Phytotaxa 59: 1–31 (2012)
www.mapress.com/phytotaxa/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

Lichens and bryophytes in Tasmanian wet eucalypt forest: floristics, conservation and ecology

GINTARAS KANTVILAS[1] & S. JEAN JARMAN[1,2]

[1] *Tasmanian Herbarium, Private Bag 4, Hobart, Tasmania 7001, Australia*
[2] *Forestry Tasmania, GPO Box 207, Hobart, Tasmania 7001, Australia*

Abstract

A total of 452 species, comprising 262 lichens, 78 mosses and 112 liverworts, is recorded from *Eucalyptus obliqua* L'Hér. dominated wet forest in southern Tasmania. A classification of the species is presented, based on their distribution and ecology. Four groups are recognised: (i) mature wet forest species, subdivided further into species of old forests, species of old trees, and foliicolous species; (ii) species of open eucalypt forests; (iii) widespread and common species; and (iv) species of disturbed habitats, subdivided into transient colonisers and persistent early colonisers. Together with an assessment of conservation status of the species, this classification provides a tool whereby simple comparisons of floristic richness or species composition can be refined so that the ecological 'quality' of a site can be evaluated. A case study comparing the flora before and after burning demonstrates the usefulness of the approach. It showed that although the diversity of cryptogams recovers quite quickly, the species composition of the flora alters significantly. The classification represents the first of its kind for lichens and bryophytes in Tasmania's forests and will be extended in the future to incorporate other forest types and non-forest vegetation. Several lichens, including *Absconditella celata* Döbbeler & Poelt, *Arthonia didyma* Körb., *Calicium hyperelloides* Nyl., *Cladonia adspersa* Mont. & Bosch., *Coenogonium lutescens* (Vězda & Malcolm) Malcolm, *Coppinsia minutissima* Lumbsch & Heibel, *Dactylospora heimleri* (Zukal) Döbbeler & Triebel, *Micarea melaneida* (Nyl.) Coppins, *Opegrapha herbarum* Mont. and *Placynthiella uliginosa* (Schrad.) Coppins & James, are recorded in Tasmania for the first time.

Key words: cryptogams, classification, forestry, burning, regeneration

Introduction

The conservation and management of Tasmania's forests have been the subjects of extensive political, economic and scientific debate. Forest and woodland occupies approximately 3.3 million ha or 47% of Tasmania's area (Sustainable Development Advisory Council 1996) and comprises cool temperate rainforest, dominated mainly by *Nothofagus* Blume and conifer species, sclerophyll forests dominated by *Eucalyptus* L'Hér., and a range of less extensive forest types dominated by other taxa such as *Acacia* Mill., *Melaleuca* L., *Leptospermum* J.R.Forst. & G.Forst. and *Allocasuarina* L. Johnson. Lichens and bryophytes are a major component of the floristic diversity of these forests and, consequently, consideration of their ecology and species composition is important in assessing the natural values of forests (e.g. Kantvilas *et al.* 1996).

Contributing information on cryptogams in Tasmania can be particularly difficult due, not least, to there being relatively few specialists and a lack of general 'conventional wisdom' on cryptogams in the Tasmanian botanical community. This contrasts with the situation in vascular plants where there is a tradition of almost 200 years of botanical endeavour and widely disseminated information from which data can be derived or evaluated. The relatively small size of lichens and bryophytes mostly discourages anything more than general interest and contributes greatly to difficulties in communicating with land managers and others who are often completely unfamiliar with the groups. Other complications arise from applying concepts of rarity to such

Accepted by T. Lumbsch: 8 Jun. 2012; published online in PDF: 13 Jul. 2012

small organisms and determining what constitutes an individual or a population. For lichens and bryophytes, the broad suite of data necessary for assessments of conservation status and ecology is not readily accessible nor widely acknowledged (Brown *et al*. 1994, Kantvilas 2000, 2005a, 2006).

The cryptogam study on which the present paper is based was conducted over a ten-year period in wet eucalypt forest in a silvicultural systems trial at the Warra Long-Term Ecological Research (LTER) Site in southern Tasmania. It was directed specifically towards evaluating the impacts on lichens and bryophytes of different silvicultural treatments and evaluating the degree to which the objective of harvesting wood sustainably whilst managing biodiversity (Hickey *et al.* 1999) is likely to be achieved. That study has enabled us to produce the most detailed inventory of lichens and bryophytes for any eucalypt-dominated forest ecosystem in Tasmania. We present the inventory here, with a discussion on the conservation status of the species. An ecological classification for as many of the species as possible, based on species distribution and ecological responses, is also given. This classification is the first of its kind for cryptogams in Tasmania, and draws on our results from the study site and our accumulated knowledge of the species within other Tasmanian vegetation types and at other locations. The usefulness of such a classification in assessing floristic change is demonstrated in a case study that examines the effect of burning on a wet forest cryptogam flora. Although ultimately the classification is intended for wider application in Tasmanian forests, at present it is restricted to those species recorded in the Warra Silvicultural Systems Trial (SST) and will provide a floristic context for a future evaluation of the silvicultural impacts on the cryptogamic flora in the Trial area.

Methods

Study area

The Warra SST study area comprises about 200 ha in southern Tasmania (43°04'S 146°41'E) within the Warra LTER Site (see Brown *et al.* 2001). The elevation of the site ranges from 80–240 m a.s.l. (Hickey *et al.* 1999), and the climate is temperate maritime (Packham 1995) with a mean annual rainfall of 1138 mm (Ringrose *et al*. 2001). Soils are derived mostly from Jurassic dolerite and, in four representative coupes (harvesting units) sampled for soils, drainage class ranged from well drained or moderately well drained (56%) through imperfectly drained (32%) to poorly drained (12%), with surface layers being typically very strongly acidic (pH < 5) (Laffan 2001). Details and maps of the study area are provided in Hickey *et al*. (2001, 2006), Neyland (2001) and Neyland *et al.* (2009).

The vegetation comprises wet forest dominated by *Eucalyptus obliqua* L'Hér. The eucalypts are about 50 m tall and of mixed age, with the oldest trees believed to date from around 1500 to 1876 (Alcorn *et al.* 2001) (Fig. 1). The most widespread understorey type comprises low wet sclerophyll forest dominated by combinations of *Leptospermum* J.R.Forst. & G.Forst., *Melaleuca* L., *Nematolepis* Turcz., *Acacia* Mill. and *Banksia* L.f. over *Gahnia* J.R.Forst. & G.Forst. and/or *Bauera* Banks ex Andrews (G-type forest, after Neyland 2001) (Figs 2–4). Rainforest understoreys of either thamnic or callidendrous character are also present (nomenclature after Jarman *et al.* 1984, 1994, Forest Education Foundation 2008). More detailed information on the vascular flora is given by Neyland (2001), Jarman & Kantvilas (2001a), Kantvilas & Jarman (2004) and Neyland & Jarman (2011).

Data collection and analysis

Sampling commenced in 1997 and concluded in 2010. Eighteen plots, each of 500 m^2, were established, sampling eight coupes (from 11 to 26 ha) within the SST. Most plots were 50 ×10 m, but the shape was modified where necessary to maintain homogeneity of the vegetation. Thirteen of the plots were established in unharvested forest. Two of these were controls; the other eleven were in coupes that were subsequently harvested, whereupon the plots were re-established. Five additional plots were established after the coupes were treated. Sixteen plots were in G-type wet sclerophyll forest, or its regenerating counterpart. The remaining two were at sites that supported thamnic rainforest before harvesting.

FIGURE 1. A forest edge, showing the typical layered structure of the vegetation. Eucalypts up to about 50 m tall form a canopy over a dense layer of secondary trees about 18–25 m tall. A layer, 1–3 m tall and dominated by the large rosette sedge *Gahnia grandis* and a vigorous scrambling shrub *Bauera rubioides*, is present in the understorey (Photo: J.Jarman).

FIGURE 2. The forest interior in a poorly drained site, where the flakey-barked tree *Melaleuca squarrosa* dominates the low tree layer. An opening in the *Gahnia*-dominated layer provides an opportunity for shade-loving cryptogams to colonise the logs and ground surface (Photo: J.Jarman).

FIGURE 3. The forest interior at a site with moderate drainage, where the smooth-barked tree *Nematolepis squamea* is common and the shrub *Bauera* dominates the understorey. A large rock in the background provides a substrate for cryptogams raised above the dense shrubbery (Photo: J.Jarman).

FIGURE 4. The forest interior, with scattered large fibrous-barked eucalypts interspersed among the smaller understorey trees (Photo: J.Jarman).

A general survey of the entire plot was conducted, sampling all accessible habitats (trunks, twigs, leaves, rocks, logs and soil) to compile a full species inventory. Fallen branches provided incomplete data for the canopy and upper levels of the forest. This approach to sampling was adopted because the patchy distribution of lichens and bryophytes in the forest results in sporadic occurrences in very localised and/or specialised microhabitats (see Kantvilas & Jarman 2002). Supplementary floristic data were obtained from transects directed specifically at exploring the ecology of particular species and from general observations in adjacent vegetation outside the formal study plots.

For harvested plots, resampling was undertaken at approximately one, three and five years after harvesting, but with some flexibility due to time constraints and weather conditions. In all, there were 52 individual 'sampling events', including both pre- and post-harvest sampling.

Inventory and identification

The species inventory is derived from the entire data set (18 plots, sampled and resampled, plus supplementary data from transects and ancillary observation, see above). Reference material of all species was collected for checking in the laboratory using standard methods of microscopy, thin-layer chromatography and comparison with reliably identified reference specimens. Australian or overseas specialists who provided identifications or information on selected species include, for bryophytes, Dr J. Engel, Dr D. Glenny, Dr R. Grolle, Dr T. Pfeiffer, Dr M. So and Dr K. Yamada, and for lichens, Dr P. McCarthy, Dr B. Coppins, Dr J. Elix, Dr R. Lücking, Dr T. Lumbsch, Dr L. Tibell and Dr A. Vězda.

Nomenclature generally follows McCarthy (2011) for lichens, Streimann & Klazenga (2002) for mosses and McCarthy (2006) for liverworts. However, alterations to the names continue in accordance with more recent publications. Authorities for all species are given in Appendices 1–3. Voucher specimens of all taxa recorded are held at the Tasmanian Herbarium (HO) or Forestry Tasmania.

Conservation

Under the *Tasmanian Threatened Species Protection Act 1995*, guidelines have been established for the listing of species of flora and fauna. Application of these chiefly quantitative criteria to cryptogams is complicated. However, on the basis of expert knowledge of distribution, inferred habitat and assessment of likely threats (Kantvilas 2006), 28 species of lichen and two bryophytes have been listed under the *Act* (http://www.dpiw.tas.gov.au/inter.nsf/WebPages/SJON-58E2VD?open). We have applied the same criteria in this paper. Species considered to be rare and therefore of conservation significance are those which, following targeted survey, have been recorded in fewer than ten standard 10 km × 10 km map grid cells, and/or are subject to an observed or inferred decline in extent. Distribution data are derived from our own observations, material held in herbaria, and reliable literature sources.

Ecology and classification

The classification is based on our observations from the study site, considered in the context of three decades of experience of Tasmanian cryptogams. The latter has involved study of Tasmanian lichens and bryophytes in the course of research on the classification and ecology of particular vegetation types (Jarman *et al.* 1984, 1988, 1991, 1994), research directed specifically at lichen and bryophyte ecology and floristic composition (Jarman & Fuhrer 1995, Jarman & Kantvilas 1995a, 1997, Kantvilas 1988, 1990, 1995a, 1995b, Kantvilas & Jarman 1988, 1993, 1999, Kantvilas *et al.* 1985, Kantvilas & James 1987, 1991, Kantvilas & Minchin 1989, McCarthy *et al.* 2001), and cryptogamic surveys of particular sites (e.g. Jarman & Kantvilas 1994, 1995b, Kantvilas & Jarman 1991, Kantvilas *et al*. 2008, plus unpublished technical reports). In addition, the taxonomy of many individual lichen species and genera has been addressed in an extensive series of publications by the first author and collaborators. Most recently, attention has been directed to *Eucalyptus obliqua*-dominated wet sclerophyll forest in southern Tasmania (Jarman & Kantvilas 2001a, b), specifically to contribute a cryptogamic perspective to a broader study on the impacts of different silvicultural methods on the regeneration of forests after logging (Kantvilas & Jarman 2002, 2004, 2006, Jarman & Kantvilas 2010).

In compiling the classification and assessing the species, we have also drawn extensively upon the information embodied in over 100,000 annotated specimens held at the Tasmanian Herbarium. These have been accumulated mainly over the last 120 years and are widely representative of the Tasmanian cryptogamic flora. Publications of other workers have also been consulted, especially taxonomic accounts that incorporate ecological and distributional information (e.g. Scott & Stone 1976, Scott 1985, Grolle 1982, Engel & Smith Merrill 2004, Klazenga 2003, Engel & Glenny 2008, Engel 2010). The classification has been constructed on a species-by-species basis, using all the information we have available to place any particular species into an ecological group. Our aim is not to classify every species; this would be impossible given that a large number are still poorly known and information on them is based on few observations from few sites. Instead, we highlight those species that we know well and for which we are confident to make an ecological assessment.

The classification is 'driven' by the lichens because we have more ecological information for them than for bryophytes in Tasmania. Supplementary information for some lichens can also be drawn from studies in the Northern Hemisphere, where ecological indicators have been recognised amongst forest cryptogams (e.g. Coppins & Coppins 2002). In contrast, published information on bryophytes from Northern Hemisphere studies is scarcely relevant to our study because the majority of bryophyte species, and even most genera, nominated as indicators in Northern Hemisphere forests (e.g. Rose 1992, Gustafsson *et al.* 1992) are not present in Tasmania's wet forest flora or not present at the study site.

Case study

The Warra SST involved several silvicultural treatments (details in Hickey *et al.* 2001, Hickey *et al.* 2006, Neyland *et al.* 2009), most of which involved burning at least some parts of the coupes. As a demonstration of the application of the ecological classification, the impact of burning on the cryptogamic flora was assessed, using plots from unharvested forest (e.g. Figs 1–4) and comparing their flora with that recorded in plots that had been burnt (e.g. Figs 5–6), whether felled or not. Given the very different ages of the vegetation studied before and after treatment, changes in the flora are expected. However, the classification provides insights into *how* the flora has changed, not simply that it has changed. A broader evaluation of the impacts of the various silvicultural methods on cryptogams is to be dealt with in a separate paper.

FIGURE 5. A typical view of the forest, 12 months after the clearfell, burn and sow treatment has been applied (Photo: J.Jarman).

FIGURE 6. A comparison of Figures 5 and 6, taken from the same place, demonstrates the dynamic nature of the vegetation in the early years after harvesting. Five to six years after the clearfell, burn and sow treatment, the large stump in Figure 5 is completely obscured by the vigorous growth of young eucalypts and *Gahnia* (Photo: J.Jarman).

For each of the classification groups, species were categorised in the following way: those recorded from unburnt forest only; those recorded only on burnt sites up to 5–6 years after the fire; and those recorded at both burnt and unburnt sites. The comparison is based on presence/absence data but observations on abundance and health/vigour provide supplementary information.

Results

Inventory

A total of 452 species, comprising 262 lichens, 78 mosses and 112 liverworts, was recorded at the study site (Appendices 1–3). Of these, 209 lichens, 57 mosses and 106 liverworts were recorded in unburnt forest. The lichen flora in the unburnt forest is predominantly epiphytic with a high proportion of crustose species. In the first stages of regeneration (up to 5–6 years) after felling and burning, most lichens are likewise crustose (Kantvilas & Jarman 2006). Bryophytes in the unburnt forest occur predominantly on the forest floor or in low epiphytic habitats, but with a small number of obligately epiphytic species found at higher levels in the forest (Jarman & Kantvilas 2001b). Recolonisation of both lichens and bryophytes is restricted almost entirely to soil, charcoal, logs and rocks, there being no suitable epiphytic habitats available at this stage.

The scarcity of previous cryptogamic studies in this vegetation type is indicated by the fact that 40 species (37 lichens, 3 liverworts; Table 1) were recorded for Tasmania for the first time during the project. Most of the lichens represent the first Southern Hemisphere records of species that are widespread in temperate oceanic regions of the Northern Hemisphere or are more-or-less cosmopolitan. The three liverwort species were previously regarded as New Zealand endemics. A further 11 species of lichens (Table 1) represent new taxa that have been discovered and described as a result of the survey. Many more taxa, identified tentatively or to genus rank only, require further work and may well represent additional novelties.

TABLE 1. Lichen and bryophyte novelties for Tasmania recorded during the cryptogam study at Warra. Numbers in parentheses indicate the accession numbers of voucher specimens held in the Tasmanian Herbarium.

NEW RECORDS	
Lichens	
Absconditella celata	Widespread in cool temperate areas of Europe. Recorded here from Tasmania for the first time. (HO 523810, 544326)
Absconditella delutula	Widespread in cool temperate areas of Europe and also recorded from Queensland. First reported for Tasmania by Kantvilas (2005b). (HO 544397, 41035)
Absconditella lignicola	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Kantvilas (2005b). (HO 526238, 538736)
Agyrium rufum	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Kantvilas (2002). (HO 34898, 544566)
Arthonia didyma	Known from temperate areas of Europe and North America. Recorded here from Tasmania for the first time. (HO 500951, 323428)
Aspidothelium cinerascens	Widely distributed in South America and New Zealand. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 446787, 445014)
Calicium hyperelloides	Cosmopolitan. Recorded here from Tasmania for the first time. (HO 500933)
Chaenotheca hygrophila	Widely distributed in temperate areas of both hemispheres. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 500830, 521615)
Chaenothecopsis nigropedata	Widely distributed in New Zealand. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 63647)
Chrysothrix sulphurella	Widely distributed in eastern Australia. First reported for Tasmania by Elix & Kantvilas (2007). (HO 53157, 542125)
Cladonia adspersa	Widely scattered in warmer latitudes. Recorded here from Tasmania for the first time. (HO 500719, 325982)
Cliostomum praepallidum	Widespread in southern South America and Tasmania, from where it was first reported by Kantvilas & Fryday (2010). (HO 502943, 549458)
Coenogonium lutescens	First described from New Zealand. Recorded here from Tasmania for the first time. (HO 547916, 503018)
Coppinsia minutissima	Widely scattered in Europe and North America. Recorded here from Tasmania for the first time. (HO 524362)
Dactylospora heimleri	Widely scattered in Europe. Recorded here from Tasmania for the first time. (HO 557196, 551701)
Fellhaneropsis pallidonigrans	Widespread in south-eastern Australian rainforest. First reported for Tasmania by Kantvilas & Lücking (2009). (HO 501562, 559811)
Hypocenomyce scalaris	Widespread in temperate climates including mainland Australia. First reported for Tasmania by Kantvilas & Jarman (2004). (HO 500729, 540291)
Japewiella pruinosula	Recorded from south-eastern Australia. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 540729, 503256)
Lepraria eburnea	Widespread in the temperate Northern Hemisphere and also known from south-eastern Australia. First reported for Tasmania by Kantvilas *et al.* (2008). (HO 447555, 542517)
Micarea alabastrites	Widespread in oceanic areas, mainly in the Northern Hemisphere. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 55831, 445009)
Micarea cinerea	Widespread in temperate climates, mainly in the Northern Hemisphere. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 526273, 544565)
Micarea deminuta	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Coppins (2009). (HO 544563, 538653)
Micarea denigrata	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Kantvilas *et al.* (2008). (HO 529851)

Micarea melaneida	Widely scattered and reported from Europe and southern Africa. Recorded here from Tasmania for the first time. (HO 549629, 517986)
Micarea peliocarpa	Widespread and possibly cosmopolitan. First recorded for Tasmania by Kantvilas & Jarman (2006). (HO 544587, 526269)
Micarea sylvicola	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 325342)
Micarea viridileprosa	Known from Europe and Great Britain. First reported for Tasmania by Coppins (2009). (HO 44275)
Opegrapha herbarum	Cosmopolitan. Recorded here from Tasmania for the first time. (HO 546530)
Placynthiella icmalea	Probably cosmopolitan. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 526155, 323426)
Placynthiella uliginosa	Probably cosmopolitan. Recorded here from Tasmania for the first time. (HO 529879, 532051)
Porina aenea	Widespread in the Northern Hemisphere. First reported for Tasmania by McCarthy (2001). (HO 501573)
Porina impolita	A predominantly subtropical/warm temperate species in eastern Australia. First reported for Tasmania by McCarthy & Kantvilas (2000a). (HO 328847, 500730)
Steinia geophana	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by Jarman & Kantvilas (2001a). (HO 515780, 544192)
Strigula albicascens	Also found in Victoria and New Zealand. First reported for Tasmania by McCarthy & Kantvilas (1999). (HO 559239, 562232)
Thelocarpon intermediellum	Widespread in the temperate Northern Hemisphere. First reported for Tasmania by McCarthy & Kantvilas (2009). (HO 540745)
Thelocarpon laureri	Widespread in the Northern Hemisphere. First reported for Tasmania by Kantvilas & Jarman (2006). (HO 544329, 544564)
Thelocarpon strasseri	Known from continental Europe and the British Isles. First reported for Tasmania by McCarthy & Kantvilas (2009). (HO 544588, 544328)
Liverworts	
Cephaloziella muelleriana	First described for New Zealand; Tasmanian record published in Glenny & Jarman (2008). (HO546907)
Plagiochila fragmentissima	First described for New Zealand; Tasmanian record published in Glenny & Jarman (2008). (HO546905)
Telaranea fragilifolia	First described for New Zealand (as *Kurzia fragilifolia*, Schuster 1980); Tasmanian record published in Engel & Smith Merrill (2004). (HO565136)
NEW LICHEN SPECIES	
Bactrospora micareoides	Rare Tasmanian endemic, epiphytic on *Banksia marginata* (Kantvilas 2004).
Chrysothrix palaeophila	Rare Tasmanian endemic, epiphytic on very old trees (Elix & Kantvilas 2007).
Hertelidea eucalypti	Widespread in wet forest in Tasmania and Victoria (Printzen & Kantvilas 2004).
Icmadophila eucalypti	Tasmanian endemic (Lumbsch *et al.* 2011).
Lepraria toilenae	Common Tasmanian epiphyte (Kantvilas & Kukwa 2006), now also known from Victoria and New South Wales.
Megalaria subtasmanica	Common epiphyte also known from Western Australia (Kantvilas 2008).
Mycobilimbia meridionalis	Rare Tasmanian endemic terricolous species (Kantvilas *et al.* 2005).
Mycoblastus kalioruber	Common epiphyte in the Tasmanian highlands (Kantvilas 2009), now also known from Victoria.
Mycoblastus sanguinarioides	A lignicolous species also known from Victoria (Kantvilas 2009).
Scoliciosporum coniectum	Widespread Tasmanian epiphyte (Kantvilas & Lumbsch 2010).
Trichothelium meridionale	Rare Tasmanian endemic foliicolous species (McCarthy & Kantvilas 2000b).

Conservation

Most species recorded are generally widespread and common in Tasmania, either because they are generalists with a wide ecological tolerance, or are specialists within a widespread habitat under no obvious threat. Such species are not of conservation concern. There is also a large number of species that are poorly known and therefore cannot be assessed; in many cases these have been recorded only at the study site, and it has not been possible to search for them elsewhere. However, seven lichens appear to fulfil the criteria for being rare and significant, and four bryophytes probably warrant similar status (Table 2, Appendices 1–3).

TABLE 2. Lichens and bryophytes of conservation significance recorded from the study area.

Lichens	
Aspidothelium cinerascens	This widespread, chiefly neotropical species is known from only two collections in Tasmania, one from leaves and the other from bark, despite extensive searches. At both locations it was represented by a single tiny thallus only.
Bactrospora micareoides	The genus *Bactrospora* was revised by Kantvilas (2004), during which project no further localities for this species were discovered. It is endemic to Tasmania and locally frequent on *Banksia marginata* in the study area.
Chrysothrix palaeophila	A recent revision of the genus *Chrysothrix* in Tasmania (Elix & Kantvilas 2007) suggests that this is a very rare species, restricted to the trunks of ancient trees. It is endemic to Tasmania and known from only four locations.
Mycobilimbia meridionalis	This endemic species, recorded at only three locations, grows on rocks and soil in wet forest.
Porina aenea	The genus *Porina* has been studied extensively in Tasmania, resulting in the discovery of several novel or uncommon species (McCarthy & Kantvilas 2000, McCarthy 2001a). The sole Southern Hemisphere record of this not uncommon Northern Hemisphere species is from the study area where it grew on the rotting leaf bases of *Gahnia*.
Porina impolita	This is a distinctive, widespread Australian endemic, known in Tasmania from a single collection from the trunk of *Melaleuca squarrosa* in the study area.
Trichothelium meridionale	Foliicolous lichens in general (McCarthy *et al*. 2001) and the genus *Trichothelium* in particular (McCarthy 2001) were the focus of study in Tasmania, but this rare endemic has been recorded only at the study site, growing on fronds of *Blechnum wattsii* and cladodes of *Phyllocladus*.
Mosses	
Orthodontium pallens	This species is endemic to Australia (Streimann & Klazenga 2002). In his revision of the genus, Meijer (1952) reported its occurrence at Recherche Bay in Tasmania. On present information, the species appears to be localised in southern Tasmania, and in the Warra study area was found only on the buttresses of large eucalypts.
Liverworts	
Cheilolejeunea comitans	This species was first recorded in Tasmania in 1982, from the forests of the north-west (Grolle 1982) and, apart from this and the Warra study, there are no other known published records for Tasmania. The species appears to be an obligate epiphyte, and is scattered across the study area in unharvested forest on smooth- and flakey-barked hosts but not on eucalypts.
Plagiochila fragmentissima	Previously described from New Zealand (Inoue & Schuster 1971), this species was first reported from Tasmania at Warra (Glenny & Jarman 2008). It has only been found at one site and, although there has been no targeted search for it since its discovery, its large size would have ensured its collection at some time in Tasmania during the last 200 years if it were at all common.
Radula retroflexa	This is a distinctive species, unlikely to be confused with any other Tasmanian *Radula*. Apart from material from the Warra study site, the few known collections from Tasmania have all been from Tasman Peninsula.

Ecology and classification

Four ecological groups, some of which are further divided, are recognised, based on species distribution, habitat preference, and length of time they persisted at a site (Appendices 1–3). A fifth group includes species

for which there is insufficient information to make an assessment, including a very few species that are typical of non-forest vegetation.

1. *Species of mature wet forests*

Mature wet forests include cool temperate rainforest, mature mixed forest where old growth eucalypts are emergent over an understorey dominated by rainforest trees and shrubs, and other forests (with a sclerophyllous understorey) where the ages of the trees and shrubs suggest an extended period since the last disturbance. In these forests, a prolonged period of continuous forest cover is also inferred, even if there has been localised disturbance such as low-intensity or patchy fire, or tree-fall in the past.

Lichens considered to be mature wet forest species can be divided into two main sub-groups: species of old forests (Group 1A) and species of old trees (Group 1B) (cf. Kuusinen & Siitonen 1998). We include a third sub-group (Group 1C) for foliicolous species. Bryophytes have not been subdivided in the same way (with one exception, see Group 1B) because their ecology is not known well enough at this stage.

Many wet forest species (both lichens and bryophytes) also occur outside of forest in Tasmania, in the cooler, wetter parts of the island, especially in low scrub or among rocks in subalpine or alpine conditions. These species may be relicts of former forest vegetation that have maintained their presence at a site where the microenvironment has remained suitable, or they may be species that are actively colonising these habitats as part of their typical behaviour. Assigning such species to Group 1 rests on our interpretation of their ecological tolerance. They are mostly associated with stable, cool, moist, shady environments that are a particular feature of wet forest. Other species that occur in wet forest but which also successfully inhabit warmer, drier, or disturbed environments, where they are exposed to fluctuating conditions leading to frequent desiccation, are considered to have a wider ecological tolerance than Group 1 species. Such species are assigned to other Groups.

1A. *Old forest species*—Old forests world-wide have attracted considerable interest from lichenologists and bryologists. Since the pivotal paper of Rose (1976), an appreciation of the role of cryptogams as indicators of forest continuity has developed and been widely applied (see Coppins & Coppins 2002). Although still at an early stage of development in Tasmania, mainly due to lack of data, the same principles are applicable (Kantvilas *et al.* 1985, Kantvilas & Jarman 2004). Potential old-forest indicators in the Tasmanian lichen flora include representatives of the large cyanolichen genera, such as *Pseudocyphellaria* Vain., *Nephroma* Ach., *Sticta* (Schreb.) Ach. and *Pannaria* Delise, members of other characteristic rainforest macrolichen genera such as *Bunodophoron* A. Massal., *Menegazzia* A. Massal. and *Sagenidium* Stirt., as well as numerous crustose species from groups such as the Arthoniaceae, Megalosporaceae, Coccotremataceae, Pilocarpaceae and Graphidaceae. These lichens are mostly epiphytes, either on the forest dominants or on understorey trees and shrubs. Some of the species may also occur in other vegetation types, but our observations indicate that their centre of distribution is in wet forest, especially rainforest.

1B. *Old tree species*—This group overlaps to a large extent with the 'old forest' group, in so far as old trees are most likely to be found in old forests. However, remnant old trees may survive in otherwise disturbed landscapes where they may retain a highly specialised flora worthy of separate consideration.

Many old tree species, especially species of *Chaenotheca* (Th.Fr.) Th.Fr. and *Calicium* Pers., have very wide distributions in temperate forests throughout the world, even though within those forests they occur in highly specialised microhabitats, notably the dry sides of old, living or dead trees (e.g. Holien 1996). Other taxa in this group include species of *Micarea* Fr. and the Arthoniales that display a similar predilection for old trees or parts of old trees, including stumps, standing dead stags or large old logs.

A single bryophyte species, the moss *Orthodontium pallens*, is provisionally allocated to this group because its only known habitat is large trees (exclusively large eucalypts). However, its occurrence outside of Warra is poorly documented.

1C. ***Foliicolous species*****—** Living leaves may be colonised by several generalist lichens and bryophytes that can occur on many surfaces (leaf, bark, wood, soil, rock) in shaded moist environments. However, the habitat also presents a highly specialised niche for lichens. Whereas in the tropics, foliicolous lichens are one of the dominant ecological groups, they become markedly less diverse and ecologically restricted at cooler latitudes. These species were the subject of a specific study in Tasmania (McCarthy *et al.* 2001). They are found on relatively few hosts, with the fern *Blechnum wattsii* Tind. and the rainforest tree *Atherosperma moschatum* Labill. being by far the most preferred. They tend to be restricted to moist gullies or highly shaded, humid understoreys and appear to be good indicators of very stable microclimates. Obligately foliicolous bryophytes in Tasmania are poorly documented but there are only a few possible contenders, none of which has been recorded at Warra.

2. ***Species of open eucalypt forests***

Open sclerophyll forest and woodland dominated by eucalypts are very common vegetation types in Tasmania, occurring in low rainfall areas or in high rainfall areas where topography, soils, climate or fire prevent their replacement by wet forest types with a closed canopy or understorey layer. They support a very characteristic lichen flora dominated by species adapted to high levels of light and desiccation. They also include a suite of lichen species that appear to be specifically adapted to eucalypt lignin and charcoal; for example, species of *Hypocenomyce* M. Choisy and *Calicium*, and *Trapeliopsis flexuosa*. Bryophytes in this group are predominantly mosses and are generally light-loving, relatively drought-tolerant species that mostly occur on soil or rock, or as epiphytes close to the ground.

3. ***Widespread and common species***

These are species that occur widely in Tasmania regardless of vegetation type. Whilst they may be very common in mature wet forest, our general observations, as well as scrutiny of herbarium collections, indicate that they occur in other vegetation types and have a wide ecological tolerance. A prime example is *Cladia aggregata* which is probably one of the most common and widespread lichens in Tasmania. It occurs in all vegetation types, including grassland, sedgeland, coastal heathland, forest and alpine communities, grows in dry, wet, exposed or shady sites, and can colonise any substrate, including rocks, soil, bark, wood, leaves and man-made surfaces. Other examples include certain species of *Cladonia* P. Browne and *Hypogymnia* Nyl. , and many crustose species. No bryophytes display such a broad ecological tolerance as the lichen *Cladia aggregata*. Nevertheless there are a number of species, mainly mosses, that can colonise both wet and dry vegetation types, including, for example, some species of *Bryum* Hedw. *sens. lat.*, *Campylopus* Brid., *Hypnum* Hedw. and *Polytrichum* Hedw.

4. ***Species of disturbed habitats***

This group comprises the early successional species, which can be subdivided into transient pioneers that decline or disappear within the first 1–3 years of succession, and others that persist for longer. They occur mainly on soil, rock, rotting plant material or wood.

4A. ***Transient colonisers*****—**These short-lived species appear in highly disturbed habitats but do not persist beyond a few years. Of the bryophytes recorded at Warra, species in this group are among the best known globally, having been documented in many studies worldwide (reviewed in Ryömä & Laaka-Lindberg 2005), especially in relation to fire disturbance. They include the liverwort genus *Marchantia* L. (*M. berteroana* in our study area), and the mosses *Funaria hygrometrica* and *Ceratodon purpureus*. Until the Warra study, lichens in Group 4A were not fully appreciated in Tasmania because highly disturbed sites had rarely been sampled and few of the species involved had been the subject of taxonomically targeted work. The main lichen taxa in Group 4A are *Steinia geophana* and species of *Absconditella* Vězda and *Thelocarpon* Nyl.; all display a similar ecology to that reported in the Northern Hemisphere (Poelt & Vězda 1990).

4B. *Persistent early colonisers*—These are early colonisers that are generally slower to mature than the transient pioneers (Group 4A) and tend to persist for several years. They are eventually outcompeted by later successional species.

There are many similarities between Group 2 and Group 4B species, especially in the bryophytes. Both groups have a requirement for brightly lit environments but Group 4B species, in the lichens at least, are characterised by an ability to colonise disturbed habitats quickly; examples include *Baeomyces heteromorphus*, *Dibaeis arcuata* and *Stereocaulon ramulosum*. Further ecological work is needed to clarify the relationship between these two groups (Groups 2, 4B) and, in the bryophytes, they are treated together.

5. *Unclassified species*

Group 5 comprises a miscellaneous assemblage of species for which there is insufficient information to assign confidently to any of the ecological categories described above (i.e. data deficient species). It also includes a few species that typify non-forest vegetation.

Case Study—an assessment of the impact of burning

Tables 3–5 show the distribution of lichens, mosses and liverworts according to the classification groups and whether they were recorded from burnt or unburnt sites. In a flora of over 450 species, approximately 13% (58 spp.) could not be allocated to any of the ecological groups, in most cases because they are uncommon in Tasmania and their ecology is very poorly understood.

Lichens—Of the total lichen species found (Table 3), 209 were recorded from unburnt vegetation and 100 were recorded from burnt vegetation. These figures indicate a modest level of recovery in the flora (48%), in terms of species numbers, 5–6 years after burning. However, examination of the ecological groups tells a rather different story. Of the 216 species that could be classified, 177 were found in the unburnt forest. Mature wet forest species (67%) and widespread species (20%) overwhelmingly dominate the unburnt flora (Table 3). Together, open forest species and disturbance species comprise a relatively minor proportion (13%) of the flora. After burning, the number of wet forest species fell markedly from 118 to 9, comprising only 11% of the regenerating flora. Furthermore, most of them are present as scattered, tiny fragments. The 'new' flora is dominated by widespread, ecologically tolerant species (35%), disturbance species (29%) and open forest species (25%). Many of these species are very common and prominent, unlike the wet forest species present. A large proportion of them (47%) comprise newcomers – species that had not been previously recorded from the plots. Their presence serves to camouflage the magnitude of losses from the unburnt forest flora when simple comparisons of pre- and post-burn species numbers are used to gauge the impact of burning on the vegetation.

TABLE 3. Classification of lichens recorded from the study area, showing the number of species that occurred in unburnt forest only, burnt forest only (within 5–6 years of burning), and in both burnt and unburnt forest.

Lichens	Total unburnt	Total burnt	Unburnt only	Unburnt and burnt	Burnt only	Total
Mature WF species (Gp1)	118	9	109	9	0	118
Open forest species (Gp2)	14	21	7	7	14	28
Widespread species (Gp3)	36	29	16	20	9	45
Disturbance species (Gp4)	9	24	1	8	16	25
Total classified	177	83	133	44	39	216
Unclassified	32	17	29	3	14	46
Total	209	100	162	47	53	262

Mosses—The moss flora comprised 78 species, of which 7 were unclassified. On species richness alone, the numbers from the unburnt forest and the regenerating forest (Table 4) are close, suggesting that the composition of the pre-burn flora has nearly recovered. However, an examination of the ecological groups shows there has been a definite change in the nature of the flora.

TABLE 4. Classification of mosses recorded from the study area, showing the number of species that occurred in unburnt forest only, burnt forest only (within 5–6 years of burning), and in both burnt and unburnt forest.

Mosses	Total unburnt	Total burnt	Unburnt only	Unburnt and burnt	Burnt only	Total
Mature WF species (Gp1)	31	16	16	15	1	32
Open forest & persistent disturbance spp. (Gp 2, 4B)	1	13	0	1	12	13
Widespread species (Gp3)	23	18	6	17	1	24
Disturbance species (Group 4A - transients)	0	2	0	0	2	2
Total classifiedl	55	49	22	33	16	71
Unclassified	2	5	2	0	5	7
Total	57	54	24	33	21	78

Before burning, wet forest species (56%) and widespread species (42%) dominated the flora, as with the lichens. At 2%, the open forest/disturbance species were a very minor component of the flora. After harvesting and burning, the number of wet forest species fell from 31 to 16, representing 33% of the regenerating flora. Widespread species remained at a similar level (37%) to that in the unburnt forest, and the open forest/persistent disturbance species increased substantially (27%). This last group, though represented by fewer species than the other two groups, was overwhelmingly the dominant group in terms of area occupied and number of individuals. The wet forest and widespread classes, in contrast, occurred as small, rare individuals. Almost all newcomers, representing approximately one-third of the regenerating flora (Table 4), were open forest or disturbance species. The single wet forest 'newcomer' is a canopy species and is likely to have been present in the unburnt forest but not recorded because of its habitat.

Liverworts—The liverwort flora comprised 112 species, of which five were unclassified. After burning, the numbers decreased to just below half (Table 5).

TABLE 5. Classification of liverworts recorded from the study area, showing the number of species that occurred in unburnt forest only, burnt forest only (within 5–6 years of burning), and in both burnt and unburnt forest.

Liverworts	Total unburnt	Total burnt	Unburnt only	Unburnt and burnt	Burnt only	Total
Mature WF species (Gp1)	91	31	60	31	0	91
Open forest & persistent disturbance spp. (Gp 2, 4B)	6	7	0	6	1	7
Widespread species (Gp3)	7	7	1	6	1	8
Disturbance species (Group 4A - transients)	0	1	0	0	1	1
Total classified	104	46	61	43	3	107
Unclassified	2	3	2	0	3	5
Total	106	49	63	43	6	112

Wet forest species dominated the pre-burn flora, both in number of species (88%) and area occupied. Open forest/persistent disturbance species (6%) were extremely inconspicuous and rare, and widespread species (7%), though present, were never very prominent. After burning, the wet forest group remained the largest one, comprising 67% of the regenerating flora, but the number of species had dropped substantially (91 to 31) and those recorded, like the widespread species in the regenerating flora, were represented by small, widely dispersed individuals. The flora was dominated now by open forest/disturbance species. Although there was only a slight change in the number of species in this group after burning, the number of individuals of some increased massively (unpublished data). In contrast to the lichen and moss floras, there were very few newcomers in the regenerating liverwort flora.

Discussion

Any forest is a complex and dynamic system that supports, at any single point in time, climax forest species, survivors from earlier stages of succession, and precursors of future stages. This complexity is demonstrated in our Warra study where not every species found on an old growth tree is necessarily a characteristic 'old tree species', just as not every species recolonising after logging is an opportunistic, early successional species. Recognition of these differences in the flora offers a means of using cryptogams in floristic comparisons and for evaluating the conservation significance, floristic richness and ecological status of forest sites and communities.

The Warra study site supports a diverse cryptogamic flora. Before logging, species richness was not much different from that of an equivalent rainforest area: 372 species (209 lichens, 163 bryophytes) in the Warra eucalypt forest, compared to 354 species (189 lichens, 165 bryophytes) in rainforest in western Tasmania (Jarman & Kantvilas 1995a). However, in the lichens for example, in spite of similar richness, the flora in rainforest was dominated overwhelmingly by mature wet forest species (e.g. species of the Pannariaceae, Lobariaceae, Pilocarpaceae, Sphaerophoraceae, Roccellaceae and Porinaceae). In contrast, the site at Warra contains a large proportion of species that are ubiquitous or characteristic of open eucalypt forest.

Even though the dominant forest trees are quite old at Warra (e.g. some over 300 years), there is a mixture of tree ages present, with the youngest cohort dating from a fire in 1934 (Alcorn *et al.* 2001). Thus the last major disturbance was relatively recent and, as a consequence, the cryptogamic flora is relatively young. There is a paucity of species generally acknowledged the world over as ‘old tree indicators’, such as the Caliciales or ‘pin lichens’ (e.g. Goward 1997, Selva 1998, Tibell 1992). There is also a near absence of species generally regarded as ‘old forest indicators’, such as cyanolichens like *Pseudocyphellaria* (e.g. Goward 1994, Goward & Arsenault 1999, Kuusinen & Siitonen 1998, Richardson & Cameron 2004). Tasmania has a very rich lichen flora with respect to these significant forest species (e.g. cyanolichens, pin-lichens, old tree species), indicating that they can and do occur in Tasmania. However, their representation in the Warra SST is extremely poor, and even those that are present are mostly very uncommon. Other characteristics in the cryptogamic flora also suggest that it is not old. For example, our unpublished observations in other eucalypt forests where the understorey is older (for example, mixed forest: Gilbert 1959) indicate that the biomass of both lichens and bryophytes is comparatively low in the SST plots.

The apparently young age of the cryptogamic flora at Warra is attributed to the occurrence of multiple fires in the past (1934, 1914, 1898: Alcorn *et al*. 2001). Eucalypts, especially *E. obliqua* with its thick bark, can survive such events and remain as old towering giants in the forest. In contrast, lichens and bryophytes are consumed by the flames, with all burnt substrates being effectively ‘wiped clean’ of their cryptogamic flora. Most of the lichens and bryophytes present are believed to post-date the last fire in the forest (1934).

After burning, a significant flora in terms of cover and species numbers is soon present: 203 species (100 lichens, 103 bryophytes) after five years! However, the key issue is not how many species are present, but which ones. The most successful colonisers in terms of cover/number of individuals are species from open habitats that do not persist in mature wet forest environments, species with a broad ecological amplitude, or

species typical of disturbed habitats (Groups 2, 3, 4). Some mature wet forest species (Group1) from the unburnt forest are present but a very large proportion is missing (about three-quarters). Those that are present are represented mostly by small, widely scattered individuals that constitute a very minor part of the post-fire flora. Thus, an examination of cover and species numbers might well suggest good recovery of cryptogams after harvesting and burning but an examination of the ecological groups present reveals that there has been a major change in the nature of the flora.

The classification offered here is conservative and provisional and will require modification as additional information comes to hand. Determining the status of individual species is a lengthy process that relies on multiple observations, accumulated across many years and based on many sites and habitats. In the longer term, it is hoped to extend the classification to include species from other vegetation types, in particular those recorded from earlier studies in rainforest, buttongrass moorland and alpine vegetation. The ultimate aim is to develop a detailed system like the one applied in the Northern Hemisphere (e.g. Coppins & Coppins 2002) but this is still some way off in Tasmania where the data are so incomplete. In the meantime, the classification is presented as a tool by which simple comparisons of floristic richness or species composition can be refined in order to evaluate the ecological 'quality' of forest sites.

A limitation to the application of our classification to practical ecological questions is that it demands a high level of taxonomic expertise in relation to cryptogams, a rare commodity, not least in Tasmania. With time, we anticipate that a scheme can be devised using target species that are recognisable by observant, trained non-specialists. However, selection of target species requires a sound knowledge of the composition and ecology of the entire flora and, at this early stage of cryptogam ecology in Tasmania, the basic floristic foundation is still being compiled.

Acknowledgements

We thank Mark Neyland and Michael Brown whose helpful comments highlighted the need for an ecological evaluation of Tasmania's forest cryptogams. The many specialists who assisted with identification of particular specimens are listed under 'Methods'. For overall support for the work at Warra, we thank present and former staff from Forestry Tasmania, especially Rob Taylor, Mark Neyland, Michael Brown, John Hickey and Tim Wardlaw.

References

Alcorn, P.J., Dingle, J.K. & Hickey, J.E. (2001) Age and stand structure in a multi-aged wet eucalypt forest at the Warra silvicultural systems trial. *Tasforests* 13: 245–259.

Brown, M.J., Elliott, H.J. & Hickey, J.E. (2001) An overview of the Warra Long-Term Ecological Research Site. *Tasforests* 13: 1–8.

Brown, M.J., Kantvilas, G. & Jarman, S.J. (1994) Conservation and reservation of non-vascular plants in Tasmania, with special reference to lichens. *Biodiversity and Conservation* 3: 263–278.

Coppins, B.J. (2009) *Micarea* Fr. (1825). *In*: Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W. & Wolseley, P.A. (eds), *The lichens of Great Britain and Ireland.* British Lichen Society, London, pp. 583–606.

Coppins, A.M. & Coppins, B.J. (2002) *Indices of ecological continuity for woodland epiphytic habitats in the British Isles.* British Lichen Society, London, 36 pp.

Elix, J.A. & Kantvilas, G. (2007) The genus *Chrysothrix* in Australia. *Lichenologist* 39: 361–369.

Engel, J.J. (2010) Austral Hepaticae 45. A monograph of the genus *Chiloscyphus* Corda (Lophocoleaceae) for Australasia. *Fieldiana, Botany New Series* 48: 1–209.

Engel, J.J. & Glenny, D. (2008) *A flora of the liverworts and hornworts of New Zealand, Volume 1.* Missouri Botanical Garden, St Louis, Missouri, 897 pp.

Engel, J.J. & Smith Merrill, G.L. (2004) Austral Hepaticae. 35. A taxonomic and phylogenetic study of *Telaranea* (Lepidoziaceae), with a monograph of the genus in temperate Australasia and commentary on extra-Australasian taxa. *Fieldiana, Botany New Series* 44: 1–265.

Forest Education Foundation (2008). Cool temperate rainforest. Published at http://www.forest-education.com/index.php/tasmania/C220. Viewed February 2012. Forest Education Foundation, and Australian Government Department of Agriculture, Fisheries and Forestry.

Gilbert, J.M. (1959) Forest succession in the Florentine Valley, Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* 93: 129–151.

Glenny, D. & Jarman, S.J. (2008) Three species regarded as New Zealand endemics, now recorded from Tasmania. *Australasian Bryological Newsletter* 55: 10–12.

Goward, T. (1994) Notes on oldgrowth-dependent epiphytic macrolichens in inland British Columbia, Canada. *Acta Botanica Fennica* 150: 31–38.

Goward, T. (1997) Lichens of ages. *Nature Canada, Summer, 1997*: 15–16.

Goward, T. & Arsenault, A. (1997). Notes on the assessment of lichen diversity in old-growth Engelmann Spruce – subalpine fir forests. *In*: Hollstedt, C. & Vyse, A. (eds), *Sicamous Creek Silvicultural Systems Project: Workshop Proceedings*, Kamloops, British Columbia, Canada, 24–25 April 1996. Research Branch, B.C. Ministry of Forests, Victoria, B.C. Working Pap 24/1997, pp. 67–78.

Grolle, R. (1982) Übersicht der Lejeuneaceae in Tasmanien. *Wissenschaftliche Zeitschrift der Friedrich-Schiller-Universität, Jena, Mathematisch-naturwissenschaftliche Reihe* 31: 207–227.

Gustafsson, L., Fiskesjo, A., Ingelog, I., Pettersson, B. & Thor, G. (1992) Factors of importance to some lichen species of deciduous broad-leaved woods in southern Sweden. *Lichenologist* 24: 255–266.

Hickey, J.E., Neyland, M.G., Edwards, L.G. & Dingle, J.K. (1999) Testing alternative silvicultural systems for wet eucalypt forests in Tasmania. *In*: *Practising Forestry Today,* the 18th Biennial Conference of the Institute of Foresters of Australia, 3–8 October, 1999. Hobart, Tasmania, pp. 136–141.

Hickey, J.E., Neyland, M.G. & Bassett, O.D. (2001) Rationale and design for the Warra silvicultural systems trial in wet *Eucalyptus obliqua* forests in Tasmania. *Tasforests* 13: 155–182.

Hickey, J.E., Neyland, M.G., Grove, S.J. & Edwards, L.G. (2006) From little things big things grow: the Warra Silvicultural Systems Trial in Tasmanian *Eucalyptus obliqua* forest. *Allgemeine Forst und Jagdzeitung* 177: 113–119.

Holien, H. (1996) Influence of site and stand factors on the distribution of crustose lichens of the Caliciales in a suboceanic spruce forest area in Central Norway. *Lichenologist* 28: 315–330.

Inoue, I. & Schuster, R.M. (1971) A monograph of the New Zealand and Tasmanian Plagiochilaceae. *Journal of the Hattori Botanical Laboratory* 34: 1–225.

Jarman, S.J. & Fuhrer, B.A. (1995) *Mosses and liverworts of rainforest in Tasmania and south-eastern Australia.* CSIRO & Forestry Tasmania, Hobart, 134 pp.

Jarman, S.J. & Kantvilas. G. (1994) Lichens and bryophytes of the Tasmanian World Heritage Area. II. Three forest sites at Pelion Plains. *Tasforests* 6: 103–120.

Jarman, S.J. & Kantvilas. G. (1995a) *A floristic study of rainforest bryophytes and lichens in Tasmania's myrtle-beech alliance.* Tasmanian NRCP Report No. 14. Forestry Tasmania, Hobart, and Department of Environment, Sport & Territories, Canberra, 56 pp.

Jarman, S.J. & Kantvilas, G. (1995b) Epiphytes on an old Huon pine tree (*Lagarostrobos franklinii*) in Tasmanian rainforest. *New Zealand Journal of Botany* 33: 65–78.

Jarman, S.J. & Kantvilas, G. (1997) *Impacts of forestry operations on cryptogams in Tasmania's eucalypt forests. Stage I. A preliminary assessment of diversity.* Report to the Commonwealth Department of Primary Industries and Energy, and Forestry Tasmania, 51 pp.

Jarman, S.J. & Kantvilas. G. (2001a) Bryophytes and lichens at the Warra LTER Site. I. An inventory of species in *Eucalyptus obliqua* wet sclerophyll forest. *Tasforests* 13: 193–216.

Jarman, S.J. & Kantvilas. G. (2001b) Bryophytes and lichens at the Warra LTER Site. II. Understorey habitats in *Eucalyptus obliqua* wet sclerophyll forest. *Tasforests* 13: 217–243.

Jarman, S.J. & Kantvilas. G. (2010) *Studies on lichens and bryophytes in the Warra Silvicultural Systems Trial 1997–2010. Background, methods and observations.* Technical Report 16/2010, Division of Forest Research and Development, Forestry Tasmania, Hobart, 168 pp.

Jarman, S.J., Brown, M.J. & Kantvilas, G. (1984) *Rainforest in Tasmania*. National Parks and Wildlife Service, Hobart, Tasmania, 201 pp.

Jarman, S.J., Kantvilas, G. & Brown, M.J. (1988) *Buttongrass moorland in Tasmania*. Research Report No. 2, Tasmanian Forest Research Council Inc., Hobart, 158 pp.

Jarman, S.J., Kantvilas, G. & Brown, M.J. (1991) *Floristic and ecological studies in Tasmanian rainforest*. Tasmanian NRCP Technical Report No. 3. Forestry Commission, Tasmania, and Department of Arts, Sport, Environment, Tourism and Territories, Canberra, 67 pp.

Jarman, S.J., Kantvilas, G. & Brown, M.J. (1994) Phytosociological studies in Tasmanian cool temperate rainforest. *Phytocoenologia* 22: 355–390.

Kantvilas, G. (1988) Tasmanian rainforest lichen communities: a preliminary classification. *Phytocoenologia* 16: 391–428.

Kantvilas, G. (1990) Succession in rainforest lichens. *Tasforests* 2: 91–95.
Kantvilas, G. (1995a) Alpine lichens of Tasmania's south-west wilderness. *Lichenologist* 27: 433–449.
Kantvilas, G. (1995b) A revised key and checklist for the macrolichens in Tasmanian cool temperate rainforest. *Tasforests* 7: 93–127.
Kantvilas, G. (2000) Conservation of Tasmanian lichens. *Forest Snow and Landscape Research* 75: 357–367.
Kantvilas, G. (2002) *Agyrium* Fr., *Bryophagus* Nitschke ex Arnold and *Racodium* Fr., lichen genera previously unrecorded for Australia. *Muelleria* 16: 65–70.
Kantvilas, G. (2004) A contribution to the Roccellaceae in Tasmania: new species and notes on *Lecanactis* and allied genera. *Symbolae Botanicae Upsalienses* 34 (1): 183–203.
Kantvilas, G. (2005a) Progress and problems in the conservation of Tasmanian lichens. *Australian Plant Conservation* 14: 13–15.
Kantvilas, G. (2005b) Two ephemeral species of the lichen genus *Absconditella* (Stictidaceae) new to Tasmania. *Muelleria* 21: 91–95.
Kantvilas, G. (2006) Tasmania's threatened lichens: species and habitats. *National Science Museum Monographs* 34: 149–162.
Kantvilas, G. (2008) Observations on some Tasmanian species of the lichen genus *Megalaria*. *Muelleria* 26: 64–71.
Kantvilas, G. (2009) The genus *Mycoblastus* in the cool temperate Southern Hemisphere, with special reference to Tasmania. *Lichenologist* 41: 151–178.
Kantvilas, G. & Fryday, A.M. (2010) Two additions to the lichen genus *Cliostomum* Fr. (Ramalinaceae) with broad ascospores. *Lichenologist* 42: 539–545.
Kantvilas, G. & James, P.W. (1987) The macrolichens of Tasmanian rainforest: key and notes. *Lichenologist* 19: 1–28.
Kantvilas, G. & James, P.W. (1991) Records of crustose lichens from Tasmanian rainforest. *Mycotaxon* 41: 271–286.
Kantvilas, G. & Jarman, S.J. (1988) Lichens of buttongrass (*Gymnoschoenus*) moorland in Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* 122: 1–17.
Kantvilas, G. & Jarman, S.J. (1991) Lichens and bryophytes of the Tasmanian World Heritage Area. I. Mount Sprent. *In*: Banks, M.R., Smith, S.J., Orchard, A.E. & Kantvilas, G. (eds), *Aspects of Tasmanian Botany – A tribute to Winifred Curtis.* Royal Society of Tasmania, Hobart, pp. 149–162.
Kantvilas, G. & Jarman, S.J. (1993) The cryptogamic flora of an isolated rainforest fragment in Tasmania. *Botanical Journal of the Linnean Society* 111: 211–228.
Kantvilas, G. & Jarman, S.J. (1999) *Lichens of rainforest in Tasmania and south-eastern Australia. Flora of Australia Supplementary Series* No. 9. ABRS, Canberra, 212 pp.
Kantvilas, G. & Jarman, S.J. (2002) Using lichens and bryophytes to evaluate the effects of silvicultural practices in Tasmanian wet eucalypt forest. *In*: Nimis, P.L., Scheidegger, C. & Wolseley, P.A. (eds), *Monitoring with lichens–monitoring lichens*. Kluwer Academic Publishers, Dordrecht, pp. 367–371.
Kantvilas, G. & Jarman, S.J. (2004) Lichens and bryophytes on *Eucalyptus obliqua* in Tasmania: management implications in production forests. *Biological Conservation* 117: 359–373.
Kantvilas, G. & Jarman, S.J. (2006) Recovery of lichens after logging: preliminary results from Tasmania's wet forests. *Lichenologist* 38: 383–394.
Kantvilas, G. & Kukwa, M. (2006) A new species of *Lepraria* (lichenized Ascomycetes) from Tasmania's wet forests. *Muelleria* 23: 3–6.
Kantvilas, G. & Lücking, R. (2009) *Fellhaneropsis pallidonigrans,* a south-eastern Australian lichen. *Muelleria* 27: 171–173.
Kantvilas, G. & Lumbsch, H.T. (2010) A new species and a new record of Australian *Scoliciosporum*. *Australasian Lichenology* 66: 4–15.
Kantvilas, G. & Minchin, P.R. (1989) An analysis of epiphytic lichen communities in Tasmanian cool temperate rainforest. *Vegetatio* 84: 99–112.
Kantvilas, G., Elix, J.A. & Jarman, S.J. (2008) A contribution to an inventory of lichens from South Sister, north-eastern Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* 142 (2): 49–60.
Kantvilas, G., Howe, D. & Elix, J.A. (1996) *A preliminary assessment of the distribution and conservation status of some lichens in Tasmania's forests.* Report for the Tasmania–Commonwealth Comprehensive Regional Assessment, 50 pp.
Kantvilas, G., James, P.W. & Jarman, S.J. (1985) Macrolichens in Tasmanian rainforest. *Lichenologist* 17: 67–83.
Kantvilas, G., Messuti, M.I. & Lumbsch, H.T. (2005) Additions to the genus *Mycobilimbia* s. lat. from the Southern Hemisphere. *Lichenologist* 37: 251–259.
Klazenga, N. (2003) A revision of Australasian species of *Dicranoloma* (Bryophyta, Dicranaceae). *Australian Systematic Botany* 16: 427–471.
Kuusinen, M. & Siitonen, J. (1998) Epiphytic lichen diversity in old-growth and managed *Picea abies* stands in southern Finland. *Journal of Vegetation Science* 9: 283–292.
Laffan, M.D. (2001) Geology and soils at the Warra LTER Site: a preliminary description. *Tasforests* 13: 23–29.

Lumbsch, H.T., Ahti, T., Alterman, S., plus 99 other authors (2011) One hundred new species of lichenized fungi: a signature of undiscovered global diversity. *Phytotaxa* 18: 1–127.
McCarthy, P.M. (2001) Trichotheliaceae. *In*: McCarthy, P.M. (ed.), *Flora of Australia Volume 58A, Lichens 3*. ABRS, Canberra/CSIRO, Melbourne: 105–157.
McCarthy, P.M. (2006) *Checklist of Australian liverworts and hornworts*. Australian Biological Resources Study, Canberra. Version 6 April 2006, viewed May 2011. <http://www.anbg.gov.au/abrs/liverwortlist/liverworts_intro.html>.
McCarthy, P.M. (2011) *Checklist of the lichens of Australia and its island territories*. Australian Biological Resources Study, Canberra. Version 21 January 2011, viewed May 2011. <http://www.anbg.gov.au/abrs/lichenlist/introduction.html>.
McCarthy, P.M. & Kantvilas, G. (1999) Additional lichen records from Australia. 37. *Strigula albicascens* (Nyl.) R.C. Harris. *Australasian Lichenology* 44: 4–5.
McCarthy, P.M. & Kantvilas, G. (2000a) A new bryophilous *Porina* from Tasmania, and notes on the diversity, ecological groups and biogeographical affinities of Tasmanian Trichotheliaceae. *Lichenologist* 32: 247–256.
McCarthy, P.M. & Kantvilas, G. (2000b) *Trichothelium meridionale* (Trichotheliaceae), a new foliicolous lichen from Tasmania. *Australasian Lichenology* 47: 5–7.
McCarthy, P.M. & Kantvilas, G. (2009) Thelocarpaceae. *In*: McCarthy, P.M. (ed.), *Flora of Australia Volume 57, Lichens 5*. ABRS, Canberra & CSIRO Publishing, Melbourne, pp. 563–569.
McCarthy, P.M., Kantvilas, G. & Vězda, A. (2001) Foliicolous lichens in Tasmania. *Australasian Lichenology* 48: 16–26.
Meijer, W. (1952) The genus *Orthodontium*. *Acta Botanica Neerlandica* 1: 3–80.
Neyland, M.G. (2001) Vegetation of the Warra silvicultural systems trial. *Tasforests* 13: 183–192. (Published at <http://www.forestrytas.com.au/assets//0000/0203/183_192.pdf>)
Neyland, M.G., Hickey, J., Beadle, C., Bauhus, J., Davidson, N. & Edwards, L. (2009) An examination of stocking and early growth in the Warra silvicultural systems trial confirms the importance of a burnt seedbed for vigorous regeneration in *Eucalyptus obliqua* forest. *Forest Ecology and Management* 258: 481–494.
Neyland, M.G. & Jarman, S.J. (2011) Early impacts of harvesting and burning disturbances on vegetation communities in the Warra silvicultural systems trial, Tasmania, Australia. *Australian Journal of Botany* 59: 701–712.
Packham, J.M. (1995) *An overview of the Warra Long Term Ecological Research and Monitoring (LTERM) Site*. Forestry Tasmania, Hobart, 20 pp.
Poelt, J. & Vězda, A. (1990) Über kurzlebige Flechten – (on shortliving lichens). *Bibliotheca Lichenologica* 38: 377–394.
Printzen, C. & Kantvilas, G. (2004) *Hertelidea*, genus novum Sterecaulacearum (Ascomycetes lichenisati). *Bibliotheca Lichenologica* 88: 539–553.
Richardson, D.H. & Cameron, R.P. (2004) Cyanolichens: their response to pollution and possible management strategies for their conservation in northeastern North America. *Northeastern Naturalist* 11: 1–22.
Ringrose, C., Meyer, S., Bren, L.J. & Neilsen, W.A. (2001) Hydrology of small catchements in the Warra LTER Site: objectives and preliminary analysis. *Tasforests* 13 (1): 31–44.
Rose, F. (1976) Lichenological indicators of age and environmental continuity in woodlands. *In*: Brown, D.H., Hawksworth, D.L. & Bailey, D.L. (eds), *Lichenology: progress and problems*. Academic Press, London, pp. 279–307.
Rose, F. (1992) Temperate forest management: its effects on bryophyte and lichen floras and habitats. *In*: Bates, J.W. & Farmer, A.M. (eds), *Bryophytes and lichens in a changing environment*. Clarenden Press, Oxford, pp. 211–233.
Ryömä, R. & Laaka-Lindberg, S. (2005) Bryophyte recolonization on burnt soil and logs. *Scandinavian Journal of Forest Research* 20 (Suppl 6): 5–16.
Schuster, R.M. (1980) Studies on Hepaticae, LIV–LVIII. *Kurzia* v. Mart, [*Microlepidozia* (Spr.) Joerg.], *Megalembidium* Schust., *Psiloclada* Mitt., *Drucella* Hodgs. and *Isolembidium* Schust. *Journal of the Hattori Botanical Laboratory* 48: 337–421.
Scott, G.A.M. (1985) *Southern Australian liverworts*. *Australian Flora and Fauna Series* No. 2, Bureau of Flora and Fauna, Canberra, 216 pp.
Scott, G.A.M. & Stone, I.G. (1976) *The mosses of southern Australia*. Academic Press, London, 495 pp.
Selva, S.B. (1998) Searching for Caliciales in the Adirondacks of New York. *In*: Glenn, M.G., Harris, R.C., Dirig, R., Cole, M.S. (eds), *Lichenographia Thomasina: North American Lichenology in Honor of John W. Thomson*. Mycotaxon Ltd, New York, pp. 337–344.
Streimann, H. & Klazenga, N. (2002) *Catalogue of Australian mosses. Flora of Australia Supplementary Series*, No. 17. Australian Biological Resources Study, Canberra, 259 pp.
Sustainable Development Advisory Council (1996) *State of the environment Tasmania, Volume 1—conditions and trends*. Compiled by the State of the Environment Unit, Land Information Services, Department of Environment and Land Management, Tasmania, 417 pp.
Tibell, L. (1992) Crustose lichens as indicators of forest continuity in boreal forests. *Nordic Journal of Botany* 12: 427–450.

APPENDIX 1. Lichens recorded from the Warra SST, arranged according to ecological groups. Abbreviations: CS (conservation status) – lc = least concern; dd = data deficient; R = rare (known from less than ten 100 km^2 grid cells in Tasmania). F (occurrence before/after fire) – 1 = recorded only in unburnt forest; 2 = recorded in both unburnt plots, and burnt plots within 5–6 years of burning; 3 = absent from the unburnt forest but recorded on burnt sites within 5–6 years of burning. Footnotes provide diagnostic notes for incompletely identified taxa, and cite selected reference specimens held in the Tasmanian Herbarium (HO).

CS	F	Species
		GROUP 1. SPECIES OF MATURE WET FOREST
		Group 1A. Old forest species
lc	1	*Arthonia apteropteridis* Kantvilas & Vězda
lc	1	*Arthonia ilicina* Taylor
dd	1	*Arthonia subramulosa* Müll.Arg.
lc	1	*Arthonia tasmanica* Kantvilas & Vězda
lc	1	*Arthothelium* sp.[1]
lc	1	*Austroblastenia pauciseptata* (Shirley) Sipman
lc	1	*Austroblastenia pupa* Sipman
R	1	*Bactrospora micareoides* Kantvilas
lc	1	*Bapalmuia buchananii* (Stirt.) Kalb & Lücking
lc	1	*Bunodophoron australe* (Laurer) A.Massal.
lc	1	*Bunodophoron insigne* (Laurer) Wedin
lc	1	*Bunodophoron patagonicum* (C.W.Dodge) Wedin
lc	1	*Chapsa lamellifera* (Kantvilas & Vězda) Mangold
lc	1	*Chrysothrix sulphurella* (Räsänen) Kantvilas & Elix
lc	1	*Cliostomum praepallidum* (Müll.Arg.) Kantvilas & Fryday
lc	1	*Coccotrema cucurbitula* (Mont.) Müll.Arg.
dd	1	*Coccotrema porinopsis* (Nyl) Imshaug ex Yoshim.
dd	1	*Coccotrema* sp. A[2]
dd	1	*Coenogonium lutescens* (Vězda & Malcolm) Malcolm
lc	1	*Collema fasciculare* var. *microcarpum* (Müll.Arg.) Degel.
lc	1	*Collema laeve* Hook.f. & Taylor var. *laeve*
dd	1	*Dactylospora heimleri* (Zukal) Döbbeler & Triebel
dd	1	*Degeliella* sp.[3]
lc	1	*Fellhaneropsis pallidonigrans* (Müll.Arg.) Kantvilas & Lücking
lc	1	*Fissurina insidiosa* C.Knight & Mitt.
lc	1	*Gyalectaria jamesii* (Kantvilas) Schmitt, Kalb & Lumbsch
lc	1	*Jarmania tristis* Kantvilas
lc	1	*Lecidea immarginata* R.Br.
lc	2	*Leifidium tenerum* (Laurer) Wedin
lc	1	*Leiorreuma exaltatum* (Mont. & Bosch) Staiger
dd	1	*Leprocaulon* sp.[4]
lc	1	*Megalaria pulverea* (Borrer) Hafellner & Schreiner
lc	1	*Megaloblastenia marginiflexa* (Hook.f. & Taylor) Sipman
lc	1	*Megalospora lopadioides* Sipman
dd	1	*Melaspilea* sp. A[5]
lc	1	*Menegazzia elongata* P.James
lc	1	*Menegazzia myriotrema* (Müll.Arg.) R.Sant.
lc	2	*Menegazzia norstictica* P.James
lc	1	*Menegazzia pertransita* (Stirt.) R.Sant.
dd	1	*Micarea alabastrites* (Nyl.) Coppins
dd	2	*Micarea cinerea* (Schaerer) Hedl.
lc	1	*Micarea* '*cinereopallida*' Coppins & Kantvilas *ined.*[6]
lc	2	*Micarea micrococca* (Körb.) Gams ex Coppins

lc	1	*Micarea mutabilis* Coppins & Kantvilas
lc	1	*Micarea* '*tubaeiformis*' Coppins & Kantvilas *ined.*[7]
lc	1	*Miltidea ceroplasta* (C.Bab.) D.J.Galloway & Hafellner
R	1	*Mycobilimbia meridionalis* Kantvilas
lc	1	*Mycoblastus dissimulans* (Nyl.) Zahlbr.
lc	1	*Mycoblastus kalioruber* Kantvilas
lc	1	*Ochrolechia* sp.[8]
lc	1	*Opegrapha stellata* Knight
lc	1	*Pannaria microphyllizan*s (Nyl.) P.M.Jørg.
lc	1	*Pannoparmelia angustata* (Pers.) Zahlbr.
lc	1	*Parmelia protosulcata* Hale
lc	2	*Parmelia tenuirima* Hook.f. & Taylor
lc	1	*Pertusaria truncata* Kremp.
lc	1	*Phlyctis subuncinta* Stirt.
dd	1	*Phlyctis* sp. A[9]
R	1	*Porina aenea* (Wallr.) Zahlbr.
lc	1	*Porina hyperleptalea* P.M.McCarthy & Kantvilas
R	1	*Porina impolita* P.M.McCarthy
dd	1	*Porina silvatica* P.M.McCarthy & Kantvilas
lc	1	*Pseudocyphellaria brattii* D.J.Galloway & Kantvilas
lc	1	*Pseudocyphellaria glabra* (Hook.f. & Taylor) Dodge
lc	1	*Pseudocyphellaria multifida* (Nyl.) D.J.Galloway & P.James
lc	1	*Pseudocyphellaria rubella* (Hook.f. & Taylor) D.J.Galloway & P.James
lc	1	*Psoroma asperellum* Nyl.
lc	1	*Psoromidium aleuroides* (Stirt.) D.J.Galloway
lc	1	*Pyrenula dermatodes* (Borrer) Schaer.
lc	1	*Pyrenula finitima* Müll.Arg.
lc	1	*Sarrameana albidoplumbea* (Hook.f. & Taylor) Farkas
dd	1	*Schizotrema zebrinum* Mangold
dd	1	*Scoliciosporum coniectum* Kantvilas & Lumbsch
lc	1	*Sticta stipitata* C.Knight ex F.Wilson
dd	1	*Strigula albicascens* (Nyl.) R.C.Harris
lc	1	*Thelotrema lepadinum* (Ach.) Ach.
lc	1	*Thelotrema suecicum* (H.Magn.) P.James
lc	1	*Topeliopsis decorticans* (Müll.Arg.) A.Frisch & Kalb
lc	1	*Topeliopsis muscigena* (Stizenb.) Kalb
lc	1	*Topeliopsis subdenticulatum* (Zahlbr.) A.Frisch & Kalb
lc	2	*Usnea oncodes* Stirt.
lc	2	*Usnea xanthopoga* Nyl.
lc	1	*Wawea fruticulosa* Henssen & Kantvilas
lc	1	*Xanthopsoroma contextum* (Stirt.) Elvebakk

Group 1B. Old tree species

dd	1	*Arthonia* cf. *cinereopruinosa* Schaer.
dd	1	*Arthonia* sp. B[10]
dd	1	*Calicium adspersum* Pers. subsp. *australe* Tibell
dd	1	*Calicium glaucellum* Ach.
dd	1	*Calicium hyperelloides* Nyl.
dd	1	*Chaenotheca chlorella* (Ach.) Müll.Arg.
lc	1	*Chaenotheca confusa* Tibell
dd	1	*Chaenotheca ferruginea* (Turn. ex Smith) Migula
lc	1	*Chaenotheca hygrophila* Tibell
dd	1	*Chaenothecopsis 'vinosae'* Tibell *ined.*
dd	1	*Chaenothecopsis* cf. *nana* Tibell

dd	1	*Chaenothecopsis nigropedata* Tibell
dd	1	*Chaenothecopsis pusilla* (Ach.) A.F.W.Schmidt
dd	1	*Chaenothecopsis savonica* (Räsänen) Tibell
dd	1	*Chaenothecopsis* sp.[11]
dd	1	*Chaenothecopsis tasmanica* Tibell
R	1	*Chrysothrix palaeophila* Kantvilas & Elix
lc	2	*Hertelidea eucalypti* Kantvilas & Printzen
lc	2	*Icmadophila eucalypti* Kantvilas
lc	1	*Lepraria toilenae* Kantvilas & Kukwa
dd	1	*Melaspilea* sp. B[12]
dd	1	*Micarea* '*ceracea*' Coppins & Kantvilas *ined.*[13]
dd	1	*Micarea* '*prasinastra*' Coppins & Kantvilas *ined.*[14]
dd	1	*Micarea* '*rubiginosa*' Coppins & Kantvilas *ined.*[15]
dd	1	*Microcalicium disseminatum* (Ach.) Vainio
lc	1	*Sagenidium molle* Stirton
dd	1	species C[16]

Group 1C. Foliicolous species

lc	1	*Arthonia trilocularis* Müll.Arg.
R	1	*Aspidothelium cinerascens* Vain.
lc	1	*Badimiella pteridophila* (Sacc.) Garn.-Jones & Malcolm
lc	1	*Byssoloma subdiscordans* (Nyl.) P.James
dd	1	*Fellhanera* sp.[17]
lc	1	*Porina subapplanata* Malcolm, Vězda, McCarthy & Kantvilas
R	1	*Trichothelium meridionale* P.M.McCarthy & Kantvilas

GROUP 2. SPECIES OF OPEN EUCALYPT FORESTS

dd	1	*Calicium salicinum* Pers.
lc	1	*Calicium tricolor* F.Wilson
lc	1	*Calicium victorianum* (F.Wilson) Tibell subsp. *victorianum*
lc	3	*Caloplaca wilsonii* S.Y.Kondr. & Kärnefelt
lc	3	*Candelariella xanthostigmoides* (Müll.Arg.) R.W.Rogers
lc	3	*Cladonia enantia* Nyl.
lc	3	*Cladonia humilis* (With.) J.R.Laundon var. *humilis*
dd	3	*Cladonia humilis* var. *bourgeanica* A.W.Archer
lc	3	*Cladonia praetermissa* A.W.Archer var. *praetermissa*
lc	1	*Graphis mucronata* Stirt.
lc	1	*Hypocenomyce foveata* Timdal
dd	2	*Hypocenomyce scalaris* (Ach.) M.Choisy
lc	2	*Japewiella pruinosula* (Müll.Arg.) Kantvilas
dd	2	*Lecanora subtecta* (Stirt.) Kantvilas & LaGreca
lc	3	*Lecidea xylogena* Müll.Arg.
lc	2	*Menegazzia subpertusa* P.James & D.J.Galloway
dd	3	*Micarea intersociella* (Stirt.) Coppins
lc	3	*Micarea melaneida* (Nyl) Coppins
lc	1	*Mycoblastus sanguinarioides* Kantvilas
lc	1	*Pertusaria pertractata* Stirt.
lc	3	*Physcia adscendens* (Fr.) H.Oliver
lc	3	*Ramalina unilateralis* F.Wilson
dd	3	*Ramboldia sorediata* Kalb
lc	2	*Ramboldia stuartii* (Hampe) Kantvilas & Elix
lc	3	*Rinodina asperata* (Shirley) Kantvilas
lc	2	*Trachylia emergens* F.Wilson
lc	3	*Trapeliopsis flexuosa* (Fr.) Coppins & P.James
lc	2	*Usnea inermis* Motyka

Group 3. WIDESPREAD AND COMMON SPECIES

lc	2	*Austroparmelina labrosa* (Zahlbr.) A.Crespo, Divakar & Elix
lc	2	*Austroparmelina pseudorelicina* (Jatta) A.Crespo, Divakar & Elix
lc	2	*Buellia disciformis* (Fr.) Mudd
lc	2	*Cladia aggregata* (Sw.) Nyl.
lc	3	*Cladia retipora* (Labill.) Nyl.
lc	3	*Cladonia chlorophaea* (Flörke ex Sommerf.) Sprengel
lc	3	*Cladonia corniculata* Ahti & Kashiw.
lc	3	*Cladonia merochlorophaea* Asahina
lc	1	*Cladonia ochrochlora* Flörke
lc	2	*Cladonia ramulosa* (With.) J.R.Laundon
lc	2	*Cladonia rigida* (Hook.f. & Taylor) Hampe var. *rigida*
lc	3	*Cladonia sarmentosa* (Hook.f. & Taylor) C.W.Dodge
lc	3	*Cladonia scabriuscula* (Delise) Nyl.
lc	2	*Cladonia subsubulata* Nyl.
lc	2	*Cladonia ustulata* (Hook.f. & Taylor) Leighton
lc	2	*Cladonia verticillata* (Hoffm.) Schaer.
lc	2	*Cladonia weymouthii* F.Wilson ex A.W.Archer
lc	1	*Cliostomum griffithii* (Sm.) Coppins
lc	1	*Fuscidea australis* Kantvilas var. *australis*
lc	3	*Hypocenomyce australis* Timdal
lc	1	*Hypogymnia lugubris* (Pers.) Krog
lc	1	*Hypogymnia mundata* (Nyl.) Rassad.
lc	2	*Hypogymnia tasmanica* Elix
lc	2	*Hypotrachyna sinuosa* (Sm.) Hale
lc	3	*Lepraria lobificans* Nyl.
lc	1	*Leptogium victorianum* F.Wilson
lc	1	*Loxospora solenospora* (Müll.Arg.) Kantvilas
lc	1	*Megalaria subtasmanica* Kantvilas
lc	1	*Menegazzia confusa* P.James
lc	1	*Menegazzia nothofagi* (Zahlbr.) P.James & D.J.Galloway
lc	1	*Mycoblastus campbellianus* (Nyl.) Zahlbr.
lc	2	*Mycoblastus coniophorus* (Elix & A.W.Archer) Kantvilas & Elix
lc	2	*Neophyllis melacarpa* (F.Wilson) F.Wilson
lc	2	*Parmelia cunninghamii* Cromb.
lc	1	*Parmeliella nigrocincta* (Mont.) Müll.Arg.
lc	2	*Pertusaria novaezelandiae* Szatala
lc	1	*Porina leptalea* (Durieu & Mont.) A.L.Smith
lc	3	*Pseudocyphellaria crocata* (L.) Vain.
lc	2	*Psilolechia lucida* (Ach.) M.Choisy
lc	1	*Ramboldia brunneocarp*a Kantvilas & Elix
lc	2	*Ramboldia laeta* (Stirt.) Kalb, Lumbsch & Elix
lc	1	*Tasmidella variabilis* Kantvilas, Elix & Hafellner var. *variabilis*
lc	1	*Tephromela atra* (Huds.) Hafellner
lc	2	*Trapelia glebulosa* (Sm.) J.R.Laundon
lc	2	*Trapeliopsis granulosa* (Hoffm.) Lumbsch

GROUP 4. SPECIES OF DISTURBED HABITATS

Group 4A. Transient colonisers

lc	3	*Absconditella celata* Döbbeler & Poelt
lc	3	*Absconditella delutula* (Nyl.) Coppins & H.Kilias
lc	2	*Absconditella lignicola* Vězda & Pisút
lc	2	*Glonium* sp.[18]

lc	3	*Gyalidea hyalinescens* (Nyl.) Vězda
lc	3	*Peltigera didactyla* (With.) J.R.Laundon
lc	3	*Placynthiella uliginosa* (Schrad.) Coppins & P.James
lc	2	*Steinia geophana* (Nyl.) B.Stein
R	3	*Thelocarpon intermediellum* Nyl.
lc	3	*Thelocarpon laureri* (Flot.) Nyl.
lc	3	*Thelocarpon strasseri* Zahlbr.

Group 4B. Persistent early colonisers

lc	3	*Agyrium rufum* (Pers.) Fr.
lc	3	*Baeomyces heteromorphus* Nyl. ex C.Bab. & Mitt.
lc	2	*Cladia schizopora* (Nyl.) Nyl.
lc	3	*Dibaeis arcuata* (Stirt.) Kalb & Gierl
dd	2	*Micarea deminuta* Coppins
lc	2	*Micarea peliocarpa* (Anzi) Coppins & R.Sant.
dd	2	*Micarea* sp. 1[19]
lc	1	*Peltigera dolichorhiza* (Nyl.) Nyl.
lc	3	*Peltigera polydactylon* (Neck.) Hoffm.
lc	3	*Placopsis* sp. A[20]
lc	2	*Placynthiella icmalea* (Ach.) Coppins & P.James
lc	3	*Scoliciosporum umbrinum* (Ach.) Arnold
lc	3	*Stereocaulon ramulosum* (Sw.) Räusch.
lc	3	*Trapelia coarctata* (Sm.) M.Choisy

GROUP 5. UNCLASSIFIED

dd	1	*Anisomeridium biforme* (Borrer) R.C.Harris
dd	3	*Arthonia* cf. *lignariella* Coppins
dd	1	*Arthonia didyma* Körb.
dd	1	*Arthonia* sp. A[21]
dd	1	*Arthonia* sp. C[22]
dd	1	*Arthonia* sp. D[23]
dd	1	*Arthopyrenia* spp.
dd	1	*Arthothelium ampliatum* (C.Knight & Mitt.) Müll.Arg.
dd	3	*Bacidia* sp.[24]
dd	3	*Buellia* sp.[25]
dd	3	*Caloplaca* cf. *flavovirescens* (Wulfen) Dalla Torre & Sarnth.
dd	3	*Caloplaca* sp.[26]
dd	1	*Celothelium* sp.[27]
dd	3	*Cladonia ?borbonica* Nyl.
dd	1	*Cladonia adspersa* Mont. & Bosch
dd	1	*Cladonia* cf. *murrayi* W.Martin
dd	1	*Coppinsia minutissima* Lumbsch & Heibel
dd	1	*Dactylospora* sp.[28]
dd	1	*Graphis* sp.[29]
dd	2	*'Hafellia'* sp.[30]
dd	3	*Lecidea sarcogynoides* Körb.
dd	1	*Lecidea* sp. A[31]
dd	1	*Lecidea* sp. B[32]
dd	1	*Lecidella* sp.[33]
dd	1	*Lepraria eburnea* J.R.Laundon
lc	1	*Lepraria yunnaniana* (Hue) Zahlbr.
dd	1	*Lepraria* sp.[34]
dd	2	*Marasmiellus affixus* (Berk.) Singer
dd	3	*Micarea denigrata* (Fr.) Hedl.

dd	3	*Micarea cf. melanoloba* (Nyl.) Coppins[35]
dd	1	*Micarea sylvicola* (Flotow) Vězda & V.Wirth
dd	1	*Micarea viridileprosa* Coppins & van den Boom
dd	1	*Micarea* sp. 2[36]
dd	2	*Multiclavula mucida* (Fr.) R.H.Petersen
dd	1	*Opegrapha herbarum* Mont.
dd	1	*Opegrapha* sp. A[37]
dd	1	*Opegrapha* sp. B[38]
lc	3	*Parmeliella thysanota* (Stirt.) Zahlbr.
dd	1	*Phlyctis* sp. B[39]
lc	3	*Placopsis perrugosa* (Nyl.) Nyl.
dd	3	*Placopsis* sp. B[40]
dd	3	*Porpidia crustulata* (Ach.) Hertel & Knoph
dd	3	*Porpidia* sp.[41]
dd	1	*Pyrenula aspistea* (Ach.) Ach.
dd	1	*?Ramalodium* sp.[42]
dd	1	species D[43]

Footnotes for Appendix 1

1. A widespread species in Tasmania with densely muriform spores and apothecia that react K+ vivid magenta; HO 323430, 503367.
2. An undescribed species with apically red apothecia, containing norstictic acid; HO 329309, 324448, 325345.
3. An undescribed, isidiate-phyllidiate species, superficially similar to *Parmeliella nigrocincta*; HO 501571.
4. An undescribed endemic Tasmanian epiphyte found in wet forest, characterised by a minutely fruticose thallus containing 2'-O-methylperlatolic acid; HO 501560, 325990.
5. A common species on smooth bark, with black, lirelliform apothecia and brown, 1-septate, ellipsoid spores, 9–13.5 × 3.5–5.5 µm; HO 443002, 325991, 324463.
6. An undescribed species of the *Micarea prasina* group; listed as '*M. prasina* Fr. agg., form B' in Jarman & Kantvilas (2001a); characterised by a K+ greenish blue pigment in the apothecia and thallus granules; HO 503364, 503356.
7. A widespread undescribed species in Tasmanian wet forests, characterised by black apothecia, filiform multi-septate spores and conspicuous, stalked, trumpet-shaped pycnidia; HO 501565, 320761.
8. An unidentified species growing mainly on twigs; HO 550634, 503392, 544331.
9. A sterile, common species with a conspicuous white thallus containing norstictic acid; HO 503383, 503384.
10. Characterised by having 3-septate, fusiform-ellipsoid spores, 12–15 × 4–5 µm; occurs on eucalypt bark; HO 323445, 500718, 500945.
11. An unidentified member of a difficult and poorly known genus; HO 323429.
12. Occurs on charred bark of mature, standing eucalypts in undisturbed forest; characterised by black, lirelliform apothecia and simple, brown to colourless spores, 8–10 × 4 µm; HO 500728, 500727.
13. An undescribed species found on mature eucalypts; listed as *Micarea* cf. *adnata* in Jarman & Kantvilas (2001a); HO 50995, 501548.
14. An undescribed species found on mature eucalypts, related to *Micarea prasina* and characterised by C+ pink apothecia; listed as '*Micarea prasina* Fr. agg., form C' in Jarman & Kantvilas (2001a); HO 500708, 501579
15. An undescribed species occurring on mature eucalypts and logs, characterised by orange-brown apothecia that are C+ orange in section; listed as '*Micarea prasina* Fr. agg., form D' in Jarman & Kantvilas (2001a); HO 445011, 329482.
16. Characterised by a yellowish, powdery thallus with red-shaped *Stichococcus* cells as the photobiont; it resembles the basal thallus of a calicioid lichen but lacks a chemistry; found in dry habitats on old eucalypts; HO 500721, 329413, 500786.
17. An unidentified species growing on the living fronds of *Blechnum wattsii*; HO 123232.
18. A common, short-lived species on rocks and wood in logged coupes, superficially similar to *Glonium circumserpens* (Nyl.) Kantvilas & Coppins but with larger spores (16–)20–23 × 6–8 µm; HO 324457, 329005, 325341. Listed as *Glonium* cf. *stellatum* Mühlenb. ex Fr. in Jarman & Kantvilas (2001a).
19. Characterised by minute, unpigmented, milky white apothecia with simple or 1-septate spores, 5–10 × 3–3.5 µm; found on consolidated clay and stones after logging; HO 538249, 538654, 520662.
20. A common species on pebbles and rocks, in exposed habitats, characterised by a small squamulose thallus with round soralia; HO 526771, 531676.
21. Characterised by having 1-septate spores 10–14 × 4–6 µm with uneven-sized locules; occurs on smooth bark; HO 5002884, 325979, 443000.

22. Similar to *Arthonia ilicina* but with spores not macrocephalic and becoming rough-walled; HO 525229.
23. Characterised by having 3-septate spores, 18–20 × 7–8 µm, with a slight central constriction and the distal cells being smaller; HO 525227.
24. Allied to *Bacidia rubella* and characterised by pinkish apothecia and thread-like spores; HO 540717.
25. An undescribed species with grey-green spores 10–16 × 6–7 µm, with one central septum and two, sometimes spurious, distal septa; found mostly on cut surfaces of eucalypt stumps in regenerating forest; HO 526852, 538003.
26. A small crustose lichen with a grey thallus and orange, K+ purple apothecia with a pruinose disc; found mainly on eucalypt wood after logging; HO 544364, 540726.
27. Characterised by black perithecia with filiform, multi-septate spores *c*. 80–100 × 2 µm; recorded from the twigs of *Coprosma*; HO 325983.
28. An inconspicuous, unidentified species with brown, 1-septate spores, found on papery bark; HO 502945, 329003, 325988.
29. Known only from a minute fragment of thallus with a totally carbonised exciple and 7–9 locular spores, 32–50 × 8–12 µm; HO 503019.
30. Related to *Hafellia (Buellia) dissa* but with spores not ornamented, 2,4/ascus, 24–30 × 10 µm; found mainly on eucalypt wood; HO 521665, 544368.
31. An epiphyte of *Melaleuca* with a brown epithecium, red-brown hypothecium, *Porpidia*-type asci and simple spores 8–12 × 4–5 µm; HO 323162, 521458.
32. A crustose species with a greenish hymenium, *Micarea*-type asci and (0–)1(–2)-septate spores 10–15 × 4–5 µm; HO 326000, 503602, 503236.
33. Similar to *Lecidea xylogena* but with coarser soredia arising in discrete soralia; on smooth-barked, subdominant trees; HO 547920, 549453, 546621.
34. An unidentified species growing on a boulder; contains porphyrilic acid; HO 525171, 549630.
35. A very common species on cut stumps after logging, characterised by a thallus of convex granules containing a UV+ unknown substance, black C– apothecia containing a sedifolia-grey pigment, and simple spores 6–8 × 3 µm; HO 530241, 529876, 45992.
36. Characterised by internally red-brown pigmented apothecia with simple spores, 8–9 × 3–4 µm; found on *Banksia*; HO 549631.
37. A taxon of uncertain classification with black lirellae arranged in parallel lines, and 3-septate spores, 26–28 × 6 µm; on eucalypt canopy wood in unlogged forest; HO 500940.
38. Recorded from the bark of *Eucryphia* and characterised by the long, flexuose lirellae with a K+ olive-green exciple and the 3-septate spores, 14–16 × 6 µm; HO 41034.
39. A sterile species with an unusual, undetermined chemistry; collected once from *Nematolepis*; HO 324446.
40. Characterised by a lobate, esorediate thallus containing stictic acid; HO 540293, 543051.
41. Recorded once, from a large boulder in unlogged forest; characterised by a reddish brown exciple and hypothecium, and non-halonate spores, 10–12 × 6–7 µm; HO 63058.
42. A gelatinous lichen of the family Collemataceae, with a fruticulose thallus resembling *Wawea* and spores 9–12 µm diam.; found on *Melaleuca*; HO 328001.
43. A sterile crustose lichen with no chemistry, trebouxioid algae and ellipsoid conidia 2 × 1 µm; found on scorched eucalypt wood and listed as ‘unknown crust 183/04’ in Kantvilas & Jarman (2006); HO 526256.

APPENDIX 2. Mosses recorded from the Warra SST, arranged according to ecological groups. Abbreviations: CS (conservation status) – lc = least concern; dd = data deficient; R = rare (known from less than ten 100 km^2 grid cells in Tasmania). F (occurrence before/after fire) – 1 = recorded only in unburnt forest; 2 = recorded in both unburnt plots, and burnt plots within 5–6 years of burning; 3 = absent from the unburnt forest but recorded on burnt sites within 5–6 years of burning.

CS	F	Species
		GROUP 1. SPECIES OF MATURE WET FOREST
lc	2	*Achrophyllum dentatum* (Hook.f. & Wilson) Vitt & Crosby
lc	2	*Austrohondaella limata* (Hook.f. & Wilson) Z.Iwats., H.P.Ramsay & Fife
lc	1	*Calyptopogon mnioides* (Schwaegr.) Broth.
lc	1	*Cyathophorum bulbosum* (Hedw.) Müll.Hal.
dd	2	*Daltonia splachnoides* (Sm.) Hook. & Taylor
lc	1	*Dicranoloma dicarpum* (Nees) Paris
lc	2	*Dicranoloma menziesii* (Taylor) Renauld
lc	1	*Dicranum trichopodum* Mitt.
lc	2	*Distichophyllum pulchellum* (Hampe) Mitt.
lc	2	*Distichophyllum rotundifolium* (Hook.f. & Wilson) Müll.Hal. & Broth.
lc	2	*Glyphothecium scurioides* (Hook.) Hampe
lc	1	*Hampeella alaris* (Dixon & Sainsbury) Sainsbury
lc	1	*Holomitrium perichaetiale* (Hook.) Brid.
lc	2	*Hypnodendron comosum* (Labill.) Mitt.
lc	2	*Hypnum chrysogaster* Müll.Hal.
lc	2	*Hypopterygium didyctio*n Müll.Hal.
lc	2	*Leptostomum inclinans* R.Br.
lc	1	*Leucobryum candidum* (Brid. ex P.Beauv.) Wilson
lc	1	*Lopidium concinnum* (Hook.) Wilson
lc	1	*Macromitrium archeri* Mitt.
lc	1	*Macromitrium microstomum* (Hook. & Grev.) Schwaegr.
dd	2	*Orthodontium pallens* (Hook.f. & Wilson) Broth.[1]
lc	3	*Orthotrichum tasmanicum* Hook.f. & Wilson
lc	1	*Rhizogonium distichum* (Sw.) Brid.
lc	2	*Rhizogonium novae-hollandiae* (Brid.) Brid.
lc	1	*Rhizogonium pennatum* Hook.f. & Wilson
lc	1	*Tayloria gunnii* (Wilson) J.H.Willis
lc	2	*Ulota lutea* (Hook.f. & Wilson) Mitt.
lc	2	*Warburgiella leucocytus* (Müll.Hal.) B.C.Tan, W.B.Schofield & H.P.Ramsay
lc	1	*Weymouthia cochlearifolia* (Schwaegr.) Dixon
lc	1	*Weymouthia mollis* (Hedw.) Broth.
lc	1	*Zygodon hookeri* Hampe
		GROUP 2 & 4B. SPECIES OF OPEN EUCALYPT FOREST/PERSISTENT EARLY COLONISERS
lc	3	*Barbula calycina* Schwaegr.
lc	3	*Breutelia affinis* (Hook.) Mitt.
lc	3	*Bryum argenteum* Hedw.
dd	3	*Bryum ?chrysoneuron* Müll.Hal.
dd	3	*Bryum crassum* Hook.f. & Wilson
lc	3	*Bryum dichotomum* Hedw.
lc	2	*Campylopus introflexus* (Hedw.) Brid.
lc	3	*Ditrichum cylindricarpum* (Müll.Hal.) F.Muell.
lc	3	*Fissidens curvatus* Hornsch.
lc	3	*Fissidens taylori* Müll.Hal.
lc	3	*Leptobryum pyriforme* (Hedw.) Wilson
lc	3	*Pogonatum subulatum* (Brid.) Brid.
lc	3	*Polytrichum commune* Hedw.

GROUP 3. WIDESPREAD SPECIES

lc	2	*Acrocladium chlamydophyllum* (Hook.f. & Wilson) Müll.Hal. & Broth.
lc	1	*Campylopus pyriformis* (Schultz) Brid.
lc	1	*Catagonium nitens* (Brid.) Cardot
lc	2	*Dicranoloma billardierei* (Brid. ex Anon.) Paris
lc	2	*Dicranoloma robustum* (Hook.f. & Wilson) Paris
lc	2	*Dicranoloma setosum* (Hook.f. & Wilson) Paris
lc	2	*Dicranoweissia microcarpa* (Hook.f. & Wilson) Paris
lc	2	*Fissidens pallidus* Hook.f. & Wilson
lc	2	*Fissidens tenellus* Hook.f. & Wilson
lc	2	*Hypnum cupressiforme* Hedw.
lc	1	*Lembophyllum clandestinum* (Hook.f. & Wilson) Lindenb.
lc	2	*Leptotheca gaudichaudii* Schwaegr.
lc	1	*Mittenia plumula* (Mitt.) Lindenb.
lc	2	*Orthodontium lineare* Schwaegr.
lc	3	*Polytrichum juniperinum* Hedw.
lc	2	*Ptychomnion aciculare* (Brid.) Mitt.
lc	1	*Racomitrium crispulum* (Hook.f. & Wilson) Hook.f. & Wilson
lc	2	*Racopilum cuspidigerum* (Schwaegr.) Ängst.
lc	2	*Raphidorrhynchium amoenum* (Hedw.) M.Fleisch.
lc	2	*Rosulabryum billardierei* (Schwaegr.) J.R.Spence
lc	2	*Tayloria octoblepharum* (Hook.) Mitt.
lc	1	*Thuidiopsis sparsa* (Hook.f. & Wilson) Broth.
lc	2	*Wijkia extenuata* (Brid.) H.A.Crum
lc	2	*Zygodon intermedius* Bruch & Schimp.

GROUP 4. SPECIES OF DISTURBED HABITATS

Group 4A. Transient colonisers

lc	3	*Ceratodon purpureus* (Hedw.) Brid.
lc	3	*Funaria hygrometrica* Hedw.

Group 4B. Persistent early colonisers

Currently placed with Group 2, pending further study.

GROUP 5. UNCLASSIFIED

dd	3	*Brachythecium paradoxum* (Hook.f. & Wilson) A.Jaeger
	3	*Bryum* sens. lat. sp. 1
	3	*Bryum* sens. lat. sp. 2
lc	3	*Campylopus kirkii* Mitt.
	3	*Pohlia* sp.
	1	*?Tortula* sp.
dd	1	*Warburgiella macrospora* (Dixon & Sainsbury) B.C.Tan, W.B.Schofield & H.P.Ramsay

Footnotes for Appendix 2

1. A possible contender for an ‘old tree’ species.

APPENDIX 3. Liverworts recorded from the Warra SST, arranged according to ecological groups. Abbreviations: CS (conservation status) – lc = least concern; dd = data deficient; R = rare (known from less than ten 100 km^2 grid cells in Tasmania). F (occurrence before/after fire) – 1 = recorded only in unburnt forest; 2 = recorded in both unburnt plots, and burnt plots within 5–6 years of burning; 3 = absent from the unburnt forest but recorded on burnt sites within 5–6 years of burning.

CS	F	Species
		GROUP 1. SPECIES OF MATURE WET FOREST
lc	1	*Acrobolbus cinerascens* (Lehm. & Lindenb.) Bastow
lc	1	*Acrobolbus concinnus* (Mitt.) Grolle
lc	1	*Acrochila biserialis* (Lehm. & Lindenb.) Grolle
lc	2	*Acromastigum anisostomum* (Lehm. & Lindenb.) A.Evans
lc	1	*Acromastigum colensoanum* (Mitt.) A.Evans ex Reimers
lc	1	*Acromastigum mooreanum* (Steph.) E.A.Hodgs.
lc	1	*Adelanthus falcatus* (Hook.) Mitt.
lc	2	*Aneura alterniloba* (Hook.f. & Taylor) Taylor & Hook.f.
lc	1	*Bazzania accreta* (Lehm. & Lindenb.) Trevis.
lc	2	*Bazzania adnexa* (Lehm. & Lindenb.) Trevis.
lc	1	*Bazzania monilinervis* (Lehm. & Lindenb.) Trevis.
dd	1	*Cheilolejeunea campbelliensis* (Steph.) R.M.Schust.
R?	1	*Cheilolejeunea comitans* (Hook.f. & Taylor) R.M.Schust.
lc	1	*Cheilolejeunea mimosa* (Hook.f. & Taylor) R.M.Schust.
lc	1	*Chiloscyphus leucophyllus* (Hook.f. & Taylor) Gottsche, Lindenb. & Nees
lc	2	*Chiloscyphus muricatus* (Lehm.) J.J.Engel & R.M.Schust.
dd	1	*Colura saccophylla* E.A.Hodgs. & Herzog
lc	1	*Cuspidatula monodon* (Taylor ex Lehm.) Steph.
lc	1	*Drepanolejeunea aucklandica* Steph.
lc	1	*Eotrichocolea polyacantha* (Hook.f. & Taylor) R.M.Schust.
lc	1	*Frullania aterrima* (Hook.f. & Taylor) Hook.f. & Taylor ex Gottsche, Lindenb. & Nees
lc	2	*Frullania deplanata* Mitt.
lc	1	*Frullania rostrata* (Hook.f. & Taylor) Hook.f. & Taylor ex Gottsche, Lindenb. & Nees
lc	1	*Gackstroemia weindorferi* (Herzog) Grolle
lc	1	*Geocalyx caledonicus* Steph.
lc	1	*Harpalejeunea latitans* (Hook.f. & Taylor) Grolle
lc	2	*Heteroscyphus coalitus* (Hook.) Schiffn.
lc	1	*Heteroscyphus conjugatus* (Mitt.) J.J.Engel & R.M.Schust.
lc	1	*Heteroscyphus cymbaliferus* (Hook.f. & Taylor) J.J.Engel & R.M.Schust.
dd	1	*Heteroscyphus decipiens* (Gottsche) J.J.Engel & R.M.Schust.
lc	2	*Heteroscyphus echinellus* (Lindenb. & Gottsche) J.J.Engel & Xiao L.He
lc	2	*Heteroscyphus fissistipus* (Hook.f. & Taylor) Schiffn. aggr.
lc	1	*Heteroscyphus limosus* (Carrington & Pearson) Schiffn.
lc	1	*Hymenophyton flabellatum* (Labill.) Dumort. ex Trevis.
lc	1	*Jamesoniella colorata* (Lehm.) Spruce ex Schiffn.
lc	1	*Jamesoniella tasmanica* (Hook.f. & Taylor) Steph.
dd	1	*Kurzia calcarata* (Steph.) Grolle
dd	2	*Kurzia ?sexfida* (Steph.) Grolle
lc	1	*Kurzia tenax* (Grev.) Grolle
lc	2	*Lejeunea drummondii* Taylor
lc	1	*Lepicolea scolopendra* (Hook.) Dumort. ex Trevis.
lc	1	*Lepidolaena brachyclada* (Taylor ex Lehm.) Trevis.
dd	2	*Lepidozia concinna* Colenso
lc	1	*Lepidozia glaucophylla* (Hook.f. & Taylor) Taylor ex Gottsche, Lindenb. & Nees

lc	2	*Lepidozia procera* Mitt.
lc	2	*Lepidozia ulothrix* (Schwaegr.) Lindenb.
dd	1	*Lepidozia* sp. S
lc	2	*Lepidozia* sp. W
lc	1	*Marsupidium surculosum* (Nees) Schiffn.
lc	1	*Metzgeria leptoneura* Spruce
lc	1	*Metzgeria saccata* Mitt.
lc	1	*Paraschistochila pinnatifolia* (Hook.) R.M.Schust.
lc	1	*Plagiochila ?baileyana* Steph.
lc	1	*Plagiochila ?fasciculata* Lindenb.
R?	1	*Plagiochila fragmentissima* Inoue & R.M.Schust.
lc	1	*Plagiochila pleurata* (Hook.f. & Taylor) Taylor & Hook.f. ex Gottsche, Lindenb. & Nees
lc	1	*Plagiochila radiculosa* Mitt.
lc	1	*Plagiochila ratkowskiana* Inoue
lc	1	*Plagiochila retrospectans* Nees
lc	1	*Plagiochila strombifolia* (Hook.f. & Taylor) Lehm.
lc	1	*Podomitrium phyllanthus* (Hook.) Mitt.
lc	1	*Radula aneurysmalis* (Hook.f. & Taylor) Nees ex Gottsche, Lindenb. & Nees
lc	1	*Radula buccinifera* (Hook.f. & Taylor) Taylor ex Gottsche, Lindenb. & Nees
lc	1	*Radula ratkowskiana* K.Yamada
R?	1	*Radula retroflexa* Taylor
lc	1	*Radula scariosa* Mitt.
lc	1	*Radula tasmanica* Steph
lc	2	*Riccardia aequicellularis* (Steph.) Hewson
lc	2	*Riccardia cochleata* (Hook.f. & Taylor) Kuntze
lc	2	*Riccardia colensoi* (Steph.) W.Martin
lc	2	*Riccardia crassa* (Schwaegr.) Carrington & Pearson
lc	2	*Riccardia lobulata* (Colenso) E.A.Hodgs.
lc	2	R*iccardia ?longiflora* (Steph.) Hewson
dd	1	*Riccardia ?wattsiana* (Steph.) Hewson
dd	1	*Riccardia* sp. A[1]
lc	1	*Saccogynidium decurvum* (Mitt.) Grolle
lc	1	*Schistochila lehmanniana* (Lehm. & Lindenb.) Carrington & Pearson
lc	2	*Symphyogyna podophylla* (Thunb.) Mont. & Nees
dd	2	*Telaranea fragilifolia* (R.M.Schust.) J.J.Engel & G.L.Merr.
lc	1	*Telaranea grossiseta* (Steph.) J.J.Engel & R.M.Schust.
lc	2	*Telaranea herzogii* (E.A.Hodgs.) E.A.Hodgs.
lc	2	*Telaranea mooreana* (Steph.) R.M.Schust.
dd	2	*Telaranea patentissima* (Hook.f. & Taylor) E.A.Hodgs.
lc	1	*Treubia tasmanica* R.M.Schust. & G.A.M.Scott
lc	2	*Trichocolea mollissima* (Hook.f. & Taylor) Gottsche
lc	2	*Tylimanthus diversifolius* E.A.Hodgs.
lc	1	*Tylimanthus pseudosaccatus* Grolle
lc	2	*Tylimanthus tenellus* (Hook.f. & Taylor) Mitt.
lc	2	*Zoopsis argentea* (Hook.f. & Taylor) Hook.f. ex Gottsche, Lindenb. & Nees
lc	2	*Zoopsis leitgebiana* (Carrington & Pearson) Bastow
lc	2	*Zoopsis setulosa* Leitg.

GROUP 2 & 4B. SPECIES OF OPEN EUCALYPT FOREST/PERSISTENT EARLY COLONISERS

lc	2	*Chaetophyllopsis whiteleggei* (Carrington & Pearson) R.M.Schust.
lc	2	*Cephaloziella exiliflora* (Taylor) Douin
lc	2	*Cephaloziella hirta* (Steph.) R.M.Schust.
dd	2	*Cephaloziella muelleriana* R.M.Schust.
lc	2	*Chiloscyphus cuspidatus* (Nees) J.J.Engel & R.M.Schust.

lc	2	*Balantiopsis diplophylla* (Hook.f. & Taylor) Mitt.
dd	3	*Fossombronia* sp.

GROUP 3. WIDESPREAD SPECIES

lc	2	*Chiloscyphus gippslandicus* J.J.Engel & R.M.Schust.
lc	1	*Frullania falciloba* Taylor ex Lehm.
lc	2	*Frullania probosciphora* Taylor
lc	2	*Heteroscyphus knightii* (Steph.) Grolle
lc	3	*Isotachis intortifolia* (Hook.f. & Taylor) Gottsche
lc	2	*Kurzia hippurioides* (Hook.f. & Taylor) Grolle
lc	2	*Telaranea centipes* (Taylor ex Gottsche, Lindenb. & Nees) R.M.Schust.
lc	2	*Telaranea tasmanica* (Steph.) J.J.Engel & G.L.Merr.

GROUP 4. SPECIES OF DISTURBED HABITATS

Group 4A. Pioneer species

lc	3	*Marchantia berteroana* Lehm. & Lindenb.

Group 4B. Persistent early colonising species

Currently placed with Group 2, pending further study

GROUP 5. UNCLASSIFIED

lc	3	*Aneura rodwayi* Hewson
dd	1	*Cheilolejeunea albovirens* (Hook.f. & Taylor) E.A.Hodgs.
dd	1	*Jackiella curvata* E.A.Hodgs. & Allison
dd	3	*Phaeoceros laevis* (L.) Prosk.
dd	3	*Riccardia* sp. B[2]

Footnotes for Appendix 3

1. An unidentified *Riccardia* with a rough cuticle.
2. A small *Riccardia* with a smooth cuticle and many tiny oil bodies in the cells.