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Biogeography of *Caladenia* (Orchidaceae), with special reference to the South-west Australian Floristic Region

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Abstract. *Caladenia* contains 376 species and subspecies, of which almost all are endemic to temperate and southern semiarid Australia. Eleven species occur in New Zealand, 10 of which are endemic, and one species is widely distributed in eastern Australia and the western Pacific. Only three species occur in both south-western and south-eastern Australia. At subgeneric level, *Drakonorchis* is endemic to the South-west Australian Floristic Region (SWAFR), *Stegostyla* to eastern Australia and New Zealand, whereas three subgenera, *Calonema*, *Phlebochilus* and *Elevatae* occur on both sides of the Nullarbor Plain. Subgenus *Caladenia* is primarily eastern Australian but also extends to the western Pacific. The largest subgenera (*Calonema* and *Phlebochilus*) have radiated extensively, with *Calonema* exhibiting a greater concentration of species in more mesic parts of the SWAFR than *Phlebochilus*. Within the SWAFR, the major biogeographic division within *Caladenia* follows the 600-mm isohyet. Within rainfall zones, biogeographic districts for *Caladenia* correlate with a combination of underlying geology and surface soils. Areas of high endemism contain diverse edaphic environments. Climatic and edaphic requirements are likely to be key drivers of rarity in *Caladenia*, although these parameters may be acting in concert with mycorrhizal and pollinator specificity.

Introduction

Caladenia R.Br. (subfamily Orchidoidae) is Australia's largest genus of orchids, with a wide distribution across temperate and semiarid parts of the continent. Australian Caladenias occupy a wide variety of terrestrial habitats (Hopper and Brown 2001; Jones 2006) and utilise a diverse range of pollination strategies (Phillips *et al*. 2009). As such, *Caladenia* provides a useful model to test biogeographic and conservation-biology hypotheses derived from wider studies of the Australian flora (e.g. Crisp *et al.* 1999, 2004; Burgman *et al.* 2007).

Caladenia R.Br. contains approximately 376 species and subspecies divided into six subgenera (Table 1, Fig. 1). Although most species are endemic to southern Australia, 11 species are found in New Zealand (Anonymous 2008), two species in New Caledonia (Jaffré *et al*. 2001) and one species in Indonesia (Comber 1990). Taxonomy of the genus has long been controversial (e.g. Hopper and Brown 2004; Jones and Clements 2005). However, with the exception of the Australian National Herbarium in Canberra, all State and Territory herbaria currently consider *Caladenia sens. lat.* as a single genus. We concur, and follow the nomenclature of Hopper and Brown (2004).

Establishing the geographical pattern of species richness, distribution and endemism of a genus constitutes the first step in determining the climatic, physiographic and ecological factors that control contemporary distributions and promote both speciation and the presence of relictual forms (e.g. Stebbins and Major 1965; Hopper 1979; Kessler 2002). Although a general outline of the biogeography of *Caladenia* has been known for some time (e.g. Jones 1988), a clear understanding of underlying pattern and process has been difficult to assimilate, given the pace of collecting and rate of discovery, and the regular description of new taxa during the past three decades. Here, we summarise a generic overview on the basis of contemporary data for Australia as a whole, and then focus on the South-west Australian Floristic Region (SWAFR – *sensu* Hopper and Gioia 2004) where biogeographic work has been the most active, stimulated by the need to secure data underpinning conservation assessment and management (Hopper *et al.* 1990; Brown *et al*. 1998).

Biogeography of *Caladenia* at the continental scale

In Australia, there are approximately 366 taxa (including species and subspecies) of *Caladenia* (see Appendix 1), including

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Table 1. Number, distribution and diversity of taxa within subgenera of *Caladenia*

SWAFR = South West Australian Floristic Region. Centres of diversity in each subgenus are in bold

Subgenus	SWAFR	Eastern Australia	Common to both	Outside Australia
Caladenia	0	**37**	0	10
Calonema	78	**141**	0	0
Drakonorchis	**4**	0	0	0
Elevatae	**10**	1	1	0
Phlebochilus	**72**	10	3	0
Stegostyla	0	**16**	0	1
Total	164	205	4	11

287 named taxa and at least 79 recognised but currently unnamed taxa (Hopper and Brown 2001, 2004; Jeanes and Backhouse 2006; Jones 2006; Brown and Brockman 2007; NOSSA 2007; Walsh and Stajsic 2007; Brown *et al.* 2008; G. Backhouse and A. P. Brown, unpubl. data). New Zealand contains 11 species of *Caladenia* (10 in subgenus *Caladenia*, one in subgenus *Stegostyla*), 10 of which are endemic and one is shared with Australia (Jones 2006). The majority of species in New Zealand are widespread and occur on both the north and south island (Anonymous 2008). *C. catenata* (Smith) Druce and *C. carnea* both occur in New Caledonia (Jaffré *et al*. 2001), with *C. carnea* R.Br. extending through Indonesia, including Sulawasi and West Papua (Comber 1990).

Within Australia, *Caladenia* has a Bassian distribution (see Crisp *et al.* 1999), with major centres of diversity in the temperate areas of the SWAFR and south-eastern Australia (Table 1, see also Fig. 2 for geographic locations). The SWAFR has about 164 taxa (including species and subspecies) in four subgenera (Table 1), comprising 142 described taxa and 22 taxa awaiting formal description (Brown *et al.* 2008). In eastern Australia (including South Australia, Victoria, Tasmania, New South Wales, the Australian Capital Territory and Queensland) there are about 205 taxa in five subgenera, comprising 149 described taxa and 56 taxa awaiting formal description. In eastern Australia, the most species-rich area is Victoria, which, although with only 3% of the land area of Australia, has 104 taxa (28% of Australia's *Caladenia* taxa).

In both south-western and south-eastern Australia, greatest diversity of *Caladenia* occurs in higher-rainfall zones (>600 mm average annual rainfall), generally within 200 km of the coast. Several species occur well inland in the 400–600-mm rainfall belt, with some occurring in areas as low as 300 mm (rarely down to 250 mm), although in these areas plants tend to be confined to creek lines, depressions and rocky areas where plants receive additional moisture because of runoff (Hopper and Brown 2001; Brown and Brockman 2007). Most species occur generally below 1000 m asl, although several extend above that, and at least three species – *C. alpina* R.S.Rogers (subgenus *Stegostyla*), *C. aestiva* D.L.Jones and *C. montana* G.W.Carr (subgenus *Calonema*) – are largely confined to montane and subalpine woodlands above 800 m (Jones 2006).

The major biogeographic division within the temperate Australian biota is the division between the western and eastern parts of the continent by the Nullabor Plain (Hooker 1860; Cracraft 1991; Schodde 2006; Crisp and Cook 2007). The Nullabor Plain is an arid, limestone plateau that has been subject to periods of marine inundation. Crisp and Cook (2007) found that the period of aridity 13–14 million years ago was the strongest correlate with west–east vicariances in numerous genera of plants, although this was not consistent across all genera. The Nullabor Plain continues to form a major climatic and edaphic boundary between the biotas of western and eastern Australia. Within *Caladenia*, only three species and one subspecies are common to both south-western and eastern Australia. Three taxa – *C. microchila* Hopper & A.P.Br., *C. bicalliata* subsp. *bicalliata* R.S.Rogers and *C. bicalliata* subsp. *cleistogama* Hopper & A.P.Br. (subgenus *Phlebochilus*) – extend from Western Australia into South Australia (Hopper and Brown 2001; Jones 2006). Only a single species – *Caladenia latifolia* R.Br. (subgenus *Elevatae*) – is widely distributed in both south-eastern and the south-western Australia.

On the basis of distributional data for the flora and vertebrates, south-eastern Australia can be divided into the following five centres of endemism: (i) Tasmania; (ii) south-eastern New South Wales; (iii) southern and eastern Victoria; (iv) south-eastern South Australia and north-western Victoria; and (v) the Eyre Peninsula (Crisp *et al.* 1995). Tasmania has the most distinct biota of this region through sustained isolation. The two regions centered on the Great Dividing Range (south-eastern New South Wales and southern and eastern Victoria) show strong similarities to each other and to a lesser extent to south-eastern South Australia and north-western Victoria. Eyre Peninsula (including Kangaroo Island) has the closest affinity with the SWAFR. Analysis of the distribution of *Caladenia* at the subgeneric level demonstrates that *Caladenia* shows similar biogeographic regions in south-eastern Australia.

Subgenera with highest diversity in eastern Australia

Subgenus *Caladenia* is distributed across eastern Australia and New Zealand (Table 1). Of the 46 species in the subgenus, *C. carnea* is the most widely distributed species, occurring in Australia from the Eyre Peninsula in South Australia to Tasmania to Cape York Peninsula in northern Queensland (Jones 2006). *C. chamaephylla* D.L.Jones is confined to northern Queensland at about 17°S, where it is restricted to the cooler tablelands and higher ranges (Jones 2006). Subgenus *Caladenia* has by far the largest distribution of any subgenus of *Caladenia* outside of Australia. The mechanism for its comparative success outside Australia is unknown. However, among the subgenera of *Caladenia*, the propensity to evolve self-pollination is greatest in this subgenus (Phillips *et al*. 2009), which may assist colonisation. In Australia, subgenus *Caladenia* occurs primarily on the eastern seaboard in the south-eastern New South Wales and Victoria regions. A small number of species extend into south-eastern South Australia and two species are endemic to the Flinders and Mt Lofty Ranges (Jones 2006). Members of subgenus *Caladenia* occur from 0 to 800 m asl, generally in areas of heath and forest, but occasionally in drier inland forests and mallee or rocky outcrops (Bishop 2001; Jones 2006). They occur in a range of well-drained soils, usually sands and loams (Bishop 2001; Jones 2006).

Fig. 1. Representatives of each of the subgenera of *Caladenia*. (*A*) *C. carnea* (subgenus *Caladenia*); (*B*) *C. congesta* (subgenus *Stegostyla*); (*C*) *C. latifolia* (subgenus *Elevatae*); (*D*) *C. caesarea* subsp. *maritima* (subgenus *Phlebochilus*); (*E*) *C. barbarossa* (subgenus *Drakonorchis*); (*F*) *C. crebra* (subgenus *Calonema*). Photos by Gary Backhouse (*C. carnea* and *C. congesta*), Andrew Brown (*C. latifolia*, *C. barbarossa* and *C. crebra*) and Ryan Phillips (*C. caesarea* subsp. *maritima*).

Similarly to subgenus *Caladenia*, subgenus *Stegostyla* is restricted to eastern Australia in its continental range, with one species occurring in New Zealand (Table 1). The centre of distribution for the 16 Australian members of this subgenus is in Tasmania and along the Great Dividing Range in Victoria and southern New South Wales (Jones 2006). A small number of species occur in south-eastern South Australia, but none occurs in the comparatively dry central areas of central South Australia (Jones 2006). This subgenus shows the greatest altitudinal range of any of the subgenera of *Caladenia*, occurring from sea level up to 1500 m (Jones 2006). Most species in subgenus *Stegostyla* occur in heath or forest (Bishop 2001; Jones 2006). *C. alpina* is a notable exception that occurs in high-altitude snow-gum woodlands. The majority of species prefer well-drained soils (Jones 2006).

Subgenus *Calonema* is by far the most diverse subgenus of *Caladenia* in both eastern Australia and the SWAFR, with about 141 taxa in eastern Australia and 78 taxa in the SWAFR Australia. Even though almost all of the species occur at low altitudes, *C. montana* reaches altitudes of 1000 m (Jones 2006). Members of this subgenus most frequently occupy forests and woodlands with well-drained soils but also occur in a diversity of other habitats such as granite outcrops, swamps and coastal sand dunes (Hopper and Brown 2001; Jones 2006; Brown *et al.* 2008). There is morphological evidence that some species complexes are shared between states (e.g. the *C. dilatata*, *C. patersonii* and

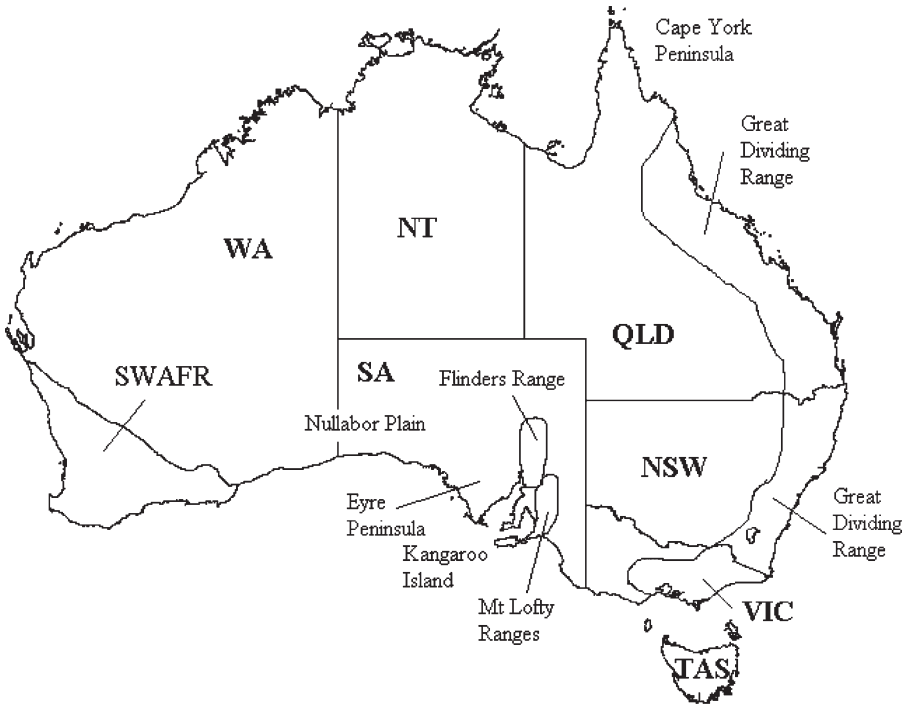

Fig. 2. The States and Territories of Australia and geographic locations referred to in the text. WA = Western Australia, NT = Northern Territory, Qld = Queensland, NSW = New South Wales, Vic. = Victoria, Tas. = Tasmania, SA = South Australia, SWAFR = South-west Australian Floristic Region.

C. huegelii complexes). Early investigations of mycorrhizal ecology have shown a high degree of specificity within this subgenus (Ramsay *et al*. 1986; Huynh *et al.* 2004; Swarts 2007). Likewise, in species pollinated by sexual deception of thynnine wasps, orchid–pollinator relationships are highly specific (Stoutamire 1983; Phillips *et al*. 2009). Comparative study of the mycorrhizal and pollinator specificity of clades that have undergone differing levels of diversification would begin to unravel the causes of the tremendous diversity within the subgenus *Calonema* and within the genus *Caladenia* more generally.

Subgenera with highest diversity in the SWAFR

Subgenus *Elevatae* is largely confined to the SWAFR, with nine endemic species and subspecies in the SWAFR and a single species (*C. latifolia*) occurring in both south-western and south-eastern Australia (Table 1). While it occurs in a variety of habitats, *C. latifolia* frequently occurs in coastal areas in Western Australia, Victoria, south-eastern South Australia and Tasmania (Bishop 2001; Jones 2006). The majority of species in this subgenus are common and widespread, with highest diversity in more mesic parts of the SWAFR (Hopper and Brown 2001). Members of subgenus *Elevatae* occupy a wide range of soil types and habitats, ranging from altitudes of 0 to 400 m (Jones 2006; Brown *et al.* 2008).

The centre of diversity for subgenus *Phlebochilus* is in the SWAFR where approximately 72 taxa occur (Table 1). The subgenus is poorly represented in eastern Australia, with only six named species and subspecies (three of which are shared with Western Australia); however, there are at least four distinct although currently unnamed taxa present in eastern Australia. A wide range of habitats and soil types are occupied at altitudes ranging from 0 to 500 m (Jones 2006; Brown *et al*. 2008). Subgenus *Phlebochilus* is more diverse than the early branching clades of *Caladenia* (Hopper and Brown 2001). This diversification may have been driven through an increase in mycorrhizal specialisation or the evolution of sexual deception in some groups of this subgenus (Stoutamire 1983; Phillips *et al*. 2009). However, these hypotheses are yet to be evaluated.

Drakonorchis is a small subgenus of four species endemic to the SWAFR. They are a morphologically conservative group, all of which use sexual deception (Stoutamire 1983; A. P. Brown, unpubl. data). The subgenus is mostly confined to semiarid Western Australia between 40- and 350-m altitude (Hopper and Brown 2001; Jones 2006). They occupy a range of habitats and soil types, although the more arid species are always associated with seasonally moist environments (Hopper and Brown 2001).

Biogeography of *Caladenia* in south-western Australia

Finer-scale resolution of biogeographic regions requires detailed distributional data, usually in the form of expansive herbarium collections (e.g. Hopper and Gioia 2004). Resolution of finer-scale regions enables inferences to be drawn on the role of geological and climatic influences on distribution and speciation. Furthermore, such analyses can highlight areas of particular conservation concern through high endemism or species richness. At present, such data are not available in eastern Australia. However, a dataset for Western Australia, using the entire orchid collection of the Western Australian Herbarium, has been collated. Here we present a summary of these data by using *Caladenia* only, with a more detailed

publication involving the entire orchid flora of the SWAFR to follow (R. D. Phillips, A.P. Brown, K.W. Dixon, S.D. Hopper, unpubl. data).

The SWAFR contains exceptionally high floristic diversity, primarily in the sclerophyllous shrublands of the Transitional Rainfall and Southeast Coastal Botanical Provinces between the mesic south-western corner (High Rainfall Botanical Province) and the arid zone (Hopper and Gioia 2004; Fig. 3). This diversity arose from a combination of diverse soil mosaics and climatic fluctuation in the Cenozoic, affording the opportunity for repeated bouts of allopatric speciation (Hopper and Gioia 2004). The major biogeograhic division within the SWAFR is between the High Rainfall Province (600+ mm) and the Transitional Rainfall Zone (*sensu* Hopper 1979). The Transitional Zone can be further subdivided into the Transitional Rainfall Province and the Southeast Coastal Province (Hopper and Gioia 2004). Within these provinces, floristic composition is primarily determined by edaphic environments.

In south-western Australia, caladenias are mostly confined to the SWAFR, with a small number of species reaching the adjacent Goldfields region, where there is only one endemic species, *Caladenia saxicola* A.P.Br & G.Brockman (Brown and Brockman 2007). A detailed biogeographic analysis of the entire Western Australian orchid flora has shown that the orchids show a strong congruence with the biogeographic patterns evident in the remainder of the flora (Hopper and Gioia 2004; R. D. Phillips, A.P. Brown, K.W. Dixon, S.D. Hopper *et al.*, unpubl. data). We used the biogeographic regions delineated by Hopper and Gioia (2004) as a framework to investigate patterns of endemism and species composition in *Caladenia* in the SWAFR. By using the specimen records of *Caladenia*, we investigated (i) patterns of species richness for the genus, (ii) the pattern of species richness for the two largest subgenera in *Caladenia* – *Calonema* and *Phlebochilus*, (iii) the similarity in composition of *Caladenia* species between biogeographic districts, and (iv) which botanical districts exhibit high levels of endemism. Combining these approaches allows us to infer the climatic origin of the Western Australian subgenera and infer the geological environments that have allowed for accumulation of species and driven speciation. Areas of particularly high endemism will also serve to focus conservation efforts in the genus.

Methods

We used the 5101 collections of *Caladenia* in the Western Australian Herbarium (PERTH) as at June 2006, to plot the distribution of Western Australian *Caladenia*. The south of the State was broken into quarter-degree latitude by longitude grid cells, with species coded as present or absent for each grid cell. The number of species occurring in each cell was then summed. This analysis was undertaken across all *Caladenia* and for the two largest subgenera, *Calonema* and *Phlebochilus*. We calculated the percentage of endemism in each biogeographic district. UPGMA cluster analysis in SYSTAT 10 was used to graphically represent the similarity of the composition between districts. Distances were measured with Euclidean distance. The Goldfields region was discounted from the cluster analysis because it contains only sporadic populations of a small number of caladenias, which are usually much more abundant within the confines of the SWAFR.

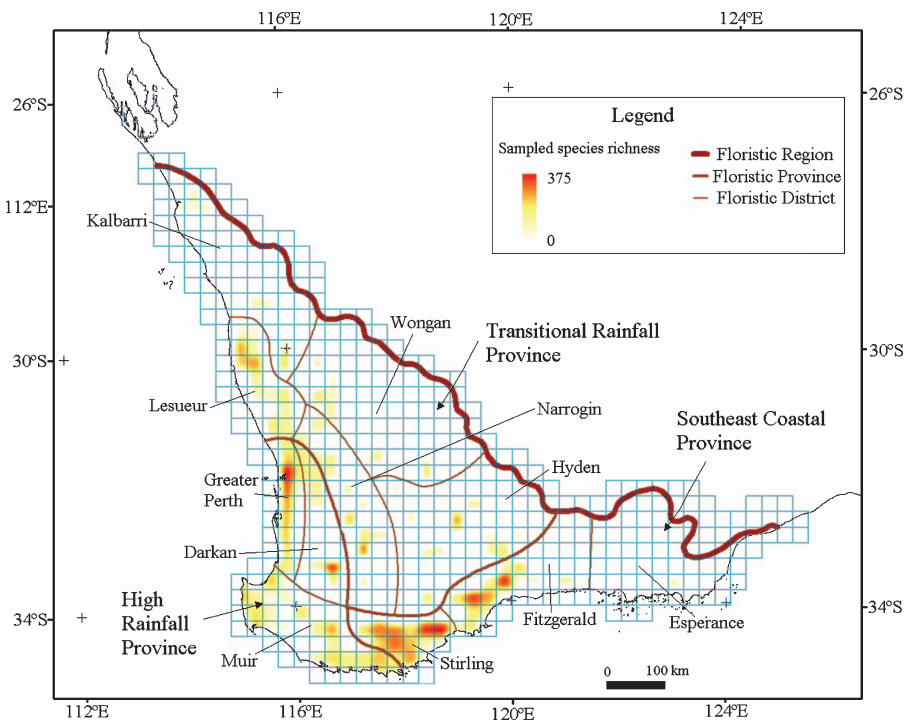

Fig. 3. A map showing floristic provinces and districts and areas of high species richness for the whole vascular flora (7380 species/subspecies) in the South-west Australian Floristic Region. Modified from Hopper and Gioia (2004).

Species richness

Most areas of high species richness are confined to within the 600-mm isohyets (Fig. 4). Although this is in contrast to the flora in general, several families of annuals and perennial herbs reach their highest diversity in the High Rainfall Botanical Province of the south-western corner (Hopper *et al*. 1992). Furthermore, outside of Australia, the geographic regions with the highest orchid diversity are all high-rainfall environments (Cribb *et al*. 2003). Within the High Rainfall Province, areas of high diversity are aligned with soil type rather than rainfall. Areas of high diversity follow high-rainfall coastal regions with a diversity of soil types (Swan Coastal Plain, Leeuwin–Naturaliste Ridge and Walpole, Fig. 5) and clay-based flats in eucalypt woodlands and forests (Brookton and Muir–Frankland region). Outside of the High Rainfall Botanical Province, the Jerramungup area is notable for its diversity, especially its wattle (*Acacia* spp.) and sheoak (*Allocasuarina huegeliana*) woodlands and shrublands. It is unknown whether these habitats have such high diversity through greater pollinator or mycorrhizal diversity, higher levels of moisture or light during the growing season, suitable levels of organic matter or lack of competition from other plants. Further inland, *Caladenia* become increasingly tied to seasonally moist environments such as granite outcrops, drainage lines, breakaways and soils of heavier texture such as loam clays (Hopper and Brown 2001; Brown and Brockman 2007).

Splitting the dataset into the two most species-rich subgenera, *Calonema* (78 spp.) and *Phlebochilus* (72 spp.), revealed major differences in their centres of distribution (Fig. 6, Fig. 7). Subgenus *Calonema* was limited to the higher-rainfall Provinces and Districts, with very high diversity on the geologically diverse Leeuwin–Naturaliste Ridge and high diversity in the clay-based flats of the Muir–Frankland area and the sands of the Swan Coastal Plain. In contrast, subgenus *Phlebochilus* has its centre of diversity in the semiarid zone, primarily in clay flats and granite outcrop communities. This subgenus is largely absent from the highest rainfall parts of the lower south-west.

Biogeographic regionalisation for Caladenia *in the SWAFR*

Biogeographic divisions in *Caladenia* generally follow those of the SWAFR flora as a whole. The major biogeographic division within *Caladenia* follows the 600-mm isohyet (Fig. 5), with the Muir, Greater Perth and Darkan Botanical Districts of the High Rainfal Botanical Province (*sensu* Hopper and Gioia 2004) distinct from the remaining provinces and districts. This is a common distributional margin for both widespread arid and mesic species (Hopper and Brown 2001). Within these Provinces, biogeographic districts correspond to a combination of geology and rainfall and show a strong correlation with the flora as a whole. For example, in the High Rainfall Botanical Province, the coastal sands of the Greater Perth District has a distinct flora compared with those of the lateritic scarp and clay flats further inland that characterise the Darkan District (Fig. 8). Similarly, in the Transitional Rainfall Province, the two northern sandplain kwongan districts, Lesueur and Kalbarri, are more similar to each other than either is to the eastern districts (Fig. 8), which tend to be dominated by a greater proportion of clay-based soils.

The Southeast Coastal Botanical Province is not strongly supported by the distribution of *Caladenia* species in comparison with the whole SWAFR flora. Many of the species occurring in the Stirling District are high-rainfall species reaching the eastern limit of their distribution, or wheatbelt (Transitional Rainfall Province) species reaching the southern end of their distribution. As such, the cluster analysis grouped this district in the Transitional Rainfall Province rather than with the Esperance and Fitzgerald Districts of the Southeast Coastal Province (Fig. 8). The Fitzgerald District has few endemic species or subspecies and forms the western end of the distribution for several species and subspecies that extend eastwards to

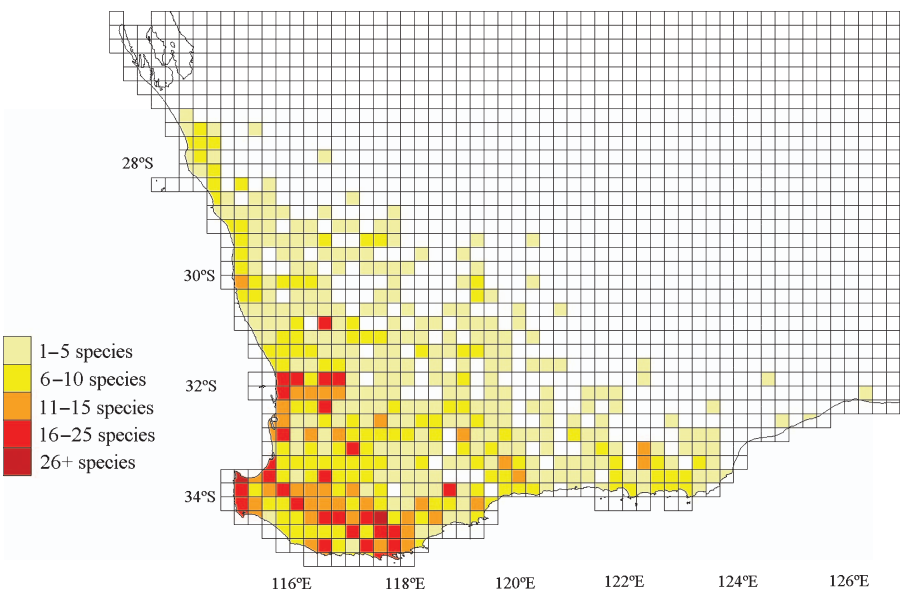

Fig. 4. Species richness of *Caladenia* per quarter-degree latitude by longitude cells in the South-west Australian Floristic Region. Presence or absence of species is based on collections at the Western Australian Herbarium.

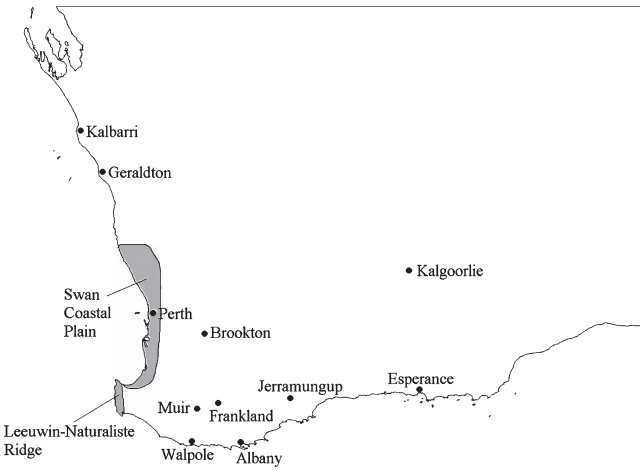

Fig. 5. Location of places mentioned in the text in the South-west Australian Floristic Region.

Esperance. The Esperance District forms the centre of distribution for numerous species and subspecies.

Assuming that sister species have recently speciated and that subspecies are in the process of doing so, contemporary distribution patterns can be used to infer the mechanisms of species formation (e.g. Hopper and Maslin 1978). Comparison of the distribution of sister species and subspecies provides evidence that the regions controlling distribution and favouring speciation in the whole SWAFR flora have also played an important role in *Caladenia*. The transition from the mesic south-western High Rainfall Province and semiarid wheatbelt Transitional Rainfall Province forms the boundary between subspecies in *Caladenia caesarea* Domin, *C. longicauda* Lindl. and *C. hirta* Lindl. Similarly, the High Rainfall Province and the Southeast Costal Province contain different subspecies of both *C. longicauda* and *C. attingens* Hopper & A.P.Br. Within provinces, it is more difficult to establish clear boundaries that are playing a role in speciation. In most cases the subspecies are clearly disjunct and the original cause of the disjunction cannot be inferred. Nonetheless, the endemic subspecies of *C. flava* R.Br. and *C. reptans* Lindl. at Kalbarri and the endemic subspecies of *C. caesarea* and *C. pholcoidea* Hopper & A.P.Br. on the Leeuwin–Naturaliste Ridge lend further support to these regions having been recent centres of speciation.

Endemism

Approximately 50% of the *Caladenia* occurring within the SWAFR occur in only a single biogeographic district (Fig. 9). Very few species occur widely throughout the region. This conforms to the trend of large numbers of short-range endemics in other plant families in the region (e.g. Hopper and Maslin 1978; Hopper 1979; Keighery 1996; George and Pieroni 2002; Hopper and Gioia 2004).

The region of highest endemism of *Caladenia* is the Muir District, the highest rainfall part of the SWAFR (Table 2). Although it contains a distinct assemblage of *Caladenia* from the remainder of the SWAFR, there is pronounced variation within this region. The Muir District can be broadly divided into the following four regions: the Leeuwin–Naturaliste Ridge, the south-coast sand dunes, the south-eastern Jarrah forest and the south-western Jarrah forest. The Leeuwin–Naturaliste Ridge and the forests on its eastern margin contain an exceptionally high level of endemism. The ridge is a granitic, fault-bounded horst of Precambrian antiquity (Myers 1990), with diverse surface soils of granite outcrop, limestone, laterite, coastal sands and loams. A series of eight endemic *Caladenia*, almost entirely members of the subgenus *Calonema*, occur the length of the Ridge (*C. pholcoidea* subsp. *augustensis* Hopper & A.P.Br., *C. caesarea* subsp. *maritima*

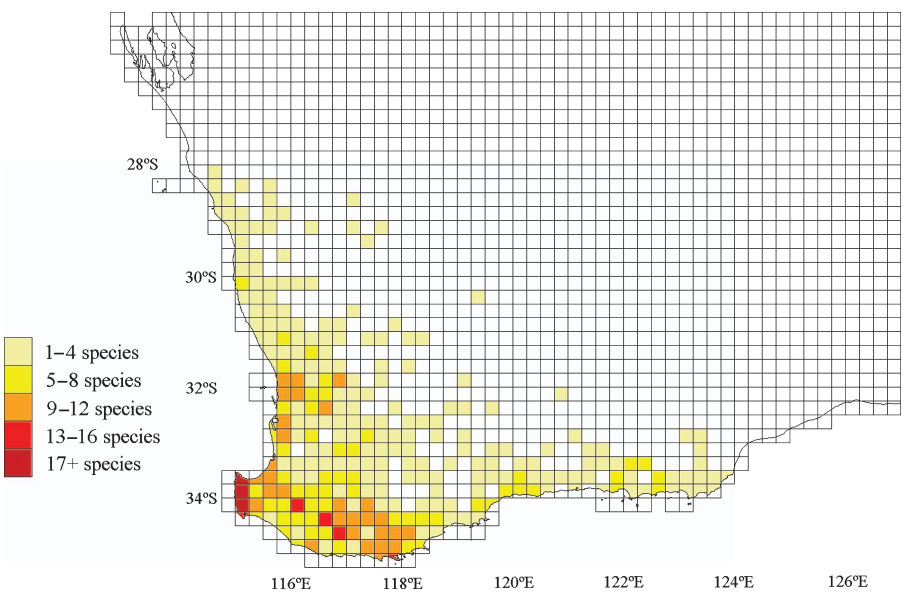

Fig. 6. Species richness of *Caladenia* subgenus *Calonema* per quarter-degree latitude by longitude cells in the South-west Australian Floristic Region. Presence or absence is based on collections at the Western Australian Herbarium.

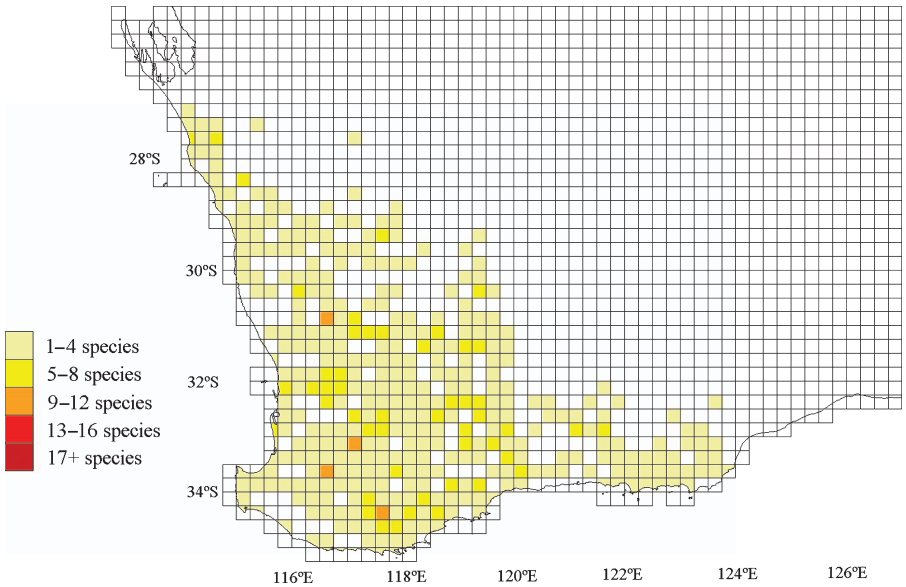

Fig. 7. Species richness of *Caladenia* subgenus *Phlebochilus* per quarter-degree latitude by longitude cells in the South-west Australian Floristic Region. Presence or absence is based on collections at the Western Australian Herbarium.

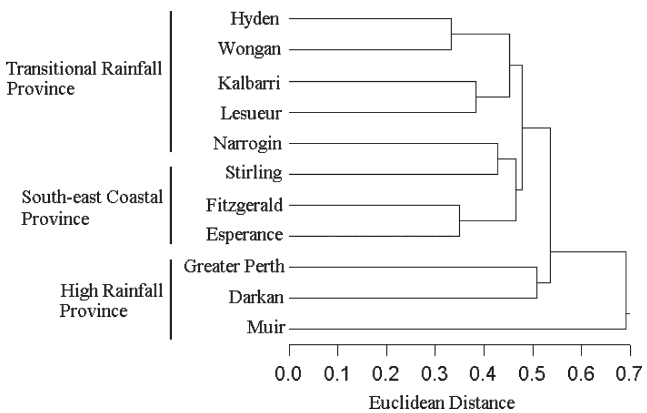

Fig. 8. Dendrogram of the composition of *Caladenia* in biogeographic districts of the South-west Australian Floristic Region. Distribution of species and subspecies based on records at the Western Australian Herbarium. Dendrogram generated with UPGMA cluster analysis. Districts follow Hopper and Gioia (2004).

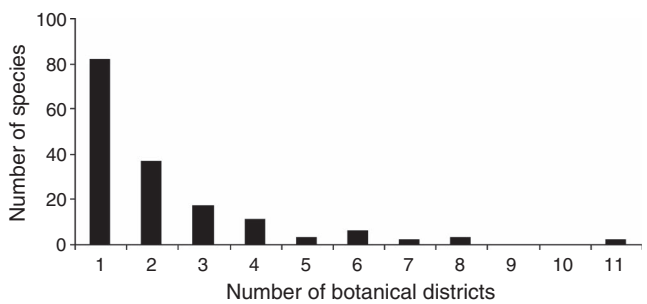

Fig. 9. The number of botanical districts occupied by *Caladenia* species in the South-west Australian Floristic Region.

Table 2. The incidence of endemism in *Caladenia* in biogeographic districts of the South-west Australian Floristic Region and the adjoining Goldfields

Biogeographic provinces and districts follow Hopper and Gioia (2004). TRP = Transitional Rainfall Province, SCP = South-east Coastal Province, HRP = High Rainfall Province, GF = Goldfields. Bold highlights the districts with the highest level of endemism

Biogeographic province	District	No. of taxa (species and subspecies)	No. of endemics	% endemics
TRP	**Kalbarri**	**25**	**9**	**36**
TRP	Lesueur	23	4	17
TRP	Wongan	23	4	17
TRP	Narrogin	31	3	10
TRP	Hyden	23	3	13
SCP	Stirling	23	1	4
SCP	Fitzgerald	30	2	7
SCP	Esperance	30	8	3
HRP	**Muir**	**69**	**37**	**54**
HRP	Darkan	42	6	14
HRP	Greater Perth	32	5	16
GF	Goldfields	10	1	10

Hopper & A.P.Br., *C. citrina* Hopper & A.P.Br., *C. excelsa* Hopper & A.P.Br., *C. lodgeana* Hopper & A.P.Br., *C. nivalis* Hopper & A.P.Br., *C.* sp. Boranup and *C. viridescens* Hopper & A.P.Br.). The sand dunes running along the south coast contain another series of six endemic taxa (*C. applanata* subsp. *erubescens* Hopper & A.P.Br., *C. bicalliata* subsp. nov, *C. evanescens* Hopper & A.P.Br., *C. fuscolutescens* Hopper & A.P.Br., *C. interjacens* Hopper & A.P.Br. and *C. meridionalis* Hopper & A.P.Br.). The swamps and depression of the south-eastern Jarrah forest (from Manjimup eastwards) contains five endemic species (*C. christineae* Hopper & A.P.Br., C. *erythrochila* Hopper & A.P.Br., *C. harringtoniae* Hopper & A.P.Br., *C. starteorum* Hopper & A.P.Br. and *C. winfieldii*

Hopper & A.P.Br.) whereas the south-western Jarrah forest (from Manjimup westwards) is relatively species poor and contains only the endemic subspecies *C. longicauda* subsp. *merritii* Hopper & A.P.Br.

In the Transitional Rainfall Province, the Kalbarri District has the highest level of endemism (Table 2), with some nine species and subspecies of endemic *Caladenia* (*C. barbarella* Hopper & A.P.Br., *C. bryceana* subsp. *cracens* Hopper & A.P.Br., *C. flava* subsp. *maculata* Hopper & A.P.Br., *C. hoffmanii* Hopper & A.P.Br., *C. longicauda* subsp. nov 'Yuna', *C. reptans* subsp. *impensa* Hopper & A.P.Br, *C.* sp. Yerina springs, *C.* sp. Yuna and *C. wanosa* A.S.George). The Kalbarri District has particularly diverse geology (Hocking 1990), including the granitic Northampton Complex (Myers 1990), and is the only part of the SWAFR containing part of the Carnarvon Basin (Hocking 1990). The geology of the district has probably played an important role in the generation of short-range endemics (e.g. George and Pieroni 2002; Hopper and Gioia 2004) by creating unique edaphic environments and highly fragmented, seasonally moist areas that encourage genetic divergence from more mesic lineages. The correlation between unique geology and high levels of endemism suggest a critical role of edaphic environment in patterns of endemism in *Caladenia*.

Future directions

There is a clear need to extend quantitative biogeographic analysis of *Caladenia* beyond the SWAFR to eastern Australia. This would provide independent tests for hypotheses arising from the SWAFR study (e.g. *C.* subg. *Calonema* on average favours higher rainfall than *C.* subg. *Phlebochilus*).

The historical biogeography of *Caladenia* and evolutionary history of ecological traits such as pollination strategies and mycorrhizal specificity remain largely unresolved. On the basis of available data, rainfall and then the edaphic environment play a dominant role in the biogeography of *Caladenia*. As such, climatic and edaphic transitions and unique edaphic environments are likely to be some of the dominant factors controlling distribution and driving speciation in *Caladenia*. However, it is unknown whether these relationships are causal or correlated with speciation. It is an untested possibility that unique mycorrhizal or pollinator communities among geographic districts could drive speciation and control distribution. From a conservation perspective, climatic and edaphic attributes are likely to be key drivers of intrinsic rarity in *Caladenia*. However, given the trend towards mycorrhizal and pollinator specificity in the group, these factors may be acting in concert with climatic and edaphic parameters to drive rarity. Future research into the conservation and evolutionary history of the genus will need to incorporate data on the ecology, distribution and phylogeny of orchid, mycorrhizae and pollinator relationships. With this information *Caladenia* may provide powerful opportunities to test the role of these factors on the diversification of terrestrial orchids.

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Appendix 1. A checklist of *Caladenia*

ACT = Australian Capital Territory, NSW = New South Wales, Qld = Queensland, SA = South Australia, Tas = Tasmania, Vic. = Victoria, WA = Western Australia, NI = North Island, New Zealand, SI = South Island, New Zealand, NC = New Caledonia, I = Indonesia

Species	Authority	Common name	Subgenus	State
Caladenia abbreviata	Hopper & A.P.Br.	Coastal spider-orchid	*Phlebochilus*	WA
C. applanata subsp. *applanata*	Hopper & A.P.Br.	Broad-lipped spider-orchid	*Calonema*	WA
C. applanata subsp. *erubescens*	Hopper & A.P.Br.	Rose spider-orchid	*Calonema*	WA
C. arenicola	Hopper & A.P.Br.	Carousel spider-orchid	*Calonema*	WA
C. arrecta	Hopper & A.P.Br.	Reaching spider-orchid	*Calonema*	WA
C. attingens subsp. *attingens*	Hopper & A.P.Br.	Forest mantis orchid	*Calonema*	WA
C. attingens subsp. *gracillima*	Hopper & A.P.Br.	Small mantis orchid	*Calonema*	WA
C. attingens subsp. nov.		Rock mantis orchid	*Calonema*	WA
C. barbarella	Hopper & A.P.Br.	Little dragon-orchid	*Drakonorchis*	WA
C. barbarossa	Reichb. f.	Common dragon-orchid	*Drakonorchis*	WA
C. bicalliata subsp. nov.			*Phlebochilus*	WA
C. bicalliata subsp. *bicalliata*	R.S. Rogers	Dwarf limestone spider-orchid	*Phlebochilus*	WA, SA
C. bicalliata subsp. *cleistogama*	Hopper & A.P.Br.	Shy limestone spider-orchid	*Phlebochilus*	WA, SA
C. brevisura	Hopper & A.P.Br.	Short-sepalled spider-orchid	*Phlebochilus*	WA
C. brownii	Hopper	Karri spider-orchid	*Calonema*	WA
C. bryceana subsp. *bryceana*	R.S.Rogers	Dwarf spider-orchid	*Phlebochilus*	WA
C. bryceana subsp. *cracens*	Hopper & A.P.Br.	Northern dwarf spider-orchid	*Phlebochilus*	WA
C. busselliana	Hopper & A.P.Br.	Bussell's spider-orchid	*Calonema*	WA
C. caesarea subsp. *caesarea*	(Domin) M.A.Clem & Hopper	Mustard spider-orchid	*Phlebochilus*	WA
C. caesarea subsp. *maritima*	Hopper & A.P.Br.	Cape spider-orchid	*Phlebochilus*	WA
C. caesarea subsp. *transiens*	Hopper & A.P.Br.	Dwarf mustard spider-orchid	*Phlebochilus*	WA
C. cairnsiana	F.Muell.	Zebra orchid	*Phlebochilus*	WA
C. chapmanii	Hopper & A.P.Br.	Chapman's spider-orchid	*Phlebochilus*	WA
C. christineae	Hopper & A.P.Br.	Christine's spider-orchid	*Calonema*	WA
C. christineae subsp. nov.			*Calonema*	WA
C. citrina	Hopper & A.P.Br.	Margaret River spider-orchid	*Calonema*	WA
C. corynephora	A.S.George	Club-lipped spider-orchid	*Calonema*	WA
C. crebra	A.S.George	Arrowsmith spider-orchid	*Calonema*	WA
C. cristata	Hopper & A.P.Br.	Crested spider-orchid	*Phlebochilus*	WA
C. cruscula	Hopper & A.P.Br.	Reclining spider-orchid	*Calonema*	WA
C. decora	Hopper & A.P.Br.	Esperance king spider-orchid	*Calonema*	WA
C. denticulata	Lindl.	Yellow spider-orchid	*Phlebochilus*	WA
C. denticulata subsp. nov. (red flowers)			*Phlebochilus*	WA
C. denticulata subsp. nov. (white flowers)			*Phlebochilus*	WA
C. dimidia	Hopper & A.P.Br.	Chameleon spider-orchid	*Phlebochilus*	WA
C. discoidea	Lindl.	Bee orchid	*Calonema*	WA
C. dorrienii	Domin	Cossack spider-orchid	*Phlebochilus*	WA
C. doutchiae	O.Sarg.	Purple-veined spider-orchid	*Phlebochilus*	WA
C. drakeoides	Hopper & A.P.Br.	Hinged dragon-orchid	*Drakonorchis*	WA
C. drummondii	Benth.	Drummond's spider-orchid	*Calonema*	WA
C. dundasiae	Hopper & A.P.Br.	Patricia's spider-orchid	*Phlebochilus*	WA
C. elegans	Hopper & A.P.Br.	Elegant spider-orchid	*Phlebochilus*	WA
C. ensata	Nicholls	Stumpy spider-orchid	*Calonema*	WA
C. erythrochila	Hopper & A.P.Br.	Lake Muir spider-orchid	*Phlebochilus*	WA
C. evanescens	Hopper & A.P.Br.	Semaphore spider-orchid	*Phlebochilus*	WA
C. excelsa	Hopper & A.P.Br.	Giant spider-orchid	*Calonema*	WA
C. exilis subsp. *exilis*	Hopper & A.P.Br.	Salt Lake spider-orchid	*Phlebochilus*	WA
C. exilis subsp. *vanleeuwenii*	Hopper & A.P.Br.	Moora spider-orchid	*Phlebochilus*	WA
C. exstans	Hopper & A.P.Br.	Pointing spider-orchid	*Calonema*	WA
C. falcata	(Nicholls) M.A.Clem. & D.L.Jones	Western mantis orchid	*Calonema*	WA
C. ferruginea	Nicholls	Rusty spider-orchid	*Calonema*	WA
C. filifera	Lindl.	Blood spider-orchid	*Phlebochilus*	WA
C. flava subsp. *flava*	R.Br	Cowslip orchid	*Elevatae*	WA
C. flava subsp. *maculata*	Hopper & A.P.Br.	Spotted cowslip orchid	*Elevatae*	WA
C. flava subsp. *sylvestris*	Hopper & A.P.Br.	Karri cowslip orchid	*Elevatae*	WA
C. flava subsp. nov.		Red cowslip orchid	*Elevatae*	WA
C. footeana	Hopper & A.P.Br.	Foote's spider-orchid	*Phlebochilus*	WA

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. fuscolutescens	Hopper & A.P.Br.	Ochre spider-orchid	*Phlebochilus*	WA
C. gardneri	Hopper & A.P.Br.	Cherry spider-orchid	*Calonema*	WA
C. georgei	Hopper & A.P.Br.	Tuart spider-orchid	*Calonema*	WA
C. graminifolia	A.S.George	Grass-leafed spider-orchid	*Calonema*	WA
C. graniticola	Hopper & A.P.Br.	Pingaring spider-orchid	*Calonema*	WA
C. granitora	Hopper & A.P.Br.	Granite spider-orchid	*Calonema*	WA
C. harringtoniae	Hopper & A.P.Br.	Pink spider-orchid	*Calonema*	WA
C. heberleana	Hopper & A.P.Br.	Heberle's spider-orchid	*Calonema*	WA
C. hiemalis	Hopper & A.P.Br.	Dwarf common spider-orchid	*Phlebochilus*	WA
C. hirta subsp. *hirta*	Lindl.	Sugar candy orchid	*Caladenia*	WA
C. hirta subsp. *rosea*	Lindl. D.L.Jones	Pink candy orchid	*Caladenia*	WA
C. hoffmanii	Hopper & A.P.Brown	Hoffman's spider-orchid	*Calonema*	WA
C. horistes	Hopper & A.P.Br.	Cream spider-orchid	*Phlebochilus*	WA
C. huegelii	Reichb. f.	Grand spider-orchid	*Calonema*	WA
C. incensa	Hopper & A.P.Br.	Glistening spider-orchid	*Phlebochilus*	WA
C. incrassata	Hopper & A.P.Br.	Puppet orchid	*Phlebochilus*	WA
C. infundibularis	A.S.George	Funnel-web spider-orchid	*Calonema*	WA
C. integra	E.Coleman	Smooth-lipped spider-orchid	*Calonema*	WA
C. interjacens	Hopper & A.P.Br.	Walpole spider-orchid	*Calonema*	WA
C. latifolia	R.Br.	Pink fairies	*Elevatae*	WA, SA, Vic., Tas
C. lobata	Fitzg.	Butterfly orchid	*Calonema*	WA
C. lodgeana	Hopper & A.P.Br.	Lodge's spider-orchid	*Calonema*	WA
C. longicauda subsp. *longicauda*	Lindl.	White spider-orchid	*Calonema*	WA
C. longicauda subsp. *albella*	Hopper & A.P.Br.	Small-lipped spider-orchid	*Calonema*	WA
C. longicauda subsp. *australora*	Hopper & A.P.Br.	Southern white spider-orchid	*Calonema*	WA
C. longicauda subsp. *borealis*	Hopper & A.P.Br.	Daddy long-legs spider-orchid	*Calonema*	WA
C. longicauda subsp. *calcigena*	Hopper & A.P.Br.	Coastal white spider-orchid	*Calonema*	WA
C. longicauda subsp. *clivicola*	Hopper & A.P.Br.	Hill's white spider-orchid	*Calonema*	WA
C. longicauda subsp. *crassa*	Hopper & A.P.Br.	Esperance white spider-orchid	*Calonema*	WA
C. longicauda subsp. *eminens*	(Domin) Hopper & A.P.Br.	Stark white spider-orchid	*Calonema*	WA
C. longicauda subsp. *merrittii*	Hopper & A.P.Br.	Merritt's white spider-orchid	*Calonema*	WA
C. longicauda subsp. *redacta*	Hopper & A.P.Br.	Tangled spider-orchid	*Calonema*	WA
C. longicauda subsp. *rigidula*	Hopper & A.P.Br.	Rigid white spider-orchid	*Calonema*	WA
C. longicauda subsp. nov (High Island)			*Calonema*	WA
C. longicauda subsp. nov. (Thomas River)			*Calonema*	WA
C. longicauda subsp. nov. (Yuna)			*Calonema*	WA
C. longiclavata	E.Coleman	Long-clubbed spider-orchid	*Calonema*	WA
C. longifimbriata	Hopper & A.P.Br.	Western green-comb spider-orchid	*Calonema*	WA
C. lorea	Hopper & A.P.Br.	Blushing spider-orchid	*Calonema*	WA
C. luteola	Hopper & A.P.Br.	Lemon spider-orchid	*Phlebochilus*	WA
C. macrostylis	Fitzg.	Leaping spider-orchid	*Calonema*	WA
C. magniclavata	Nicholls	Big-clubbed spider-orchid	*Calonema*	WA
C. marginata	Lindl.	White fairies	*Elevatae*	WA
C. melanema	Hopper & A.P.Br.	Ballerina spider-orchid	*Phlebochilus*	WA
C. meridionalis	Hopper & A.P.Br.	South coast spider-orchid	*Phlebochilus*	WA
C. mesocera	Hopper & A.P.Br.	Narrow-lipped dragon-orchid	*Drakonorchis*	WA
C. microchila	Hopper & A.P.Br.	Western wispy spider-orchid	*Phlebochilus*	WA, SA
C. multiclavia	Reichb. f.	Lazy spider-orchid	*Phlebochilus*	WA
C. nana subsp. *nana*	Endl.	Little pink fan orchid	*Elevatae*	WA
C. nana subsp. *unita*	Hopper & A.P.Br.	Pink fan orchid	*Elevatae*	WA
C. nivalis	Hopper & A.P.Br.	Exotic spider-orchid	*Calonema*	WA
C. nobilis	Hopper & A.P.Br.	Noble spider-orchid	*Phlebochilus*	WA
C. occidentalis	Hopper & A.P.Br.	Ruby spider-orchid	*Phlebochilus*	WA
C. pachychila	Hopper & A.P.Br.	Dwarf zebra orchid	*Phlebochilus*	WA
C. paludosa	Hopper & A.P.Br.	Swamp spider-orchid	*Calonema*	WA
C. paradoxa	Hopper & A.P.Br.	Mystery spider-orchid	*Phlebochilus*	WA
C. pectinata	R.S.Rogers	King spider-orchid	*Calonema*	WA
C. pendens subsp. *pendens*	Hopper & A.P.Br.	Pendant spider-orchid	*Phlebochilus*	WA
C. pendens subsp. *talbotii*	Hopper & A.P.Br.	Talbot's spider-orchid	*Phlebochilus*	WA

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. petrensis	A.P.Br & G.Brockman	Banded ironstone spider-orchid	*Phlebochilus*	WA
C. pholcoidea subsp. *pholcoidea*	Hopper & A.P.Br.	Albany spider-orchid	*Calonema*	WA
C. pholcoidea subsp. *augustensis*	Hopper & A.P.Br.	Augusta white spider-orchid	*Calonema*	WA
C. plicata	Fitzg.	Crab-lipped spider-orchid	*Calonema*	WA
C. polychroma	Hopper & A.P.Br.	Joseph's spider-orchid	*Phlebochilus*	WA
C. aff. *polychroma*		Yellow wispy spider-orchid	*Phlebochilus*	WA
C. postea	Hopper & A.P.Br.	Dark-tipped spider-orchid	*Phlebochilus*	WA
C. procera	Hopper & A.P.Br.	Carbunup spider-orchid	*Calonema*	WA
C. pulchra	Hopper & A.P.Br.	Slender spider-orchid	*Phlebochilus*	WA, SA?
C. radialis	R.S.Rogers	Drooping spider-orchid	*Phlebochilus*	WA
C. radiata	Nicholls	Ray spider-orchid	*Calonema*	WA
C. remota subsp. *remota*	Hopper & A.P.Br.	Perenjori spider-orchid	*Phlebochilus*	WA
C. remota subsp. *parva*	Hopper & A.P.Br.	Outback spider-orchid	*Phlebochilus*	WA
C. reptans subsp. *reptans*	Lindl.	Little pink fairy	*Elevatae*	WA
C. reptans subsp. *impensa*	Hopper & A.P.Br.	Pale pink fairy	*Elevatae*	WA
C. rhomboidiformis	(E.Coleman) M.A.Clem & D.L.Jones	Diamond spider-orchid	*Calonema*	WA
C. roei	Benth.	Clown orchid	*Phlebochilus*	WA
C. saxicola	A.P.Br & G.Brockman	Rock spider-orchid	*Phlebochilus*	WA
C. serotina	Hopper & A.P.Br.	Christmas spider-orchid	*Calonema*	WA
C. sigmoidea	R.S.Rogers	Sigmoid spider-orchid	*Phlebochilus*	WA
C. sp. 'Boranup'			*Calonema*	WA
C. sp. 'Boyup Brook'			*Phlebochilus*	WA
C. sp. 'Brookton Highway'			*Phlebochilus*	WA
C. sp. 'Julimar'			*Phlebochilus*	WA
C. sp. 'Muddarning Hill'			*Phlebochilus*	WA
C. sp. 'Muir Highway'			*Phlebochilus*	WA
C. sp. 'Murray district'			*Phlebochilus*	WA
C. sp. 'Nyabing'			*Phlebochilus*	WA
C. sp. 'Quindanning'		Quindanning spider-orchid	*Phlebochilus*	WA
C. sp. 'Westdale'			*Phlebochilus*	WA
C. sp. 'Wyalkatchem'			*Phlebochilus*	WA
C. sp. 'Yellow'			*Phlebochilus*	WA
C. sp. 'Yerina Springs'			*Phlebochilus*	WA
C. speciosa	Hopper & A.P.Br.	Sandplain white spider-orchid	*Calonema*	WA
C. splendens	Hopper & A.P.Br.	Splendid spider-orchid	*Calonema*	WA
C. starteorum	Hopper & A.P.Br.	Start's spider-orchid	*Calonema*	WA
C. thinicola	Hopper & A.P.Br.	Scott River spider-orchid	*Calonema*	WA
C. uliginosa subsp. *uliginosa*	A.S.George	Dainty spider-orchid	*Calonema*	WA
C. uliginosa subsp. *candicans*	Hopper & A.P.Br.	Darting spider-orchid	*Calonema*	WA
C. uliginosa subsp. *patulens*	Hopper & A.P.Br.	Frail spider-orchid	*Calonema*	WA
C. ultima	Hopper & A.P.Br.	Late spider-orchid	*Phlebochilus*	WA
C. viridescens	Hopper & A.P.Br.	Dunsborough spider-orchid	*Calonema*	WA
C. voigtii	Hopper & A.P.Br.	Mohawk spider-orchid	*Phlebochilus*	WA
C. vulgata	Hopper & A.P.Br.	Common spider-orchid	*Phlebochilus*	WA
C. wanosa	A.S.George	Kalbarri spider-orchid	*Phlebochilus*	WA
C. williamsiae	Hopper & A.P.Br.	Judy's spider-orchid	*Calonema*	WA
C. winfieldii	Hopper & A.P.Br.	Majestic spider-orchid	*Calonema*	WA
C. xantha	Hopper & A.P.Br.	Primrose spider-orchid	*Phlebochilus*	WA
C. actensis	D.L.Jones	Canberra spider-orchid	*Calonema*	ACT
C. aestiva	D.L.Jones	Mountain summer spider-orchid	*Calonema*	Vic., ACT
C. alata	R.Br.	Fairy fingers	*Caladenia*	Vic., NSW, Tas, Qld?, NI
C. aff. *alata*		Painted fingers	*Caladenia*	NSW
C. alpina	R.S.Rogers	Mountain caps	*Stegostyla*	Vic., NSW, Tas, ACT
C. amnicola	D.L.Jones	Streamside spider-orchid	*Calonema*	NSW
C. amoena	D.L.Jones	Charming spider-orchid	*Calonema*	Vic.
C. ampla	(D.L.Jones) G.N.Backh.	Hard Hills spider-orchid	*Calonema*	Vic.

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. ancylosa	(D.L.Jones) G.N.Backh.	Gippsland spider-orchid	*Calonema*	Vic.
C. angustata	Lindl.	White caps	*Stegostyla*	Tas
C. anthracina	D.L.Jones	Black-tail spider-orchid	*Calonema*	Tas
C. arenaria	Fitzg.	Sandhill spider-orchid	*Calonema*	NSW
C. aff. *arenaria*		Miram Piram spider-orchid	*Calonema*	Vic.
C. aff. *arenaria*		Yanipy spider-orchid	*Calonema*	Vic.
C. argocalla	D.L.Jones	White beauty spider-orchid	*Calonema*	SA
C. armata	D.L.Jones	Army spider-orchid	*Calonema*	NSW
C. arulenta	D.L.Jones	Golden-clubbed spider-orchid	*Calonema*	SA
C. atrata	D.L.Jones	Dark caps	*Stegostyla*	Tas
C. atrochila	D.L.Jones	Dark-heart fingers	*Caladenia*	Tas
C. atroclavia	D.L.Jones & M.A.Clem.	Black-clubbed spider-orchid	*Calonema*	Qld
C. attentuata	(W.Brinsley) D.L.Jones	Durama fingers	*Caladenia*	NSW
C. audasii	R.S.Rogers	McIvor spider-orchid	*Calonema*	Vic.
C. aurantiaca	(R.S.Rogers) Rupp	Orange-tip fingers	*Caladenia*	Vic., Tas
C. australis	G.W.Carr	Southern spider-orchid	*Calonema*	Vic.
C. aff. *australis*		Moondarra spider-orchid	*Calonema*	Vic.
C. aff. *australis*		Otway spider-orchid	*Calonema*	Vic.
C. aff. *australis*		Cathedral spider-orchid	*Calonema*	Vic.
C. behrii	Schldl.	Lofty Ranges spider-orchid	*Calonema*	SA
C. brachyscapa	G.W.Carr	Short spider-orchid	*Calonema*	Vic.
C. branwhitei	D.L.Jones	Bethungra spider-orchid	*Calonema*	NSW
C. brumalis	D.L.Jones	Winter spider-orchid	*Calonema*	SA
C. cadyi	D.L.Jones	Cady's spider-orchid	*Calonema*	NSW
C. calcicola	G.W.Carr	Limestone spider-orchid	*Calonema*	SA?, Vic.
C. callitrophylla	D.L.Jones	Pine spider-orchid	*Calonema*	NSW
C. campbellii	D.L.Jones	Thick-stem fairy fingers	*Caladenia*	Tas
C. capillata	D.L.Jones	White daddy long-legs	*Phlebochilus*	SA, Vic.
C. aff. *capillata*		Short wispy spider-orchid	*Phlebochilus*	SA
C. cardiochila	Tate	Heart-lip spider-orchid	*Calonema*	SA, Vic., Tas
C. carnea subsp. *carnea*	R.Br.	Pink fingers	*Caladenia*	Vic., NSW, Tas, Qld, ACT, NC, I
C. carnea subsp. *subulata*	Nicholls	Striped pink fingers	*Caladenia*	Vic.
C. aff. *carnea*		Tiny white fingers	*Caladenia*	SA
C. aff. *carnea*		Coorong pink fingers	*Caladenia*	SA
C. aff. *carnea*		Scented fingers	*Caladenia*	Vic.
C. catenata	(Smith) Druce	White fingers	*Caladenia*	Vic., NSW, Qld, NC
C. aff. *catenata*		Variable fingers	*Caladenia*	Vic.
C. caudata	Nicholls	Tailed spider-orchid	*Calonema*	Tas
C. chamaephylla	D.L.Jones	Red-leaf fingers	*Caladenia*	Qld
C. clarkiae	D.L.Jones	Pink caps	*Stegostyla*	Vic., NSW
C. clavescens	(D.L.Jones) G.N.Backh.	Castlemaine spider-orchid	*Calonema*	Vic.
C. clavigera	A.Cunn. ex Lindl.	Plain-lip spider-orchid	*Calonema*	SA, Vic., NSW, Tas
C. aff. *clavigera*		Finnis spider-orchid	*Calonema*	SA
C. clavula	D.L.Jones	Kimba spider-orchid	*Calonema*	SA
C. cleistantha	D.L.Jones	Closed fingers	*Caladenia*	SA?, Vic., NSW
C. coactilus	D.L.Jones	Thick fingers	*Caladenia*	SA
C. colorata	D.L.Jones	Multicoloured spider-orchid	*Calonema*	SA
C. aff. *colorata*		Perplexing spider-orchid	*Calonema*	SA
C. aff. *colorata*		Nelson spider-orchid	*Calonema*	Vic.
C. concinna	(Rupp) D.L.Jones & M.A.Clem	Trim spider-orchid	*Calonema*	NSW
C. aff. *concinna*		Hidden spider-orchid	*Calonema*	NSW
C. concolor	Fitzg.	Crimson spider-orchid	*Calonema*	Vic., NSW
C. aff. *concolor*		Midlands spider-orchid	*Calonema*	Vic.
C. aff. *concolor*		Violet town spider-orchid	*Calonema*	Vic.
C. aff. *concolor*		Carboor spider-orchid	*Calonema*	Vic.
C. conferta	D.L.Jones	Crowded spider-orchid	*Calonema*	SA
C. congesta	R.Br.	Black-tongue caladenia	*Stegostyla*	SA, Vic., NSW, Tas, ACT
C. cracens	D.L.Jones	Neat caps	*Stegostyla*	Tas

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. cremna	(D.L.Jones) G.N.Backh.	Beady spider-orchid	*Calonema*	Vic.
C. cretacea	(D.L.Jones) G.N.Backh.	Stuart Mill spider-orchid	*Calonema*	Vic.
C. cruciformis	D.L.Jones	Red-cross spider-orchid	*Calonema*	Vic.
C. cucullata	Fitzg.	Hooded caladenia	*Stegostyla*	SA, Vic., NSW, ACT
C. curtisepala	D.L.Jones	Short fingers	*Caladenia*	NSW
C. dienema	D.L.Jones	Windswept spider-orchid	*Calonema*	Tas
C. dilatata	R.Br.	Green-comb spider-orchid	*Calonema*	Vic.?, Tas
C. dimorpha	Fitzg.	Spicy caps	*Stegostyla*	NSW
C. douglasiorum	(D.L.Jones) G.N.Backh.	Douglas's spider-orchid	*Calonema*	Vic.
C. echidnachila	Nicholls	Fawn spider-orchid	*Calonema*	Tas
C. filamentosa	R.Br.	Red daddy long-legs	*Phlebochilus*	SA, Vic., NSW, Tas, Qld
C. aff. *filamentosa*		Floppy spider-orchid	*Phlebochilus*	SA
C. aff. *filamentosa*		Portland daddy Long-legs	*Phlebochilus*	Vic.
C. aff. *filamentosa*		Burgundy daddy Long-legs	*Phlebochilus*	Vic.
C. fitzgeraldii	Rupp	Fitzgerald's spider-orchid	*Calonema*	NSW, ACT
C. flaccida	D.L.Jones	Limp spider-orchid	*Phlebochilus*	SA?, Vic.?, NSW, Qld
C. flavovirens	G.W.Carr	Summer spider-orchid	*Calonema*	Vic.
C. flindersica	D.L.Jones	Flinders Ranges spider-orchid	*Calonema*	SA
C. formosa	G.W.Carr	Scarlet spider-orchid	*Calonema*	SA, Vic.
C. fragrantissima	D.L.Jones & G.W.Carr	Scented spider-orchid	*Calonema*	SA?, Vic.
C. aff. *fragrantissima*		Swan Lake spider-orchid	*Calonema*	Vic.
C. aff. *fragrantissima*		Bendigo spider-orchid	*Calonema*	Vic.
C. fuliginosa	D.L.Jones	Sooty spider-orchid	*Calonema*	SA
C. fulva	G.W.Carr	Tawny spider-orchid	*Calonema*	Vic.
C. fuscata	(Rchb. f.) M.A.Clem. & D.L.Jones	Dusky fingers	*Caladenia*	SA, Vic., NSW, Tas, Qld
C. gladiolata	R.S.Rogers	Small bayonet spider-orchid	*Calonema*	SA
C. gracilis	R.Br.	Musky caladenia	*Stegostyla*	SA, Vic., NSW, Tas
C. gracillima	D.L.Jones	Pretty fingers	*Caladenia*	Qld
C. grampiana	(D.L.Jones) G.N.Backh.	Grampians spider-orchid	*Calonema*	Vic.
C. hastata	(Nicholls) Rupp	Mellblom's spider-orchid	*Calonema*	Vic.
C. helvina	D.L.Jones	Sallow spider-orchid	*Calonema*	Tas
C. hildae	Pescott & Nicholls	Blushing caps	*Stegostyla*	Vic., NSW
C. hillmanii	D.L.Jones	Hillman's fingers	*Caladenia*	NSW
C. insularis	G.W.Carr	French Island spider-orchid	*Calonema*	Vic.
C. interanea	D.L.Jones	Granite mantis orchid	*Calonema*	SA
C. intuta	D.L.Jones	Ghost spider-orchid	*Calonema*	SA
C. iridescens	R.S.Rogers	Western bronze caladenia	*Stegostyla*	Vic.
C. aff. *iridescens*		Golden caladenia	*Stegostyla*	Vic.
C. leptochila subsp. *leptochila*	Fitzg.	Narrow-lip spider-orchid	*Calonema*	SA
C. leptochila subsp. *dentata*	(Fitzg.) D.L.Jones	Toothed spider-orchid	*Calonema*	SA
C. leptoclavia	D.L.Jones	Thin-clubbed spider-orchid	*Calonema*	NSW
C. lindleyana	(Rchb. f.) M.A.Clem. & D.L.Jones	Lindley's spider-orchid	*Calonema*	Tas
C. lowanensis	G.W.Carr	Wimmera spider-orchid	*Calonema*	Vic.
C. macroclavia	D.L.Jones	Great-clubbed spider-orchid	*Calonema*	SA
C. aff. macroclavia		Port Lincoln spider-orchid	*Calonema*	SA
C. magnifica	(Nicholls) D.L.Jones & G.W.Carr	Magnificent spider-orchid	*Calonema*	Vic.
C. maritima	D.L.Jones	Angahook fingers	*Caladenia*	Vic.
C. mentiens	D.L.Jones	Cryptic fingers	*Caladenia*	SA?, Vic., Tas
C. montana	G.W.Carr	Mountain spider-orchid	*Calonema*	Vic.
C. necrophylla	D.L.Jones	Wilting spider-orchid	*Calonema*	SA, Vic.?
C. oenochila	G.W.Carr	Wine-lipped spider-orchid	*Calonema*	Vic.
C. aff. *oenochila*		St Andrews spider-orchid	*Calonema*	Vic.
C. aff. *oenochila*		Strathbogie spider-orchid	*Calonema*	Vic.
C. oreophila	(D.L.Jones) G.N.Backh.	Monaro spider-orchid	*Calonema*	Vic., NSW
C. orestes	D.L.Jones	Burrinjuck spider-orchid	*Calonema*	NSW
C. orientalis	(G.W.Carr) Hopper & A.P.Br.	Eastern spider-orchid	*Calonema*	Vic.

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. ornata	(Nicholls) D.L.Jones	Ornate fingers	*Caladenia*	SA, Vic.
C. osmera	(D.L.Jones) G.N.Backh.	Pungent spider-orchid	*Calonema*	Vic., NSW
C. ovata	R.Rogers	Oval-lip spider-orchid	*Calonema*	SA
C. pallida	Lindl.	Rosy spider-orchid	*Calonema*	Tas
C. parva	G.W.Carr	Small spider-orchid	*Calonema*	SA, Vic.
C. patersonii	R.Br.	Paterson's spider-orchid	*Calonema*	Vic.?, Tas
C. aff. *patersonii*		Illawarra spider-orchid	*Calonema*	NSW
C. aff. *patersonii*		Killawarra spider-orchid	*Calonema*	Vic.
C. aff. *patersonii*		Inverleigh spider-orchid	*Calonema*	Vic.
C. peisleyi	(D.L.Jones) G.N.Backh.	Heath spider-orchid	*Calonema*	Vic.
C. phaeoclavia	D.L.Jones	Brown-clubbed spider-orchid	*Calonema*	SA, Vic., NSW, ACT
C. picta	(Nicholls) M.A.Clem. & D.L.Jones	Painted fingers	*Caladenia*	NSW
C. pilotensis	D.L.Jones	Mt Pilot spider-orchid	*Calonema*	Vic.
C. porphyrea	D.L.Jones	Purple fingers	*Caladenia*	NSW, Qld
C. praecox	Nicholls	Early caladenia	*Stegostyla*	Vic., NSW?
C. prolata	D.L.Jones	Fertile fingers	*Caladenia*	SA, Vic., Tas?
C. pumila	R.S.Rogers	Pygmy spider-orchid	*Calonema*	Vic.
C. pusilla	W.M.Curtis	Tiny fingers	*Caladenia*	SA, Vic., Tas
C. aff. *pusilla*		Killawarra fingers	*Caladenia*	Vic.
C. aff. *pusilla*		Diapur fingers	*Caladenia*	Vic.
C. quadrifaria	D.L.Jones	Large pink fingers	*Caladenia*	NSW
C. reticulata	Fitzg.	Veined spider-orchid	*Calonema*	SA
C. aff. *reticulata*		Padthaway spider-orchid	*Calonema*	SA
C. aff. *reticulata*		Bordertown spider-orchid	*Calonema*	SA
C. aff. *reticulata*		Clown spider-orchid	*Calonema*	SA, Vic.?
C. aff. *reticulata*		McCann's spider-orchid	*Calonema*	Vic.
C. richardsiorum	D.L.Jones	Richard's spider-orchid	*Calonema*	SA
C. rigens	D.L.Jones	Buttercup-clubbed spider-orchid	*Calonema*	NSW
C. rigida	R.S.Rogers	Stiff spider-orchid	*Calonema*	SA
C. rileyii	D.L.Jones	Riley's spider-orchid	*Calonema*	NSW
C. robinsonii	G.W.Carr	Frankston spider-orchid	*Calonema*	Vic.
C. rosella	G.W.Carr	Rosella spider-orchid	*Calonema*	Vic.
C. saggicola	D.L.Jones	Sag spider-orchid	*Calonema*	Tas
C. sanguinea	D.L.Jones	Kangaroo Island spider-orchid	*Phlebochilus*	SA
C. saxatilis	D.L.Jones	Rancid spider-orchid	*Calonema*	SA
C. septuosa	D.L.Jones	Eyre Peninsula spider-orchid	*Calonema*	SA
C. sp.		Koolunga spider-orchid	*Calonema*	SA
C. stellata	D.L.Jones	Starry spider-orchid	*Calonema*	SA, NSW
C. stricta	(R.J.Bates) R.J.Bates	Upright spider-orchid	*Calonema*	SA, Vic.
C. strigosa	D.L.Jones	Bristly spider-orchid	*Calonema*	SA
C. subtilis	D.L.Jones	Delicate spider-orchid	*Calonema*	NSW
C. sylvicola	D.L.Jones	Forest fingers	*Caladenia*	Tas
C. tensa	G.W.Carr	Rigid spider-orchid	*Calonema*	SA?, Vic., NSW?
C. aff. *tensa*		Small stiff spider-orchid	*Calonema*	SA
C. tentaculata	Schltdl.	Eastern mantis orchid	*Calonema*	SA, Vic., NSW, ACT
C. aff. *tentaculata*		Inland mantis orchid	*Calonema*	NSW, Qld?
C. aff. *tentaculata*		North flinders spider-orchid	*Calonema*	SA
C. tesselata	Fitzg.	Thick-lip spider-orchid	*Calonema*	Vic., NSW
C. testacea	R.Br.	Honey caps	*Stegostyla*	NSW
C. thysanochila	G.W.Carr	Fringed spider-orchid	*Calonema*	Vic.
C. tonellii	D.L.Jones	Robust fingers	*Caladenia*	Tas
C. toxochila	Tate	Bow-lip spider-orchid	*Calonema*	SA, Vic.?
C. aff. *toxochila*		Kiata spider-orchid	*Calonema*	SA, Vic.
C. transitoria	D.L.Jones	Eastern bronze caladenia	*Stegostyla*	Vic., NSW, Tas
C. aff. *transitoria*		Dwarf golden caps	*Stegostyla*	SA, Vic.?
C. valida	(Nicholls) M.A.Clem & D.L.Jones	Robust spider-orchid	*Calonema*	SA, Vic.

Appendix 1. (*continued*)

Species	Authority	Common name	Subgenus	State
C. aff. *valida*		Raymond Island spider-orchid	*Calonema*	Vic.
C. venusta	G.W.Carr	Large white spider-orchid	*Calonema*	SA, Vic.
C. aff. *venusta*		Ararat Hills spider-orchid	*Calonema*	Vic.
C. aff. *venusta*		Kilsyth south spider-orchid	*Calonema*	Vic.
C. aff. *venusta*		Kooyera spider-orchid	*Calonema*	Vic.
C. aff. *venusta*		Canabolas spider-orchid	*Calonema*	NSW
C. aff. *venusta*		Carabost spider-orchid	*Calonema*	NSW
C. aff. *venusta*		Richmond spider-orchid	*Calonema*	NSW
C. aff. *venusta*		Sunshine spider-orchid	*Calonema*	Qld
C. aff. *venusta*		Dark-tailed spider-orchid	*Calonema*	Vic.
C. aff. *venusta*		Tallageira spider-orchid	*Calonema*	SA?, Vic.
C. verrucosa	G.W.Carr	Mallee spider-orchid	*Calonema*	SA, Vic.
C. aff. *verrucosa*		Golden bayonet spider-orchid	*Calonema*	SA
C. versicolor	G.W.Carr	Candy spider-orchid	*Calonema*	Vic.
C. villosissima	G.W.Carr	Hairy spider-orchid	*Calonema*	SA?, Vic.
C. vulgaris	D.L.Jones	Slender fingers	*Caladenia*	SA, Vic., Tas
C. aff. *vulgaris*		Ironbark fingers	*Caladenia*	NSW
C. aff. *vulgaris*		Ghost fingers	*Caladenia*	SA, Vic.?
C. whiteheadii	D.L.Jones	Whitehead's spider-orchid	*Calonema*	NSW
C. woolcockiorum	D.L.Jones	Woolcock's spider-orchid	*Calonema*	SA
C. xanthochila	D. & C.Beardsell	Yellow-lip spider-orchid	*Calonema*	Vic.
C. xantholeuca	D.L.Jones	Cliff fingers	*Caladenia*	SA
C. aff. *xantholeuca*		Mambray fingers	*Caladenia*	SA
C. zephyra	D.L.Jones	Zephyr spider-orchid	*Calonema*	SA
C. atradenia	D.L.Jones, Molloy & M.A.Clem	Bronze fingers	*Caladenia*	NI, SI
C. aff. *alpina*		White fingers	*Stegostyla*	NI, SI
C. bartleti	Hatch	Mauve fingers	*Caladenia*	NI, SI
C. chlorostylus	D.L.Jones, Molloy & M.A.Clem	White fingers	*Caladenia*	NI, SI
C. aff. *fuscatus*		Pink fingers	*Caladenia*	NI
C. lyalii	Hook.f.	White fingers	*Stegostyla*	NI, SI
C. nothofageti	D.L.Jones, Molloy & M.A.Clem	White fingers	*Caladenia*	NI, SI
C. minor	Hook.f.		*Caladenia*	NI, SI
C. aff. *pusillus*		Pink fingers	*Caladenia*	NI
C. variegatus	(Col.) D.L.Jones & M.A.Clem.	Pink fingers	*Caladenia*	NI, SI