ECOLOGICAL OBSERVATIONS AND NEW LOCATIONS OF A RARE MOSS, *AMBUCHANANIA LEUCOBRYOIDES* (AMBUCHANANIACEAE)

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(with one text-figures, three plates, two tables and one appendix)

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Ambuchanania leucobryoides is a moss listed as rare under the Tasmanian *Threatened Species Protection Act 1995.* It is endemic to Tasmania and is monotypic at the genus and family levels. It is sister group to the widespread and speciose genus *Sphagnum.* In 2008, a survey funded by the Tasmanian Wilderness World Heritage Area Program (Department of Primary Industries and Water) established the exact location of the *A. leucobryoides* type locality and extended the known range of the moss. The moss is now known from three locations in southwest Tasmania and has a range of 127^2 km. It occurs in sandy washes or "daisy pans" derived from Precambrian quartzite.

Key Words: threatened species, moss, Ambuchananiaceae, southwest Tasmania, monotypic, *Ambuchanania leucobryoides.*

INTRODUCTION

The moss *Ambuchanania leucobryoides* (T. Yamag., Seppelt. & Z. Iwat.) Seppelt & H. A. Crum is endemic to Tasmania, Australia. First described in the genus *Sphagnum* (Yamaguchi *et al.* 1990), it was included in the Tasmanian moss flora under that name (Dalton *et al.* 1991). Its present taxonomic status in the monotypic genus *Ambuchanania* and monotypic family Ambuchananiaceae recognises its isolated position within the class Sphagnopsida (Crum & Seppelt 1999, Seppelt 2000). The class Sphagnopsida comprises two genera: *Ambuchanania* and *Sphagnum* (Shaw *et al.* 2003, Shaw 2000). The latter is one of the most widespread genera of mosses, extending from the Arctic through to sub-Antarctic Macquarie Island (Moore & Bellamy 1974). *A. leucobryoides* was listed as rare under the Tasmanian *Threatened Species Protection Act 1995* in 2003.

Ambuchanania leucobryoides was first collected in 1987 by A. Buchanan, in a remote part of the Tasmanian Wilderness World Heritage Area (Wallaby Bay near Davey Head).

The aims of the present study were to relocate the type locality (a small sandy wash near Wallaby Bay), document the habitat and plant species occurring with it and improve the knowledge of its distribution by conducting extension surveys. *A. leucobryoides* is of international interest; researchers from the University of London and Duke University requested, and were supplied with, a collection of stems for the establishment of axenic cultures that will be used in research including the interpretation of moss phylogenies.

METHODS

On 3 March 2008, the Tasmanian Wilderness World Heritage Area Program conducted a helicopter expedition to the *A. leucobryoides* type locality at Wallaby Bay. Habitat with a similar appearance to the type locality was located by helicopter and a further three sites were inspected for the presence of *A. leucobryoides.* Brief searches were undertaken on foot in sandy habitat along the lower slopes of the Bathurst Range and in sandy habitat adjacent to the Cox Bight to Melaleuca walking track (5 March 2008); along McKays track from Scotts Peak to Junction Creek and Arthur Plains just beyond Junction Creek (9 April 2008); and at the base of the Sentinel and Twelvetrees Ranges (14 May 2008). Penny Tyson (Wildcare Volunteer) undertook a search in the Birchs Inlet area (19 March 2008).

The only other *A. leucobryoides* collection held at the Tasmanian Herbarium (HO) was reported to be from the Adelaide River, near the Jane River track (over 100 km from the type locality and over 60 km inland). Few habitat details were available for this record as the moss was located amongst the roots of a sedge, *Isolepis aucklandica* Hook. f., Fl. Antarct. 1: 88 (1844). T.50 (1845) (HO 3450) (Crum &Seppelt 1999). A helicopter trip and foot search was undertaken along the Jane River track from near the Adelaide River to the Lyell Highway (16 April 2008).

Environmental information on the southwest Tasmania study area including the geology, soils and climate was gathered from various published sources and field observations. A soil sample was taken from the *A. leucobryoides* type locality at Wallaby Bay and analysed at Allison Laboratories (Hobart, Tasmania) for exchangeable nitrogen, organic content, pH, conductivity, and the nutrients: phosphorous, nitrogen, potassium, sodium, calcium and magnesium. The pH of a soil sample from Birchs Inlet was taken using an Inoculo Laboratories Australia Soil pH Test Kit. Vascular and non-vascular plant species were recorded at *A. leucobryoides* sites. Vascular plant nomenclature follows Buchanan (2007) and non-vascular follows Streimann & Klazenga (2002) for mosses and McCarthy (2003) for liverworts. A permanent-monitoring site was established at Wallaby Bay. All collections were made under a permit issued in accordance with the *Threatened Species Protection Regulations* and the *National Parks and Reserved Land Regulations.*

RESULTS

Distribution and habitat

Ambuchanania leucobryoides was relocated at the type locality at Wallaby Bay in March 2008. It was originally recorded from only one point location but is now known from numerous sandy pans both north and south of Coffin Creek. There is approximately one kilometre between the furthest sites observed in this brief and localised survey. Further extension surveys carried out at this time located the moss near Swallow Creek, Louisa Bay, 38 km southeast of the Wallaby Bay site. It was also found near Birchs Inlet (south of Macquarie Harbour), 90 km north of the Wallaby Bay site and up to 5 km inland from Birchs Inlet. However, the species was not observed in the sandy washes between Cox Bight and Melaleuca. These were observed to be generally of coarser gravel rather than the finer sand of the Wallaby Bay site.

Ambuchanania leucobryoides was not found in brief searches that were carried out in two washes on the eastern low slopes of Mt Rugby, near Eds Cove (despite the presence of fine sand) and at the base of the Bathurst Range, behind Cox Bight. *A. leucobryoides* was not found along McKays track, Arthur Plains near Junction Creek, or at the base of the Sentinel or Twelvetrees ranges. The habitat in these areas is quite different from the near coastal environment of Wallaby Bay with black organic soils and no white sandy washes. If sand was present it was a covering of surface sand only. Alex Buchanan and Tony Moscal (Tasmanian Herbarium) have undertaken many collecting trips in southwest Tasmania (before and since 1987) and have not observed this species more widely.

Ambuchanania leucobryoides was not found in moorland near the Adelaide River or at other locations searched along the Jane River track. Its absence and the difference in habitat from the type locality (black organic soils rather than fine white sandy washes) prompted the original identification of the specimen, as *A. leucobryoides,* to be re-examined. It has now been redetermined as *Sphagnum novozelandicum* (Rod Seppelt pers. comm. 2008).

Ambuchanania leucobryoides is currently known from three locations in the warm perhumid climate of southwest Tasmania: Wallaby Bay at Port Davey on the southwest coast; Swallow Creek near Louisa Bay on the south coast; and Birchs Inlet, south of Macquarie Harbour (fig. 1). The linear range of the species is 127 km and the altitude is 20–50 m above sea level. The species is most likely restricted to Precambrian quartzite sandy washes (pl. 1). Across this range the mean maximum temperature is about 16ºC and the mean minimum about 9ºC. The hottest month is February and the coldest period is July to August. The mean rainfall is about 1450 mm and falls on an average of 192 days (Bureau of Meteorology 2008 – annual figures averaged from the closest weather station to Wallaby Bay and Swallow Creek (Maatsuyker Island Lighthouse) and Birchs Inlet (Vivian St, Strahan)). Collections of *A. leucobryoides* were made at each location and specimens were lodged in the Tasmanian Herbarium (HO). A small number of stems were sent to researchers at the University of London for axenic cultures (these cultures will be made available to scientists worldwide for DNA studies) and cryopreservation in the Millenium Seed Bank (Prof. J. Duckett pers. comm.). Jon Shaw, Duke University, has previously examined the molecular genetics from the holotype specimen in Hiroshima and has also received fresh material from the present collection for further molecular genetic analysis. Field data has been entered into the Natural Values Atlas (Department Primary Industries and Water).

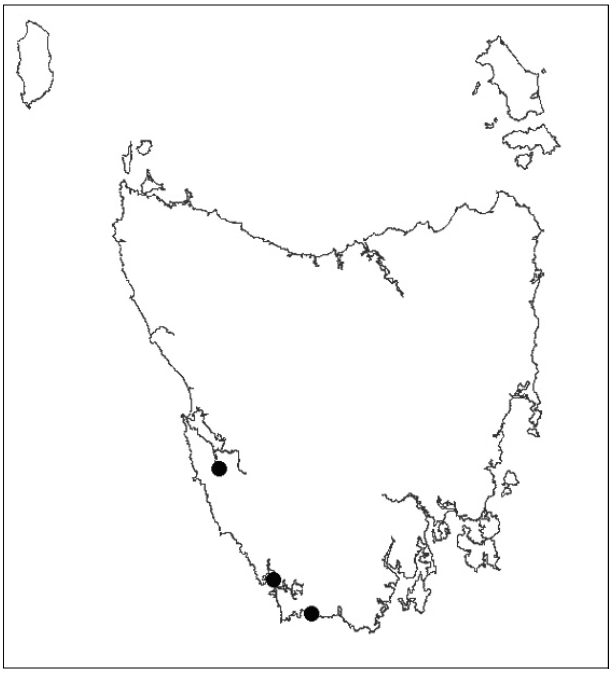

FIG. 1 — Distribution of Ambuchanania leucobryoides *in Tasmania.*

Identification

Ambuchanania leucobryoides was originally described as *Sphagnum leucobryoides* due to its similarities to that genus (Yamaguchi *et al.* 1990). The description provides morphological details and illustrations not repeated here. Seppelt (2000) provides a key to the Australian Sphagnopsida that separates *Ambuchanania* from *Sphagnum.* In the field, the shoot tips of *A. leucobryoides* are almost flush with the ground surface, the tips of the uppermost leaves are generally the only parts showing above ground, giving the sandy surface a spotted appearance - like "measles" (pls 2, 3). *A. leucobryoides* is distinguished from *Sphagnum* as follows (Crum & Seppelt 1999):

- notably whitish and glossy, dry character;
- leaves are unusually large, the stem leaves up to 4.3 mm long and those at the ends of the short branches up to 8.6 mm long; the internal arrangement of chlorocysts and hyalocysts is quite different;
- capsules are produced singly in the terminal position (at the ends) of the stems.

Geomorphology and soil composition

The *A. leucobryoides* habitat at Wallaby Bay is a series of nearly flat, alluvial sand pans or washes consisting almost entirely of white, fine-grained, quartzitic sand. These washes occur in the undulating near-coastal landscape dominated by buttongrass (*Gymnoschoenus*) moorland. At Wallaby Bay the sandy soil is derived from Precambrian quartzite and is of very low nutrient status (Yamaguchi *et al.* 1990). The soil sample collected from the type locality is likely to have been derived from the local catchment and transported only a

PLATE 1
The sandy wash of the Ambuchanania habitat stands out from surrounding vegetation. Photo: J. Whinam.

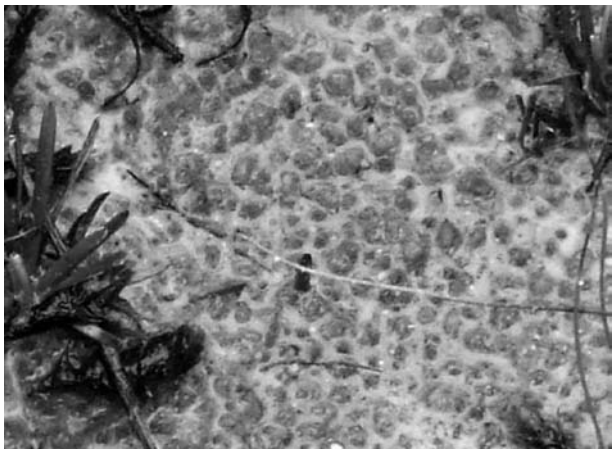

PLATE 2
In the field, Ambuchanania leucobryoides *is recognised by spots (or "measles") on the sand surface. It is densely distributed in this photo. Photo: J. Whinam.*

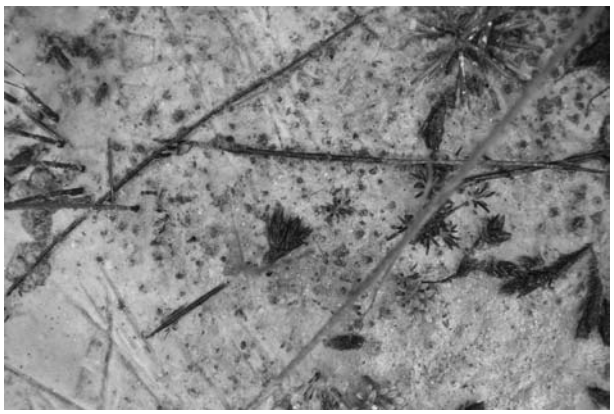

PLATE 3
Ambuchanania leucobryoides *sparsely distributed and largely covered by sand. Photo: J. Whinam.*

short distance by overland flow or small streams (I. Houshold pers. comm. 2008). The pH of the sandy soil sample from the type locality (pH 6.8) and from Birchs Inlet (pH 6) is close to neutral (table 1) — well above that of the 4.1–4.4 of organosols (peaty soils) on Precambrian quartzite till (Bowman *et al.* 1986). It is also well above the pH of 3.4–3.5 for soils associated with "buttongrass moorland on slopes" and "buttongrass moorland on rises and broad valleys and flats" (di Folco 2007). All nutrients and the organic content are lower than figures given for organosols on Precambrian quartzite till. In particular the 2% organic content from the type locality is much lower than the 42–44% given by Bowman *et al.* (1986). This reflects the sandy composition of the surface substrate that had no visible peat. The pH of alkaline pans (on limestone) in the Hardwood Valley (southwest Tasmania) was generally above seven (Brown *et al.* 1982). Brown *et al.* (1982) found that plant species in and around alkaline pans responded individually to changes in pH and that strong boundaries were present at the edge of the pans with pH changes of more than three units over 20 cm. The sandy pans or washes observed in our study are strongly associated with a vegetation community that is distinct from the surrounding buttongrass moorland and reflects the similarly dramatic change from wet sand to acid organosols.

Vegetation

A list of vascular and non-vascular plant species observed at the Wallaby Bay and Swallow Creek *A. leucobryoides* sites is given in appendix 1. *A. leucobryoides* at Wallaby Bay and Swallow Creek is located in sparsely vegetated almost flat sandy washes or "sand pans". The Wallaby Bay washes with *A. leucobryoides* have greater species richness than the Swallow Creek washes but all have the following plants: *Leptocarpus tenax* (Labill.) R.Br., *Chordifex hookeri* (D.I.Morris) B.G.Briggs, *Actinotus suffocatus* (Hook.f.) Rodway, *Helichrysum pumilu*m Hook.f., *Drosera binata* Labill., and/or *D. pygmaea* DC., and the mosses *Dicranoloma billardierei* (Broth.&Geh.) and/or *D. eucamptodontoides* (Broth.&Geh.). The vegetation at these sites fits the descriptions for both buttongrass moorland communities "daisy pans" and "mossy sand" (Jarman et al. 1988). Both communities are restricted to southwest Tasmania. Buttongrass moorland vegetation surrounding the sandy washes is a "standard blanket moor" community on peaty soil (Jarman et al. 1988) and is mapped as "sparse buttongrass moorland on slopes"-"MBR" (Harris & Kitchener 2005) on the Tasmanian Vegetation Map (TASVEG 1.3, Department of Primary Industries and Water). *A. leucobryoides* is most common in open areas of sand and is often associated with filamentous algae growing on the wet surface of the sand (Yamaguchi et al. 1990).

TABLE 1
Soil sample composition[1] (type locality, Wallaby Bay)

Exchangeable nitrogen (ppm)	Organic content (LOI) %	PH	Conductivity	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)
12	2	6.8	100	<1	12	100	50	40

[1] Determined by Allison Laboratories Pty Ltd, Hobart, Tasmania.

Total population estimate

At least 10 000 *A. leucobryoides* stems were observed across eight sandy washes during the one-day field survey at Wallaby Bay and Swallow Creek (table 2). The species occurs in localised patches in variable densities: a small number of counts found between 50–160 stems in 100 cm^2. The areas of the washes are variable with sizes of less than 10 m^2 being common. The occurrences north of Coffin Creek at Wallaby Bay contained the densest patches of the moss. The species rarely occurs across an entire sandy wash, more frequently occurring as variable sized patches within the wash. Further field survey is required to determine the extent of the species distribution, the area occupied within its range of occurrence and to gain a better estimation of the total population.

GENERAL DISCUSSION AND MANAGEMENT RECOMMENDATIONS

Conservation and reservation status

All known occurrences are in the Tasmanian Wilderness World Heritage Area. *A. leucobryoides* is currently listed as rare under the Tasmanian *Threatened Species Protection Act 1999*. It qualifies for listing as rare under state legislation as it is a species subject to stochastic risk of endangerment because of naturally small subpopulation sizes and naturally small area of occupancy (Tasmanian Threatened Species Scientific Advisory Committee 2008). Over-collecting was identified as a threat to the species (Seppelt 2002). The availability of *A. leucobryoides* axenic cultures from the University of London will help to alleviate some of the collecting pressure. Damage from field identification and monitoring is potentially a threat to the moss as removal of a layer of covering sand may be necessary for identification and this action can result in the breaking of stems, the apices of which sit at or just above the surface. It is possible that a loss of *A. leucobryoides* habitat from changed fire regimes and/or climate change may be an issue if the alluvial sands cease to accumulate, the bare sands dry out, or the pans are colonised by denser buttongrass moorland vegetation or scrub.

Further work recommended

This field survey provided the first extension of the known distribution of *A. leucobryoides* since it was originally found in 1987. Although more is now known of its habitat, future searches will still need to rely on ground truthing. While it is possible to observe open quartzite environments on aerial photographs, it is not possible to pick up the subtleties relating to microhabitat. This is particularly true for determining fine-grained sand, which appears to be an important feature of *A. leucobryoides* habitat, versus coarser gravel. It is likely that this species occurs in other fine-grained sandy quartzite washes between Birchs Inlet and Louisa Bay.

Targeted extension surveys of fine-grained sandy washes in southwest Tasmania would assist in determining the extent of occurrence, area of occupancy and providing a better estimate of total population size. This would provide information to reassess the conservation status of *A. leucobryoides.* The species is fragile and may be impacted upon during the simple act of wiping away sand to enable identification. In the long term a minimal intervention and visitation approach is recommended to minimise disturbance to this species.

It is recommended that monitoring be undertaken for habitat changes, such as the number, extent and size of sandy pans occupied by the species. This form of monitoring is likely to result in less damage to the species than monitoring the numbers of stems. A 60 m transect was established in March 2008, at the original Wallaby Bay site and is intended for long-term monitoring of the cover of the species in the pan.

ACKNOWLEDGEMENTS

A special thanks to Penny Tyson who went searching in sandy washes at Birchs Inlet and found a new site for the inconspicuous *Ambuchanania leucobryoides*; and Ian Houshold for geomorphic interpretation of sand collected from the type locality. Many thanks to Mikayla Jones (UTAS), Sib Corbett (DPIW), Lyn Cave (Tasmanian Herbarium), Rod Seppelt (Australian Antarctic Division; Honorary

TABLE 2
Total population summary for *Ambuchanania leucobryoides* in Tasmania

Site	Tenure	1:25 000 mapsheet	Year (first) last seen	Area occupied	Number of stems
1	Wallaby Bay TWWHA[1] (Southwest National Park)	Breaksea	(1987) 2008	observed in 5 pans south and 2 pans north of Coffin Creek – potential for more in this area >50m^2	10 000+
2	Swallow Creek TWWHA (Southwest National Park)	Louisa	(2008) 2008	observed in 1 pan – no potential for more in this area c. 10m^2	200+
3	Birchs Inlet TWWHA (Franklin-Gordon Wild Rivers National Park)	Birchs	(2008) 2008	observed in 2 pans – potential for more in this area	Unknown

[1] Tasmanian Wilderness World Heritage Area.

Botanist, Tasmanian Herbarium) and Alan Gray (Tasmanian Herbarium) for assisting with field searches; and Jean Jarman (Tasmanian Herbarium) for the provision of valuable field data. Thanks to Wendy Potts (DPIW) for comments on the manuscript.

REFERENCES

Bowman, D., Maclean, A. & Crowden, R. 1986: Vegetation-soil relations in the lowlands of south-west Tasmania. *Australian Journal of Ecology* 11: 141–153.

Brown, M.J., Crowden, R.K. & Jarman, S.J. 1982: Vegetation of an alkaline pan – acidic peat mosaic in the Hardwood River Valley, Tasmania. *Australian Journal of Ecology* 7: 3–12.

Buchanan, A. 2007: *A Census of the Vascular Plants of Tasmania & Index to the Student's Flora of Tasmania*, Tasmanian Herbarium, www.tmag.tas.gov.au/Herbarium/Herbarium2.htm. Accessed May 2008.

Bureau of Meteorology 2008: Tasmanian climate averages. www.bom.gov.au/weather/tas. Accessed May 2008.

Crum, H. & Seppelt, R.D. 1999: *Sphagnum leucobryoides* reconsidered. *Contributions from the University of Michigan Herbariun* **22**: 29–31

Dalton, P.J., Seppelt, R.D. & Buchanan, A.M. 1991: An annotated checklist of Tasmanian mosses. *In* Banks, M.R., Smith, S.J., Orchard, A.E. & Kantvilas, G. (eds): 1991(31:iii): Aspects of Tasmanian botany – A tribute to Winifred Curtis. *Papers and Proceedings of the Royal Society of Tasmania,* Hobart: 15–32.

di Folco, M.B. 2007: Tasmanian Organic Soils. Unpublished PhD thesis, University of Tasmania.

Harris, S. & Kitchener, A. 2005: *From Forest to Fjaeldmark. Descriptions of Tasmania's Vegetation.* Department of Primary Industries, Water and Environment. Printing Authority of Tasmania, Hobart: xx pp.

Jarman, S.J., Kantvilas, G. & Brown, M.J. 1988: *Buttongrass Moorland in Tasmania.* Research Report No. 2. Tasmanian Forest Research Council Inc., Hobart: xx pp.

McCarthy, P.M. 2003: *Catalogue of Australian Liverworts and Hornworts.* Flora of Australia Supplementary Series No. 21; Australian Biological Resources Study, Canberra: xx pp.

Moore, P.D. & Bellamy D.J. 1974: *Peatlands.* London: Elek Science: xx pp.

Seppelt, R.D. 2000: The Sphagnopsida (Sphagnaceae; Ambuchananiaceae) in Australia. *Hikobia* 13: 163–183.

Seppelt, R.D. 2002: Ambuchanania leucobryoides: *Nomination for Listing or De-listing of a Taxon of Flora or Fauna.* Threatened Species Scientific Advisory Committee, Hobart, Tasmania: xx pp.

Shaw, A.J. 2000: Phylogeny of the Sphagnopsida based on chloroplast and nuclear DNA sequences. *Bryologist* 103: 277–306.

Shaw, A.J., Cox, C.J. & Boles, S.B. 2003: Polarity of peatmoss *(Sphagnum)* evolution: who says bryophytes have no roots? *American Journal of Botany.* 90(12): 1777–787.

Streimann, H. & Klazenga, N. 2002: *Catalogue of Australian Mosses.* Australian Biological Resources Study, Canberra. Volume 17: xx pp.

Tasmanian Threatened Species Scientific Advisory Committee 2008: *Guidelines Used for the Listing of Species under the Tasmanian Threatened Species Protection Act 1995.* Department of Primary Industries and Water, Hobart: xx pp.

Yamaguchi, T., Seppelt, R.D., Iwatsuki, Z. & Buchanan, A.M. 1990: *Sphagnum* (sect. *Buchanania) leucobryoides* sect. et sp. nov. from Tasmania. *Journal of Bryology.* 16: 45–54.

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APPENDIX 1
Plant species occurring at *Ambuchanania leucobryoides* sites

Species Name	Wallaby Bay (from 7 sandy washes)	Swallow Creek (from 1 sandy wash)
Non-Vascular		
Ambuchanania leucobryoides	+	+
Dicranoloma billarderi	+	
Dicranoloma eucamptodontoides	+	+
Goebelobryum unguiculatum	+	
Vascular		
Shrubs		
Bauera rubioides	+	
Baeckea leptocaulis	+	
Cenarrhenes nitida	+	
Epacris obtusifolia	+	
Leptospermum nitidum	+	
Melaleuca squamea	+	
Sprengelia propinqua	+	
Herbs		
Actinotus suffocatus	+	
Drosera binata	+	+
Drosera pygmaea	+	
Drosera arcturi	+	+
Helichrysum pumilum	+	
Utricularia dichotoma		+
Utricularia lateriflora	+	
Oschatzia saxifraga	+	
Graminoids		
Baumea tetragona	+	
Calorophus erostris	+	+
Centrolepis monogyna	+	+
Chordifex hookeri	+	+
Empodisma minus	+	+
Eurychorda complanata	+	
Gaimardia amblyphylla	+	
Gymnoschoenus sphaerocephalus	+	+
Haemodorum distichophyllum	+	
Lepidosperma filiforme	+	
Leptocarpus tenax	+	+
Schoenus lepidosperma subsp. filiforme	+	
Schoenus sp.		+
Sporadanthus tasmanicus	+	
Tetraria capillaris	+	+
Xyris marginata	+	
Xyris sp.	+	
Ferns and fern allies		
Gleichenia dicarpa	+	+
Selaginella uliginosa	+	