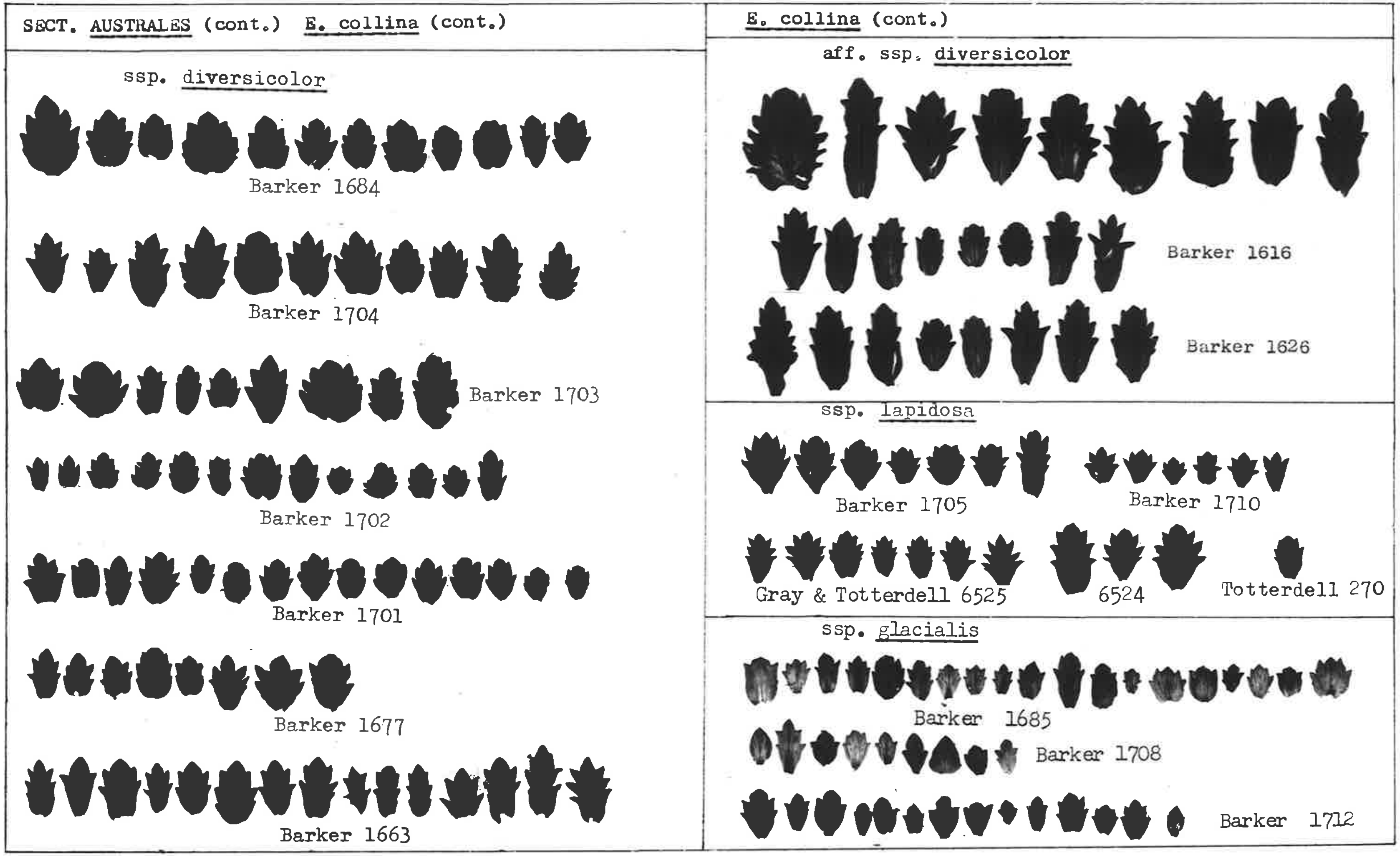

SECT. AUSTRALES (cont.)
E. collina (cont.)
ssp. diversicolor
Barker 1684
Barker 1704
Barker 1703
Barker 1702
Barker 1701
Barker 1677
Barker 1663
E. collina (cont.)
aff. ssp. diversicolor
Barker 1616
Barker 1626
ssp. lapidosa
Barker 1705
Barker 1710
Gray & Totterdell 6525
6524
Totterdell 270
ssp. glacialis
Barker 1685
Barker 1708
Barker 1712

PLATE 11

The uppermost leaves of the main floral axis(es) of taxa in Sect. Australes (continued) and Sect. Cuneatae.

For each sample of E. durietziana (Sect. Cuneatae) a leaf from the lower parts of the main axis is shown on the left, and one of the uppermost leaves is displayed on the right.

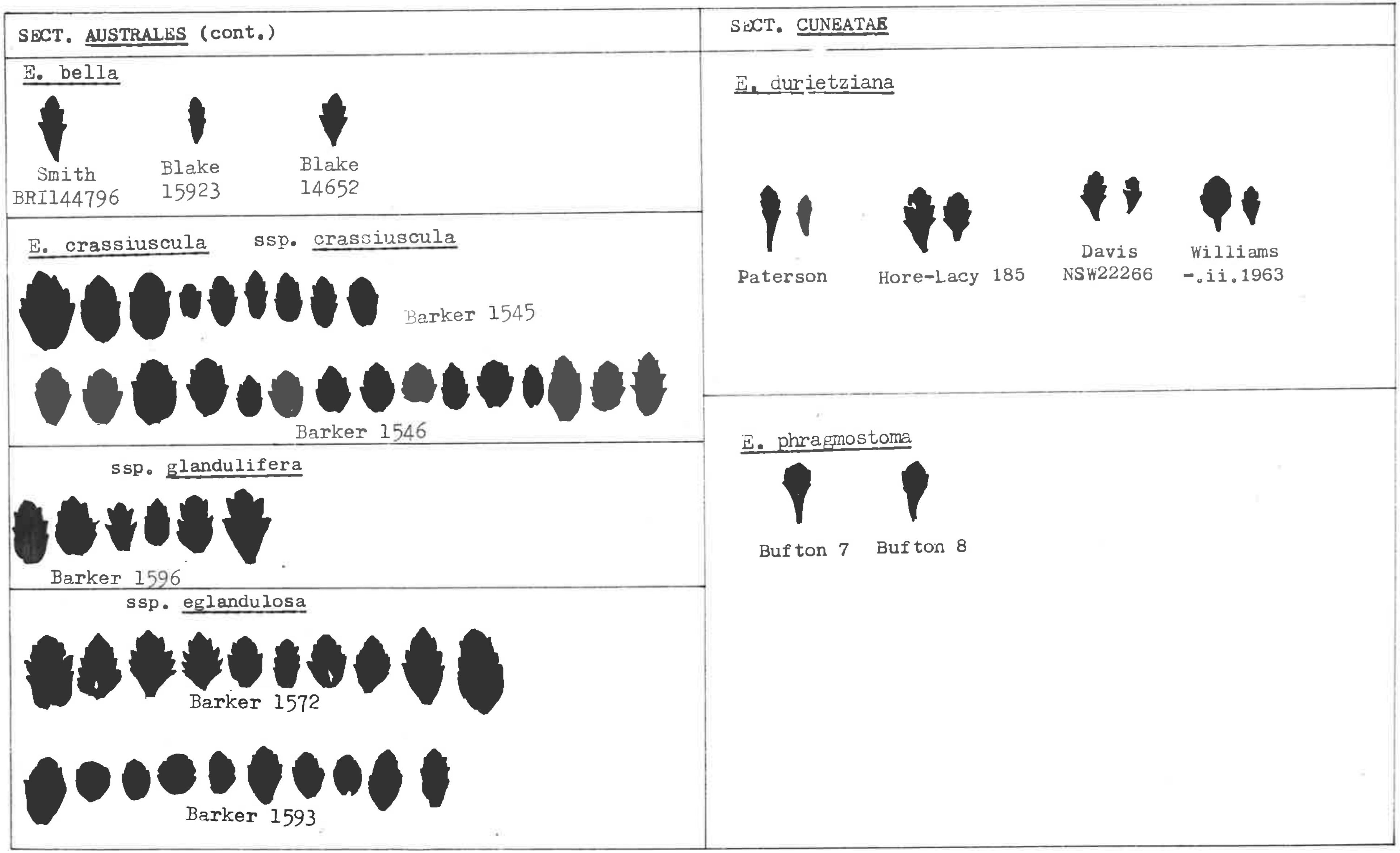

SECT. AUSTRALES (cont.)
E. bella
Smith BRI144796
Blake 15923
Blake 14652
E. crassiuscula ssp. crassiuscula
Barker 1545
Barker 1546
ssp. glandulifera
Barker 1596
ssp. eglandulosa
Barker 1572
Barker 1593
SECT. CUNEATAE
E. durietziana
Paterson
Hore-Lacy 185
Davis NSW22266
Williams -.ii.1963
E. phragmostoma
Bufton 7
Bufton 8

PLATE 12

UPPER

E. alsa

LOWER

Flower of E. lasianthera being pollinated by native bee.

PLATE 13

Sketches of meiotic configurations in pollen mother cells of *E. alsa* and *E. caudata*. (Not to scale.)

A. *E. alsa* (Barker 1696)
   Diakinesis
   n=27

B. *E. caudata* (Barker 1649)
   Diakinesis
   n=27/28

C. *E. caudata* (Barker 1649)
   Diakinesis
   n=27/28

D. *E. caudata* (Barker 1649)
   Part of cell at Diakinesis

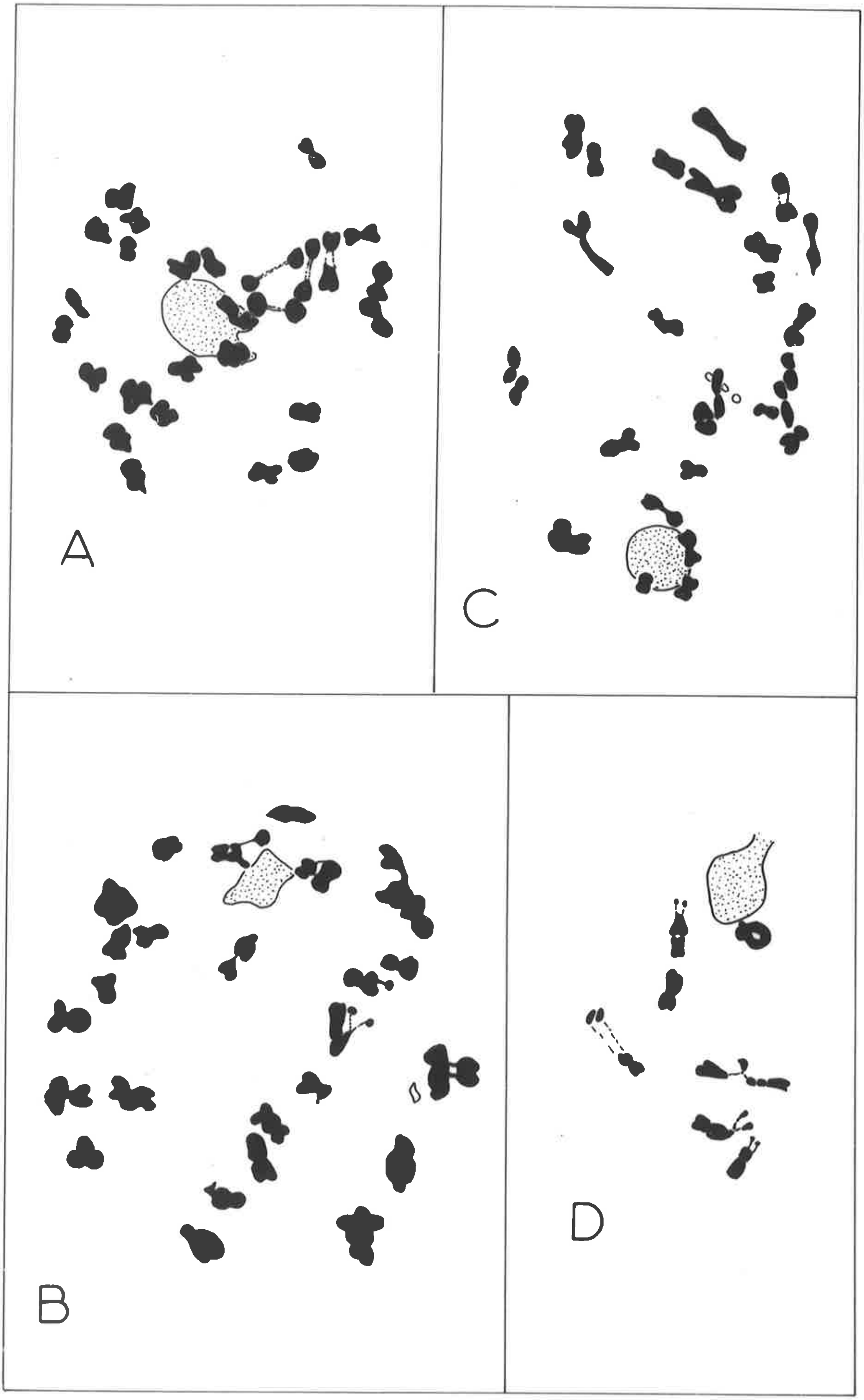

A
C
B
D

PLATE 14

Sketches of meiotic configurations in pollen mother cells of <u>E. caudata</u>. (Not to scale.)

A. <u>E. caudata</u> (Barker 1649)
   Metaphase I - Early Anaphase I
   n=27/28

B. <u>E. caudata</u> (Barker 1649)
   Early Anaphase I
   n=27II + 2I (arrowed)

C. <u>E. caudata</u> (Barker 1649)
   Diakinesis
   n=26 + ?2III (arrowed)

D. <u>E. caudata</u> (Barker 1649)
   Early Anaphase I
   n=28

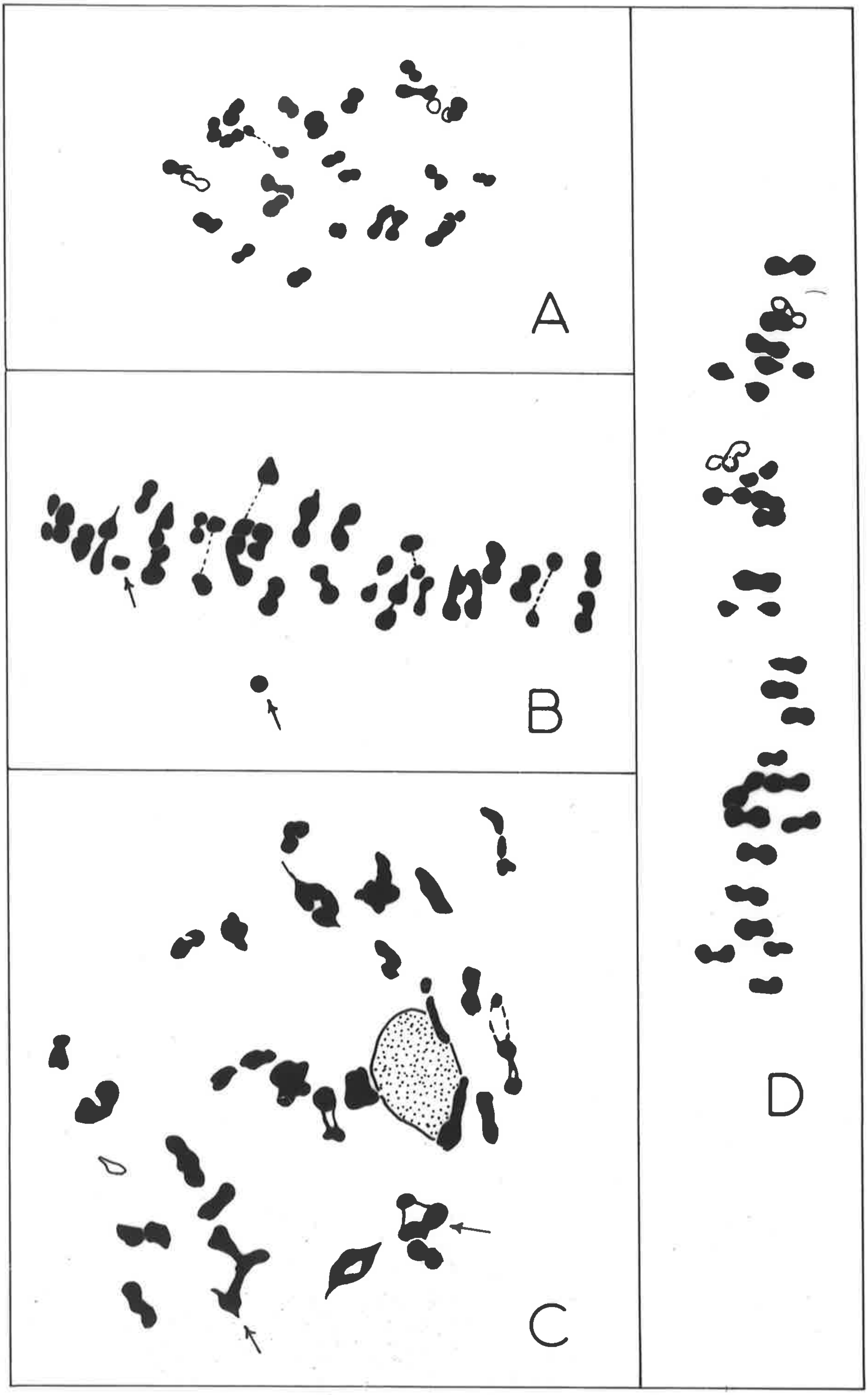

A
B
C
D

PLATE 15

UPPER

Holotype of _E. durietziana_

LOWER

Holotype of _E. phragmostoma_


Holo
-TYPE of
MEL 41727
PHYTOLOGIC MUSEUM OF MELBOURNE.
BARON FERD. VON MUELLER, PH. & M.D.


Holo
-TYPE of
HERBARIUM OF THE UNIVERSITY OF
NEW ENGLAND (NE)
SCROPHULARIACEAE
Ebor Falls
28.11.1958
Among granite
B. R. Paterson
NSW 126388

PLATE 16

UPPER

Holotype of E. gibbsiae ssp. wellingtonensis

LOWER

Holotype of E. gibbsiae ssp. microdonta


E. striata R.Br.
Holo
- TYPE of
Euphrasia gibbsiae Du Rietz
ssp. microdonta BARKER
16.i.1974
HERBARIUM, CANBERRA BOTANIC GARDENS
HERBARIUM, CANBERRA BOTANIC GARDENS
No.
Loc.
Notes
Coll.
Date
Det.


Holo
- TYPE of
Herb. AD
97117025
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
1008
Leg.
Collector's No.
Date

PLATE 17

UPPER

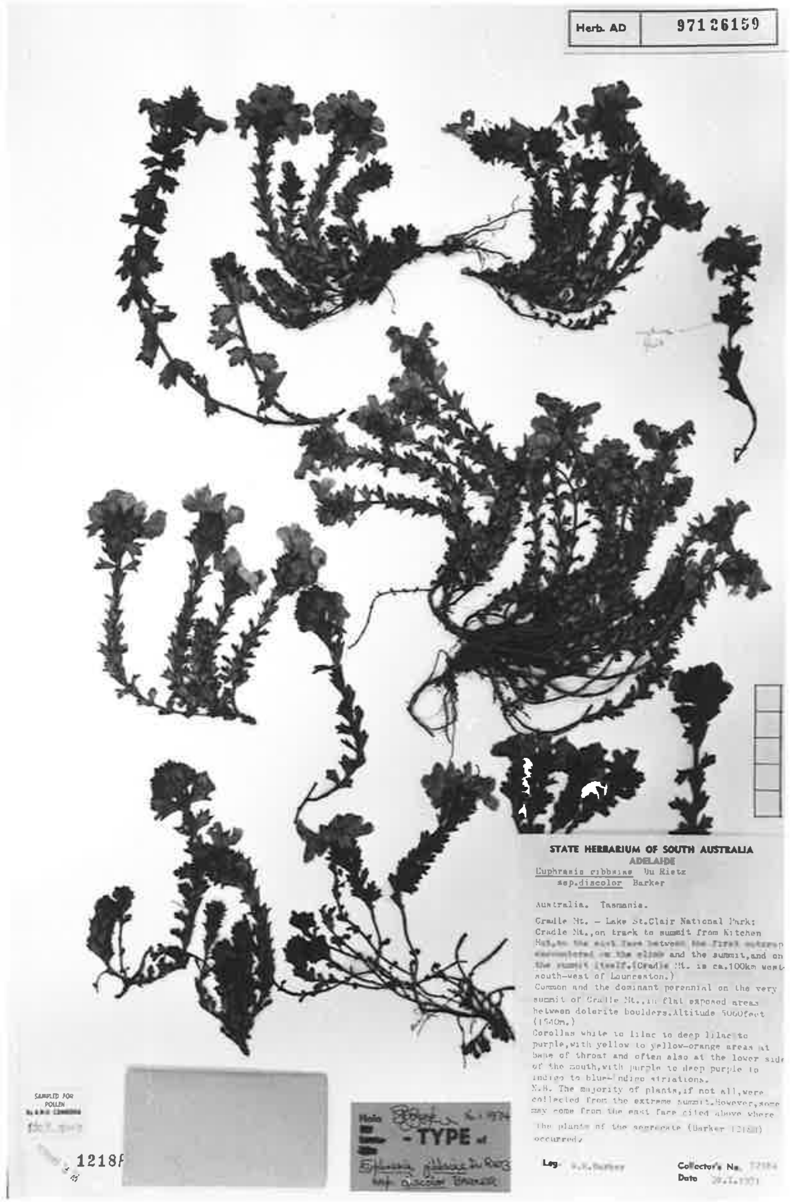
Holotype of _E. gibbsiae_ ssp. _discolor_

LOWER

Holotype of _E. gibbsiae_ ssp. _pulvinestris_

Herb. AD
97116946
-TYPE of
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Leg.
Collector's No.
Date

1151



Herb. AD
97126159
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Euphrasia gibbsiae Du Rietz
ssp.discolor Barker
Australia. Tasmania.
Cradle Mt. – Lake St.Clair National Park: Cradle Mt.,on track to summit from Kitchen Hut,on the east face between the first outcrop encountered on the climb and the summit,and on the summit itself.(Cradle Mt. is ca.100km west-south-west of Launceston.)
Common and the dominant perennial on the very summit of Cradle Mt.,in flat exposed areas between dolerite boulders.Altitude 5060feet (1540m.)
Corollas white to lilac to deep lilac to purple,with yellow to yellow-orange areas at base of throat and often also at the lower side of the mouth,with purple to deep purple to indigo to blue-indigo striations.
N.B. The majority of plants,if not all,were collected from the extreme summit.However,some may come from the east face cited above where the plants of the aggregate (Barker 12180) occurred.
Leg.
Collector's No.
Date
-TYPE of
1218

PLATE 18

UPPER LEFT

E. striata : Habit.

UPPER RIGHT

E. striata ($1\frac{1}{2}$ x life-size)

LOWER

Holotype of *E. semipicta*

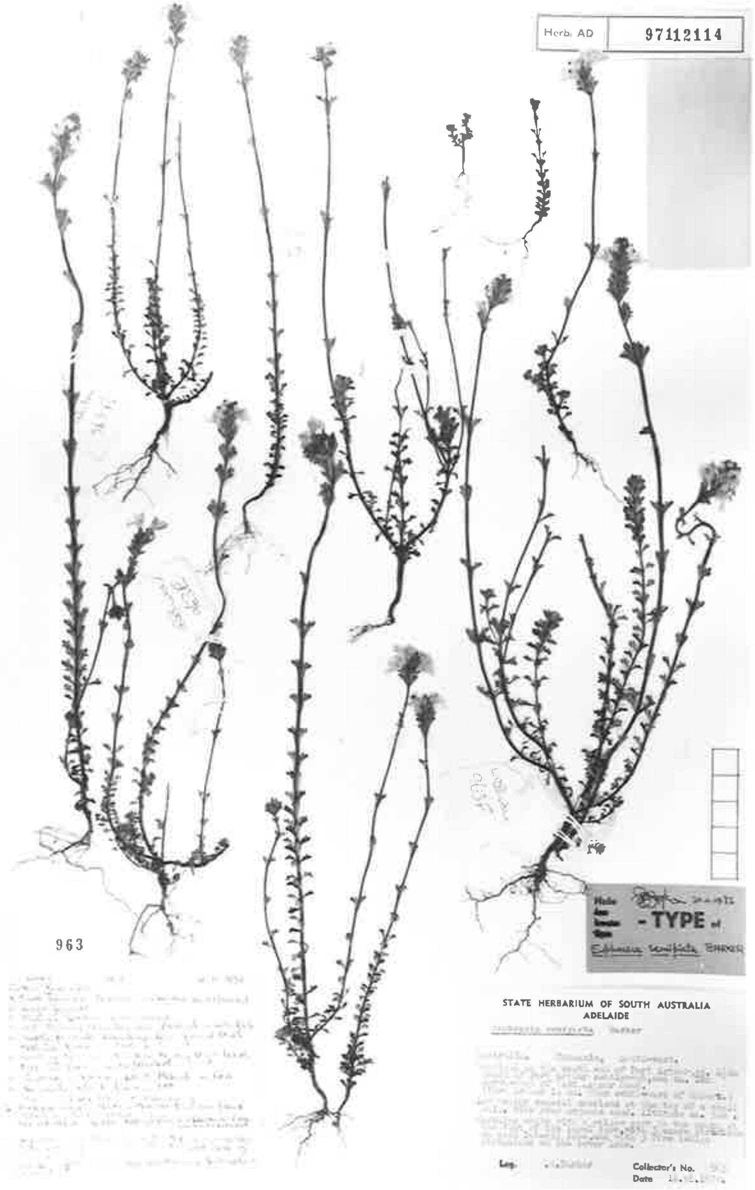

Herb. AD
97112114
963
-TYPE of
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Leg.
Collector's No.
Date

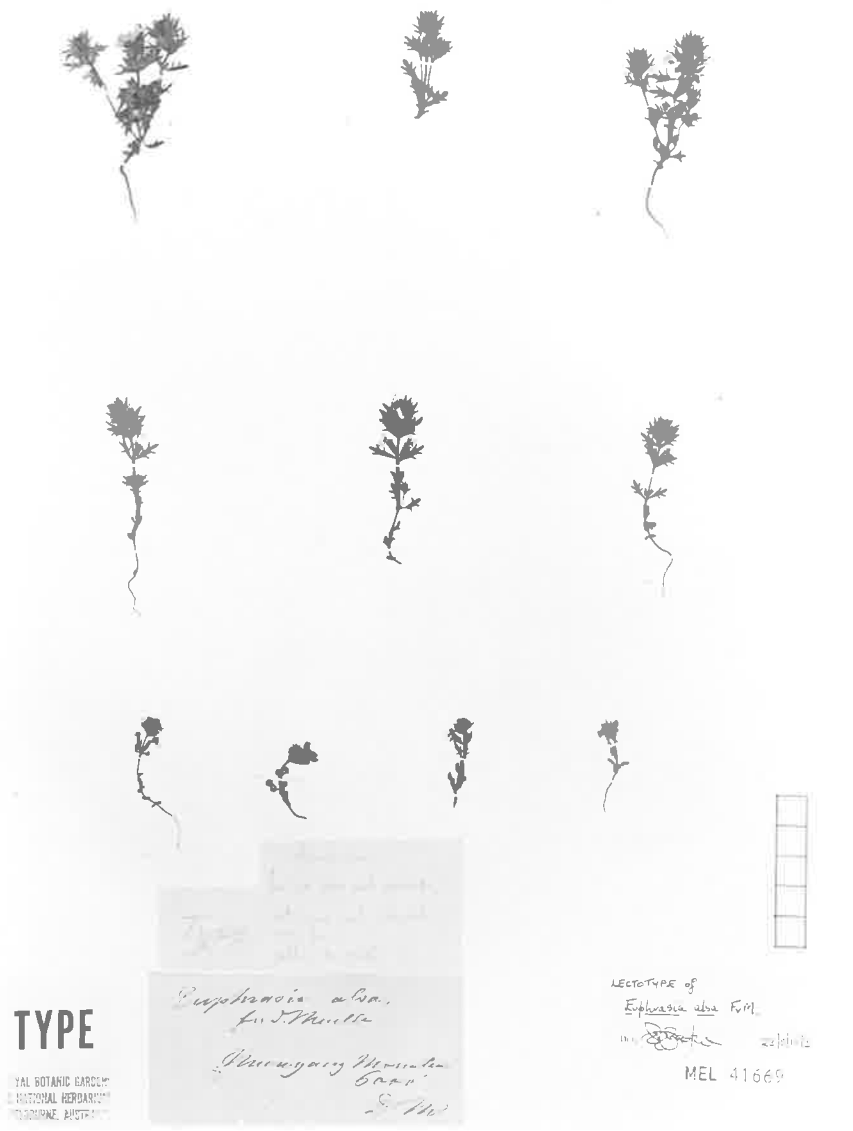
PLATE 19

UPPER

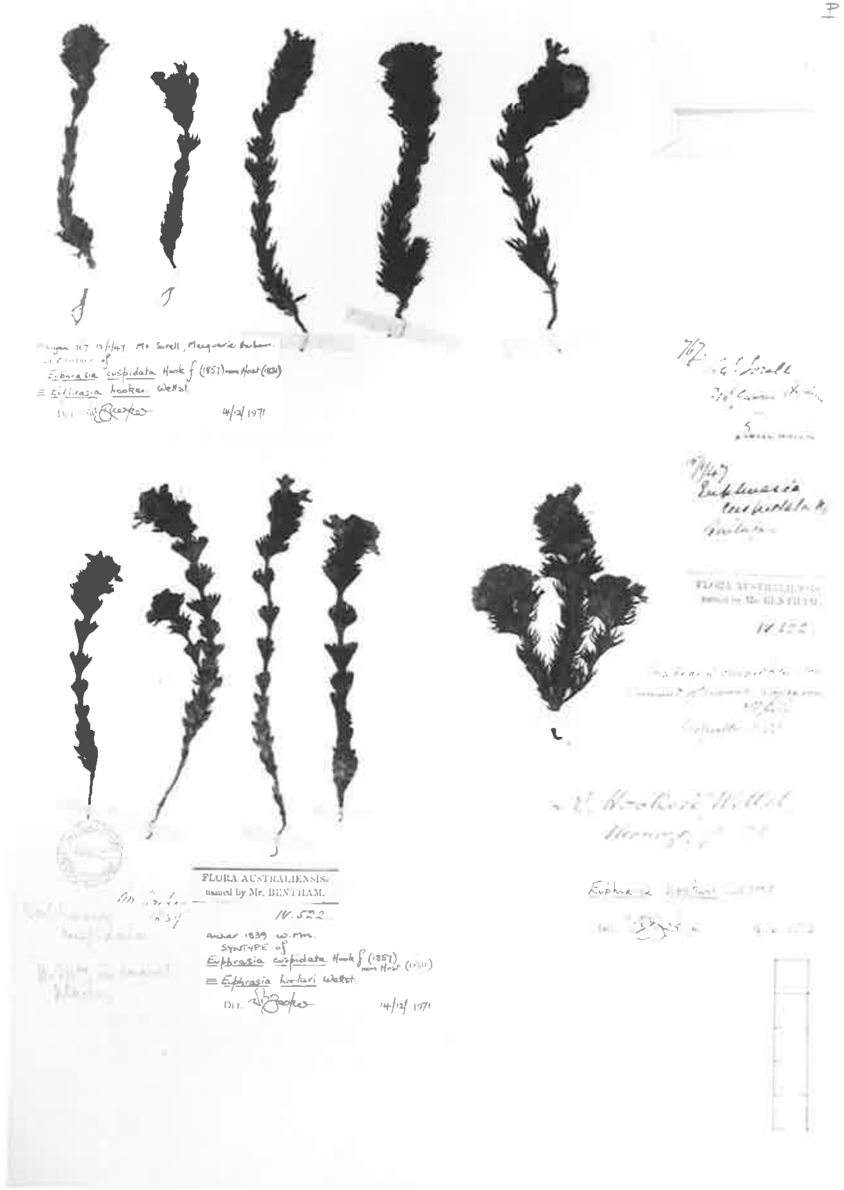
Lectotype of _E. hookeri_

LOWER

Lectotype of _E. alsa_



TYPE
LECTOTYPE of
Euphrasia alba FvM.
MEL 41669



Mt Sorell, Macquarie Harbour.
Euphrasia cuspidata Hook f (1857) non Host (1831)
4/12/1971
FLORA AUSTRALIENSIS.
named by Mr. BENTHAM.
IV. 522
Archer 1839 W.Pton.
SYNTYPE of
Euphrasia cuspidata Hook f (1857) non Host
≡ Euphrasia hookeri Wettst.
Det.
14/12/1971

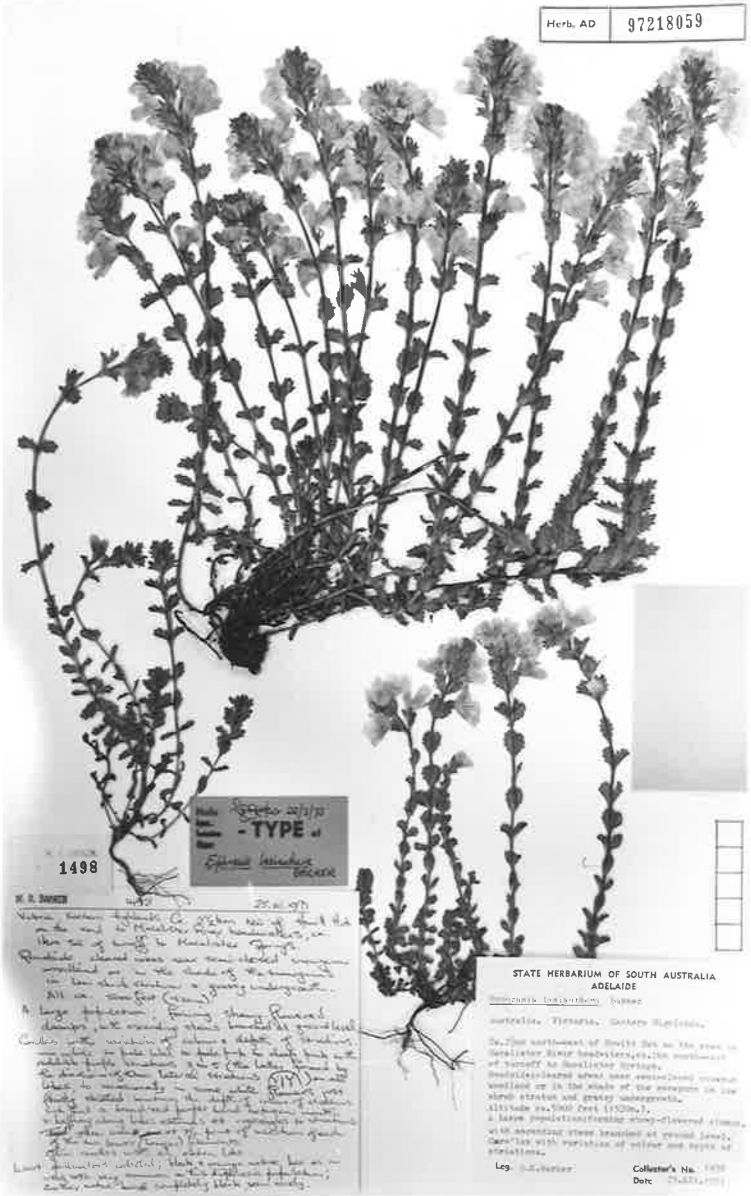
PLATE 20

UPPER

Holotype of E. eichleri

LOWER

Holotype of E. lasianthera


Herb. AD 97218059
1498
-TYPE of
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Leg.
Collector's No.
Date


Herb. AD
-TYPE of
14825
HERBARIUM HANSJOERG EICHLER
Bogong High Plains.
ca. 1900 m alt.
14825

PLATE 21

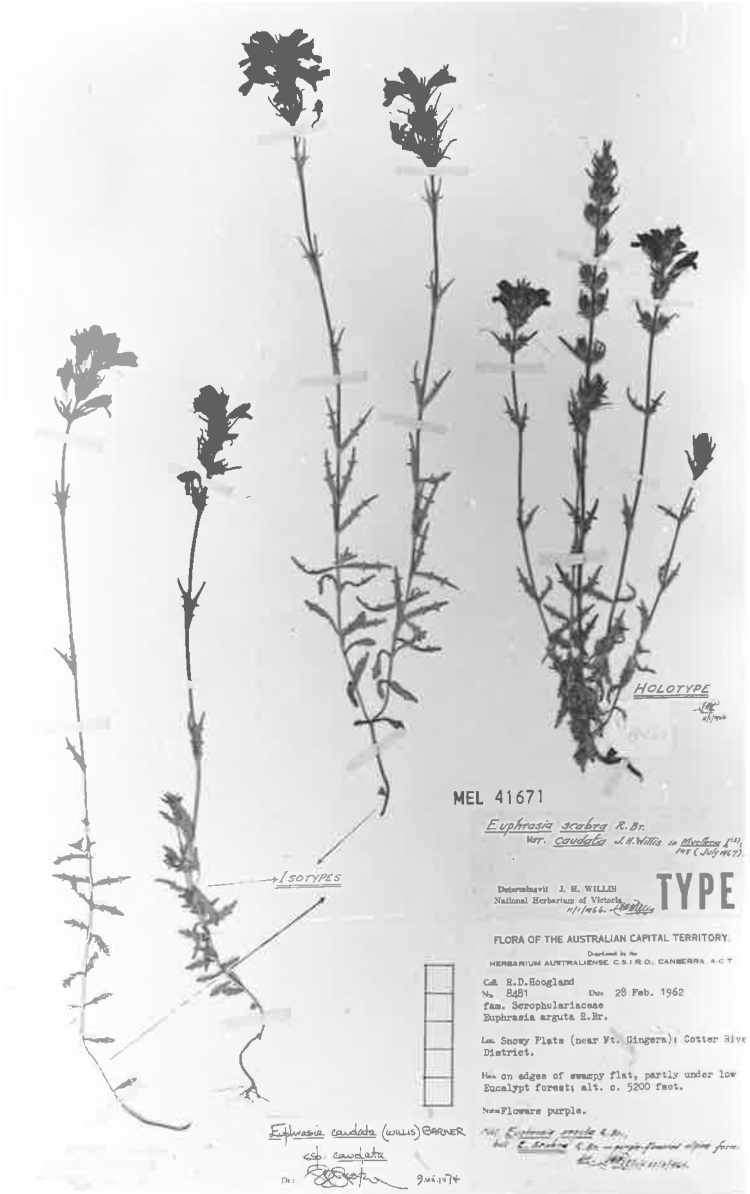
UPPER

Holotype of *E. caudata* ssp. *caudata*

LOWER

Holotype of *E. caudata* ssp. *nana*

ROYAL BOTANIC GARDENS
AND
NATIONAL HERBARIUM, MELBOURNE
VICTORIA, AUSTRALIA
Euphrasia scabra R.Br.
var. caudata J.H.Willis
Loc. Charlotte Pass, Kosciusko Plateau, N.S.W.
Notes:
Coll. Mrs Thistle Y. Stead, 14/2/1966
-TYPE of
Euphrasia caudata (Willis) Barker
MEL 41650
ROYAL BOTANIC GARDENS
& NATIONAL HERBARIUM
AUSTRALIA



HOLOTYPE
ISOTYPES
MEL 41671
Euphrasia scabra R.Br.
var. caudata J.H.Willis in Muelleria
Determinavit J. H. WILLIS
National Herbarium of Victoria
TYPE
FLORA OF THE AUSTRALIAN CAPITAL TERRITORY
HERBARIUM AUSTRALIENSE C.S.I.R.O., CANBERRA, A.C.T.
Coll. R.D.Hoogland
No. 8481
Date 28 Feb. 1962
fam. Scrophulariaceae
Euphrasia arguta R.Br.
Loc. Snowy Flats (near Mt. Gingera); Cotter River District.
Hab. on edges of swampy flat, partly under low Eucalypt forest; alt. c. 5200 feet.
Notes Flowers purple.
Euphrasia caudata (Willis) Barner
ssp. caudata
9.viii.1974

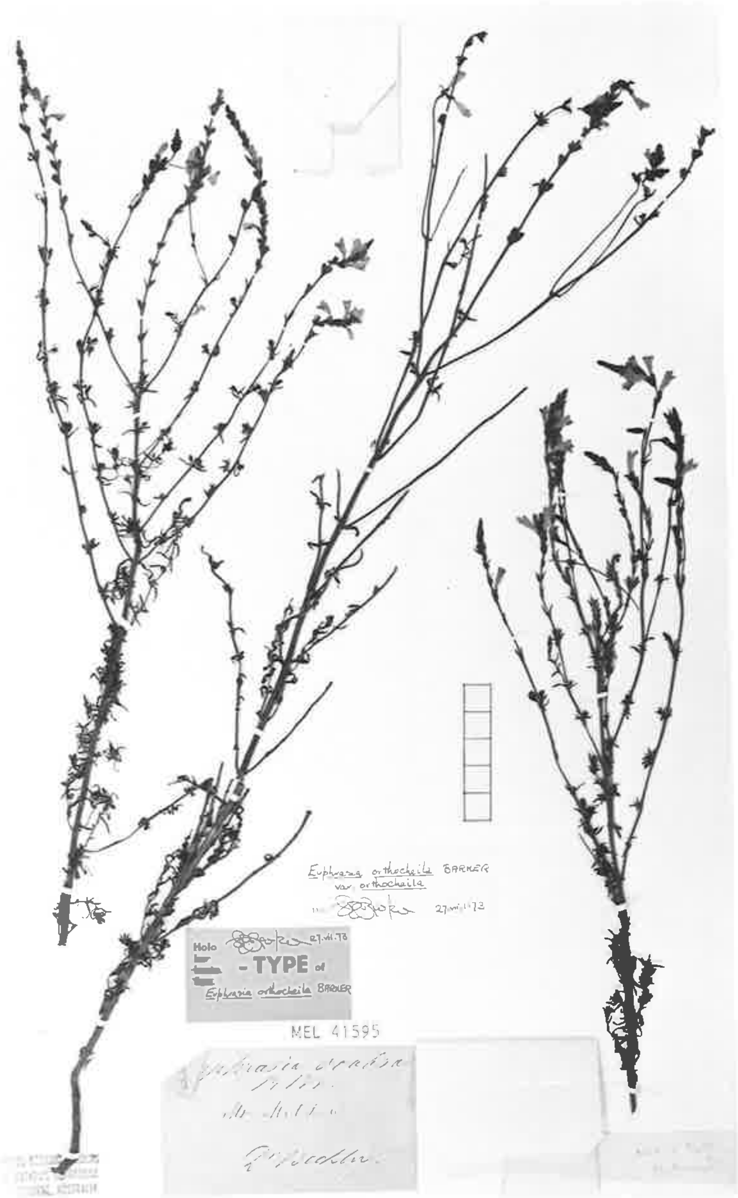
PLATE 22

UPPER

Lectotype and other syntype of E. scabra

LOWER

Holotype of E. orthocheila var. orthocheila


Euphrasia orthocheila BARKER
var. orthocheila
Holo
-TYPE of
Euphrasia orthocheila BARKER
MEL 41595

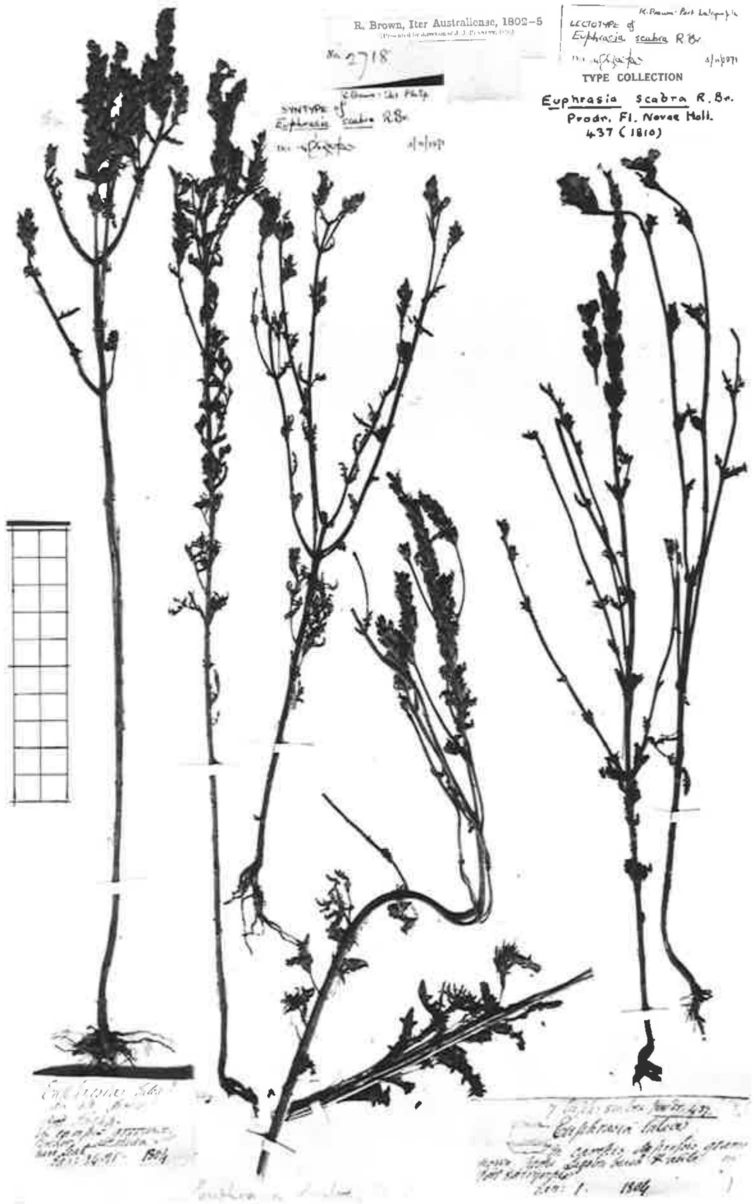

R. Brown, Iter Australiense, 1802-5
No. 2718
SYNTYPE of
Euphrasia scabra R.Br.
LECTOTYPE of
Euphrasia scabra R.Br.
TYPE COLLECTION
Euphrasia scabra R. Br.
Prodr. Fl. Novae Holl.
437 (1810)

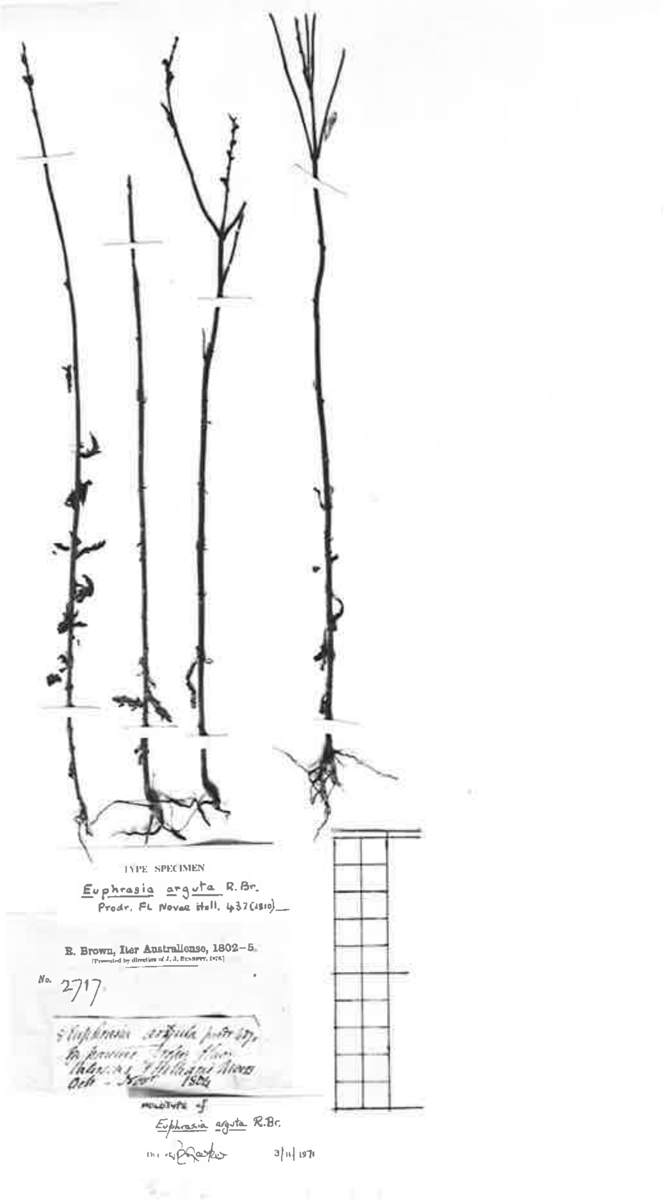
PLATE 23

UPPER

Holotype of _E. orthocheila_ var. _peraspera_

LOWER

Holotype of _E. arguta_


TYPE SPECIMEN
Euphrasia arguta R.Br.
Prodr. Fl. Novae Holl. 437 (1810)
R. Brown, Iter Australiense, 1802–5.
No. 2717
HOLOTYPE of
Euphrasia arguta R.Br.
3/11/1970


- TYPE of
MEL 41718
PHYTOLOGIC MUSEUM OF MELBOURNE.

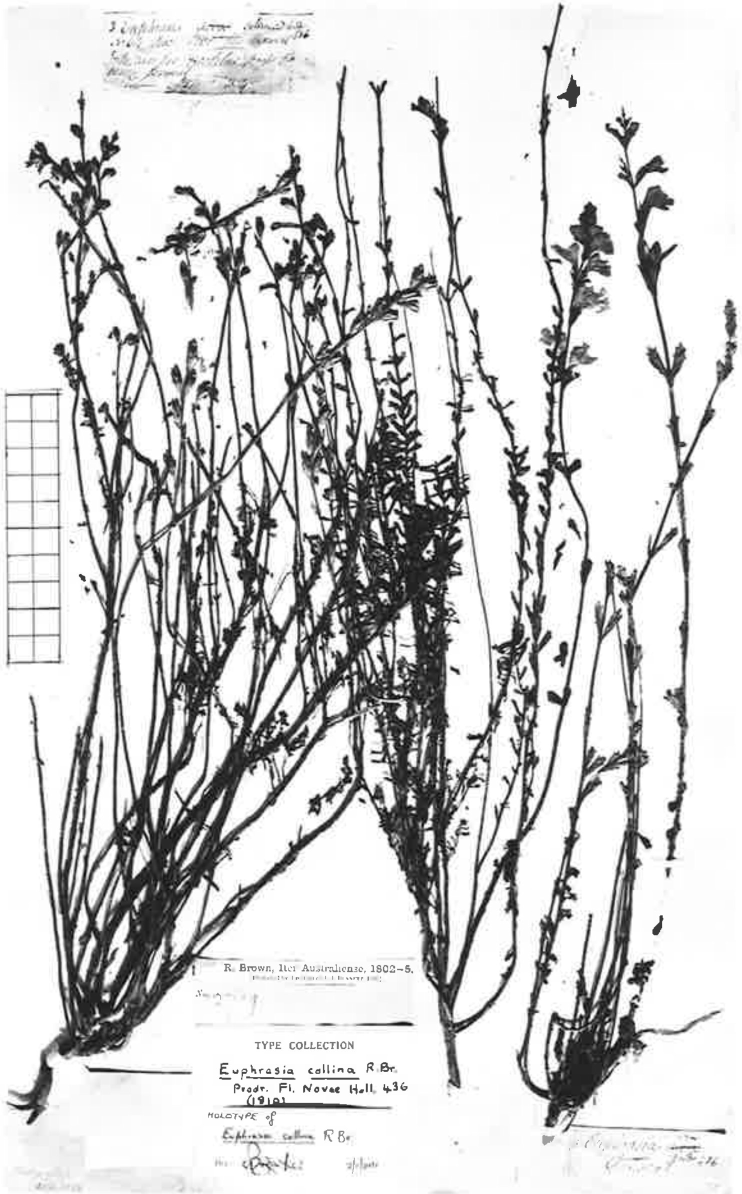
PLATE 24

UPPER

Holotype of _E. ciliolata_

LOWER

Lectotype and other syntype of _E. collina_


R. Brown, Iter Australiense, 1802–5.
TYPE COLLECTION
Euphrasia collina R.Br.
Prodr. Fl. Novae Holl. 436 (1810)
HOLOTYPE of
Euphrasia collina R.Br.


Holo- TYPE of
Euphrasia ciliolata
BARKER
HERBARIUM, CANBERRA BOTANIC GARDENS
No 051293
Euphrasia ciliolata Barker (ms.)
Loc. Barrington Tops, N.S.W.: Polblue Creek, at 600 m.
Notes
Coll. J. Culley
Date 10/2/1971
Det. W. Barker

PLATE 25

UPPER

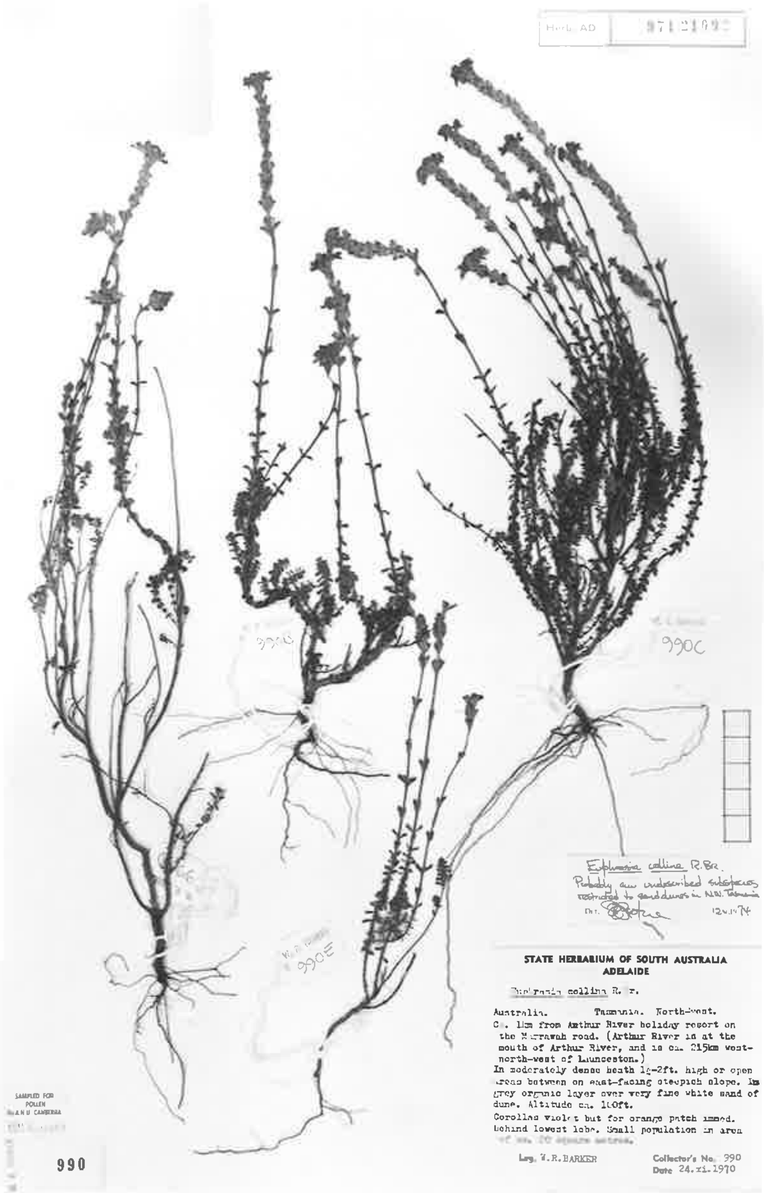
The collection Barker 990 which belongs to a possibly undescribed subspecies of E. collina (q.v.: Note 1).

LOWER LEFT

Location near Mt. Kosciusko with stony fjaeldmark on a platform jutting into the channel cut out by a stream, short alpine herbfield at the level of the stream, and tall alpine herbfield covering the broad valley floor, all within a few metres of each other and supporting their respective subspecies of E. collina (q.v.: Intraspecific Variation).

LOWER RIGHT

Location near Mt. Kosciusko where E. collina ssp. diversicolor of tall alpine herbfield (on slopes) and ssp. glacialis of short alpine herbfield (at stream level) intergrade along an ectone (on the steep bank of the stream) between the two habitats.



990C
Euphrasia collina R.Br.
Probably an undescribed subspecies restricted to sand dunes in N.W. Tasmania
12.vi.74
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Euphrasia collina R. Br.
Australia. Tasmania. North-west.
Ca. 1km from Arthur River holiday resort on the Marrawah road. (Arthur River is at the mouth of Arthur River, and is ca. 215km west-north-west of Launceston.)
In moderately dense heath 1½-2ft. high or open areas between on east-facing steepish slope. In grey organic layer over very fine white sand of dune. Altitude ca. 100ft.
Corollas violet but for orange patch immed. behind lowest lobe. Small population in area
Leg. W.R. BARKER
Collector's No. 990
Date 24.xi.1970
990

PLATE 26

UPPER

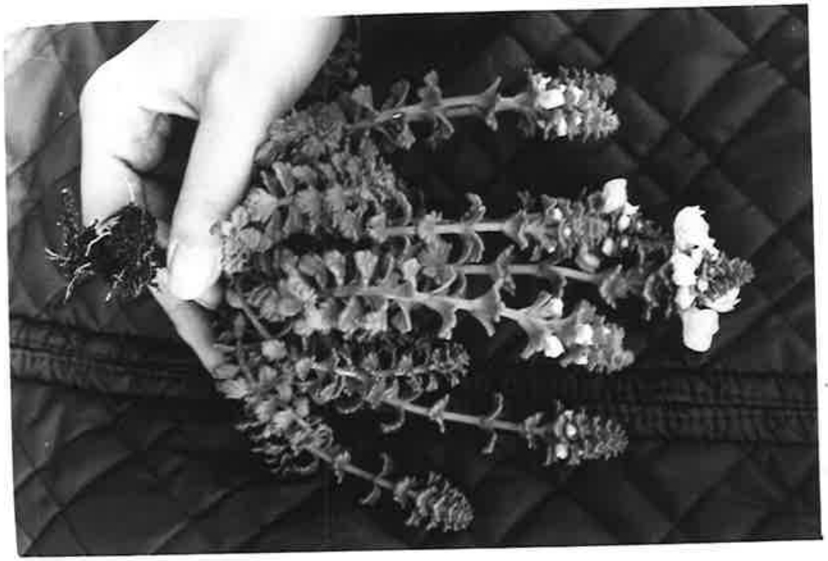
Lectotype and other syntype of *E. walteri*

LOWER LEFT

Location of the cliff-top population of *E. collina* ssp. *tetragona* on the exposed tip of West Cape, south-west Yorke Peninsula.

LOWER RIGHT

Very fleshy specimen of *E. collina* ssp. *tetragona* from the West Cape population.



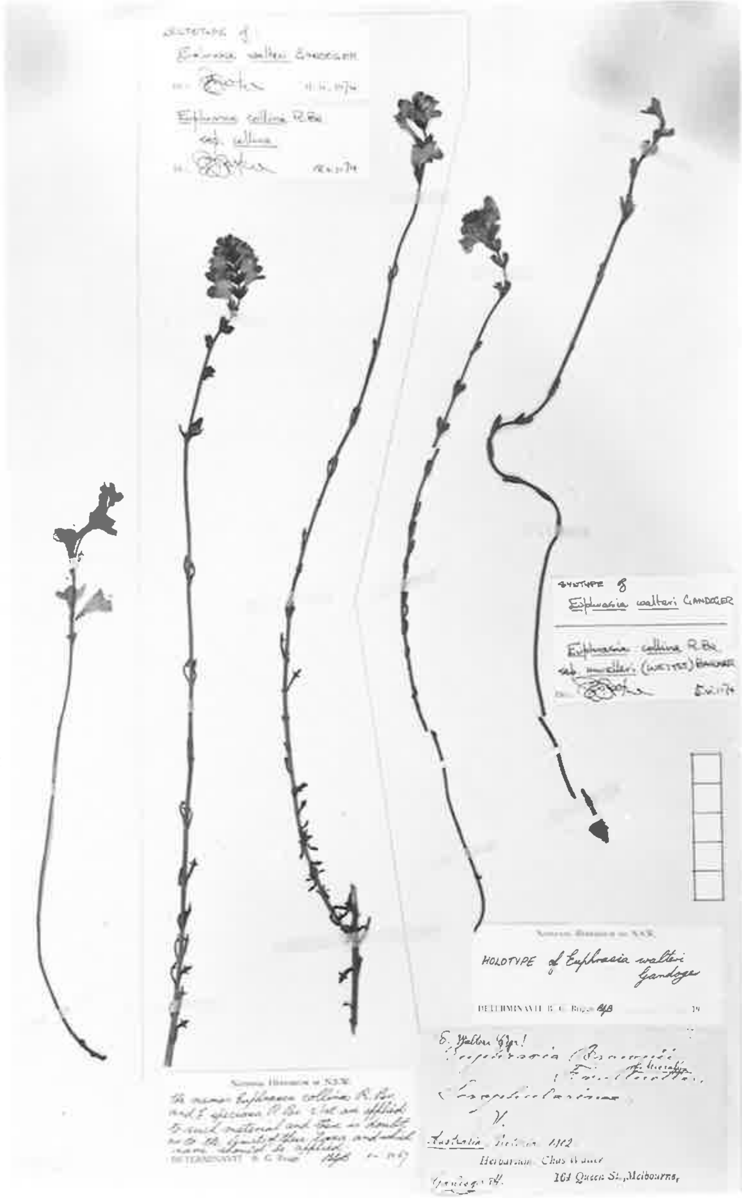

SYNTYPE of
Euphrasia walteri GANDOGER
Euphrasia collina R.Br.
HOLOTYPE of Euphrasia walteri Gandoger
Australia
161 Queen St., Melbourne,

PLATE 27

UPPER

Lectotype and other syntype of E. collina ssp. muelleri.

LOWER

Holotype of E. collina ssp. bowdeniae.


Holo -TYPE of
Euphrasia collina R.Br.
ssp. [illegible] BARKER
NATIONAL HERBARIUM OF NEW SOUTH WALES
ROYAL BOTANIC GARDENS, SYDNEY
To be cited as: NSW
Euphrasia
Loc. Blackheath N.S.W.
between Govetts Leap and Pulpit Rock
Coll. R. G. Coveny Date 16-x-1966
Notes: [illegible] in damp soil near rock face


Euphrasia . Mülleri Wett.
det. Wettstein
LECTOTYPE of
Euphrasia muelleri WETTST.
15/12/1971
Euphrasia collina R.Br.
ssp. muelleri (WETTST.) BARKER
HERBARIUM
MUSEI CAESAREI
PALATINI VINDOBONENSIS

PLATE 28

UPPER

Holotype of *E. collina* ssp. *nandewarensis*

LOWER

Holotype of *E. collina* ssp. *osbornii*


Herb. AD
-TYPE
1346
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Collector's No.
Date

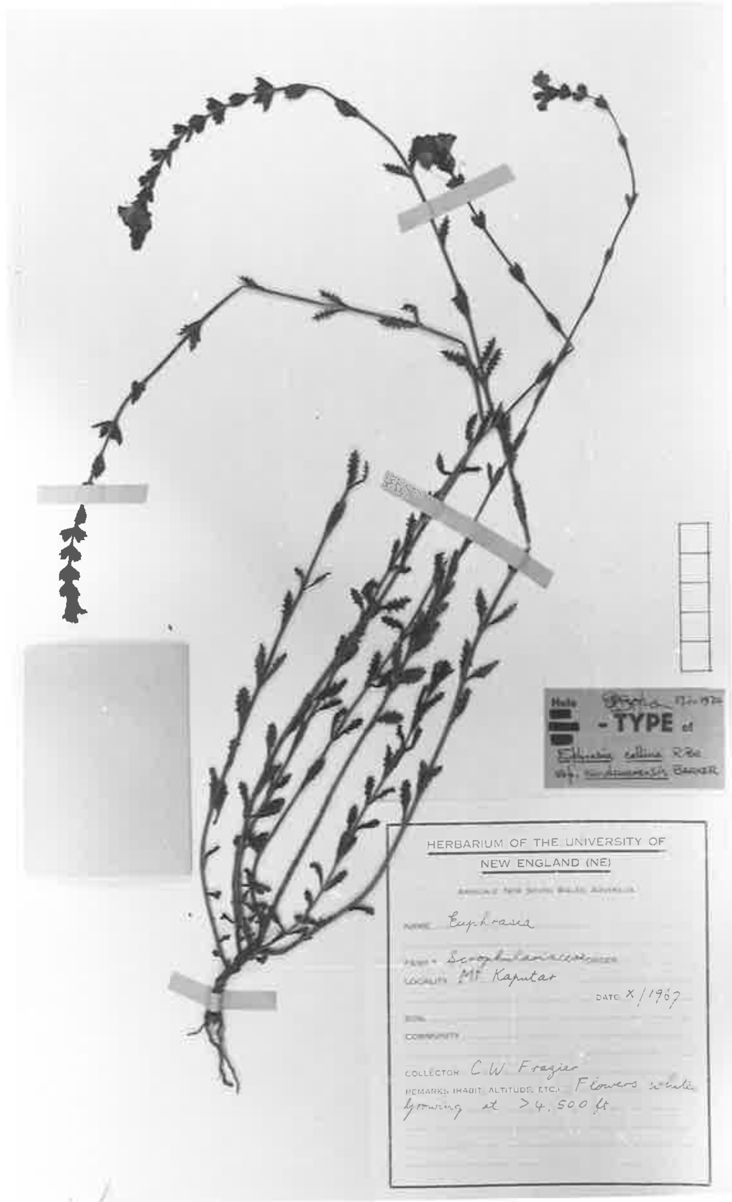

Holo
-TYPE of
HERBARIUM OF THE UNIVERSITY OF
NEW ENGLAND (NE)
NAME Euphrasia
LOCALITY Mt Kaputar
DATE X/1967
COMMUNITY
COLLECTOR C.W. Frazier
REMARKS (HABIT, ALTITUDE, ETC.) Flowers white
growing at >4,500 ft

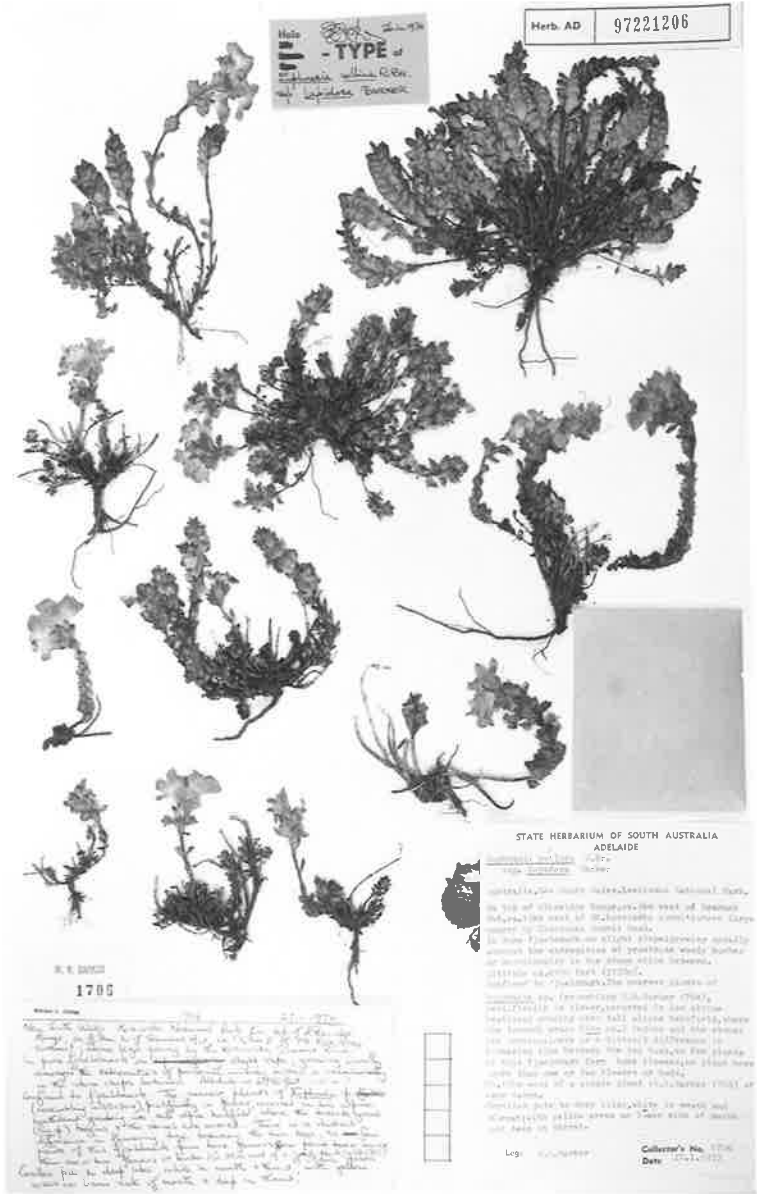
PLATE 29

UPPER

Holotype of _E. collina_ ssp. _diversicolor_

LOWER

Holotype of _E. collina_ ssp. _lapidosa_


Herb. AD
97221206
-TYPE of
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
1706
Leg.
Collector's No.
Date

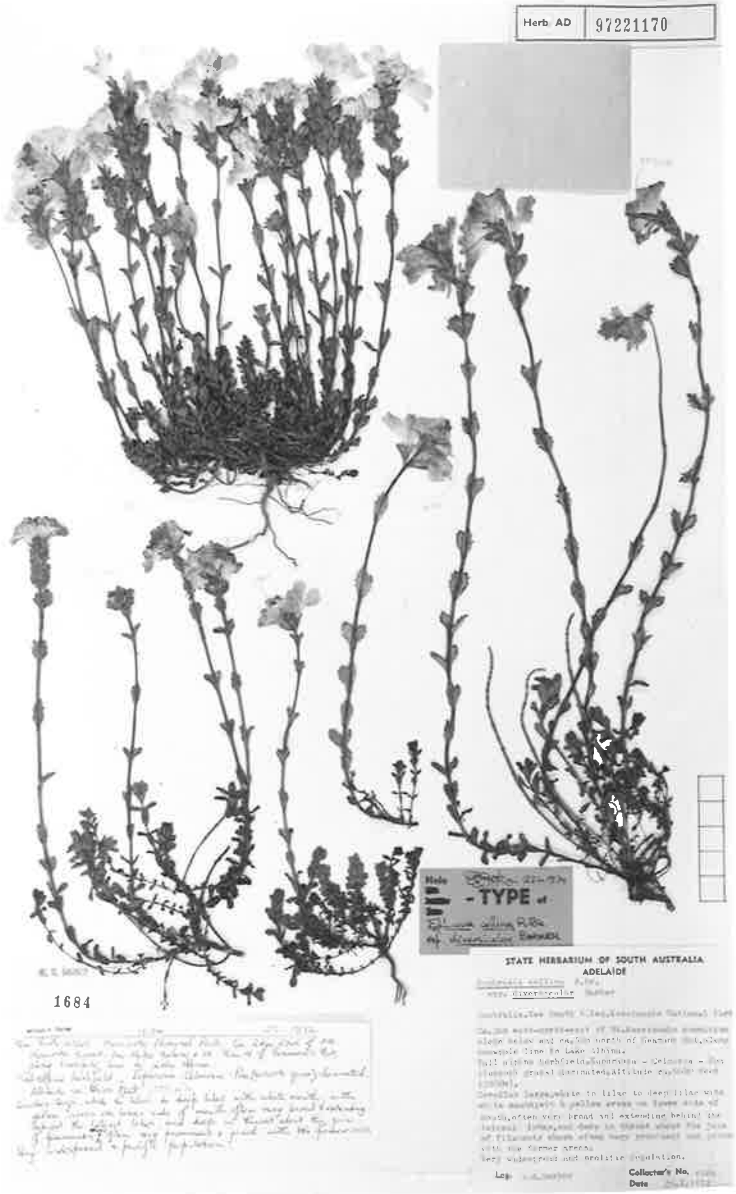

Herb. AD
97221170
-TYPE of
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
1684
Leg.
Collector's No.
Date

PLATE 30

UPPER

Holotype of _E. bella_

LOWER

Holotype of _E. crassiuscula_


Euphrasia glacialis Wettst. var. eglandulosa J.H. Willis
Holotype of Euphrasia crassiuscula Gandoger
excluding specimen on left which is not Euphrasia
HERBARIUM MICHAELIS GANDOGER
Michael GANDOGER, — Arnas (Rhône) France


PART OF TYPE COLLECTION
(holotype)
BRISBANE

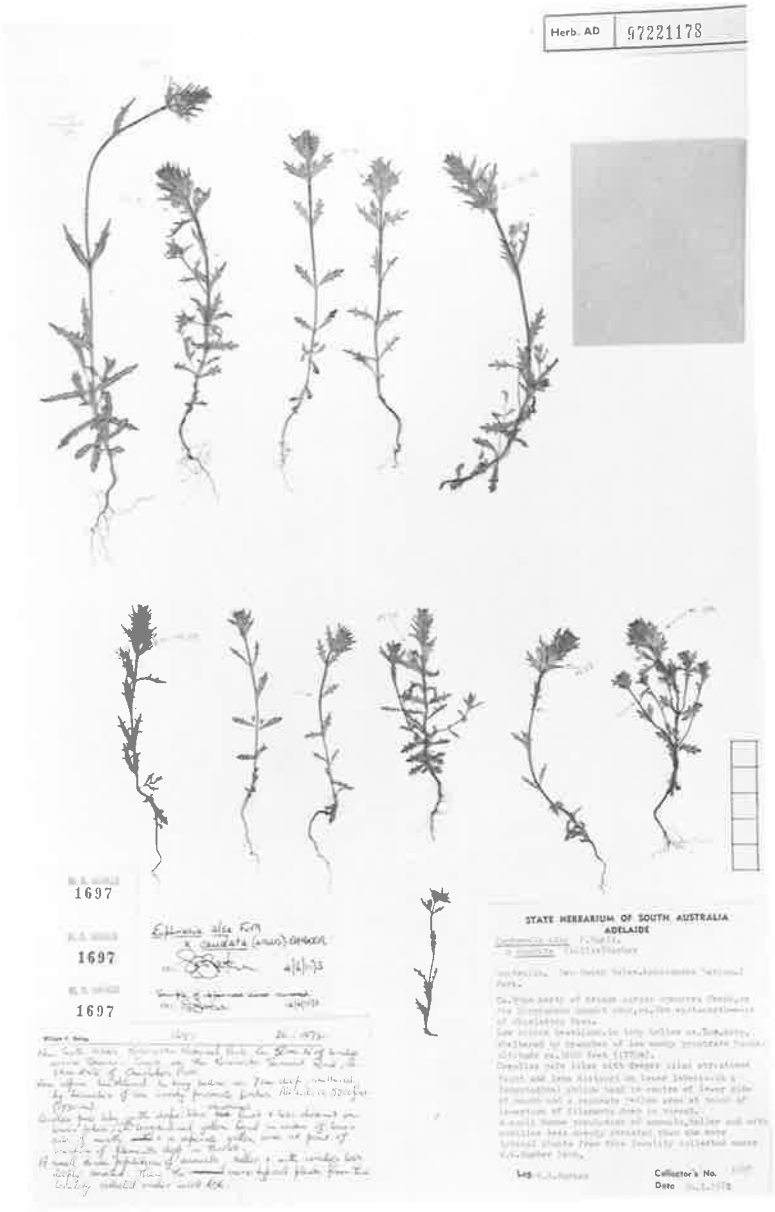
PLATE 31

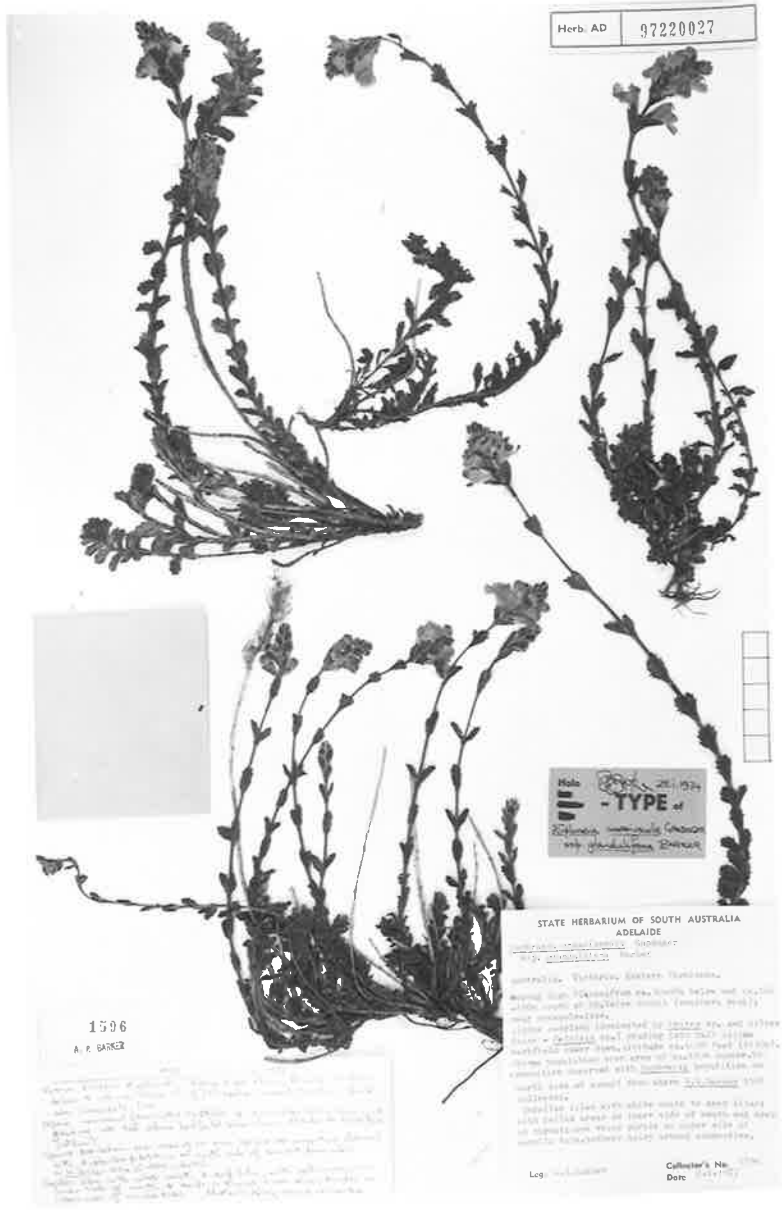
UPPER

Holotype of E. crassiuscula ssp. glandulifera

LOWER

E. alsa x E. caudata ssp. caudata


Herb. AD 97221178
1697
1697
1697
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Leg.
Collector's No.
Date


Herb. AD 97220027
Holo
TYPE of
1596
A. F. BARKER
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Leg.
Collector's No.
Date