SOME MACROFUNGI FROM ALPINE TASMANIA

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Abstract

Macrofungi from the alpine area of Mt Wellington were surveyed fortnightly in 1999 and 2001 on permanent plots of known fire history. Macrofungi were present during half of the surveys. Other incidental surveys were carried out in Tasmanian alpine areas on the Central Plateau and at Mt Field. A total of 22 taxa were recognised. These included *Aleuria rhenana*, *Cystoderma muscicola*, *Heterotextus peziziformis*, *Hygrocybe chlorophana*, *Mycena epipterygia*, *Rhodocollybia butyracea* and species of *Entoloma*, *Gymnopus*, *Mycena*, *Lycoperdon*, *Marasmius*, *Omphalina*, *Panaeolus*, *Psathyrella* and *Psilocybe*. Two mycorrhizal taxa, *Laccaria* sp. B and an unidentified species of *Inocybe*, were found in alpine heath from the Tasmanian Central Plateau. The Tasmanian alpine macrofungi are compared with those present in adjacent non-alpine areas, and to the macrofungi of alpine areas in the northern hemisphere.

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Introduction

Alpine vegetation is that which occurs above the climatic limit for the growth of trees. In Tasmania alpine vegetation occurs in habitat islands, relictual from a much wider distribution in the last glacial period. The boundary of Tasmanian alpine vegetation is rarely abrupt, and treeless areas can occur in the lowlands. The climatic tree line in Tasmania varies from 800 to 1400 m above sea level, depending on latitude and distance inland from the sea (Kirkpatrick 1982, 1997). Tasmania's alpine vegetation is globally unusual in that most of its area is dominated by scleromorphic shrubs and/or hard cushion (bolster) plants, a product of the inconstancy of snow in a maritime environment (Kirkpatrick 1983, 1997).

Three main elements of the vascular plant flora have been described for alpine Tasmania: Cosmopolitan, Australian and Gondwanan (Kirkpatrick & Brown 1984). In contrast, little work has been done on alpine macrofungi in Tasmania, or indeed Australasia. There have been no systematic surveys for Australian alpine macrofungi, with only a few species of alpine Hygrophoraceae and *Galerina* included in recent revisions (Wood 2001, Young & Wood 1997). Globally, there is some similarity between the fungi of alpine areas and those from arctic regions (Laursen 1982). Horak (1982) studied macrofungi from Antarctica and subantarctic islands, including Macquarie Island. He found no evidence of ectomycorrhizal associations, contrasting with the northern polar and subpolar areas where ectomycorrhizal associations are common. For Macquarie Island, Laursen *et al.* (1997) also found no evidence of ectomycorrhizal associations.

In this paper we report both systematic and casual observations of macrofungi in three Tasmanian alpine areas: Mount Wellington, Mount Field and the Central Plateau. The data presented include records from permanent plots of known fire history, part of a larger survey of the macrofungi of Mt Wellington. We compare the suite of Tasmanian alpine macrofungi with the macrofungi of adjacent non-alpine areas and also with data on alpine macrofungi from the northern hemisphere.

Methods

On Mt Wellington, ten 30 × 30 m sites were established in the alpine zone within 1 km of the summit (Australian Map Grid Zone 55G 518000E 5250000N) (Table 1). Five sites were burnt in 1962 (1962 sites), three sites were last burnt in 1947 (1947 sites), and two sites are in areas on the boundary of the 1962 fire where there is a patchy

distribution of areas last burnt in 1947 or 1962. Within each site ten 1 × 5 m parallel strip-plots were randomly located. These strip-plots gave an area of 50 m^2 to be used for intensive and substrate cover surveys.

Intensive surveys of these strip plots were carried out for five of the ten sites on Mt Wellington in April 1999; three sites burnt in 1962, one burnt in 1947 and one on the boundary of the 1962 and 1947 fires. At each site the strip-plots were surveyed for all macrofungal taxa present. For the intensive survey, taxa not seen in strip-plots but seen within the site were also recorded. Any taxa seen incidentally while moving between sites were also recorded. Substrate types were recorded during surveys in 2001–2003 for the strip-plots from all sites using the following cover classes: 1 = 0–1%, 2 = 2–5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76–100%. Leaf litter is the leaf litter not including the leaf litter from *Orites acicularis*. *Orites acicularis* litter is the leaf and seed pod litter only from *O. acicularis*. Wood Total is all wood greater than 50 mm in diameter, and is the cumulative total of wood classes.

Table 1. Location and site data. Vegetation types are according to Kirkpatrick (1997).

Location	Elevation (m)	Vegetation	No. Sites	Aspect & Slope (site no. (direction, M.N., slope))	Fire History	Surveys
Mt Wellington	1210–1230	Alpine heath and grassland	3	1(078°, 4°), 2(169°, 2°), 3(179°, 1°)	Last fire 1947	Short (all sites) + Intensive (1 site)
Mt Wellington	1210–1230	Alpine heath and grassland	5	1(114°, 1°), 2(065°, 2°), 3(0, 0°), 4(0, 0°), 5(091°, 1°)	Last fire 1962	Short (all sites) + Intensive (3 sites)
Mt Wellington	1210–1230	Alpine heath and grassland	2	1(031°, 1°), 2(076°, 1°)	Last fire 1947 or 1962	Short (all sites) + Intensive (1 site)
Mt Field, Newdegate Pass	1280	Bolster heath	-		Not known	Incidental only
Central Plateau	900–1150	Alpine heath and grassland	-		Not known	Incidental only

On Mt Wellington all sites were also surveyed by a short survey each month between June–December 1999 and March–October 2001. The short surveys involved searching for macrofungi for ten minutes along a central 30 × 2 m transect. Half the sites were surveyed each fortnight, so each site was visited monthly during survey periods. Complete snow cover prevented surveys about a fifth of the time.

Surveys for macrofungi involved looking at all potential fungi habitat, without damaging the substrates or vegetation as repeated surveys were made. The frequency of macrofungi was observed by considering each new patch of substrate as a single occurrence, rather than by counting individual fruiting bodies (the density and spacing of which can vary for different taxa). Occurrence of a taxon on the same piece of wood or patch of leaf litter was considered as a single observation. So, if a taxon was seen on five separate pieces of substrate on one site it was recorded as having a frequency of five for that site. For a particular survey occasion, frequency was pooled over sites.

Incidental observations, when between sites and visiting sites for other surveys, were recorded for Mt Wellington. Macrofungi were also collected and observed incidentally, during vegetation investigations, in two other alpine areas in Tasmania: Newdegate Pass, Mt Field (AMG Zone 55G 462800E 527740N) and at five localities on the Central Plateau (within the rectangle defined by AMG Zone 55G 473000-483000E 5270000-5360000N) (Table 1). The Mt Field observation period was one survey day in February 1999. The Central Plateau observation period included one day in November 1999 and one day in December 2001. All surveys were carried out by one observer (SJMM).

Fungi fruit bodies for identification were collected. Characteristics were recorded within a day of collection, photographs were taken and if possible, a spore print was made. Specimens were dried using a food dehydrator at 30°C. Identifications were carried out using a light microscope with magnification up to ×1000 and material mounted in a weak KOH solution or Melzer's reagent. Whenever possible, a voucher specimen for each taxon

was lodged at the National Herbarium of Victoria (MEL). For some taxa, material was immature or over-mature or in poor condition and not suitable for vouchering. Names for fungi follow May *et al.* (2003). Mycorrhizal status follows Trappe (1962) and Hobbie *et al.* (2001).

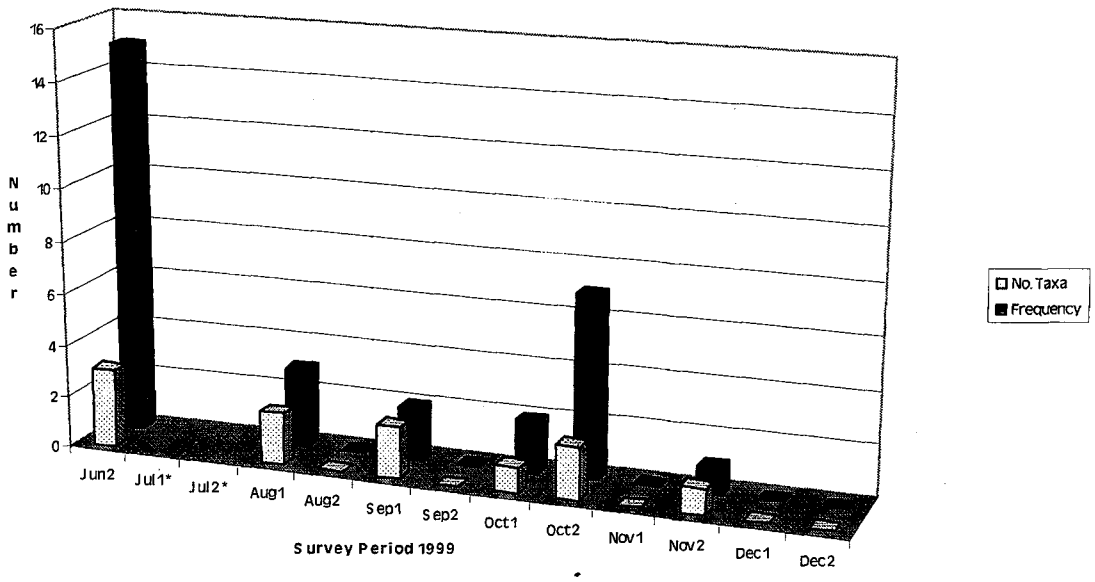

Figure 1. Short surveys of macrofungi on Mt Wellington in 1999, showing total number of taxa, and frequency of observations (* indicates that no survey was completed due to complete snow cover of vegetation).

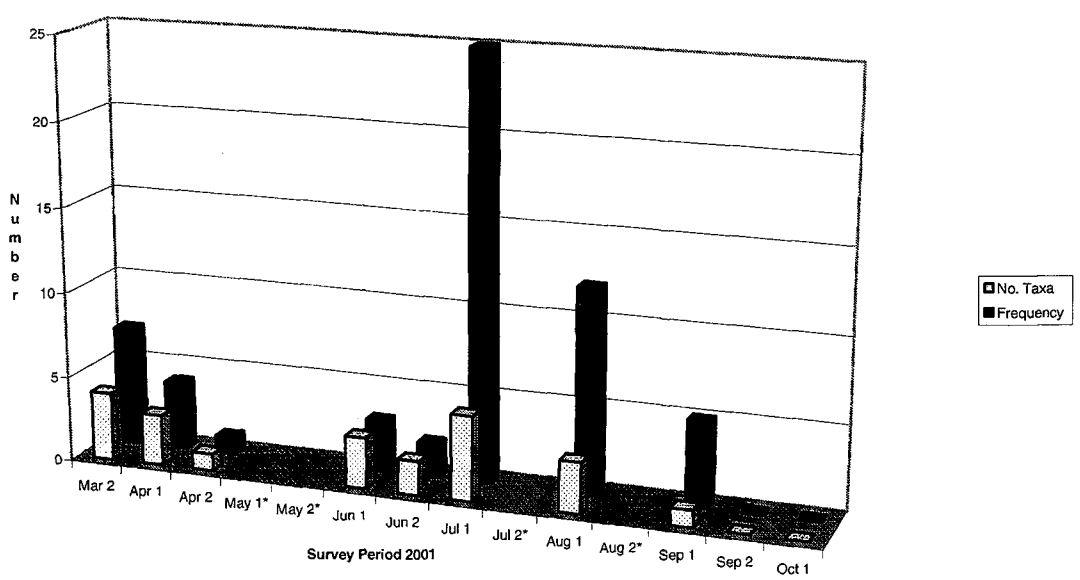

Figure 2. Short surveys of macrofungi on Mt Wellington in 2001, showing total number of taxa, and frequency of observations (* indicates that no survey was completed due to complete snow cover of vegetation).

Results

For the Mt Wellington sites at least one taxon was seen during half of the short surveys (Figs 1 and 2). When fungi were present, there were between one and four taxa, usually at low frequencies. On July 1 2001 the high frequency was due to Discomycete sp. A and *Heterotexus peziziformis,* with frequencies of fourteen and seven respectively. For the intensive survey, a total of nine taxa were seen (Fig. 3). Ten taxa in total were seen during

short surveys. Two taxa (*Entoloma* sp. and *Lycoperdon* sp.) were only seen during incidental surveys, and did not occur on the sites. Across all the sites and surveys, a total of 22 taxa were observed (Table 2). Of these, eight taxa were only seen once, and most other taxa were seen less than ten times. Discomycete sp. A, *H. peziziformis* and *Marasmius* spp. were seen 38, 35 and 13 times respectively. The accumulation of species over visits (Fig. 4) was a reasonably steep curve initially, but with no new taxa recorded after the ninth visit when considering the total for all sites.

Of the 17 taxa collected overall, six were named species, and the *Laccaria* agreed with the description of *Laccaria* sp. B by May (1997). A further six taxa were distinctive enough to be recognised from one visit to the next, although they were not described in the current literature. These six were distinguished as Discomycete sp. A, *Gymnopus* sp. A, and three species of *Omphalina* (spp. A, B and C). The remaining eight macrofungal taxa were identified to family or genus, and in some cases more than one species could have been present, such as in *Marasmius*. The only mycorrhizal taxa collected were *Laccaria* sp. B and *Inocybe* sp.

Comparing the sites on Mt Wellington of known fire history (Table 3), one taxon was found only on 1947 sites, six on both site types, and six only on the 1962 sites. The total number of taxa on the 1962 sites was about twice that of the 1947 sites, although there were fewer 1947 sites. Of the taxa seen on more than four occasions, *Heterotexus peziziformis*, *Marasmius* spp. and Discomycete sp. A were found on both age classes, with the latter on all of the 1947 and three of the five 1962 sites, whilst *Omphalina* sp. A only occurred on 1962 sites (two of five sites). Discomycete sp. A was only found on the leaf litter of *Orites acicularis*. This is one of the plants that differs greatly in cover between the two ages classes (Kirkpatrick *et al.* 2002). The amount of this substrate differed between the two age classes in the present samples (Fig. 5). Total wood also differs between the two age classes.

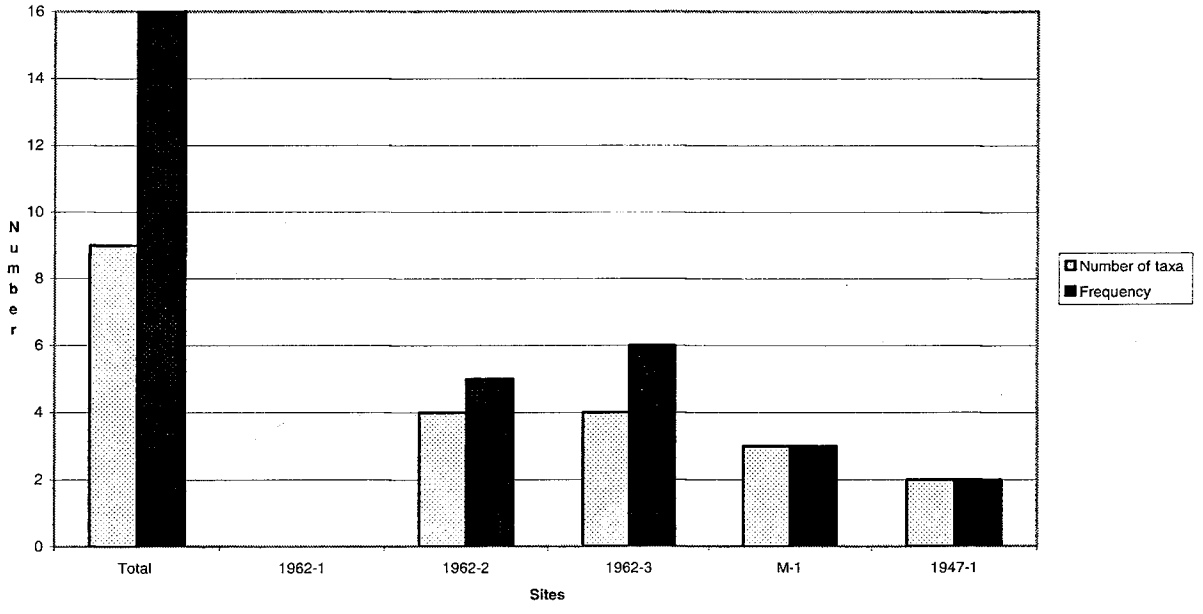

Figure 3. Intensive survey for macrofungi on Mt Wellington in 1999, showing the number of taxa in total and for each site surveyed, and the frequency of macrofungi observations. Sites burnt in 1962 (three sites), M: fire boundary of 1947–1962 site (one site), site burnt in 1947 (one site).

Discussion

The levelling out of the species accumulation curve after one year shows that the survey effort was adequate to gain a preliminary picture of the most common taxa of macrofungi present in the alpine zone of Mt Wellington. The low sample intensity of 22 days over the study period indicates that many taxa are likely to have been overlooked, as species could have been present only as mycelia, or might not have produced fruiting bodies. There will also have been additional diversity present since some of the taxa recorded may well represent more than one species. Despite this, the study established that there is a suite of macrofungi present in alpine habitats in Tasmania.

Table 2. Macrofungi recorded from three alpine areas in Tasmania.

Taxon	Mt Wellington	Central Plateau	Mt Field
Ascomycota			
Aleuria rhenana	+	-	-
Discomycete sp. A	+	-	-
Basidiomycota			
Cystoderma muscicola	+	-	-
Entoloma spp.	+	+	-
Gymnopus sp. A	+	-	-
Heterotexus peziziformis	+	-	-
Hygrocybe chlorophana	+	+	-
Inocybe sp.	-	+	-
Laccaria sp.	-	+	-
Lycoperdon sp.	+	+	-
Marasmius spp.	+	+	-
Mycena epipterygia	+	-	-
Mycena sp.	+	-	-
Omphalina sp. A	+	-	-
Omphalina sp. B	+	-	-
Omphalina sp. C	-	-	+
Panaeolus sp.	-	+	-
Psathyrella sp.	-	+	-
Psilocybe sp.	+	-	-
Rhodocollybia butyracea	+	-	-
Strophariaceae spp.	+	+	-
Tricholomataceae sp.	+	-	-
Total number of taxa	**17**	**9**	**1**

Table 3. Comparison of macrofungi on sites on Mt Wellington burnt in the 1947 or 1962 fires. Figures are percentage of sites on which taxon present (total number of observations of taxon on sites). Data are pooled across the 22 days of short and intensive surveys.

Taxon	1947	1962
Psilocybe sp.	33 (1)	
Discomycete sp. A	100 (12)	80 (8)
Heterotexus peziziformis	67 (9)	60 (17)
Marasmius spp.	33 (1)	60 (8)
Mycena sp.	33 (1)	20 (1)
Omphalina sp. B	33 (1)	20 (1)
Strophariaceae spp.	33 (1)	20 (1)
Aleuria rhenana		20 (1)
Rhodocollybia butyracea		20 (1)
Cystoderma muscicola		20 (1)
Gymnopus sp. A		20 (1)
Hygrocybe chlorophana		20 (1)
Omphalina sp. A		40 (4)
Number of sites	**3**	**5**
Total number of taxa	**7**	**12**

The rather restricted suite of macrofungi contrasts markedly with the much greater diversity of fruit bodies at generic and species level observed in nearby lower elevation forested areas (McMullan-Fisher unpubl.). Such vegetation is characterised by a diverse mycoflora including numerous species of *Cortinarius*, *Lactarius*, *Russula* and members of the Boletales (among ectomycorrhizal fungi) and *Mycena*, Poriales and Stereales (among saprotrophs). Numerous species in these and other genera that have been recorded from nearby forests on Mt Wellington, Mt Field and on the Central Plateau (McMullan-Fisher unpubl., Ratkowsky & Gates 2002) were not observed on the alpine sites.

The Tasmanian alpine environment is climatically variable, with short periods of snow recorded from all months of the year. This absence of protective snow cover exposes the alpine heath community to the particularly harsh weather conditions common in alpine Tasmania (Kirkpatrick 1982, Kirkpatrick *et al.* 2002), which may limit the fruiting period of macrofungi. We observed that the alpine macrofungi often were morphologically deformed, probably due to these harsh growing conditions. The single taxon from Mt Field, *Omphalina* sp. C, was recorded during days of over 25°C, highlighting that some taxa may appear at any time. Ten of the taxa seen from Mt Wellington were recorded from the fortnightly short surveys. Some of these taxa seem periodically abundant, especially *H. peziziformis*, Discomycete sp. A and *Marasmius* sp. One day of intensive surveying of five of the ten Mt Wellington sites did yield five additional species (*Cystoderma muscicola*, *Gymnopus* sp. A, *Mycena epipterygia*, *Mycena* sp. and *Psilocybe* sp.) bringing the total taxa observed from Mt Wellington to seventeen. The use of frequent short surveys is one means of detecting peak fruiting times; then more intensive surveys can be carried out. Research into the climatic conditions that stimulate fruit body production would also assist in targeting surveys to times of high macrofungal abundance.

The alpine macrofungal mycota found to date is dominated by saprotrophs. It is likely that these fungi have an important role in decomposition in the alpine areas of Tasmania. The Central Plateau surveys gave a total of nine taxa, four of which had not been recorded in other areas, including two ectomycorrhizal taxa; *Laccaria* sp. B and *Inocybe* sp. The difference in sampling effort (three days only as compared with 22 days for Mt Wellington) means that the differences in the diversity are not statistically meaningful, but the distribution of ectomycorrhizal taxa is of interest. *Laccaria* is a distinctive genus in the field and readily confirmed from microscopic characters. While several species of *Laccaria*, including *Laccaria* sp. B, have been observed in forested areas of Mt Wellington, no fruit bodies were seen on the alpine sites on Mt Wellington despite the regular sampling. *Eucalyptus*, a common host of ectomycorrhizal fungi, was absent from all the alpine sites surveyed, but other potential host genera in the Myrtaceae (Brundrett 1999) and Asteraceae were present (Warcup 1990). Further observations are required on the associated plants of alpine ectomycorrhizal fungi. Once potential hosts have been identified, the variation in occurrence of associated fungi could be investigated across sites. *Aleuria* and *Entoloma* species may be ectomycorrhizal (Antibus *et al.* 1981, Hobbie *et* al 2001), and these genera also warrant further investigation as to their possible hosts. Laursen *et al.* (1997) found no evidence of ectomycorrhizal fungi on Macquarie Island, but this is most likely because this is a recently vegetated island, whilst Tasmania has been consistently vegetated throughout the Pleistocene.

The particularly slow growth of Tasmanian alpine vegetation and its relatively poor regenerative capacity (Bridle *et al.* 2001, Kirkpatrick & Dickinson 1984, Kirkpatrick *et al.* 2002), means that, as far as their vascular plant communities, areas burnt in 1947 and 1962 are still easily distinguished more than thirty-years after fire. The cover of substrates relevant to macrofungi (such as litter and wood) is similar for sites of different fire history, with the exception of *Orites acicularis* leaf litter and total wood. However, we have presented no strong evidence for a distinct suite of fungi in each age class. Although the species richness was higher on sites burnt in 1962 (12 taxa compared with seven on 1947 sites), the differences between the two age classes could be explained by the greater number of 1962 burn sites, especially since many of the taxa were observed only once.

Of the macrofungi that could be named in the alpine sites, *H. peziziformis*, *Rhodocollybia butyracea*, *Mycena epipterygia* and *Laccaria* sp. B are common in other vegetation communities in Tasmania and mainland Australia, while *Aleuria rhenana* and *Cystoderma muscicola* are less common but also widely distributed (May unpubl.). Only *Hygrocybe chlorophana* has been previously recorded from alpine Australia. This species is known only from alpine heath in Kosciuzsko National Park (Young & Wood 1997: as *Hygrocybe flavescens*; Young 2000). The only other agarics reported from alpine Australia are two species of *Galerina* (Wood 2001), but no species of this genus were recorded in the present study. *Omphalina* sp. A, distinguished by its short, robust habit and dark brown/grey colour, was always found on cushion plants, which have an alpine distribution. This taxon has not been observed elsewhere, and because of the association with cushion plants, may also be restricted to alpine sites.

The suite of Tasmanian alpine macrofungi is broadly similar to that recorded in the northern hemisphere, although with some notable absences. Species of *Cystoderma*, *Entoloma*, *Omphalina* and *Laccaria* are common in montane areas in the northern hemisphere (Cripps 2002, Horak 1993, Watling 1987). Although two taxa of *Entoloma* were found from Mt Wellington and the Central Plateau, this is relatively low species richness when considering the 22 *Entoloma* species recorded from the Swiss Alpine National Park (Horak 1993). Taxa commonly reported from northern hemisphere alpine areas which have not been recorded from the Tasmanian alpine zone are members of the Bolbitiaceae, Cortinariaceae and Russulales, (Ammirati & Laursen 1982,

Bendiksen *et al.* 1993, Borgen 1998, Fenner & Landa 1993, Lamoure 1987, Watling 1987), which are often associated with alpine *Salix* (Moser 1982, Senn-Irlet 1993).

The taxa recorded in this study demonstrate for the first time that macrofungi do occur in alpine Tasmania. Although the frequency and intensity of surveys in this study were limited, there were notable absences of numerous species common in nearby forests. Alpine specific surveys of greater frequency, intensity and geographic area are needed to increase the limited understanding of macrofungi in this climatic zone. The species recorded provide a basis for further surveys. It is to be hoped that future taxonomic revisions will include material collected from alpine sites, such as from the present study. Such revisions may identify further specific alpine macrofungi.

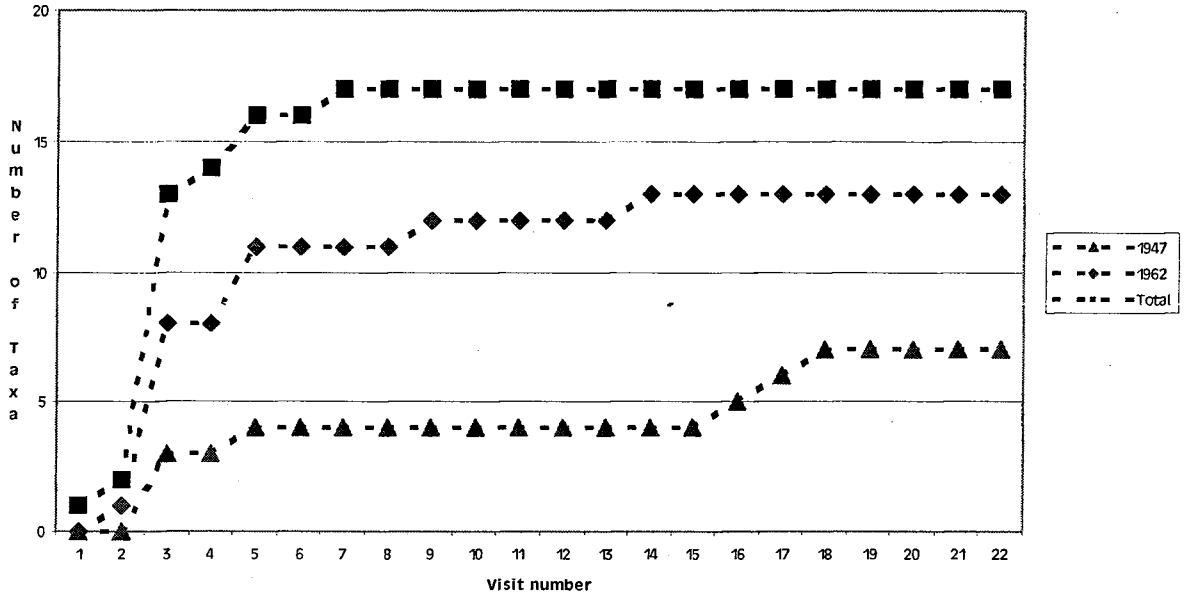

Figure 4. Species accumulation curve for repeated visits to Mt Wellington permanent sites. Burnt in 1947, burnt in 1962, total taxa observed from the alpine area of Mt Wellington.

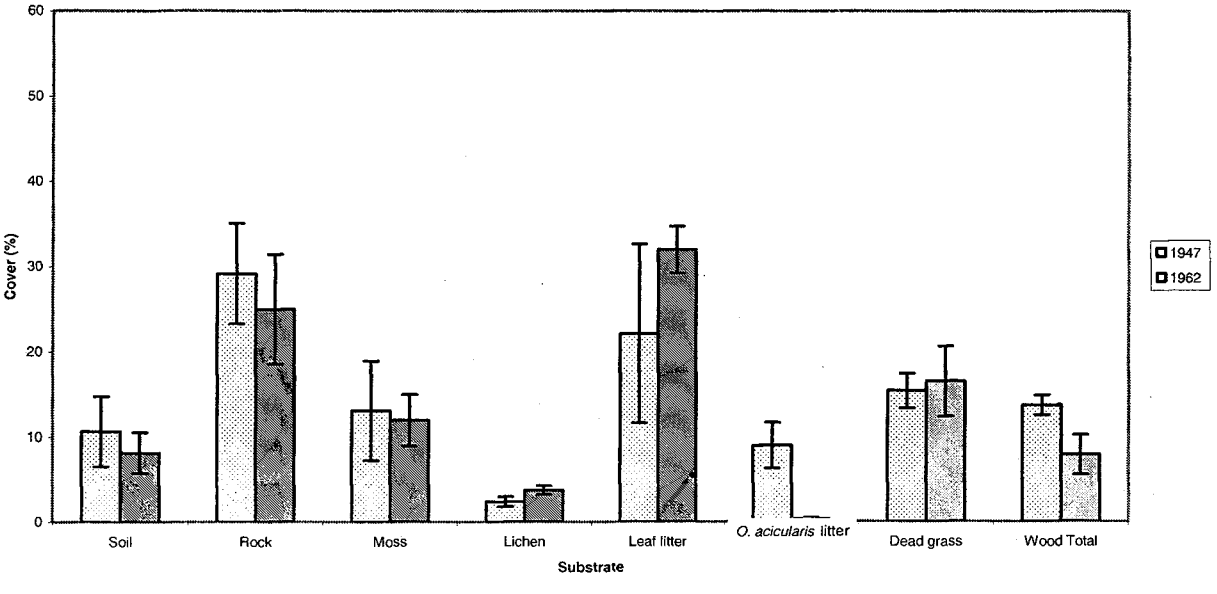

Figure 5. Comparison of substrate cover between 1947 and 1962 age class sites (averaged for each site using mid-point value for Braun-Blanquet cover classes, with standard error bars).

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