

# Biogeography and composition of the flora of the Cape Range peninsula, Western Australia

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## Abstract

The Cape Range peninsula is here considered as the area north of a line joining Ningaloo Homestead and the base of Exmouth Gulf. The Cape is dominated by a series of limestone hills of moderate to low relief, surrounded by sandplain or coastal plains. The Cape Range itself is vegetated with *Eucalyptus* over *Triodia*, with *Acacia-Cassia* shrubs as understory or locally dominant. The lower ranges are vegetated with *Acacia* shrublands over *Triodia*. The coastal plain is vegetated with grasslands, coastal strand vegetation, low shrublands (including Samphires and Saltbush) and Mangrove low forest and the sandplain by heath over *Triodia*.

Six hundred and thirty taxa of vascular plants have been recorded from the peninsula, a rich flora. The flora is dominated by widespread desertic elements, both of a temperate and tropical nature, reflecting the geographic position of the peninsula and the general composition of the flora of the Carnarvon Botanical District. Analysis of the composition of the flora indicates it is most similar to the flora of Barrow Island, and other coastal sites at Lake MacLeod and the Burrup Peninsula. A distinct feature of the flora is a group of taxa that occur from Shark Bay to North West Cape. Another related group links the flora of the Geraldton area to that of Shark Bay.

The peninsula has 12 endemic taxa and six taxa largely confined to the peninsula. All taxa are listed and distribution patterns compared in this paper.

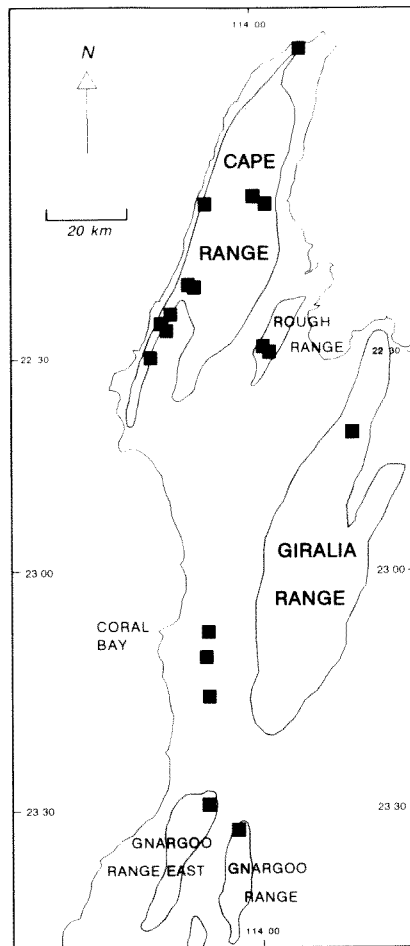
The flora also encompasses a significant number (50) of taxa of southern temperate affinities here at the end of their ranges. Most of these taxa extend from the Geraldton area to North West Cape. These taxa occur on the sandplain (*Banksia ashbyi*, *Emblingia calceoliflora*), or the western coastal dunes (*Santalum spicatum*, *Scaevola crassifolia*) rather than on the massive limestone hills. In addition the peninsula has a number of unusual disjunctions associated with Yardie Creek. These are several taxa of freshwater emergent aquatic species and, remarkably, the Millstream Palm.

Few weeds have been recorded from the peninsula, 30 taxa are listed, most of which occur around the townsite of Exmouth. Significant weed invasion has also occurred in the Yardie Creek gorge with infestations of *Emex australis* and *Asphodelus fistulosus* and on the western coastal plain, where Buffel grassland has replaced the native *Triodia* grassland.

A brief site based survey of the limestone surfaces of the study area has revealed significant floristic differences between the Ranges. Distinctive groups are associated with the Coral Bay limestone outcrops; the Gnargoo and Giralia Ranges; central Cape Range; Rough Range and the western coastal plain of the peninsula; and sand over the limestone on Cape Range. Future studies on the floristics of the sandplain and coastal plain areas would be rewarding. A study to place the floristics of the peninsula within the wider context of the Carnarvon Botanical District is also needed.

## Introduction

The vascular flora of the Cape Range peninsula has not been extensively surveyed and its relationship with the flora of other similar areas is poorly known. The Cape Range peninsula is considered as the land north of a line between Ningaloo homestead on the west coast and



**Figure 1.** Map showing the location of the study area and various ranges. The dark squares denote the location of the sample plots used in the floristic analysis.

the base of the Bay of Rest on the eastern side, including Cape Range and the Rough Range, an area of approximately 2,200 km<sup>2</sup> (Figure 1).

Because of the arid and isolated nature of the peninsula, few early explorers visited and collected in the area. However, with the advent of the Second World War and oil exploration in the 1950's and 1960's a series of access tracks were constructed that could be used by collectors and ecologists. There were two major early contributors - Alex George, who first collected and subsequently described several of the endemic plants (Gardner and George 1963), and John Beard who compiled the first complete vegetation map of the area (Beard 1975). Subsequent to the work of these collectors have been a series of studies - by the Rangeland group of the Western Australian Department of Agriculture (Hesp and Morrisey 1984; Payne *et al.* 1982, 1987) and several consultant reports (Trudgen 1988, 1989) on areas of the Cape Range. Currently Start and McKenzie (1993) are surveying the islands of Exmouth Gulf, some of which are in the study area.

### The composition and relationships of the flora

Six hundred and thirty taxa of vascular plants have been recorded from the Cape Range region (Appendix 1).

The composition of the flora is essentially arid in nature as reflected by the principal families on the peninsula. All of these families are rich in annual species, annuals being a major component of the flora of most arid areas. The largest families represented are the Amaranthaceae (21 species), Asteraceae (51), Chenopodiaceae (45), Goodeniaceae (26), Malvaceae (31), Myrtaceae (24), Papilionaceae (47) and Poaceae (75). These eight families contribute 51% of the total flora of the peninsula.

Within the boundaries of the Cape Range peninsula 630 taxa (46.7%) of the 1348 known for the Carnarvon Botanical District have been recorded. Of these records 143 are only recorded for the District on the Cape Range. While this probably indicates a tropical influence on the flora of the peninsula, it may reflect the lack of other botanical studies in the surrounding area (this District has been suggested as the target for the next major biological survey: Anon. 1991). Seven hundred and twenty two species recorded for the District are not found on the peninsula, and 484 are found on the peninsula and elsewhere in the District. Of these fifty taxa are at the northern ends of their ranges, and the others are the widespread desertic or coastal elements. Therefore, these widespread taxa constitute approximately 77% of the flora of the peninsula, illustrating again the arid nature of this flora.

That this is a relatively rich flora for an arid region is indicated by the comparative data in Table 1 in which the last four areas are on the margins of the South West Botanical Province, which enhances their species richness. Of particular note is the very low species richness of the Nullarbor, the other major arid limestone region. Limestone soils in arid areas are apparently species poor, especially if accompanied by low relief and a lack of habitat diversity (Beard 1975).

Cape Range peninsula is the exception to this - while habitat diversity is low, environmental conditions are quite different from other arid limestone areas. Obvious features of the peninsula absent elsewhere is the ameliorating effect of the sea around the peninsula, the sharp climatic gradient across the Range and the location of the area in both summer and winter rainfall regions. Some special features of the flora related to these features contribute to the higher species richness.

**Table 1.** The floristic species richness of various arid regions and subregions.

Region	Number of species	Area (km <sup>2</sup> )	Species/1000km <sup>2</sup>	Authority
Cape Range peninsula	630	2185	288	This paper
Carnarvon Botanical District	1348	91 046	14.8	This paper
Central Australia	977	-	-	Jessup 1981
Fortesque Botanical District	1700	178 017	9.5	Trudgen, pers. comm.
Nullarbor Plain	317	148 764	2.1	Keighery <i>et al.</i> 1987
Karijini National Park	481	c. 5 000	96.2	Trudgen, pers. comm. cited in Matisse and Associates 1991
Murchison Catchment	823	85 000	9.7	Cranfield 1991
Shark Bay Area	828	c. 5 000	165.6	Trudgen and Keighery unpublished
Kalgoorlie-Kurnalpi	491	c. 6 600	74.4	Keighery <i>et al.</i> 1992
Widgiemooltha-Zanthus	560	c. 6 600	84.8	Newbey and Hnatiuk 1984

### Disjunctions

The Yardie Creek freshwater wetland has a fringing vegetation of emergent aquatics, chiefly *Typha domingensis* and *Schoenoplectus litoralis*. Both of these species are disjunct from their main ranges by many hundreds of kilometres. At the top of the Yardie Creek system is a stand of *Livistonia alfredii* (Humphreys *et al.* 1990), also a considerable disjunction from its main area of occurrence in the Millstream area of the Fortesque River in the Pilbara. The Millstream area, perhaps not surprisingly, also has calcareous soils.

### Range ends

A feature of the flora of Cape Range peninsula is the mixing of the tropical and temperate floras of Western Australia. This is achieved because of the numbers of such taxa at the margins of their ranges.

Busby and Bridgewater (1986) note that the eastern side of Cape Range peninsula is the southern limit of the mangroves *Aegialitis annulata*, *Ceriops tagal* and *Suaeda arbusculoides*, whereas the western side is the limit of *Rhizophora stylosa*, a species apparently declining locally (Kendrick and Morse 1990).

Many species of tropical affinities approach the ends of their ranges although some of these species penetrate further down the coast to the Shark Bay Islands (Keighery 1990) or along the western side of Lake MacLeod (Tyler 1988). Such taxa include all locally occurring members of the families Acanthaceae, Moraceae, most of the Asclepiadaceae, and species such as *Livistonia alfredii*, *Acyranthes aspera*, *Gomphrena canescens*, *Crinum flaccidum*, *Blumea tenella*, *Olearia dampieri*, *Flaveria australasica*, *Pluchea rubelliflora*, *Pterocaulon sphaeranthoides*, *Streptoglossa* species, *Polycarpaea longiflora*, *Commelina ensifolia*, *Evolvulus alsinoides*, *Drosera indica*, *Basilicum polystachyon*, *Neptunia gracilis*, *Desmodium* sp., *Aeschynomene indica*, *Erythrina indica* and *Rhynchosia minima*. Many of these are only (or most frequently) found along the gorges and valleys of the western side of Cape Range. These are obviously relatively sheltered as the climate is ameliorated by the sea breeze, and the valleys are slightly wetter, and fire free, thus forming environments conducive to the survival of this tropical element of the flora. However the wetter tropical elements apparently have been eliminated, even from these refuge areas, by the harsh dry summers the peninsula, which with the freely draining soils limit water availability in this period. Summer is also the major growth period for tropical species.

The other major component of this species group are the 50 temperate species at the northern ends of their ranges. These occur in three areas (Table 2). On the red sandplains between the ranges and at the top of the peninsula (21 species), in the valleys on the western side of the range or on limestone (15 species), and on the white coastal sands on the western side of the range (21 species).

The area is also a mixing ground for temperate and tropical seagrass species with Exmouth Gulf being a major zone of species richness for these marine flowering plants (Walker and Prince 1987).

### Endemic plants and plants centred on the peninsula

The endemic and localized flora of the Cape Range peninsula has been poorly studied. The known distribution of each endemic and plant taxon centred on the peninsula is shown in the following maps (Figure 2) on a 25 km<sup>2</sup> grid. Brief notes are presented below on the biology of each of the taxa.

**Table 2.** Northern range limits and their location on the Cape Range peninsula.

Taxon	White sand	Red sand	Limestone
<i>Acanthocarpus humilis</i>			*
<i>Acanthocarpus preissii</i>	*		
<i>Acanthocarpus robustus</i>		*	
<i>Actinobole drummondiana</i>		*	
<i>Actinobole oldfieldiana</i>		*	
<i>Adriana tomentosa</i>	*		
<i>Amyema</i> "myoporum"		*	
<i>Banksia ashbyi</i>	*	*	
<i>Beyeria cinerea</i>			*
<i>Brachycome latisquamea</i>	*		
<i>Brachysema macrocarpum</i>		*	
<i>Callistemon phoenicis</i>			*
<i>Calothamnus oldfieldii</i>		*	
<i>Carpobrotus</i> "septentrionalis"	*		*
<i>Corynotheca pungens</i>		*	
<i>Dampiera incana</i>	*	*	
<i>Dioscorea hastifolia</i>			*
<i>Diplolaena grandiflora</i>			*
<i>Diplolaena microcephala</i>			*
<i>Emblingia calceoliflora</i>		*	
<i>Geleznovia verrucosa</i>		*	
<i>Glisrocharyon flavescens</i>	*	*	
<i>Goodenia berardiana</i>	*		
<i>Halgania</i> sp. (ASG 10290)			*
<i>Hibbertia spicata</i> subsp. <i>spicata</i>			*
<i>Lasiopetalum oldfieldii</i>	*		
<i>Lechenaultia subcymosa</i>	*		
<i>Logania vaginalis</i>	*		*
<i>Malleostemon</i> sp. (Trudgen sn)		*	
<i>Melaeuca cardiophylla</i>			*
<i>Mirbelia ramulosa</i>		*	*
<i>Olex aurantia</i>		*	
<i>Olearia axillaris</i>	*		
<i>Opercularia spermacoea</i>		*	
<i>Oxalis perennans</i>			*
<i>Phyllanthus calycinus</i>		*	
<i>Pileanthus limacis</i>	*		
<i>Pityrodia loxocarpa</i>	*	*	
<i>Plantago drummondii</i>			*
<i>Santalum spicatum</i>	*		
<i>Scaevola crassifolia</i>	*		
<i>Scaevola</i> aff. <i>nitida</i> (GK 12899)	*		
<i>Scaevola spicigera</i>	*		
<i>Scaevola tomentosa</i>	*		
<i>Sowerbaea laxiflora</i>	?	?	?
<i>Tetragonia diptera</i>		*	
<i>Tricoryne corynothecoides</i>		*	
<i>Verticordia forrestii</i>		*	
<i>Wurmbea odorata</i>	*		*
<i>Zygophyllum fruticosum</i>	*		

## (A) Endemic plants (Figure 2)

1: *Abutilon* sp. nov. (Trudgen 6634).

Erect shrub to 40 cm with large yellow flowers in spring. Bee pollinated, fire response unknown. Grows on red sand over limestone. Related to *Abutilon oxycarpum*, a widespread arid zone species.

2: *Acanthocarpus rupestris* A.S. George.

Clumped rhizomatous herb, bearing white flowers with purple stripes, in winter and spring. Pollination unknown. Restricted to Cape Range, on limestone. Related to *Acanthocarpus parviflorus*, a species occurring between Kalbarri and Cape Range.

3: *Acanthocarpus* sp. (Trudgen 6654).

Clumped rhizomatous herb, bearing white flowers in winter and spring. Pollination unknown, resprouts after fire. Restricted to Cape Range. Grows on red sand over limestone. Related to *Acanthocarpus robustus*, a species of red dunes and sand over limestone, growing from Shark Bay to Cape Range.

4: *Brachychiton obtusilobus* Guymer.

A small tree, with cream flowers in ?spring and ?early summer. Pollination unknown, probably insects, fire response unknown. Found on limestone ridges on the western coastal plain, in gullies and gorges, scattered occurrences on limestone outcrops in the dunefields. Related to *Brachychiton acuminatus*, a species endemic to the Pilbara.

5: *Daviesia* sp. nov. (Trudgen sn).

Low spreading shrub, with small red-orange flowers in winter and spring. Insect pollinated, fire response unknown. Found on red sand dunes and sand over limestone. Related to *Daviesia pleurophylla* a species occurring on sand over limestone on and south of the Cape Range peninsula.

6: *Eucalyptus* "ultima" Johnson and Hill.

Mallee, bearing small white flowers in winter and spring. Pollinated by honeyeaters and insects. Found in gorges and gullies and on the summit of Cape Range, on skeletal soils over limestone. Related to *Eucalyptus oleosa*, a very widespread species of southern arid and semi-arid Australia.

7: *Grevillea calcicola* A. S. George.

Shrub to small tree with sprays of small white flowers in winter and spring. Insect pollinated, killed by fire. Grows on the western escarpment of the Range, commonly in gullies, gorges and deep valleys, scattered over the Range and on low limestone ridges in the sand dune fields. Possibly related to *Grevillea berryana*, a species occurring on sand dunes between Mullewa and the Murchison River.

8: *Grevillea variifolia* C.A. Gardn. and A.S. George ssp. *variifolia*.

Spreading shrub, with pendant racemes of red flowers in winter and spring. Pollinated by Honeyeaters. Fire response unknown. Confined to the main Range and the Rough Range, with a few populations on the west coast terraces at the base of the Cape Range. Often found where

there is a shallow mantle of red sand over the limestone. Related to *Grevillea preissii* a species of coastal limestones between Shark Bay and Mandurah.

9: *Ipomoea yardiensis* C.A. Gardn. and A.S. George.

A tuberous erect shrub to 1 metre, bearing large single pink flowers in autumn and winter. Pollinated by hawkmoths and ? bees. Resprouts after fires. Apparently confined to the limestone terraces below Cape Range on the western coastal plain between Yardie Station Homestead and just south of Yardie Creek, although scattered plants and populations were seen on the main range, in gullies and on limestone outcrops. Probably related to *Ipomoea costata*, a tropical species.

10: *Lechenaultia* aff. *lutescens* (Trudgen 6628).

Erect annual herb, with single yellow flowers in spring. Probably bee pollinated. A post fire annual, on red sand dunes over limestone. Related to *Lechenaultia lutescens* a species of the central Australian deserts.

11: *Stackhousia umbellata* A.S. George and C.A. Gardn.

Much branched low shrub, bearing umbels of yellow flowers in winter and spring. Pollination unknown. Fire response unknown. Found along the entire Cape Range, on some of the west coast terraces as far south as the Ningaloo area, but not on Rough Range or the Coral Bay calcarenites. Not closely related to any other species of *Stackhousia*, perhaps distantly to *S. scoparia*, a species found on sandplains in S.W. Western Australia.

12: *Verticordia serotina* A.S. George.

Shrub, with pink flowers in spring. Pollination unknown. Resprouts from a rootstock after fire. Occurs on shallow red sand over limestone. Closely related to *Verticordia forrestii*, a dune dwelling species growing between Carnarvon, Kennedy Ranges and Cape Range.

#### (B) Near endemics

13: *Acacia alexandri* B.R. Maslin.

Erect shrub to 3 metres, with cream flowers in winter and spring. Pollination unknown, fire response unknown. Grows on shallow soils over limestone, often along gullies. Related to *Acacia victoriae*, a widespread species of arid Australia.

14: *Acacia startii* B.R. Maslin and Chapman.

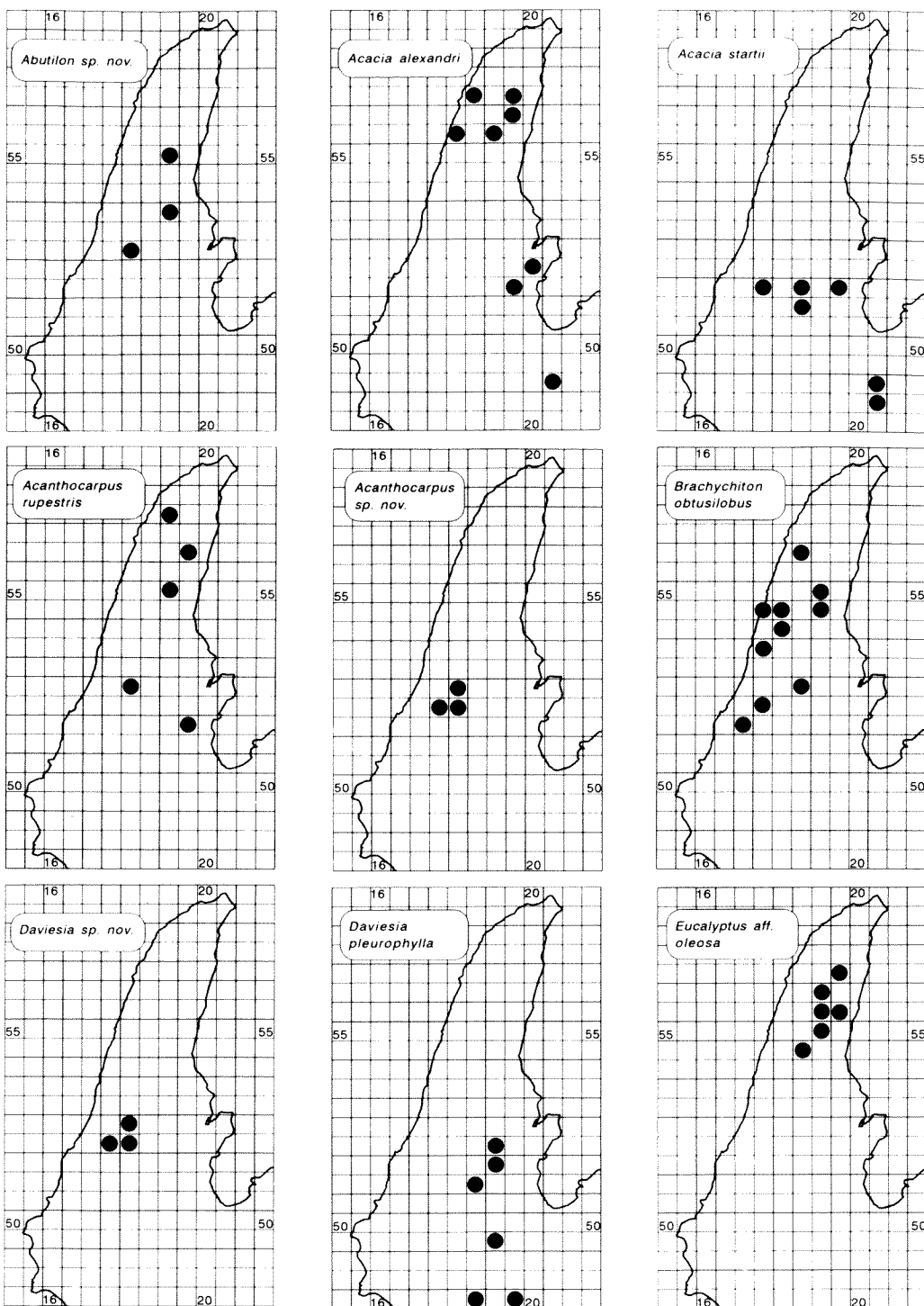
A low spreading shrub, to 2 metres. With pale yellow flowers in winter and early spring. Pollination unknown, killed by fire. Related to *Acacia bivenosa*, a species of coastal sands and limestones between Shark Bay and the Kimberley.

15: *Daviesia pleurophylla* M. Crisp.

Much branched erect shrub to 1 metre, flowers orange-red, in spring. Pollinated by native bees, resprouts after fires. Related to *Daviesia divaricata*, a species of sandplains from Bunbury to Shark bay.

16: *Grevillea stenobotrya* ssp. nov. (Keighery 12879).

Tall shrub, with sprays of white flowers in spring. Pollination unknown, resprouts after fires. Occurs on red sand over limestone and on red sand dunes around Cape Range. The nominate subspecies occurs on dunes between Kalbarri and the Kennedy Range.



**Figure 2.** Distribution maps of plant taxa endemic or nearly endemic to the study area. The grid is 5 km square and based on the national AMG.



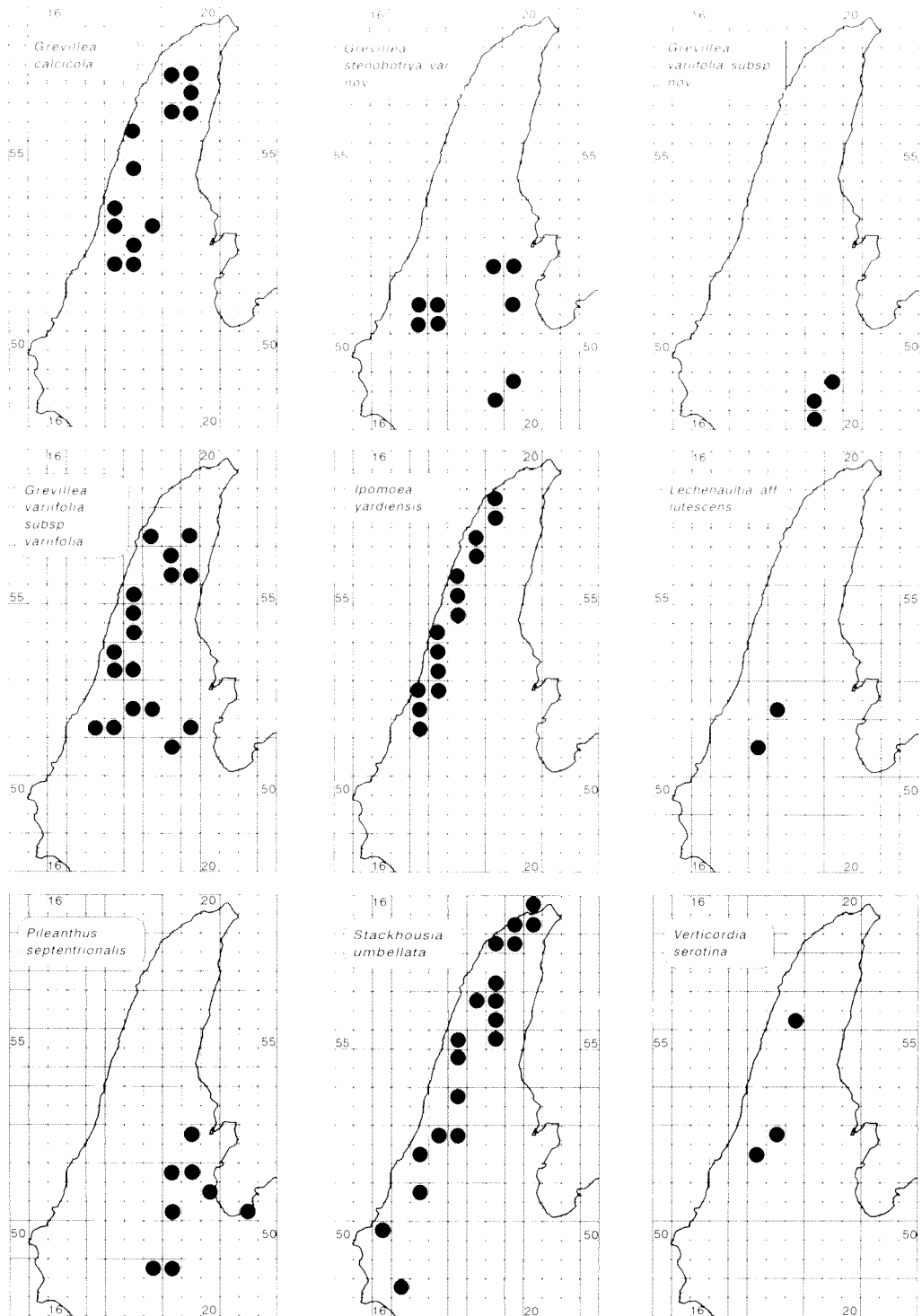


Figure 2. (cont.)

17: *Grevillea variifolia* ssp. "bundera" G.J. Keighery.

Spreading shrub with red flowers in winter and spring. This subspecies of *G. variifolia* is found only on the Bundera calcarenites, and not on the ranges.

18: *Pileanthus* "septentrionalis" G.J. Keighery.

Erect shrub, bearing pale pink flowers in spring. Insect pollinated. Occurs on the dune fields on the southern Cape Range and between the Rough Range and Cape Range. Related to *Pileanthus limacis*, a species occurring along the coast between Shark Bay and Cape Range.

#### (C) Notes on other species

*Acanthocarpus humilis* A.S. George.

Largely confined to Cape Range peninsula, but extends along the coastal calcarenites south to the western side of Lake MacLeod.

*Amyema* "myoporum" (Start 18-11-92-3).

This species was considered a rare endemic of the west coast plain of the Cape Range peninsula, being only known from four small populations parasitic on *Myoporum insulare*. During the September 1992 survey we collected a species of mistletoe on *Acacia* species near Port Gregory which appears to be this species (A. Start, pers. comm.). Hence this species is no longer considered an endemic of the peninsula.

*Sowerbaea laxiflora*, *Geleznovia verrucosa* and *Diplolaena microcephala*.

Collections of these species by the partner of a geologist who worked in the area in the 1950's and 1960's suggest that these species are disjunct in the Range from Shark Bay.

*Verticordia pulchella* A.S. George.

There is a specimen in Perth labelled Cape Range, Exmouth, extreme north of W.A., W. Rogerson, Oct. 1966. This species is confined to the central wheatbelt around Narembeen. The locality must be in error, it is retained in the species list.

The endemic and near endemic plant taxa of Cape Range peninsula are a mixed assortment. Most are closely related to taxa occurring south of the Range (*Acanthocarpus ruprestris*, *Daviesia pleurophylla*, *Daviesia* sp., *Grevillea calcicola*, *Grevillea stenobotrya* ssp. nov., *Grevillea variifolia* - both subspecies, *Pileanthus* "septentrionalis" and *Verticordia serotina*), three are related to desert species (*Abutilon* sp., *Eucalyptus* "ultima", *Lechenaultia* aff. *lutescens*) and three (*Acacia startii*, *Brachychiton obtusilobus* and *Ipomoea yardiensis*) have tropical affinities. There is only one species, *Stackhousia umbellata*, which does not presently appear to be closely related to any other species of *Stackhousia*. Thus nearly all the endemic and near endemic taxa appear to be of relatively recent origin, at least at the alpha taxonomic level. Little is known about the biology of any of these taxa, and neither are their ranges adequately documented. On our maps only those species which occur on the limestones of the main range appear to be well represented in Cape Range National Park. The proposed extension to include much of the bombing range (EPA 1975) would capture the sand dune taxa, and probably most of the near endemic taxa except *Grevillea variifolia* ssp. "bundera."

#### Weeds

Only 30 species of weed have been recorded from the area, compared to 81 species for the Carnarvon Botanical District. The arid nature of the peninsula, lacking sandy riverine areas,

major towns, intensive agriculture or alluvial flats, inhibits the establishment of many weed species. Nine species were only found around Exmouth or in man altered habitats (*Sisymbrium irio*, *Sisymbrium orientale*, *Rhaphanus raphanistrum*, *Chenopodium murale*, *Urtica urens*, *Alternanthera pungens*, *Lactuca serriola*, *Nicotiana glauca* and *Solanum nigrum*).

Significant weed invasion has occurred in the lower Yardie Creek gorge by *Asphodelus fistulosus* and *Emex australis*. These weeds may decline now cattle grazing has been discontinued, but feral goats will need to be controlled.

The most widespread and serious weed is Buffel Grass, *Cenchrus ciliaris*, which has largely replaced *Triodia* grasslands because of heavy grazing pressure and fire on the western coastal plain. This species was found in almost all quadrats sampled (see Vegetation) across the peninsula, and requires monitoring and a management program to limit its spread and to reverse the decline of the native grasslands on the western coastal plain.

### Total flora comparisons

The Cape Range peninsula is one of the three major regions of massive limestone features in the State, the others being the Devonian Reef Complex in the Kimberley (comprising the Oscar, Napier, Lawford and Nimbing Ranges), and the Nullarbor Plain. Knowledge of the flora of the Devonian Reef Complex is superficial (Burbidge *et al.* 1991), but it is a tropical flora, not a desert flora, and the complex is located inland. The flora of the Nullarbor is well documented (Keighery *et al.* 1987), as a combination of Mediterranean and temperate desertic species. A comparison between the flora of the entire Eucla Basin and Cape Range peninsula reveals only 15 % of species are shared, and these are all widespread desert taxa many of which occur in marginal sandy habitats rather than on the Nullarbor Plain proper. Hence, the three major limestone features of Western Australia have very different floras principally because of the distances between them and their very different geographical localities. One cannot substitute one area for the other, each is unique.

**Table 3.** Comparison between the flora of the Cape Range peninsula and limestone areas in the same geographical area. Barrow Island, 219 km<sup>2</sup> (list from Buckley 1983); the Shark Bay peninsulas, 5000 km<sup>2</sup> (list from Trudgen and Keighery, unpublished); the Quobba ridge/Bejaling Dunes west of Lake MacLeod, 600 km<sup>2</sup> (list from Tyler 1988); the Burrup Peninsula, 91 km<sup>2</sup> (list from Blackwell *et al.* 1978).

Cape Range-Barrow Island		Cape Range-Shark Bay	
Cape Range	630	Cape Range	630
Barrow	270	Shark Bay	828
Combined total	751	Combined total	1248
Cape Range only	481	Cape Range only	320
Barrow only	121	Shark Bay only	518
Shared	149	Shared	310
Cape Range-Lake MacLeod		Cape Range-Burrup Peninsula	
Cape Range	630	Cape Range	630
Lake MacLeod	269	Burrup	284
Combined total	713	Combined total	743
Cape Range only	444	Cape Range only	459
Lake MacLeod only	83	Burrup only	113
Shared	186	Shared	171

The flora of the peninsula can be compared to that of four other coastal areas in the same geographical area (Table 3). The Cape Range peninsula is most similar to the Quobba Ridge/Bejaling Dunes with 69% of the 269 species recorded for this area being also found on the peninsula. The Quobba Ridge/Bejaling Dunes are also a limestone area. Burrup Peninsula shares 60% of its flora with Cape Range despite being of granite composition. Barrow Island, with 55% of the 270 species recorded for the island shared with the peninsula. Of the 828 species recorded for Shark Bay only 38% are also found on the peninsula.

These results confirm that the flora of Cape Range is essentially composed of widespread desertic elements, with a tropical and to a lesser degree temperate coastal overlay. Despite Barrow Island and the Burrup Peninsula being placed in a different botanical district by Beard (1975), they are more similar to Cape Range than the overlap area between the temperate Irwin District and the Carnarvon District at Shark Bay.

### Detailed floristic studies

Beard (1975) mapped the coastal vegetation of the study area as low open scrub on recent dunes, samphire flats, *Acacia* scrub over *Triodia*, *Triodia* grasslands and heath over spinifex. The upland areas were mapped as Scrub steppe over heath and *Triodia* tree steppe (Cape Range) and *Acacia* sparse shrubs over *Triodia* (Rough Range). Payne *et al.* (1987) recognised four land systems in the Region, namely Coastal, Learmonth, Cardarbia and Range land systems. These correspond to the coastal white dunes, the coastal plain, the undulating sandplain with minor limestone ridges and the uplands of Cape Range and the Rough Range. No quantitative floristic sampling has previously been undertaken in the area.

Much of the Cape Range peninsula area consists of a series of limestone features with limestone hills and ranges and calcarenite outcrops, extending north from Lake MacLeod to Vlaming Head. A vegetation survey of these surfaces was undertaken to investigate the floristic pattern and to compare this pattern with Beard's (1975) structural classification and Payne *et al.*'s (1987) land system classification.

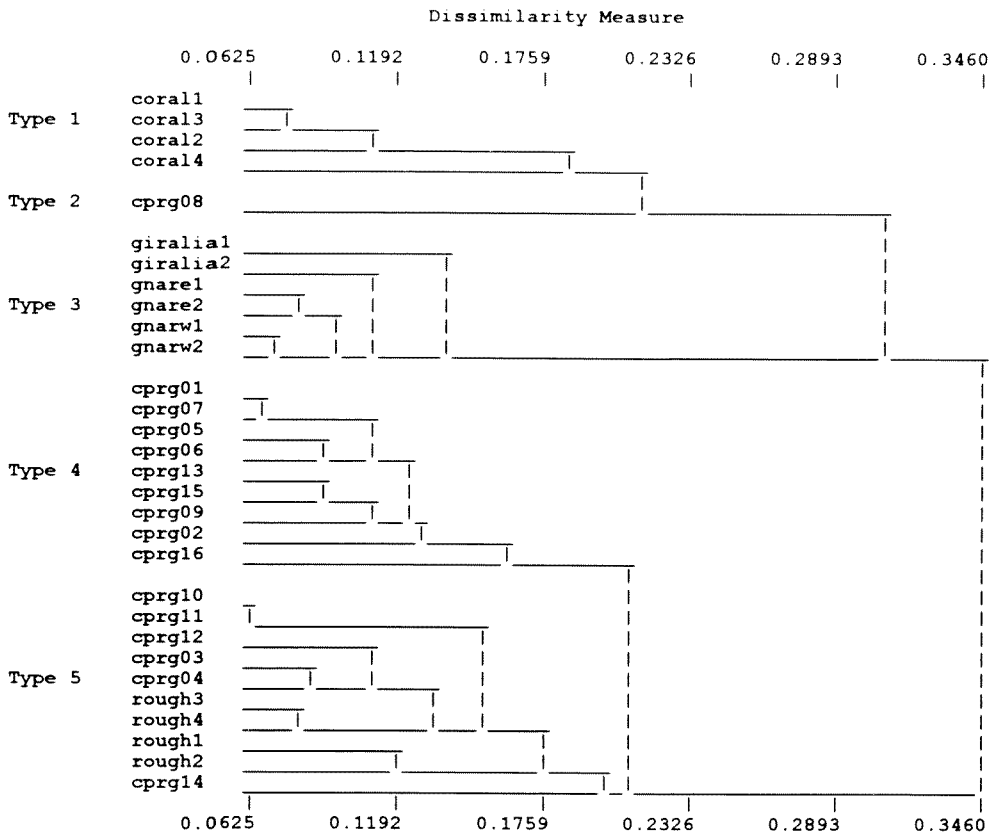
### Methods

A series of 30 permanent quadrats (each 100 m<sup>2</sup>) were located across the various calcareous regions (Figure 1). For each of the 30 quadrats species lists were compiled. The resulting species by site matrix was analysed using the Bray-Curtis dissimilarity measure for sites, the two step dissimilarity measure for species and UPGMA clustering routine for both site and species analysis (Belbin 1989).

Climate estimates for the sites were derived from BIOCLIM (Busby 1986) and surficial geology was coded as 1 for Quaternary limestones (mainly calcarenites) and as 2 for Tertiary limestones. Each site was marked and located using a G.P.S. unit. In addition slope, aspect, percentage bare ground, percentage litter and vegetation structure was recorded for each site.

### Community classification

In all 209 species were recorded in the 30 quadrats with species richness varying from 12 to 44 species per quadrat. The quadrats were classified into five distinct community types, two southern groups (types 1 and 3), two northern groups (types 4 and 5) and a single quadrat representing Quaternary red sands over limestone (Figure 3, Appendix 2). There was no significant difference in species richness between community types but the Coral Bay Calcarenites tended to have the highest species richness (Table 4).



**Figure 3.** Dendrogram of floristic relationships between 30 sampled quadrats. coral = Coral Bay; cprg = Cape Range; giralia = Giralia Range; gnare = Ngargoo Range east; gnarw = Ngargoo Range west; rough = Rough Range.

The species classification shows seven major species groups with each community type represented by a species group (or groups) with moderate levels of fidelity (restriction to a particular group) but generally low constancy, *i.e.* represented by only some quadrats in each community type (Appendix 2).

Community type 1 consists of low heaths variously dominated by *Grevillea variifolia*, *Melaleuca cardiophylla* or *Acacia tetragonophylla* over a *Triodia* sp. This community occurs on the low ridges of Bundera calcarenite in the Coral Bay area and is species rich. Species such as *Acanthocarpus humilis*, *Themeda triandrus* and *Thryptomene baeckeacea* are largely restricted to it. The community was characterised by species groups E and F and the lack of species group D2 which were common on the younger limestones to the north.

The single quadrat located in red Quaternary sands over limestone was very different from all other quadrats. It was a shrubland dominated by *Banksia ashbyii*, *Hibbertia spicata* and *Hakea stenophylla*. Six out of the 16 species at this site were unique to this community. These species were classified into species group A by virtue of the co-occurrence of *Hakea stenophylla* and *Heliotropium curassavicum* in this quadrat and in community type 5. Clearly more sampling of this community is needed to determine their relationships to the other limestone communities.

Community type 3 was restricted to the tertiary limestones of the Gnargoo and Giralia Ranges. These quadrats were dominated by either *Acacia startii*, *A. victoriae* or *A. tetragonophylla* or combinations of these species. Grass species were variable but they had a rich herb layer which generally included such species as *Helichrysum ayersii*, *Ptilotus helichrysoides*, and *Angianthus milnei*. A large number of herbs were restricted to this community (species group G, Appendix 2). In addition to the species listed in group G, a further 13 singletons (species recorded at a single quadrat) were recorded from this community type. Species from groups D1 and D2 were largely lacking in this community. Group D1 occurred in all other communities except the red sand quadrat (type 2) and D2 being restricted to the north eastern limestones.

The quadrats on the massive tertiary limestones of the Cape Range itself made up community type 4. These quadrats were shrublands dominated by *Acacia tetragonophylla*, *A. bivenosa*, *Grevillea variifolia* subsp. *variifolia*, *G. calcicola*, *Melaleuca cardiophylla* or on the terraces north of Yardie Creek by *Ipomoea yardiensis*. *Triodia wiseana* or *T. pungens* were the obvious hummock grasses. A whole series of less common herbs and shrubs were restricted to this community; these included *Ipomoea costata*, *Acacia arida*, *Centaureium spicatum* and *Portulaca conspicua*. This community is characterised by species group C which includes a further seven singletons not shown.

This community is similar in some respects to the upland limestone communities dominated by *Triodia wiseana* of Barrow Island described by Buckley (1983). Detailed community data were not presented in that paper so a detailed comparison is not possible.

The younger limestones of the western coastal plain and the Rough Range are generally dominated by *Melaleuca cardiophylla* and for *Hibbertia spicata* low heaths over *Triodia* spp. (community type 5). Occasionally they are dominated by *Acacia* low heaths. This community is also characterised by a series of less common species such as *Dysphania plantaginella*, *Hibiscus sturtii*, and *Threlkeldia diffusa* (species group A and B which include a further 23 singletons restricted to this community type).

### Environmental correlates

Analysis of the environmental data showed a major rainfall gradient running from north west to south east, with the northern peninsula receiving significantly more rainfall than the southern ranges (Kruskal-Wallis  $P < 0.0001$ , Table 4). This gradient is clearly seen in the floristic classification and correlates with the major split between community types 1 and 3 and community types 4 and 5.

Both the northern and southern groups further segregate on the limestone type (Table 4). The quadrats on the southern Coral Bay calcarenites of Holocene age (type 1) separate from

**Table 4.** Comparison of estimated annual rainfall and surficial geology by community types. (Surficial geology coded as 1 for Quaternary limestones and 2 for Tertiary limestones).

Community Type	Annual rainfall		Substrate score		Mean species richness	Number of quadrats
	Mean	S.D.	Mean	S.D.		
Type 1	245.6	0.6	1.0	0.0	32.3	4
Type 2	284.0	-	1.0	-	16.0	1
Type 3	250.2	7.3	2.0	0.0	28.5	6
Type 4	286.9	20.9	2.0	0.0	25.7	9
Type 5	278.6	17.6	1.3	0.4	25.5	10

the Tertiary limestones of the Giralia Range and Gnargoo Ranges (type 3). And the Tertiary limestones of the Cape Range (type 4) largely separate from the Pleistocene deposits of the Rough Range and the coastal limestone terraces found to the west of Cape Range (type 5). This separation is not complete with some of the species poor quadrats from the peninsula and two quadrats near the boundary of the Pleistocene and Tertiary surfaces being classified into the younger limestone group (type 5).

### Discussion

The floristic classification of the vegetation of the limestone surfaces in the Cape Range area clearly indicates a much finer scale of patterning than the can be seen from the available vegetation or land system maps.

Payne *et al.* (1987) classify the uplands of both the Cape Range and the Rough Range into the same land system. Our floristic data shows the Rough Range to be more closely allied to the young limestones of the coastal plain to the west of the Cape Range (part of the Learmonth land system). Our Coral Bay calcarenite (type 1) corresponds to the minor limestone ridges in their Cardabia land unit but this unit is largely dominated by the floristically distinct sandplain. Indeed our very distinct community type 2 is also mapped as the Cardabia unit. Similarly our resolution is much finer than seen in Beard's (1975) vegetation map.

While our floristic data have much finer resolution than the previous work the level of heterogeneity seen in the dendrogram indicates a more refined classification could be expected from more intensive sampling, especially for community type 1, 2 and 3 (Figure 3). Given the much finer scale of patterning that can be resolved from quadrat based surveys any future assessment of this area should use these techniques rather than the published vegetation or land system maps.

The Cape Range peninsula has a very rich flora for an arid area. While it is most similar to the Burrup Peninsula and Barrow Island (remembering that these areas are much smaller and have in the first case very different geologies), these areas have a flora less than half that recorded for Cape Range peninsula. The peninsula is obviously an area of very high conservation significance. Within the Cape Range itself the creek system and the semi-permanent wetlands of Yardie Creek stand out as a refugia for a number of southern taxa that reach their northern limits in this area.

As yet little detailed botanical work has been carried out on the Cape Range peninsula. The most obvious needs are for a comprehensive species list to be compiled for the area; the eastern and western creek systems of the Range have received little attention. There is also a need to expand the provisional vegetation classification presented in this paper and to map accurately distributions of the endemics and near endemics and to determine their conservation requirements, especially as development pressures for tourism (Anon. 1992) increase.

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**Appendix 1.** Flora list for the Cape Range peninsula study area as defined in text. The list is arranged by families and weed species are denoted \*. DC = distribution code: e = endemic to Cape Range; ne = near endemic; s = southern range end; n = northern range end. Species ticked in column  $\checkmark$  occur in Cape Range National Park. “ ” denotes a manuscript name.

Taxon	DC	CRNP
<b>Acanthaceae</b>		
<i>Dicladanthera forrestii</i>		$\checkmark$
<i>Dipteracanthus australasicus</i> subsp. <i>corynothecus</i>		$\checkmark$
<i>Rostellularia adscendens</i> var. <i>pogonathera</i>		
<i>Sarajusticia kempiana</i>		$\checkmark$
<b>Adiantaceae</b>		
<i>Cheilanthes lasiophylla</i>		
<b>Aizoaceae</b>		
<i>Carpobrotus</i> “septentrionalis”	n	$\checkmark$
* <i>Mesembryanthemum crystallinum</i>		
<i>Sesuvium portulacastrum</i>		$\checkmark$
<i>Tetragonia diptera</i>	n	
<i>Trianthema oxycalyptra</i>		$\checkmark$
<i>Trianthema triquetra</i>		
<i>Zaleya galericulata</i>		$\checkmark$
<b>Amaranthaceae</b>		
<i>Achyranthes aspera</i>		$\checkmark$
* <i>Aerva javanica</i>		$\checkmark$
<i>Alternanthera nodiflora</i>		$\checkmark$
<i>Amaranthus mitchellii</i>		$\checkmark$
* <i>Amaranthus pungens</i>		
<i>Gomphrena canescens</i>		$\checkmark$
<i>Hemichroa diandra</i>		
<i>Ptilotus aervoides</i>		$\checkmark$
<i>Ptilotus appendiculatus</i>		
<i>Ptilotus astrolasius</i>		
<i>Ptilotus axillaris</i>		
<i>Ptilotus calostachyus</i>		
<i>Ptilotus clementii</i>		
<i>Ptilotus divaricatus</i>		
<i>Ptilotus exaltatus</i>		$\checkmark$
<i>Ptilotus gaudichaudii</i>		$\checkmark$
<i>Ptilotus helipteroides</i>		
<i>Ptilotus macrocephalus</i>		
<i>Ptilotus obovatus</i>		$\checkmark$
<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>		$\checkmark$
<i>Ptilotus villosiflorus</i>		$\checkmark$
<b>Amaryllidaceae</b>		
<i>Crinum flaccidum</i>	s	$\checkmark$
<b>Anthericaceae</b>		
<i>Corynotheca flexuosissima</i>	s	$\checkmark$
<i>Corynotheca pungens</i>	n	
<i>Murchisonia volubilis</i>		$\checkmark$
<i>Sowerbaea laxiflora</i>	n	
<i>Thysanotus exiliflorus</i>		
<i>Tricoryne corynothecoides</i>	n	$\checkmark$

Taxon	DC	CRNP
<b>Apiaceae</b>		
<i>Daucus glochidiatus</i>		✓
<i>Trachymene hemicarpa</i>		
<i>Trachymene oleracea</i>		✓
<b>Areaceae</b>		
<i>Livistona alfredii</i>	s	
<b>Asclepiadaceae</b>		
<i>Cynanchum floribundum</i>		✓
<i>Gymnanthera nitida</i>		
<i>Leichardtia australis</i>		✓
<i>Marsdenia cinerascens</i>		✓
<i>Rhyncharrhena linearis</i>		
<i>Sarcostemma viminale</i> subsp. <i>australe</i>		✓
<b>Asphodelaceae</b>		
* <i>Asphodelus fistulosus</i>		✓
<b>Asteraceae</b>		
<i>Actinobole drummondiana</i>	n	
<i>Actinobole oldfieldiana</i>	n	
<i>Angianthus acrohyalinus</i>		
<i>Angianthus cunninghamii</i>		
<i>Angianthus milnei</i>		✓
<i>Angianthus tomentosus</i>		✓
* <i>Bidens bipinnata</i>		✓
<i>Blumea tenella</i>		
<i>Brachyscome cheilocarpa</i>		✓
<i>Brachyscome ciliocarpa</i>		
<i>Brachyscome iberidifolia</i>		✓
<i>Brachyscome latisquamea</i>	n	✓
<i>Brachyscome oncocarpa</i>		
<i>Calocephalus</i> sp.		
<i>Calotis hispidula</i>		✓
<i>Calotis multicaulis</i>		✓
<i>Centipeda minima</i>		
<i>Cephalopterum drummondii</i>		
* <i>Conyza bonariensis</i>		
<i>Craspedia</i> sp. (GJK 13202)		
<i>Cratystylis subspinescens</i>		
<i>Decazesia hecatocephala</i>		✓
<i>Erymophyllum ramosum</i>		
<i>Flaveria australasica</i>		✓
<i>Gnephosis arachnoidea</i>		
<i>Helichrysum ayersii</i>		
<i>Rhodanthe condensatum</i>		
* <i>Lactuca sarmentosa</i>	s	
* <i>Lactuca serriola</i>		
<i>Millotia myosotidifolia</i>		
<i>Olearia axillaris</i>	n	
<i>Olearia "dampieri"</i>		✓
<i>Olearia grandiflora</i>		
<i>Olearia revoluta</i>		
<i>Pluchea rubelliflora</i>		
<i>Podolepis canescens</i>		
<i>Pseudognaphalium luteo-album</i>		

Taxon	DC	CRNP
<i>Pterocaulon sphaeranthoides</i>		√
<i>Rhodanthe floribundum</i>		√
<i>Rhodanthe humboldtianum</i>		√
<i>Rhodanthe sterilesens</i>		√
<i>Rhodanthe strictum</i>		√
<i>Rhodanthe citrina</i>		
<i>Senecio lautus</i> subsp. <i>dissectifolius</i>		
<i>Senecio magnificus</i>		
<i>Sigesbeckia microcephala</i>		√
* <i>Sonchus oleraceus</i>		√
<i>Streptoglossa bubakii</i>		
<i>Streptoglossa decurrens</i>		√
<i>Streptoglossa macrocephala</i>		√
<i>Vittadinia arida</i>		√
<i>Vittadinia hispidula</i>		
<b>Avicenniaceae</b>		
<i>Avicennia marina</i>		√
<b>Boraginaceae</b>		
<i>Ehretia saligna</i>		
<i>Halgania</i> sp. (ASG 10290)	n	√
<i>Heliotropium crispatum</i>		
<i>Heliotropium curassavicum</i>		√
<i>Heliotropium ramosissimum</i>		√
<i>Heliotropium strigosum</i>		
<i>Trichodesma zeylanicum</i>		√
<b>Brassicaceae</b>		
<i>Lepidium linifolium</i>		√
<i>Lepidium pedicellosum</i>		
<i>Lepidium platypetalum</i>		
<i>Lepidium rotundum</i>		
<i>Menkea villosula</i>		√
* <i>Raphanus raphanistrum</i>		
* <i>Sisymbrium irio</i>		
* <i>Sisymbrium orientale</i>		
<i>Stenopetalum pedicellare</i>		√
<b>Caesalpinaceae</b>		
<i>Cassia chatelainiana</i>		
<i>Cassia desolata</i>		
<i>Cassia glutinosa</i>		
<i>Cassia helmsii</i>		
<i>Cassia helmsii</i> x <i>oligophylla</i>		
<i>Cassia nemophila</i>		
<i>Cassia nemophila</i> var. <i>nemophila</i>		
<i>Cassia notabilis</i>		
<i>Cassia oligophylla</i>		√
<i>Cassia pleurocarpa</i>		
<i>Cassia pruinosa</i>		
<i>Cassia sturtii</i>		
<i>Cassia venusta</i>		
<i>Petalostylis cassioides</i>		
<i>Petalostylis labicheoides</i>		

Taxon	DC	CRNP
<b>Campanulaceae</b>		
<i>Wahlenbergia communis</i>		
<i>Wahlenbergia tumidifructa</i>		
<b>Capparaceae</b>		
<i>Capparis lasiantha</i>		
<i>Capparis mitchellii</i>		✓
<i>Capparis spinosa</i> var. <i>nummularia</i>		✓
<i>Cleome uncifera</i>		✓
<i>Cleome viscosa</i>		
<b>Caryophyllaceae</b>		
<i>Polycarpea longiflora</i>		
* <i>Polycarpon tetraphyllum</i>		
<b>Chenopodiaceae</b>		
<i>Atriplex bunburyana</i>		
<i>Atriplex codonocarpa</i>		
<i>Atriplex holocarpa</i>		✓
<i>Atriplex isatidea</i>		✓
<i>Atriplex semilunaris</i>		
<i>Atriplex vesicaria</i>		
* <i>Chenopodium album</i>		✓
<i>Chenopodium gaudichaudianum</i>		✓
<i>Chenopodium melanocarpum</i>		✓
<i>Dissocarpus paradoxus</i>		✓
<i>Dysphania plantaginella</i>		✓
<i>Dysphania rhadinostachya</i>		✓
<i>Dysphania sphaerosperma</i>		
<i>Enchylaena tomentosa</i>		✓
<i>Halosarcia auriculata</i>		
<i>Halosarcia doleiformis</i>		
<i>Halosarcia halocnemoides</i>		
<i>Halosarcia leptoclada</i>		
<i>Halosarcia peltata</i>		
<i>Halosarcia pruinosa</i>		
<i>Halosarcia pterygosperma</i>		
<i>Maireana aphylla</i>		
<i>Maireana georgei</i>		
<i>Maireana lanosa</i>		
<i>Maireana melanocoma</i>		
<i>Maireana polypterygia</i>		
<i>Maireana</i> sp. (GJK 13201)		
<i>Maireana</i> sp. (GJK 13090)		
<i>Maireana trichoptera</i>		
<i>Neobassia astrocarpa</i>		
<i>Osteocarpum salsuginosum</i>		
<i>Rhagodia baccata</i>		✓
<i>Salsola kali</i>		✓
<i>Sarcocornia quinqueflora</i>		✓
<i>Sclerolaena bicornis</i>		
<i>Sclerolaena costata</i>		
<i>Sclerolaena diacantha</i>		✓
<i>Sclerolaena eriacantha</i>		
<i>Sclerolaena limbata</i>		
<i>Sclerolaena recurvicauspis</i>		

Taxon	DC	CRNP
<i>Sclerolaena uniflora</i>		√
<i>Sclerostegia disarticulata</i>		
<i>Suaeda arbusculoides</i>		
<i>Threlkeldia diffusa</i>		√
<b>Chloanthaceae</b>		
<i>Dicrastylis cordifolia</i> var. <i>barnettii</i>		
<i>Dicrastylis georgei</i> var. <i>georgei</i>		
<i>Pityrodia loxocarpa</i>	n	√
<i>Pityrodia paniculata</i>		√
<i>Spartothamnella teucriflora</i>		
<b>Clusiaceae</b>		
<i>Hypericum gramineum</i>		
<b>Colchicaceae</b>		
<i>Wurmbea odorata</i>	n	√
<b>Commelinaceae</b>		
<i>Commelina ensifolia</i>		√
<b>Convolvulaceae</b>		
<i>Bonamia rosea</i>		√
<i>Convolvulus erubescens</i>		√
<i>Evolvulus alsinoides</i> var. <i>alsinoides</i>		√
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>		
<i>Ipomoea brasiliensis</i>		√
<i>Ipomoea calobra</i>		
<i>Ipomoea costata</i>		√
<i>Ipomoea muelleri</i>		
<i>Ipomoea ochrophylla</i>		
<i>Ipomoea yardiensis</i>	e	√
<i>Polymeria calycina</i>		
<i>Porana sericea</i>		
<b>Crassulaceae</b>		
<i>Crassula colorata</i>		√
<b>Cucurbitaceae</b>		
<i>Cucumis melo</i>		
<i>Momordica balsamina</i>		
<i>Mukia maderaspatana</i>		√
<i>Trichosanthes cucumerina</i> var. <i>cucumerina</i>		√
<b>Cuscutaceae</b>		
* <i>Cuscuta epithymum</i>		√
<b>Cymodoceaceae</b>		
<i>Amphibolis antarctica</i>		
<i>Amphibolis griffithii</i>		
<i>Cymodocea angustata</i>		
<i>Cymodocea serrulata</i>		
<i>Halodule uninervis</i>		
<i>Halodule wrightii</i>		
<i>Syringodium isoetifolium</i>		
<i>Thalassodendron ciliatum</i>		
<b>Cyperaceae</b>		
<i>Bulbostylis barbata</i>		√

Taxon	DC	CRNP
<i>Cyperus bifax</i>		
<i>Cyperus bulbosus</i>		√
<i>Cyperus iria</i>		
<i>Cyperus squarrosus</i>		
<i>Cyperus vaginatus</i>		
<i>Schoenoplectus litoralis</i>		√
<b>Dasypogonaceae</b>		
<i>Acanthocarpus humilis</i>	n	√
<i>Acanthocarpus preissii</i>	n	√
<i>Acanthocarpus robustus</i>	n	
<i>Acanthocarpus rupestris</i>	e	√
<i>Acanthocarpus</i> sp. (Trudgen 6654)	e	
<i>Acanthocarpus verticillatus</i>	ne	
<b>Dilleniaceae</b>		
<i>Hibbertia spicata</i> subsp. <i>spicata</i>	n	√
<b>Dioscoreaceae</b>		
<i>Dioscorea hastifolia</i>	n	
<b>Droseraceae</b>		
<i>Drosera indica</i>		
<b>Elatinaceae</b>		
<i>Bergia perennis</i>		
<b>Emblingiaceae</b>		
<i>Emblingia calceoliflora</i>	n	
<b>Euphorbiaceae</b>		
<i>Adriana tomentosa</i>	n	√
<i>Beyeria cinerea</i>	n	√
<i>Euphorbia alsiniflora</i>		
<i>Euphorbia atoto</i>		
<i>Euphorbia australis</i>		√
<i>Euphorbia boophthona</i>		√
<i>Euphorbia coghlanii</i>		
<i>Euphorbia drummondii</i>		√
<i>Euphorbia myrtoides</i>		
<i>Euphorbia sharkoensis</i>		
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>		
<i>Phyllanthus calycinus</i>	n	√
<i>Phyllanthus fuernrohrii</i>		√
<i>Phyllanthus maderaspatensis</i>		√
<b>Frankeniaceae</b>		
<i>Frankenia ambita</i>		
<i>Frankenia magnifica</i>		
<i>Frankenia pauciflora</i>		√
<b>Gentianaceae</b>		
* <i>Centaurium spicatum</i>		√
<b>Geraniaceae</b>		
<i>Erodium angustilobum</i>		√
<i>Erodium cygnorum</i>		√

Taxon	DC	CRNP
<b>Goodeniaceae</b>		
<i>Dampiera candidans</i>		
<i>Dampiera incana</i> var. <i>incana</i>	n	√
<i>Goodenia berardiana</i>	n	√
<i>Goodenia corynocarpa</i>		
<i>Goodenia cusackiana</i>		
<i>Goodenia forrestii</i>		
<i>Goodenia heterochila</i> var. <i>racemosa</i>		
<i>Goodenia lamprosperma</i>		
<i>Goodenia microptera</i>		
<i>Goodenia muelleriana</i>		
<i>Goodenia pascua</i>		
<i>Goodenia pinnatifida</i>		
<i>Goodenia stobbsiana</i>		
<i>Goodenia tenuiloba</i>		√
<i>Lechenaultia</i> aff. <i>lutescens</i> (Trudgen 6628)	e	
<i>Lechenaultia subcymosa</i>	n	
<i>Scaevola</i> aff. <i>decepiens</i> (GJK 13331)		
<i>Scaevola</i> aff. <i>nitida</i> (GJK 12899)	n	
<i>Scaevola anchusifolia</i>		
<i>Scaevola crassifolia</i>	n	
<i>Scaevola cunninghamii</i>		√
<i>Scaevola globulifera</i>		
<i>Scaevola pulchella</i>		
<i>Scaevola sericophylla</i>		√
<i>Scaevola spicigera</i>	n	
<i>Scaevola spinescens</i>		
<i>Scaevola tomentosa</i>	n	
<b>Gyrostemonaceae</b>		
<i>Codonocarpus cotinifolius</i>		
<i>Gyrostemon ramulosus</i>		
<b>Haloragaceae</b>		
<i>Glischrocaryon flavescens</i>	n	
<i>Haloragis gossei</i>		√
<i>Haloragis trigonocarpa</i>		√
<i>Myriophyllum verrucosum</i>		√
<b>Hydrocharitaceae</b>		
<i>Halophila ovalis</i>		
<b>Juncaginaceae</b>		
<i>Triglochin calcitrapa</i>		√
<i>Triglochin hexagona</i>		
<b>Lamiaceae</b>		
<i>Basilicum polystachion</i>		
<i>Plectranthus intraterraneus</i>		√
<i>Teucrium racemosum</i>		
<i>Westringia dampieri</i>		
<b>Lauraceae</b>		
<i>Cassytha aurea</i> var. <i>aurea</i>		√
<i>Cassytha filliformis</i>		√
<i>Cassytha nodiflora</i>		

Taxon	DC	CRNP
<b>Lobeliaceae</b>		
<i>Lobelia heterophylla</i>		
<b>Loganiaceae</b>		
<i>Logania vaginalis</i>	n	√
<b>Loranthaceae</b>		
<i>Amyema benthamii</i>		
<i>Amyema fitzgeraldii</i>		
<i>Amyema miquelii</i>		
<i>Amyema</i> "myoporum" (ANS 18-11-92-3)	n	√
<i>Amyema preissii</i>		
<i>Amyema sanguineum</i>		
<i>Lysiana</i> sp. (Trudgen sn)		
<b>Malvaceae</b>		
<i>Abutilon amplum</i>		
<i>Abutilon cryptopetalum</i>		
<i>Abutilon exonemum</i>		
<i>Abutilon fraseri</i>		
<i>Abutilon geranioides</i>		
<i>Abutilon lepidum</i>		
<i>Abutilon otocarpum</i>		
<i>Abutilon oxycarpum</i>		
<i>Abutilon</i> sp. (Trudgen 6634)	e	
<i>Alyogyne cuneiformis</i>		√
<i>Alyogyne pinoniana</i>		√
<i>Gossypium australe</i>		
<i>Gossypium robinsonii</i>		
<i>Hibiscus brachysiphonius</i>		
<i>Hibiscus coatesii</i>		
<i>Hibiscus goldsworthii</i>		
<i>Hibiscus leptocladus</i>		
<i>Hibiscus panduriformis</i>		
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>		√
<i>Lawrenxia viridigrisea</i>		
* <i>Malva parviflora</i>		
* <i>Malvastrum americanum</i>		
<i>Sida calyxhymenia</i>		√
<i>Sida clementii</i>		
<i>Sida corrugata</i>		√
<i>Sida echinocarpa</i>		
<i>Sida intricata</i>		
<i>Sida physocalyx</i>		
<i>Sida rohlenae</i>		
<i>Sida spinosa</i>		
<i>Sida virgata</i>		
<b>Marsileaceae</b>		
<i>Marsilea hirsuta</i>		
<b>Mimosaceae</b>		
<i>Acacia alexandri</i>	ne	√
<i>Acacia arida</i>		√
<i>Acacia bivenosa</i>		√
<i>Acacia coriacea</i>		



Taxon	DC	CRNP
<i>Acacia cuspidifolia</i>		
<i>Acacia gregorii</i>		√
<i>Acacia pyrifolia</i>		√
<i>Acacia sclerosperma</i>		
<i>Acacia spathulifolia</i>		
<i>Acacia startii</i>	ne	
<i>Acacia synchronicia</i>		
<i>Acacia tetragonophylla</i>		√
<i>Acacia translucens</i>	s	
<i>Acacia wiseana</i>		
<i>Acacia xiphophylla</i>		
<i>Neptunia gracilis</i>		
<b>Molluginaceae</b>		
<i>Glinus lotoides</i>		
<i>Mollugo molluginis</i>		
<b>Moraceae</b>		
<i>Ficus platypoda</i> var. <i>minor</i>		√
<i>Ficus virens</i> var. <i>virens</i>	s	√
<b>Myoporaceae</b>		
<i>Eremophila clarkei</i>		
<i>Eremophila cuneifolia</i>		
<i>Eremophila exilifolia</i>		√
<i>Eremophila fraseri</i>		
<i>Eremophila glabra</i>		√
<i>Eremophila latrobei</i>		√
<i>Eremophila forrestii</i>		
<i>Eremophila longifolia</i>		√
<i>Eremophila maculata</i>		
<i>Eremophila pantonii</i>		
<i>Eremophila platycalyx</i>		
<i>Eremophila subfloccosa</i>		√
<i>Eremophila youngii</i>		
<i>Myoporum montanum</i>		
<b>Myrtaceae</b>		
<i>Callistemon phoeniceus</i>	n	
<i>Calothamnus oldfieldii</i>	n	√
<i>Calytrix brevifolia</i>		
<i>Calytrix truncatifolia</i>		
<i>Eucalyptus</i> aff. <i>prominens</i> (Brooker 4569)		
<i>Eucalyptus aspera</i>		
<i>Eucalyptus fruticosa</i>		
<i>Eucalyptus</i> "hammersleyana"		√
<i>Eucalyptus lenziana</i>		
<i>Eucalyptus microtheca</i>		
<i>Eucalyptus patellaris</i>		
<i>Eucalyptus prominens</i>		√
<i>Eucalyptus trivalvis</i>		√
<i>Eucalyptus</i> "ultima"	e	
<i>Eucalyptus xerothermica</i>		
<i>Malloestemon</i> sp. (Trudgen sn)	n	
<i>Melaleuca cardiophylla</i> var. <i>longistaminea</i>		√
<i>Melaleuca cardiophylla</i>	n	√

Taxon	DC	CRNP
<i>Pileanthus</i> "septentrionalis"	ne	
<i>Pileanthus limacis</i>	n	
<i>Thryptomene baeckeacea</i>		√
<i>Verticordia forrestii</i>	n	
<i>Verticordia pulchella</i> (see text)		
<i>Verticordia serotina</i>	e	√
<b>Najadaceae</b>		
<i>Najas marina</i>		√
<b>Nyctaginaceae</b>		
<i>Boerhavia burbidgeana</i>		√
<i>Boerhavia coccinea</i>		
<i>Boerhavia schomburgkiana</i>		
<i>Commicarpus australis</i>		√
<b>Olacaceae</b>		
<i>Olax aurantia</i>	n	
<b>Oleaceae</b>		
<i>Jasminum calcareum</i>		
<i>Jasminum didymum</i> subsp. <i>lineare</i>		√
<b>Ophioglossaceae</b>		
<i>Ophioglossum lusitanicum</i>		
<b>Oxalidaceae</b>		
* <i>Oxalis corniculata</i>		
<i>Oxalis perennans</i>	n	√
<b>Papaveraceae</b>		
* <i>Argemone ochroleuca</i>		
<b>Papilionaceae</b>		
<i>Aeschynomene indica</i>		
<i>Atylosia cinerea</i>		
<i>Brachysema macrocarpum</i>	n	√
<i>Clianthus formosus</i>		√
<i>Crotalaria cunninghamii</i>		
<i>Crotalaria medicaginea</i>		√
<i>Daviesia</i> "pleurophylla"	ne	
<i>Daviesia</i> sp. (Trudgen sn)	e	
<i>Desmodium</i> sp. (Trudgen sn)		
<i>Erythrina vespertilio</i>		√
<i>Glycine canescens</i>		
<i>Indigofera bovipерda</i>		√
<i>Indigofera brevidens</i>		√
<i>Indigofera georgei</i>		
<i>Indigofera linifolia</i>		
<i>Indigofera linnaei</i>		
<i>Indigofera monophylla</i>		√
<i>Indigofera viscosa</i>		
<i>Isotropis atropurpurea</i>		√
<i>Lotus australis</i>		√
<i>Lotus cruentus</i>		√
<i>Mirbelia ramulosa</i>	n	
<i>Psoralea cinerea</i>		
<i>Psoralea graveolens</i>		

Taxon	DC	CRNP
<i>Psoralea lachnostachys</i>		
<i>Psoralea leucantha</i>		√
<i>Psoralea martinii</i>		
<i>Rhynchosia minima</i>		√
<i>Sesbania bispinosa</i>		
<i>Sesbania cannabina</i> var. <i>cannabina</i>		√
<i>Swainsona beasleyana</i> subsp. <i>beasleyana</i>		
<i>Swainsona canescens</i> var. <i>canescens</i>		√
<i>Swainsona elegans</i>		
<i>Swainsona kingii</i>		√
<i>Swainsona microphylla</i>		
<i>Swainsona phacoides</i>		
<i>Swainsona pterostylis</i>		√
<i>Swainsonia</i> sp. (ASG 11570)		
<i>Templetonia egena</i>		
<i>Tephrosia bidwillii</i>		
<i>Tephrosia eriocarpa</i>		
<i>Tephrosia flammea</i>		
<i>Tephrosia purpurea</i>		
<i>Tephrosia rosea</i>		
<i>Tephrosia uniovulata</i>		
<i>Trigonella suavissima</i>		
<i>Vigna lanceolata</i>		
<b>Passifloraceae</b>		
* <i>Passiflora foetida</i>		√
<b>Pedaliaceae</b>		
<i>Josephinia eugeniae</i>		
<b>Phormiaceae</b>		
<i>Dianella revoluta</i>		
<b>Pittosporaceae</b>		
<i>Bursaria occidentalis</i>		
<i>Pittosporum phylliraeoides</i> var. <i>phylliraeoides</i>		√
<b>Plantaginaceae</b>		
<i>Plantago drummondii</i>	<i>n</i>	
<b>Plumbaginaceae</b>		
<i>Aegialitis annulata</i>	<i>s</i>	
<i>Muellerolimon salicorniaceum</i>		√
<i>Plumbago zeylanica</i>		√
<b>Poaceae</b>		
<i>Amphipogon caricinus</i>		
<i>Aristida contorta</i>		
<i>Aristida holathera</i>		√
<i>Aristida nitidula</i>		
<i>Astrebla elymoides</i>		
<i>Astrebla pectinata</i>		
<i>Bothriochloa ewartiana</i>		√
<i>Brachiaria occidentalis</i>		
<i>Bromus arenarius</i>		
* <i>Bromus diandrus</i>		√
* <i>Cenchrus ciliaris</i>		√

Taxon	DC	CRNP
<i>*Cenchrus echinatus</i>		
<i>*Cenchrus setigerus</i>		
<i>Chloris pectinata</i>		
<i>Chloris pumilio</i>		
<i>*Chloris virgata</i>		
<i>Chrysopogon fallax</i>		
<i>Cymbopogon ambiguus</i>		√
<i>Cymbopogon bombycinus</i>		√
<i>Cynodon dactylon</i>		
<i>*Dactyloctenium aegyptium</i>		√
<i>Dichanthium sericeum</i> var. <i>sericeum</i>		√
<i>Digitaria ctenantha</i>		
<i>Diplachne fusca</i>		√
<i>Elytrophorus spicatus</i>		
<i>Enneapogon avenaceus</i>		
<i>Enneapogon caerulescens</i> var. <i>occidentale</i>		
<i>Enneapogon caerulescens</i> var. <i>caerulescens</i>		√
<i>Enneapogon oblongus</i>		
<i>Enneapogon polyphyllus</i>		√
<i>Enteropogon acicularis</i>		
<i>Eragrostis basedowii</i>		
<i>Eragrostis cumingii</i>		
<i>Eragrostis dielsii</i>		√
<i>Eragrostis eriopoda</i>		√
<i>Eragrostis falcata</i>		
<i>Eragrostis setifolia</i>		
<i>Eriachne aristidea</i>		
<i>Eriachne helmsii</i>		
<i>Eriachne mucronata</i>		
<i>Eulalia aurea</i>		√
<i>*Hordeum leporinum</i>		
<i>Iseilema dolichotrichum</i>		
<i>Iseilema ermaeum</i>		√
<i>Iseilema membranaceum</i>		√
<i>Iseilema vaginiflorum</i>		
<i>*Lolium multiflorum</i>		
<i>Monachather paradoxa</i>		
<i>Panicum decompositum</i>		
<i>Panicum latzii</i>		
<i>Paracteanum novae-hollandiae</i>		
<i>Paracteanum refractum</i>		
<i>Paraneurachne muelleri</i>		
<i>Paspalidium clementii</i>		
<i>Paspalidium gracile</i>		
<i>Paspalidium jubiflorum</i>		
<i>Paspalidium tabulatum</i>		
<i>Perotis rara</i>		
<i>Plectrachne schinzii</i>		√
<i>*Polypogon monspeliensis</i>		
<i>*Rostraria pumila</i>		
<i>Setaria dielsii</i>		
<i>Spinifex longifolius</i>		
<i>Sporobolus actinocladius</i>		
<i>Sporobolus caroli</i>		

Taxon	DC	CRNP
<i>Sporobolus virginicus</i>		
<i>Themeda triandra</i>		
<i>Tragus australianus</i>		√
<i>Triodia angusta</i>		√
<i>Triodia basedowii</i>		
<i>Triodia lanigera</i>		√
<i>Triodia pungens</i>		√
<i>Triodia wiseana</i> var. <i>brevifolia</i>	s	
<i>Triodia wiseana</i> var. <i>wiseana</i>		√
<i>Triraphis mollis</i>		
<i>Whiteochloa cymbiformis</i>		
<b>Polygalaceae</b>		
<i>Polygala isingii</i>		
<b>Polygonaceae</b>		
* <i>Emex australis</i>		√
* <i>Rumex vesicarius</i>		√
<b>Portulacaceae</b>		
<i>Calandrinia balonensis</i>		
<i>Calandrinia polyandra</i>		
<i>Portulaca conspicua</i>		√
<b>Potamogetonaceae</b>		
<i>Ruppia maritima</i>		
<b>Primulaceae</b>		
<i>Samolus repens</i> var. <i>floribundus</i>		
<b>Proteaceae</b>		
<i>Banksia ashbyi</i>	n	√
<i>Grevillea calcicola</i>	e	√
<i>Grevillea eriostachya</i>		
<i>Grevillea gordoniana</i>		
<i>Grevillea stenobotrya</i> subsp. nov. (GJK 12879)	ne	√
<i>Grevillea variifolia</i> subsp. <i>variifolia</i>	e	√
<i>Hakea cunninghamii</i>		
<i>Hakea stenophylla</i>		√
<i>Hakea suberea</i>		√
<b>Rhizophoraceae</b>		
<i>Rhizophora stylosa</i>		√
<b>Rubiaceae</b>		
<i>Canthium attenuatum</i>		
<i>Canthium latifolium</i>		
<i>Hedyotis crouchiana</i>		√
<i>Opercularia spermacoea</i>	n	
<i>Synaptantha tillaeacea</i>		√
<b>Rutaceae</b>		
<i>Diplolaena grandiflora</i>	n	√
<i>Diplolaena microcephala</i> var. <i>microcephala</i>	n	
<i>Geleznovia verrucosa</i>	n	
<b>Santalaceae</b>		
<i>Exocarpos aphyllus</i>		√
<i>Exocarpos sparteus</i>		√

Taxon	DC	CRNP
<i>Santalum lanceolatum</i>		√
<i>Santalum spicatum</i>	n	
<b>Sapindaceae</b>		
<i>Alectryon oleifolius</i> subsp. <i>oleifolius</i>		√
<i>Diplopeltis eriocarpa</i>		√
<i>Diplopeltis intermedia</i> var. <i>incana</i>		√
<i>Diplopeltis intermedia</i> var. <i>intermedia</i>		√
<i>Dodonaea pachyneura</i>		√
<i>Dodonaea viscosa</i>		√
<b>Scrophulariaceae</b>		
<i>Limosella australis</i>		√
<i>Morgania pubescens</i>		
<i>Stemodia grossa</i>		√
<i>Stemodia viscosa</i>		
<i>Striga multiflora</i>		
<b>Solanaceae</b>		
<i>Datura leichhardtii</i>		√
<i>Duboisia hopwoodii</i>		√
<i>Nicotiana occidentalis</i>		√
<i>Solanum cleistogamum</i>		√
<i>Solanum diversiflorum</i>		√
<i>Solanum lasiophyllum</i>		√
* <i>Solanum nigrum</i>		√
<i>Solanum phlomoides</i>		
<i>Solanum sturtianum</i>		
<b>Stackhousiaceae</b>		
<i>Stackhousia intermedia</i>		√
<i>Stackhousia muricata</i>		√
<i>Stackhousia umbellata</i>	e	√
<b>Sterculiaceae</b>		
<i>Brachychiton obtusilobus</i>	e	
<i>Hannafordia quadrivalvis</i>		
<i>Keraudrenia hermannifolia</i>		√
<i>Keraudrenia integrifolia</i>		
<i>Lasiopetalum oldfieldii</i>	n	
<i>Rulingia kempeana</i>		
<i>Rulingia luteiflora</i>		
<i>Waltheria indica</i>		
<b>Surianaceae</b>		
<i>Stylobasium spathulatum</i>		√
<b>Thymelaeaceae</b>		
<i>Pimelea ammocharis</i>		√
<i>Pimelea microcephala</i>		
<b>Tiliaceae</b>		
<i>Corchorus crassifolius</i>		
<i>Corchorus elachocarpus</i>		√
<i>Corchorus sidoides</i>		
<i>Corchorus walcottii</i>		√

Taxon	DC	CRNP
<b>Typhaceae</b>		
<i>Typha domingensis</i>		✓
<b>Urticaceae</b>		
<i>Parietaria cardiostegia</i>		
* <i>Urtica urens</i>		
<b>Verbenaceae</b>		
<i>Clerodendrum floribundum</i>		
<i>Clerodendrum lanceolatum</i>		✓
<b>Violaceae</b>		
<i>Hybanthus aurantiacus</i>		✓
<b>Zygophyllaceae</b>		
<i>Tribulus astrocarpus</i>		
<i>Tribulus hirsuta</i>		
<i>Tribulus hystrix</i>		
<i>Tribulus macrocarpus</i>		
<i>Tribulus occidentalis</i>		
<i>Tribulus platypterus</i>		✓
<i>Tribulus terrestris</i>		✓
<i>Zygophyllum aurantiacum</i>		✓
<i>Zygophyllum compressum</i>		
<i>Zygophyllum fruticosum</i>	n	
<i>Zygophyllum retivalve</i>		









