

## Conservation of Tasmanian lichens

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### Abstract

The island of Tasmania supports a very diverse range of habitats and plant species, including more than 1000 lichens. It has an extensive system of formal reserves, accounting for approximately 40% of its total area, established mainly for their scenic, wilderness and biological values. However, due to lack of data, non-vascular plants have not been specifically considered in the delimitation of reserves. The major threat to lichens in Tasmania is habitat destruction. Although a significant proportion of species are probably adequately conserved by default, many others are totally confined to areas where current land use practices may place them at risk. Developing a conservation strategy for lichens is hampered by a lack of knowledge of the taxonomy, ecology and distribution of most species. In this paper problems and possible strategies for the conservation of lichens in Tasmania are discussed, using as a case study the family Parmeliaceae, which amounts to approx. 130 species. Reserving land, formal listing of rare or threatened species, and identifying critical habitats for particular target species are seen as critical components of a lichen conservation strategy. However, the management of lichen habitats may be very complex and special prescriptions may be required. Priorities for future research include: exploring the extent to which vascular plants and communities or environmental domains are reliable surrogates for identifying critical lichen habitats; basic inventory and taxonomic work; surveying data-deficient taxa; and sampling poorly studied habitats. Educating the wider community about the importance of lichens is also important.

Keywords: lichens, Tasmania, Parmeliaceae, conservation, non-vascular plants

## 1 Introduction

Tasmania is an island in the Southern Ocean, approximately 240 km south of the south-eastern corner of the Australian mainland. Together with New Zealand and the southern part of South America, it is one of three significant land masses that lie in the path of the prevailing winds known as the Roaring Forties. The area of Tasmania is approximately 68 000 km<sup>2</sup>, roughly comparable to the islands of Sri Lanka or Ireland.

Tasmania has a rich flora comprising approximately 1660 native angiosperms, 11 native gymnosperms, 100 pteridophytes (BUCHANAN 1999) and several thousand non-vascular species (KANTVILAS 1994, DALTON *et al.* 1991, RATKOWSKY 1987, MAY 1997, and unpublished estimates). This flora reflects Tasmania's ancient origins in the super-continent of Gondwana and its subsequent isolation as part of Australia. The flora also displays significant tropical, bipolar, pantemperate and cosmopolitan elements (KANTVILAS 1996a). Approximately 20% of the native vascular flora is endemic (HILL and ORCHARD 1999).

About 700 additional vascular species, amounting to 29% of the total vascular flora, are introduced species, mainly from Europe (ROZEFELDS *et al.* 1999). Since European settlement in 1803, much of the Tasmanian landscape has been significantly modified by pastoralism, forestry, agriculture, mining, industrialisation and urbanisation. Even so, very large, unpopu-

lated, natural areas are found in the mountainous and often inhospitable terrain mainly in the west, whilst the relatively low population of only 470 000 is concentrated very much in the northern and south-eastern lowlands.

Tasmania's complex and variable geology, highly dissected topography, and steep west to east climatic gradient provide it with an intricate mosaic of habitats and vegetation types, including a diverse range of cool temperate rainforest and sclerophyll forest types, heathlands, moorlands, sedgeland and grasslands. In many respects, this complexity of vegetation belies the island's rather small size and provides added challenges to the botanist and land manager.

## 2 Lichenology in Tasmania

A reasonable current estimate of the diversity of the Tasmanian lichen flora would be approximately 1000 species (KANTVILAS 1994 and unpublished data). However, the large number of undetermined entities, and the significant number of poorly studied habitats means that this figure will inevitably be revised upwards in the future. Knowledge of the lichen flora is patchy and based on detailed taxonomic studies of only a limited number of groups, and on detailed floristic and ecological studies in particular habitats or locations. Thus, for example, rainforest (KANTVILAS 1995a; JARMAN and KANTVILAS 1995) and some alpine habitats (KANTVILAS 1995b) have been extensively researched, as have lichen families such as the Parmeliaceae (KANTVILAS *et al.* 1997), Siphulaceae (KANTVILAS 1996, 1998), Cladoniaceae (ARCHER 1992) and Lobariaceae (KANTVILAS and ELIX 1999). However, many groups, particularly saxicolous crustose lichens, and some habitats, especially in eastern Tasmania in areas of low rainfall, are poorly known.

At present, lichenology in Tasmania is virtually a one-person operation, with occasional contributions on well-defined, typically taxonomic projects by specialists from mainland Australia or beyond. All the associated tasks of field survey, taxonomy, habitat ecology, data-base management and input into species and habitat management and conservation are carried out essentially by the same individual. Hence progress towards a comprehensive flora, a conspectus of distribution patterns, and a Red List of threatened species is exceedingly slow. Some reference to the conservation status of lichens in Tasmania was made by STEVENS (1997) in the course of an overview for non-marine non-vascular plants in Australia (SCOTT *et al.* 1997). However, most remarks on Tasmanian species are poorly supported by sound evidence or interpretation of available data.

Ironically, a major part of the existing data on lichen floristics and distribution has been derived through projects such as pre-logging surveys in wood production zones. Such work has led to the discovery of new species as well as new records for Tasmania. That such important data come from areas that are in the process of being completely modified or disturbed in a major way may present a bleak picture for the future of some of Tasmania's unique lichen flora. However, it is mainly as a result of limited resources that attention has focussed on areas being disturbed rather than on the whole breadth of the landscape. It also reflects the sources for funding for lichenological field studies and research.

### 3 Threats to lichens

Threats to lichens in Tasmania have been discussed by BROWN *et al.* (1994). The most serious threat is *habitat destruction*, either through clearing for forestry or agriculture, or through inappropriate grazing and fire regimes. Activities such as the repeated use of fire to reduce fuel, regenerate forest or maintain fauna habitat, may have only subtle visible effects on the vascular vegetation, but can have a dramatic and deleterious impact on the often unique habitat requirements of lichens.

Some preliminary surveys that consider cryptogams as monitors of habitat integrity have been initiated in recent years. For example, a project is underway (by J. Jarman and G. Kantvilas) in State forest within the Warra Long Term Ecological Research site in the Huon Valley, southern Tasmania, to explore the effects of different silviculture methods on lichens and bryophytes in *Eucalyptus obliqua*-dominated oldgrowth forest. A brief survey of lichens and bryophytes in roadside vegetation has also been undertaken (KANTVILAS and JARMAN 1998). However, such ecological projects in Tasmania are typically restricted to vascular plants.

*Air and water pollution* in Tasmania pose localised threats in urban, industrial and intensively farmed areas, but lichens have not been used as pollution indicators in any formal way. Being a rather remote island, Tasmania does not receive pollution effects from its neighbours, and such problems are essentially self-induced and self-contained.

*Direct exploitation* of lichens in Tasmania is very limited. Dyeing and similar uses are not widespread, and have been actively discouraged wherever possible. However, collecting for scientific work can be a serious problem in localised sites, such as easily accessible remnant wet gullies or along the edges of walking tracks, despite the existence of a comprehensive permit system and strict limitations on collecting exsiccata.

*Plant disease and exotic organisms* may pose an indirect threat. The pathogen *Phytophthora cinnamomi* can remove the entire complement of woody shrubs from certain plant communities, and thereby the bulk of the epiphytic lichen habitat. Similarly, exotic species such as *Ulex europaeus* can exclude native host shrubs from some communities, or produce light and moisture conditions unsuitable for lichens.

These threats are by no means unique to lichens, and also apply to other groups of organisms. To conserve the more conspicuous components of its biota, Tasmania has developed a quite sophisticated conservation approach over the years, often not without controversy. This includes a complex and extensive system of land reservation, a *Threatened Species Protection Act*, various off-reserve conservation programmes such as *Land for Wildlife* and a *Threatened Species Strategy*. However, with respect to lichen conservation, Tasmania is very much a newcomer, and lichens, as will be discussed, can often require specialised approaches.

### 4 Vascular plant conservation

Initial reservation of land in Tasmania occurred primarily for scenic and aesthetic reasons, and in this way, many important areas, especially of alpine habitats, were reserved as National Parks (BROWN and HICKEY 1990; HARRIS and WHINAM 1993). Increasing pressure on the landscape and its hydro-electric and timber resources from the 1970s saw a dramatic increase in public awareness of wilderness. Against a background of widespread controversy and political instability, large areas of Tasmania were reserved for their wilderness values, and ultimately listed by UNESCO as a World Heritage Area (WHITLAM 1993). These major gains

saw, by default, the reservation of extensive habitats for many of Tasmania's unique, uncommon or localised plant species, especially those occurring in highland areas, or in the wet moorlands and forests of the west.

More recently the rationale for conservation has entailed a more scientific approach based on biological values. Floristic surveys directed at particular vegetation types, for example, rain-forest (JARMAN *et al.* 1984, 1994), wet sclerophyll (KIRKPATRICK *et al.* 1988) and dry sclerophyll forests (DUNCAN and BROWN 1985), coastal vegetation (KIRKPATRICK and HARRIS 1995) and buttongrass moorland (JARMAN *et al.* 1988), provided an overview of the reservation status of particular plant communities, species or species populations. Other studies were directed at particular species of significance, such as *Eucalyptus cordata* (POTTS 1989), *Lagarostrobos franklinii* (PETERSON 1990) and *Athrotaxis selaginoides* (BROWN 1988). Further information was derived from expert knowledge, a well-established taxonomic base for species and communities, good regional floras and well-documented, reliable voucher collections. Quantitative environmental domain analysis has also been widely applied. This method assumes that vegetation responds to the physical environment in a predictable manner. In Tasmania, the regional conservation status of forest types was assessed in order to protect examples of all component communities in secure reserves. The occurrence of recognised forest communities within stratified geological and altitudinal categories across Tasmania's nature conservation regions was determined and followed up with selected ground-based surveys. This led to a system of Recommended Areas for Protection (RAPs) (Working Group for Forest Conservation 1990). The approach was further refined during the Comprehensive Regional Assessment of forests which led to a Regional Forest Agreement between Tasmania and the Commonwealth government in 1997 (Tasmanian Public Land Use Commission 1997). As a result, about 40% of Tasmania today lies within some form of reserve.

These major achievements have been directed at vascular plants and vascular plant communities, and are based on a very good knowledge of the flora. Information has been accumulated over 200 years of botanical endeavour, and currently there is a community of amateur and professional people in Tasmania able to contribute information which can be used as a basis for making conservation decisions. Conservation awareness has essentially arisen out of an appreciation and knowledge of the flora. This is not the case for lichens where the goals of conservation pre-date the floristic and ecological knowledge upon which a conservation strategy can be based. Thus an interim approach is required, based on what data are available as well as a degree of guess-work.

## 5 Conservation strategies for lichens

### 5.1 Reservation

The extensive reservation system in Tasmania means that, by default, many lichens in Tasmania are well represented within secure reserves. This certainly accounts for most species from cool temperate rainforest, alpine areas and buttongrass moorlands, although the very localised nature of some lichens means that particular species from these vegetation types may still be unprotected. Examples include the very rare rainforest species, *Roccellinastrum neglectum* and *Hypotrachyna laevigata*, whose very localised distributions on Tasmania's west coast fall outside any formal reserve and within a wood production zone. Lichens restricted to small isolated rainforest remnants well outside the main range of the vegetation, for

example, on the drier east coast, are also often outside reserves, although such vegetation on public land is excluded from timber production and is therefore in a sense a *de facto* reserve.

A species within a National Park may still require individual management prescriptions. At present, reserves are managed for their vascular plant values and lichens are not specifically considered. Many uncommon species that occur entirely within a reserve, for example, *Alectoria nigricans*, *Neofuscelia imitatrix* and *Cetaria islandica* ssp. *antarctica*, remain potentially at risk from fire or other factors, simply because of their overall rarity and highly specialised habitat. However, at least these lichens are in reserves where they are relatively secure from direct and deliberate habitat degradation, development and resource extraction. Therefore they probably do not have highest priority for conservation effort.

The main question is how to manage the many other species that occur almost entirely outside reserves. These are especially the species occurring in wood production eucalypt forest, in open woodland subject to grazing, firewood cutting or clearing, in grasslands subject to 'improvement' and in coastal areas available for residential development. Non-forest vegetation is the main source of concern. With respect to forests, an extensive system of representative reserves has been established as a result of the RAPs process and the Tasmanian Regional Forest Assessment outlined above. The concept of 'representative' is based entirely on vascular plant values, and it remains to be seen to what extent these parameters are reliable surrogates for lichens; this should be a priority for future investigation.

One impediment to managing species that occur outside of reserves is that, due to lack of data, it is difficult to estimate how many such species there are. There are very many unknown taxa; within almost any family investigated, detailed study will reveal an overlooked species, and a detailed survey of any new area will almost certainly reveal a significant number of previously unrecorded taxa.

### 5.1.1 Pilot study: the Parmeliaceae

The family Parmeliaceae provided a good subject for a pilot study. This work commenced under the Tasmanian Regional Forest Assessment (KANTVILAS *et al.* 1997) and is being developed into a review of distribution patterns, ecology and conservation status for the family in Tasmania (G. Kantvilas, J.A. Elix and S.J. Jarman, in prep.). As a focus for a conservation study, the Parmeliaceae displays the following advantages:

- i) It is widely collected, due to the conspicuousness of most of its species. The work is based on approx. 3000 records, represented by herbarium specimens. The identification of all specimens was checked, as were details of their locations. There tends to be a high rate of mistakes in the identification of lichen herbarium specimens, hence anecdotal, unvouchered or literature records, or unchecked herbarium specimens, were not included in the study.
- ii) It has a high level of diversity, with approx. 130 taxa in approx. 20 genera, ranging across all habitats throughout Tasmania.
- iii) It has been the subject of a recent taxonomic revision (GRGURINOVIC 1994), so problems of nomenclature and identification could be expected to be minimal. However, even within this well studied family, the detailed review of the data uncovered some taxonomic problems, several overlooked records including some undescribed species, and several species that had been mistakenly recorded for Tasmania, either through misidentification, misinterpretation or typographical error. In addition, there were numerous errors with respect to locality within Tasmania, all of which pose problems when determining conservation status.

Throughout the work it has been recognised that herbarium specimens may not necessarily represent extant viable populations in the field. Firstly, due to the size of the organisms involved, collecting lichen herbarium specimens can sometimes remove the entire population. Secondly, some habitat degradation could be anticipated in the time since the collection was first made.

The review of the Parmeliaceae revealed that of the 123 species studied to date, 48 could be considered sufficiently widespread and well reserved to be secure. (In Tasmania, to be 'well-reserved' a species must occur within two or more secure reserves [KIRKPATRICK *et al.* 1980 and subsequent workers]). Seventy-five species of the Parmeliaceae were data-deficient in some way but included a large proportion of species which were apparently rare, or restricted and uncommon, and so potentially at risk. Further work is required before these species can be categorised either as secure or at risk, and these taxa should be treated as priorities for future study and survey.

The statistics for the Parmeliaceae are not necessarily indicative of all Tasmanian lichen families. For example, in the Lobariaceae, of the 25 species, 21 are considered secure, whereas of the 12 Sphaerophoraceae, 11 are secure; these two families occur mainly in the wetter western forest and alpine habitats, where much study has been undertaken, much land is in a natural state, and reserves are extensive. Together, all three families share the characteristics of being readily recognised and recorded, making data-gathering relatively simple, at least in comparison to certain other groups such as the crustose lichens.

### 5.1.2 Limitations of reservation

Whereas reservation on a large-scale in the infertile, rugged, western part of Tasmania has been a good option, a similar approach in the eastern parts to accommodate the unreserved species that occur there is not a viable option. This is primarily because:

- This is where most of Tasmania's population resides and most economic activity occurs; it is not just vacant land.
- Much of the land is privately owned, and there are not the resources to buy it, even if it were for sale.
- The undisturbed areas are smaller and more fragmented.
- Unlike the wetter, western landscape where most plant communities can be managed by excluding or minimising human impact, many of the plant communities of the drier areas have evolved with a long history of interaction with fauna and people. Marsupial grazing and the fire-stick activities of the indigenous hunter gatherers have been replaced by sheep grazing and other 'European' activities, posing complex ecological and management problems.

## 5.2 Listing of species

The listing of species on the schedules of the *Threatened Species Protection Act 1995* provides some mechanism for their conservation in the form of legislative protection from activities which may place them at risk. More than 460 species of vascular plant are currently listed, although this list is soon to be reviewed to accommodate new data on species taxonomy, biology, ecology and distribution. Guidelines for listing are based as far as possible on IUCN criteria (1994), as well as on local geographic and biological knowledge, and expert assessments of threatening impacts.

It is generally recognised that producing quantitative guidelines for non-vascular plants can be difficult due to lack of data (HALLINGBÄCK *et al.* 1995), although Red Data Books for these groups have been prepared in various regions, for example, for lichens in Britain and Ireland (CHURCH *et al.* 1996), in Norway (TØNSBERG *et al.* 1996) and in Sweden (ARUP *et al.* 1997). When evaluating bryophytes for listing, HALLINGBÄCK *et al.* (1998) maintain that the most relevant data include population decline, decline in habitat quality, present distribution, number of locations, and numbers of individuals in the population; it is likely that a similar approach will be applicable for lichens as well. In Tasmania, listing for non-vascular groups is very much based on expert knowledge of inferred habitat, known distribution and risk.

As a result of the Parmeliaceae project, four lichens have been listed under the *Threatened Species Protection Act 1995* (Tasmanian Government Gazette Vol. CCXCIII- 8 Sept. 1999):

1. *Xanthoparmelia vicaria* Elix & J. Johnst., a Tasmanian endemic species, is listed as 'rare' on account of its small, localised population.
2. *Punctelia subflava* (Taylor) Elix & J. Johnst. is listed as 'presumed extinct' because no Tasmanian specimen has been collected since 1839. This species also occurs in mainland Australia, but its inferred habitat in Tasmania, coastal swamp forests, have been severely depleted, fragmented or disturbed.
3. *Hypotrachyna laevigata* (Sm.) Hale is listed as 'vulnerable' on account of its apparent intrinsic rareness and likely risk to its viability. Although widespread in the temperate Northern Hemisphere, the sole Australian record of this species is a Tasmanian collection from a fallen rainforest tree in a wood production zone in western Tasmania.
4. *Parmotrema crinitum* (Ach.) M. Choisy is listed as 'rare' because of stochastic risk to its very small populations (in lowland swamp forest).

A further three species, the endemic *Xanthoparmelia jarmaniae* Elix & Kantvilas, and two grassland species also known from mainland Australia, *X. willisii* (Kurok. & Filson) Elix & J. Johnst. and *X. molliuscula* (Ach.) Hale, are likely to be nominated for listing in the near future.

The listing strategy depends very much on the availability of good data. For vascular plants, the schedules of listed species were derived from many years of deliberations by specialists, and the synthesis of herbarium and other data. No such data exist for most lichens. Yet in the author's opinion, no species should be listed until the scientific evidence is there to substantiate it. Indeed, to maintain credibility in what is often an unsympathetic political environment, lists of threatened species should be exclusively for taxa that meet rigidly defined, transparent criteria.

Another limitation of listing is that, in the absence of good data and an understanding of a species' ecology, listing *per se* simply highlights the threats and degree of risk to a species, but does not necessarily conserve it. Nevertheless, the listing process is very important. *Xanthoparmelia willisii*, a rare Tasmanian lichen, was the subject of a specific study (see KANTVILAS and JARMAN, this volume) and as a result, sufficient information now exists to nominate this species. However, given the resources required for such projects, a strategy of tackling each species one-by-one cannot possibly deal with potentially hundreds of data-deficient taxa.

### 5.3 Habitat identification and management

This strategy, like the listing approach, also requires much detailed data gathering. However, it has the advantage of providing a better and broader focus for limited resources. For example, the *X. willisii* project revealed unequivocally that native grasslands can support

a concentration of species that are potentially vulnerable, for example, *Neofuscelia torulosa*, *Xanthoparmelia molliuscula*, *Rinodina conradii*, species of *Endocarpon* and *Placidium*, and many other terricolous lichens. At present, limited resources make it impossible to pursue each taxon individually through a structured route of taxonomic, ecological and biogeographical enquiry in order to nominate it for listing. However, to target selected grassland areas for conservation would be a major step towards the conservation of a whole suite of potentially very vulnerable species.

In the same way, preliminary studies, often prompted initially by some single-species-orientated problem, have revealed particular locations as important hot spots of rare lichen diversity. For example, an informal survey targetting the rare Tasmanian endemic, *Xanthoparmelia vicaria*, showed that the Gunners Quoin area in south-eastern Tasmania where it occurs is also home to several other uncommon species, including *Paraparmelia leucophaea* and *Neofuscelia parviloba*. Similarly the granite peak, Mt Cameron, in Tasmania's far north-east is a hot-spot for unusual lichens with very limited distributions.

The habitat-focussed approach still leads to specific land management problems. Within forests, mechanisms such as the *Forest Practices Code* include provisions for dealing with rarities on public and private land where timber harvesting is involved. To date, however, no lichens have been considered, mainly because no species are listed under the *Threatened Species Protection Act*, and none are specifically cited in the manuals that accompany the *Code*. Furthermore, not all threats relate to commercial forestry, or even to species on forested land. Acquisition of land for conservation may even be deleterious, at least on land where the lichens depend on some level of activity by animals and people. For example, observations suggest that fencing a site to keep out stock may be very advantageous to terricolous lichens on some geological types or aspects such as steep slopes on Permian mudstone. However, in other cases, such as on more fertile rock types like basalt, the growth of grass and forbs in the absence of sheep would probably lead to the loss of species. Each site thus requires special management, in consultation with the land-owners and land managers.

## 6 Conclusion

For its relatively small size, Tasmania possesses an unusually rich and generally unspoilt lichen flora of global significance, but irreversible change is occurring in the landscape and the number of species which are threatened is likely to be great. Hence, lichen conservation in Tasmania deserves to be given considerable priority. It is unfortunate that many existing funding programs which purport to focus on flora (for example, the *Bushcare Programme* of the *Natural Heritage Trust*) still operate exclusively within the paradigm that flora conservation is equivalent to vascular plant conservation. There is certainly merit in the reserve system and to a large extent, the biological approach of developing representative reserves can be trusted to protect a large proportion of the lichens. This approach has probably worked well with rainforest lichens (BROWN *et al.* 1994). However, there is no evidence that vascular plant communities are consistent surrogates for all lichen species and critical lichen habitats in all vegetation types. The view that lichens will be 'looked after' in the course of vascular plant conservation and management should not go unchallenged and requires detailed investigation. Likewise, listing of selected, better known species provides an important focal point for public and Government attention. In the meantime, the fundamental tasks of field survey, taxonomic study, and identifying key species and sites must continue, albeit gradually.

## 6.1 Priorities for action

- Extending the review of the lichen flora currently underway for the Parmeliaceae to other families; this type of data is the raw material on which any further work, be it listing taxa or identifying priority taxa for further study, is based.
- Surveying and studying further those taxa already identified as being data-deficient but possibly at risk so that they can eventually be either listed formally or deleted from further consideration.
- Continuing the sampling of poorly studied habitats, especially in low rainfall areas; highest priority should be given to sampling remnant grasslands, calcareous habitats and coastal swamp forests.
- Instilling an awareness of lichens and their importance to Tasmania's biodiversity in land owners, land managers, land or resource users and the public. Notwithstanding the urgent need for resources and support for the essentially scientific, specialised tasks listed above, a major educational effort is required to ensure conservation principles are adhered to. The wider community must have a basic ability to recognise the organisms that are regarded as important.

Tasmania is very much a newcomer to lichen conservation, but the process has begun, despite the fact that so much is yet to be fully explored lichenologically. One of the greatest challenges ahead is to maintain the impetus of this work, especially in a climate where pressure on the landscape is likely to increase, and community commitment and sources of financial support are likely to diminish.

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