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Author
Williams, KJ, Bradley Potts

**Bibliographic citation**
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# The natural distribution of *Eucalyptus* species in Tasmania

K.J. Williams and B.M. Potts
Cooperative Research Centre for Temperate Hardwood Forestry,
Department of Plant Science, University of Tasmania,
GPO Box 252–55, Hobart 7001
email: Kristen.Williams@plant.utas.edu.au. / B.M.Potts@plant.utas.edu.au

**Abstract**

*A summary is provided of the natural geographic distributions of the 29 Tasmanian* Eucalyptus *species. The work is based on over 60 000 observations from numerous data sources. A map on a 10 km x 10 km grid-cell scale is presented for each species and is accompanied by graphs of the altitudinal range and flowering times, as well as descriptive notes on distribution and ecology, supplemented with a list of key references. The geographic pattern of species richness is examined at generic, subgeneric and series levels. Total species richness is greater in the drier, eastern regions compared to the wet, western regions of Tasmania, with highest concentrations of species occurring mainly in the central east coast and south-eastern regions.* Monocalyptus *species occur in 8% more grid cells than* Symphyomyrtus *species but are absent from King Island. At the series level, greatest species richness is reached by the* Obliquae *in the north-east, the* Piperitae *in the south-east, the* Ovatae *on the central east coast, and the* Viminales *in highland areas of the south-east and Central Plateau. Series* Obliquae *species are absent from Flinders Island and are poorly represented in the south-west.*

*The general patterns of eucalypt distribution and ecology are reviewed. Species are classified into nine categories based on the grid cells they occupy within their geographic range. The most widespread species are* E. delegatensis, E. obliqua, E. ovata, E. viminalis *and the endemic* E. amygdalina. *Most species with localised distributions have been nationally recognised as rare (i.e.* E. barberi, E. morrisbyi, E. perriniana *and* E. risdonii*). Rare species with regional distributions have either dispersed* (E. cordata) *or disjunct* (E. archeri) *occurrences. Most species that are rare in Tasmania are endemics, with the exception of* E. perriniana *and* E. *aff.* radiata*, although the taxonomic status of the latter requires investigation. Unresolved issues relating to the natural distribution and taxonomic affinities of the Tasmanian eucalypt species are summarised.*

**Introduction**

In Tasmania and the Bass Strait islands, 29 native eucalypt species (one of which has two subspecies) are recognised by Buchanan (1995), from two informal subgenera, *Monocalyptus* and *Symphyomyrtus* (Pryor and Johnson 1971). In the present study, we have treated all Tasmanian records of *Eucalyptus globulus* as *E. globulus* subsp. *globulus*. The other subspecies of *E. globulus* listed for Tasmania, subsp. *pseudoglobulus*, occurs only in forms which intergrade with *E. globulus* subsp. *globulus* (Jordan *et al.* 1993) and we do not include it here as a separate taxon.

The Tasmanian native eucalypts include 12 species from two series in the subgenus *Monocalyptus* and 17 species from two series in the subgenus *Symphyomyrtus* (Table 1)[1]. Seventeen taxa are known to be endemic to Tasmania (Brown *et al.* 1983), including *E. delegatensis* subsp. *tasmaniensis* (Boland 1985). The *Monocalyptus* and *Symphyomyrtus*

[1] An alphabetical list of the Tasmanian eucalypt species, including common names, is given in Table 2 (p. 47).

*Table 1. Taxonomic classification of the Tasmanian* Eucalyptus *species (after the informal classification of Pryor and Johnson 1971). Authorities for nomenclature follow Chippendale (1988). Subgroupings of the series* Viminales *generally follow Jackson (1965) and Duncan (1989) except* E. cordata *which has closest affinities with the alpine white gum subgroup (Pryor and Johnson 1971). Common names for series groups follow Duncan (1989; see also Jackson 1965).* Eucalyptus globulus *subsp.* globulus *includes forms which intergrade morphologically with the mainland taxon* E. globulus *subsp.* pseudoglobulus *(Jordan* et al. *1993). (* = Tasmanian endemic)*

**SUBGENUS *Monocalyptus***

**Series *Obliquae*** (Ash Group)

* *E. delegatensis* R.T. Baker subsp. *tasmaniensis* Boland
*E. obliqua* L'Hér.
*E. pauciflora* Sieber ex Sprengel subsp. *pauciflora*
*E. regnans* F. Muell.
*E. sieberi* L. Johnson

**Series *Piperitae*** (Peppermint Group)

* *E. amygdalina* Labill.
* *E. coccifera* J.D. Hook.
* *E. nitida* J.D. Hook.
* *E. pulchella* Desf.
*E.* aff. *radiata* Sieber ex DC.
* *E. risdonii* J.D. Hook.
* *E. tenuiramis* Miq.

**SUBGENUS *Symphyomyrtus***

**Series *Ovatae*** (Black Gum Group)

* *E. barberi* L. Johnson & Blaxell
*E. brookeriana* A.M. Gray
*E. ovata* Labill.
* *E. rodwayi* R. Baker & H.G. Smith

**Series *Viminales*** (White Gum Group)

**White gum subgroup**

*E. dalrympleana* Maiden subsp. *dalrympleana*
*E. rubida* Deane & Maiden
*E. viminalis* Labill. subsp. *viminalis*

**Yellow gum subgroup**

* *E. johnstonii* Maiden
* *E. subcrenulata* Maiden & Blakely
* *E. vernicosa* J.D. Hook.

**Blue gum subgroup**

*E. globulus* Labill. subsp. *globulus*

**Alpine white gum subgroup**

* *E. archeri* Maiden & Blakely
* *E. cordata* Labill.
* *E. gunnii* J.D. Hook.
* *E. morrisbyi* Brett
*E. perriniana* F. Muell.
* *E. urnigera* J.D. Hook.

subgenera are reproductively isolated (Ellis *et al.* 1991) but, within subgenera, extensive hybridisation and intergradation may occur (Griffin *et al.* 1988). Recognised cases of hybridisation and clinal variation amongst the Tasmanian eucalypts are summarised by Duncan (1989; Figure 1). A field key for the identification of Tasmanian eucalypts, which caters for the complex variation within and between species, is given by Duncan (1996).

This atlas of the natural geographic and altitudinal distribution of the Tasmanian *Eucalyptus* species is a compendium of annotated maps on a 10 km x 10 km grid-cell scale, collated from diverse information sources. Mapping has been the first stage in screening for errors in a database that will ultimately be used for predictive analyses, contribute to land management decisions and assist ecological research. The main impetus for publishing these distributional data is to

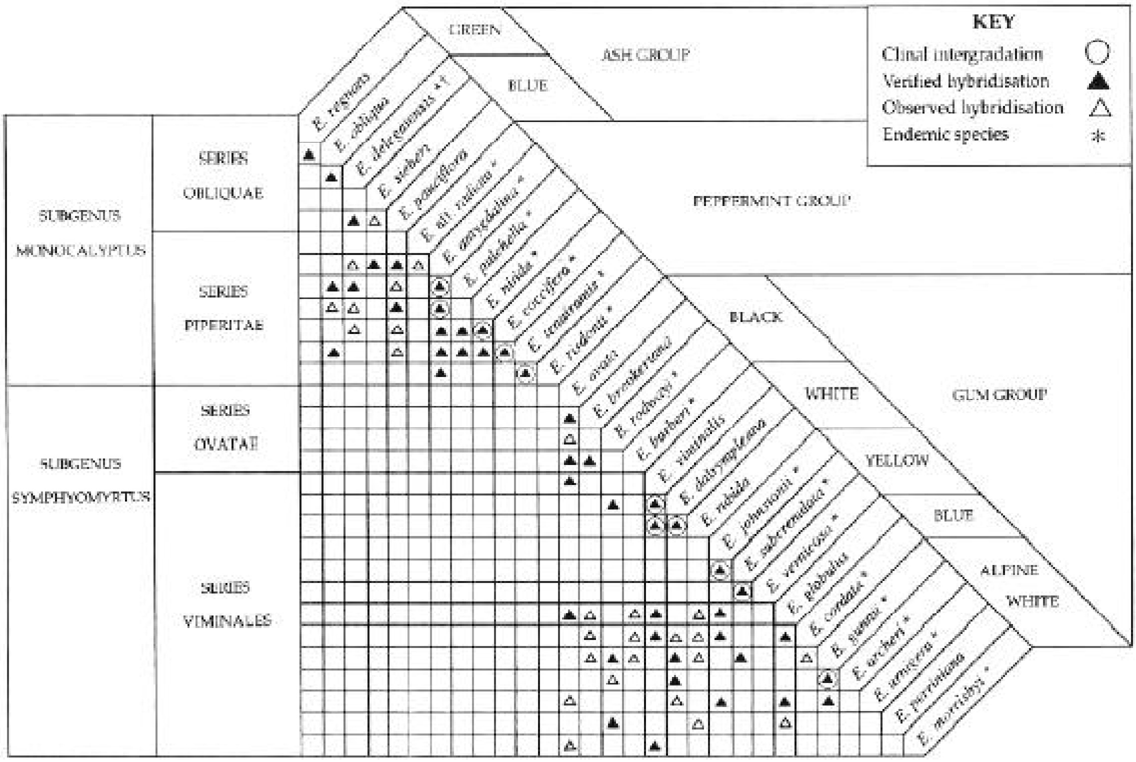



*Figure 1. Species of* Eucalyptus *native to Tasmania, showing species which form clines and natural hybrids. Hybrids only occur within subgenera. For each species, follow horizontal and vertical axes. For example,* E. barberi *is known to hybridise with* E. brookeriana *and* E. ovata *(horizontal axis) and possibly with* E. globulus, E. gunnii *and* E. cordata *(vertical axis).* † E. delegatensis *is represented in Tasmania by an endemic subspecies. (Figure adapted from Duncan 1989)*

quantify current knowledge, to stimulate the collection of herbarium voucher specimens from new localities, and to encourage the verification of outliers. It is important to clarify the natural distribution of *Eucalyptus* species in Tasmania as land clearing and plantings for ornamental and forestry purposes will eventually confuse natural and artificial occurrences. The maps and graphs presented should allow clear assessment of whether an occurrence is novel and represents an extension of the geographic or altitude range of a species, or whether it represents a poorly verified or well-known location.

*Previously published data on eucalypts*

Several previous studies have published maps of eucalypt distributions at the level of species or vegetation type. The maps of Jackson (1965) are still the main overall source of information on the distribution of eucalypt species in Tasmania (e.g. Davidson *et al.* 1981; Forest Resources 1995). Other publications such as Boland *et al.* (1984) and Chippendale (1988) include broad-scale maps of Tasmanian eucalypt species in the context of Australia-wide eucalypt occurrences. Local texts such as Kirkpatrick and Backhouse (1985) and the atlas of Tasmanian endemics (Brown *et al.* 1983) include eucalypts in the context of other Tasmanian plant species. Mapping at higher resolutions, such as the 1:500 000 distribution maps of vegetation types (Kirkpatrick and Dickinson 1984), tall eucalypt forest types (Forestry Commission 1988), and the specific studies of wet and dry eucalypt forests by Wells (1989) and Williams (1989) display the predominance of eucalypts in the landscape (cf. Pryor and Johnson 1981). Regional and local vegetation mapping has also contributed significantly to our knowledge of eucalypt occurrences. For example, Brown and Bayly-Stark (1979a) mapped the vegetation of Maria Island, Duncan (1983) mapped communities in the Douglas River region, Brown and Duncan (1989) mapped the vegetation of Tasman Peninsula, Fensham (1989) reconstructed the vegetation patterns for the Midlands from extant and remnant community distributions, and Kirkpatrick and Balmer (1991) mapped the northern portion of the Cradle Mountain – Lake St Clair National Park (see also Corbett and Mackie 1994).

Geo-coded flora inventory surveys with well-designed sampling strategies provide a lasting contribution to our knowledge of the distribution patterns of eucalypts. Such inventories include, for example, the broad-scale vegetation surveys of heathlands (Kirkpatrick 1977), dry sclerophyll forests (Duncan and Brown 1985), grassy woodlands (Kirkpatrick and Duncan 1987; Kirkpatrick *et al.* 1988a), wet eucalypt forests (Neyland 1986; Kirkpatrick *et al.* 1988b), swamp forests (Pannell 1992), rainforest (Jarman *et al.* 1984, 1991), riparian vegetation (Askey-Doran 1993), buttongrass moorlands (Jarman *et al.* 1988), and alpine vegetation (e.g. Kirkpatrick 1980, 1984a, b; Kirkpatrick and Harwood 1980; Kirkpatrick and Whinam 1988). Other purpose-specific flora inventory surveys encompass many local areas in particular regions throughout Tasmania; for example, the non-allocated Crown land surveys (e.g. Duncan 1986; Neyland 1988a, b; Neyland and Duncan 1988a, b; Slater 1988; Cullen 1990; Mendel 1991), the land system surveys (Richley 1978, 1984; Pinkard 1980; Pinkard and Richley 1984; Pemberton 1986, 1991; Davies 1988), and the numerous unpublished environmental impact and investigation surveys of Crown and private land areas by management agencies such as Forestry Tasmania, the Department of Environment and Land Management, the Department of Primary Industry and Fisheries, Works Tasmania, and local councils.

For reasons of inherent interest, or for management-orientated research and academic study, many individuals have also under-

*Photo 1. The first distribution maps of Tasmanian eucalypts were published by Prof. W.D. Jackson (right) in 1965. He is shown with Prof. L.D. Pryor examining a specimen of* E. globulus.

taken flora surveys of local land areas such as the Rheban Spit (Bowden and Kirkpatrick 1974), Cape Raoul (Kirkpatrick 1975c), Mount Wellington Range (Ratkowsky and Ratkowsky 1976, 1977, 1982), East Risdon Nature Reserve (Brown and Bayly-Stark 1979b), Hellfire Bluff (Harris and Brown 1980), Rocka Rivulet (Duncan *et al.* 1981), Cherry Tree Hill (Duncan and Duncan 1984), Ben Lomond National Park (Davies and Davies 1989), Table Cape (Willis 1991) and Hummocky Hills (Ratkowsky *et al.* 1993c). Details of the distribution of some species have become known following studies of the genetic structure of populations such as *E. barberi* (McEntee *et al.* 1994), *E. cordata* (Potts 1989), *E. globulus* (Kirkpatrick 1974, 1975b; Jordan *et al.* 1993, 1994), *E. gunnii* and *E. archeri* (Potts 1985; Potts and Reid 1985a, b), *E. morrisbyi* (Wiltshire *et al.* 1991b), *E. perriniana* (Wiltshire and Reid 1987), *E. risdonii* and *E. tenuiramis* (Wiltshire *et al.* 1991a, 1992) and *E. vernicosa, E. subcrenulata* and *E. johnstonii* (Jackson 1960). Information on distributions has also been derived from ecological studies such as those on interactive effects of drought, frost and waterlogging (e.g. Davidson and Reid 1985, 1987, 1989), insolation (e.g. Kirkpatrick and Nunez 1980), fire regime (e.g. Neyland and Askey-Doran 1994), and the nature of an inverted tree-line (e.g. Gilfedder 1988).

Collectively, these diverse studies have assisted in formulating the conservation status of individual species (e.g. Brown *et al.* 1983; Briggs and Leigh 1988; Kirkpatrick *et al.* 1991a, b) and communities (e.g. Kirkpatrick *et al.* 1994), enabling priorities to be identified for management and research (e.g. Wiltshire *et al.* 1989). Collation of the distribution information from these and other studies is summarised here for eucalypts.

## Methods

### *Species nomenclature*

Subspecies have been abbreviated to their species name wherever appropriate, providing this leads to no ambiguity in a Tasmanian context, and no loss of clarity in the discussion.

### *Data collation*

A generalised 10 km x 10 km map scale, corresponding to the Australian Map Grid (AMG) system, has been widely used in Tasmania for presenting the distributions of native plant and animal communities or taxa (e.g. Thomas 1979; Brook 1979; Brown *et al.* 1983; Kirkpatrick *et al.* 1988a, b). The eucalypt distribution maps are based on over 60 000 records collated from the published literature (7%), unpublished reports (7%) and existing databases (86%), where these could at least be located within a 10 km x 10 km grid cell. Literature from which records were derived is indicated in the Bibliography (see p. 150). The existing databases were contributed by Forestry Tasmania (CFI, Lawrence 1978; floristic data, Orr and Manson 1994), the Tasmanian Department of Environment and Land Management (TASPAWS / TASFORHAB databases, Peters 1983), and CSIRO Division of Plant Industry (EUCALIST, Chippendale and Wolf 1984). Extensive distribution data held in collections at the Tasmanian Herbarium were accessed via EUCALIST prior to 1984, or directly from the Herbarium for later collecting dates. The unpublished reports of Forestry Tasmania were derived largely from the botanical surveys of Forest Reserves, Recommended Areas for Protection (RAPs) and forest coupes prior to logging. The unpublished reports of the Department of Environment and Land Management comprised investigation surveys and specific research projects. Other unpublished records were generously provided by individuals of these Government agencies and the University of Tasmania, or unaffiliated field botanists. The published literature was generally derived from Tasmanian and Australian journals on botany, forestry and ecology, and locally produced reports.

### *Data verification*

A conservative approach to data verification was undertaken to encourage the future accurate location of suspect records. Draft maps of the distribution of each species were reviewed for obvious errors, outliers and single records in a grid cell on the margins of a distribution. Such occurrences that were considered possible, albeit unlikely, were usually deleted from the distribution maps and discussed in the text for each species as unverified outliers. Particular attention was also paid to inconsistencies with the original maps of Jackson (1965) and locations in Brown *et al.* (1983) which were unverified.

Collated occurrences which were clearly in error were omitted from the maps. These errors included clear misidentifications for historic or accidental reasons and mis-read or mis-typed grid references. In some cases, errors arose in conversion of locations from minutes of latitude and longitude to AMG. The conversion frequently placed the record in an adjacent and incorrect 10 km x 10 km grid cell. For example, records of *E. coccifera* with a location given as 'Herringback' appeared in grid cell 5023 following conversion of latitude and longitude to AMG, but the location actually refers to cell 5123. In other cases, earlier collectors, in the absence of accurate maps, gave descriptions with reference to the nearest landmarks and named places which, when converted to latitude and longitude, lead to some spurious locations due to the existence of several places by the same name or the same place by different names. For example, Mount Wellington in southern Tasmania was referred to previously as Plateau Mountain or Table Mountain, and when Robert Brown collected *E. globulus* in 1804 from the 'Derwent River Table' or 'Table Mountain', it was incorrectly attributed to Table Mountain in the Midlands. Other causes of error are outdated nomenclature in some species or the difficulties of distinguishing morphologically similar species and their intergrading forms. For example, the fine-leaved peppermints *E. amygdalina* and *E. nitida* may appear superficially similar when adult leaves, fruits and buds are compared, but are more readily distinguished on bark and habitat. In the case of their intergrading forms, the naming preferences of different recorders are expressed. Overlapping nomenclature is particularly apparent for data collated from numerous sources.

Some other inadvertent errors have arisen in the database following the collation of published distributions where these are based upon floristic classifications and summarised data (e.g. Kirkpatrick *et al.* 1988a, b; Askey-Doran 1993). In such cases, the community nomenclature which is frequently derived from the dominant tree species and vegetation type does not necessarily reflect a verifiable presence for that species.

Errors of these types in the distribution data accounted for approximately 5% of the initial 63 567 records, leaving 60 412 records available for mapping[2].

Sampling bias due to duplicated and replicated data may have masked some records that would otherwise have been reviewed for potential error. For example, duplication in the data arises where field records of some collectors have been used in several publications, collated in several databases, and voucher specimens simultaneously lodged with different herbaria, giving a perception of several separate sources. Intensive sampling in some locations relative to others (replication) may also contribute to enhanced perceptions of record validity. The degree of multiple occurrences of data or sources in each 10 km x 10 km grid cell results in considerable redundancy at this scale. The raw data have a redundancy of approximately 75% and the sources themselves have a redundancy of approximately 40%. To overcome some of these problems of sampling bias, an indication is provided for each grid cell of the the number of separate sources recording the presence of a species. It was felt that displaying separate sources, rather than the number of records per cell gave a better indication of independent identifications and thus the reliability of the presence of a species.

In the context of the number of sources per grid cell per species, the overall rate of

[2] In the ORACLE database 'EUCDATA' at the University of Tasmania, all data up to 'INDEX_NUM = 63 672' have been used in this atlas of distributions.

obvious error and unverified observations accounts for approximately 14% of the initial 16 523 observations from the condensed set of data, leaving 14 185 independent identifications available for mapping. The verified data are derived from 441 different sources and the unverified data derive from 89 sources. Together, the data comprise 455 distinct sources.

*Altitude occurrences and flowering time*

Altitude occurrences in 100 m classes and monthly flowering incidence for each species accompany the distribution maps. The altitude data were collated with distribution records. Obvious errors in the altitude records were screened by considering outliers in the context of the predominant habitat for each species and the upper and lower limits of the particular response curve. Sampling bias among the altitude records for each species was reduced by combining, into a single observation, replicates from the same grid cell which differed by less than 10 m. This left 20 169 records for defining the response curves.

The flowering-time records were separately collated from EUCALIST (Chippendale and Wolf 1984), with additional records from the Tasmanian Herbarium (up to 1992), field notes (BMP) and published data (*E. gunnii* Potts and Reid 1985a, b; *E. urnigera* Savva *et al.* 1988; *E. cordata* Potts 1989). Flowering times are given for a 15-month period starting from May (autumn) to produce an optimal display of the response curves for most species. In several cases, the flowering information will be biased by extensive records from specific studies, involving specific years or specific localities or, conversely, by inadequate data.

Response curves for flowering times are defined by a moving average (summed weights of 0.5 to the observation and 0.25 to each adjacent record), where each observation represents the middle of the respective month. Absence data were not available for either flowering times or altitude responses. Thus, the documented responses (see relevant Figures on pp. 49–121) are conditional probabilities which reflect the distribution of occurrences in the specified classes.

*Distribution types and conservation status*

The collated data were used to explore some attributes of species' distributions (see Rabinowitz 1981). The geographic range of each species within Tasmania was estimated by connecting occupied grid cells from the outer marginal extremes of a core distribution, or from the coast, to outliers by straight lines and interpolating the number of cells within the resulting envelope (e.g. see 'extent' in Gaston 1996). The aggregation of species occurrences within their range was estimated as a percentage of the occupied grid cells and the geographic range. The continuous variation in the distribution of the Tasmanian eucalypts is categorised into nine types based on the geographic range and aggregation of occurrences for each species.

*Distribution maps, habitat descriptions and community classifications*

Distribution, altitude profiles and flowering times for the 29 eucalypt species, in alphabetical order, are given in the following atlas of maps and figures. The presence of a species in a grid cell is represented by a dot, the size of which reflects the number of separate sources recording a presence (Legend, p. 47). The annotated text summarises distribution, taxonomic affinities and ecology for each species. Specific occurrences and outliers of particular note are discussed, often in the context of clinal intergradation and hybridisation. Taxonomic notes were derived from Boland *et al.* (1984), Chippendale (1988) and Curtis and Morris (1975), as well as from specific studies referenced in each case. Similarly, broad habitat and community descriptions were integrated with assistance from the floristic classifications of dry sclerophyll forest (Duncan and Brown 1985), grassy woodlands (Kirkpatrick *et al.* 1988a), and wet eucalypt forest (Kirkpatrick *et al.* 1988b), and the habitat descriptions given in Davidson *et al.* (1981). To avoid excessive repetition, these sources are generally not cited in the annotated text for each species. Other specific sources used are indicated in the text for each species. Key references on the biology of a particular species are listed in alphabetical order. Locations mentioned when commenting on the distribution of a species are referenced to 10 km x 10 km grid cells which are directly related to the Tasmanian TASMAP series (Department of Environment and Land Management).

*Photo 2. Very tall specimens of* E. viminalis, *exceeding 85 m in height and known as the 'White Knights', occur in wet forest at Evercreech in the Fingal Valley.*

# *Atlas of distributions of Tasmanian eucalypts*

**Legend to distribution maps:** Dot size reflects the number of separate sources recording presence in a grid cell (see p. 45). • = 1, 2 ● = 3–5 ⬤ = > 5

*Table 2. Index to species in the atlas of Tasmanian eucalypts. Common names for species mostly follow, or are based on, Curtis and Morris (1975). Those of* E. archeri *and* E. brookeriana *are taken from Boland* et al. *(1984), and* E. *aff.* radiata *has unclarified taxonomic affinities in Tasmania. In a few cases, common names have been changed to more accurately reflect relationships between species at the level of the ash, peppermint or gum groups. Where this has occurred, old common names are shown in brackets.*



### New records

The authors welcome new locations for Tasmanian eucalypts, and information on the unverified or doubtful records discussed in this atlas. All records should be in writing, stating location of the plant, date of observation / collection, and name of the collector and / or person providing the information. It is important that range extensions (geographic or altitudinal) are supported by the collection of herbarium material (providing it causes minimal damage to the plant), since voucher specimens provide the best level of verification of a species (see Duncan 1996, this volume).

# *Eucalyptus amygdalina*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
black peppermint

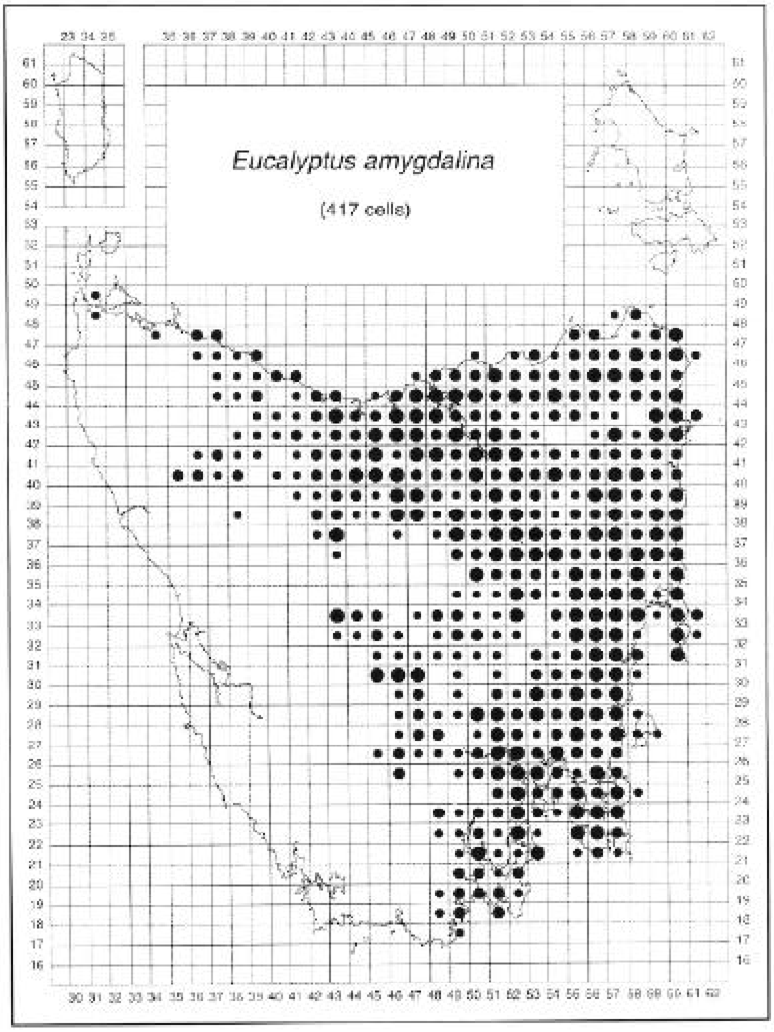



*Figure 2. Distribution of* E. amygdalina *in Tasmania.*

*Eucalyptus amygdalina* is a widespread and common endemic species of eastern coastal regions and inland tiers and plateaux (Figure 2). It occurs on undulating or steep terrain across a wide range of substrates that are generally infertile, comparatively sunny and periodically drought prone. It is generally absent from the wetter regions of western Tasmania, and the upland regions of the Central Plateau and north-east. It intergrades with *E. nitida* in the north-western coastal region and towards the south-west along the western margins of its distribution, and with *E. pulchella* towards the east coast and throughout the Eastern Tiers on dolerite substrates.

*Eucalyptus amygdalina* is predominantly a lowland species, generally occurring from near sea-level to 600 m but occasionally up to 800 m, with rare, scattered occurrences up to 1020 m (Figure 3). The higher altitude occurrences are known from the Eastern Tiers near Snow Hill and Mount Foster, and from the south-eastern Central Plateau and Western Tiers. Its main flowering period is

August to January, peaking around October to November (Figure 4).

*Eucalyptus amygdalina* (Figure 5) is a typical dominant of dry sclerophyll forests and woodlands, usually occurring in mixed stands with other eucalypt species. Sharp ecotonal transitions between the three lowland peppermints *E. pulchella*, *E. amygdalina* and *E. tenuiramis* are most notable in south-eastern Tasmania in association with the geological contact zones between dolerite, sandstone and mudstone respectively. Elsewhere, *E. amygdalina* occupies a range of sites, and the tree form and understorey type reflect an interaction between substrate, climate and fire frequency. For example, on predominantly siliceous substrates deposited after erosive processes, the understorey is heathy where drainage is rapid (e.g. deep sands and granitic slopes), grassy on alluvial flats with medium drainage and a relatively high fire frequency, and sedgey on the margins of hollows with seasonally poor drainage. Alternatively, on dolerite and granite substrate-types, heathy understoreys develop in well-drained, undulating terrain, grassy woodlands develop on the stoney flats of inland tiers and plateaux with slightly impeded drainage, and shrubby communities develop on the more insolated rocky slopes and ridges. Wet sclerophyll understoreys occur locally in northern inland regions, and on the protected slopes and aspects of mountainous and hilly terrain elsewhere. *Eucalyptus obliqua* frequently co-exists with *E. amygdalina* in these ecotonal situations of increased moisture availability and substrate fertility. *Eucalyptus viminalis* is a common subdominant or minor species which may be replaced by *E. dalrympleana* in upland situations. Other species which may occur with *E. amygdalina* include *E. globulus* in shaded gullies, or *E. ovata* on poorly drained sites.

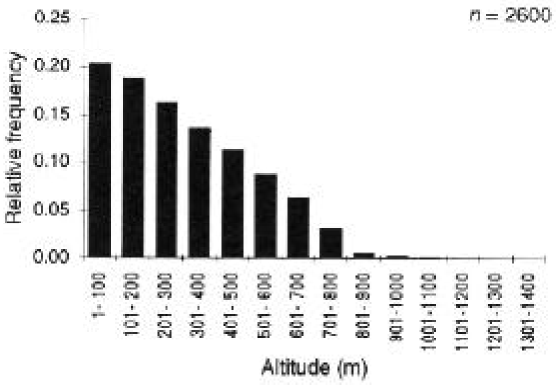



*Figure 3. Altitude distribution of* E. amygdalina.

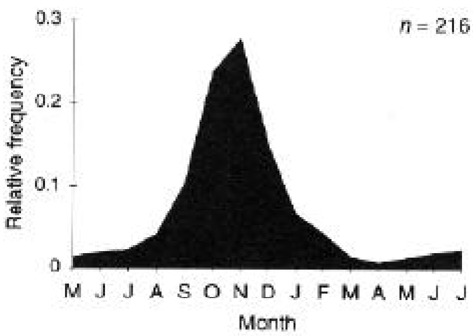



*Figure 4. Flowering times for* E. amygalina.

COMMENTS: There are several unverified outliers on the west coast from north of West Point to Macquarie Harbour (cells 2946, 3044, 3046, 3141, 3532, 3533, 3633, 3830), and south to Cox Bight (cells 4020, 4120, 4318). Other unverified outliers or unverified marginal occurrences are recorded from western and north-western inland regions (cells 3544, 3545, 3637, 3931) or adjacent to the Lyell Highway and the Gordon–Serpentine impoundments (cells 4033, 4134, 4233, 4234, 4235, 4324, 4327, 4328, 4426, 4429, 4527). Some of these may be actual occurrences of *E. amygdalina*, but others may represent forms intergrading with *E. nitida* or misidentifications of *E. nitida*. A similar westward extension of *E. amygdalina* between Savage River and Guildford in the north-west (cells 3540, 3640, 3641, 3740, 3741, 3840, 3841) and near Tullah (cell 3838) appears well verified and has been mapped. *Eucalyptus amygdalina* may also intergrade with *E. nitida* in the far south-east, such as in the vicinity of Exit Cave (cell 4819).

On dolerite in the Eastern Tiers, the distinction between *E. amygdalina* and

*E. pulchella* is unclear and field identification as either species has generally followed the preference of the surveyor. The genetic affinities of the south-eastern and Midland forms of these 'half-barked' *E. amygdalina* were investigated by Kirkpatrick and Potts (1987) and found to be most comparable with *E. amygdalina*. Occurrences of *E. amygdalina* in the eastern regions were therefore unqueried, although it is likely that the same ecotype may be identified by separate sources as either *E. pulchella* or *E. amygdalina*. *Eucalyptus amygdalina* has not been verified from Flinders Island, and all such putative occurrences were treated as misidentifications of *E. nitida* (i.e. cells 5658, 5758, 5856, 5857, 5953, 5954, 5956, 6052, 6054, 6057).

KEY REFERENCES: Duncan and Brown (1985); Kirkpatrick and Nunez (1980); Kirkpatrick and Potts (1987); Ladiges *et al.* (1983); Potts (1986, 1990a); Potts and Reid (1985c, 1988); Shaw *et al.* (1984); Whitham *et al.* (1994).

*Figure 5.* Eucalyptus amygdalina.

# *Eucalyptus archeri*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
Archer's gum
alpine cider gum

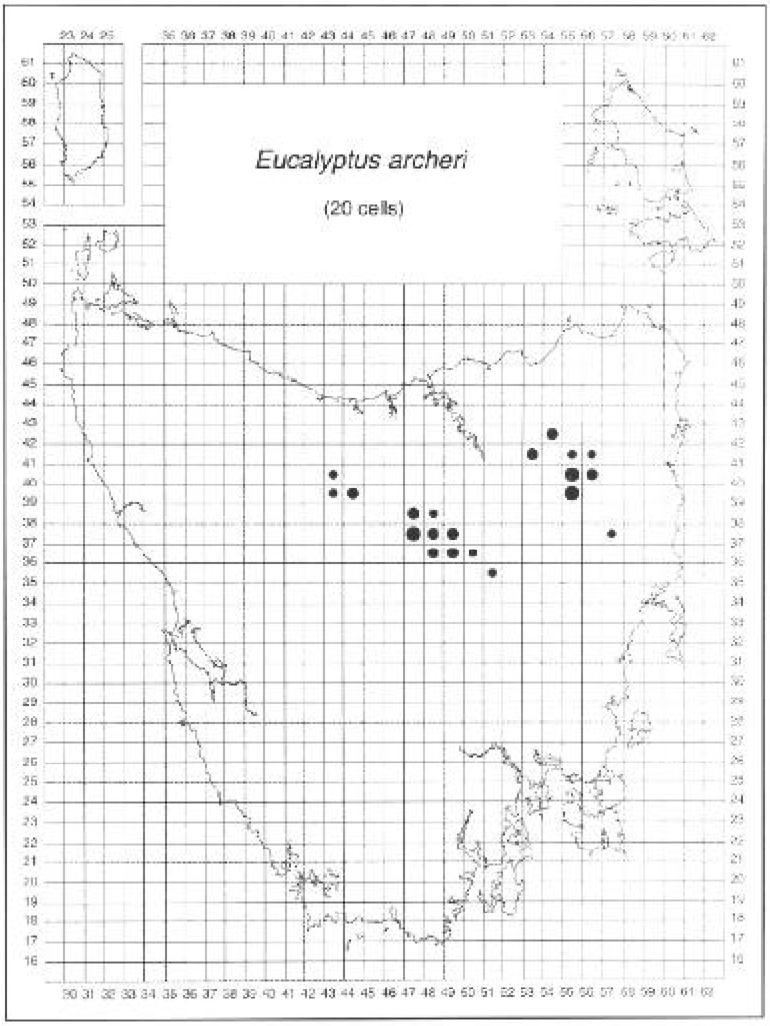



*Figure 6. Distribution of* E. archeri *in Tasmania.*

*Eucalyptus archeri* is a localised endemic species associated with cold, relatively poorly drained, shallow, peaty soils of rocky outcrops at, or immediately below, tier and plateau escarpments along the northern edge of the Central Plateau and mountains of the north-east (Figure 6). It has been treated as a subspecies of *E. gunnii* by some authors (Pryor and Johnson 1971; Potts and Reid 1985 a, b) but is treated as a separate species by Curtis and Morris (1975) and Chippendale (1988). It intergrades clinally with *E. gunnii* following a gradient of decreasing rainfall and increasing frost severity on the Central Plateau but, in the north-east, the habitats of these two species are geographically separated (Potts 1985; Potts and Reid 1985a, b).

*Eucalyptus archeri* occurs at altitudes above 980 m but is predominant between 1100 m to 1200 m throughout its range (Figure 7), and extends to 1350 m in the north-east on Ben Lomond. The lowest altitude site occurs on Mount Foster on Fingal Tier. The main flowering period is January to April, peaking in February and March (Figure 8).

*Eucalyptus archeri* occurs locally in alpine scrub and subalpine open woodland as a mallee-form shrub or straggly small tree, or with other subalpine eucalypts such as *E. dalrympleana* in the north-east, or *E. coccifera* on the Central Plateau. On the Central Plateau, *E. archeri* intergrades continuously with *E. gunnii* following the transition in habitat from the subalpine mixed eucalypt / rainforest and closed scrub on the northern scarp of the Western Tiers to the open woodland bordering the extensive frost hollows around Great Lake (Potts 1985).

*Eucalyptus archeri* is largely found on the talus slopes at or above the altitudinal limit of the subalpine *E. delegatensis/E. dalrympleana* forests. It is confined to high-rainfall areas and may extend into closed, subalpine mixed forest with temperate rainforest species (Potts and Reid 1985a). In contrast to *E. gunnii*, which frequently occurs on the inverted tree-line surrounding frost hollows, *E. archeri* occurs at the tree-line on the north-eastern mountains (where *E. coccifera* is absent) and near the tree-line on the Western Tiers (Potts and Reid 1985a). *Eucalyptus gunnii* and *E. archeri* are two subalpine species which transcend habitat disjunctions between highland areas in the centre, north-east, east and south-east that are isolated by major fault grabens.

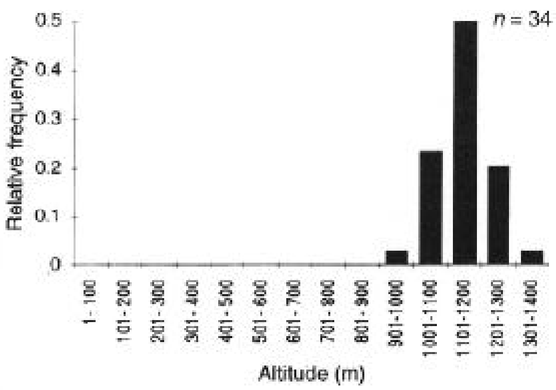



*Figure 7. Altitude distribution of* E. archeri.

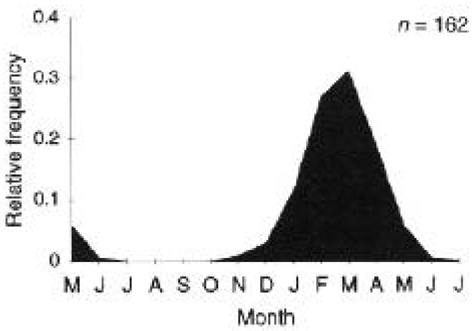



*Figure 8. Flowering times for* E. archeri.

COMMENTS: *Eucalyptus archeri* is more restricted in its distribution than *E. gunnii*, and outlier occurrences are generally attributed to misidentifications of *E. gunnii* or intermediates that are treated here as *E. gunnii* (e.g. cells 4136, 4138, 4139, 4240, 4334, 4736, 4935, 5033, 5035). In the north-eastern highlands, *E. archeri* occurs on Ben Lomond (cells 5539, 5540), Ben Nevis (cell 5541), Mount Barrow (cell 5341), Mount Maurice (cell 5442) and Mount Saddleback (5640). Across the Fingal Valley at Mount Foster (cell 5737), *E. archeri* is recorded as a small mallee tree amongst the shrubby, subalpine understorey of *E. delegatensis* forest on the plateau escarpments (F. Duncan, pers. comm. 1989). This latter location requires further verification as it represents a major range extension across the Fingal – South Esk Valley system, with bio-geographic implications. An outlier for *E. archeri* on Millers Bluff (cell 5135) has been included in the distribution map because it is within the expected geographic and habitat range.

KEY REFERENCES: Barber (1955); Jackson (1973); Potts (1985); Potts and Jackson (1986); Potts and Reid (1985a, b); Pryor and Briggs (1981).

# *Eucalyptus barberi*

SUBGENUS: *Symphyomyrtus*
SERIES: *Ovatae*

Common name:
Barber's gum

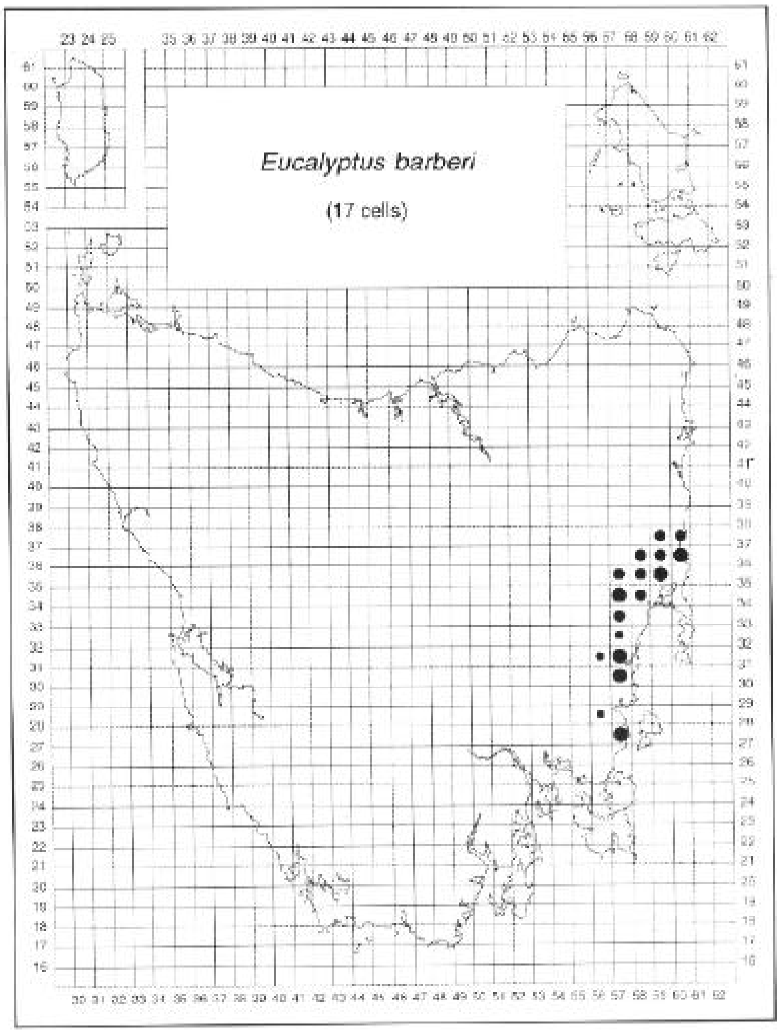



*Figure 9. Distribution of* E. barberi *in Tasmania.*

*Eucalyptus barberi* (Photo 3) is a rare endemic species which occurs locally as small, disjunct populations on highly insolated, dry, rocky, dolerite ridges and drought-prone, north-west facing slopes of the Eastern Tiers and associated seaward foothills (Figure 9). There is a minor geographic discontinuity in the range of this species in the vicinity of the Prosser River valley. The morphological distinction between northern and southern populations of *E. barberi* does not correspond with this geographic disjunction. Rather, the high level of genetic variability is typical of a species distributed as a series of small isolated populations (McEntee *et al.* 1994).

*Eucalyptus barberi* is predominant in the altitude range from 200 m to 400 m, with a few occurrences down to 130 m or up to 500 m (Figure 10). The lowest known altitude occurrence is from Cherry Tree Hill, north-east of Cranbrook, and the highest is from near Organ Hill, south of the Douglas River. The main flowering period appears to be from March to August, broadly peaking between April and July (Figure 11).

Although *E. barberi* occurs as a mallee shrub or small tree in patches forming pure stands, it occurs more frequently as an understorey shrub in *E. pulchella* low, open woodlands. On these sites, *E. globulus* may also be present as a minor species, or *E. ovata* as drainage becomes slightly impeded. *Eucalyptus barberi* appears to be a relict species that may have been displaced from intervening wetter sites by competition from faster growing species (McEntee *et al.* 1994). The northern populations of *E. barberi* tend to be relatively large, but southern ones are particularly small and disjunct, and exhibit the greatest range in phenotypic variation. Many of these latter populations are of scientific interest (McEntee *et al.* 1994).

COMMENTS: The disjunction in the geographic distribution of *E. barberi* may be an artefact of the paucity of sampling due to small population sizes and relative inaccessibility (McEntee *et al.* 1994) rather than the absence of a suitable habitat. Several altitudinal outliers on the western margins of the main population need field verification. For example, occurrences at altitudes above 600 m are recorded from the upper catchments of the Brushy River (cell 5735) and the Douglas and Apsley Rivers (cell 5737). A low-altitude outlier (c. 100 m) to the north-west of the Grange Hills near Cranbrook (cell 5934) is also unverified. Other doubtful records include grid cells 5630, 5633 and 5634. Putative occurrences south of Bicheno (cell 6035) were not verified. However, a record for *E. barberi* from the vicinity of Donkeys Track Point near Three Thumbs (cell 5628) extends the southern population range (A. Gray, pers. comm. 1995). Other recent records in the Wielangta forests (cell 5727) have also extended the known range of the disjunct *E. barberi* populations in this region (F. Duncan and F. Coates, pers. comm. 1992). The populations on Meredith Tier (cell 5732) represent a hybrid swarm but are considered to be genetically closer to *E. barberi* than to any other single species (McEntee *et al.* 1994). Additional field verification of the northern and western range limits of *E. barberi* is needed to clarify its distribution and habitat.

KEY REFERENCES: Barber (1954); Gray (1974); Johnson and Blaxell (1972); Ladiges *et al.* (1981, 1984); McEntee *et al.* (1994); Pryor and Briggs (1981).

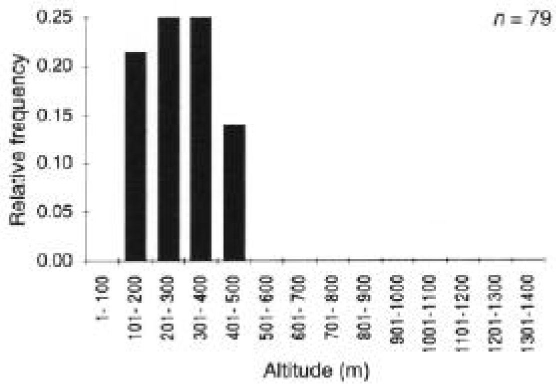



*Figure 10. Altitude distribution of* E. barberi.

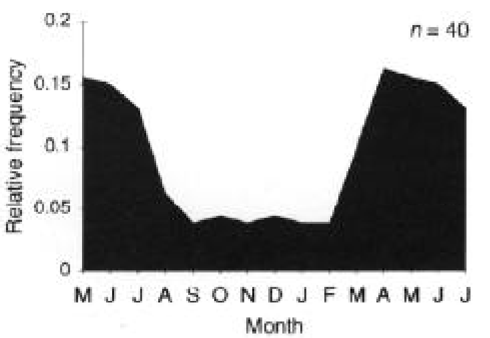



*Figure 11. Flowering times for* E. barberi.

*Photo 3. Buds of* E. barberi *(pressed material).*

# *Eucalyptus brookeriana*

SUBGENUS: *Symphyomyrtus*
SERIES: *Ovatae*

Common name:
Brooker's gum

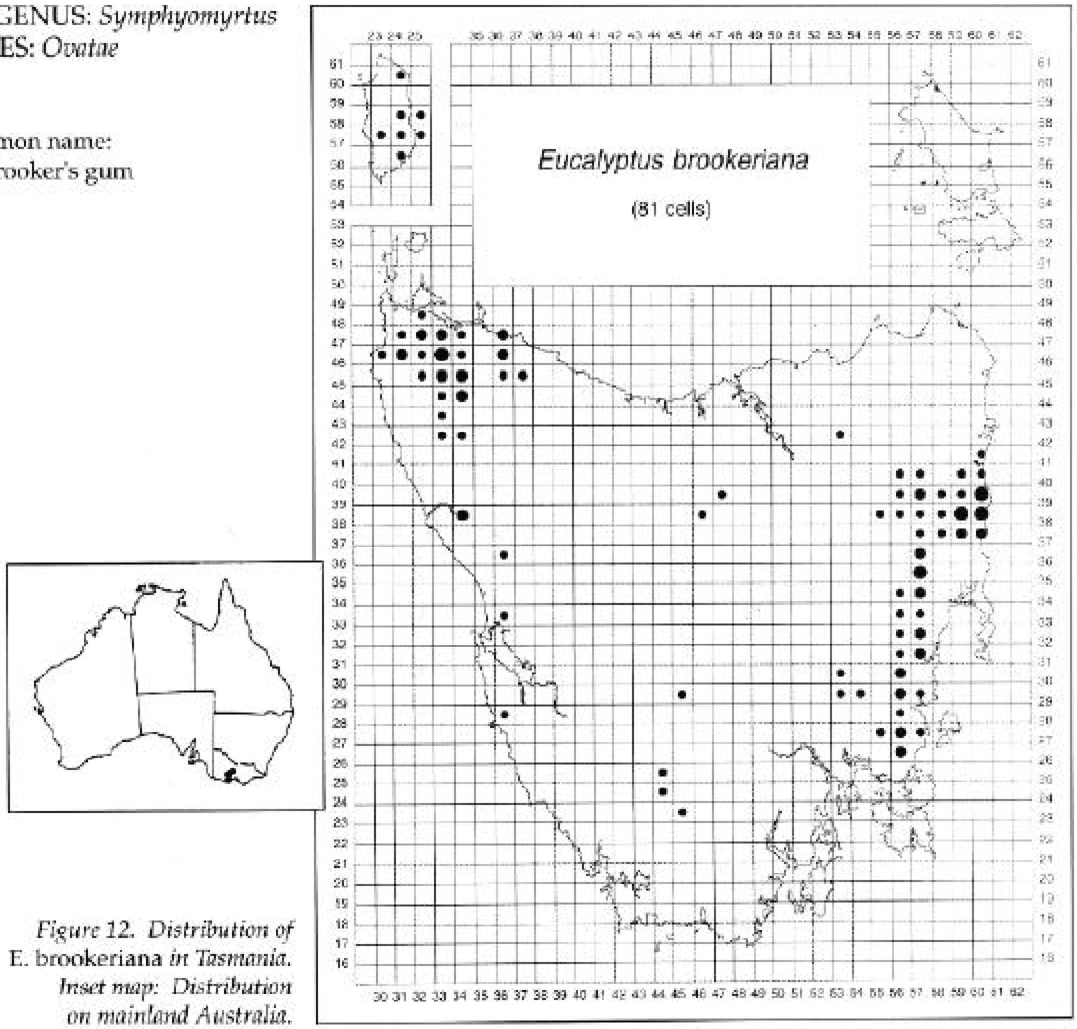



*Figure 12. Distribution of* E. brookeriana *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus brookeriana* has a broad geographic range and occurs locally in the warm, wet regions of the north-west, King Island and the east coast (Figure 12). It is usually located on well-drained, rocky soils of dolerite slopes and ridges, on alluvial deposits adjacent to streams, or on the margins of blackwood-swamp forest. Small, scattered, isolated populations exist between the two large, disjunct centres in eastern and western Tasmania. Many additional occurrences in pockets of suitable habitat between these population centres may be discovered.

*Eucalyptus brookeriana* (Photos 4, 5) is the most recently described Tasmanian species (Gray 1979), and previous occurrences were classified as *E. ovata.* Jackson (1965) distinguished a western variant of *E. ovata* which may include forms currently classified as *E. brookeriana.* However, forms with affinities to *E. ovata* are also likely to occur in these western regions and *E. brookeriana* appears to intergrade with *E. ovata* across its range, further confusing the distinction between these two species. The two taxa are not well differentiated on reproductive traits, but the adult and juvenile leaves of *E. brookeriana* have a higher density of oil glands and the juvenile foliage has crenulate margins (Brooker and Lassak 1981). In wet forest habitats, particularly in the west, field distinction of either species may also be difficult due to the similarity of the mature tree habit and the frequent absence of juvenile material in the understorey.

The morphological and ecological distinction between *E. brookeriana* and *E. ovata* is clearest in eastern regions, but remains unresolved in the northern, western and King Island regions. In the east, *E. brookeriana* is readily distinguished in habitat from *E. ovata* as a tall tree amongst wet forest on protected, well-drained, rocky slopes and ridges at middle altitudes, whilst *E. ovata* is a low woodland tree associated with poorly drained flats and hollows. However, *E.* aff. *ovata* may occupy habitats more similar to *E. brookeriana* in the northern and western regions (e.g. Western Tiers; F. Duncan, pers. comm. 1995).

The eastern and western populations of *E. brookeriana* appear to have distinct altitudinal ranges. The western and north-western populations are generally found below 100 m altitude, and occasionally up to 200 m. The eastern populations, however, range from approximately 200 m to 700 m, with rare occurrences down to 100 m (Figure 13). The highest altitude record (720 m) is from the vicinity of Mount Punter in the Eastern Tiers, and the lowest (10 m) is from flats adjacent to Hibbs Lagoon in the south-west. The flowering time of *E. brookeriana* is poorly known, but current data are bimodal, with the main flowering periods being September to December (peaking in Spring) and March to May (Figure 14). The bimodality of flowering time may be related to the different climatic regimes experienced by the disjunct eastern

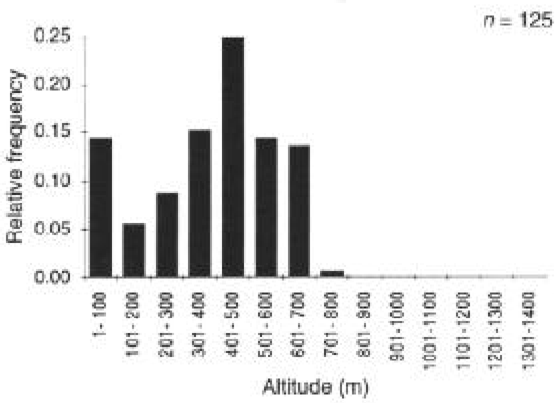



*Figure 13. Altitude distribution of* E. brookeriana.

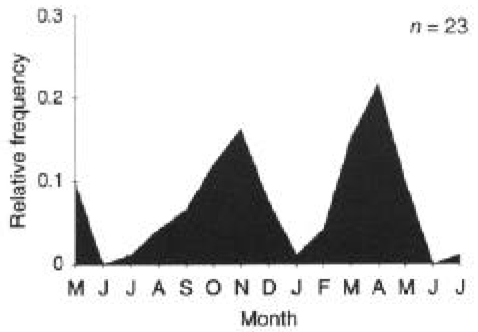



*Figure 14. Flowering times for* E. brookeriana.

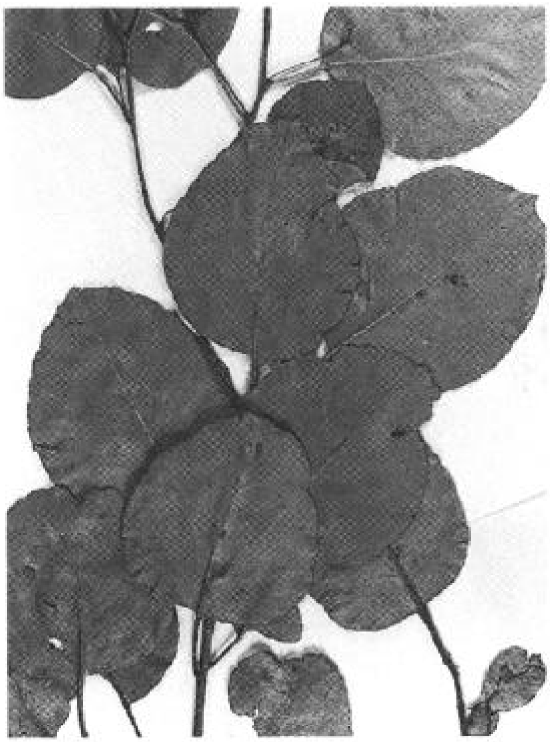


*Photo 4. Typical juvenile leaves (pressed) of* E. brookeriana *showing the crenulate leaf margins.*

and western populations, but may also be due to misidentification of *E. ovata* given the correspondence between their respective peaks in spring flowering time (cf. Figures 14, 49).

COMMENTS: The disjunct distribution of *E. brookeriana* requires clearer ecological and taxonomic definition, considered in context with the distribution of *E. ovata*, particularly in western regions. In ambiguous cases, botanists in the field have probably classified populations conservatively as the more widespread *E. ovata*. This predilection is reflected in the small number of verified, outlier occurrences of *E. brookeriana* between the eastern and western population centres. For example, *E. brookeriana* has been verified south of Deloraine at Golden Valley (cells 4739, 4740; M.I.H. Brooker, pers. comm. 1996), and other locations within this region require verification (cells 4638, 5035). Recent records from south-western coastal regions (e.g. cell 5628) also suggest a more extensive distribution than is shown here. In the south-east, unverified outliers for *E. brookeriana* are recorded from the vicinity of Woodbridge Hill (cell 5122), Snug Tiers (cell 5123) and Forestier Peninsula (cell 5724). In the north-east, voucher records in the vicinity of Mount Barrow (cell 5342) add credence to the unverified outlier east of Goulds Country (cell 5943).

KEY REFERENCES: Brooker and Lassak (1981); Gray (1979); Ladiges *et al.* (1981, 1984).

*Photo 5. A young tree of* E. brookeriana, *raised from seed taken from the holotype and now growing in the grounds of the University of Tasmania.*

# *Eucalyptus coccifera*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
snow peppermint

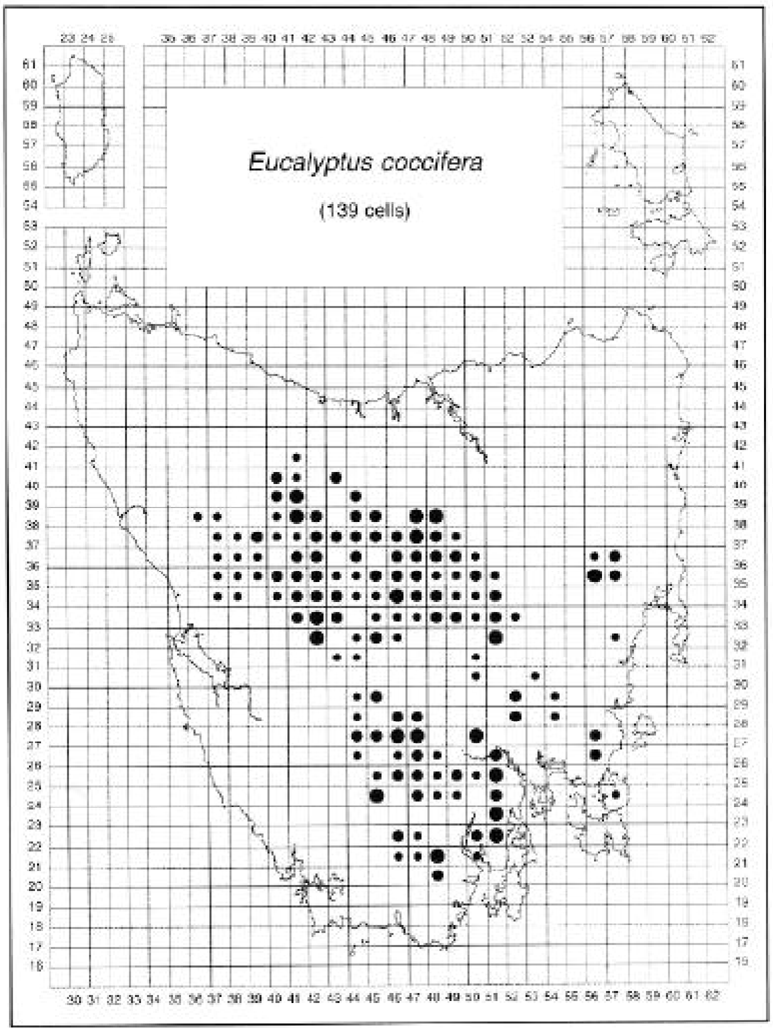



*Figure 15. Distribution of* E. coccifera *in Tasmania.*

*Eucalyptus coccifera* is an endemic subalpine species occurring with a disjunct distribution at the tree-line on most exposed, rocky, dolerite-capped mountains of the south-east and Central Plateau (Figure 15). It is absent from the north-eastern dolerite mountains where it is replaced by *E. archeri* as the tree-line eucalypt. Localised stands of *E. coccifera* occur throughout the eastern highlands and isolated mountains of the south-east. Towards the western quartzite mountains, *E. coccifera* intergrades with, and is eventually replaced by, *E. nitida* as the tree-line eucalypt.

Shaw *et al.* (1984) studied the phenetic continuum in adult and seedling morphology between *E. coccifera* and *E. nitida* on several mountains in central south-western Tasmania. On these mountains (e.g. Tim Shea, The Thumbs, Clear Hill), there is a transition in adult form from stands typical of *E. nitida* at the base to forms approximating *E. coccifera* at the summit. The high-altitude populations develop waxy glaucousness on the stems and foliage, characteristic of *E. coccifera.* Although these clines were not marked in the seedling characters studied, *E. coccifera* exhibited a comparatively high level of intraspecific variation, and Shaw *et al.* (1984) suggest that populations tending towards *E. coccifera* on mountains within the range of *E. nitida* are probably remnants of upslope migration since the last glacial. They suggest that the restricted distribution of *E. coccifera* in the west may be due to limited migration since that time from a south-eastern refuge.

On the Central Plateau, Eastern Tiers and mountains of the south, *E. coccifera* generally occurs above 800 m to the tree-line (up to 1290 m at Drys Bluff). On isolated mountains of the south-east, it occurs at the lower altitude range of 390 m to 800 m (cf. Figure 16). It is also found at these lower altitudes along the western margins of its range where it intergrades with *E. nitida.* The main flowering period is November to February, peaking through December and January (Figure 17).

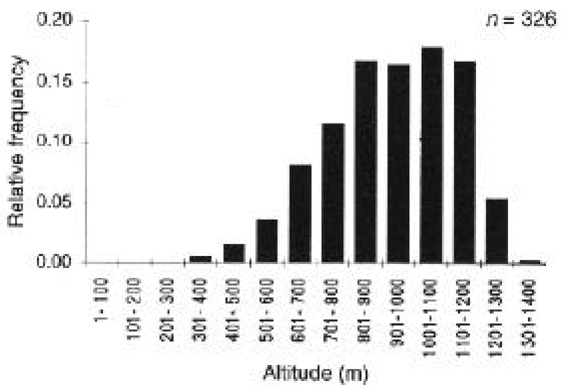



*Figure 16. Altitude distribution of* E. coccifera.

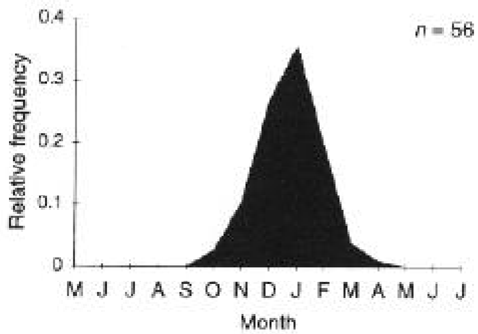



*Figure 17. Flowering times for* E. coccifera.

*Eucalyptus coccifera* is a widespread dominant of low, shrubby forests and woodlands in subalpine environments (Photo 6). The form is generally poor, ranging from a forest tree with low, spreading branches to a twisted and gnarled mallee with attractively red-streaked bark as exposure increases. It frequently forms pure stands, but a species from the series *Viminales* (i.e. *E. dalrympleana, E. rubida, E. archeri, E. gunnii, E. urnigera, E. subcrenulata* or *E. johnstonii*) may sometimes be present and subdominant, depending upon the geographic location. In topographic situations that are generally protected from the climatic extremes, *E. coccifera* shrubby woodlands merge into *E. delegatensis* open forest.

COMMENTS: Apart from the intergradation between *E. coccifera* and *E. nitida* along the western geological divide, isolated stands of *E. coccifera* in the east may hybridise or intergrade with the lowland peppermints *E. pulchella, E. amygdalina* and *E. tenuiramis.* For example, the population included here from Alma Tier (cell 5033) is intermediate between *E. tenuiramis* and *E. coccifera* (Shaw *et al.* 1984; Wiltshire *et al.* 1991a, 1992) and, on Snug Plains (cell 5122), hybrids between *E. pulchella* and *E. coccifera* result from an unusual juxta-position of these species (Davidson *et al.* 1987). Intermediates between *E. coccifera* and *E. tenuiramis* have been reported from exposed coastal situations on Tasman Peninsula (e.g. cells 5722, 5723, 5822), Cape Deslacs (Kitchener 1985), and in some populations on Bruny Island (Wiltshire *et al.* 1991a). A putative record for *E. coccifera* on McGregor Peak (cell 5724) needs field verification to determine whether a pure population of *E. coccifera* does actually exist in the Forestier – Tasman Peninsula region. However, recent work on the relationships among the peppermints by analysis of leaf oils (Li *et al.* 1995) suggests that 'typical' *E. coccifera* has closer affinities with *E. nitida* than with *E. tenuiramis.* Similarly, a record for *E. coccifera* from Freycinet Peninsula (cell 6033) is also likely to represent a misidentification of *E. tenuiramis*. Other relatively low altitude, localised occurrences of *E. coccifera* from the south-east include Mount Ponsonby (cell 5429), Snow Hill (cell 5636), Middle Peak (cell 5627), Quoin Mountain (cell 5228) and Mount Seymour (cell 5330).

Several unverified outliers have been recorded around the margins of the main *E. coccifera* distribution. Along the western margins of its range, unverified records for the occurrence of *E. coccifera* were treated as misidentifications of *E. nitida* (i.e. cells 3841, 3939, 4041, 4126, 4240, 4329). However, recent reports of *E. coccifera* on Companion Hill (cell 3942) and Mount Pearse (cell 3840) (F. Duncan, M. Brown, A. North, pers. comm. 1996) suggest that this species extends further into the far north-west than shown in Figure 15. In the north-east at Mount Barrow (cell 5341), an herbarium voucher specimen has never been verified, although there are ornamental plantings on Ben Lomond (cell 5540, see Davies and Davies 1989). In the far south, Mount La Perouse (cell 4718) represents an unlikely disjunct population on a sandstone substrate and, at Grass Tree Hill (cell 5226), the very low altitude suggests a mis-identification or some form of hybrid with *E. tenuiramis*. Some very low altitude records for *E. coccifera* in the east (< 200 m, e.g. cells 5631, 5533) are also expected to be mis-identifications of *E. tenuiramis* or intermediates between *E. coccifera* and *E. tenuiramis*.

KEY REFERENCES: Davidson and Reid (1987, 1989); Davidson *et al.* (1987); Davies and Davies (1989); Gilfedder (1988); Jackson (1973); Ladiges *et al.* (1983); Potts (1990a); Shaw *et al.* (1984).

*Photo 6.* Eucalyptus coccifera *growing amongst dolerite boulders in subalpine forest.*

# *Eucalyptus cordata*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
heart-leaved silver gum

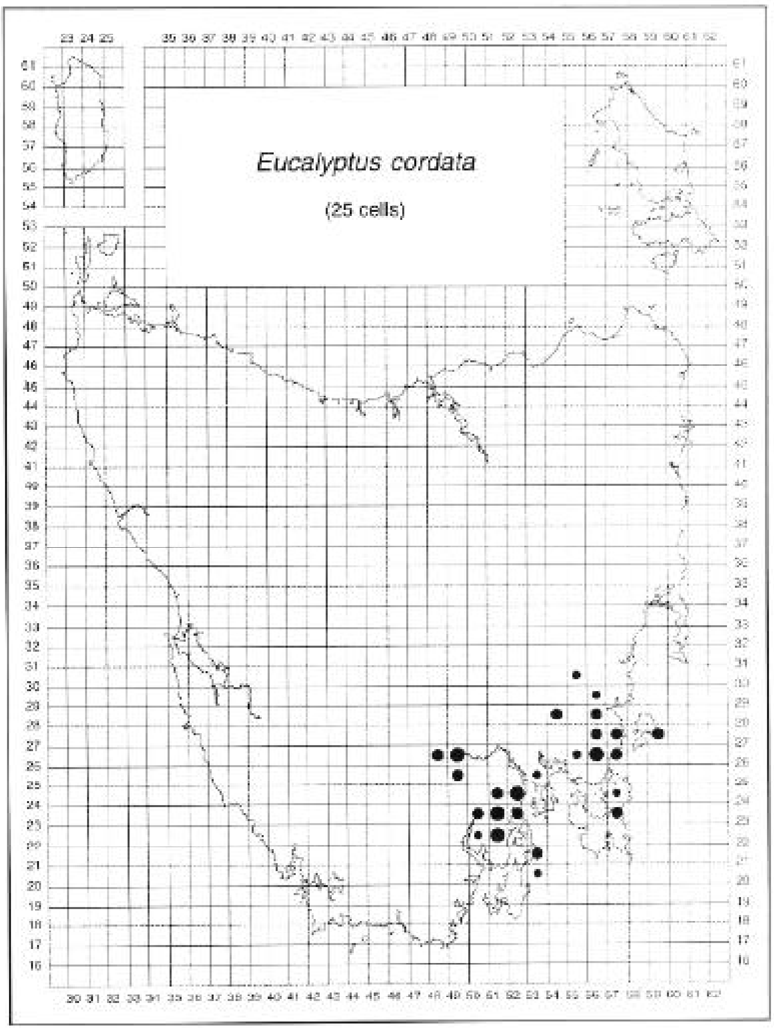



*Figure 18. Distribution of* E. cordata *in Tasmania.*

*Eucalyptus cordata* is a rare endemic species confined to south-eastern Tasmania (Figure 18). Small populations are scattered in two disjunct areas representing relatively distinct morphs (Potts 1989) (Photo 7). They are centred around the Wellington Range to the west and the general vicinity of Prossers Sugarloaf in the east. Potts (1989) undertook a population survey to evaluate the genetic diversity of the species over its full ecological and geographic range as a basis for the development of a conservation strategy. Its distribution closely follows the south-eastern glacial refuge (*sensu* Davies 1974) and the small, scattered, insular populations, frequently comprising suppressed individuals, are consistent with this relict pattern and are vulnerable to disturbance.

*Eucalyptus cordata* is usually associated with medium to deep clay-loam soils derived from Jurassic dolerite bedrock. In the west (with increasing altitude), there is a trend towards occurrence on the poorer drained sites and, in the east (with decreasing rainfall and altitude), there is a shift to the drier micro-habitats and higher rock cover.

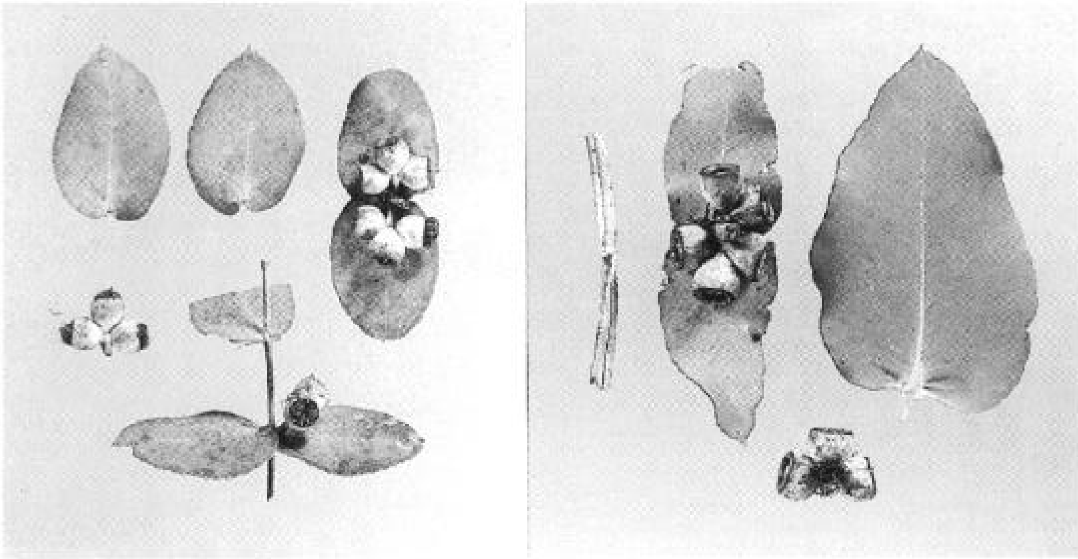


*Photo 7. The eastern, round-stemmed morph (left) and western, square-stemmed morph (right) of* E. cordata.

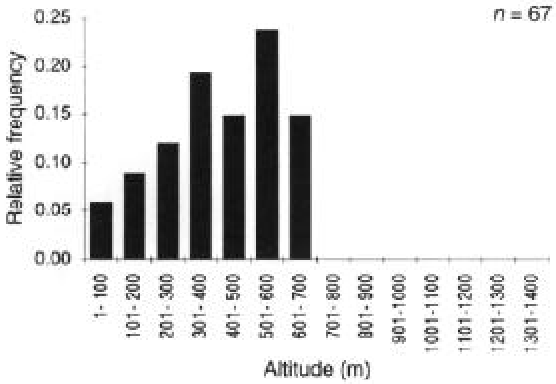



*Figure 19. Altitude distribution of* E. cordata.

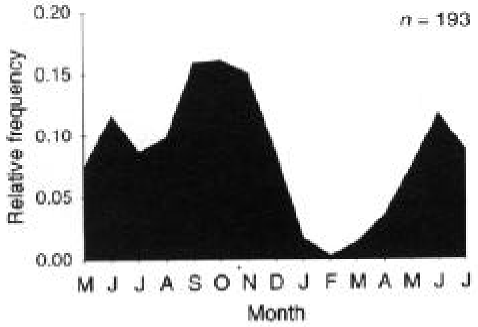



*Figure 20. Flowering times for* E. cordata.

*Eucalyptus cordata* occurs from near sea-level to 680 m but is most often found between 200 m and 600 m (Figure 19). The eastern morph generally occurs at the lower altitudes (100–400 m) and the western morph is associated with subalpine habitats (400–680 m). The highest altitude occurrences are known from Herringback and Mundys Hills, east of Huonville. *Eucalyptus cordata* generally flowers from May to November (Figure 20) and exhibits a bimodal pattern which appears to be associated with the two morphs. The main flowering period of the eastern morph appears to be April to July (peaking in autumn) and, for the western morph, from September to November. However, more population-specific data are required to clarify this pattern.

*Eucalyptus cordata* rarely forms pure stands, known exceptions being found at the summit of Perpendicular Mountain on Maria Island in the east, on the exposed, dry cliff scarp on Cape Queen Elizabeth and Penguin Island off Fluted Cape (Bruny Island), and in wet forest at Moogara to the west. In the east, *E. cordata* usually occurs as a stunted mallee shrub, scattered in the understorey of dry, open, lowland woodland dominated by *E. pulchella*, with occasional *E. globulus*.

*Photo 8. Regeneration of* E. cordata *(western morph) locally dominating a site adjacent to* E. delegatensis *forest.*

However, with increasing altitude and rainfall to the west of its range, there is a shift towards greater cover and site dominance by *E. cordata*, and co-occurrence with species more commonly associated with wetter (e.g. *E. obliqua, E. regnans*) or subalpine habitats (e.g. *E. delegatensis, E. coccifera, E. johnstonii, E. urnigera*) (Photo 8). In these wetter regions, *E. cordata* can achieve a tree habit and frequently replaces the surrounding eucalypt species on the poorer drained sites dominated by the sedge *Gahnia grandis*. The persistent, highly glaucous, cordate juvenile foliage of *E. cordata* is a distinctive feature for which the species is widely planted as an ornamental.

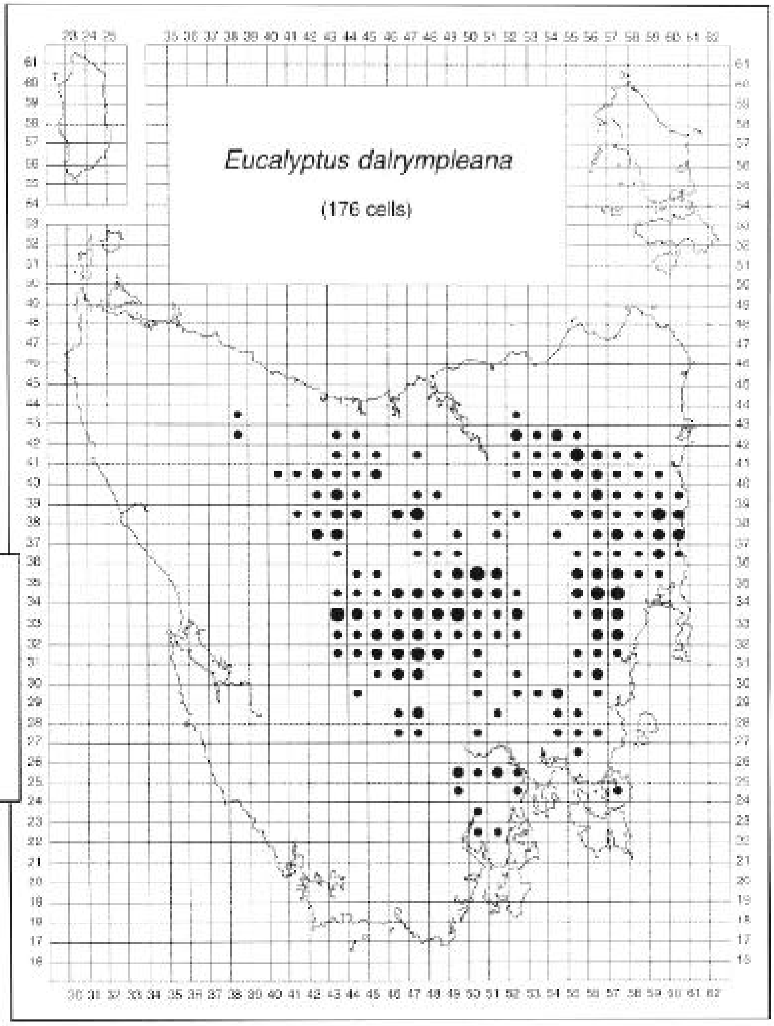
COMMENTS: The distribution of *E. cordata* was verified by Potts (1988, 1989), and locations that were more recently discovered fall within this domain. Putative locations of the eastern morph (cells 5427, 5527) suggested by Brown *et al.* (1983) were not verified. A hybrid swarm in the vicinity of Meredith Tier (cells 5732, 5733) was believed to involve *E. cordata*, but a recent study (McEntee *et al.* 1994) indicates that glaucous morphs in this population may be related to *E. gunnii*. Persistent reports of *E. cordata* on Big Marsh near Platform Peak (cell 5027) and on Tasman Peninsula (cells 5622, 5721) also need field checking. The herbarium specimen from the former location may be juvenile *E. urnigera*. There is a verified population of *E. cordata* on Penguin Island (cell 5320, Potts 1988) off Fluted Cape, which is the type locality and represents the lowest altitude record (20–40 m) for the species. A large stand of tall trees of the western morph of *E. cordata*, occurring with *E. regnans*, has recently been found near Moogara (cell 4926; C. Mitchell, pers. comm.). There are also reports from the northern foothills of Mount Wellington near Glenorchy (cells 5225, 5125, D. Ziegler, J. Kirkpatrick, pers. comm. 1996).

KEY REFERENCES: McEntee *et al.* (1994); Potts (1988, 1989).

# *Eucalyptus dalrympleana* subsp. *dalrympleana*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
mountain white gum



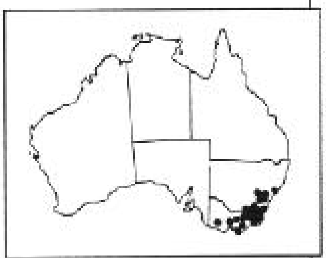



*Figure 21. Distribution of* E. dalrympleana *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus dalrympleana* is widespread and common on well-drained, upland slopes of the dolerite mountains and plateaux in northern, central, eastern and south-eastern regions (Figure 21). It intergrades clinally at lower altitudes with *E. viminalis* on the more fertile substrates such as Jurassic dolerite, and with *E. rubida* on dry, comparatively infertile, sedimentary substrates exposed to cold-air drainage. Intergradation with *E. viminalis* is more frequent than with *E. rubida* and has been studied by Phillips and Reid (1980). They found that clinal intermediates were the most common form, with genetically based, continuous variation in several characters occurring between morphs known as *E. viminalis* or *E. dalrympleana.* This variation is most noticeable in the juvenile leaf shape which grades from long, thin, lanceolate leaves typical of south-eastern coastal *E. viminalis,* to broad, cordate leaves characteristic of inland, subalpine *E. dalrympleana.* The morphs become more distinct (fewer intermediates) with the northward trend in latitude and steeper environmental gradients.

*Eucalyptus dalrympleana* is a mid- to high-altitude species generally occupying sites between 400 m and 800 m, and occasionally up to 1170 m (Figure 22). The lower altitude occurrences (150–400 m) are associated with cool, moist habitats, generally along the northern margins of its range, where intermediate forms become blurred in identity with *E. viminalis*. The highest altitude records are known from the Lake River catchment, east of Arthurs Lake on the Central Plateau. The main flowering period is from March to May, peaking in March and April (Figure 23).

*Eucalyptus dalrympleana* rarely forms pure stands but is known to dominate small patches of forest in the north-eastern highlands. It is more commonly a subdominant or minor species in upland shrubby, wet and dry sclerophyll forests. In the wet forests, it usually occurs with *E. delegatensis* and, in the dry forests, *E. pauciflora* or *E. amygdalina* are frequent dominants.

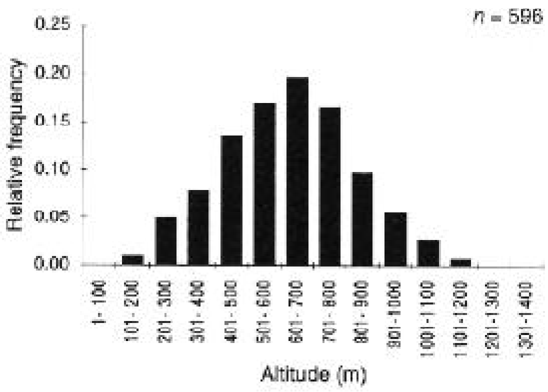



*Figure 22. Altitude distribution of* E. dalrympleana.

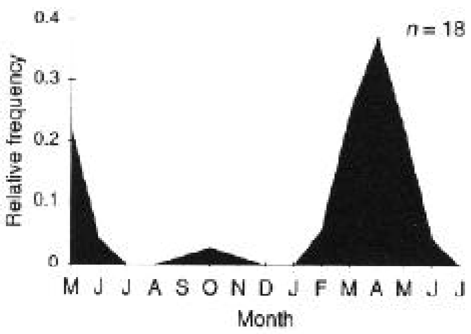



*Figure 23. Flowering times for* E. dalrympleana.

COMMENTS: In Tasmania, *E. dalrympleana* is known to be phenotypically distinct from its mainland counterpart (Barber 1955; Pryor and Johnson 1971), and Barber (1955) applied the term 'vim-dal' to refer to intermediates between *E. dalrympleana* of the Australian mainland and *E. viminalis* (Phillips and Reid 1980). However, the term is widely applied by Tasmanian observers in reference to the uncertain identity of the frequent clinal intermediates between *E. viminalis* and *E. dalrympleana*.

The distinction between *E. viminalis*, *E. dalrympleana* and *E. rubida* becomes obscure at altitudes between 200 m and 600 m, where the various clinal intermediates are not easy to classify. Low-altitude outliers (i.e. < 150 m) that were not verified were considered misidentifications of intergrading forms of *E. viminalis* (e.g. cell 4343). In the west, unverified outliers of *E. dalrympleana* are recorded near Strahan (cell 3633) and Waterfall Creek (cell 3830), and these same populations appear to have been ascribed to *E. viminalis* by some observers. In the north-east, unverified outliers are recorded for Mount Cameron (cells 5746, 5846), west of Mount Horror (cell 5545) and near Goulds Country (cell 5944). No verified occurrences are recorded on Maria Island, although Jackson (1965) indicates the presence of *E. dalrympleana* there (e.g. cell 5927). In the south-east, unverified outliers are recorded from near Balts Spur (cell 5723) and elsewhere on Tasman Peninsula (cells 5523, 5622). Other unverified outliers in southern Tasmania (cells 4918, 5019) are more doubtful.

KEY REFERENCES: Austin *et al.* (1983); Battaglia (1990b); Phillips and Reid (1980); Valentini *et al.* (1990).

# *Eucalyptus delegatensis* subsp. *tasmaniensis*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
gum-topped stringy bark,
white-top

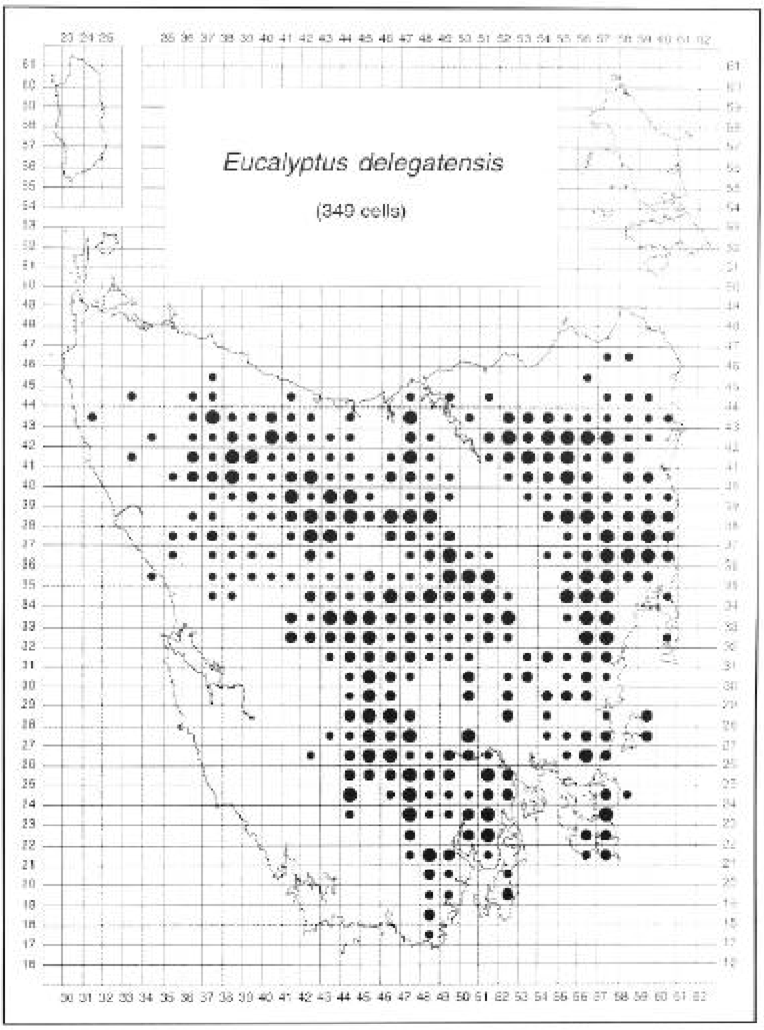



*Figure 24. Distribution of* E. delegatensis *in Tasmania.*

*Eucalyptus delegatensis* subsp. *tasmaniensis* is a widespread and common endemic subspecies found throughout Tasmania (Figure 24), replacing *E. obliqua* and *E. regnans* in the highland regions on comparatively fertile, moist, well-drained sites. It is generally absent from the oligotrophic environments of the far west and south-west, and it is not known from the Bass Strait islands.

*Eucalyptus delegatensis* most typically occurs at altitudes between 400 m and 900 m (Figure 25), the upper and lower limits depending on the particular geographic region. For example, in southern and western Tasmania, it is recorded from mountain slopes and valleys as low as 100 m to 200 m where exposure to frost and cool growing-season temperatures is comparable with inland sites at higher altitudes. In the vicinity of the Central Plateau and Great Western Tiers, it has a lower altitude limit of around 400 m, while in the north-eastern highlands this is closer to 600 m. The highest altitude records known for *E. delegatensis* (up to 1240 m) are from the north-east, on Ben Lomond. The south-west to north-east trend in the upper and lower altitude limits of *E. delegatensis* parallels the observations for the alpine tree-line in Tasmania (see Kirkpatrick 1982). However, *E. delegatensis* is also recorded at relatively low altitudes (150–400 m) along the northern margins of its range, consistent with similar low altitude occurrences of *E. dalrympleana.* The main flowering period is from January to March, peaking in January and February (Figure 26).

*Eucalyptus delegatensis* (Figure 27) dominates a range of community types and is strongly associated with substrates derived from Jurassic dolerite, which are typically free-draining and have a high surface-rock cover. In upland tall, wet forest, such as in the north-eastern highlands and Western Tiers, under-

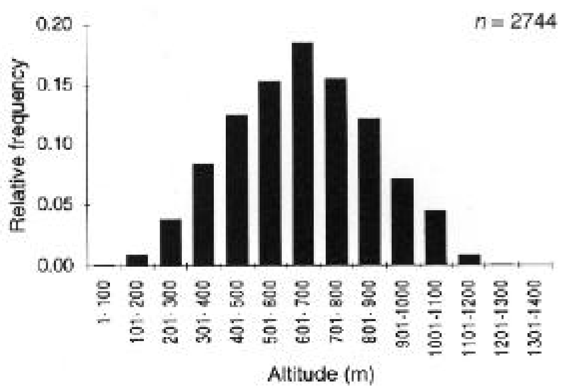



*Figure 25. Altitude distribution of* E. delegatensis.

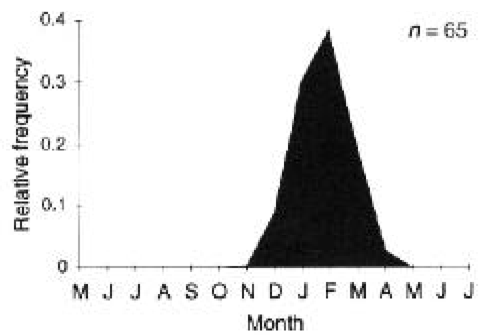



*Figure 26. Flowering times for* E. delegatensis.

storeys vary from rainforest to mesophytic shrubs. On the moist ridges, plateaux and slopes of the Eastern Tiers and south-eastern Central Plateau, a shrubby or grassy dry sclerophyll understorey develops in open forest. Open forest gives way to woodland in subalpine climates and in the drier regions of undulating country on the upland margins of the Midlands and Derwent Valley. *Eucalyptus delegatensis* frequently forms pure stands in wet forests but may co-exist ecotonally with *E. obliqua* at lower altitudes, with *E. regnans* on the more fertile sites, or with *E. amygdalina* as moisture availability decreases. In subalpine situations closer to the tree-line, it may co-exist with *E. coccifera,* or with *E. pauciflora* in the inverted tree-line near the margin of frost hollows (Jackson 1973). Typical minor or subdominant species which co-occur with *E. delegatensis* include *E. dalrympleana* at higher altitudes or *E. viminalis* at lower altitudes.

COMMENTS: In the far north-west, scattered records of *E. delegatensis* (i.e. cells 3143, 3341, 3344, 3442) may be indicative of other western locations that are currently considered unverified outliers (i.e. cells 3548, 3631, 3633, 3724). Western, low-altitude occurrences are recorded from the Heemskirk River region (cells 3536, 3537) and Cumberland Hill (cell 3435), and eastern, low-altitude occurrences are known from Mount Pearson near St Helens (373 m, cell 6043), which is exposed to the prevailing weather of the north-east.

Many of the southern coastal forms of *E. obliqua* (e.g. see cells 4517, 4717 in Figure 43) appear similar to *E. delegatensis,* with rough stem bark and smooth branches but are otherwise morphologically true to *E. obliqua* (F. Duncan, pers. comm. 1994). Occasional hybrids between *E. obliqua* and *E. regnans* in the Southern Forests (e.g. Lune River to Cockle Creek, cells 4818, 4819) and Tasman Peninsula (e.g. cell 5722) are sometimes incorrectly ascribed to *E. delegatensis* (M.J. Brown, pers. comm. 1994). Such hybrids may also account for some of the low-altitude, unverified outliers in the north (e.g. cell 3945, 5145) and other low-altitude occurrences recorded here for *E. delegatensis* (Figure 25).

KEY REFERENCES: Battaglia (1990a, 1993a, b); Battaglia and Reid (1993a, b); Battaglia and Wilson (1990); Boland (1985); Boland and Dunn (1985); Bowman (1986); Bowman and Kirkpatrick (1984, 1986a, b, c); Davidson and Reid (1985, 1987, 1989); Davidson *et al.* (1987); Ellis *et al.* (1985, 1987); Grose (1963); Hallam and Reid (1989); Hallam *et al.* (1989); Keenan and Candy (1983); Moran and Brown (1980); Moran *et al.* (1990); Nunez and Bowman (1986); Ohmart *et al.* (1984); Pederick (1990); Raymond (1994).

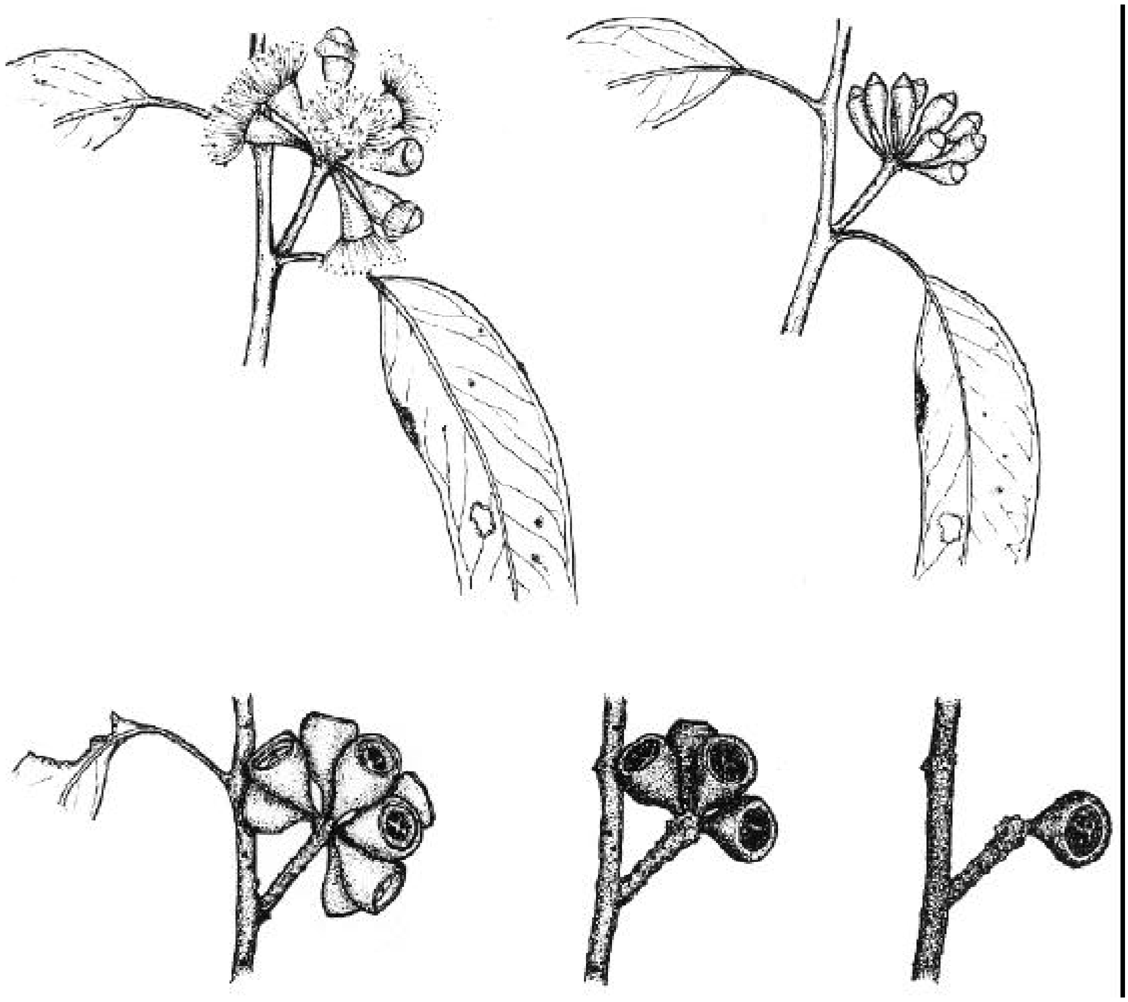
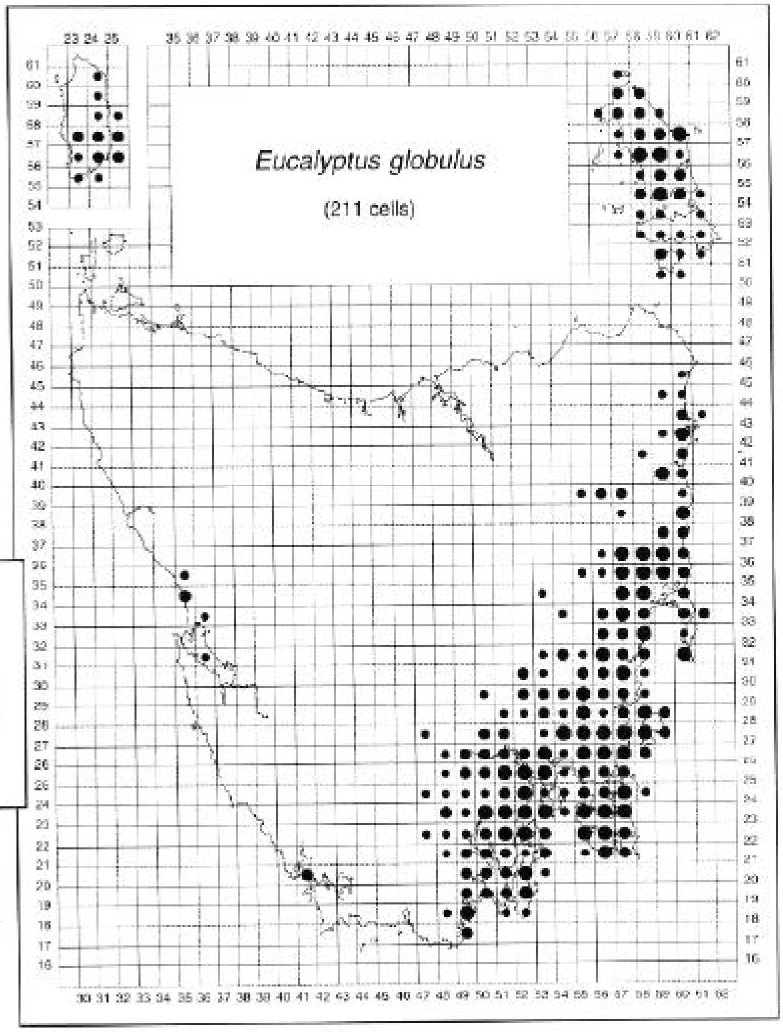


*Figure 27. Buds, flowers and fruits of* E. delegatensis.

# *Eucalyptus globulus* subsp. *globulus*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
blue gum



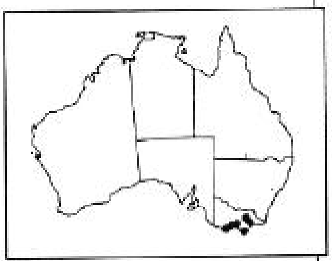



*Figure 28. Distribution of* E. globulus *in Tasmania. Inset map: Distribution on mainland Australia.*

Populations of *E. globulus* with multiple fruit per umbel which have been previously classified as *E. globulus* subsp. *pseudoglobulus* (Buchanan 1995) or *E. bicostata* (Curtis and Morris 1975; Chippendale 1988) are included here with *E. globulus* subsp. *globulus* (after Jordan *et al.* 1993). On capsule morphology, populations of *E. globulus* on the west coast and northern Flinders Island are intermediate between *E. globulus* subsp. *globulus* and the mainland *E. globulus* subsp. *pseudoglobulus* (Kirkpatrick 1975b; Jordan *et al.* 1993; Potts and Jordan 1994b). Similar intermediates are also found in Victoria (e.g. Otway Ranges and south Gippsland; Jordan *et al.* 1993). However, the morphologically intergrading populations on northern Flinders Island are not markedly differentiated from other populations on Flinders Island on the basis of molecular markers (Nesbitt *et al.* 1995), growth response (Potts and Jordan 1994a), or juvenile leaf morphology (Potts and Jordan 1994b).

*Eucalyptus globulus* is widespread in predominantly coastal and near-coastal situations of lowland eastern and south-eastern Tasmania and the Bass Strait islands (Figure 28). It occupies a range of substrates, from the undulating country and fertile wet gullies of the generally seaward foothills and tiers, to the infertile, dry dune sands and sea cliffs of the coast. There are scattered populations of *E. globulus* along the west coast, and inland extensions in the Midlands and associated eastward valley systems.

*Eucalyptus globulus* is a lowland species occurring from near sea-level to about 650 m and up to 830 m, but is typically found below 400 m (Figure 29). Most of the higher altitude occurrences are known from the vicinity of the Eastern Tiers and north of the Fingal Valley. Its main flowering period is September to December, peaking in October and November in eastern Tasmania (Figure 30). More information is needed to define the flowering period of the western populations (including King Island) which consistently flower later than eastern populations in field trials (Gore and Potts 1995).

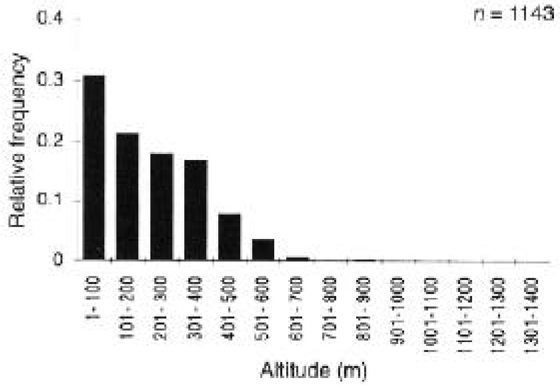



*Figure 29. Altitude distribution of* E. globulus.

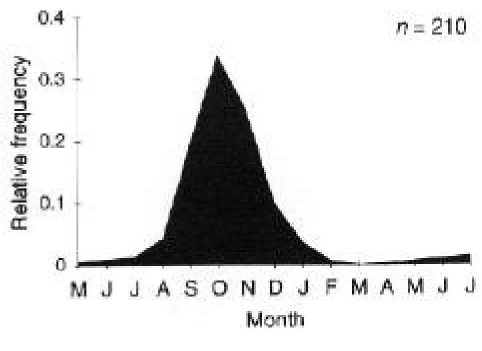



*Figure 30. Flowering times for* E. globulus.

*Eucalyptus globulus* is an occasional dominant and frequent subdominant tree in wet and dry sclerophyll forests and woodlands. In wet sclerophyll forests, it occurs in the canopy with *E. obliqua* or *E. regnans* over tall shrub understoreys. In dry sclerophyll forests, *E. globulus* may form pure stands in grassy communities but, in heathy or shrubby communities, is frequently co-dominant with, or occurs as an occasional emergent above, the more common peppermint species (*E. amygdalina, E. pulchella* or *E. tenuiramis*). In exposed coastal situations, fully mature, stunted individuals of *E. globulus* with heights less than 1.5 m have been recorded from Maria Island (Brown and Bayly-Stark 1979a) and at Cape Tourville on Freycinet Peninsula (Chambers 1992). The transition from the dwarf habit on cliff edges to tall trees in nearby sheltered forest is associated with genetically based clinal variation (Chambers 1992; Dingle 1994).

COMMENTS: The distribution of *E. globulus* is well known due to extensive seed collecting from native stands throughout Tasmania, the Bass Strait islands and southern Victoria (Orme 1983b; Volker and Orme 1988). *Eucalyptus globulus* is a fast-growing species with relatively large flowers (Photo 9) that are easily manipulated in breeding studies, and it has become one of the most important species for pulpwood production in temperate regions throughout the world (Eldridge *et al.* 1993). The King Island provenance has been of interest to plant breeders but was cleared extensively in the last century for agriculture. Many of the remnant trees are relatively isolated and seed collected from them may be inbred (Potts and Jordan 1994a).

Some records of *E. globulus* from the Midlands, and north and north-east coasts are considered spurious and may reflect roadside introductions or forest plantation sites (e.g. cells 5141, 5240, 5243, 5244, 5341, 5445, 5745). However, a recently reported, although unverified, occurrence may extend the north-eastern distribution towards Gladstone (cells 5745, 5846) and a rare, high-altitude outlier (830 m) is recorded from the north-east (F. Duncan, unpublished data). Marginal unverified records in the southern Midlands (e.g. cells 4928, 4728, 5432) may reflect actual occurrences but require field investigation.

The west coast populations of *E. globulus* are markedly differentiated from east coast populations and these scattered, disjunct occurrences are of particular biogeographic interest (Jordan *et al.* 1993; Potts and Jordan 1994a). Genetic studies of the relative affinities of the eastern and western populations may ultimately indicate likely directions of migration between Tasmania and Victoria. Putative locations near Sandy Cape (cells 3140, 3142) indicated by Jackson (1965) are possible but have remained unverified despite persistent searches. Anecdotal rumours of the Port Davey population of *E. globulus* having been planted by early European settlers at Whalers Cove are unlikely as this population is relatively distinct and appears to contain advanced generation hybrids with a series *Ovatae* species (Potts and Jordan 1994a).

KEY REFERENCES: Battaglia *et al.* (1995); Eldridge and Griffin (1990); Farrow *et al.* (1994); Gore *et al.* (1990); Griffin (1993); Hallam *et al.* (1989); Hardner and Potts (1995a); Jordan *et al.* (1993, 1994); Kirkpatrick (1971, 1974, 1975a, b); Kirkpatrick *et al.* (1973); McAulay (1937); Metcalfe *et al.* (1991); Nesbitt *et al.* (1994, 1995); Orme (1983b); Paton (1980); Potts and Jordan (1994a, b); Potts and Marsden-Smedley (1989); Potts and Savva (1989); Rhizopoulou and Davies (1993); Scarascia-Mugnozza *et al.* (1989); Tibbits (1986a); Volker and Orme (1988); Volker *et al.* (1990, 1994); West (1981).

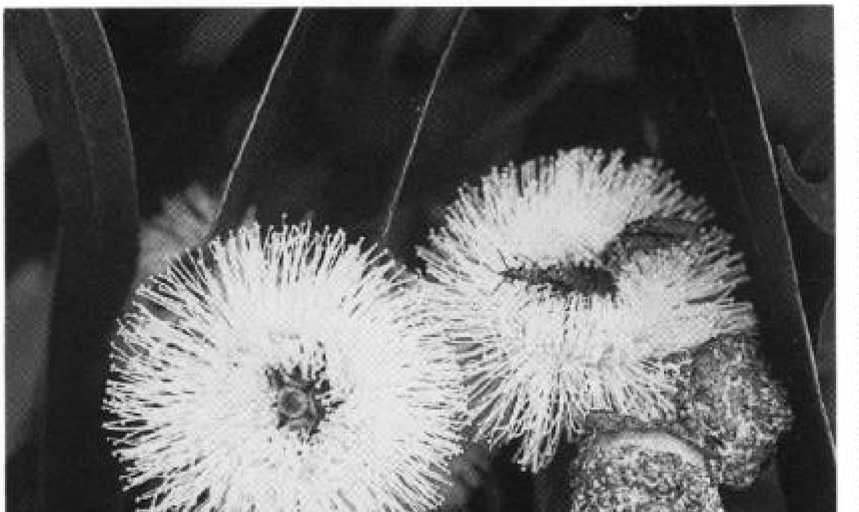


*Photo 9.* Eucalyptus globulus (x *1*), *the largest flowered eucalypt species in Tasmania.*

# *Eucalyptus gunnii*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
cider gum

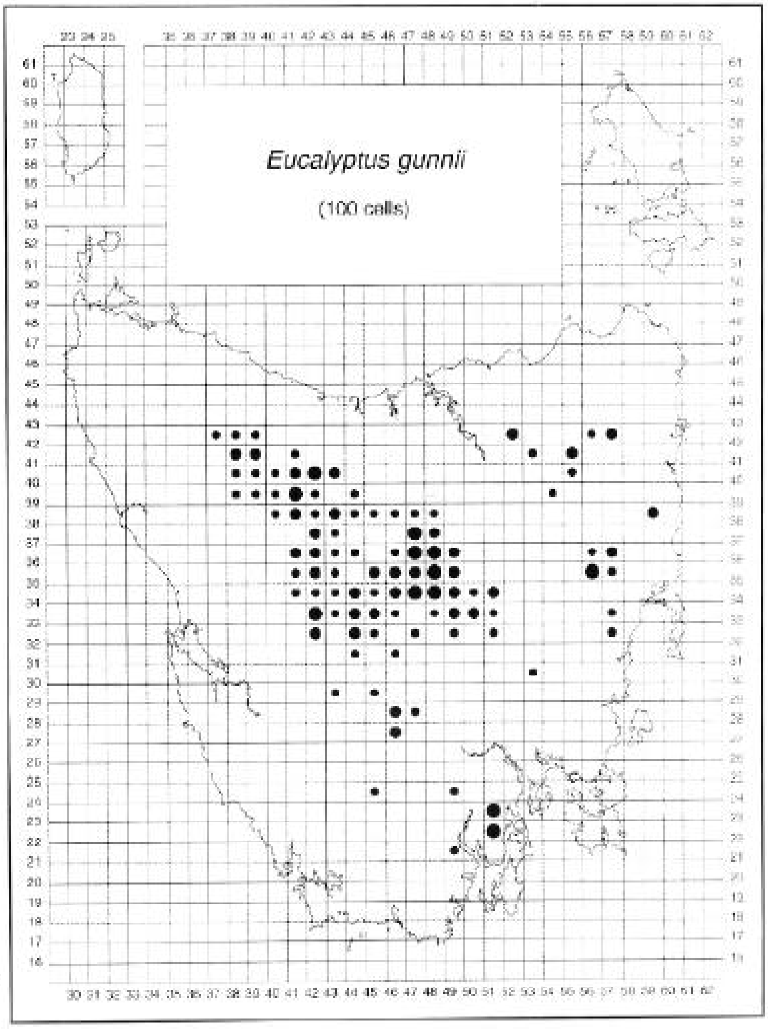



*Figure 31. Distribution of* E. gunnii *in Tasmania.*

*Eucalyptus gunnii* is an endemic subalpine species growing on poorly drained, frost-prone plateaux, flats and hollows. It occurs in north-western, central and north-eastern highland regions, and in disjunct habitats of the Eastern Tiers and the southern dolerite mountains (Figure 31). *Eucalyptus gunnii* and *E. archeri* clinally intergrade on the Central Plateau along the north–south gradient in rainfall and frost severity, but occupy spatially separate habitats in the north-eastern mountains. In the alpine plateau environment, an east–west gradient in exposure results in the clinal transition between *'divaricata'* and 'southern *gunnii*' morphs of *E. gunnii* (Potts and Reid 1985a; Potts 1985). The *'divaricata'* morph, distinguished as a species by Brett (1938, i.e. *E. divaricata* McAulay and Brett) is now treated as a minor variant of *E. gunnii* (Pryor and Johnson 1971; Potts and Reid 1985a). Potts and Reid (1985a) summarised the variation in the *E. gunnii–archeri* complex into five morphs, corresponding to the cline from green to waxy glaucousness (Barber 1955), which is the main taxonomic character used in distinguishing *E. gunnii* and *E. archeri* (Curtis and Morris 1975).

*Eucalyptus gunnii* is generally found above 800 m in the inverted tree-lines on the Central Plateau, and more widely (500–1200 m) in the north-east (Figure 32). However, relict populations generally occur at lower altitudes (330–740 m) in the east, south-east and far north-west where poorly drained sites are locally subject to frost and cold-air pooling. The main flowering period is from November to March, peaking from December to February (Figure 33).

*Eucalyptus gunnii* (Photo 10) most typically dominates grassy and sedgey open forest and woodlands. In restricted situations at lower altitudes, it may dominate montane tall forest

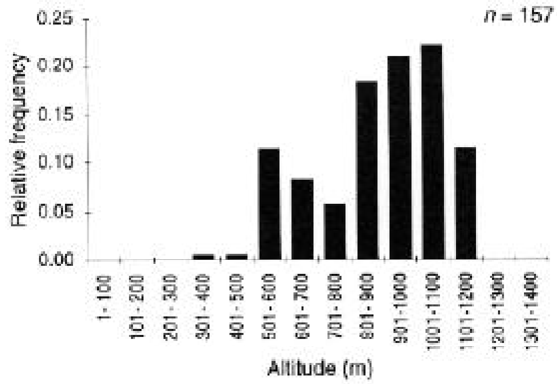



*Figure 32. Altitude distribution of* E. gunnii.

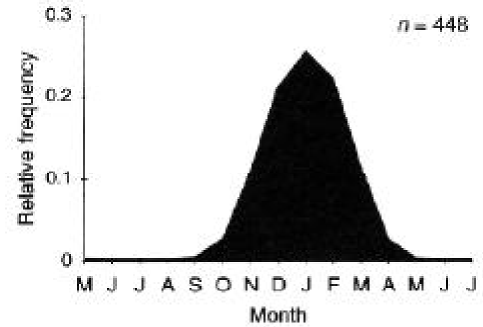



*Figure 33. Flowering times for* E. gunnii.

with various shrub and rainforest understoreys, or co-exist with other subalpine eucalypts such as *E. delegatensis*, *E. coccifera* or *E. dalrympleana*. *Eucalyptus gunnii* and *E. urnigera* are closely related taxa that may co-occur on the southern Central Plateau but, in the south-east (e.g. Snug Plains), they are ecologically separate. The small southern and far north-western populations of *E. gunnii* occur at relatively low altitudes where they are associated with buttongrass plains and tussock grassland respectively (Potts and Reid 1985a). Relict patches of *E. gunnii* have also been found within closed riparian scrub at relatively low altitudes (500 m) in the Eastern Tiers (Askey-Doran 1993). *Eucalyptus gunnii* frequently forms large plate lignotubers which survive aerial defoliation due to extreme frost or fire and resprout vigorously. The ability to coppice from an underground lignotuber following adversity has enabled some individuals to exhibit unusual longevity (Head and Lacey 1988).

*Eucalyptus gunnii* is one of the most frost tolerant eucalypts (Hooker 1844; Barber 1955; Marien 1979) and is the subject of a breeding program to develop frost resistant clones for eucalypt plantation establishment in France (Cauvin 1983; Cauvin and Potts 1991). Some populations of *E. gunnii* are known for the production of a sugary sap from the trunk that was reputedly used by the local Aboriginal community for the production of an alcoholic drink, and hence the common name of 'cider gum' (e.g. Ellis 1973). The attractive juvenile leaf of the coppice foliage has also led to its widespread use by florists.

COMMENTS: The intergradation between *E. gunnii* and *E. archeri* leads to some difficulties in field identification of the two species. In addition, both *E. gunnii* and *E. archeri* may be present in the same grid cell, but occupying separate habitats. For example, in the north-eastern highlands, *E. gunnii* occurs on Mount Arthur (cell 5242) and Mount Victoria (cells 5642, 5742), whilst *E. archeri* occurs on the other nearby mountains, and both species are recorded from near Ben Nevis (cell 5541). Additional relict, relatively low-altitude occurrences of *E. gunnii* may be found where habitat conditions suffice (cf. Askey-Doran 1993, cell 5938). The population near the fire tower on Snow Hill (cell 5635) has some morphological affinities with *E. urnigera* (Potts and Reid 1985a, b) but has been encompassed here in *E. gunnii*. Several unverified, marginal records of *E. gunnii* require further evidence of an occurrence (e.g. cells 4241, 4727, 4826, 4828, 5139, 5141). Some old herbarium records collected by Gunn in 1840 near Plenty (cell 4926) and Rodway in 1892 near Hamilton (cell 4829) were not verified and no populations have been reported in this area.

Records of *E. gunnii* from Mount Wellington (cells 5125, 5225) have not been verified and probably represent misidentification of mallee *E. urnigera* in poorly drained, exposed situations on the plateau.

KEY REFERENCES: Barber (1955, 1956); Cauvin (1983); Cauvin and Potts (1991); Cauvin *et al.* (1993); Head and Lacey (1988); Hooker (1844); Jackson (1973); Maiden (1901); Orme (1983a); Paton (1980); Potts (1984, 1987, 1985, 1990b); Potts and Jackson (1986); Potts and Reid (1985a, b); Potts *et al.* (1987); Scarascia-Mugnozza *et al.* (1989); Tibbits *et al.* (1991).

*Photo 10.* Eucalyptus gunnii *in a subalpine woodland.*

# *Eucalyptus johnstonii*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
yellow gum

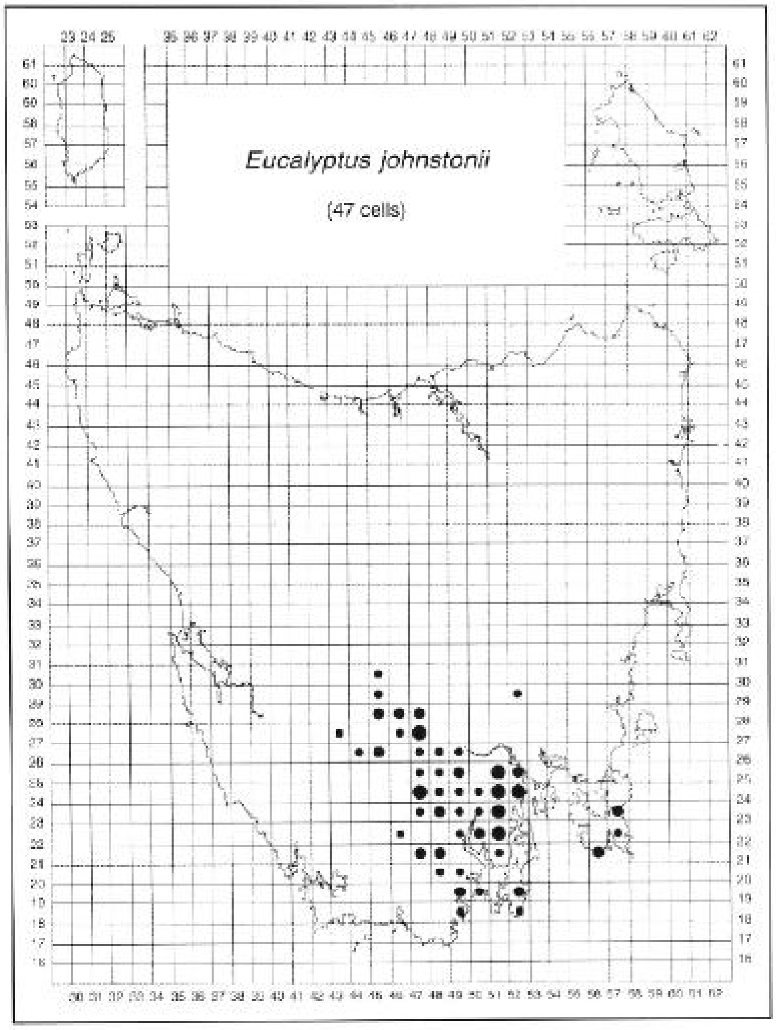



*Figure 34. Distribution of* E. johnstonii *in Tasmania.*

*Eucalyptus johnstonii* is a localised regional endemic species found on south-eastern mountains and plateaux (Figure 34). It grows on sites subject to waterlogging, where peaty soils have developed over siliceous bedrocks (e.g. sandstone) that have a relatively low nutrient status.

*Eucalyptus johnstonii* forms a geographic cline with *E. subcrenulata* along the western margins of its distribution. In intermediate locations, such as the Florentine and Weld Valleys, a tall forest tree with intergrading morphology occurs, reflecting the continuum between *E. subcrenulata* and *E. johnstonii,* and is locally known as the unpublished cline form *'columnaris'* (Jackson 1960).

*Eucalyptus johnstonii* is an upland species of mid- to high-altitude regions, occurring mostly in the range from 500 m to 800 m (Figure 35). The higher altitude records (up to 920 m on the Wellington Range) occur along the northern margins of the distribution. The lower altitude records (300–500 m, but down to 130 m) occur along the southern margins of the Southern Forests, Bruny Island and Tasman Peninsula, consistent with the location of the cooler habitat. Its flowering period is from January through April, peaking from February to April (Figure 36).

*Eucalyptus johnstonii* typically occurs as a tall tree of montane forest, or wet forest and open forest, where it is a dominant, or subdominant with *E. obliqua* or *E. delegatensis* over rainforest or tall shrub understoreys. On dolerite mountains, it frequently replaces *E. urnigera* and *E. coccifera* on poorly drained and frost-exposed Triassic sandstone outcrops

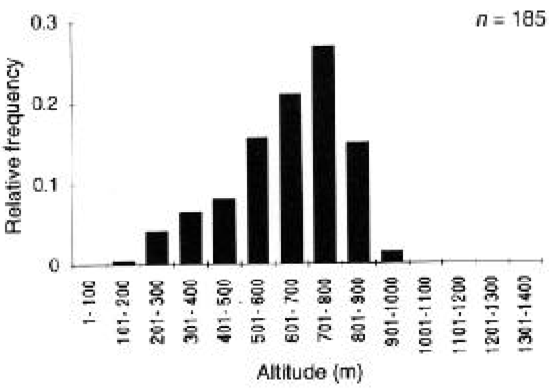



*Figure 35. Altitude distribution of* E. johnstonii.

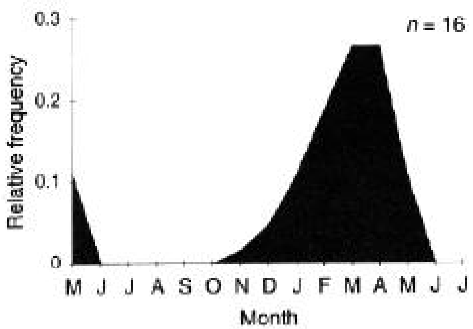



*Figure 36. Flowering times for* E. johnstonii.

(Davidson and Reid 1985). The growth form of yellow gums reflects the degree of exposure to alpine environments such that *E. johnstonii* tends to be a tall tree of montane forest, *E. subcrenulata* a small tree of subalpine forest or woodland, and *E. vernicosa* a mallee shrub in alpine scrub. The freshly exposed bark may be attractively streaked green-yellow or yellow-orange, being especially vivid when wet.

COMMENTS: The maps reflect the western intergrading zone between *E. subcrenulata* and *E. johnstonii* where field botanists may observe the *'columnaris'* cline form (Jackson 1960) and allocate it to either species (i.e. cells 4327, 4526, 4528, 4529, 4627, 4628, 4724, 4725, 4726, 4727, 4728). In the north of the yellow gum range, outliers of *E. johnstonii* (e.g. Brown *et al.* 1983) were treated as misidentificatons of *E. subcrenulata* (i.e. cells 4235, 4237, 4238, 4239, 4432). Conversely, in the south of the yellow gum range, outliers of *E. subcrenulata* were treated as *E. johnstonii* (i.e. cells 5024, 5122, 5123, 5125, 5229).

In the north-east, an unverified outlier from a marsh near Emu Flat (cell 5744) may be a misidentification of a white gum. In the Eastern Tiers, an unverified outlier near Snow Hill (cell 5736) may be a misidentification of *E. brookeriana.* In the south-east, putative occurrences for *E. johnstonii* near the lower Jordan River (cell 5127), near Leprena (cell 4918), in the Wielangta Forests (cells 5626, 5727) and on Forestier Peninsula (cell 5724) need verification. Other outliers, such as those at Mount Dromedary (cell 5127), Quoin Mountain (cell 5229) and Cape Raoul (cell 5621), also need verification but are presently retained in the mapping. In the far south-east at Tylers Hill (cell 4919), *E. johnstonii* hybridises with *E. urnigera* and *E. globulus* (W. D. Jackson, unpublished data).

KEY REFERENCES: Jackson (1960); Potts and Jackson (1986).

# *Eucalyptus morrisbyi*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
Morrisby's gum

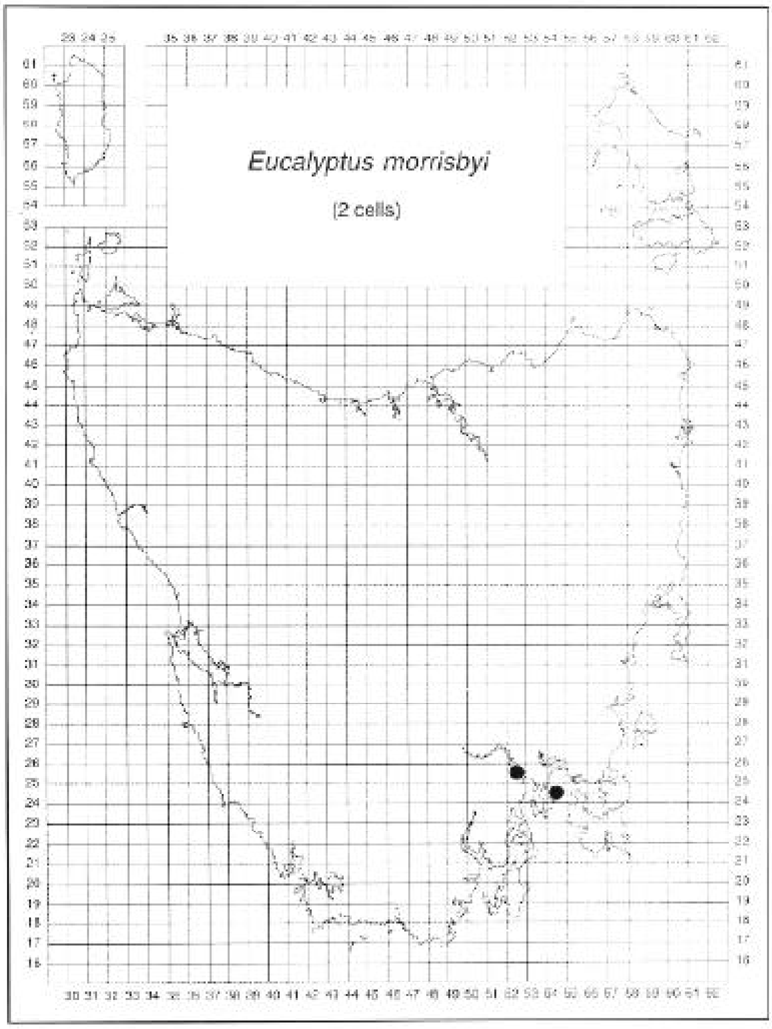



*Figure 37. Distribution of* E. morrisbyi *in Tasmania.*

*Eucalyptus morrisbyi* is a rare endemic species locally restricted to the moister aspects or undulating slopes of several coastal hills on the eastern shore of the Derwent River estuary (Figure 37). However, clearing for agricultural purposes has restricted its range considerably. It is extant in the Cremorne area and near Risdon in the Government Hills, and is regarded as one of the rarest and most endangered eucalypt species (Pryor and Briggs 1981; Wiltshire *et al.* 1991b). The largest stand comprises nearly 2000 adult trees and covers 11.5 ha on Calverts Hill (Wiltshire *et al.* 1991b).

Other remnant stands consisting of less than 20 mature individuals are known from Pipeclay Lagoon and in the Government Hills. A few minor occurrences as scattered roadside individuals occur near Lumeah Point and South Arm. The recent past distributions and conservation genetics of *E. morrisbyi* are discussed by Wiltshire *et al.* (1991b). *Eucalyptus morrisbyi* is closely related to *E. gunnii*, and Pryor and Briggs (1981) speculate on the origins of the species as 'the surviving coastal part of a population of eucalypts from which *E. gunnii* has been derived'.

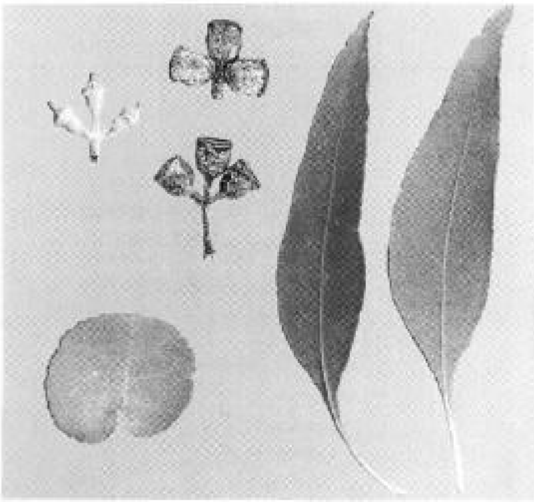


*Photo 11. Buds, fruit and leaves of* E. morrisbyi. *(Left, juvenile leaf; right, adult leaves.)*

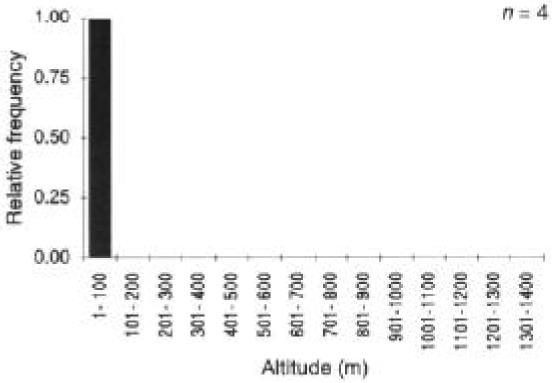



*Figure 38. Altitude distribution of* E. morrisbyi.


*Figure 39. Flowering times for* E. morrisbyi.

*Eucalyptus morrisbyi* occurs from near sea-level to 80 m (Figure 38) on sandy loams derived from mudstone in the Government Hills and on dolerite with a Quaternary sand influence at Calverts Hill. Its main flowering period is March to April (Figure 39).

*Eucalyptus morrisbyi* at Calverts Hill appears to be the remnants of a much wider distribution prior to land clearing. It dominates dry sclerophyll forest on southern to western aspects of a gently sloping hill (Wiltshire *et al.* 1991b). Surrounding forest on the north-western aspects is dominated by *E. viminalis* and *E. tenuiramis.* The small stand of *E. morrisbyi* in the Government Hills grades into *E. amygdalina* forest. At Calverts Hill and elsewhere, it is threatened by local land-use practices, and must be considered endangered.

COMMENTS: *Eucalyptus morrisbyi* (Photo 11) may have been confused with *E. gunnii* or *E. cordata* by some early collectors, and some herbarium specimens are derived from artificial plantings along roadsides and in parks or gardens. The natural distribution of *E. morrisbyi* is verified from only two grid cells. A third location comprises a single roadside tree near South Arm, which is believed to be a natural occurrence (cell 5323; F. Coates and L. Mendel, unpublished data), but further verification is needed. Wiltshire *et al.* (1991b) also report several roadside trees in the same area which may be remnants of a natural population. They consider that other isolated trees in the Cremorne area may exist which are remnants of the past distribution. An avenue of mature trees near the junction of the South Arm and Cremorne Roads is considered by Wiltshire *et al.* (1991b) to be the one reported in the original species description as having been planted by J.R. Morrisby. Other locations are derived from general descriptions and have not been verified (i.e. cells 5324, 5423). Ornamental and conservation plantings are being encouraged in the urban and rural districts where *E. morrisbyi* occurs naturally.

KEY REFERENCES: Brown and Bayly-Stark (1979b); Pryor and Briggs (1981); Wiltshire *et al.* (1989, 1991b).

# *Eucalyptus nitida*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
Smithton peppermint

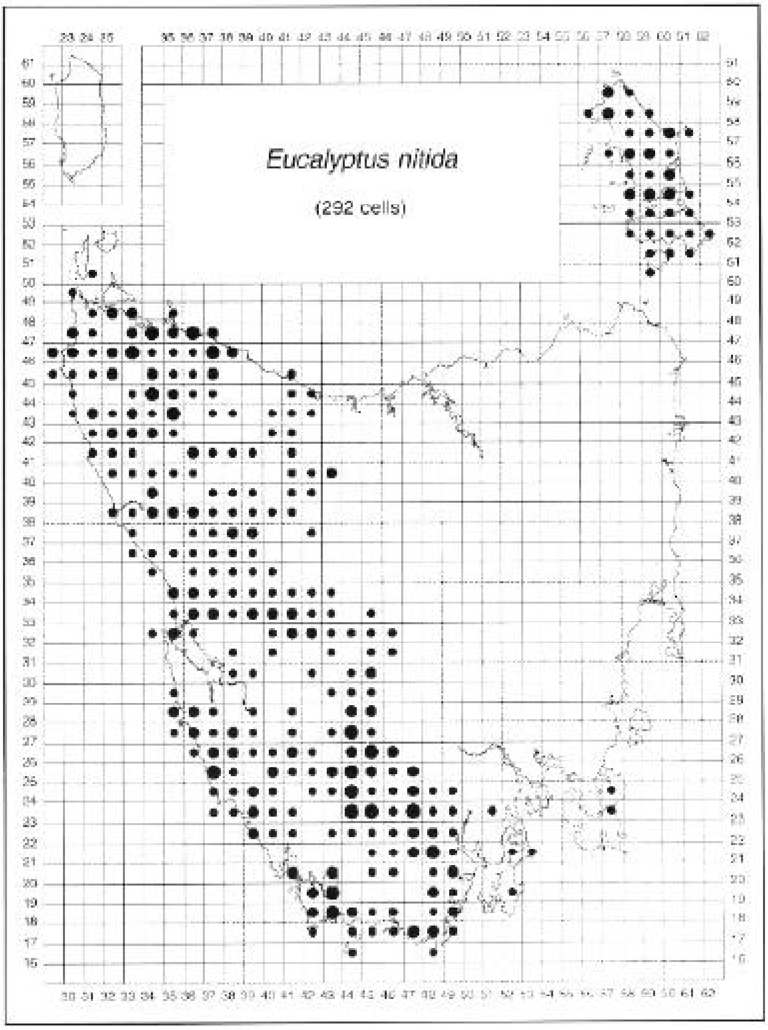



*Figure 40. Distribution of* E. nitida *in Tasmania.*

*Eucalyptus nitida* is a locally widespread endemic species in the western regions of Tasmania (Figure 40), complementing the eastern distribution of *E. amygdalina.* The two species intergrade across broad lowland contact zones, particularly in the north but also in the south. A disjunct population of *E. nitida* is also centred on the Furneaux Group of islands, where it is widespread on Flinders Island and Cape Barren Island. *Eucalyptus nitida* occupies a more-or-less continuous ecological range in the west, in various topographic situations where peats and skeletal soils develop on the oligotrophic quartzite, granite and siliceous-sedimentary substrates. In upland situations of western Tasmania, it intergrades eastward with *E. coccifera* and is replaced by that species at the tree-line where the more fertile soils occur, derived from Jurassic dolerite (Shaw *et al.* 1984). In lowland situations of the north and north-west, the eastward intergradation of *E. nitida* with *E. amygdalina* is found most frequently where a gradient of decreasing rainfall coincides with the geological divide between older and younger sedimentary substrates.

*Eucalyptus nitida* generally occurs from near sea-level to about 800 m (Figure 41). On Flinders Island, it occurs predominantly below 200 m and occasionally up to 500 m near Strzelecki Peaks. In the west, it ranges widely in altitude from near sea-level in coastal regions and up to 1020 m in inland regions (e.g. at Clear Hill), but is found predominantly below 700 m. The higher altitude records are generally located along the eastern margins of this western range. The main flowering period is from November to February, peaking in December and January (Figure 42). Flowering time does not appear to be a barrier to gene exchange between the intergrading forms of *E. coccifera* and *E. nitida* (Shaw *et al.* 1984).

In lowland western Tasmania, *E. nitida* usually occurs as a tree in pure stands, dominating tall wet sclerophyll forest and mixed forest, but may also occur in mixed stands with *E. obliqua* or *E. delegatensis*. In the northern and western coastal lowlands (including Flinders Island), *E. nitida* is frequently associated with heathy forests, occurring with and eventually replaced by *E. ovata* as drainage declines and sites become seasonally waterlogged. *Eucalyptus nitida* also exists as a mallee shrub in scrub boundaries and in the small copses scattered amongst blanket moorland in the west and south-west (Jarman *et al.* 1988) (Photo 12). In the western uplands, it is a common dominant of subalpine woodlands. On Flinders Island, mallee-form *E. nitida* occurs with *E. globulus* and, to a lesser extent, *E. viminalis*, in low, open, heathy forests and woodlands on drought-prone, infertile, siliceous substrates and sites that offer some protection from the extremes of the prevailing westerly winds.

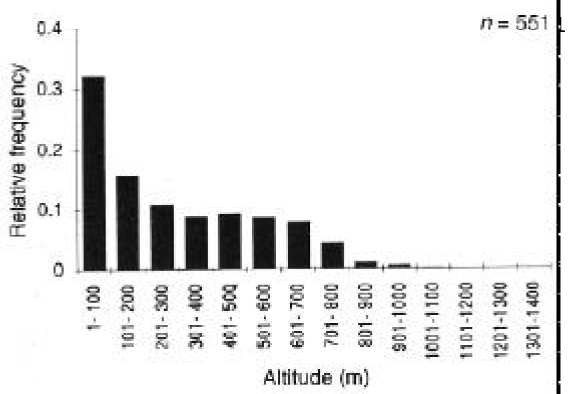



*Figure 41. Altitude distribution of* E. nitida.

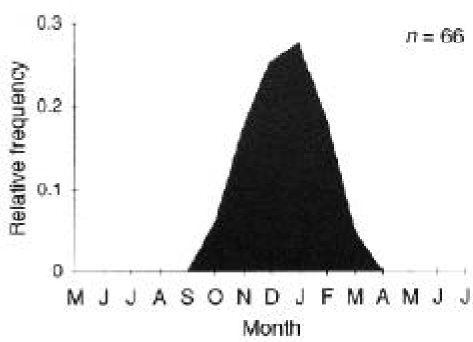



*Figure 42. Flowering times for* E. nitida.

COMMENTS: There is a broad, northern geographic transition between *E. nitida* and *E. amygdalina* (e.g. cells 3447, 3646, 3647, 3745, 3746, 3747, 3846, 4043, 4340) that extends throughout the east–west contact zone for these two species (e.g. cells 4237, 4432, 4626, 5123, 5321, 5723). Field observers frequently encounter both species and intergrading forms of indeterminate identity in this region. For example, intergrading forms at Lake St Clair (cell 4333) are associated with changes in geological substrate as well as a climatic gradient. In the central intergrading zones, small populations with their closest affinities to *E. coccifera* are recorded from the Thumbs and Tim Shea (cell 4527), but the high-altitude peppermint nearby at Clear Hill (cell 4427) tends to have closer affinities with *E. nitida* (Shaw *et al.* 1984). Unverified outliers in this central intergrading zone have been treated as misidentifications of *E. coccifera* or *E. amygdalina* (cells 4635, 4727, 4728, 4736, 5224, 5225).

Biogeographically, the disjunction in the main occurrences of *E. nitida* on the Furneaux Group of islands and in western Tasmania is difficult to explain. However, recent studies by D. Rankin (pers. comm. 1995) suggest that the island peppermints are intermediate between the western *E. nitida* and populations attributable to *E. nitida* (*E.* aff. *nitida*) at Wilsons Promontory in Victoria. Whinray (1977) identified the peppermint on Cape Barren Island as *E. tenuiramis* and recent field observations confirm a large degree of variation in glaucousness amongst the peppermints there (S. Harris, pers. comm. 1993; R. Gaffney, pers. comm. 1996), which is unusual for *E. nitida.* However, in the absence of distinguishing data, all verifiable records of a peppermint on the Furneaux Group of islands were treated as *E. nitida.* The taxonomic affinity of the peppermint on these islands requires re-assessment as does the unverified extension of *E. nitida* populations into coastal northern and north-eastern Tasmania (e.g. cells 4144, 4145, 4845, 4945, 5042, 5848). Other mallee-form peppermints of indeterminate identity in eastern coastal regions associated with wet heathlands, and on exposed coastal headlands, may also have affinities with the peppermint on the Furneaux Group of islands (e.g. cells 5219, 5221, 5321, 5723, 5724, and unverified cells 5621, 5622). The occurrences of *E. nitida* from the Furneaux Group of islands contribute to the relatively high frequency of low-altitude records (Figure 41). The patchiness of the western distribution (Figure 40) is probably indicative of a paucity of sampling in the relatively inaccessible west and south-west regions.

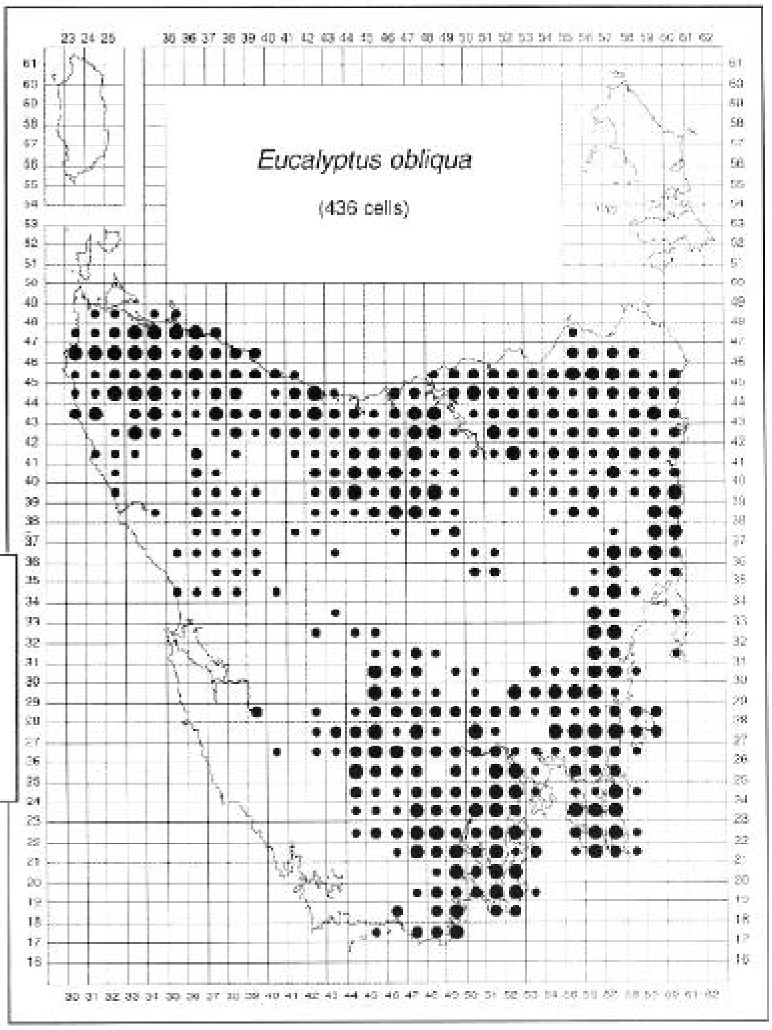
KEY REFERENCES: Ladiges *et al.* (1983); Li *et al.* (1995); Marginson and Ladiges (1982); Paton (1980); Shaw *et al.* (1984); Whinray (1977).

*Photo 12.* Eucalyptus nitida, *dominating small copses and gully forests in buttongrass moorland in south-western Tasmania.*

# *Eucalyptus obliqua*

SUBGENUS: *Monocalyptus*
SERIES: *Obliquae*

Common name:
stringy bark
brown-top



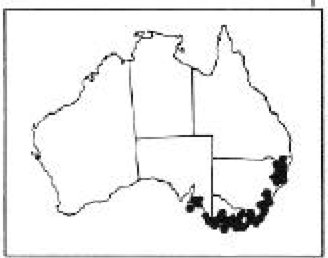



*Figure 43. Distribution of E. obliqua in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus obliqua* is a widespread and common species found throughout Tasmania in comparatively mesic, well-drained, lowland habitats on a variety of substrates and terrain (Figure 43). It is rare or absent from the predominantly oligotrophic environments of the west and south-west, and it is not known from the Bass Strait islands. It displaces *E. regnans* on deep, well-drained soils of fertile sites with moderate to high fire frequency, and is itself replaced by *E. delegatensis* at higher altitudes at similar sites.

*Eucalyptus obliqua* generally occurs below about 600 m altitude throughout its range (Figure 44) and is frequently found near sea-level in coastal areas. It is found occasionally above 600 m, and up to 860 m near St Marys. These higher altitude records are predominantly from the north and north-east. Some of the higher altitude records in the more southern or central regions are likely to represent misidentifications of *E. delegatensis*. The main flowering period is January to March, peaking in January and February (Figure 45).

*Eucalyptus obliqua* (Figure 46) occurs as a medium to tall tree (Photo 13) in wet sclerophyll forest and, more occasionally, is emergent over rainforest. It extends into shrubby dry sclerophyll forest, upland grassy forests and drier coastal heath communities where it may be stunted or reduced to a mallee shrub (Photo 14). It occurs across a range of substrates, including dolerite, sandstone and mudstone wherever conditions are sufficiently mesic. Heathy understoreys are typical of the more siliceous substrates, and tall mesophytic shrub understoreys are well developed on the more fertile dolerite substrates. *Eucalyptus obliqua* frequently forms pure stands in wet forests but, as moisture availability declines, it typically co-exists in ecotones with peppermint species which dominate on the drier sites. *Eucalyptus viminalis* is the most frequently co-occurring minor or subdominant species, and *E. globulus* may co-occur with *E. obliqua*, particularly in the south-east.

COMMENTS: *Eucalyptus obliqua* is unknown from the Bass Strait islands, except for an unverified outlier near Pegarah on King Island (cell 2457) recorded by Gardiner and Crawford (1987). In the south-west, *E. obliqua* is recorded from the Gordon River valley (cells 3928, 4026), and may also be found in suitable habitats from other valley systems in the same region. Many of the southern forms of *E. obliqua*, particularly in coastal forests (e.g. cells 4517, 4717), appear aberrant, with rough bark on the stem and smooth bark on the major branches, but are otherwise morphologically true to the taxon (F. Duncan, pers. comm. 1994). Other patches of *E. obliqua* are likely to be found in suitable habitats in southern coastal forest areas (e.g. west of cell 4618). At higher altitudes (> 800 m) in central and southern regions, records of *E. obliqua* are

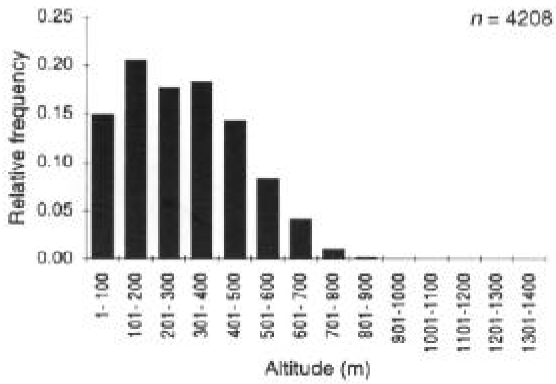



*Figure 44. Altitude distribution of* E. obliqua.

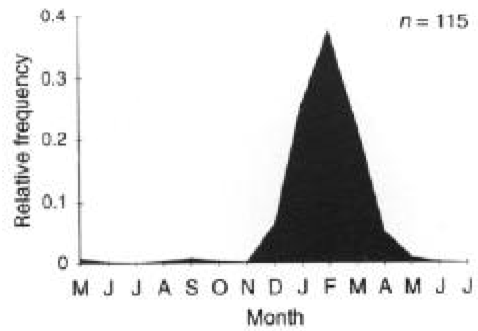



*Figure 45. Flowering times for* E. obliqua.

*Photo 13.* Eucalyptus obliqua *on fertile soils.*

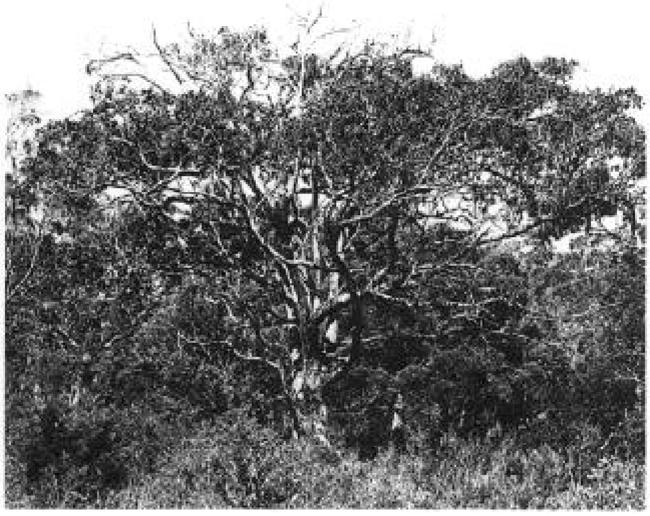


*Photo 14. Stunted* E. obliqua *in coastal vegetation.*

treated as misidentifications of *E. delegatensis* (e.g. cells 4337, 4535, 4733, 4934, 5033).

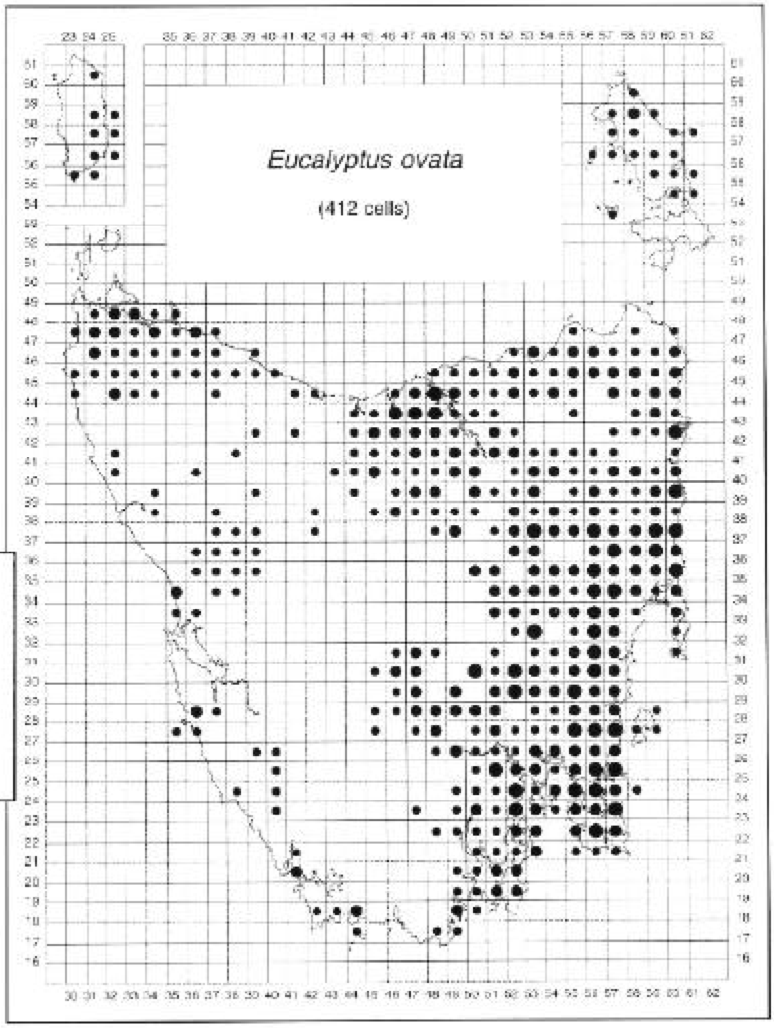
KEY REFERENCES: Anderson and Ladiges (1982); Ashton (1981a, 1984); Ashton and Williams (1973); Blake (1976); Brown *et al.* (1975, 1976); Dess and Ashton (1982); Green (1971); Griffin and Eldridge (1980); Hamilton *et al.* (1991); Martin and Specht (1962); Pederick (1960); Podger *et al.* (1980); Potts and Reid (1983); Sinclair (1980); West (1979, 1981, 1982); Wilkinson and Jennings (1993).

*Figure 46.* Eucalyptus obliqua, *showing the oblique leaf base, from which the species derives its name.*

# *Eucalyptus ovata*

SUBGENUS: *Symphyomyrtus*
SERIES: *Ovatae*

Common name:
swamp gum
black gum



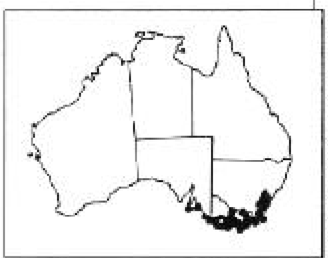



*Figure 47. Distribution of* E. ovata *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus ovata* is widespread and local throughout the lowlands of the north, east and south, extending across a wide range of substrates (Figure 47). In the drier regions, it typically occurs in topographically distinct situations that collect water into drainage basins. Such sites include the shallow to medium slopes in undulating coastal terrain, or seasonally waterlogged soaks and hollows of poorly drained valley flats and plateaux. On Flinders Island, *E. ovata* is closely associated with low-lying flats on recent marine sediments, and has a corresponding disjunct distribution. In western and south-western regions, it occurs sporadically in coastal and inland situations, where it appears to intergrade with *E. brookeriana.*

*Eucalyptus ovata* is a lowland species often occurring below 400 m, but also widespread in northern, central and eastern highland areas to about 700 m (Figure 48), and occasionally extends up to 830 m (e.g. near Lake Sorell on the eastern Central Plateau). In western regions, populations with affinities to *E. ovata* generally occur below 200 m. It is replaced by *E. rodwayi* on sites subject to severe frosts and cold-air drainage, particularly at the higher elevations. Its main flowering period is June to February, peaking from August to November (Figure 49).

*Eucalyptus ovata* is a local dominant of grassy and sedgey dry sclerophyll woodlands but, as drainage improves, it grades into peppermint-dominated forests, especially those with *E. amygdalina. Eucalyptus viminalis* may be present as a minor species. *Eucalyptus ovata* is a rare dominant or co-dominant with *E. obliqua* in wet sclerophyll forest on flats adjacent to drainage lines. Occasionally, it extends onto well-drained, wet forest sites as a subdominant with *E. obliqua* where, in the absence of juvenile foliage (Photo 15), it may be morphologically difficult to distinguish from *E. brookeriana.* In dry coastal and exposed locations, *E. ovata* occurs as a small spreading tree or mallee-form shrub (Photo 16) but, in wet forests, it assumes a taller tree form. On Flinders Island and the coastal plains of the north-east, grassy and sedgey *E. ovata* low woodlands have been cleared across much of their range and remnant stands are threatened by further clearing and other agricultural practices.

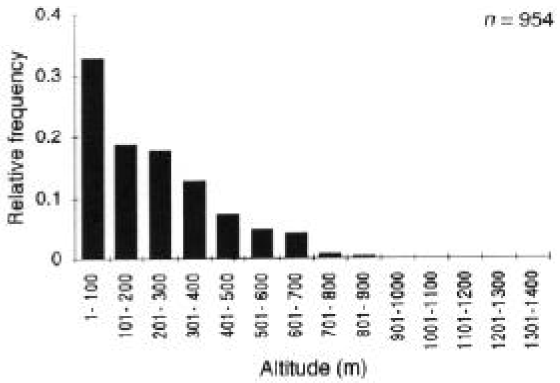



*Figure 48. Altitude distribution of* E. ovata.

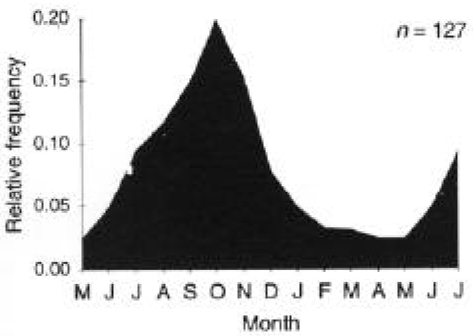



*Figure 49. Flowering times for* E. ovata.

COMMENTS: Jackson (1965) differentiates an east and a west coast form of *E. ovata,* the latter encompassing some populations now ascribed to *E. brookeriana* (Gray 1979). The western series *Ovatae* populations appear to have closer affinities with *E. brookeriana* according to recent work on leaf chemistry (Li *et al.* 1996). Therefore, some western and south-western occurrences ascribed to *E. ovata* may represent misidentifications of populations with closer affnities to *E. brookeriana,* but have been retained as *E. ovata* in the present mapping, being indicative of the geographic range of the black gum group in these regions. However, a detailed re-assessment of the taxonomic status of these western populations is required.

The identity of the high-altitude outliers (above 700 m) is uncertain, but may reflect misidentifications of *E. brookeriana* or *E. rodwayi,* or actual 'rare' occurrences of *E. ovata.* Further verification of these sites is

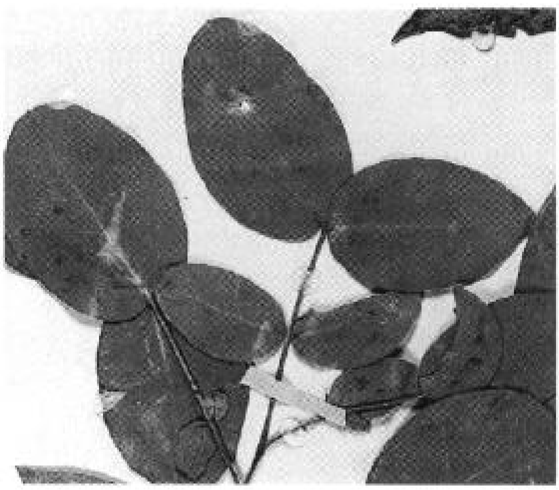


*Photo 15. Juvenile leaves (pressed) of* E. ovata.

needed. For example, high-altitude records in the Eastern Tiers near Snow Hill and Mount Foster (cells 5635, 5735, 5736, 5737, 5738) or the eastern Central Plateau (cell 4934) could represent intergrading forms of *E. ovata* and *E. rodwayi* with stunted stature and broader leaves, whilst the occurrences of tall trees in wet forests in the Fingal Valley near Tower Hill may be misidentifications of *E. brookeriana* (e.g. cell 5639). Although the identity of these high-altitude occurrences is uncertain, most were retained as *E. ovata*, where represented by more than one source.

Amongst the tall wet forests of the Western Tiers, *E. ovata* is known to occur in well-drained, wet forest habitats (F. Duncan, pers. comm. 1995) and may occasionally be recorded as *E. brookeriana* (e.g. cells 4638, 5035), but *E. brookeriana* is not well verified from this northern region except at Golden Valley (cell 4739; M.I.H. Brooker, pers. comm. 1996).

KEY REFERENCES: Brooker and Lassak (1981); Clucas and Ladiges (1979); Gray (1979); Ladiges *et al.* (1981, 1984); Li *et al.* 1996; McAulay (1937); Withers and Ashton (1977).

*Photo 16.* Eucalyptus ovata *dominating poorly drained, grassy forest.*

# *Eucalyptus pauciflora* subsp. *pauciflora*

SUBGENUS: *Monocalyptus*
SERIES: *Obliquae*

Common name:
cabbage ash
weeping ash

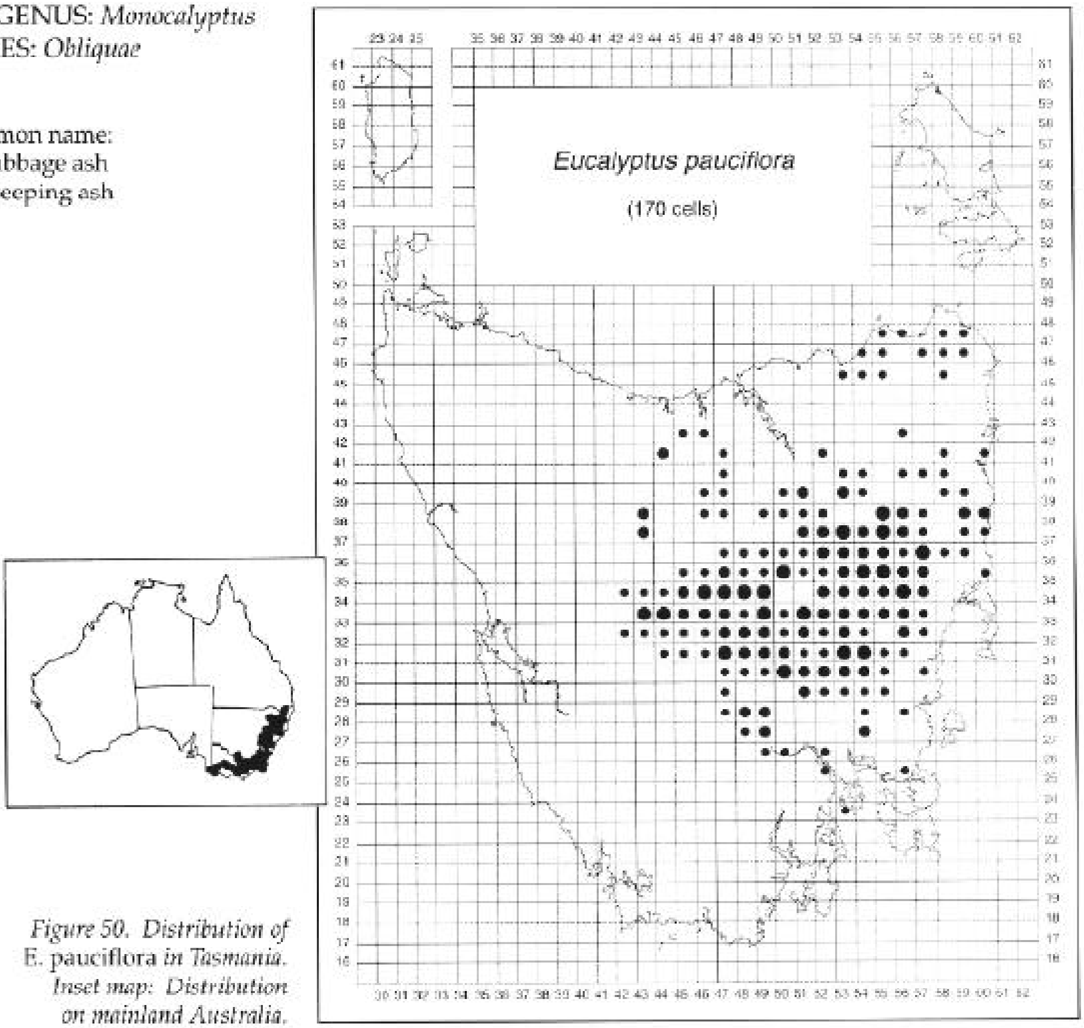



*Figure 50. Distribution of E. pauciflora in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus pauciflora* (Photos 17, 18) is widespread throughout the Midlands and the southern Central Plateau, and it is scattered through the Eastern Tiers, northern Tasmania, and the far north-eastern coastal plains (Figure 50). In upland plateau regions, it occurs in habitats that are frequently exposed to cold, dry winds, and have a high rock cover, with the surface-water drainage being fair to impeded. Similarly, the habitat on the lowland flats is subject to sweeping winds, frosts, cold-air drainage and periodic drought, the combination of environmental stress depending on the particular location. It occurs on a wide range of substrates of both sedimentary and igneous origin, being most frequently found on Jurassic dolerite and occasionally amongst coastal sand dunes.

*Eucalyptus pauciflora* has a broad altitude range from near sea-level (10 m) to 1080 m, but has most occurrences between 200 m and 700 m (Figure 51). The altitude profile may be indicative of lowland and upland ecotypes, following the stepped topography in Tasmania. For example, the low-altitude records (< 300 m) reflect the coastal or inland plains and subcoastal hills of the north, north-east, east, south-east and Midlands; the mid-altitude range (300–800 m) largely reflects the Eastern Tiers and lower Central Plateau surface; and the highest altitude records (800–1080 m) are largely located on the southern to south-eastern Central Plateau such as in the vicinity of Great Lake to Lake St Clair. The main flowering period is December to February, peaking in January (Figure 52).

*Eucalyptus pauciflora* is a local dominant of dry forests and low woodlands with a variable understorey of heathy, shrubby, sedgey or grassy elements, reflecting the wide environmental range. The tree form similarly varies in response to the prevailing conditions, from a small forest tree to a twisted, wind-pruned and stunted woodland tree (Photo 18). *Eucalyptus pauciflora* usually forms mixed stands with other eucalypt species. In lowland regions, it may co-exist with *E. ovata* where drainage is slightly impeded, or with *E. rubida* where inland sites are subject to frost and cold air. In upland regions, *E. delegatensis* may co-exist ecotonally with *E. pauciflora* on the wet sites with deep soils and protected aspects (e.g. Jackson 1973), but is replaced by *E. amygdalina* as the co-existing species on the well-drained, mid slopes with northern aspects. *Eucalyptus dalrympleana* is a subdominant or minor co-occurring species on the better drained upland sites and *E. rodwayi* co-occurs where drainage becomes impeded.

COMMENTS: Occurrences of *E. pauciflora* in the far north-eastern coastal plains and the Midlands may be relicts of a distribution across the cold, dry and windy glacial Bassian Plain, as similar low-altitude occurrences are

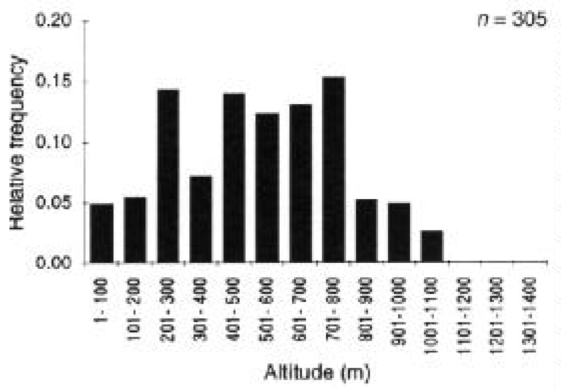



*Figure 51. Altitude distribution of* E. pauciflora.

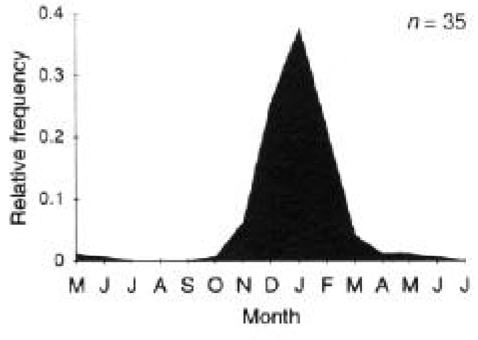



*Figure 52. Flowering times for* E. pauciflora.

*Photo 17. A weeping form of* E. pauciflora, *growing as a remnant in paddocks of the Midlands.*

found in Gippsland (Williams and Ladiges 1985; Rule 1994). The numerous marginal or outlier records (e.g. cells 4925, 5323, 5625, 5642, 6041) may be indicative of scattered populations that are yet to be discovered between these verified records (e.g. Apsley Marshes, cell 6035, S. Harris, J. Kirkpatrick, pers. comm. 1996). Old herbarium records near Mole Creek (cell 4439) and Chudleigh (cell 4540) may represent occurrences of *E. pauciflora* that have since been cleared for farmland. Field checking of remnant trees is needed to verify the locations, although these are not inconsistent with observations from the Western Tiers (e.g. cells 4638, 4738). In the north-west, an unverified outlier near Middlesex Plains (cell 4139) would, if verified, represent a significant range extension. Other unverified or doubtful records include a location near Port Dalrymple (e.g. cell 4844) and several possibilities in the north-eastern highlands (cells 5444, 5539, 5541). Along the Lyell Highway, a single tree of *E. pauciflora* (cell 4132) occurs in a patch of apparently undisturbed vegetation and may be an example of long-distance seed dispersal. This outlier is presently omitted from the natural distribution.

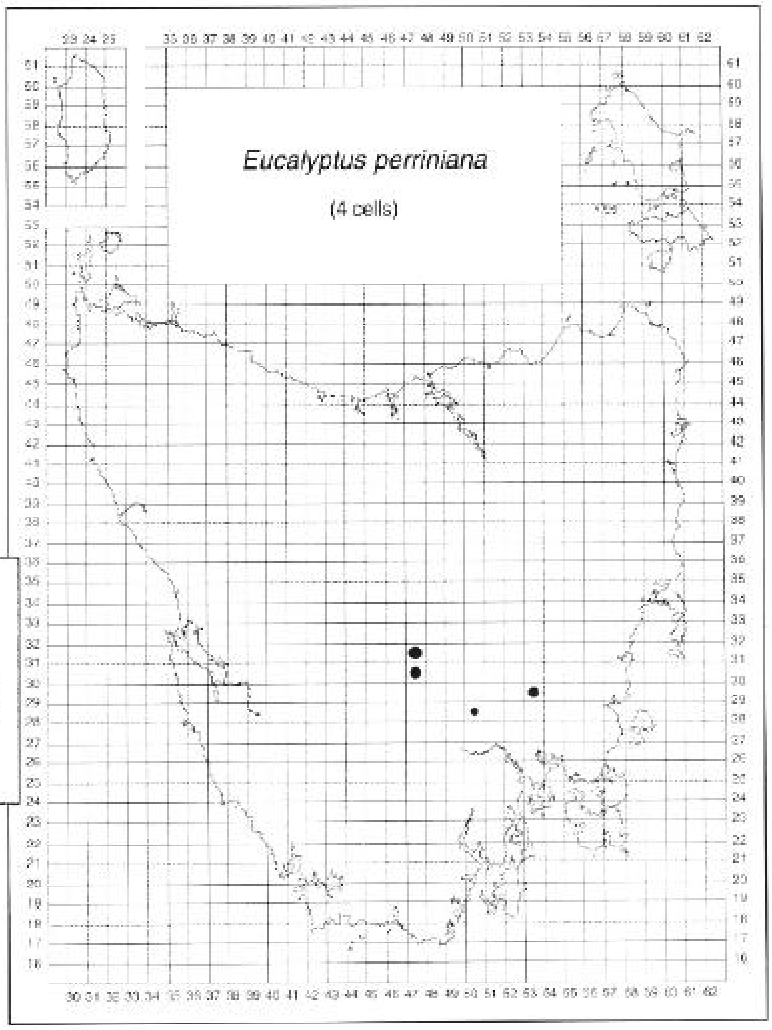
KEY REFERENCES: Austin *et al.* (1983); Barker (1988); Battaglia (1990b); Burden and Chilvers (1974); Green (1969a, b); Howard and Ashton (1967); Jackson (1973); Noble (1984); Phillips and Brown (1977); Pryor (1957); Rule (1994); Slatyer (1977a, b, c); Slatyer and Ferrar (1977); Slatyer and Morrow (1977); Whiffin (1981); Williams and Ladiges (1985).

*Photo 18. Grassy* E. pauciflora – E. viminalis *woodland.*

# *Eucalyptus perriniana*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
spinning gum



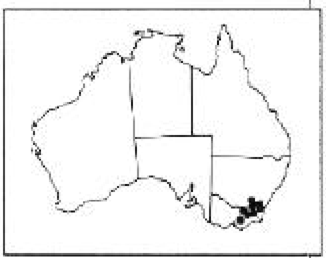



*Figure 53. Distribution of* E. perriniana *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus perriniana* is a rare species in Tasmania known from three small, isolated populations in the south-east and southern Midlands (Figure 53). It is restricted to a specialised habitat on mid-altitude plateaux where drought-prone, sandy, skeletal soils over sedimentary rock are seasonally inundated in localised, marshy hollows. The limited size and isolation of *E. perriniana* populations suggests a relict distribution, confined to the marginal habitats of its former ecological range (Wiltshire and Reid 1987). In this harsh environment, the distinct, connate, juvenile leaf form often persists after reproductive maturity. On older stems, when the leaf tissue dies at the centre around the twig, the joined pair of leaves becomes detached and spins in the wind (Wiltshire and Reid 1987).

*Eucalyptus perriniana* is found at intermediate altitudes in a narrow range between about 500 m and 620 m (Figure 54). It occurs on sites exposed to severe frosts, with extended cold-air pooling in winter contrasting with the summer drought. In the south-east at Hungry Flats, the altitude range is between 540 m and

560 m and, in the southern Midlands near Strickland, it is from 500 m to 560 m. The highest altitude occurrence (620 m) reflects a poorly verified site from Pelham Tier in the southern Midlands. The main flowering period for *E. perriniana* is poorly defined but appears to be from January to March (Figure 55).

*Eucalyptus perriniana* forms a bushy mallee or small straggly tree in sedgey dry sclerophyll low woodland where it may co-exist ecotonally and hybridise with *E. rodwayi* in the wetter depressions. As drainage improves and soil depths increase on the slightly elevated margins of hollows, it occurs as an understorey shrub with scattered *E. rubida* or *E. viminalis* in *E. tenuiramis* open forest. The mallee form of *E. perriniana* is

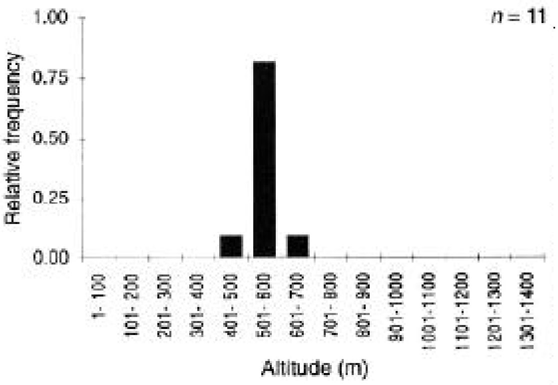



*Figure 54. Altitude distribution of* E. perriniana.

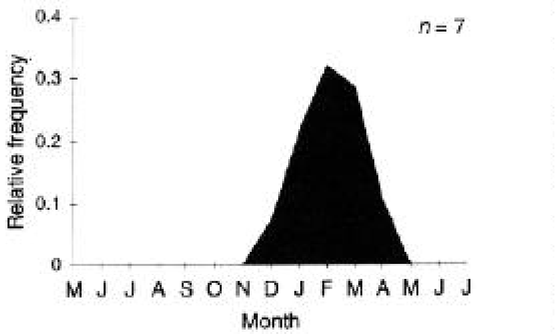



*Figure 55. Flowering times for* E. perriniana.

reinforced by frequent low-intensity fires, with refoliation occurring as slender, vegetative sprouts from lignotubers that may be hundreds of years old (Wiltshire and Reid 1987). These small populations and their surrounding peppermint forest habitat are vulnerable to disturbances associated with human activities.

The Tasmanian populations of *E. perriniana* are distinct from mainland ones and are important for maintenance of the species' genetic variability (Wiltshire and Reid 1987). This distinction is consistent with the longer period of isolation from the more widespread occurrences on the Australian mainland, which are in similarly specialised, albeit subalpine, habitats (e.g. Harris 1975; Hall and Brooker 1973). The species is used for garden and amenity plantings, and the attractive juvenile leaves of the slender coppice branches are used widely by florists.

COMMENTS: There are only three verified locations for *E. perriniana* in Tasmania, represented by Hungry Flats (cell 5329), Strickland (cell 4730) and Duckholes Lagoons (cell 4731). A fourth location near Espies Craig (Pelham Tier, cell 5028; A. Mount, pers. comm. 1995) has been included in the mapping but requires verification of the population condition and ecology.

Old herbarium records from places such as River Dee (cell 4630; collected by R.G. Brett in 1934), the Dee (cell 4631; collected by J.H. Maiden in 1918), Ouse (cell 4729; collected by L. Rodway in 1912), or Macquarie (cell 4927; collected by J.H. Maiden in 1918) could not be verified in the present study and are most likely to represent mis-locations of known occurrences, or sites that have since been cleared. These records may also account for the additional sites for *E. perriniana* mapped by Jackson (1965). An herbarium record from Summerleas Road, Hobart (cell 5224), is probably *E. cordata*.

KEY REFERENCES: Hall and Brooker (1973); Paton (1980); Sheppard (1979); Steane *et al.* (1991); Wiltshire and Reid (1987).

# *Eucalyptus pulchella*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
white peppermint

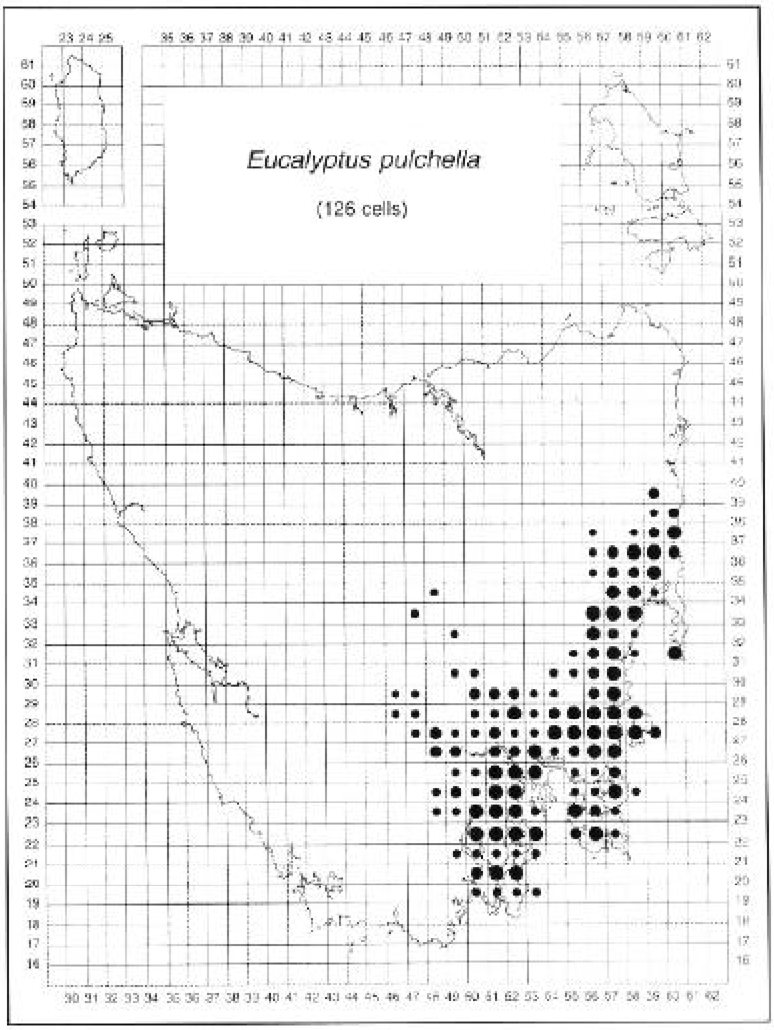



*Figure 56. Distribution of* E. pulchella *in Tasmania.*

*Eucalyptus pulchella* (Photo 19) is a locally widespread endemic species on the undulating to hilly terrain of lowland south-eastern Tasmania (Figure 56). It typically occurs on the upper hill-slopes and knolls where the free-draining, Jurassic dolerite substrates have a high surface rock cover. Such sites are usually topographically exposed, being very sunny with a north- to west-facing aspect and subject to periodic drought stress. *Eucalyptus pulchella* extends eastward where it intergrades morphologically with *E. amygdalina,* and the distinction between the two species becomes unclear on dolerite substrates throughout the Eastern Tiers.

*Eucalyptus pulchella* is predominantly a lowland species of the mid-altitude range between 100 m and 500 m but extends from near sea-level (10 m) to about 740 m (Figure 57), where it may hybridise with *E. coccifera* (Davidson *et al.* 1987). The altitude range and topographic position are likely to coincide, to some extent, with the availability of suitable habitats on lowland dolerite substrates. The higher altitude occurrences

(> 600 m) for *E. pulchella* are known from sites in the south-east at Snug Tiers, the southern Central Plateau near Waddamana and in the Eastern Tiers towards the northern limits of its range. Its flowering period extends from August to February, peaking from October to December (Figure 58).

*Eucalyptus pulchella* most frequently occurs as a small to moderate-sized spreading tree of grassy to heathy dry sclerophyll open forests and woodlands. Occasionally, it extends onto moister sites with shrubbier understoreys where it has a straighter form. In the south-east, and most notably in the D'Entrecasteaux Channel region, *E. pulchella* characteristically forms sharp ecotonal transitions and narrow hybrid zones with *E. amygdalina* where there is a juxtaposition of dolerite and sandstone substrates, and more rarely with *E. tenuiramis* in the contact zone between mudstone and dolerite. It frequently forms mixed stands with other eucalypts such as *E. viminalis*, *E. globulus* or *E. rubida*, depending on local site conditions.

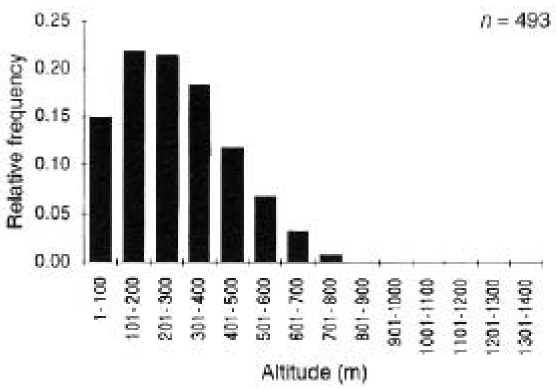



*Figure 57. Altitude distribution of* E. pulchella.

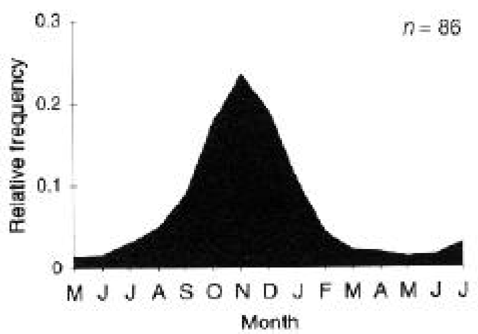



*Figure 58. Flowering times for* E. pulchella.

COMMENTS: There are many inconsistencies in the northern extent of the distribution of *E. pulchella* due to problems of field distinction between it and 'half-barked' intergrading forms of *E. amygdalina* (Kirkpatrick and Potts 1987). Jackson (1965) indicated that the northward distribution of *E. pulchella* extended no further than Bothwell (cell 5030), Oatlands (cell 5331) and Swansea (cell 5633). However, there are persistent records for *E. pulchella* throughout the Eastern Tiers, including the Douglas–Apsley region, and these are included in the mapping. Records for *E. pulchella* that exist north of the Fingal Valley were treated as unverified outliers (e.g. cells 5145, 5537, 5538, 5637, 5639, 5738, 5741, 5742, 5846, 5939, 5940, 5941, 5942, 5944, 6039, 6042, 6043) and the few occurrences of *E. pulchella* that were not related to dolerite substrates were considered to be misidentifications of *E. amygdalina* (e.g. cells 6033, 6034, 6035).

*Eucalyptus pulchella* has also been recorded from the southern Midlands and the lower plateau surface north of Bothwell and near Interlaken (i.e. 4733, 4834, 4932). These records may represent identification problems of 'half-barked' *E. amygdalina*, although the essential oils of a 'half-barked' population from Bakers Tier (cell 4933) did have close affinities with *E. pulchella* (Li *et al.* 1995). Other Midland and south-eastern Central Plateau populations recorded as intergrading forms between *E. pulchella* and *E. amygdalina* have been treated here as *E. amygdalina* (i.e. cells 5035, 5036, 5233, 5235, 5237). Recent studies of morphology and ecology indicate that some populations of a 'half-barked' peppermint in the Eastern Tiers, north of Swansea (e.g. cell 5935), are distinct from the southern forms of both *E. amygdalina* and *E. pulchella* (K. Williams, unpublished data). However, the nature of the morphological and ecological distinction between *E. amygdalina* and *E. pulchella* across their full geographic and substrate range requires comprehensive study. Some western occurrences of a peppermint recorded as *E. pulchella* are considered to be misidentifications of *E. nitida* or various intergrading forms between *E. nitida*, *E. coccifera* and *E. amydalina* (i.e. cells 3633, 3945, 4333, 4622, 4723, 4819, 4918, 4919).

KEY REFERENCES: Davidson and Reid (1989); Davidson *et al*. (1987); Kirkpatrick and Marks (1985); Kirkpatrick and Potts (1987); Ladiges *et al.* (1983); Potts and Reid (1983).

*Photo 19.* Eucalyptus pulchella *in heathy dry sclerophyll forest.*

# *Eucalyptus* aff. *radiata*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
none designated

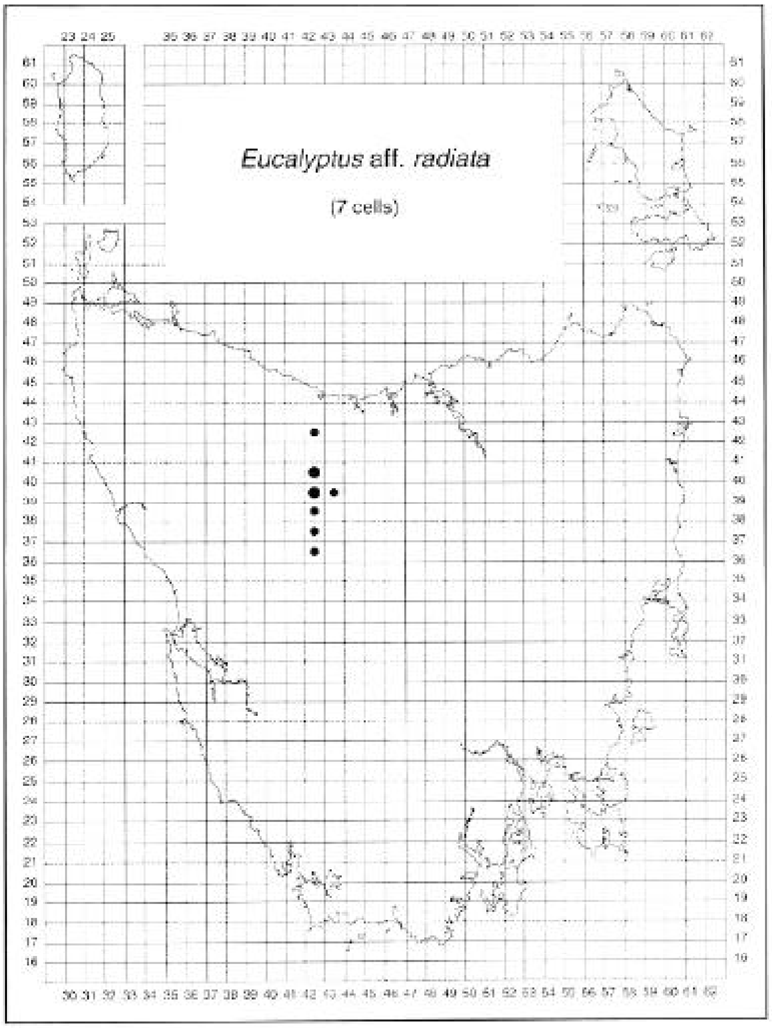



*Figure 59. Distribution of* E. *aff.* radiata *in Tasmania.*

This species has been referred to as *E. radiata* subsp. *robertsonii* by Curtis and Morris (1975), although they indicate that this nomenclature had been questioned by Johnson and Blaxell (1972), and that 'the taxon is considered to be distinct, not yet named, and related to *E. amygdalina*'. Furthermore, in the recent texts by Chippendale (1988) and Boland *et al.* (1984), *E. radiata* subsp. *robertsonii* is not shown to occur in Tasmania. Duncan (1989) considered it sufficiently distinct to warrant recognition as an endemic species. Recent unpublished work on the chemical profile of the population near the Lemonthyme Power Station has indicated that the species has closest affinities to mainland forms of *E. radiata* subsp. *radiata* (D. Rankin, pers. comm. 1995) and recent inspection of the population by M.I.H. Brooker (pers. comm. 1996) also suggests that it would classify within *E. radiata* subsp. *radiata*. Other biochemical work has shown this population to have close affinities to other populations of the Tasmanian *Piperitae* (Li *et al.* 1995), although comparisons were made only amongst Tasmanian species. Until the

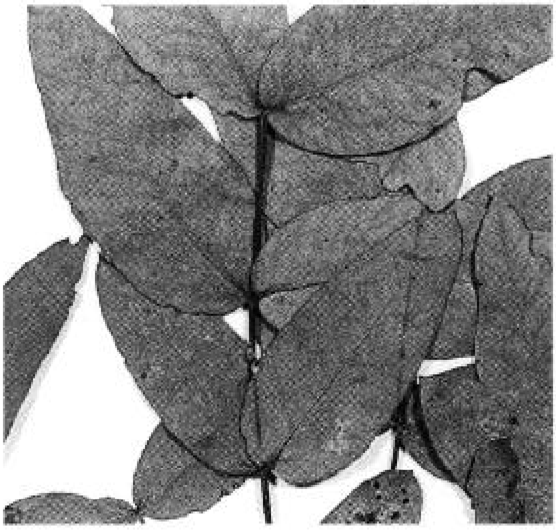


Photo 20. *Juvenile leaves (pressed) of* E. *aff.* radiata.

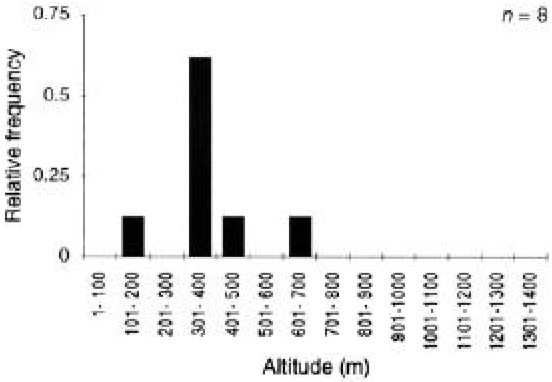



Figure 60. *Altitude distribution of* E. *aff.* radiata.

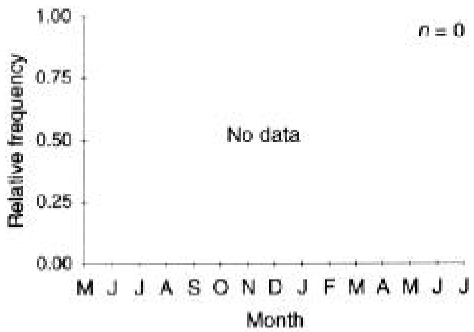



Figure 61. *Flowering times for* E. *aff.* radiata.

taxonomic affinities of this species have been clarified, we have adopted the terminology of '*E.* aff. *radiata'* to indicate uncertainty in the current nomenclature.

*Eucalyptus* aff. *radiata* is rare in Tasmania, having a restricted, remnant distribution in the mid to upper valleys of the Mersey, Forth and Wilmot River systems on well-drained slopes and flats of Ordovician gravels (Figure 59 and cf. Jackson 1965). It may be overlooked as a tall-tree variant of *E. amygdalina*, but the juvenile foliage is distinct, being broad-lanceolate with rounded bases rather than lanceolate or narrow linear (Curtis and Morris 1975) (Photos 20, 21). It generally occurs in a limited altitude range between about 300 m to 400 m (Figure 60) following the availability of suitable habitats. However, an occurrence at 150 m is recorded adjacent to the Wilmot River and it extends up to 610 m, following the Forth River valley. The flowering time of *E.* aff. *radiata* is unknown.

*Eucalyptus* aff. *radiata* occurs as a dominant of shrubby wet or dry sclerophyll forest, or subdominant with *E. obliqua* on the moister sites. It appears to be hybridising with *E. amygdalina* near Croesus Caves (M.J. Brown, pers. comm. 1987). The habitat of *E.* aff. *radiata* is not well known and much of it appears to have been flooded by hydro-electric schemes in the Mersey and Forth River valleys. Some remaining populations have been further disturbed by forestry operations and clearing for agriculture.

COMMENTS: Jackson (1965) mapped occurrences of *E.* aff. *radiata* from the Wilmot, Forth and Mersey Rivers. Most records for the distribution of *E.* aff. *radiata* have come from observations of the most accessible population adjacent to the Lemonthyme Power Station (cell 4239) in the Forth River valley. It also extends along the upper Forth River in the region of the Wolfram Mines (e.g. cells 4236, 4237, 4238), and below the power station adjacent to the Lake Cethana impoundment (cell 4240). Details of the extent of the population near Lake Cethana have been recorded by J. Davies and D. Chester

*Photo 21.* Eucalyptus *aff.* radiata.

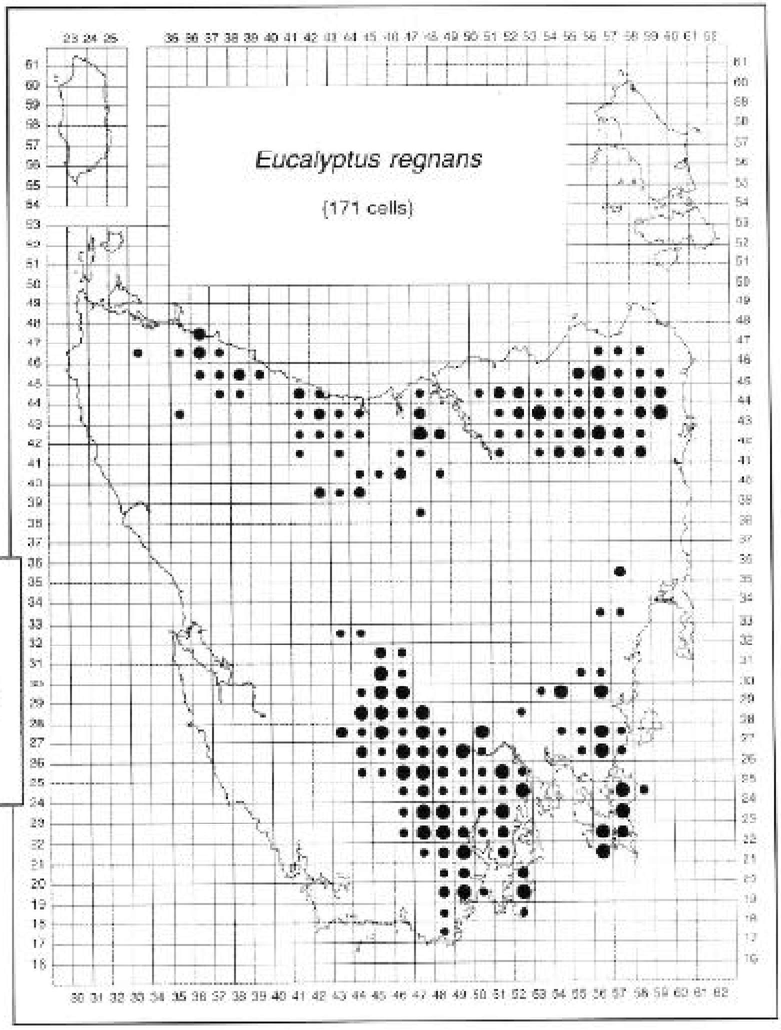
(Forestry Tasmania, unpublished data). Other occurrences are known from the Mersey River valley above Liena, adjacent to Croesus Caves (cell 4339), and in the Wilmot River, below the Iris River tributary (cell 4242). The Leven River has been investigated for occurrences of this species without success (M.J. Brown and K. Williams, unpublished data). Other tributaries of the Forth River (e.g. Dove River) and the Mersey River (e.g. Arm River) may also support stands of *E.* aff. *radiata,* although none was found following a search of the latter (cell 4338) (*loc. cit.*). An unverified outlier has been suggested for the upper Murchison River (cell 4035) by J.B. Davies (pers. comm. 1992), where samples were collected from individuals located on gravel banks in early 1978 and their identity confirmed by W.D. Jackson, although no voucher specimens are available. The uncertain taxonomic status of *E.* aff. *radiata* has probably contributed to it being overlooked by researchers and field surveyors.

KEY REFERENCES: Duncan (1989); Curtis and Morris (1975); Johnson and Blaxell (1972).

# *Eucalyptus regnans*

SUBGENUS: *Monocalyptus*
SERIES: *Obliquae*

Common name:
giant ash



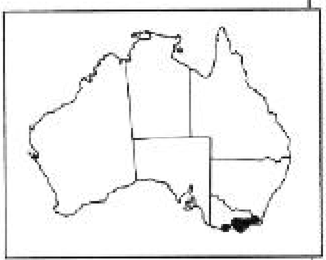



*Figure 62. Distribution of* E. regnans *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus regnans* is widespread in Tasmania, although in a restricted habitat, with major population centres in the north-east and south, and scattered occurrences in the north, north-west and east (Figure 62). It occupies deep, well-drained soils of moist, fertile sites characterised by a low fire frequency. On sites prone to higher fire frequencies, it is replaced by *E. obliqua* and, at higher altitudes, by *E. delegatensis*.

*Eucalyptus regnans* mostly occurs between 200 m and 500 m altitude (Figure 63), reflecting a preference for mesic sites in fire-sheltered aspects of coastal foothills and inland mountain valleys. Occasionally, it extends up to 870 m or down to 20 m. The highest altitude sites (> 600 m) are known from central regions in the vicinity of the upper Florentine and Broad River Valleys, the northern face of the Western Tiers and the north-eastern highlands. The low-altitude occurrences (< 100 m) are mostly recorded from Tasman Peninsula and river valleys of the Southern Forests. The main flowering period for *E. regnans* is February to May, peaking in March and April (Figure 64).

*Eucalyptus regnans* (Photo 22) is a tall, wet forest species, towering above rainforest as a sparse emergent or more densely over tall, mesophytic shrubs. With recorded heights of up to 100 m, it is the tallest flowering plant in the world (Boland *et al.* 1984).

*Eucalyptus regnans* usually occurs in pure stands but may hybridise with *E. obliqua* at ecotonal boundaries (Ashton 1981a). Some hybrids between these two species may appear similar in tree morphology to *E. delegatensis* and may be mistakenly identified as such (M.J. Brown, pers. comm. 1994).

*Eucalyptus regnans* lacks lignotubers and is usually killed by fires of sufficient intensity to burn rainforest or wet forest during infrequent (about 200–300 years), extreme fire-weather events (Gilbert 1959). However, the tree morphology of *E. regnans,* with long, deciduous bark streamers and open crowns, promotes these periodic fires and the species is well adapted for regeneration following fire, with a pulse of regrowth from seed protected in woody capsules retained in the canopy (Cremer 1965a, b, 1966). In the absence of fire (> 300–400 years), rainforest predominates as emergent eucalypts senesce and become locally extinct (Jackson 1968). Natural oldgrowth forests of tall *E. regnans* are prized for their sawn-timber qualities, and considerable provenance-based research has been undertaken to define the physiological and genetic range for forestry purposes (e.g. Rook *et al.* 1980; Wilcox 1982a, b; Griffin 1983; Griffin and Cotterill 1988; Raymond and Volker 1993).

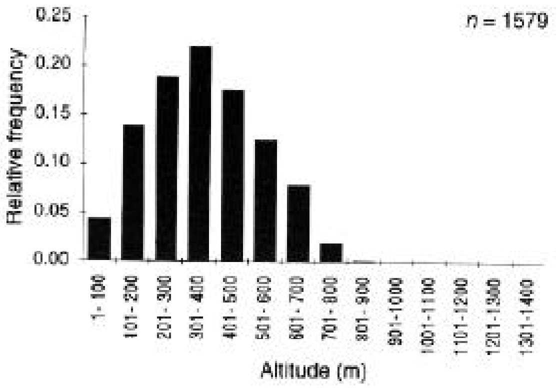



*Figure 63. Altitude distribution of* E. regnans.

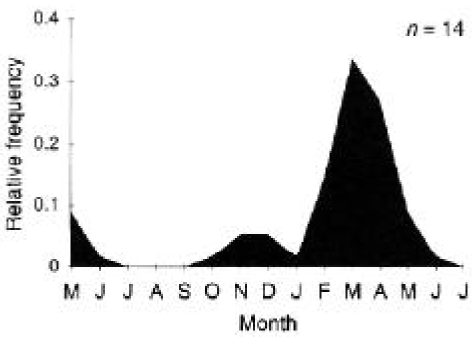



*Figure 64. Flowering times for* E. regnans.

COMMENTS: Throughout the Eastern Tiers, poorly verified, patchy occurrences recorded for *E. regnans* (cells 5735, 5633, 5733), and other unverified outliers in this vicinity (cells 5739, 6037, 5632, 5730), may be indicative of a potential link between population centres in the north-east and south. However, this is not consistent with the distribution suggested by Jackson (1965), and clarification of the distribution of *E. regnans* in the Eastern Tiers region is needed. In the north-west, outliers of the main distribution near Christmas Hills (cell 3446) and Mount Bertha (cell 3543) add credence to the disparate, unverified outliers near the Interview River (cell 3239) and the Huskisson River (cell 3738), suggesting a southern extension of the western range. In the Western Tiers, the putative extension for *E. regnans* in the upper Mersey or Forth River Valleys is unverified (cell 4237). Occurrences from the south-western mountains are also spurious (i.e. cell 4520). *Eucalyptus regnans* is also unverified from central regions north of Tarraleah (cell 4632), the southern Midlands (cells 4930, 5030), coastal hills in the north-east (cell 5145, 5942) and the south-east, on parts of Tasman Peninsula (cells 5521, 5522, 5523, 5623, 5721).

KEY REFERENCES: Ashton (1958, 1975a, b, c, 1976, 1981a, b, c, 1979, 1984); Ashton and Sandiford (1988); Ashton and Turner (1979);

Ashton and Williams (1973); Ashton and Willis (1982); Attiwill (1991); Cremer (1965a, 1966); Cunningham (1957); Dess and Ashton (1982); Eldridge (1965, 1970, 1972); Eldridge and Griffin (1983); Fripp *et al*. (1987); Gilbert (1959); Griffin (1980, 1983); Griffin and Cotterill (1988); Griffin and Eldridge (1980); Griffin and Hand (1979); Griffin *et al.* (1982, 1987); Hallam *et al.* (1989); Hardner and Potts (1995b); Moran *et al*. (1989); Nielson and Pataczeck (1991); Pederick (1976, 1990); Podger *et al.* (1980); Raymond and Volker (1993); Rook *et al.* (1980); Sedgley *et al.* (1989); West (1979, 1981, 1982); Wilcox (1982a, b).

*Photo 22.* Eucalyptus regnans *(giant ash) is the tallest flowering plant in the world, with recorded heights of up to 100 m.*

# *Eucalyptus risdonii*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
Risdon peppermint

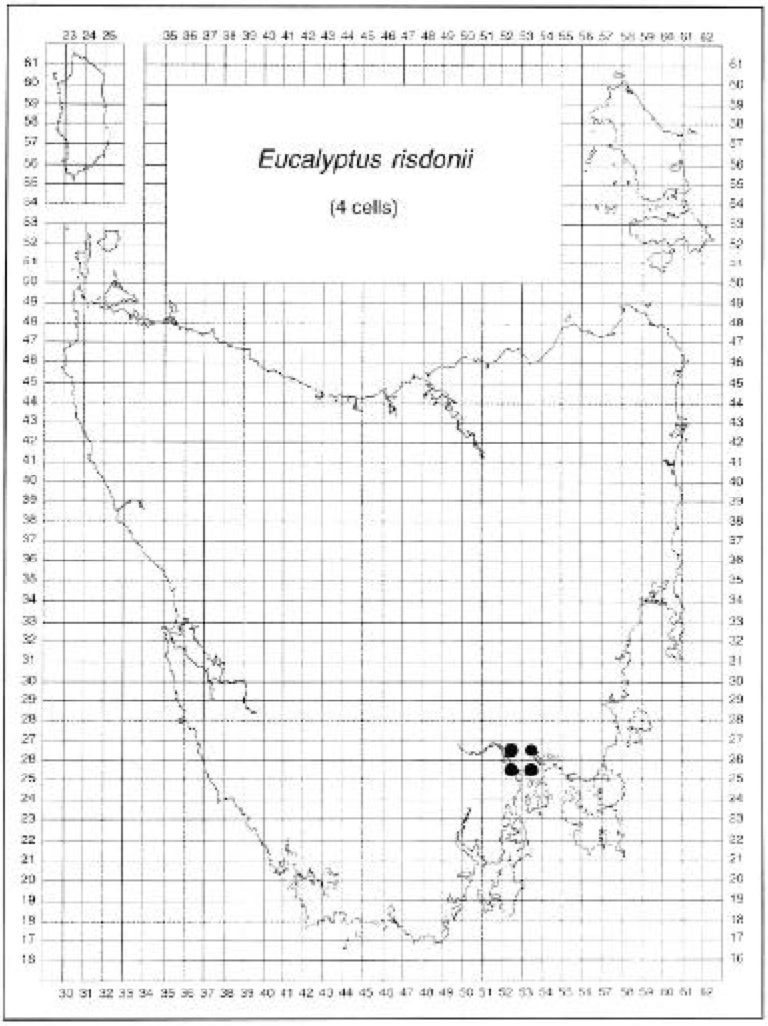



*Figure 65. Distribution of* E. risdonii *in Tasmania.*

*Eucalyptus risdonii* is a rare endemic species of low open forest, with a limited, localised distribution in a relatively uniform habitat in south-eastern Tasmania (Figure 65). It occurs as numerous, small, disjunct populations on very sunny ridges and north-west facing upper slopes of the Meehan Range and associated northern foothills adjacent to the Derwent River estuary. It grows in drought-prone, shallow, Permian mudstone soils which become relatively impermeable to water after prolonged periods of low rainfall, locally exacerbating the duration and intensity of drought. *Eucalyptus risdonii* is closely related to and clinally intergrades with *E. tenuiramis* where populations are geographically contiguous on the Meehan Range. The genetic variation between reproductively mature individuals of *E. risdonii* which retain the connate, juvenile leaf morphology and *E. tenuiramis* which bears petiolate, adult leaves is small and continuous in this transitional area (Wiltshire *et al.* 1991a, 1992).

*Eucalyptus risdonii* is a lowland species occurring predominantly below 200 m altitude to near sea-level (2 m) at Bedlam Walls, and with localised occurrences up to 280 m on the Meehan Range (Figure 66). Its main flowering period is from August to December, peaking in October and November (Figure 67).

*Eucalyptus risdonii* is locally dominant in relatively small areas of low open forest and woodland. It occurs as a small tree or mallee shrub, the latter being a deflection from the tree form due to frequent, low-intensity fires and subsequent coppice regeneration from lignotubers (Photo 23). *Eucalyptus viminalis* may be present as a minor species. *Eucalyptus amygdalina* forms a more-or-less continuous population surrounding the disjunct *E. risdonii* patches. Hybridisation between these two closely related species is common in localised areas (Potts 1986; Potts and Reid 1985c). The potential evolutionary significance of hybridisation as a gene dispersal mechanism is discussed by Potts and Reid (1988). The conservation role of such hybrid zones in maintaining insect biodiversity has also been considered (e.g. Whitham *et al.* 1991, 1994).

*Photo 23. Coppice regeneration in* E. risdonii.

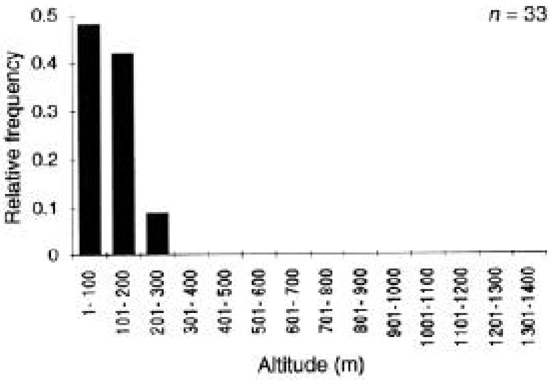



*Figure 66. Altitude distribution of* E. risdonii.

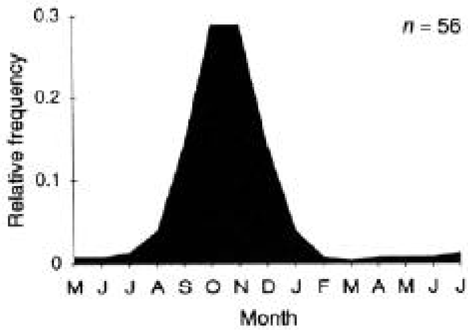



*Figure 67. Flowering times for* E. risdonii.

COMMENTS: The natural distribution of *E. risdonii* is known only from four contiguous grid cells (Figure 65). A western extension along the Derwent River (cell 5126) needs verification. Many of the location errors for *E. risdonii* actually represent records for *E. tenuiramis*, being either misidentifications of geographically intergrading forms or old herbarium collections reflecting early names for *E. tenuiramis* that had not been updated (i.e. cells 5026, 5027, 5125, 5133, 5223, 5328, 5329, 5424, 5622, 5723). Records of *E. risdonii* from Bruny Island, Southport Lagoon and other south-eastern coastal sites (e.g. cells 4918, 5219, 5221, 5321) most probably represent *E. tenuiramis* individuals which have developed floral buds on juvenile, epicormic foliage due to salt and wind pruning of exposed branches.

KEY REFERENCES: Brown and Bayly-Stark (1979b); Hogg and Kirkpatrick (1974); Kirkpatrick and Nunez (1980); Ladiges *et al.* (1983); Potts (1986, 1988); Potts and Reid (1985c, 1988, 1990); Pryor and Briggs (1981); Whitham *et al.* (1991, 1994); Wiltshire (1991); Wiltshire *et al.* (1989, 1991a, 1992).

# *Eucalyptus rodwayi*

SUBGENUS: *Symphyomyrtus*
SERIES: *Ovatae*

Common name:
black swamp gum

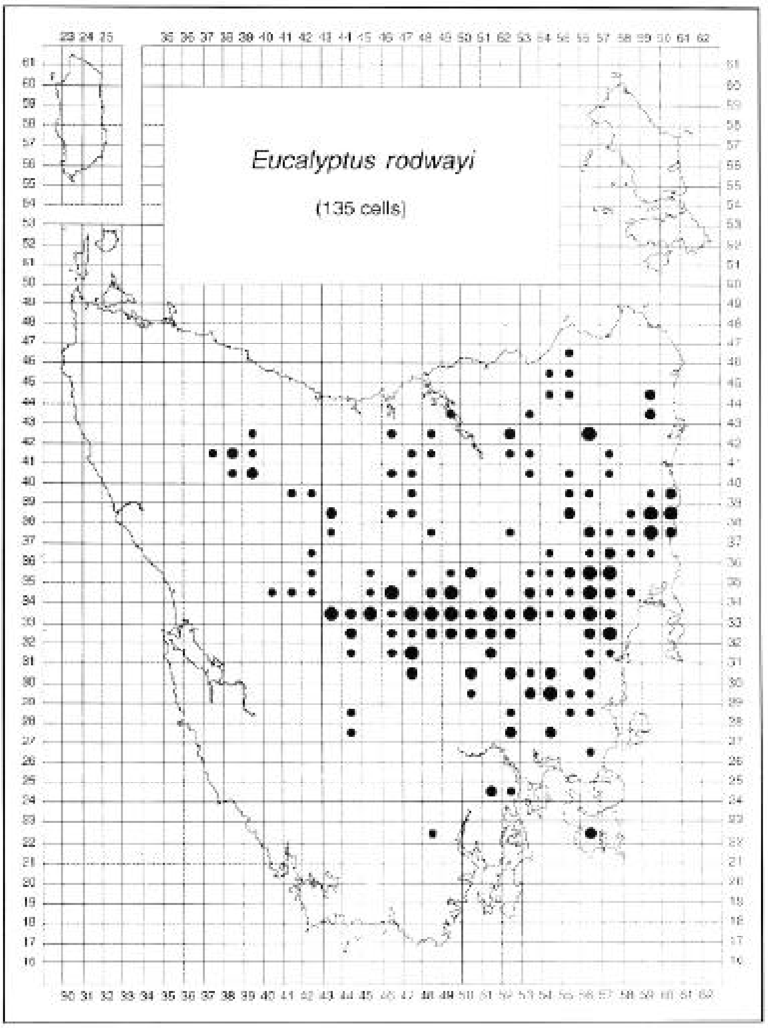



*Figure 68. Distribution of* E. rodwayi *in Tasmania.*

*Eucalyptus rodwayi* is a widespread endemic species scattered throughout inland areas of northern, eastern and central Tasmania (Figure 68). It occurs locally on poorly drained, upper valley flats, or on plateaux subject to seasonal waterlogging where severe frosts and cold-air drainage generally preclude *E. ovata*. It grows as a medium to small tree or mallee shrub depending on fire frequency and the severity of frost and waterlogging.

*Eucalyptus rodwayi* is predominantly a mid- to high-altitude species in the range from 300 m to 800 m (Figure 69), occasionally extending up to 1120 m, or down to 60 m (Table 3, p. 124). Low altitude sites (< 300 m) are widespread throughout northern, north-eastern, eastern and south-eastern regions, and generally reflect subcoastal plains and hollows exposed to seasonal frosts or cold-air drainage. The high-altitude sites (> 800 m) are recorded from the southern to south-eastern Central Plateau, the Eastern Tiers and the north-eastern highlands. The outlying high-altitude record (1120 m) is known from near the scarp of the Western Tiers at Westons Rivulet. The broad distribution and associated altitude profile for *E. rodwayi* is reminiscent of the patterns observed for *E. pauciflora* which follows the stepped topography from coastal to subcoastal hills and plains to inland mountain regions. The main flowering period of *E. rodwayi* is between November and May, peaking from January to March (Figure 70).

*Eucalyptus rodwayi* occurs as a dominant of grassy and sedgey woodlands. Grassy communities develop where waterlogging is less severe and fertility is sufficient to favour the dominance of grasses in the understorey. Such sites, especially in lowland situations, are relatively arable in summer and many have been drained, cleared and converted to pasture. In poorly drained, upland situations, *E. rodwayi* often forms pure stands, or may occur as scattered individuals on the edge of buttongrass moorland. In woodlands or open forests at the margins of plains where drainage improves and cold-air effects are less severe, *E. rodwayi* may co-exist with an ash species (*E. delegatensis* or *E. pauciflora*) or peppermint (*E. amygdalina* or *E. coccifera*). Other white gums such as *E. dalrympleana*, *E. gunnii*, *E. archeri* or *E. urnigera* may also co-occur with *E. rodwayi* in the transition from woodland to open forest on the Central Plateau (Jackson 1973). *Eucalyptus ovata* co-occurs with *E. rodwayi* in some ecotonal situations at the lower altitudes where the effects of frost and cold-air drainage are less severe.

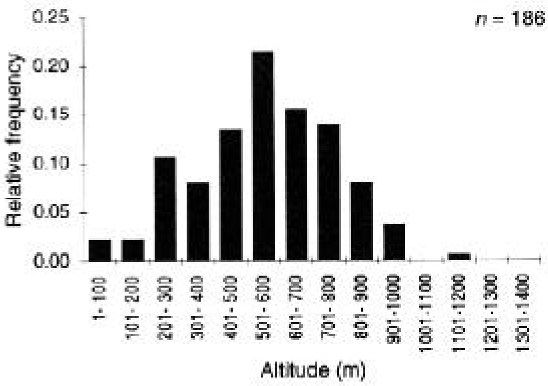



*Figure 69. Altitude distribution of* E. rodwayi.

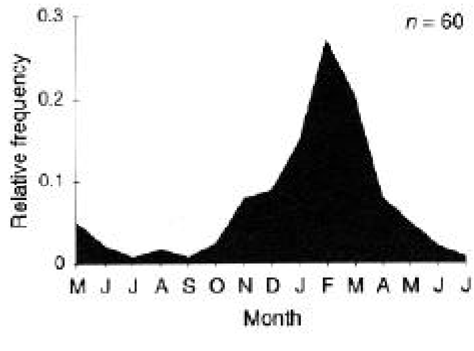



*Figure 70. Flowering times for* E. rodwayi.

COMMENTS: Putative occurrences of *E. rodwayi* that are not adequately verified were removed from the map to emphasise the need for further study. For example, in the far north-west, an unverified outlier near Montagu Swamp (cell 3245) would greatly extend the western range of *E. rodwayi* and may represent a remnant stand that has been cleared. However, it could equally be a misidentification of a form which intergrades with *E. ovata* or *E. brookeriana.* Similarly, intergrading forms of *E. rodwayi* are known from localised populations near Guildford (M.I.H. Brooker, pers. comm. 1996) and may be reflected in the unverified outliers in this region (cells 3839, 4041). Other putative occurrences to the south of the Lyell Highway also require further investigation (cells 3832, 3932, 4429). There are also numerous unverified occurrences for *E. rodwayi* in the central highlands (cells 4138, 4233, 4238, 4334, 4532, 4734, 5031), the north-eastern highlands (cells 5440, 5441, 5442, 5443, 5542, 5640, 5739), the Midlands (cells 5336, 5431) and on the east coast (cell 6036). Many of these unverified records are derived from the endemics atlas (Brown *et al.* 1983) and may be rediscovered in the course of future surveys. The ecological and morphological differences between forms of *E. rodwayi* in the central highlands and the Eastern Tiers also require study.

KEY REFERENCES: Baker and Smith (1912); Jackson (1973); Ladiges *et al.* (1984); Paton (1980).

# *Eucalyptus rubida*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
candlebark

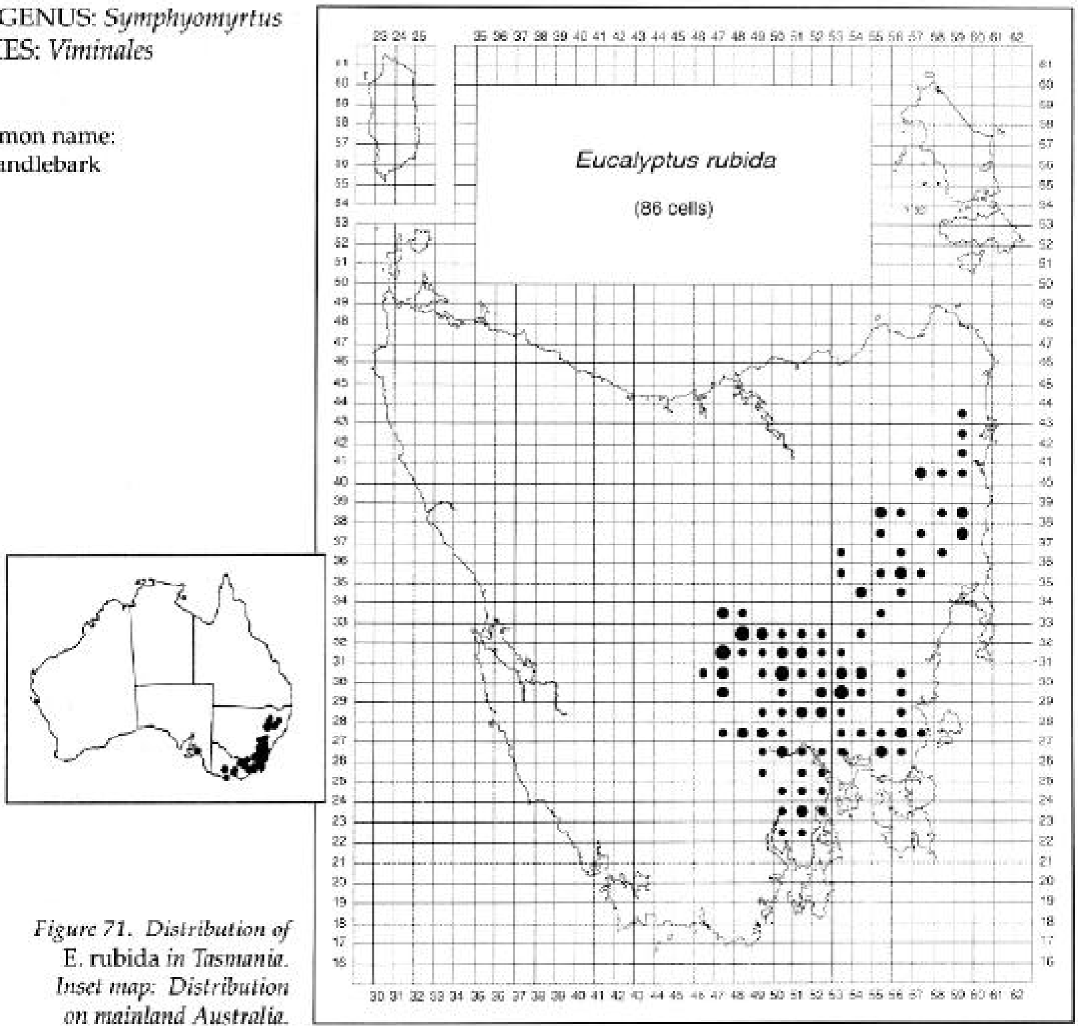



*Figure 71. Distribution of* E. rubida *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus rubida* has a sparse distribution throughout the cooler, inland regions of eastern and south-eastern Tasmania (Figure 71). It generally occurs on shallow, dry, relatively infertile soils derived from Triassic or Permian sediments of the southern Midlands and Derwent Valley, or on Jurassic dolerite where the mid slopes of hills and the lower surfaces of the Eastern Tiers support shallow, rocky or well-drained soils. These sites are not only dry but are seasonally prone to extended periods of frosts and cold-air drainage.

*Eucalyptus rubida* is a mid-altitude species, predominant in the range from 200 m to 600 m (Figure 72), but extends up to 880 m at Den Hill, east of Bothwell, and down to 90 m near Lynbrae in the Coal River Valley. The high altitude sites (> 600 m) are generally known from the southern Midlands in the vicinity of Bothwell, and among the southern foothills of Ben Lomond in the north-east. The low altitude sites (< 200 m) generally occur in subcoastal foothills and open valleys of the south-east, particularly the lower Huon, Derwent and Coal Rivers. The upper and lower altitude occurrences may also reflect intergradation with *E. dalrympleana* and *E. viminalis* respectively. *Eucalyptus rubida* replaces *E. viminalis* on the inland sites subject to frost and cold-air drainage, and may intergrade with *E. dalrympleana* on wetter sites at higher altitudes. Few data are available on the flowering time of *E. rubida,* but existing observations record flowering mainly between November and January, peaking in December and January (Figure 73).

*Eucalyptus rubida* is typically a subdominant tree of dry sclerophyll communities. It occurs sporadically in heathy open forest and grassy woodlands with one of the peppermints, *E. amygdalina, E. pulchella, E. tenuiramis* and occasionally *E. coccifera,* or the ash species *E. pauciflora,* depending on substrate type, altitude and the severity of the cold, mountain winds. In the southern Midlands and Derwent Valley, the grassy woodlands in particular, and much of the heathy forest, are remnant stands (Fensham 1989; Fensham and Kirkpatrick 1989), which are subject to disturbance by selective logging, rough grazing or further clearing. Remnant trees of *E. rubida* in paddocks are obvious for their attractive appearance with pink or red patches on the bark and broadly spreading branches. The originally sparse population densities of this species appear to have exacerbated the extent of local extinctions across parts of its range.

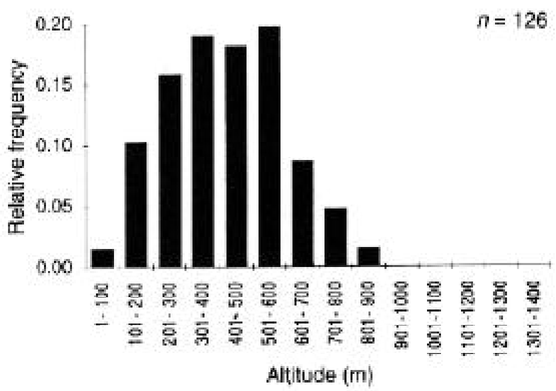



*Figure 72. Altitude distribution of* E. rubida.

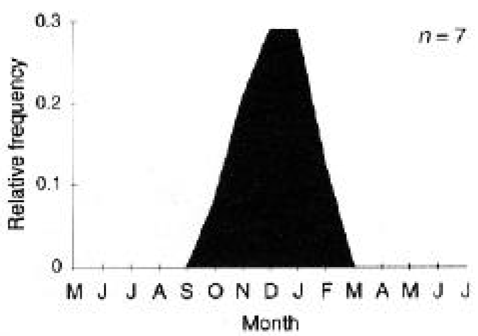



*Figure 73. Flowering times for* E. rubida.

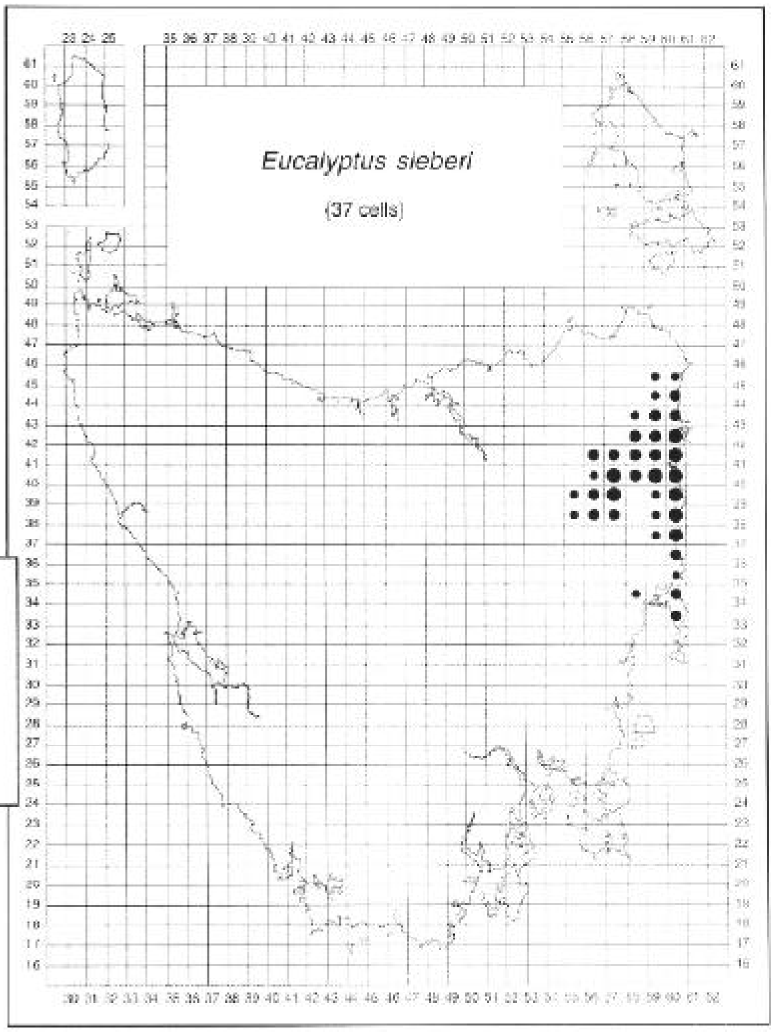
COMMENTS: Several unverified outliers for *E. rubida* occur to the north (cell 4140) and west (cells 4232, 4333) of the main distribution. These are most likely to be misidentifications of *E. dalrympleana,* although future verifications of *E. rubida* should not be discounted. The unverified high-altitude outliers for *E. rubida* from the eastern Central Plateau (cells 4934, 5035) and Eastern Tiers (cell 5736) are also likely to represent misidentifications of *E. dalrympleana.* However, unverified outliers from Tasman Peninsula in the south-east (cells 5522, 5524) and in the east near Tooms Lake (cell 5732) may represent occurrences of *E. rubida* but require confirmation. The identity of remnant trees in paddocks, particularly the isolated individuals and stands (lacking regeneration and vulnerable to dieback), throughout the Midlands and the Derwent Valley may further contribute to the known range of *E. rubida* and provide important basic information for ecological studies (Photo 30, p. 134). There is currently a dearth of information relating to specific genetic or ecological aspects of this species in Tasmania.

KEY REFERENCES: Boland *et al.* (1984); Fensham (1989); Fensham and Kirkpatrick (1989); Kirkpatrick *et al.* (1988a); Parsons (1986); Pryor and Dadswell (1964).

# *Eucalyptus sieberi*

SUBGENUS: *Monocalyptus*
SERIES: *Obliquae*

Common name:
ironbark



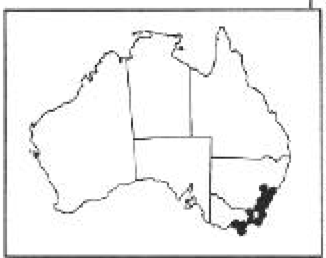



*Figure 74. Distribution of* E. sieberi *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus sieberi* is local and extensive in the north-east and along the east coast. It grows in scattered populations from Freycinet Peninsula to north of St Helens and inland along the mountains and hills that rim the northern side of the Fingal Valley (Figure 74). It occurs on undulating to steep terrain of the comparatively infertile, fine-grained Ordovician sediments (Mathinna beds) and dry, coastal hills of Devonian granite origin. It is also found, to a lesser extent, on Jurassic dolerite in the northern coastal hills of the Eastern Tiers.

*Eucalyptus sieberi* is predominantly a lowland species but broadly occupies suitable habitats of the mid and low altitudes below 650 m (Figure 75). Sites near sea-level (10 m) occur locally in coastal areas between Coles Bay and St Helens. The high altitude sites (> 600 m, up to 720 m) generally occur along the more inland margins of the distribution between Rossarden and Mathinna, among the southern and eastern foothills of Ben Lomond and Tower Hill. The flowering time of this species is poorly known but appears to occur mainly between September and

March, peaking in October and November (Figure 76).

*Eucalyptus sieberi* is a dominant species of dry sclerophyll forest supporting shrubby or heathy understoreys. However, bare gravels and simplified understoreys are more typical of *E. sieberi* forests as a result of frequent, low intensity fires in recent history (Neyland and Askey-Doran 1994). It typically forms uneven-aged, monospecific stands across much of its range on the driest sites of Mathinna substrates. *Eucalyptus viminalis* is present as a minor species or subdominant on the lower slopes and frequently dominates the gully habitats. *Eucalyptus globulus* is occasionally present as a minor species. *Eucalyptus sieberi* frequently co-exists ecotonally with *E. amygdalina* on granites and dolerite, and intermediates between these two species were previously described as the separate taxon, *E. taenifolia* (Baker and Smith 1912). These plants are now recognised as hybrids (Jackson 1958; Pryor and Johnson 1971; Curtis and Morris 1975). With increasing moisture, such as in drainage lines and on the cooler, sheltered aspects, *E. sieberi* is replaced by *E. obliqua* as the dominant species.

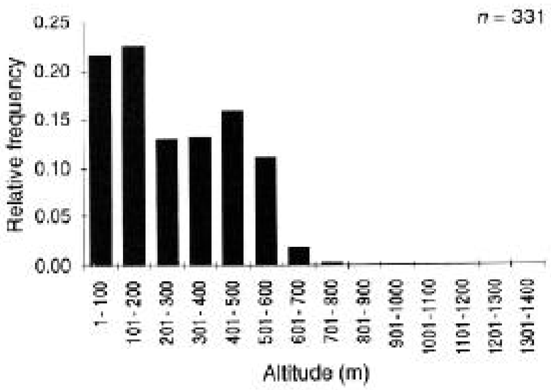



*Figure 75. Altitude distribution of* E. sieberi.

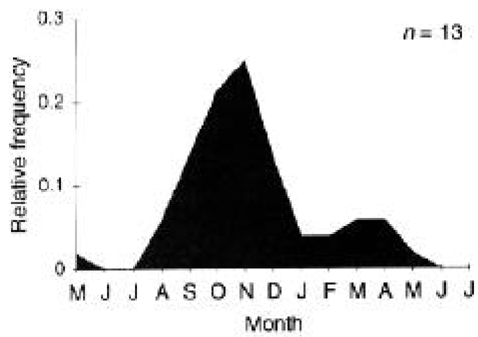



*Figure 76. Flowering times for* E. sieberi.

*Eucalyptus sieberi* has a characteristic straight-boled stem on many sites in Tasmania, with deeply furrowed bark extending onto the larger limbs, and smooth, white upper branches.

COMMENTS: The distribution of *E. sieberi* suggests a minor 'gap' in the central region of occurrences around the Fingal Valley and adjacent forest areas (cells 5838 and 5839). Locations around the upper South Esk River valley may not include suitable habitats, but the forested slopes of Mount Foster to the south of the Fingal Valley may contain unreported occurrences of *E. sieberi*. A recently verified record near Cranbrook (cell 5834) extends the southern limits of *E. sieberi* (S. Harris, pers. comm. 1992; M. Neyland, pers. comm. 1994). In the far north-east, an outlier from State forest south of Gladstone (cell 5845; D. Allen, unpublished data) cannot be verified by recent studies (M. Neyland, pers. comm. 1995). An old herbarium record with the location given as 'Scottsdale' (e.g. cell 5444; collected by J.M. Firth in 1931) is also unverified.

KEY REFERENCES: Austin *et al.* (1983); Bachelard (1986a, b); Baker and Smith (1912); Eldridge (1965); Gibson and Bachelard (1986a, b, 1987, 1988); Jackson (1958); Lambert and Turner (1983); Neyland and Askey-Doran (1994).

# *Eucalyptus subcrenulata*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
alpine yellow gum

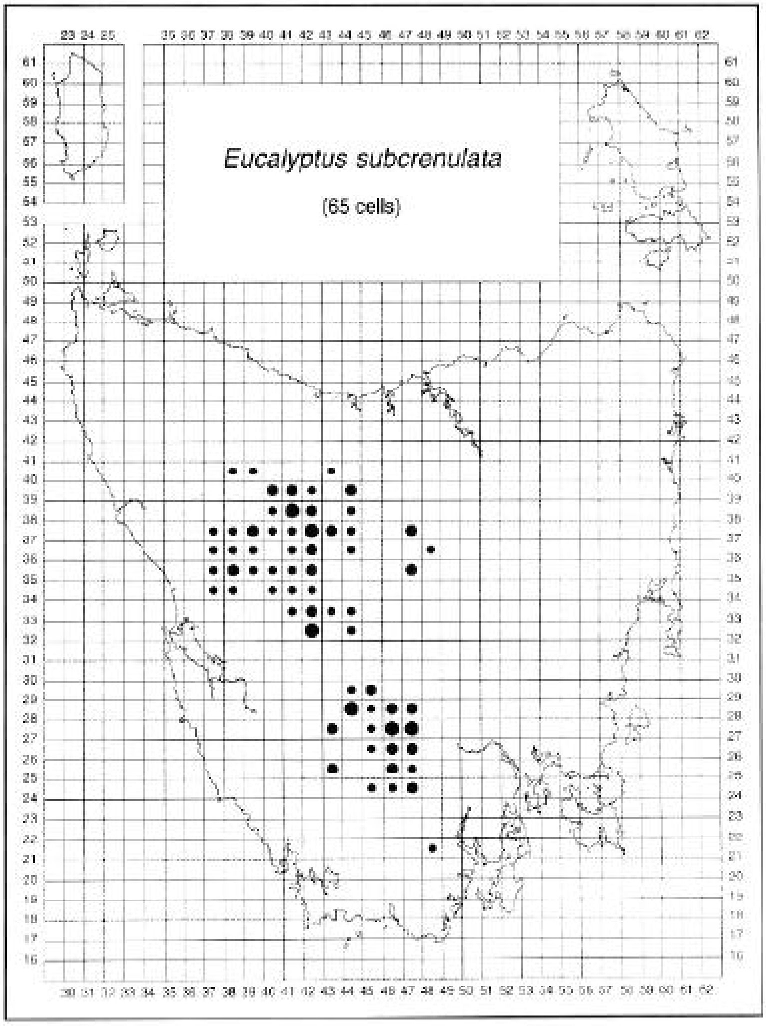



*Figure 77. Distribution of* E. subcrenulata *in Tasmania.*

*Eucalyptus subcrenulata* is an endemic, subalpine, yellow-gum species of the west and central mountain regions (Figure 77). It grows on well-drained, exposed, rocky ridges, gully slopes and stony plateaux where dolerite screes form over sandstone bedrock, or on the margins of poorly drained flats and soakages. It forms a geographic cline with *E. johnstonii* towards the south-east and is clinally replaced by *E. vernicosa* in the exposed, alpine situations on western and south-western mountains. Intermediates between *E. subcrenulata* and *E. vernicosa* have been informally classified as the cline-form *'parvula'* by Jackson (1960).

*Eucalyptus subcrenulata* occurs at altitudes between 550 m and 1180 m but is found mostly from 700 m to 1100 m (Figure 78). The lower altitude sites (< 700 m) are largely known from the south-western margins of the distribution. The higher altitude sites (> 1100 m) are from the Western Tiers, the eastern Central Plateau and Mount Field. The main flowering period is from January to April, peaking between January and March (Figure 79).

*Eucalyptus subcrenulata* occurs as a small tree emergent over subalpine rainforest, or as a sub-dominant or co-dominant with *E. delegatensis* in montane wet forest with rainforest or tall shrub understoreys. It also occurs with *E. coccifera* in the more exposed subalpine woodlands.

COMMENTS: Some inconsistencies exist between verifiable records for the distribution of *E. subcrenulata* and the mapped occurrences of Jackson (1965). In the latter, *E. subcrenulata* is shown to extend into the south-western mountain regions, which is consistent with clinal intergradation with *E. vernicosa*, but there are no data available to verify this trend apart from records from the Hartz Mountains (cell 4821). The altitudinal cline-form *'parvula'* (*sensu* Jackson 1960) may also confuse the disjunction between *E. subcrenulata* and *E. vernicosa* in other western and north-western mountain regions. Similarly, in the geographic zone of intergradation between *E. subcrenulata* and *E. johnstonii*, there is considerable confusion in distinguishing either taxon due to the intermediate cline-form informally termed *'columnaris'* by Jackson (1960). For the convenience of mapping, unverified occurrences centred in either region are allocated to the predominant species. At Snug Plains (cells 5122, 5123), for example, records for *E. subcrenulata* are considered to be misidentifications of *E. johnstonii* as the population is regenerating from the 1976 fire. Records from Quoin Mountain (cell 5229) and Mount Wellington (cell 5125) are treated as misidentifications of *E. johnstonii*.

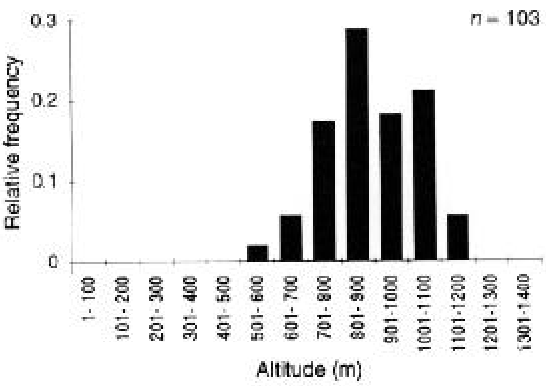



*Figure 78. Altitude distribution of* E. subcrenulata.

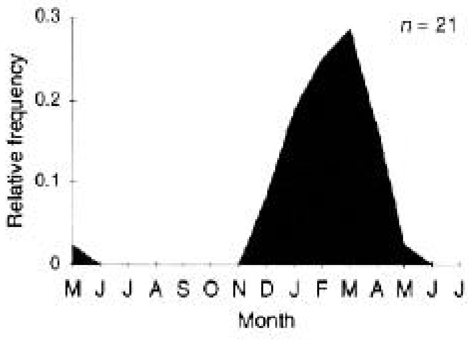



*Figure 79. Flowering times for* E. subcrenulata.

On the Central Plateau, most of the locations for *E. subcrenulata* occur west of Great Lake, although isolated populations are known from the east (e.g. cells 4735, 4737, 4836). Unverified outliers for *E. subcrenulata* are widespread in many locations throughout the eastern Central Plateau. Some of these may represent misidentifications of *E. archeri*, a species which occasionally exhibits yellow-green streaked bark (i.e. cells 4738, 4837, 4936, 5135). Other putative occurrences require further verification (i.e. cells 4533, 4634, 4635, 4734, 4832, 4833, 4935, 5034, 5035). There is a need to verify the extent of *E. subcrenulata* in the eastern Central Plateau as additional isolated populations almost certainly exist in this region.

Several other records on the northern or western margins of the distribution are also unverified (i.e. cells 4141, 4331, 4634). An outlier suggested for Gog Range (cell 4540) also needs verifying. Unverified outliers of *E. subcrenulata* in the north-east (cells 5442, 5540, 5741) are likely to be misidentifications of *E. archeri*. An unverified outlier in the Eastern Tiers, near Lucks Lookout (cell 5837) also needs checking but is likely to represent a misidentification of some other *Symphyomyrtus* species.

KEY REFERENCES: Jackson (1960); Li *et al.* (1996); Potts and Jackson (1986).

# *Eucalyptus tenuiramis*

SUBGENUS: *Monocalyptus*
SERIES: *Piperitae*

Common name:
silver peppermint

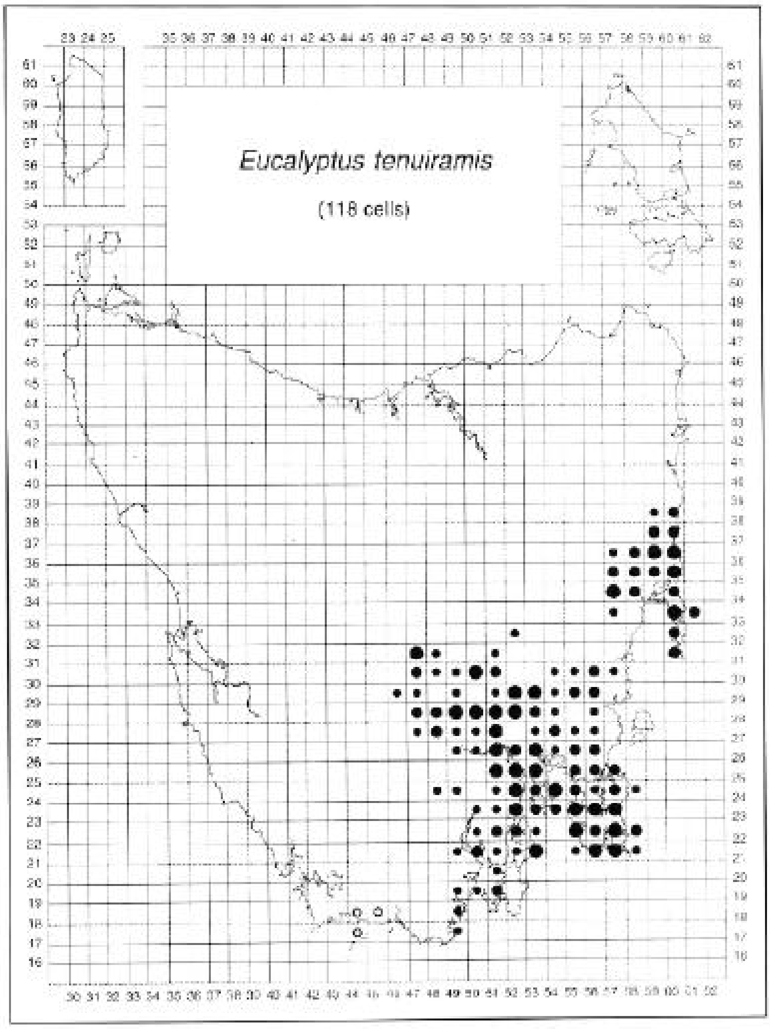



*Figure 80. Distribution of* E. tenuiramis (●) *and* E. *aff.* tenuriamis (○) *in Tasmania.*

*Eucalyptus tenuiramis* (Photo 24) is an endemic species, locally common in south-eastern and eastern Tasmania (Figure 80) on relatively sunny sites subject to moderate drought stress. It typically occurs on sedimentary substrates derived from mudstone, sandstone or quartzite gravels in the south-east and southern Midlands but shifts to substrates of igneous origin towards the east, occurring on Jurassic dolerite in the Eastern Tiers, or Devonian granites on the east coast near Freycinet Peninsula. *Eucalyptus tenuiramis* is a highly variable species, with populations on the east coast and in some coastal areas being quite different from the typical populations in the south-east. In the Hobart region, *E. tenuiramis* clinally intergrades with *E. risdonii* in the height of transition to adult foliage, flowering precocity and juvenile leaf shape (Wiltshire *et al.* 1991a, 1992; Wiltshire and Reid 1992).

*Eucalyptus tenuiramis* is predominantly a lowland species in the altitude range from near sea-level to 600 m, with rare occurrences up to 700 m (Figure 81). The altitude range of the eastern and south-eastern populations of *E. tenuiramis* is very similar. The low-altitude records generally occur in coastal localities and the high-altitude records in more inland regions. For example, the highest altitude records (> 600 m) are known from Yarlington Tier in the southern Midlands, and on Tom Legges Tier in the Eastern Tiers. The main flowering period is from November to February, peaking from November to January (Figure 82).

*Eucalyptus tenuiramis* is a frequent dominant of dry sclerophyll forest across its range, usually in association with other eucalypts. Grassy *E. tenuiramis* forests and woodlands occur typically on free-draining mudstone sediments in coastal and hinterland areas of the south-east near Hobart and the D'Entrecasteaux Channel region. Heathy *E. tenuiramis* open forests are widespread on free-draining sandstone sediments associated with the drier, colder inland climates of the southern Midlands and Derwent Valley, or on eastern coastal granites near Freycinet Peninsula. Shrubby *E. tenuiramis* forests occur locally in eastern Tasmania from Tasman Peninsula to the central east coast. They are found on the seaward foothills of the Eastern Tiers and other upland shelves where Jurassic dolerite forms lower slopes and flats with a moderate rock cover and free to slightly impeded drainage. Populations of *E. tenuiramis* also occur on the better drained sites in wet heathland and sedgeland on Tasman Peninsula and in the south-east near Southport Lagoon.

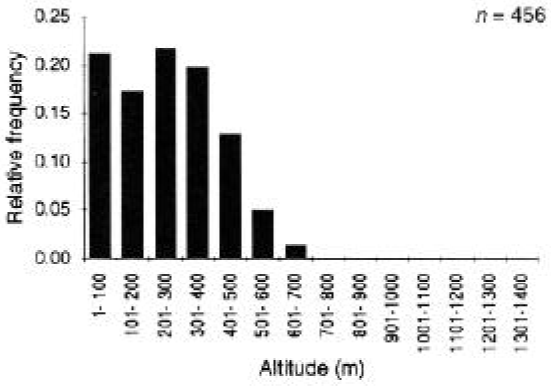



*Figure 81. Altitude distribution of* E. tenuiramis.

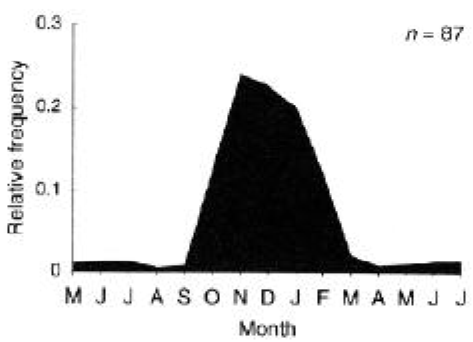



*Figure 82. Flowering times for* E. tenuiramis.

*Eucalyptus tenuiramis* forms sharp ecotonal transitions and narrow hybrid zones with the other lowland peppermints, *E. pulchella* or *E. amygdalina,* in the south-east across dolerite–mudstone or mudstone–sandstone substrate boundaries respectively. In the east on dolerite, the ecotonal transitions and hybrid zones between *E. tenuiramis* and these other peppermints are much broader, in parallel with the more subtle changes in substrate water relations. *Eucalyptus obliqua* may occur with *E. tenuiramis* on ecotonal sites as moisture availability increases, and it co-exists with *E. pauciflora* on dry inland sites subject to cold-air drainage. *Eucalyptus viminalis* is a frequent subdominant or minor species throughout the range of *E. tenuiramis, E. globulus* may be present on shaded slopes, or *E. rubida* on sites subject to the passage or pooling of cold air.

COMMENTS: There appears to be a major disjunction in the range of *E. tenuiramis* in the vicinity of the central east coast. However, this disjunction may partially reflect under-sampling in the intervening regions, and requires confirmation. Several unverified outliers occur in the vicinity of this disjunction around the Little Swanport River, Tooms Lake and the Macquarie River (e.g. cells 5533, 5633, 5732). Adjacent unverified low altitude outliers for *E. coccifera* (< 200 m) may actually represent *E. tenuiramis* (e.g. cells 5533, 5631). The two populations studied

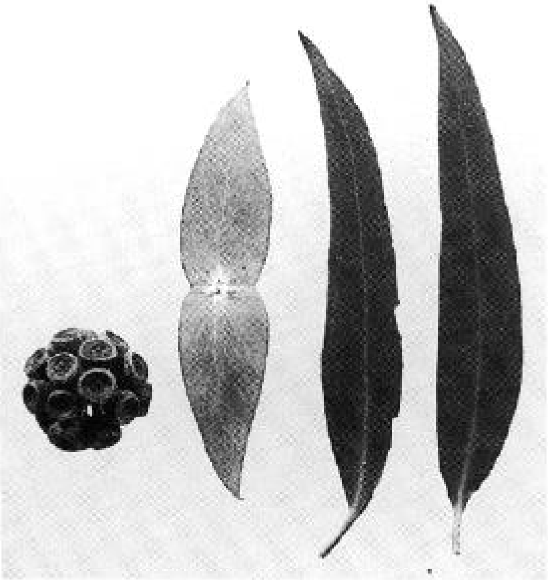


*Photo 24. From left, capsules, juvenile leaves and adult leaves of* E. tenuiramis.

from the northern distribution (cf. Bicheno and Friendly Beaches) differ markedly in juvenile morphology from the typical southern population (Wiltshire *et al.* 1991a). However, whether this difference is characteristic of the northern distribution or is a reflection of a substrate difference (granite versus mudstone / sandstone or dolerite) is unknown at present. Another unexpected gap in the distribution of *E. tenuiramis* is Maria Island, where there are large patches of both Jurassic dolerite and Permian sediments. No verified occurrences of *E. tenuiramis* are known from the low foothills and flats of the St Pauls or Esk River Valleys, or in the north-east (e.g. cells 5539, 5540, 5737, 5738, 5739, 5838).

In the southern Central Plateau, there are persistent unverified outliers for *E. tenuiramis* between Lake Echo and Arthurs Lake (cells 4634, 4734, 4733), suggesting the existence of a small, high-altitude population. A high-altitude population which is intermediate between *E. coccifera* and *E. tenuiramis* is known to occur on the nearby Alma Tier (cell 5033; Shaw *et al.* 1984; Wiltshire *et al.* 1991a, 1992) and this may be representative of the unverified location near Lake Sorell (cell 5133; Brown *et al.* 1983). However, records from the vicinity of Great Lake are likely to represent misidentifications of *E. coccifera* (cell 4737).

In the far south (Figure 80), a glaucous peppermint occurs near Louisa Bay and on the Red Point Hills (cells 4417, 4418, 4518). These populations occur at relatively low altitudes (40–120 m) in small forest and scrub copses surrounded by buttongrass moorland (K. Williams and J. Marsden-Smedley, unpublished data). They appear to have close affinities with *E. tenuiramis* which is known to occur in a similar buttongrass-plains habitat associated with peaty substrates or from the better drained knolls at Cape Pillar (cells 5721, 5821) and Southport Lagoon (cells 4918, 4919). However, this glaucous peppermint may also have affinities with *E. coccifera*. Further study is needed to verify the identity of these populations and other southern records for *E. tenuiramis* (i.e. cell 5118).

Putative occurrences of *E. tenuiramis* from the Broad River Valley (cell 4628) and the catchment of the Plenty River (cell 4825) are on the western margins of the distribution and require verification, although occurrences are known from the adjacent Repulse River catchment (cell 4629) and Lonnavale (cell 4824). Extensions to the Midlands distribution of *E. tenuiramis* are known from Monks Sugarloaf (cell 5131; F. Duncan, pers. comm. 1995) but are otherwise unverified from the western face of the Eastern Tiers, adjacent to the northern Midlands (e.g. cell 5635). Other reported occurrences of *E. tenuiramis* beyond these south-eastern and eastern range limits (i.e. cells 3647, 3742, 4043, 4138, 4432) are likely to be misidentifications of other peppermints or their intergrading forms.

Glaucous forms of a peppermint from Flinders Island and Cape Barren Island (i.e. cells 5853, 5856, 5857, 5952) ascribed either to glaucous forms of *E. nitida* (S. Harris, pers. comm. 1993; R. Gaffney, pers. comm. 1996) or *E. tenuiramis* (Whinray 1977) require investigation.

KEY REFERENCES: Ladiges *et al.* (1983); Shaw *et al.* (1984); Wiltshire (1991); Wiltshire *et al.* (1991a, 1992); Wiltshire and Reid (1992).

# *Eucalyptus urnigera*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
urn gum

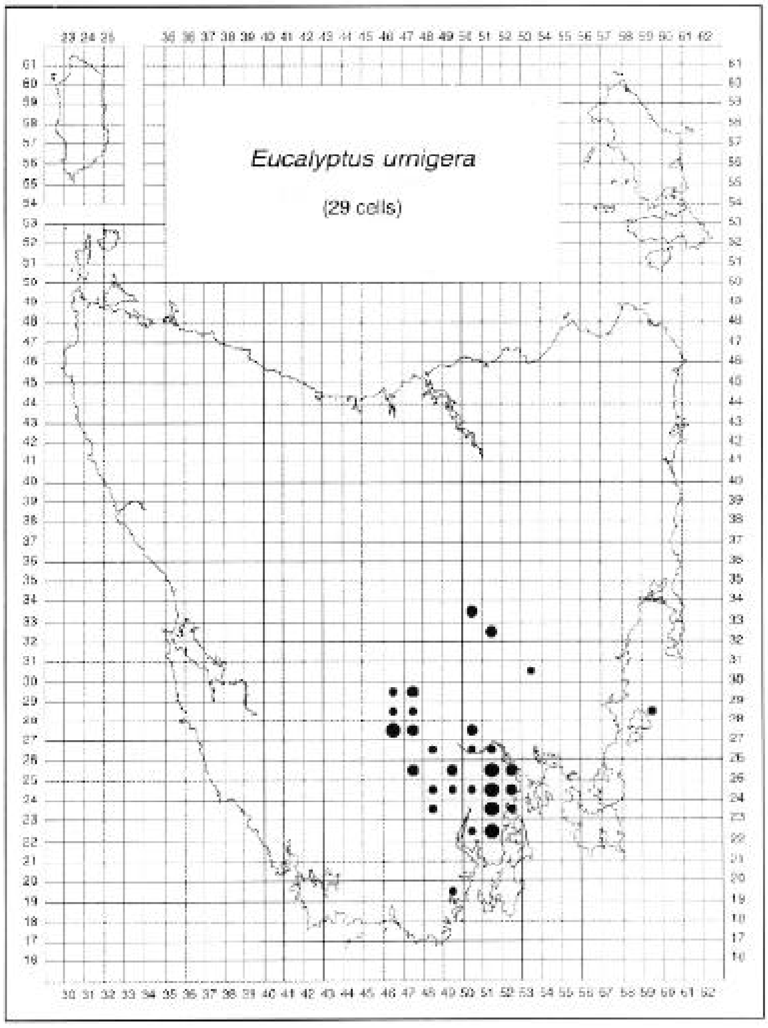



*Figure 83. Distribution of* E. urnigera *in Tasmania.*

*Eucalyptus urnigera* (Photos 25, 26) is an endemic species of mountains and plateaux of the south-east and the southern Central Plateau (Figure 83) where it occurs on well-drained, rocky dolerite soils. Isolated, disjunct populations also occur in the southern Midlands at Mount Seymour, on Maria Island, and in the south at Tylers Hill.

*Eucalyptus urnigera* is a subalpine species predominant in the altitude range from 600 m to 1000 m (Figure 84), but may extend up to 1160 m on Mount Wellington and down to 420 m at Tylers Hill. On Mount Wellington, a stepped, intraspecific cline in adult and juvenile leaf glaucousness occurs with increasing altitude (Barber and Jackson 1957). Juvenile leaves are uniformly glaucous near the tree-line, and green at the lower altitudinal range. Corresponding with this cline from green to glaucous leaves is a steep cline in flowering time (Savva *et al.* 1988). *Eucalyptus urnigera* has a broad flowering period from March to November, and is the only subalpine eucalypt flowering during winter, peaking from May to August (Figure 85). This broad

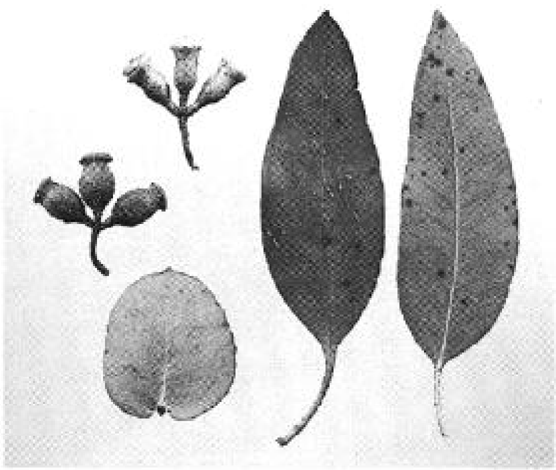


*Photo 25. Leaves of* E. urnigera*, and the urn-shaped fruit and buds, from which the species derives its scientific and common names.*

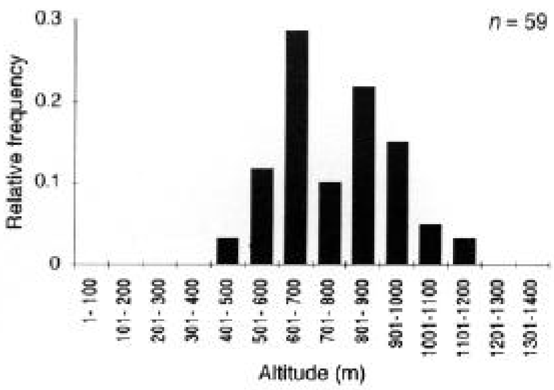



*Figure 84. Altitude distribution of* E. urnigera.

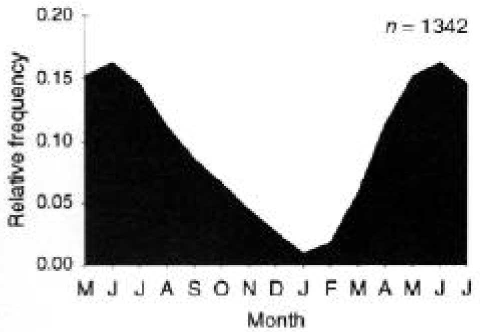



*Figure 85. Flowering times for* E. urnigera.

range in flowering time may, in part, be due to the lower temperatures slowing rates of flower development, coupled with clinal variation in flowering time (e.g. Potts and Reid 1985a). On Mount Wellington, for example, the peak flowering time of the low-altitude, green populations of *E. urnigera* is over three months earlier than the high-altitude, glaucous populations (Savva *et al.* 1988). This difference in flowering time would act as a barrier to pollen-mediated gene flow along the stepped cline in leaf glaucousness (see also Potts and Reid (1985a) for *E. gunnii–archeri*).

*Eucalyptus urnigera* occurs as a shrub, or small tree with numerous low branches, on exposed rocky slopes where it may be the principal species subdominant to *E. coccifera* in subalpine woodland (Photo 26). In wet sclerophyll forest, it attains a moderate size and straight form, growing as a subdominant tree with *E. delegatensis*. It may also co-exist ecotonally with *E. johnstonii* or *E. subcrenulata* on mountains of the south-east, as the substrate becomes dominated by sandstone. Potts and Reid (1985b) suggest that *E. urnigera* and southern populations of *E. gunnii* would have co-existed during the last glacial, but parapatric populations of the two species have remained discrete and are reproductively isolated by a shift in flowering time and a divergence in reproductive characters. *Eucalyptus urnigera* occurs in close proximity to or ecotonally with *E. gunnii* on the Alma Tier.

COMMENTS: The distribution and morphological types of *E. urnigera* are well known from the Hobart region and Derwent Valley, but persistent records from the south-eastern Central Plateau and the Eastern Tiers are less well studied. For example, the population from Alma Tier (cell 5033) is highly glaucous and differentiated from southern populations in both morphology and habit, having smaller capsules (Potts and Reid 1985a, b). A probable location at Lake Crescent (cell 5132) has also been included in the mapping, but requires further verification. There are persistent records for *E. urnigera* at other Central Plateau sites west of these locations

*Photo 26.* Eucalyptus urnigera *in subalpine forest.*

(cells 4733, 4734, 4833, 4931, 4933, 4934, 4935, 4936, 5035, 5036). Some of these may represent misclassification of a low altitude variant of *E. gunnii* (e.g. morphs resembling the *'E. divaricata'* type; Potts and Reid 1985a), with a tendency toward urn-shaped fruits. However, an unverified population of *E. urnigera* in the vicinity of Tunbridge Tier (cell 5233; Brown *et al.* 1983) may have affinities with the Alma Tier form. Voucher collections are needed to clarify this occurrence.

A population of *E. gunnii* from the vicinity of Snow Hill (cells 5635, 5636) and *E. cordata* from Brown Mountain (cell 5428) have some morphological affinities with *E. urnigera.* The isolated population of *E. urnigera* on the eastern side of Maria Island (cell 5928) is of the green phenotype (M.J. Brown, pers. comm. 1993), and an adjacent location (cell 5927) is also likely but is unverified. A recently reported occurrence of *E. urnigera* from Mount Seymour in the southern Midlands (cell 5330; F. Duncan, pers. comm. 1995) adds credence to a nearby unverified outlier (cell 5128; Brown *et al.* 1983). Other localised occurrences in the southern Midlands may also be discovered in the future.

Occurrences of *E. urnigera* have not been verified from the north-east (cells 5243, 5341, 5638), or from Tasman Peninsula in the south-east (cell 5622) which is probably a mistaken location from an old herbarium record for Mount Arthur on the Wellington Range (cell 5125). The most southerly known occurrence of *E. urnigera* is from Tylers Hill (cell 5019) where hybridisation with *E. globulus* and *E. johnstonii* occurs (W.D. Jackson, unpublished manuscript). The extensive occurrences of *E. urnigera* in the far south-east (e.g. Mount La Perouse, Hartz Mountain, Bruny Island, Tasman Peninsula) indicated by Jackson (1965) have not been verified.

KEY REFERENCES: Barber (1956, 1965); Barber and Jackson (1957); Paton (1980, 1981); Potts and Jackson (1986); Potts and Reid (1985a, b); Savva *et al.* (1988); Thomas and Barber (1974a, b).

# *Eucalyptus vernicosa*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common name:
varnished gum

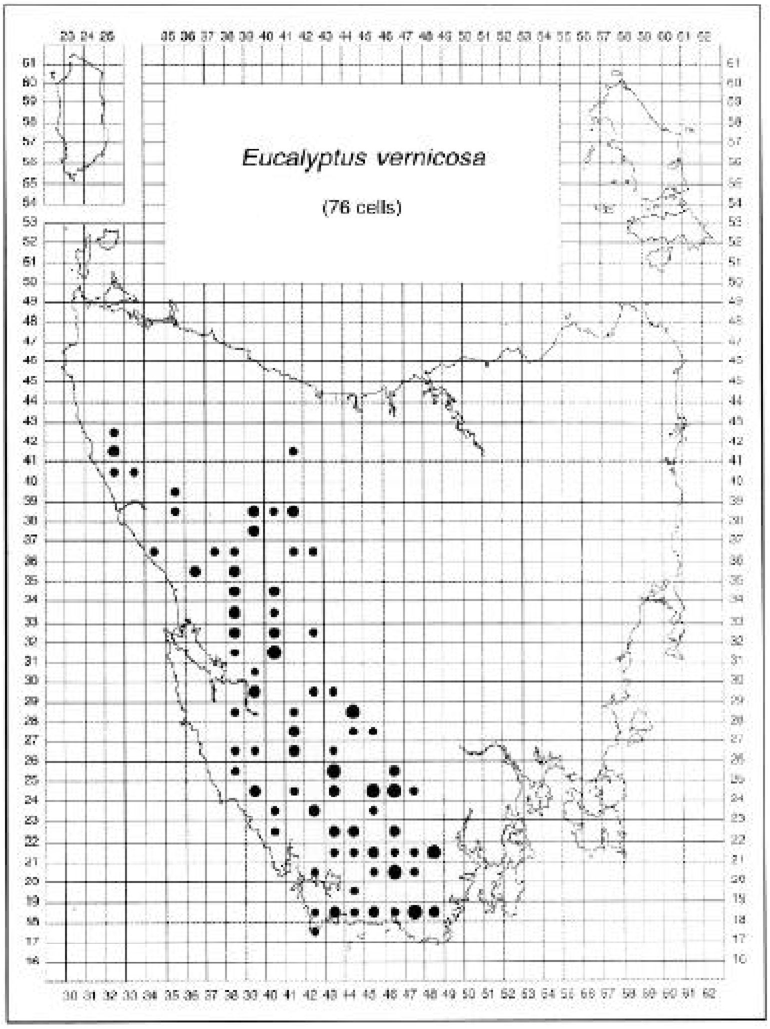



*Figure 86. Distribution of* E. vernicosa *in Tasmania.*

*Eucalyptus vernicosa* is a localised endemic species of the western and south-western mountain regions (Figure 86). It occurs as a small, stunted tree or, more typically, as a shrub on steep, exposed upper slopes or poorly drained alpine plateaux. It grows in peat soils, usually developed over quartzite, sandstone or granite bedrock. It is part of the altitudinal and geographic cline in the yellow gums, intergrading with *E. subcrenulata* on western subalpine mountains where intermediates have been informally referred to as the cline-form *'parvula'* (Jackson 1960).

*Eucalyptus vernicosa* usually grows at altitudes between 700 m and 1000 m (Figure 87), a range which is superficially similar to that of *E. subcrenulata* but is climatically more alpine due to the south-west to north-east trend in the altitude of the tree-line (e.g. Kirkpatrick 1982). For example, in the far south-west, *E. vernicosa* occurs in exposed alpine habitats at altitudes as low as 600 m but, around the eastern margins of its range, it normally occurs above 1000 m and up to 1250 m near Frenchmans Cap. Lower altitude occurrences (240–600 m) are known from the climatically exposed knolls and ridges of subcoastal hills, such as in the Norfolk Range and Heemskirk River regions in the west, Mount Osmond in the south-west, and the Red Point Hills and the foothills of the Ironbound Range in the south. Its main flowering period is from December to April, peaking between January and February (Figure 88).

*Eucalyptus vernicosa* is the only eucalypt consistently found above the tree-line where it forms a low mallee shrub in alpine coniferous scrub and heathland communities (Photo 29, p. 126). It is found occasionally as a dwarf tree in the more protected rocky, leeward slopes. Phenetic variation in tree size of *E. vernicosa*, with increasing exposure to the alpine environment, is coupled with a decrease in leaf size and increase in lamina thickness,

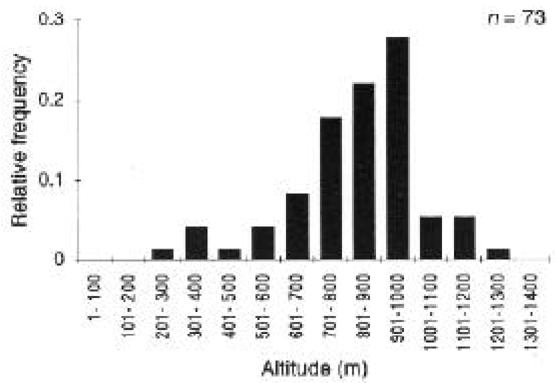



*Figure 87. Altitude distribution of* E. vernicosa.

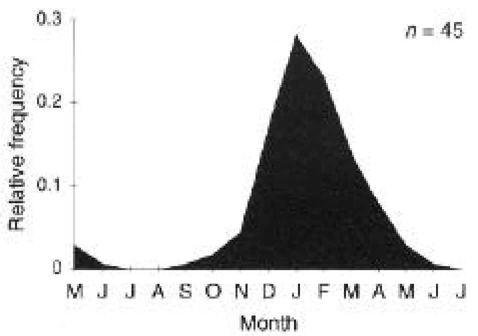



*Figure 88. Flowering times for* E. vernicosa.

and the retention of juvenile or intermediate foliage at reproductive maturity (Jackson 1960; Potts and Jackson 1986). This is a common adaptive response to the alpine environment.

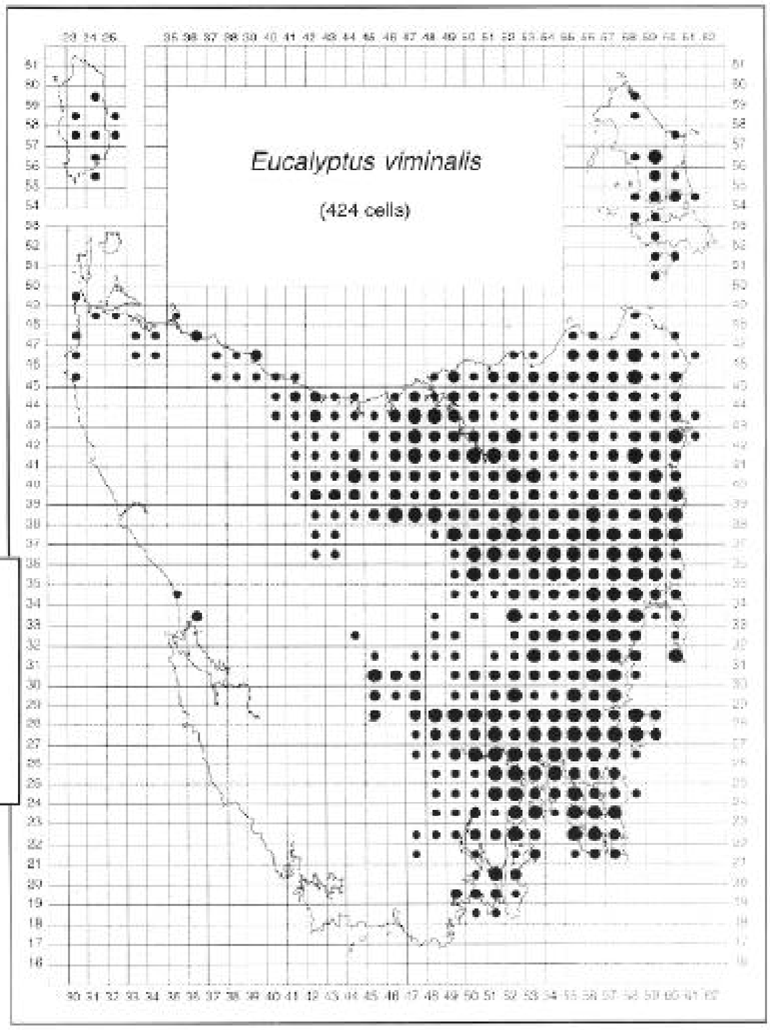
COMMENTS: Along the eastern boundary of the *E. vernicosa* distribution, such as in the vicinity of Black Bluff (cell 4141), and Mount Pelion East and Mount Pelion West (cells 4136, 4236), the identity of the yellow gum is uncertain due to clinal variation. However, it is considered to be *E. vernicosa* where sandstone outcrops occur in the alpine environment, and to be *E. subcrenulata* on dolerite colluvium, in accord with the known substrate preferences of these two species in this region and their position with respect to the altitudinal cline. *Eucalyptus vernicosa* has not been recorded on the Western Tiers, although W.D. Jackson (pers. comm. 1992) suspects that it may be there. In the far north-west, it is known from relatively low altitudes (300–600 m) near the Norfolk Ranges (cells 3241, 3242, 3340), presumably due to exposure to the prevailing westerly and south-westerly weather. Recent observations of *E. vernicosa* on low granite outcrops from the Heemskirk River locality (cell 3436, 470 m altitude, S. Mattingly, pers. comm. 1995) add credence to the other low altitude records from these western coastal hinterlands. Verified, low-altitude occurrences of *E. vernicosa* are also known from herbarium specimens collected near the summit of Mount Osmond (350 m; cell 3825) and from Red Point Hills (240 m; cell 4418). Some unverified outliers on the eastern margins of the *E. vernicosa* distribution are likely to represent misidentifications of *E. subcrenulata* (cell 4737 from the Western Tiers; cells 4727, 4627 from the Mount Field region) or *E. johnstonii* (cells 5124, 5125 from the Wellington Range). Other occurrences from western and south-western Tasmanian mountains are expected to extend the verified distribution of this species when detailed surveys are undertaken in the remoter regions (e.g. unverified cells 3837, 3927, 4039, 4123, 4219, 4222, 4224, 4240, 4420, 4429, 4725).

KEY REFERENCES: Jackson (1960); Potts and Jackson (1986).

# *Eucalyptus viminalis* subsp. *viminalis*

SUBGENUS: *Symphyomyrtus*
SERIES: *Viminales*

Common names:
white gum
manna gum



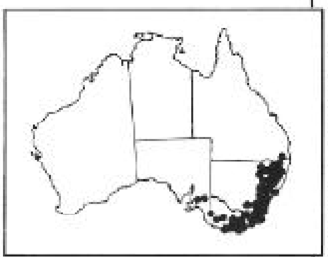



*Figure 89. Distribution of* E. viminalis *in Tasmania. Inset map: Distribution on mainland Australia.*

*Eucalyptus viminalis* is widespread throughout lowland coastal and inland environments of northern, eastern and southern regions and the Bass Strait islands (Figure 89). It grows on relatively fertile, rocky, occasionally drought-prone or well-drained sites and riverine corridors. It is largely absent from the oligotrophic environments of the west and south-west, and intergrades with *E. dalrympleana* in the upland areas of the Central Plateau, Eastern Tiers and north-eastern highlands. Observations in Tasmania suggest that continuously varying, clinal intermediates are the most common form of *E. viminalis*, with typical *E. viminalis* and *E. dalrympleana* occurring only at the end points of the cline (Phillips and Reid 1980). In inland regions of the east and south-east, *E. viminalis* also intergrades with *E. rubida* on dry, infertile sites subject to frost and cold-air drainage.

*Eucalyptus viminalis* is predominant at altitudes below 600 m to near sea-level (Figure 90), but may extend up to 940 m in the highlands of the north-east. Other high altitude occurrences (> 600 m) are more typically found in northern regions such as the Western Tiers and Cluan Tier, and occasionally on Fingal Tier and the adjacent Eastern Tiers. In these highland regions, *E. viminalis* may be confused with *E. dalrympleana*. The main flowering period is November to April, peaking in February and March (Figure 91).

*Eucalyptus viminalis* rarely forms pure stands, but may dominate grassy (Photo 28) and shrubby dry sclerophyll forests and woodlands in drought-prone habitats in south-eastern Tasmania. Forest stands dominated by *E. viminalis* that occurred throughout the alluvial valleys of the Midlands and northern coastal hinterlands have been extensively cleared (M.J. Brown, pers. comm. 1995). *Eucalyptus viminalis* is usually subdominant or co-dominant with other eucalypts from the subgenus *Monocalyptus* in wet and dry sclerophyll forest. In wet sclerophyll forest, it has been observed to dominate stands on the drier, rocky dolerite sites of the lower slopes of the Western Tiers but more typically occurs as a subdominant species with *E. obliqua*. It varies in form from a tall tree up to 90 m in some north-eastern wet forests (e.g. the 'White Knights' (Photo 2, p. 46) in Evercreech Forest Reserve) to a mallee shrub in coastal heathland. Where it occurs as a minor species in dry sclerophyll forests, it frequently forms an emergent crown over the more continuous canopy of peppermint eucalypts (i.e. *E. amygdalina, E. pulchella* or *E. tenuiramis*).

COMMENTS: In Tasmania, it is frequently difficult to distinguish the taxonomic limits of

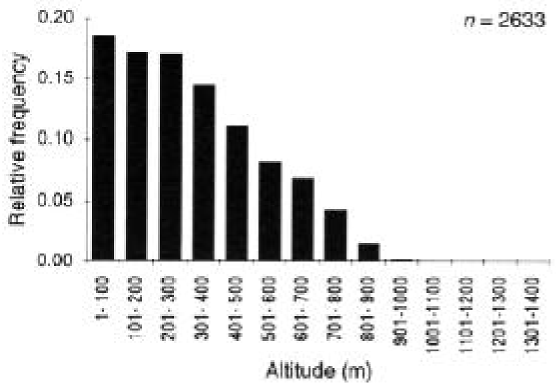



*Figure 90. Altitude distribution of* E. viminalis.

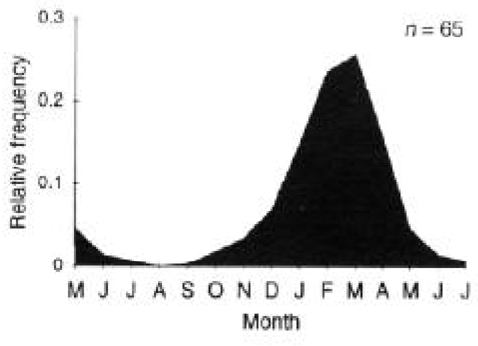



*Figure 91. Flowering times for* E. viminalis.

*Photo 27. Manna on a trunk of* E. viminalis *(manna gum) produced in response to feeding by the redeye cicada,* Psaltoda moerens *(top, left).*

*E. viminalis* and *E. dalrympleana* because of continuous variation between the two (e.g. Maiden 1918; Barber 1955, 1956; Phillips and Reid 1980). The white-gum subgroup of the series *Viminales* is largely absent from western regions (Figures 21, 71, 89). However, some western outliers of *E. viminalis* occur near Strahan and the Henty River sand dunes (cells 3534, 3633), and other scattered outliers exist along the coast in the far north-west and around Smithton (e.g. cells 3045, 3049, 3347). The extent of *E. viminalis* on the west coast and the exact affinity of these forms to *E. viminalis* and *E. dalrympleana* require further study. One extreme, unverified outlier is recorded from inland forest of the north-west, near the Huskisson River (cell 3739), which may be indicative of a similar habitat to that of the south-western outliers adjacent to the Picton River (cells 4721, 4722). Unverified outliers from the southern Central Plateau are likely to reflect intergrading forms with closer affinities with *E. dalrympleana* (i.e. 4433, 4532, 4535, 4631, 4632, 4731, 4733, 4933). Glaucous-leaved *E. viminalis* plants have been observed in localities such as New Norfolk, Snug and Nugent (F. Duncan, pers. comm. 1994). It is not clear whether these intermediates are clinal or hybrids with *E. rubida*, or a result of adaptation of populations of *E. viminalis* to local dry sites.

KEY REFERENCES: Almeida *et al.* (1994); Duncan (1981); Higa (1986); Ladiges (1974a, b, 1977); Ladiges and Ashton (1974, 1977); Paton (1972, 1980); Phillips and Reid (1980); Pryor (1955); Valentini *et al.* (1990); Withers and Ashton (1977).

*Photo 28.* Eucalyptus viminalis *in grassy dry sclerophyll forest, its form markedly different from that seen under more favourable conditions (see Photo 2, p. 46).*

## Results and discussion

*Sampling range of the distribution data*

Eucalypts have been recorded in 757 of the 837 grid cells that cover Tasmania, King Island and the Furneaux Group of islands (Table 3). The number of eucalypt records per cell indicates the relative levels of sampling intensity between regions (Figure 92). For example, the greatest number of records is from the central east coast region where detailed transect studies were undertaken for multiple-use forest management zoning prior to the proclamation of a National Park (e.g. Blakesley and McDonald 1989). In this region, one grid cell may have as many as 2000 eucalypt records (e.g. cell 5937), and surrounding cells may be represented by 500 records or more. Nearly 60% of all cells in which eucalypts are recorded are represented by 20 or more records and relatively few cells (10.4%) contain only one or two eucalypt records. Gaps in the database, where eucalypts are expected to be present, are particularly apparent in coastal and inland localities of the west and south-west. Other isolated database omissions are indicated for coastal areas of the far north-west and north-east, and some parts of King Island. Apart from western regions, reduced sampling relative to other localities is evident for the Midlands, the central north-west and the Central Plateau, and coastal plains of the north-east and on Flinders Island. Records of eucalypt occurrences for some of these locations may exist but are uncollated. Conversely, these may represent real absences for eucalypts due to extreme environments or following the clearing of forests and woodlands for agriculture.

The data are derived from over 450 different sources, including published and unpublished articles or reports, numerous personal communications, and recent herbarium collections. Up to 29 different sources have been collated for any one grid cell (e.g. cells 5224, 5225). One-quarter of the cells with eucalypt occurrences are represented by three or less sources and 30% of the cells are represented by ten or more sources (Figure 93). The cells with many different sources represent the most accessible locations or specific localities and regions of economic or botanical significance. In particular, these include parts of the Eastern Tiers and the south-east near Nugent, Tasman Peninsula, southern Bruny Island and Snug, Mount Field National Park, the Southern Forests, the Western Tiers, the West Tamar and parts of the central north coast. In the south-east, for example, numerous independent studies of eucalypts have been undertaken close to Hobart (e.g. Barber 1955; Hogg and Kirkpatrick 1974; Ratkowsky and Ratkowsky 1976, 1977, 1982; Brown and Bayly-Stark 1979a; Kirkpatrick and Marks 1985; Potts 1986; Potts and Reid 1983, 1985c; Davidson and Reid 1985, 1987, 1989; Davidson *et al.* 1987; Gilfedder 1988; Wiltshire *et al.* 1991a, b, 1992; Pyrke and Kirkpatrick 1994), and herbarium records abound for the Wellington Range.

*Eucalypt species richness*

Eucalypt species richness, defined as the number of species recorded for each 10 km x 10 km grid cell, is given in Figure 94. There is clearly much greater species richness in eastern regions than western regions of Tasmania, with concentrations on the central east coast and in the south-east. Approximately 12% of the cells in which eucalypts have been recorded contain at least one-third of the Tasmanian taxa, and 12 of these cells contain 15 or more species. There is a noticeable paucity of eucalypt species in the south-west, and this is unlikely to change with increased sampling.

Species richness will be a function of several factors including environmental heterogeneity within a grid cell and adequacy of surveying. There are, for example, local concentrations of species richness around the Mount Field National Park and Cradle Mountain National Park that could reflect greater sampling than elsewhere, although both centres are also on geological transition zones. In other regions, such as the Midlands, the north and north-eastern coastal plains, parts of the Central

*Table 3. Summary statistics for altitude range, flowering times, eucalypt presence and aggregation. For altitude, figures given for the minimum, maximum, mean and standard deviation are in metres a.s.l. and the means and standard deviations are rounded to the nearest 10 m. The number of records used to calculate the altitude statistics is given by* 'n'. *The flowering times are given in months as the 5–95% range and the 25–75% interquartile range. Aggregation is calculated as the percentage of the number of grid cells in which a species is present and the number of grid cells within the envelope of its range. The ordering of species within subgenera follows Table 1 (p. 40).*

| | Altitude | | | | | Flowering time (range in months) | | No. | |
|---|---|---|---|---|---|---|---|---|---|
| Taxonomic grouping | *n* | min | max | mean | s.d. | 5%–95% | 25%–75% | grid cells present | Aggregation (%) |
| ***Monocalyptus*** | | | | | | | | | |
| *E. delegatensis* | 2744 | 100 | 1240 | 655 | 211 | Jan–Mar | Jan–Feb | 349 | 68 |
| *E. obliqua* | 4208 | 1 | 860 | 300 | 176 | Jan–Mar | Jan–Feb | 436 | 68 |
| *E. pauciflora* | 305 | 10 | 1080 | 531 | 255 | Dec–Feb | Jan–Jan | 170 | 55 |
| *E. regnans* | 1579 | 20 | 870 | 372 | 169 | Feb–May | Mar–Apr | 171 | 40 |
| *E. sieberi* | 331 | 1 | 720 | 277 | 179 | Sep–Mar | Oct–Nov | 37 | 73 |
| *E. amygdalina* | 2600 | 1 | 1020 | 305 | 209 | Aug–Jan | Oct–Nov | 417 | 87 |
| *E. coccifera* | 326 | 390 | 1290 | 938 | 195 | Nov–Feb | Dec–Jan | 139 | 49 |
| *E. nitida* | 551 | 1 | 1020 | 291 | 244 | Nov–Feb | Dec–Jan | 292 | 76 |
| *E. pulchella* | 493 | 10 | 740 | 286 | 167 | Aug–Feb | Oct–Dec | 126 | 70 |
| *E.* aff. *radiata* | 8 | 150 | 610 | 369 | 126 | na | na | 7 | 88 |
| *E. risdonii* | 33 | 2 | 280 | 123 | 68 | Aug–Dec | Oct–Nov | 4 | 100 |
| *E. tenuiramis* | 456 | 1 | 700 | 264 | 158 | Nov–Feb | Nov–Jan | 118 | 78 |
| ***Symphyomyrtus*** | | | | | | | | | |
| *E. barberi* | 79 | 130 | 500 | 298 | 96 | Mar–Oct | Apr–Jul | 17 | 68 |
| *E. brookeriana* | 125 | 10 | 720 | 392 | 193 | Sep–Apr | na | 81 | 22 |
| *E. ovata* | 954 | 1 | 830 | 233 | 186 | Jun–Feb | Aug–Nov | 412 | 49 |
| *E. rodwayi* | 186 | 60 | 1120 | 557 | 212 | Nov–May | Jan–Mar | 135 | 36 |
| *E. dalrympleana* | 596 | 150 | 1175 | 630 | 200 | Mar–May | Mar–Apr | 176 | 54 |
| *E. rubida* | 126 | 90 | 880 | 430 | 172 | Nov–Jan | Dec–Jan | 86 | 55 |
| *E. viminalis* | 2633 | 1 | 940 | 322 | 216 | Nov–Apr | Feb–Mar | 424 | 71 |
| *E. johnstonii* | 185 | 130 | 920 | 645 | 168 | Jan–Apr | Feb–Apr | 47 | 41 |
| *E. subcrenulata* | 103 | 550 | 1180 | 902 | 135 | Jan–Apr | Jan–Mar | 65 | 43 |
| *E. vernicosa* | 73 | 240 | 1250 | 840 | 208 | Dec–Apr | Jan–Feb | 76 | 41 |
| *E. globulus* | 1143 | 1 | 830 | 218 | 154 | Sep–Dec | Oct–Nov | 211 | 54 |
| *E. archeri* | 34 | 980 | 1350 | 1148 | 81 | Jan–Apr | Feb–Mar | 20 | 28 |
| *E. cordata* | 67 | 20 | 680 | 422 | 178 | May–Nov | Jun–Nov | 25 | 37 |
| *E. gunnii* | 157 | 330 | 1200 | 897 | 194 | Nov–Mar | Dec–Feb | 100 | 36 |
| *E. morrisbyi* | 4 | 10 | 80 | 45 | 35 | Mar–Apr | Mar–Apr | 2 | 33 |
| *E. perriniana* | 11 | 500 | 620 | 537 | 40 | Jan–Mar | Jan–Mar | 4 | 14 |
| *E. urnigera* | 59 | 420 | 1160 | 779 | 174 | Mar–Nov | May–Aug | 29 | 21 |
| Full data range | 20169 | 1 | 1350 | 480 | 270 | | | 757 | 90 |

Plateau and the north-west, the depressed levels of species richness may be due to inadequate sampling of the environmental range per grid cell.

The relative distributions of the two sub-genera are similar, although *Monocalyptus* species are present in 10% more grid cells than are *Symphyomyrtus* species (Figures 95, 96). Unexpectedly, *Monocalyptus* species are not verified from King Island. Species richness per grid cell for the *Monocalyptus* subgenus is greater in north-eastern, northern and north-western regions than for the *Symphyomyrtus* subgenus, even though there are nearly 30% fewer *Monocalyptus* species than *Symphyomyrtus* species in Tasmania. However, this trend is consistent with the prevalence of *Monocalyptus* species such as *E. delegatensis, E. obliqua, E. amygdalina* and *E. nitida* across a wide range of sclerophyll forest, woodland and scrub habitats, and their frequent occurrence among the canopy dominants.

The relative distribution and species richness of the four *Eucalyptus* series (from Table 1) are given in Figures 97–100. In the *Monocalyptus* subgenus, the series *Obliquae* and *Piperitae* both include species with widespread distributions (e.g. *E. obliqua* and *E. amygdalina*). The series *Obliquae* reaches its greatest species richness in the north-east (Figure 97), and in the series *Piperitae* this is highest in the south-east (Figure 98). The series *Piperitae* species are broadly absent from the north-eastern montane forests and woodlands but extend into the far south-west and Flinders Island. Conversely, the series *Obliquae* species are largely absent from the far south-west, are not known from the Furneaux Group of islands and King Island but are well represented in the north-eastern highlands.

In the *Symphyomyrtus* subgenus, species in the series *Ovatae* and *Viminales* are also widely distributed in a range of habitats (e.g. *E. ovata* and *E. viminalis*). The series *Ovatae* species reach their greatest richness on the east coast and tiers (Figure 99), and the series *Viminales* species are richest in the highland regions of the south-east and, to a lesser extent, the Eastern Tiers and the Central Plateau (Figure 100). Representative species from both series occur on King Island and Flinders Island. The series *Ovatae* species appear to extend more consistently into the north-west and the series *Viminales* species extend further into the environments of the south-west.

Endemism in the Tasmanian species of *Eucalyptus* (Table 1) is dominated by the series *Piperitae* (Figure 98) and *Viminales* (Figure 100). Species richness amongst the 17 endemics is centred in the south-east between the Huon and Derwent River estuaries, and at Mount Field (Figure 101). Endemism is also high in eastern regions and the Central Plateau, but is absent from King Island, and is sparse on Flinders Island, in the Midlands and in northern regions. Conversely, species richness among the 12 non-endemic eucalypts is highest in eastern regions, extends throughout northern regions including the Bass Strait islands, and into the Midlands and lower Central Plateau (Figure 102).

### *Altitude profiles*

Altitude is an intuitively observed and easily recorded, indirect environmental descriptor of a species' habitat. It provides an immediate impression of the climate in a familiar locality. However, Tasmania-wide, altitude is confounded by continentality (distance from the coast) and the geographic trend in the degree of climatic exposure, induced by the prevailing westerly airstream. This effect is most readily observed in the upward shift of the altitude of the alpine tree-line in a south-west to north-east direction (see Jackson 1960; Kirkpatrick 1982). Consequently, a species may appear to grow in a broader range of environments than is actually the case. For example, *E. vernicosa* occurs in south-western habitats over a broad range of altitudes (240–1250 m, Figure 87), but the actual alpine or subalpine climatic range it grows in is likely to be much narrower than the altitude figures suggest.

Despite these limitations to ecological interpretation, altitude is a useful field guide

*Photo 29.* Eucalyptus vernicosa *(foreground) grows as a low shrub in exposed alpine environments, occupying one of the harshest habitats in Tasmania.*

to the general type of environment in which a species is likely to be found, and provides a basis for broad comparison of trends in habitat between taxa. For example, the local clinal variation between lowland and subalpine species that is commonly observed for the yellow gums (e.g. Potts and Jackson 1986) and white gums (e.g. Phillips and Reid 1980) reflects a continuum in habitat encapsulated in the altitude range. Altitude, in combination with other local site-factors such as slope, aspect and substrate type, and physical-process models for climate and soil, may be used to define more physiologically based environmental indices (e.g. water balance, growing degree-days, nutrient status) for assessing the nature of the ecological relationship between a species and its habitat.

The response of individual species to altitude (see Figures on pp. 49–121; Table 3) indicates some of the confounding factors involved in species identification due to clinal intergradation and hybridisation. The lower or upper altitude limits to a species' distribution are abrupt at sea-level due to the physical barrier or at the tree-line where plants are physiologically limited by the seasonally low temperatures. Some of the distributions are apparently bimodal, potentially indicating geographically distinct ecotypes, while others are excessively peaked, skewed or long-tailed, which could represent error, sampling bias or a real effect. For example, the altitude profile for *E. pauciflora* may reflect the distribution of this species across two separate altitudinal ranges. The first is the lowland, coastal plateau between 100 m and 300 m, and the second is a mid-altitude, inland plateau in the range from 400 m to 700 m (Figure 51). In the case of *E. nitida*, the distribution extends across a broad altitudinal range and does not form distinct peaks (Figure 41). For this species, it is likely that more comprehensive sampling in the south-west would give a clearer indication of the environmental trend. The distribution for *E. nitida* is also confounded by possible separate ecotypes from Flinders Island and western Tasmania (Figure 40).

The geographic sampling range for which accurate altitudes were available is shown in Figure 103. Most regions are well sampled. Under-sampling is evident from western and south-western regions, parts of the Central Plateau and the Midlands. Apart from a probable under-sampling in highland areas, there is a natural bias in altitude for lowland environments since these are more common in the landscape (Figure 104).

The highest altitude recorded for any species was for *E. archeri*, found at 1350 m in the north-east. However, this altitude does not represent the most alpine habitat for eucalypts in Tasmania, which is occupied by *E. vernicosa* (Photo 29) in the south-west.

*Flowering times*

Geographic isolation or differences in flowering time are the main pre-mating barriers to hybridisation in natural eucalypt populations. However, once these barriers are removed, many species from the same subgenera will form viable hybrids following artificial pollination. The major post-mating barriers identified to date include differences in flower morphology and physiological incompatibility. Pollen tubes of small-flowered species are frequently unable to grow the full length of the style of large-flowered species (Gore *et al.* 1990). *Eucalyptus globulus* has the largest flowers of the Tasmanian species (Photo 9) and while it can successfully act as a pollen parent, no seed, or very little, is obtained when it is pollinated by the smaller flowered Tasmanian species (Potts and Savva 1989; Potts *et al.* 1992). When floral morphology is compatible, the success of controlled pollination tends to decline with increasing taxonomic distance between parents. Thus, intra-sectional hybrids tend to be more common (Griffin *et al.* 1988) and successful (Ellis *et al.* 1991) than inter-sectional hybrids. The major eucalypt subgenera are reproductively isolated and despite many attempts, no viable artificial hybrids have been obtained between *Monocalyptus* and *Symphyomyrtus* species (Griffin *et al.* 1988; B. Potts, unpublished data).

Monthly flowering times for each species are presented as Figures (see pp. 49–121), with a general summary in Table 3. No data are currently available for *E.* aff. *radiata*, and few data are available for *E. perriniana, E. dalrympleana, E. johnstonii, E. regnans, E. rubida, E. sieberi* and *E. brookeriana.* The monthly flowering times for the taxonomic groups of subgenera and series are given in Figures 105a–g.

Most flowering of *Eucalyptus* occurs from September to March, with very little flowering over winter (Figure 105a). *Eucalyptus urnigera* is the only subalpine species in which flowering is centred over the winter period and it appears to be primarily bird pollinated (Savva *et al.* 1988). Other subalpine to alpine species tend to be summer flowering (e.g. *E. vernicosa, E. subcrenulata, E. gunnii, E. archeri, E. rodwayi, E. delegatensis, E. pauciflora* and *E. coccifera*). Many lowland species may commence flowering in the late autumn (e.g. *E. barberi, E. cordata*) or early spring (e.g. *E. amygdalina, E. pulchella, E. risdonii, E. tenuiramis, E. sieberi, E. globulus* and *E. ovata*), although their peak flowering generally occurs in spring. An apparent bimodality in flowering time for *E. cordata* is probably related to the different habitats of the eastern and western morphs (Figure 20). The strong bimodality in the flowering time of *E. brookeriana* requires investigation but is more likely to be a function of under-sampling or misidentification of west coast forms of *E. ovata* (compare Figures 14, 49). However, differences in flowering time between east and west coast occurrences of *E. brookeriana* cannot be excluded at this stage.

There is complete overlap in flowering between the *Monocalyptus* and *Symphyomyrtus* species (Figures 105b, c). Within the subgenus *Monocalyptus*, the series *Obliquae* species tend to flower in late summer or early autumn (Figure 105d), whereas the peak flowering of most series *Piperitae* species is in spring or early summer (Figure 105f). This difference in flowering time may partly explain the lack of extensive hybridisation between these series (Potts and Reid 1983), but is also a function of the general predominance of series *Piperitae* species in summer-dry habitats. The flowering of the series *Ovatae* species is spread widely throughout the year (Figure 105e), whereas, with the exception of *E. urnigera*, the flowering of series *Viminales* species appears to be concentrated into the early summer to early autumn period (Figure 105g).

There are clear differences in the flowering of some groups of closely related species, and this would reduce the probability of hybridisation. In the *Viminales*, the alpine white gums (e.g. *E. archeri, E. gunnii, E. urnigera* and *E. morrisbyi*) differ markedly in their flowering times, and the peak flowering periods of the *Ovatae* species *E. ovata, E. rodwayi* and *E. barberi* also differ considerably. However, these generalised flowering curves underestimate the degree of reproductive isolation which may arise between species through differences in flowering time, and confound the large variations in flowering time which may occur within a species (e.g. Potts and Reid 1985a, c; Davidson *et al.* 1987; Savva *et al.* 1988; Gore and Potts 1995) and in different seasons. When flowering has been monitored in the same geographic locality, species from the same subgenus growing in close proximity are often well differentiated in flowering time. For example, the generalised flowering curves would suggest extensive overlap in the flowering of *E. amygdalina* and *E. risdonii.* However, detailed studies of an ecotonal area between these species have shown a significant difference in the time of peak flowering when species are in close proximity, although more distant populations may overlap (Potts and Reid 1985c). Flowering also tends to occur as 'waves' along altitudinal gradients, with higher altitude populations usually flowering later (e.g. Ashton 1975c; Savva *et al.* 1988).

There is little information available about the extent to which the differences in flowering time within species, or even between species, are determined by environmental (e.g. temperature) or genetic effects. Nevertheless, studies of populations of *E. globulus* have shown differences in flowering time within the same field trial to be highly heritable (Gore and Potts 1995). Large, genetically based differences in flowering time occur between populations within this species, and even between trees within populations. Populations of *E. globulus* on the Furneaux Group of islands and eastern Tasmania flower in spring whereas those from western Tasmania, King Island and the Otway Ranges flower several months later, which corresponds with the pattern observed in natural stands. The flowering-time curve for *E. globulus* in the present study is based only on observations of *E. globulus* from eastern Tasmania.

*Distribution types and conservation status*

The natural continuum in the distribution of Tasmanian eucalypts can be divided into several types based upon categories for their geographic range and aggregation of occurrences (Table 3; Figure 106). Nine distribution types distinguish the wide-spread, dispersed or disjunct species from the more common species with widespread, clustered distributions (Table 4).

Within Tasmania, species with localised distributions and those with widespread distributions, at the 10 km x 10 km grid-cell scale, have representatives in each of the four *Eucalyptus* series. The rarest species always have localised distributions, but may exhibit different levels of aggregation across their respective ranges. For example, *E. risdonii* and *E. barberi* have a clustered aggregation of sites within a localised geographic range, whereas *E. morrisbyi* has a dispersed distribution. Other interesting distributions are species with dispersed or disjunct populations within regional or widespread occurrences. For example, the most disjunct species is *E. brookeriana*, with widely separated population centres in the north-west and the central east coast. *Eucalyptus urnigera* is a regionally disjunct species and *E. perriniana* exemplifies a locally disjunct distribution. Regional or widespread species with dispersed or disjunct patterns of occurrence typically occupy mid- to high-altitude habitat zones which are naturally dispersed in the landscape. *Eucalyptus*

*Table 4. The nine distribution types of Tasmanian eucalypts as defined by their geographic range and aggregation level in 10 km x 10 km grid cells (see Figure 106). Species are listed in order of decreasing aggregation within each group. Taxonomic divisions are indicated by letters preceding the species name.* ***M*** = Monocalyptus, ***S*** = Symphyomyrtus, *Ob* = Obliquae, *Ov* = Ovatae, *P* = Piperitae, *V* = Viminales *(see Table 1). Species conservation status is from the Flora Advisory Committee (1994).*

*Criteria for the definition of conservation status (after Kirkpatrick* et al. *1991a):*

*Ee—taxa that are likely to become extinct in native stands in Tasmania if present causal factors of decline continue.*
*R—taxa that have limited distributions nationally following Briggs and Leigh (1988).*
*r1—taxa that have a distribution in Tasmania that does not exceed 100 km x 100 km.*
*r2—taxa that occur in 20 or less 10 km x 10 km national mapping grid cells in Tasmania.*
*r3—taxa that do not fit r1 or r2, but which have very small and/or localised populations wherever they occur in Tasmania.*

| Aggregation (patterns of occurrence) | Geographic Range: localised (< 5 000 km$^2$) | Geographic Range: regional (5 000–25 000 km$^2$) | Geographic Range: widespread (> 25 000 km$^2$) |
|---|---|---|---|
| Clustered (50–100%) | **M** P *E. risdonii* **R r1** | **M** P *E. tenuiramis* | **M** P *E. amygdalina* |
| | **M** P *E.* aff. *radiata* **r1** | **M** Ob *E. sieberi* | **S** V *E. viminalis* |
| | **S** Ov *E. barberi* **R r2** | **M** P *E. pulchella* | **M** P *E. nitida* |
| | | **S** V *E. rubida* | **M** Ob *E. obliqua* |
| | | | **M** Ob *E. delegatensis* subsp. *tasmaniensis* |
| | | | **M** Ob *E. pauciflora* |
| | | | **S** V *E. dalrympleana* |
| | | | **S** V *E. globulus* subsp. *globulus* |
| Dispersed (30–50%) | **S** V *E. morrisbyi* **Ee, r1** | **S** V *E. subcrenulata* | **S** Ov *E. ovata* |
| | | **S** V *E. vernicosa* | **M** P *E. coccifera* |
| | | **S** V *E. johnstonii* | **M** Ob *E. regnans* |
| | | **S** V *E. cordata* **R r3** | **S** Ov *E. rodwayi* |
| | | | **S** V *E. gunnii* |
| Disjunct (< 30%) | **S** V *E. perriniana* **r2** | **S** V *E. archeri* **R r2** | **S** V *E. brookeriana* |
| | | **S** V *E. urnigera* | |

*regnans* is an exception, being a lowland species with a narrow ecological range (e.g. Ashton 1958, 1981a). Most species with clustered distributions usually occupy mid-altitude to lowland habitats, exceptions being the widespread species *E. delegatensis*, *E. dalrympleana* and the more enigmatic *E. nitida*. The distribution of *E. sieberi* is barely regional (Figure 74) using the type definition (Table 4), and may equally be considered as localised in Tasmania.

These distributions have important implications for the definition of conservation status and subsequent management in the context of genetic variation of the rarer species (Moran and Hopper 1987; Moran 1992). However, the 10 km x 10 km grid-cell scale used in this simple analysis of distributions does not accurately distinguish the species such as *E. barberi* and *E. risdonii* with small populations that are dispersed at a finer scale. Naturally rare species (clustered, dispersed or disjunct populations with a localised geographic range) are the most vulnerable to disturbance and reflect the highest priority for conservation (e.g. Pryor and Briggs 1981; Fry and Benson 1986; Briggs and Leigh 1988; Flora Advisory Committee 1994).

Priorities for conservation management of *E. morrisbyi* (Wiltshire *et al.* 1989, 1991b), *E. risdonii* (Wiltshire *et al.* 1989), *E. perriniana* (Wiltshire and Reid 1987), *E. cordata* (Potts

1989), *E. barberi* (McEntee *et al.* 1994) and, indirectly, *E. archeri* (Potts and Reid 1985a, b) have been considered, but little is known of the rare northern peppermint *E.* aff. *radiata*. Other more regionally distributed species with somewhat localised populations such as *E. rubida*, *E. tenuiramis*, *E. pulchella* and *E. sieberi* tend to be poorly conserved across parts of their range where this is characterised by intensive land-use practices such as agriculture and forestry. For these species, the conservation priority shifts to population and plant community considerations. Many other regional and widespread eucalypt species can also be identified with reservation needs within their distributions where conservation of the genetic and ecological variability is inadequate. These regional community conservation needs have been addressed in preliminary work combining generalised information on environment, land-use patterns and species or community occurrences (Working Group for Forest Conservation 1990; Kirkpatrick and Brown 1991; Kirkpatrick *et al.* 1994). However, the adequacy of these conservation measures needs to be more comprehensively addressed using ecological gradient analyses with collated data of species presence and absence (e.g. Austin *et al.* 1990; Austin 1992) coupled with information on patterns of genetic diversity within the eucalypt species (e.g. Potts 1989).

## Key issues in clarifying eucalypt distributions

The propensity of eucalypts for intergradation due to hybridisation, clinal variation or parallel adaptation (Duncan 1989; Figure 1) has led to considerable difficulties in identification of taxa. The recognition of specific regional or environmental locations in which species identifications have been problematic or in which range extensions are likely to be encountered may assist future observers in naming taxa. Many of these problem situations are indicated in the annotated text for each species. However, this study has highlighted several key features of the distribution and taxonomy of the Tasmanian *Eucalyptus* species which require clarification.

### *Issues of biogeography, taxonomy and genecology*

Eucalypts commonly form replacement series or intergrade along environmental gradients, particularly those associated with altitude and substrate, with underlying factors including temperature limits and water availability. For example, in lowland regions of the north and north-west, *E. nitida* intergrades eastward with *E. amygdalina* following a gradient of decreasing rainfall, coincident with the geological divide. The 'tongue' of *E. amygdalina* occurrences (Figure 2) on dry sites north of the Pieman River appears to be associated with Devonian or Cambrian volcanics and Ordovician sediments, whilst *E. nitida* occurs where substrates are underlain by the older Precambrian and Cambrian sediments.

The extension of predominantly eastern species such as *E. obliqua*, *E. viminalis*, *E. ovata* and *E. globulus* into the habitats of the south-west and west coasts is of considerable biogeographic and genetic interest. Populations in these areas may have adapted to the west coast environment and be genetically differentiated from eastern populations. Near Strahan, for example, white gums ascribed to either *E. viminalis* or *E. dalrympleana* appear different from their respective eastern populations. Similarly, populations of some different species may converge in their morphological and ecological characteristics. For example, on King Island, the same forest trees in the Kentford State Reserve have been identified as *E. ovata* and *E. brookeriana* by different observers. This epitomises the difficulty in distinguishing the two species in western Tasmania where they converge in both morphology and habitat. The maps of these species reveal the potential extent of overlap (Figures 12, 47). In the Eastern Tiers, morphological and habitat differentiation between *E. ovata* and *E. brookeriana* is more marked. Recent work by Li *et al.* (1996) using leaf oil chemistry confirms that the two taxa are distinct in the east (Ladiges *et al.* 1981, 1984) but difficult to differentiate in the west. The genetic and ecological relationships of the east and west coast forms of *E. ovata* and *E. brookeriana* (series *Ovatae*) require detailed study.

The distribution and affinities of the northern populations of *E. urnigera* on the southern edge of the Central Plateau also require study (Figure 83). Most of our knowledge of the ecology and taxonomy of *E. urnigera* is based on southern populations (e.g. on the Mount Wellington Range and Mount Field). Studies of the northern population at Alma Tier (Potts and Reid 1985a, b) suggest the possibility of consistent differences from the southern populations in morphology, habit and ecology.

Variation within *E. tenuiramis* requires further study. For example, the differences observed by Wiltshire *et al.* (1991a, 1992) for the northern populations of *E. tenuiramis* near Bicheno and Friendly Beaches may be specific to the granite substrates, whereas *E. tenuiramis* extends onto dolerite substrates in the Eastern Tiers (Figure 80). Similarly, the coastal mallee peppermint on Tasman Peninsula has been variously identified as *E. tenuiramis, E. coccifera* and *E. nitida*, but it is believed to have its closest affinities with *E. tenuiramis* which occurs nearby on mudstone and dolerite substrates (Marginson and Ladiges 1982; Wiltshire *et al.* 1991a, 1992). However, stabilised populations intermediate between *E. coccifera* and *E. tenuiramis* have been reported from near sea-level on Bruny Island and at high altitudes on Alma Tier (Wiltshire *et al.* 1992; see also Li *et al.* 1995). A glaucous peppermint in the south-west near Red Point Hills needs its affinities investigated in the context of the coastal mallee peppermints (Figure 80). It is certainly possible that other, as yet unidentified taxa may be lurking within the Tasmanian peppermints.

The peppermint on the Furneaux Group of islands has been classified historically as *E. nitida*, but the disjunction with other populations of *E. nitida* is difficult to explain (Figure 40). The affinities of this peppermint with the west coast ecotype of *E. nitida* and the other coastal peppermints, such as *E. amygdalina* from the north-eastern coastal plains and related mainland coastal species, have not been adequately determined. Studies of seedling morphology have shown that the peppermint on Flinders Island has affinities with *E. nitida* (Wiltshire *et al.* 1992). Studies of leaf oils have suggested that the peppermint on the Furneaux Group of islands is intermediate between the narrower leaved west-Tasmanian *E. nitida* and a broader leaved *E.* aff. *nitida* population occurring on Wilsons Promontory (David Rankin, pers. comm. 1994). On Cape Barren Island, the large degree of variation observed in glaucousness amongst the peppermints is not typical of *E. nitida*. The waxy glaucousness suggests affinities with coastal populations of *E.* (aff.) *tenuiramis* which do not have the typical connate juvenile leaf morphology of *E. tenuiramis* (Wiltshire *et al.* 1992), and the affinities of these populations require investigation.

All the peppermints in Tasmania are endemic (except possibly *E.* aff. *radiata*) and display a high degree of variation due to hybridisation and intergradation (Figure 1). Sharp boundaries between the lowland populations of *E. tenuiramis*, *E. pulchella* and *E. amygdalina* exist in the south-east, usually associated with shifts in substrate. Toward the east coast, the sharp edaphic boundaries and narrow hybrid zones of the south-east break down and the morphological and ecological differences between the species are more diffuse (see Davidson *et al.* 1981). While hybridisation between all three species is common, the morphological similarity of *E. pulchella* and *E. amygdalina* makes identification uncertain where 'half-barked' forms exist. The northern limits to the distribution of *E. pulchella* are similarly difficult to determine. Kirkpatrick and Potts (1987) investigated the genetic affinities of the 'half-barked' forms of the fine-leaved peppermint, and concluded this to be *E. amygdalina*. However, recent work on ecotypes of the three lowland peppermints (K. Williams, unpublished data) indicates that the fine-leaved peppermint in the Eastern Tiers is distinct from both the south-eastern *E. pulchella* and *E. amygdalina* in morphological and ecological characteristics.

*Table 5. Distributions of the Tasmanian eucalypts that require clarification. Problems are listed by subgeneric group in no order of importance.*

*Monocalyptus* species

1. The putative absence of any *Monocalyptus* species from King Island.
2. The north-western extent of the range of *E. delegatensis.*
3. The south-western extent of *E. obliqua* from inland valley forests to coastal woodlands.
4. The north-eastern limits of *E. coccifera, E. pulchella* and *E. tenuiramis.*
5. The south-eastern extent of relatively low-altitude occurrences of *E. coccifera.*
6. The occurrences of *E. pulchella* and *E. tenuiramis* at relatively high altitudes on the Central Plateau.
7. The population discontinuity between the south-eastern and eastern forms of *E. tenuiramis,* and the apparent absence of this species from Maria Island.
8. The identity and disjunct distribution of the glaucous peppermint (*E.* aff. *tenuiramis*) in the south-west, and on Cape Barren Island and Flinders Island.
9. The northern occurrence of *E.* aff. *radiata,* and a putative location for it in the Murchison River valley.
10. The western extent of *E. risdonii* on the foothills adjacent to the eastern shore of the Derwent Estuary.

*Symphyomyrtus* species

1. The western and south-western distribution and taxonomic status of populations with affinities to *E. ovata* and *E. brookeriana.*
2. The north-western extent of *E. rodwayi* and the morphological differences between these and the Central Plateau and eastern populations.
3. The eastward extent of *E. subcrenulata* on the Central Plateau and its occurrence on southern mountains.
4. The eastward extent of *E. johnstonii* in the south-eastern mountains and eastern highlands.
5. The north-western and south-western extent of relatively low-altitude occurrences of *E. vernicosa.*
6. The putative absence of *E. dalrympleana* from Maria Island.
7. The distribution and affinities of populations ascribed to series *Viminales* in coastal regions of the west coast.
8. The putative north-eastern occurrence of *E. globulus* near Gladstone and the north-western occurrence near Sandy Cape.
9. The extent of *E. urnigera* on the southern Central Plateau, Midlands and Eastern Tiers, and its differentiation from southern populations.

Further work is needed to determine the distributional limits of *E. pulchella* in Tasmania in the context of the taxonomic and ecological variation of the lowland peppermints. Li *et al.* (1995) investigated the chemistry of leaf oils as a means of differentiating the Tasmanian *Piperitae* species but was unable to find suitable species-specific markers. Further work is needed to identify suitable markers, such as DNA or other biochemical traits (e.g. wax chemistry, Li 1993), to distinguish between members of the *Piperitae.*

*Distributions requiring clarification*

A summary of the main areas requiring clarification in the distribution of *Eucalyptus* species is given in Table 5. Many of these unresolved issues are associated with under-sampling in some localities and some regions, particularly in the remote south-west and parts of the Central Plateau and Eastern Tiers. Other issues are associated with outlier or marginal occurrences of species at the limits of their known range. For example, the distributions of the series *Obliquae* and *Ovatae* species are reasonably well known, and the main unresolved issues concern range extensions toward the west. However, it is notable that species from the subgenus *Monocalyptus* are not verified from King Island.

Distributions of particular interest with regard to the series *Piperitae* species include the apparent population discontinuity between the south-eastern and east coast forms of *E. tenuiramis* in the vicinity of the Little Swanport River, Tooms Lake and the Macquarie River, the extent and identity of the glaucous peppermint in the south-west, the extent of *E.* aff. *radiata* in the north, and the north-eastern distribution limits for *E. coccifera, E. pulchella* and *E. tenuiramis* such as in the vicinity of the Fingal Valley.

Amongst the series *Viminales* species, the distributions of particular note for clarification include specific locations for *E. perriniana, E. gunnii* and *E. cordata* in the south-east; the north-eastern and north-western extent of *E. globulus*; and the north-western low-altitude occurrences of *E. vernicosa*. The extent of the yellow gum *E. subcrenulata* on the south-eastern Central Plateau, and the alpine white gum *E. urnigera* on the southern edge of the Central Plateau, also needs to be resolved.

## Conclusions

The natural distribution of eucalypts in Tasmania is best explained by considering both historical and ecological factors. For example, the climatic conditions of the last glaciation resulted in a different pattern in extent and juxtaposition of alpine, subalpine and lowland habitats, and the selective nature of environmental gradients affecting clinal variation. It is estimated that mean temperatures were about 5°C lower than present (Davies 1974; Macphail 1979; Kiernan *et al.* 1983), and this equates with the tree-line near the present sea-level on the west coast, rising to about 400–500 m above the present sea-level on the east coast (Macphail 1979).

Considering the bathymetric contours of the continental shelf surrounding Tasmania (e.g. Bureau of Mineral Resources 1980), the most extensive area of suitable habitat for eucalypts would have been in the east and south-east (Davies 1974), and the current distribution patterns of many of the endemic *Eucalyptus* species are consistent with their confinement to a south-eastern glacial refuge (Potts and Reid 1985b).

The major rise in mean temperatures between 12 000 and 10 000 years ago, accompanied by rising precipitation, resulted in the expansion of arboreal taxa inland and upslope onto mountains (Macphail 1979). Concomitantly, the distribution range and connectedness of many of the alpine and subalpine taxa would have contracted, and extant populations of species such as *E. coccifera, E. gunnii, E. archeri, E. urnigera* and *E. johnstonii* would have no doubt become isolated in small refugia on mountain regions and coastal hills in the east and south-east. Conversely, the lowland species may have expanded from their isolated refugial habitats into the new lowland areas following the retreat of the glacial and periglacial zones, and the flooding of their former habitat by rising sea-levels. Some of these previously isolated populations may have become genetically distinct (e.g. *E. tenuiramis* populations in the central east coast and the south-east). Other taxa, such as *E.* aff. *radiata, E. regnans, E. brookeriana, E. cordata* and *E. barberi* which currently occupy specialist habitats intermediate in altitude between the subalpine and lowland environments, may have experienced similarly narrow habitat ranges in both glacial and post-glacial times. This may be reflected in the distribution pattern of their extant populations which are frequently small and locally or widely dispersed. Few species truly transgress these altitude zones: exceptions may be the stepped distribution of *E. pauciflora* and the widespread predominance of *E. nitida* in the south-west.

Outliers in the present-day distributions of eucalypts may be biogeographically significant. For example, they may reflect

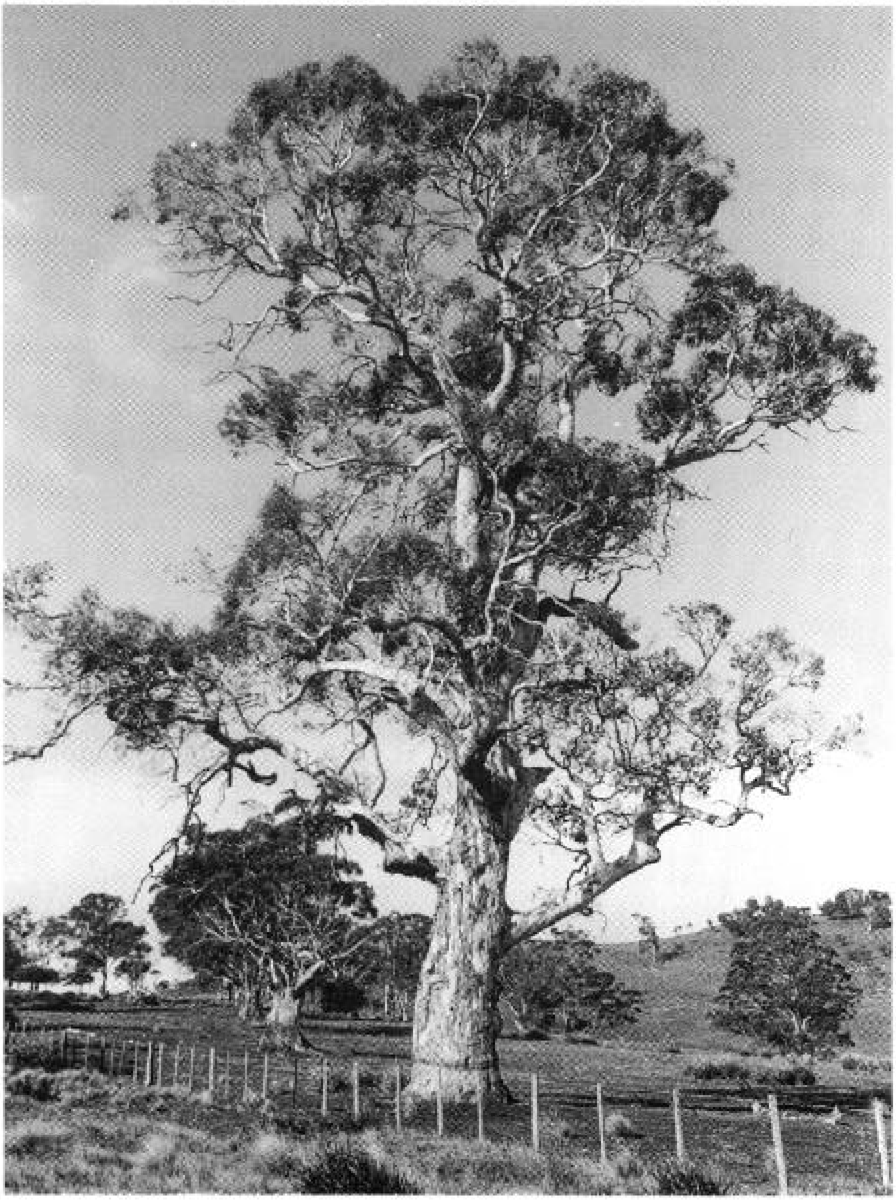


*Photo 30.* Eucalyptus rubida, *a species whose occurrence has been greatly reduced by clearing. Mature eucalypts in paddocks have a special role in conservation, particularly for rarer species, because they may be the best evidence in some areas that certain species ever occurred there.*

adaptive extensions of the ecological range of a species, or relict or remnant populations, important in the context of genetic resources for both conservation and exploitation.

The *Eucalyptus* species distributions presented in this atlas provide a basis for assessing the significance of population outliers and new localities. They also highlight areas most in need of further work. For example, it is clear from the study that the remoter mountain regions and the west of Tasmania, in general, require more intensive survey. More detailed work is also needed where present or past land-use practices are altering distribution patterns. For example, the introduction of non-provenance species and ecotypes in seed mixes sown for native forest regeneration following logging may confuse the future interpretation of natural eucalypt occurrence and patterns of genetic variation (e.g. Elliott *et al.* 1991). In other areas, where the land has been cleared during the early history of European settlement, remnant trees in farmland (Photo 30) are indicators of natural distribution limits for some eucalypt taxa (e.g. Fensham 1989). These remnants need to be assessed urgently given the rate of clearing of native forest, the increasing dieback of isolated trees, and artificial planting of eucalypts in rural areas that are not necessarily provenances from local sources.

## Acknowledgements

The electronic data sources for eucalypt distributions were collated with the co-operation and enthusiasm of staff at Forestry Tasmania, the Tasmanian Parks and Wildlife Service, the Tasmanian Herbarium and the CSIRO Division of Plant Industry. We particularly wish to acknowledge the assistance of Simon Orr, Andrea Manson, Alex Buchanan, Sonya James, Eddie Steenbergen, Colin Reed, Andrew Slee, Peter Cinquini and Kevin Hortle in making these data available. Thanks also to individuals within these Departments and the University of Tasmania, and others who happily rummaged through paper and electronic files to provide additional distributions from specific surveys: Fred Duncan, Stephen Harris, Jamie Kirkpatrick, Mick Brown, Tony Moscal (Tasmanian Conservation Trust files), Mark Neyland, Jean Jarman, Michael Askey-Doran, Jayne Balmer, Jennie Whinam, Phil Barker, Jill Hickey, Karen Johnson, Andrew North, John Hickey, John Grant, Peter Kube, Rob Wiltshire, John Davies, Fiona Coates, Ross Peacock, Jon Marsden-Smedley, Michael Battaglia, Peter Gore, Mirranie Barker, Jill Packham, Ian Brooker and Rob Taylor. We also appreciate the letters, notes and other personal communications provided by other individuals who have assisted us in determining the validity of some occurrences: Stephen Mattingly, David Ziegler, Brett Cusick, Heidi Dungey, Greg Jordan, Alan Gray and Dennis Chester. Thanks to Bill Jackson, Jamie Kirkpatrick, Fred Duncan, Mark Neyland, Rob Wiltshire, Jim Reid, Mick Brown, Alan Gray, Alex Buchanan and Tony Mount for their patience in the face of our persistent queries. The flowering data were collated with the co-operation of staff of the Tasmanian Herbarium and with the technical assistance of Peter Gore, Milton Savva, Heidi Dungey and Anne McEntee.

Thanks to Michael Henry and Tony Grainger at the University of Tasmania Computing Centre in Hobart who provided advice on databasing in ORACLE and cheerfully allocated sufficient space for the growing list of records. We are also indebted to Simon Orr, Tony Rainbird and Andrea Manson for cartographic assistance in the early draft production stages of the maps. The final distribution maps were produced using MAPSPECIES software (version May 1996) written for MacIntosh computers by Mark Fowler (Dept. of Geography and Environmental Studies, University of Tasmania). The inset Australia-wide distribution maps were reproduced from G.M. Chippendale's (1988) account in Bureau of Flora and Fauna, *Flora of Australia*, Vol. 19: *Myrtaceae - Eucalyptus, Angophora*, AGPS, Canberra (maps: 137, 141, 146, 154, 411, 413, 441, 451, 460, 462, 470), Commonwealth of Australia copyright reproduced by permission from the Australian Government Publishing Service and the Australian Biological Resources Study. We also thank Fred Duncan for allowing us to include his drawings of selected eucalypt species (Figures 5, 27, 46), and acknowledge the use of photos from Fred Duncan (Photos 14, 18), Humphrey Elliott (Photos 6, 17, 26, 27), Dennis Harding (Photo 2), Jean Jarman (Photos 5, 12, 13, 16, 19, 28, 29) and the Tasmanian Herbarium (Photos 3, 4, 7, 11, 15, 20, 24, 25).

We gratefully acknowledge Jean Jarman, Mick Brown, Jim Reid, Humphrey Elliott and Fred Duncan for their friendly cajolery and helpful comments on the manuscript, and suggestions in the editing and final production stages of this atlas. This work was undertaken by KJW as part of post-graduate study supported by a Commonwealth Department of Primary Industry and Energy Forestry Scholarship.

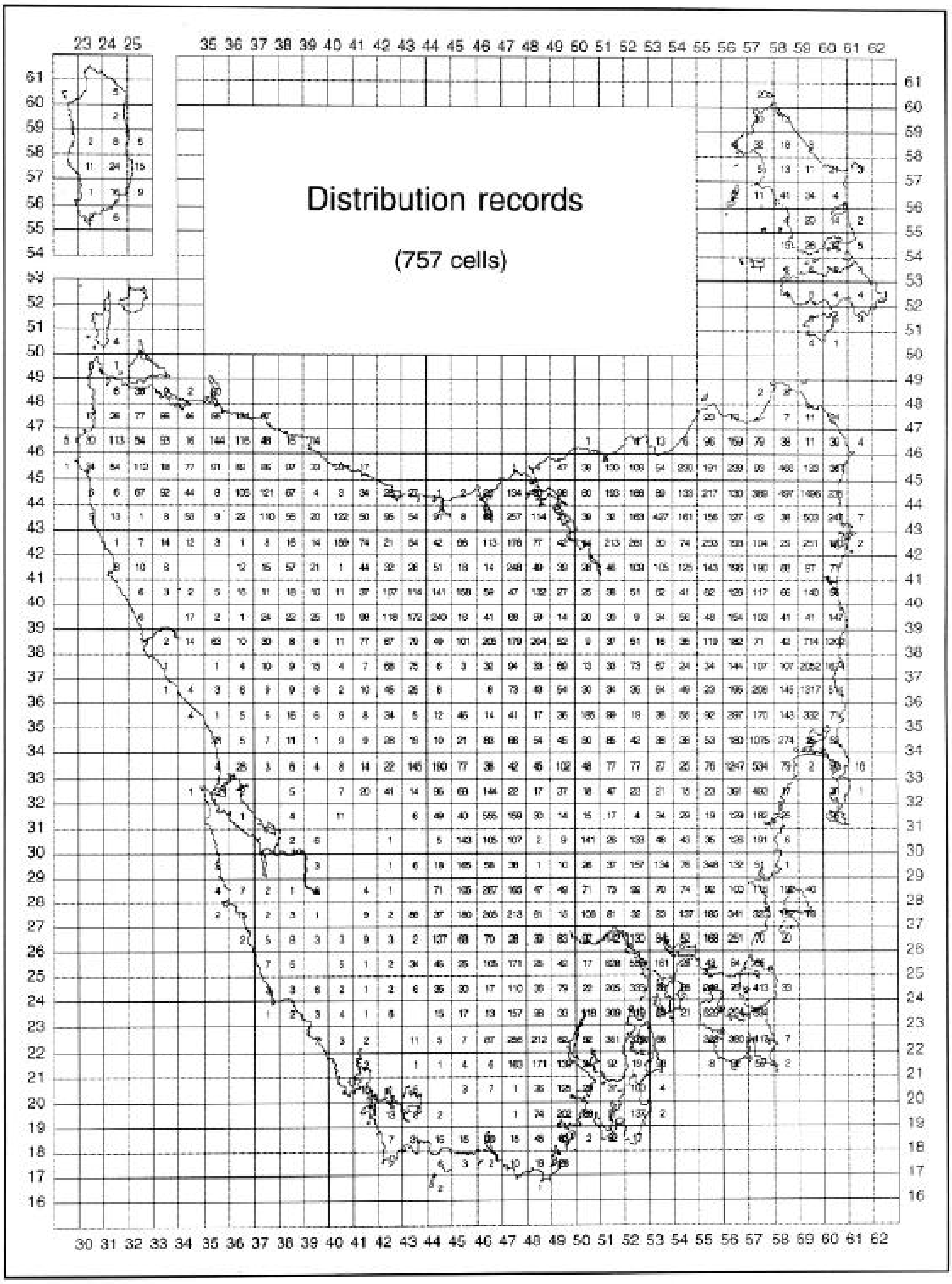



*Figure 92. Sampling intensity. Figures shown in each 10 km x 10 km grid cell indicate the number of eucalypt records used.*

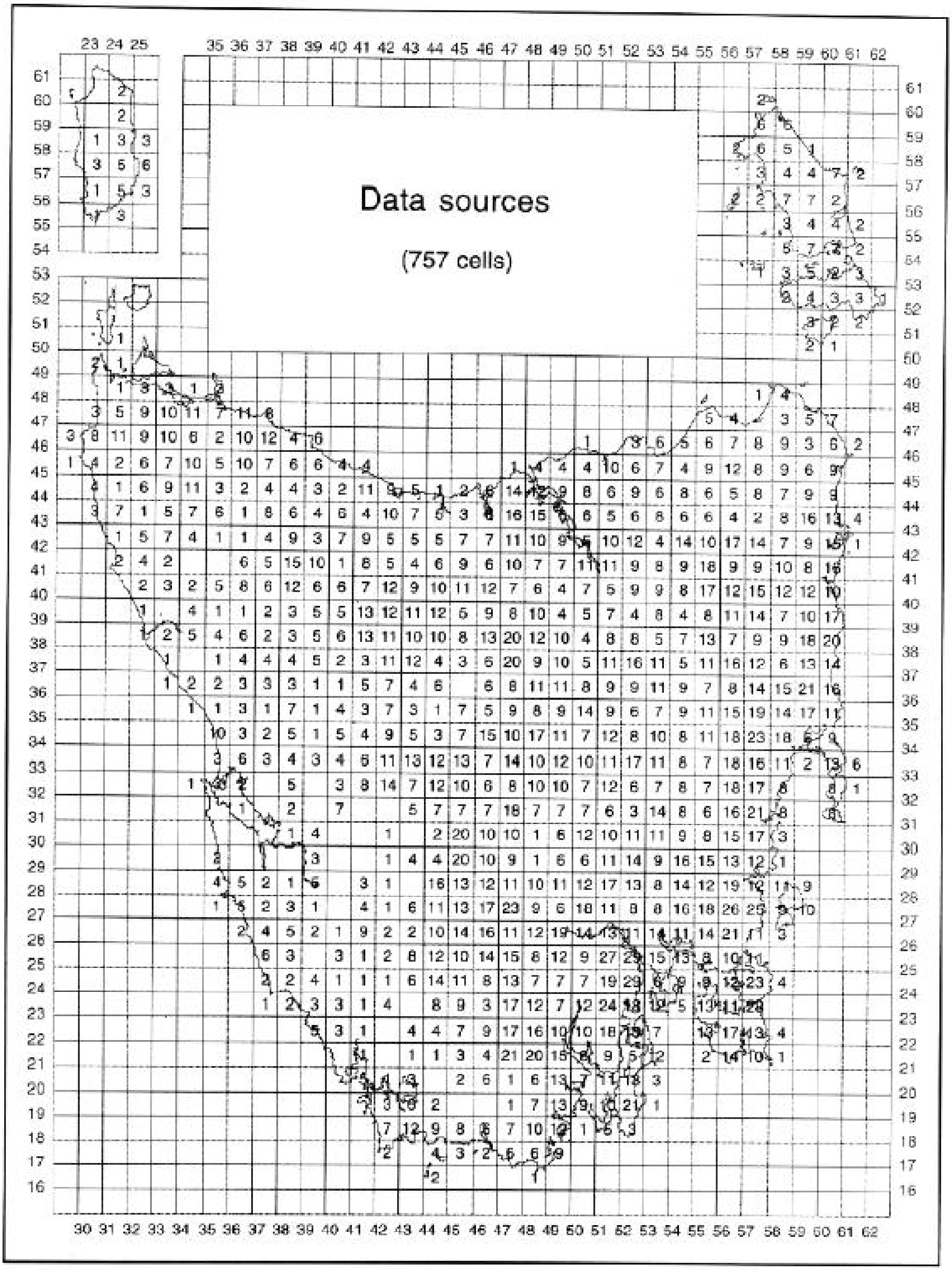



*Figure 93. The number of different data sources per 10 km x 10 km grid cell used to compile the atlas.*

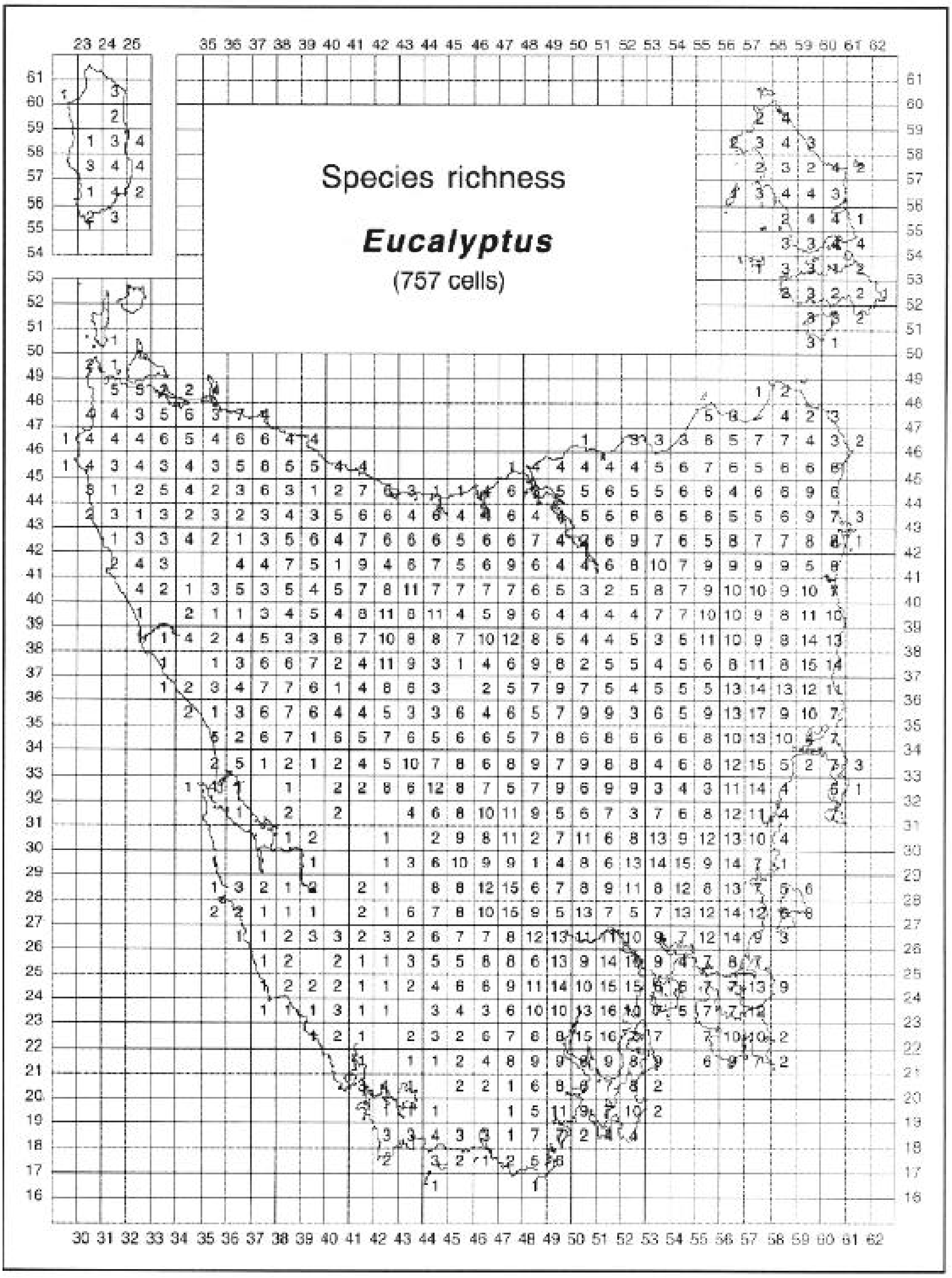



*Figure 94. The number of eucalypt species recorded in each grid cell. (Twenty-nine taxa occur in Tasmania.)*

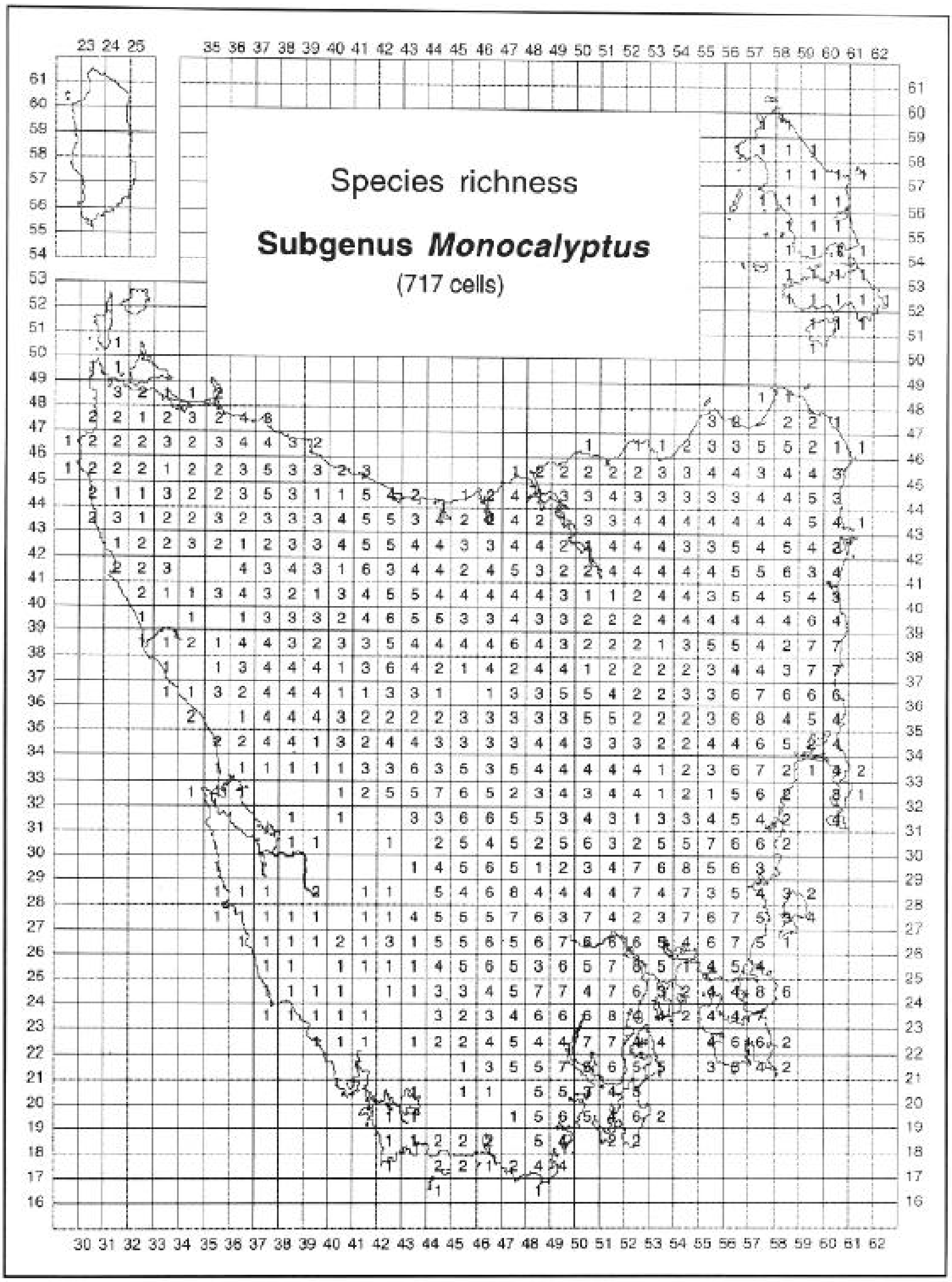



*Figure 95. The number of* Monocalyptus *species recorded in each grid cell. (Twelve taxa occur in Tasmania.)*

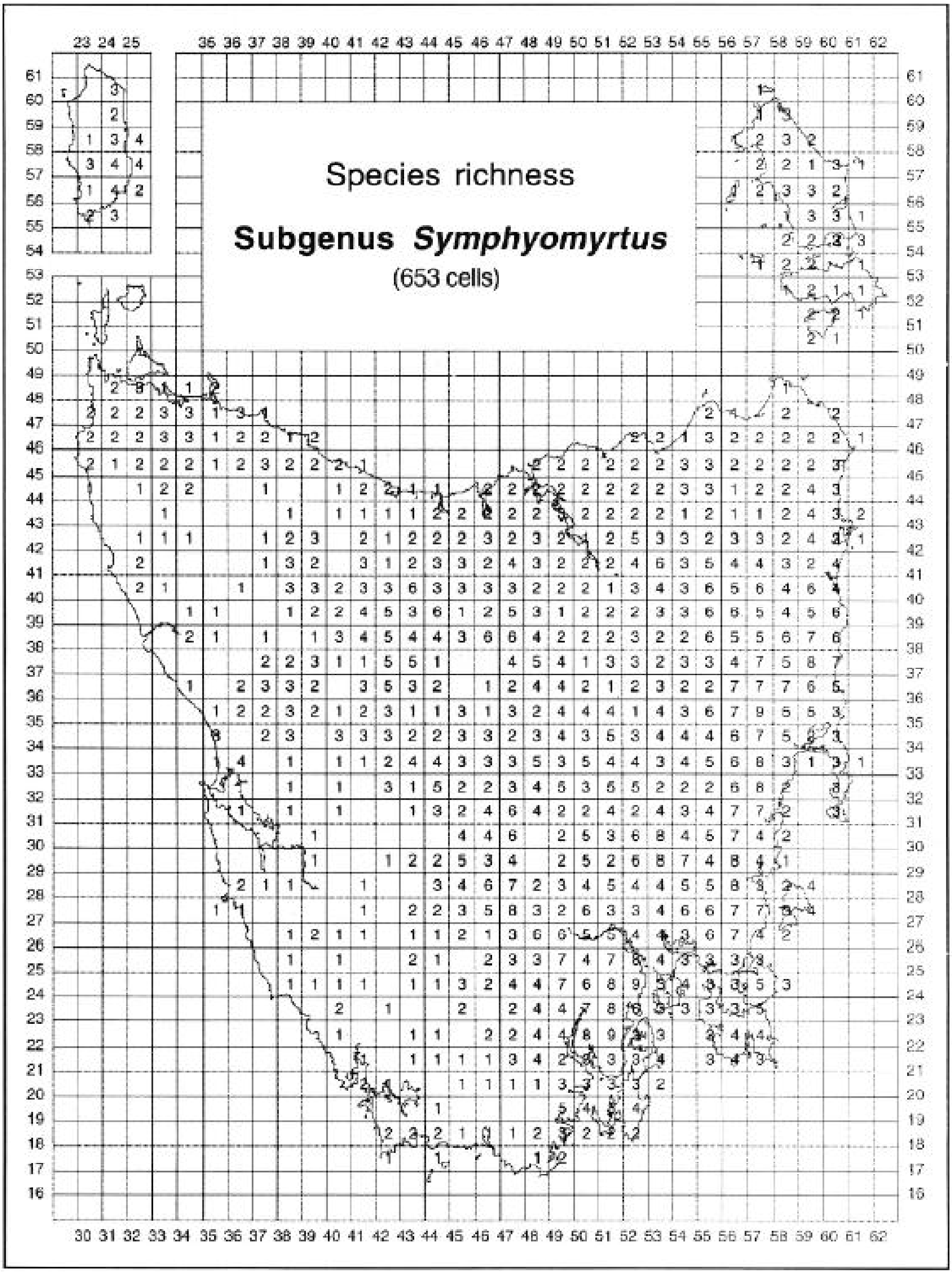



*Figure 96. The number of* Symphyomyrtus *species recorded in each grid cell. (Seventeen taxa occur in Tasmania.)*

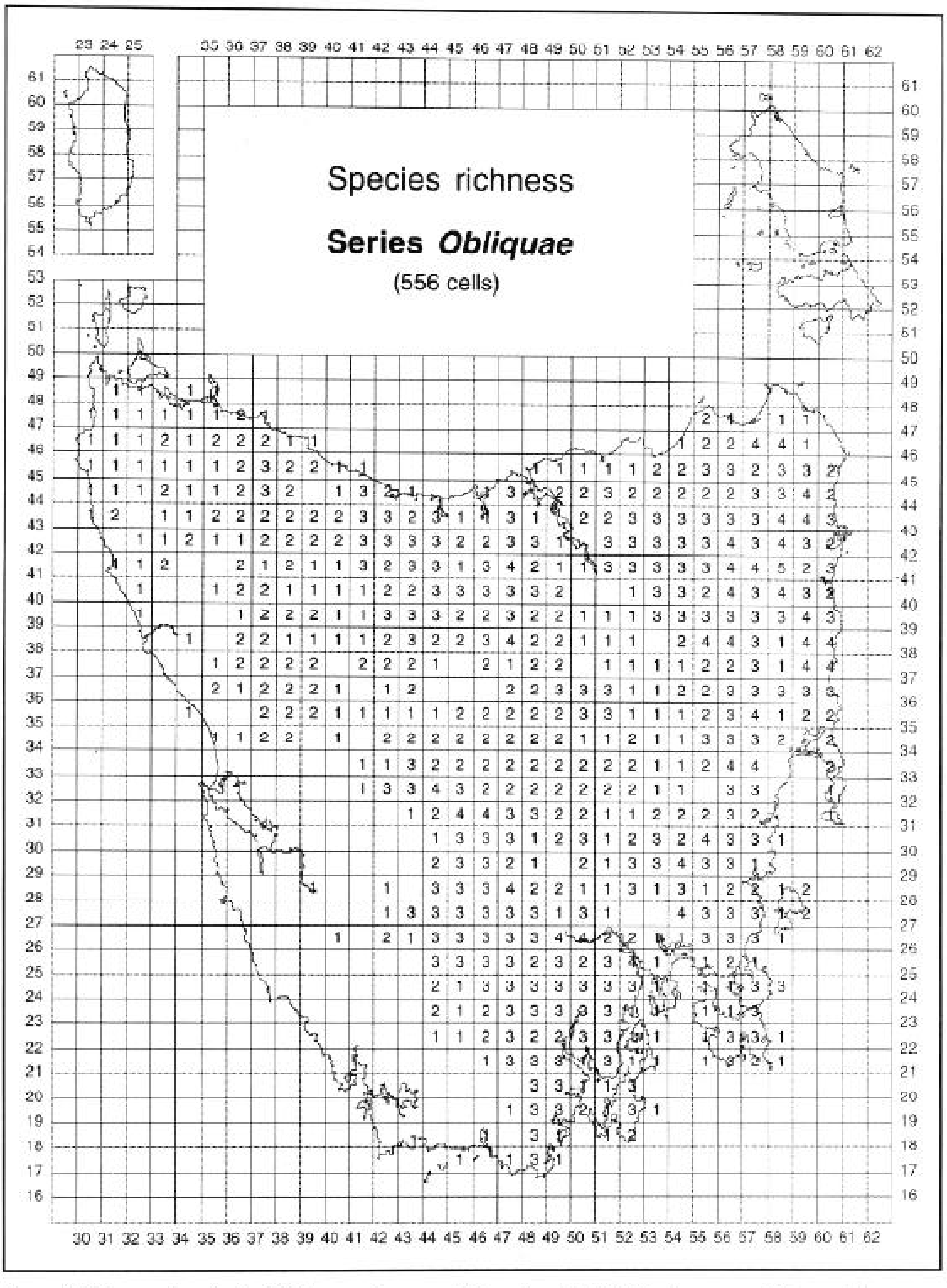



*Figure 97. The number of series* Oblique *species recorded in each grid cell. (Five taxa occur in Tasmania.)*

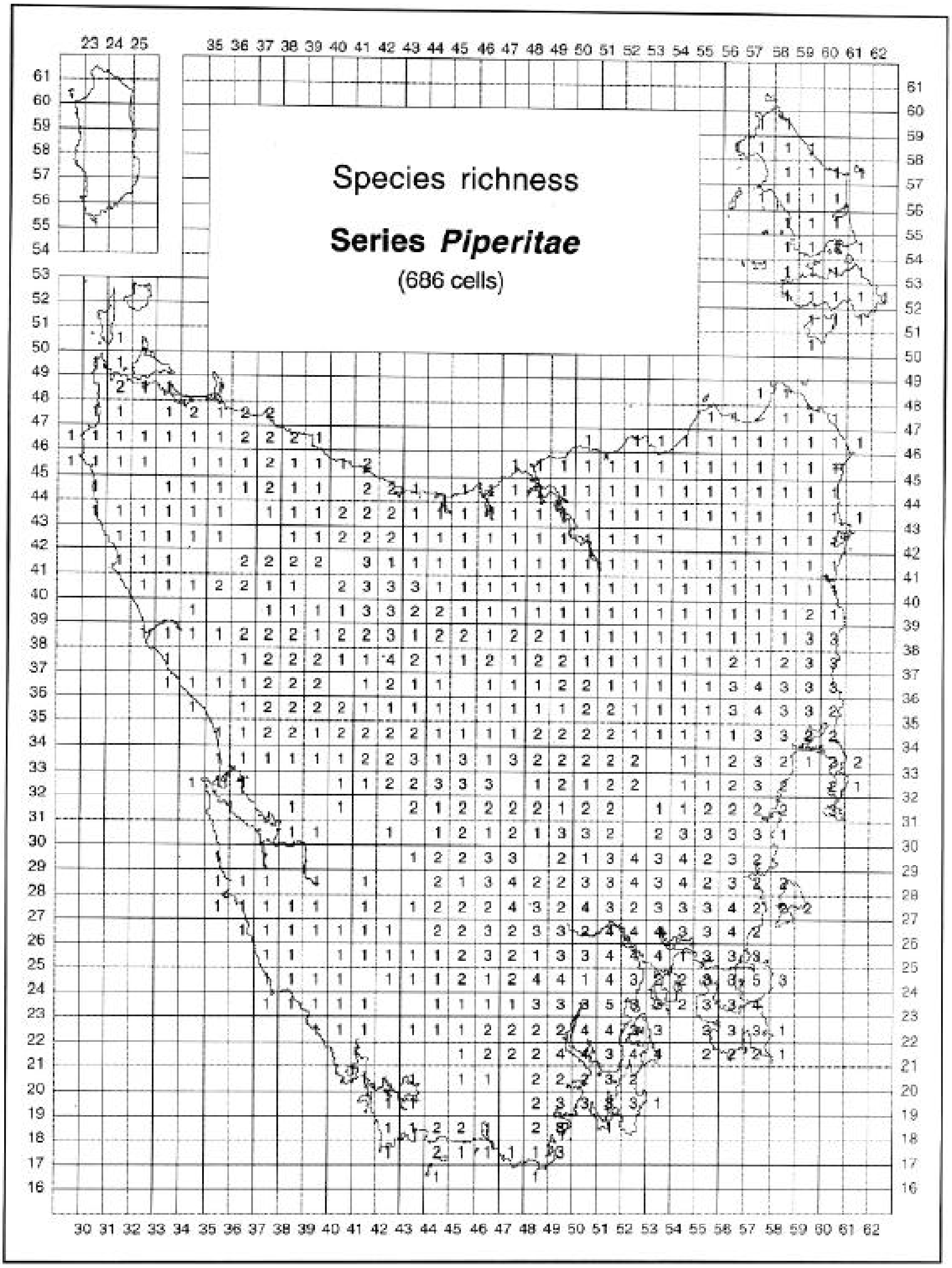



*Figure 98. The number of series* Piperitae *species recorded in each grid cell. (Seven taxa occur in Tasmania.)*

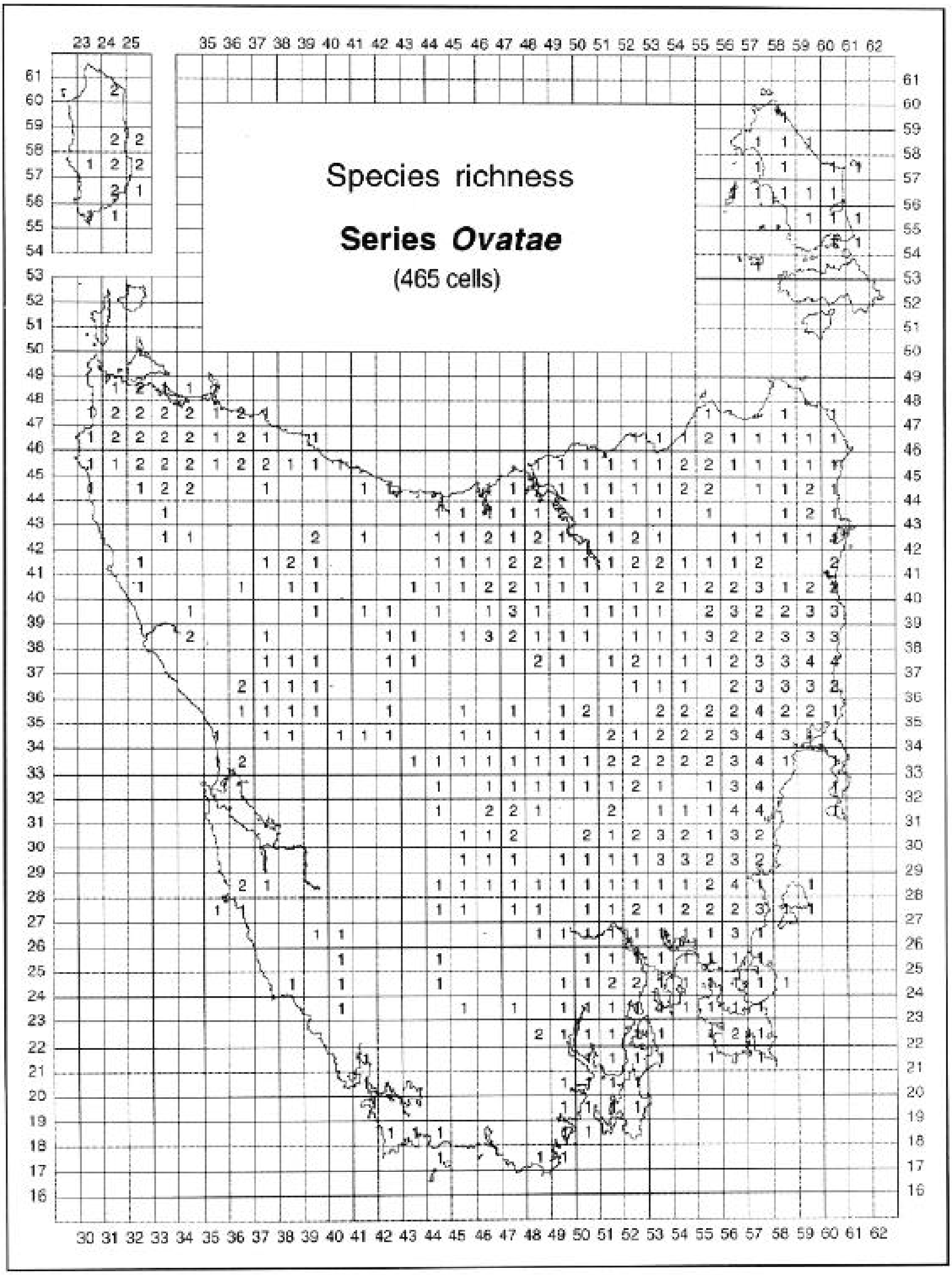



*Figure 99. The number of series* Ovatae *species recorded in each grid cell. (Four taxa occur in Tasmania.)*

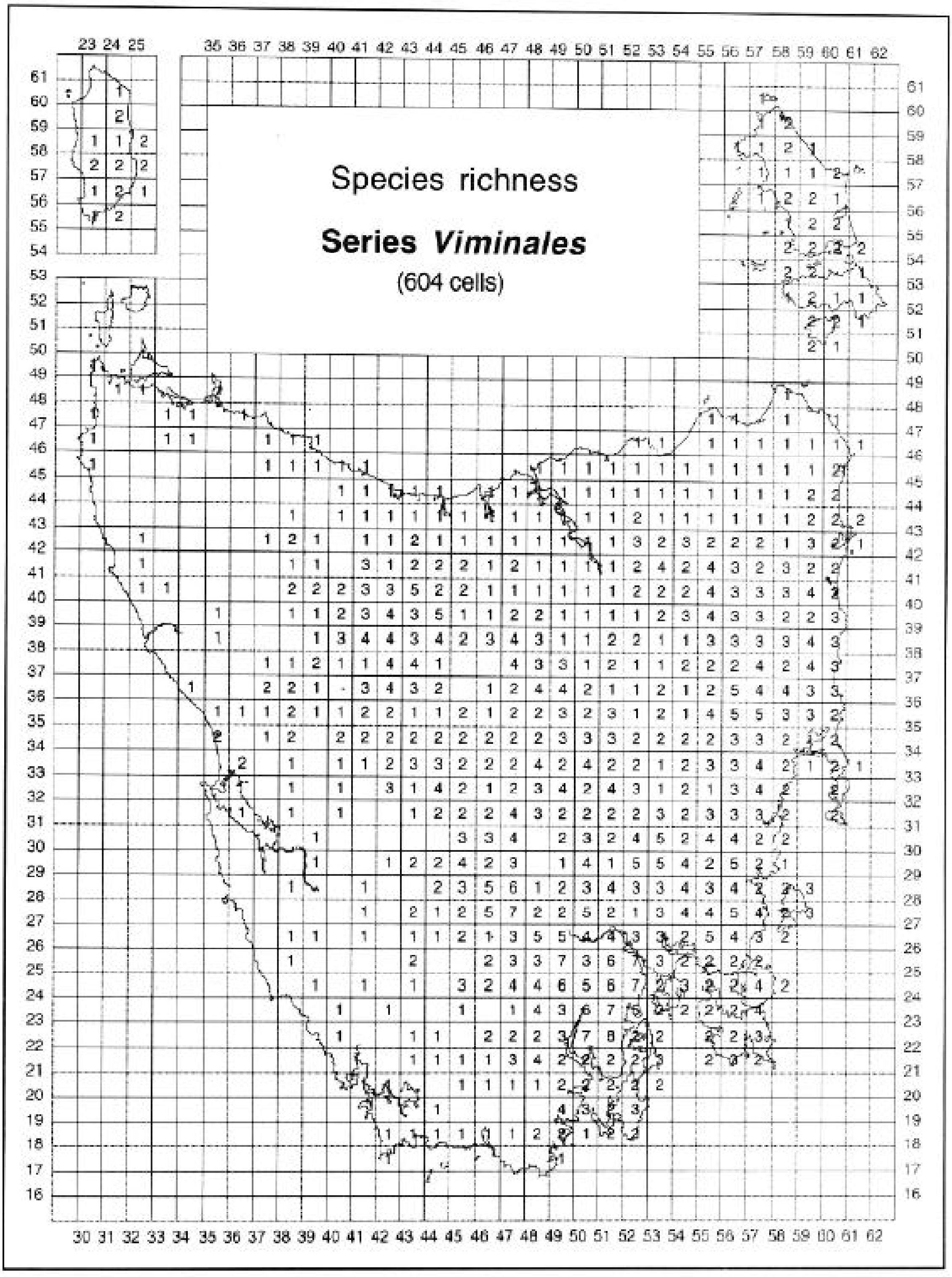



*Figure 100. The number of series* Viminales *species recorded in each grid cell. (Thirteen taxa occur in Tasmania.)*

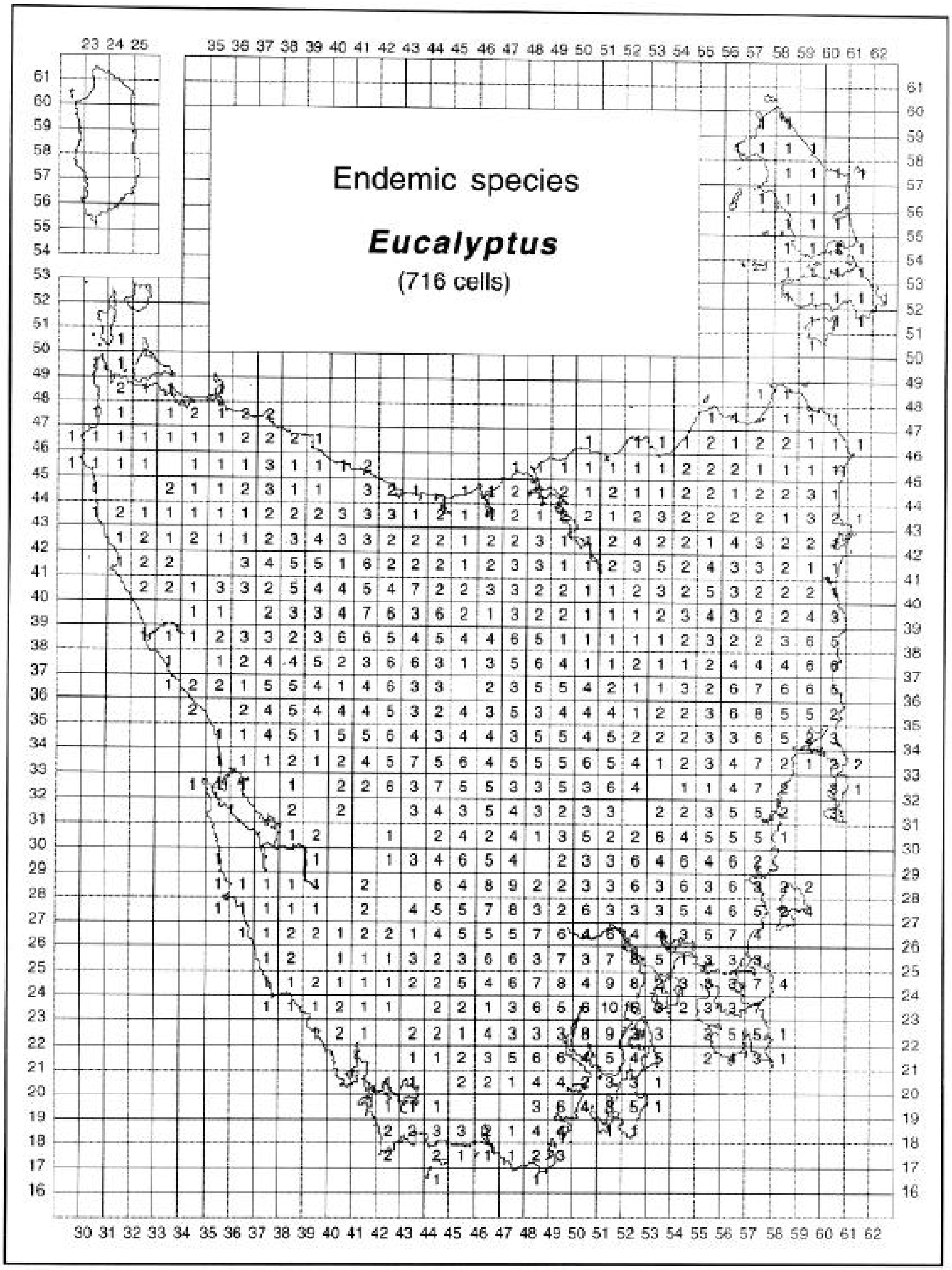



*Figure 101. The number of endemic eucalypt species recorded in each grid cell. (Seventeen endemic eucalypt taxa occur in Tasmania.)*

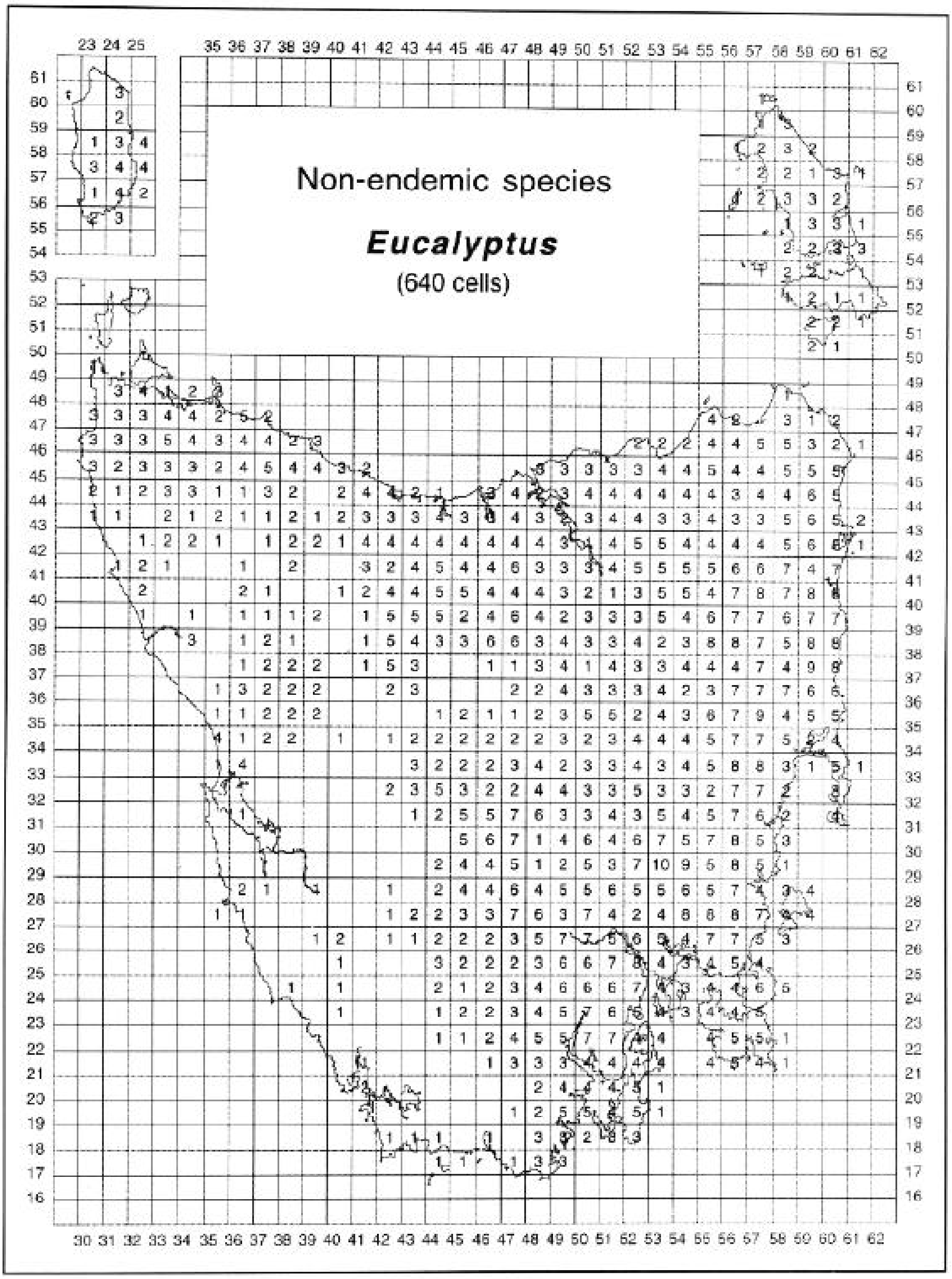



*Figure 102. The number of non-endemic eucalypt species recorded in each grid cell. (Twelve non-endemic taxa occur in Tasmania.)*

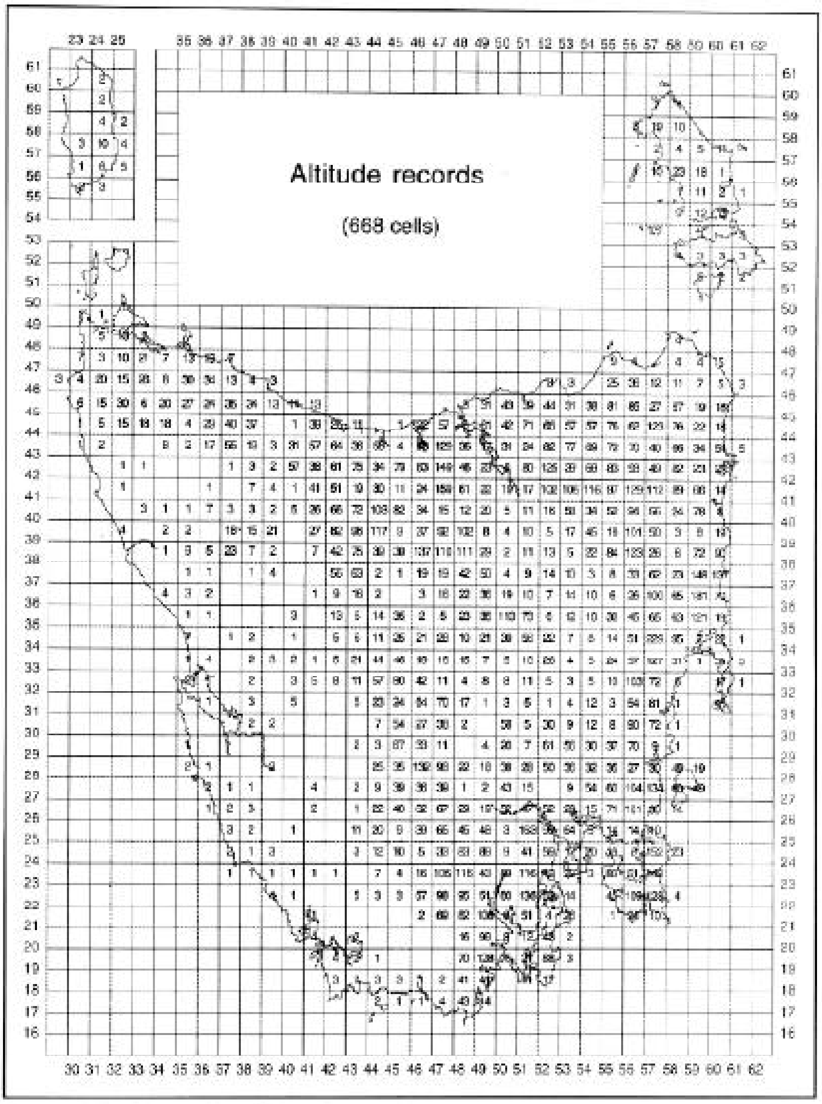



*Figure 103. The number of altitude records in each grid cell that was used to compile the altitude profiles.*

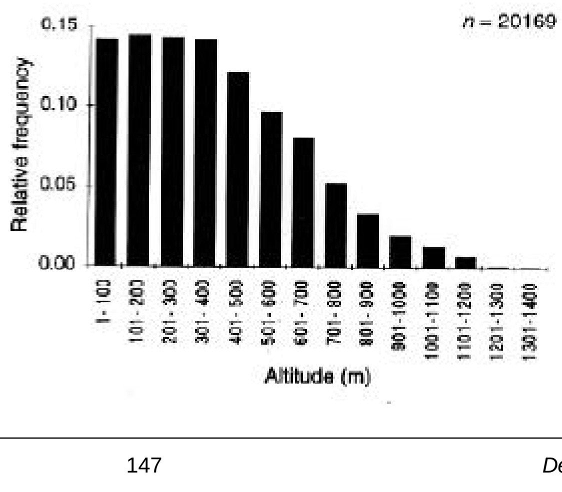



*Figure 104. The number of records in 100 m altitude classes.*

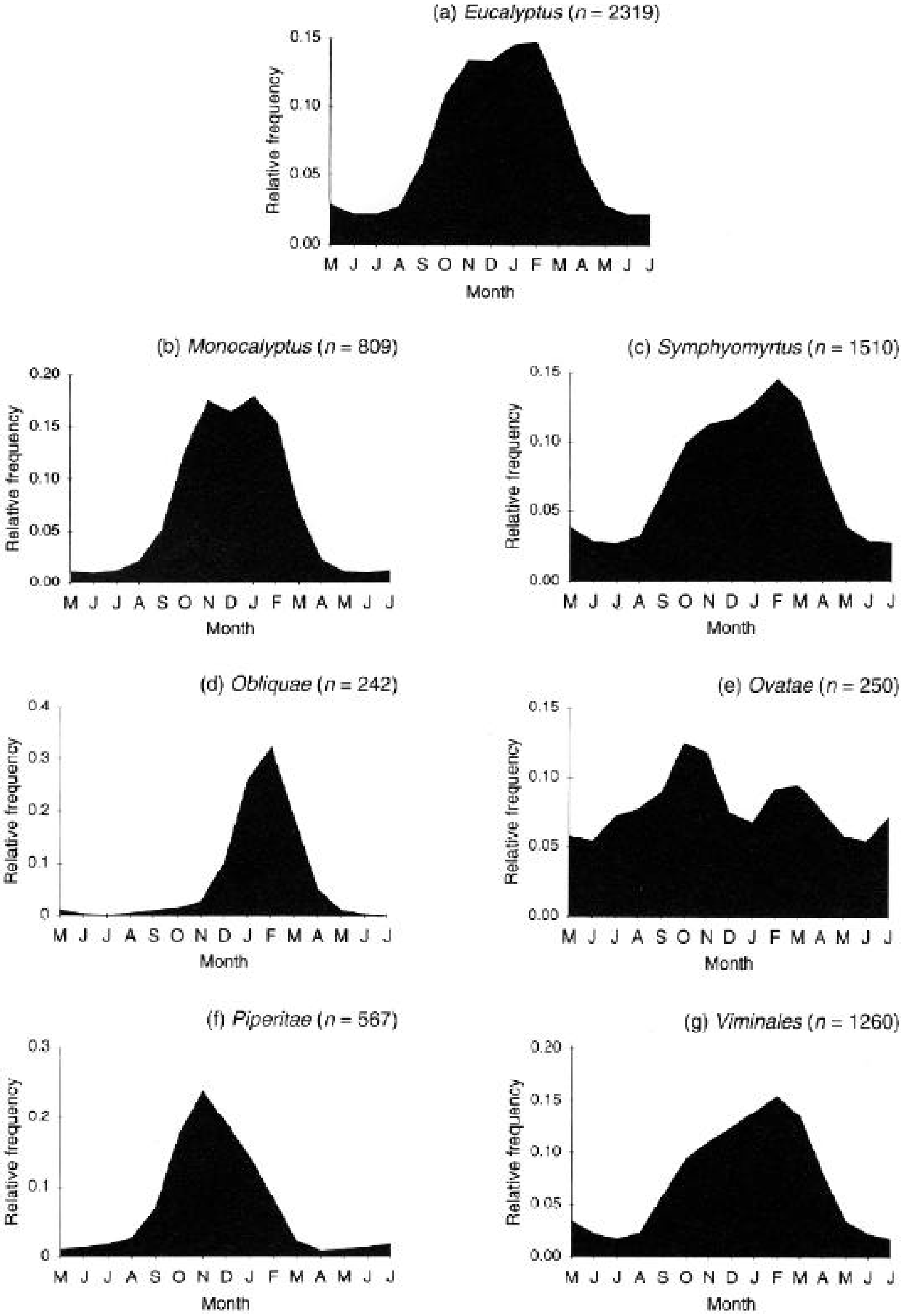



*Figure 105. Flowering time of the genus* Eucalyptus *and its subgroups in Tasmania:* Eucalyptus *(a); subgenera* Monocalyptus *(b),* Symphyomyrtus *(c); and the series* Obliquae *(d),* Ovatae *(e),* Piperitae *(f) and* Viminales *(g).*

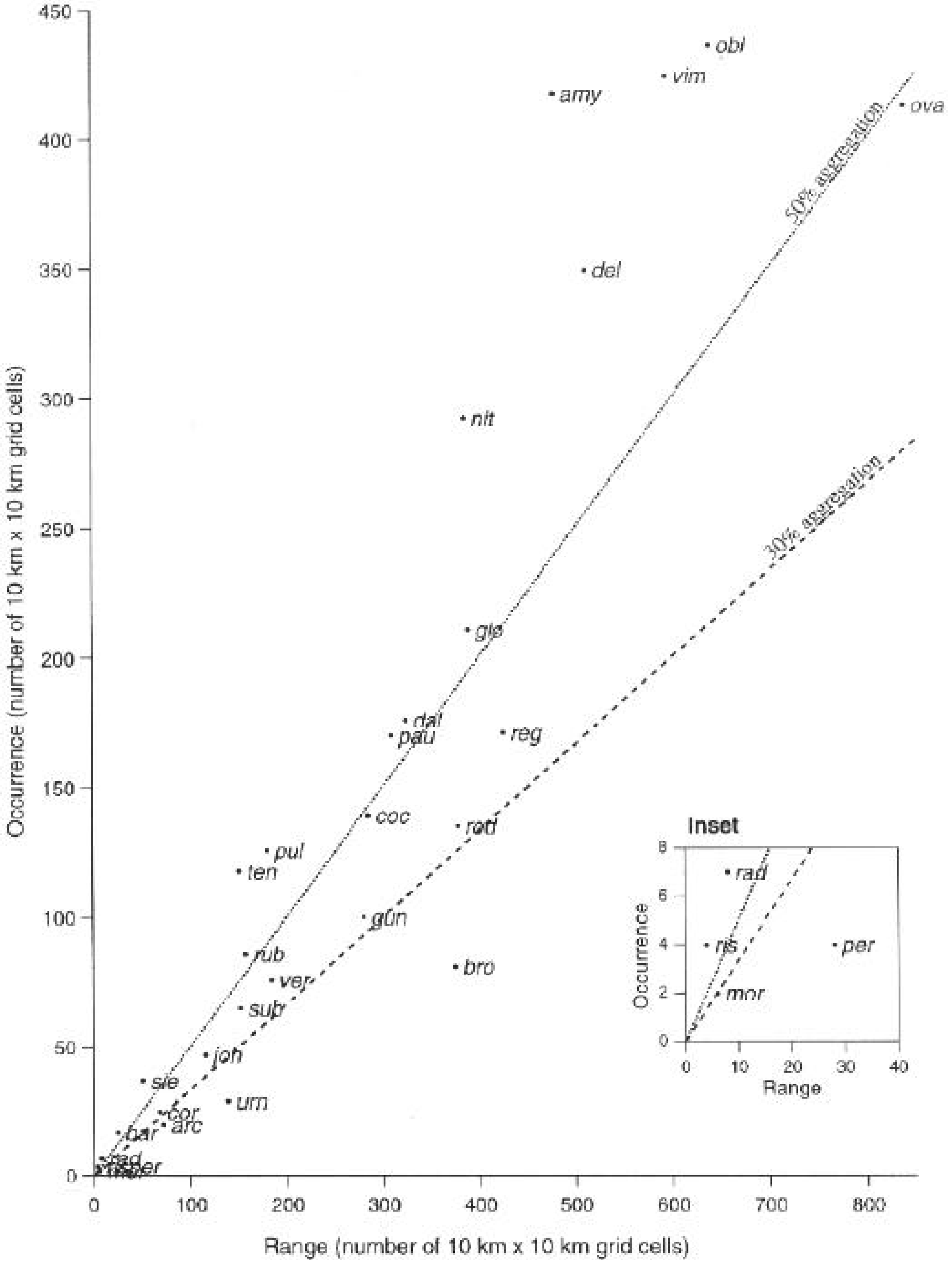



*Figure 106. Eucalypt distribution types. The display shows the number of grid cells in which a species occurs compared with the number of grid cells in the envelope which defines its geographic range (see Table 3). Species may be aggregated, dispersed or scattered within localised, regional or widespread distributions (see Table 4). A species is 100% aggregated if the number of grid cells in which it occurs is equivalent to the number of grid cells across its range. A species is 50% aggregated if it is at least present in half of the cells across its range. Abbreviations refer to the first three letters of the species name.*