Distribution and abundance of *Blandfordia cunninghamii* Lindley (Blandfordiaceae)

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Abstract

Porter, C.L.(Department of Applied Biology, University of Technology Sydney, P.O. Box 123, Broadway, Australia 2007) 1992. Distribution and abundance of* Blandfordia cunninghamii *Lindley (Blandfordiaceae). Cunninghamia 2(4): 523–532.* Distribution and abundance were compared in the rare *Blandfordia cunninghamii* and the more widespread *B. grandiflora* in the Blue Mountains of New South Wales. Environmental characteristics were studied at 13 sites. Approximately 750 plants of *B. cunninghamii* were found at 12 sites, nine of which are in conservation reserves. The habitat of *B. cunninghamii* is cooler and moister with more soil organic matter than that of *B. grandiflora*.

Introduction

Blandfordia cunninghamii Lindley (family Blandfordiaceae), one of four species in the genus, occurs in the Upper Blue Mountains and Illawarra regions of New South Wales. A rare species, it is coded 3RC- by Briggs & Leigh (1988), indicating some populations occur in conserved areas with the range exceeding 100 km, but the population size in reserves is unknown.

Another species, *B. grandiflora* R. Br., occurring in the Blue Mountains, has a more widespread range south from Fraser Island in Queensland to Sydney district.

The habitats of *B. cunninghamii* have damp soil (Beadle, Evans & Carolin 1982), and include hanging swamps at Kings Tableland, Wentworth Falls and Blackheath (Baker, Corringham & Dark 1984), rock ledges and in heath (Fairley & Moore 1989). Published localities for *B. cunninghamii* include: Blue Mountains, Mt Wilson, Wentworth Falls, Leura, Mt Kembla (Henderson 1987); Blue Mountains National Park; Illawarra State Recreation Area (Briggs & Leigh 1988); Wentworth Falls, Mt Tomah (Keith & Benson 1988).

The distribution and population size of *B. cunninghamii* and occurrence of *Blandfordia* species in the Blue Mountains were studied to confirm that populations are extant in the area, and to determine the range of communities and environments over which *B. cunninghamii* survives.

Methods

Distribution and population size

To confirm the distribution of the two *Blandfordia* species in the Blue Mountains, potentially suitable habitats were surveyed during summer 1989–1990, when the plants

* Present address: National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000.

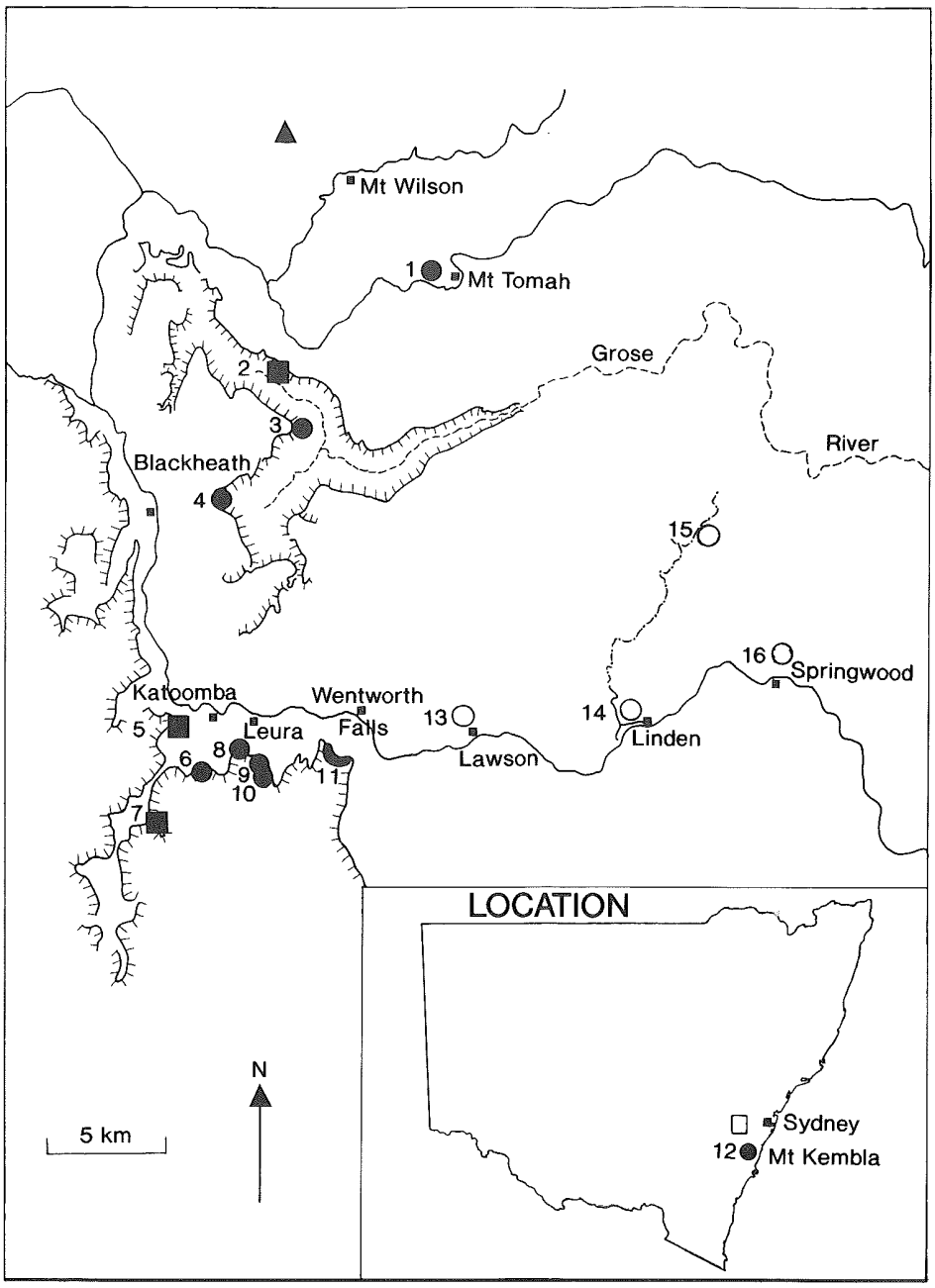
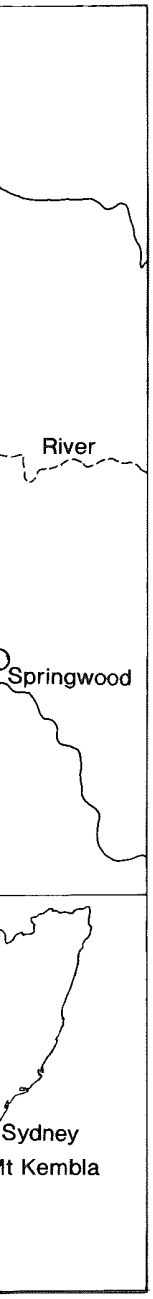


Figure 1. Distribution in the Blue Mountains of New South Wales of *Blandfordia cunninghamii*, localities confirmed (●); new localities (■) and prior collection locality not visited (▲) in this study; *B. grandiflora* (○) study sites. Localities listed in Table 1.



cunninghamii,
▲) in this study;

were easier to see if they were flowering. The survey was based on information about localities and habitats from herbarium specimens at the National Herbarium of New South Wales. Populations were counted in each site visited.

Site characteristics

Counting the plants in *B. cunninghamii* populations was difficult as individuals were often not distinctly separate but were in clumps of two or more. This was particularly so on rock faces where plants grew in a curtain of leaves, as at Mt Kembla. Typically *B. cunninghamii* plants were each approximately 30–50 cm in diameter and spaced 0.5–5 m apart. The area over which a population occurred was usually no more than 100 square metres. Most occurrences were on cliff edges, which affected the accuracy of counts.

Vegetative characters were often all that were available for identification of *Blandfordia*, as very few plants were flowering. Characters markedly associated with the particular species include: leaf margin crenulation, smooth in *B. cunninghamii* and crenulate in *B. grandiflora*; growth habit: *B. cunninghamii* leaves are laxer and *B. grandiflora* leaves have a distinct V-shaped cross-section. At a distance, it is difficult to differentiate *B. grandiflora* from juvenile *Xanthorrhoea* spp. and *B. cunninghamii* from *Lomandra longifolia* and occasionally from small, non-flowering *Gahnia* spp. (although *Gahnia* is scabrous). The leaves of *B. cunninghamii* are bright green and of similar width to those of *Lomandra longifolia* (though *B. cunninghamii* leaves are much longer and do not have a toothed leaf tip) and the leaf tips of *B. cunninghamii* are often necrotic. Numerous dark longitudinal veins (more obvious on the abaxial surface) along the length of the leaves is observed in *Blandfordia*. The number of veins ranges from 12–16 in *B. cunninghamii* and 6–10 in *B. grandiflora*.

Thirteen sites (nine populations of *B. cunninghamii* and four of *B. grandiflora*) representing the range over which the two species were observed were studied in detail in June 1990. At each site, attitude, aspect, slope and soil depth were recorded and three soil samples from the top 20 cm of the profile (excluding the A_0 horizon) were collected with an auger. Three replicates of each soil sample were analysed using the methods of Allen (1989) and pH, moisture content, organic content (estimated as % loss on ignition) and particle-size were measured. Site variation between the *Blandfordia* species in altitude, aspect, slope and soil depth was analysed by one-factor analyses of variance (Wilkinson 1987). Aspect data was transformed before analysis by subtracting 90° from each reading (and added after analysis). Variation in soil characteristics between-species in water content, loss on ignition, pH, % clay, % silt, % sand and % gravel was analysed by two-factor (*Blandfordia* species, site) nested analyses of variance (Wilkinson 1987) after averaging the replicate laboratory samples.

Associated species

Other vascular plant species rooted within one metre of each of three *Blandfordia* plants in the population were recorded. The pattern of plant species composition among the sites was analysed using hybrid multidimensional scaling (Belbin 1989). A two-dimensional ordination was used, with the Bray-Curtis dissimilarity measure, and a cut point of 0.8. The categorical nature of the pattern was tested using polythetic divisive clustering by indicator species analysis (Hill 1979).

Table 1. *Blandfordia* populations in the Blue Mountains: location, controlling authority of sites and estimated numbers of plants.

Site Number	Location	Control of land	Number of Plants (No. flowering 1989–1990)
1*	Mt Tomah	P.P.	20 (0)
2*	Pierces Pass	N.P.W.S.	45 (1)
3*	Blackheath	N.P.W.S.	40 (0)
4	Blackheath	N.P.W.S.	c. 30 (0)
5*	Katoomba-Cliff Walk	N.P.W.S.	25 (2)
6	Katoomba-Falls	B.M.C.C.	1 (0)
7	Katoomba-Narrow Neck	N.P.W.S.	3 (0)
8	Leura Cascades	B.M.C.C.	13 (0)
9*	Leura	N.P.W.S.	42 (0)
10*	Leura	N.P.W.S.	60 (0)
11	Wentworth Falls	N.P.W.S.	325 (0)
11a*	Wentworth Falls	N.P.W.S.	30 (0)
11b*	Wentworth Falls	N.P.W.S.	23 (0)
12*	Mt Kembla+	N.P.W.S.	100 (0)
13*	Lawson	N.P.W.S.	60 (1)
14*	Linden	B.M.C.C	200+ (1)
15*	Linden Ridge	N.P.W.S.	30 (1)
16*	Springwood	Crown Land	200+ (0)

* Denotes sites studied further; 1-12 *B. cunninghamii,* 13-16 *B. grandiflora*

\+ Illawarra State Recreation Area

P.P. = Private Property; N.P.W.S = National Parks and Wildlife Service; B.M.C.C. = Blue Mountains City Council

Results

Distribution

The reported range of *B. cunninghamii* in the Upper Blue Mountains and at Mt Kembla was confirmed (Figure 1, Table 1). New locality records at Pierces Pass and Katoomba, also in the Upper Blue Mountains are indicated in Figure 1. Previously recorded sites of *B. cunninghamii* at Mt Wilson (specimen collected 1898) and at Yerrinbool (collected 1932) were not visited. Also one site reliably reported by R. Payne (in 1989) at Wedderburn could not be confirmed.

The occurrence of *B. grandiflora* in the Lower Blue Mountains was also confirmed. Based on personal observations and herbarium specimens, it is more widely distributed in the Lower Mountains than *B. cunninghamii* is in the Upper Mountains (note Figure 1 shows the study sites only of *B. grandiflora*).

The number of plants of *B. cunninghamii* within the boundaries of Blue Mountains National Park was approximately 620. Wentworth Falls contains 60% of these. The total number in all localities visited including Blue Mountains National Park was approximately 750 plants. Most of these plants (nine out of 12 populations) occur in areas controlled by the National Parks and Wildlife Service of New South Wales (Table 1).

Population size and flowering

Each population of *B. cunninghamii* was less than 100 plants (Table 1). For Site 11, all

plants observed at Wentworth Falls were included (except 11a & 11b; two geographically separate populations used for study sites). This covers approximately two square kilometres and is comprised of numerous populations. *B. grandiflora* populations were generally larger, ranging from 30 to approximately 250 plants.

Three *B. cunninghamii* plants out of the total located (Table 1) flowered during summer 1989–1990 and none flowered during 1990–1991 (not shown on Table 1). More *B. grandiflora* plants were observed than *B. cunninghamii* plants to be flowering during 1989–90. The two sites in which *B. cunninghamii* flowered appeared to receive relatively high levels of solar radiation. At well-lit sites, such as along the National Pass at Wentworth Falls, leaves were generally broad with widths up to 15 mm, contrasting with plants in more shaded sites whose leaves were narrower.

Site characteristics

Examination of environmental data for the significance of the between-species variation (Table 2) indicate *B. cunninghamii* tends to occur at higher altitudes, on more southerly aspects and on steeper slopes than *B. grandiflora*, though Mt Kembla is of lower altitude. The soils at these sites are, as a result, more moist with higher organic content than the mostly north-facing *B. grandiflora* sites. Both species occur on acid soils. The most noticeable difference between sites of the two species is the sand content of their soils. Sand comprises approximately 80% of the soil on which *B. grandiflora* occurs, and between 50 and 75% for *B. cunninghamii*. Subsequently there is a higher proportion of silt and clay at sites where *B. cunninghamii* occurs.

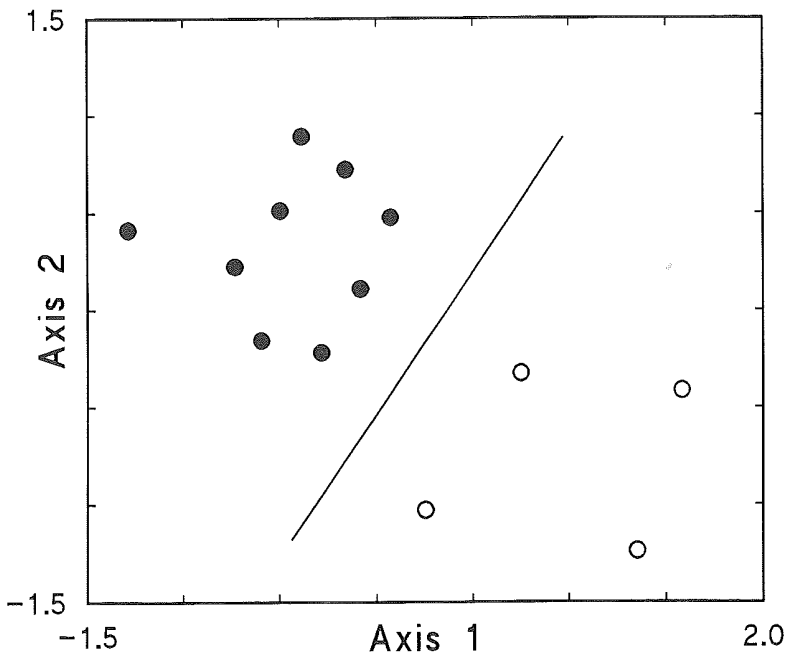


Figure 2. Two-dimensional hybrid scaling ordination of the plant species composition at the *Blandfordia cunninghamii* (●) and *B. grandiflora* (○) sites. The line indicates the principal division of the indicator species analysis.

Table 2. Average environmental characteristics at nine *Blandfordia cunninghamii* and four *B. grandiflora* sample sites

Environmental characteristic	*B. cunninghamii*									*B. grandiflora*				Analysis of variance between-species
	1	2	3	5	9	10	11a	11b	12	13	14	15	16	F
Site Characteristic														
Altitude (m)	920	670	720	960	900	880	820	820	500	680	530	520	330	10.57 *
Aspect (°)	216	204	162	135	160	130	216	216	186	20	10	344	200	20.23 *
Slope (°)	45	50	55	30	47	32	67	85	70	20	25	12	20	13.31 *
Soil depth (cm)	12	30	18	40	25	25	25	10	18	28	15	23	10	0.44 **
Soil Characteristic														
Total water content (%)	24.7	13.4	19.8	19.0	27.0	22.0	24.5	37.7	12.1	9.3	15.1	9.9	15.3	33.83 *
Loss on ignition (%)	15.1	6.7	6.8	8.9	9.5	5.4	7.3	15.2	7.7	2.8	8.4	3.7	5.7	27.22 *
pH	4.78	4.88	4.72	4.59	4.06	4.59	4.65	4.77	4.14	5.09	4.68	4.60	5.01	11.80 *
Gravel (>2.0 mm)(%)	3.6	51.4	11.1	11.1	9.1	2.9	2.4	4.8	7.2	7.7	3.3	2.0	4.3	3.59 **
Sand (0.05-2.0 mm)(%)	61.5	63.6	53.8	57.4	62.4	74.8	63.5	58.3	71.0	79.8	78.6	79.4	79.9	72.92 *
Silt (0.002-0.05 mm)(%)	14.1	17.6	24.6	14.8	19.0	9.9	15.4	19.8	13.7	7.9	8.0	7.3	8.5	65.74 *
Clay (<0.002 mm)(%)	24.4	18.8	21.5	27.9	18.6	15.3	21.1	21.9	15.3	12.3	13.4	13.3	11.5	25.79 *

Sand, silt and clay calculated as a percentage of non-gravel soil

* significant at $p<0.01$

** not significant at $p>0.01$

Localities listed in Table 1

Associated species

Ordination and clustering analysis of the floristic data (Figure 2) reveal two groups of sites. These correspond with the respective occurrences of the two *Blandfordia* species investigated thus indicating that each occurs with a distinct set of associated species. Of the 69 species recorded at more than one site (Appendix 1), 29 were recorded only at *B. cunninghamii* sites and eight only at *B. grandiflora* sites. Thus 46% of these widespread and common species occurred with both of the *Blandfordia* taxa. *B. cunninghamii* is associated with species commonly found in moist habitats, particularly damp rock faces, including *Acacia elata, Callicoma serratifolia* and *Ceratopetalum apetalum* in the overstorey, with an understorey of *Hakea dactyloides, Leptospermum polygalifolium, Stylidium productum, Dianella caerulea, Epacris pulchella, Gonocarpus teucrioides* and *Styphelia triflora. B. grandiflora* occurs with species more common in drier and more exposed areas often containing *Banksia serrata* in the overstorey, and an understorey of *Daviesia mimosoides, Entolasia stricta, Grevillea buxifolia* and *Platysace linearifolia.*

Two other rare plant species were found with *B. cunninghamii* at site 11a at Wentworth Falls, i.e. *Allania endlicheri* Kunth (Liliaceae), coded 3RCa (Briggs & Leigh 1988), growing on moist rock faces in the Blue Mountains and *Lomandra fluviatilis* (R.Br.) A.T. Lee (Lomandraceae), coded 3RC-. The latter species was not previously reported to occur on the Central Tablelands.

Discussion

The recording of distribution of *B. cunninghamii* in this survey was affected by access. All sites (except Sites 1 & 12) were located beside walking or vehicular tracks. Despite this, it is apparent that *B. cunninghamii* occurs at moist sites. Both species of *Blandfordia* are drought-tender (Bodkin 1986), but drainage may also be important to them, since all sites have some slope (Table 2). All *B. cunninghamii* sites have a significantly greater slope than *B. grandiflora* sites. This is inversely related to the sand content; the sand fraction is greater in *B. grandiflora* sites. The soils on which *Blandfordia* occurs in the Blue Mountains are mostly derived from sandstone, though *B. cunninghamii* was found also to occur on a sloping shale terrace at Pierces Pass (Site 2) and below the basalt cap of Mt Tomah (Site 1) where the plants are probably influenced by colluvium (second highest organic content (Table 2)).

Although two years is a short period to observe populations, it is clear that only very few plants of *B. cunninghamii* flower in some seasons at least. Low levels of seed set and germination may also be indicated in *B. cunninghamii* by the lack of juvenile plants. The exception was at Site 3 at Blackheath. This lack of juveniles may, however, be due to the recent absence of fire. Baker *et al.* (1984), state that *B. cunninghamii* 'occur in profusion after bushfires when the forest canopy is sparse'. In *Telopea speciosissima* and *Lambertia formosa*, flowering declines with time since the last fire after a peak approximately two years after a summer fire (Pyke 1983). In *B. nobilis*, peak flowering occurs one year after a fire (K.A. Johnson pers. comm.), and presumably this also occurs in *B. cunninghamii.* Plants of *Blandfordia* readily survive fire, as at Mt Tomah after a fire in 1976 (N. Rodd, pers. comm.). Although not documented, rapid growth with reproduction after fire in *Blandfordia* is almost certainly related to their underground rhizomes (Dahlgren, Clifford and Yeo, 1985). The longevity of *B. cunninghamii* plants is unknown, though from this survey it is clear that populations previously recorded are at least persisting.

Daviesia mimosoides was found to be a key associate of *B. grandiflora* as it occurred at the four sites studied in detail. Species with relatively high moisture requirement (Appendix 1) are indicators of probable presence of *B. cunninghamii* in the Upper Blue Mountains. These include *Hakea dactyloides, Leptospermum polygalifolium, Ceratopetalum apetalum, Callicoma serratifolia, Acacia elata* and *Smilax glyciphylla.*

Sand, silt and clay calculated as a percentage of non-gravel soil
* significant at p<0.01
** not significant at p>0.01
Localities listed in Table 1

At all *Blandfordia* sites exotic species are absent. The sites are mostly large distances from roads and picnic areas (minimal disturbance from external sources). Their low-nutrient soils generally do not provide good habitat for weeds. There is no perceived threat from exotic species to *Blandfordia* in the Blue Mountains.

Conservation

According to Briggs and Leigh (1988), for a species to be considered adequately conserved, there should be a minimum of 1 000 individuals in conservation reserves; conservation reserves in New South Wales being areas controlled by National Parks and Wildlife Service and the Forestry Commission. The known number of *B. cunninghamii* plants in conservation reserves is approximately 700. Hence, under the definition of Briggs and Leigh (1988), the conservation of this species remains inadequate (i). Surveys carried out shortly after fires may raise this status. It is unknown whether the single plant found at Katoomba Falls (Site 6) was originally part of a population that has diminished. The area of greatest concern is at Leura Cascades (Site 8) where there is severe trampling of the track edges, requiring some control of walking whilst retaining the aesthetic appeal of the area. Overall, however, the conservation status of *B. cunninghamii* is excellent, provided there is no further development in the escarpment/catchment areas of Wentworth Falls.

Acknowledgements

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APPENDIX 1

Average frequency of occurrence of plant species found in association with *Blandfordia*

Species	*B. cunninghamii*	*B. grandiflora*
PTERIDOPHYTES		
BLECHNACEAE		
+*Blechnum wattsii*	0.14	0.00
DENNSTAEDTIACEAE		
+*Hypolepis muelleri*	0.07	0.08
GLEICHENIACEAE		
+*Gleichenia rupestris*	0.11	0.08
+*Sticherus flabellatus*	0.07	0.00
LINDSAEACEAE		
+*Lindsaea microphylla*	0.04	0.08
ANGIOSPERMS-MONOCOTYLEDONS		
BLANDFORDIACEAE		
+*Blandfordia cunninghamii*	1.00	0.00
B. grandiflora	0.00	1.00
CYPERACEAE		
Caustis flexuosa	0.15	0.25
Lepidosperma laterale sens. lat.	0.11	0.17
Schoenus imberbis	0.00	0.17
IRIDACEAE		
+*Patersonia fragilis*	0.07	0.00
LILIACEAE		
Dianella caerulea	0.22	0.00

Species	*B. cunninghamii*	*B. grandiflora*
EPACRIDACEAE		
+*Dracophyllum secundum*	0.15	0.00
+*Epacris longiflora*	0.15	0.00
+*E. pulchella*	0.44	0.00
Leucopogon lanceolatus	0.07	0.00
Styphelia triflora	0.30	0.00
Woollsia pungens	0.04	0.25
ESCALLONIACEAE		
+*Quintinia sieberi*	0.15	0.00
EUPHORBIACEAE		
Amperea xiphoclada	0.22	0.08
FABACEAE-Mimosoideae		
+*Acacia elata*	0.11	0.00
A. terminalis	0.07	0.25
FABACEAE-Faboideae		
Bossiaea obcordata	0.00	0.17
B. scolopendria	0.00	0.17
Daviesia mimosoides	0.00	0.50
Dillwynia retorta	0.26	0.25
Gompholobium latifolium	0.07	0.00
Mirbelia rubiifolia	0.04	0.17
+*Pultenaea glabra*	0.11	0.00
P. scabra	0.11	0.25
GOODENIACEAE		
+*Dampiera stricta*	0.04	0.25
Goodenia bellidifolia	0.11	0.08
G. decurrens	0.33	0.17
HALORAGACEAE		
Gonocarpus teucrioides	0.33	0.08

Species	*B. cunninghamii*	*B. grandiflora*
LOMANDRACEAE		
Lomandra filiformis	0.07	0.00
L. gracilis	0.30	0.25
L. longifolia	0.04	0.17
L. obliqua	0.04	0.08
ORCHIDACEAE		
Terrestrial orchid	0.07	0.00
POACEAE		
Chionochloa pallida	0.41	0.17
Entolasia marginata	0.22	0.33
E. stricta	0.00	0.33
SMILACACEAE		
Smilax glyciphylla	0.19	0.17
XANTHORRHOEACEAE		
Xanthorrhoea sp.	0.15	0.00
ANGIOSPERMS-DICOTYLEDONS		
APIACEAE		
Platysace linearifolia	0.15	0.50
Xanthosia pilosa	0.22	0.08
X. tridentata	0.19	0.08
ASTERACEAE		
Olearia erubescens	0.15	0.00
CASUARINACEAE		
Allocasuarina littoralis	0.07	0.00
CUNONIACEAE		
+*Callicoma serratifolia*	0.15	0.00
+*Ceratopetalum apetalum*	0.19	0.00

Species	*B. cunninghamii*	*B. grandiflora*
MYRTACEAE		
+*Baeckea linifolia*	0.04	0.08
Leptospermum polygalifolium	0.41	0.33
L. trinervium	0.22	0.00
+*Tristaniopsis collina*	0.15	0.00
PITTOSPORACEAE		
Billardiera scandens	0.11	0.08
POLYGALACEAE		
Comesperma ericinum	0.11	0.00
PROTEACEAE		
Banksia ericifolia	0.11	0.00
+*B. marginata*	0.19	0.00
B. serrata	0.00	0.17
Grevillea buxifolia	0.00	0.25
G. sericea	0.00	0.17
+*Hakea dactyloides*	0.30	0.00
Lambertia formosa	0.04	0.08
Lomatia silaifolia	0.07	0.00
Persoonia laurina	0.07	0.00
+*Symphionema montanum*	0.07	0.00
STYLIDIACEAE		
Stylidium productum	0.52	0.00
RUTACEAE		
Boronia pinnata	0.07	0.08

Species recorded at only one site are omitted

+ Species noted by Beadle *et al.* (1982), or known to have a relatively high moisture requirement

Species nomenclature follows updated *Plants of New South Wales* (Jacobs & Pickard 1981)

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