THE EFFECT OF WILDFIRE ON THE FRUITING OF MACROFUNGI IN REGROWTH KARRI FORESTS

SPP 98/0015 Progress report: Results from the first year of monitoring

by

RICHARD M. ROBINSON

Department of Conservation and Land Management
CALMScience Division
Manjimup, WA

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Cortinarius rotundisporus

Mycena sp.

Amanita xanthocephala

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SUMMARY

On Christmas Day, 1997, a wildfire swept through a large tract of 20-25-year-old karri regrowth forest in the south-west of Western Australia. Immediately following this fire, plots were established in the burnt stands and in similarly aged unburnt stands. During 1988 the number and species of fungal fruitbodies occurring in the plots were recorded. Results showed a distinct mycoflora fruited on recently burnt sites. A total of 226 species were recorded in this, the first year of the study. Eighty nine species were recorded on the burnt and 149 on the unburnt plots . Nine species were recorded on both burnt and unburnt plots. Species diversity was at its maximum in the autumn, and fruitbody production peaked in both autumn and spring on the burnt plots and in the autumn on the unburnt plots.

On the burnt sites, *Polyporus mylittae*, *P. tumulus* and *Neolentinus dactyloides*, responded by developing large fruitbodies from subterranean sclerotia within days following the fire. Ascomycetes then dominated the fruiting on the burnt plots. Several species of *Peziza* and several Discomycetes, including *Peziza tenacella* and *Anthrocobia muelleri*, fruited in large numbers in the autumn and spring. A mass fruiting of *Morchella elata* also occurred in the spring.

The high species diversity recorded on the unburnt plots can be attributed to litter decaying fungi. For example, 27 species of *Mycena* were (tentatively) recorded fruiting on leaf and twig litter. In addition several common genera of mycorrhizal fungi, including 10 species of *Cortinarius* and 7 species of *Russula*, recorded on the unburnt plots were not present on the burnt plots.

INTRODUCTION

In forest ecosystems fungi play important roles in the decomposition of organic matter and nutrient cycling, and many species form intimate and essential associations with the roots of forest plants (mycorrhiza). At present very little is known regarding the fungal flora of karri regrowth forests and the role these fungi play in ecosystem sustainability. Any changes in species composition mediated by fire may well impact on the rehabilitation of burnt sites.

Despite early observations that many species of soil fungi occur only on burnt ground (Seaver 1909, Seaver and Clark 1910), the influence of fire on fungal communities has largely been overlooked in favour of effects on the vascular flora and vertebrates. Seaver (1909) coined the term "pyrophilous" to describe fungi which are stimulated to fruit by fire. Studies from the Northern hemisphere (Jarmie and Rogers 1996, Penttilä and Kotiranta 1996) show that the species of fungi evident immediately after fire and over time following fire, change. In a retrospective study on the effects of fire history on larger soil fungi in the jarrah forests near Denmark in Western Australia, Syme *et al.* (1997) found that 48.5% of species found on previously burnt sites and 38.9% of the species found on the "unburnt" site (28 years since burnt) were unique to those sites. However, no quantitative studies, either retrospective or longitudinal, concerning the effects of fire on fungal communities has been undertaken in the karri forests (regrowth or mature) in the south-west of Western Australia.

To determine fire mediated differences in the fungal flora of regrowth karri forests, a study was undertaken to compare over time the fungal flora on burnt sites with that on unburnt sites within karri regrowth stands. The project will also be used to identify fungal species and contribute to the database of fungi found in karri forests.

METHODS

Site Selection

Following a wildfire on Christmas Day, 1997, sites were chosen in burnt and unburnt karri regrowth (Table 1). At each site 4 plots, 5m x 5m, were installed. On the burnt sites, *N. dactyloides* was fruiting in large numbers and within the 4 plots, 2 contained fruit of *N. dactyloides,* the remaining 2 were free of any fungal fruitbodies. To eliminate a bias towards either wood or soil inhabiting fungi, on both burnt and unburnt sites, two plots contained fallen woody debris in the form of logs and the other two were installed on either bare ground (burnt) or contained no large fallen woody debris (unburnt). Plot edges were oriented N-S and E-W. The location of trees and large woody debris was mapped for each plot. Sites were chosen, plots installed and the survey commenced within one month of the fire. In February 1999, site types for the plots were assessed based on the newly established and resprouting flora on the burnt sites and on already established flora on the unburnt sites (Table 1).

Plot Monitoring and Specimen Collection

Initially plots were visited on a monthly basis. When the fruiting season began (late April) they were visited every two weeks until the end of the fruiting season (late

Table 1. Characteristics of sites chosen for fungal survey following wildfire in karri regrowth.

Site Number	Site Locations		Year of Regeneration	Plot Numbers	Community Type[1]
	Burnt	Unburnt			
1	Curtin 1		1979	1-4	Stewart
2	Curtin 2		1979	5-8	Stewart
3	Gobblecannup		1979	9-12	Stewart
4	Flybrook		1972	13-18	Beggs
5	June Rd 1		1978	19-22	Stewart
6	Landing Rd		1977	23-26	McNamara
7		Cripple Rd 1	1981	1-4	Stewart
8		Cripple Rd 2	1980	5-8	Shea/Stoate/ White
9		June Rd 2	1978	9-12	Beggs/White
10		Wallace Rd	1981	13-16	Beggs
11		Lockyer Rd	1980	17-20	Beggs/Annels
12		Flybrook	1978	21-24	Shea

[1] Community type is based on the floristic attributes of Inions *et al*. (1990). NB. Stewart, Beggs and McNamara community types belong to Community-Group 3, which occurs on drier sites with low summer rainfall, high radiation all year and soils with low P levels.

August). Monthly visits were then resumed. Restrictions on time and personnel prevented more frequent visits and after May 22, the sites had to be reduced to 4 burnt and 4 unburnt. The sites which were not monitored after May 22 were Curtin 1, Curtin 2, Cripple Rd 1 and Wallace Rd. It is planned to continue monitoring these sites in 1999. At each site, the number of fruitbodies, the species and the location within each plot was recorded. Voucher specimens were photographed in the field (or later in the laboratory), collected and lodged at the Tony Annels Herbarium (CALM, Manjimup). Spore prints were taken and descriptions compiled for species of unknown or uncertain identity. Identification of species is continuing, however, many will be undescribed and as such will only be given a “field identification”.

RESULTS AND DISCUSSION

Throughout the collecting period in 1998, 226 species of fungi were collected. Of these 89 species (which produced 9,287 fruitbodies) were recorded on the burnt plots and 149 species (which produced 4,292 fruitbodies) on the unburnt plots. A species list and numbers recorded are presented in Appendix 1. Twenty eight species are illustrated with photographs in Appendix 2[1]. Nine species occurred on both burnt and unburnt plots (Appendix 1). Many of the species are as yet unidentified and possibly undescribed. As taxonomic studies continue these numbers may change. Figures 1 and 2 show the distribution of species and fruitbody formation throughout the year.

On the burnt sites, the number of species peaked in early-May and gradually declined through the rest of the year (Fig. 1). Fruitbody production was high immediately after the fire and peaked in the period May to April and again in mid-September (Fig. 2). On the unburnt sites, The maximum number of species was recorded in mid-May to

[1] These species are illustrated in order of reference within the text and denoted by an asterix (*).

early-June and then gradually declined through the rest of the year (Fig. 1). Fruitbody production peaked in June and following a gradual decline a small peak was experienced in September (Fig. 2). Fruitbody production in the spring on unburnt sites coincided with a reduction in the number of species recorded, however, on the burnt sites the spring peak equalled the autumn peak despite a 66% reduction (from 32 to 11) in the number of species recorded.

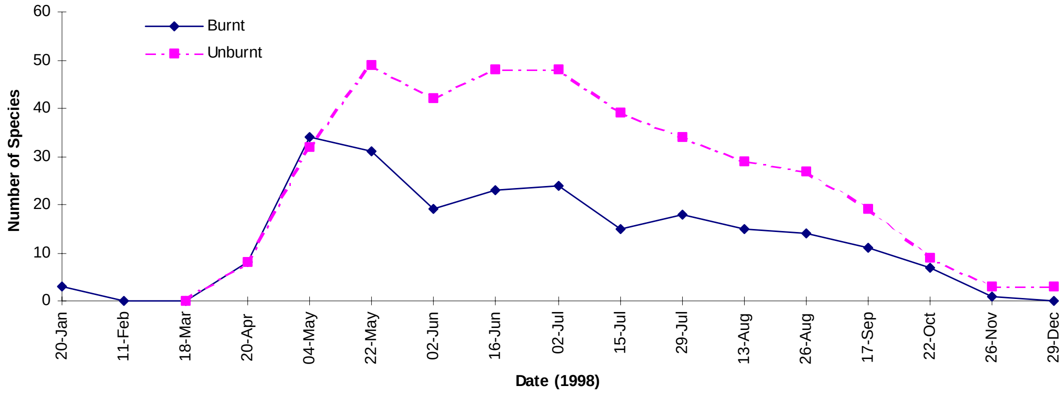

Figure 1. The number of fungal species recorded in burnt and unburnt karri regrowth plots in 1998.

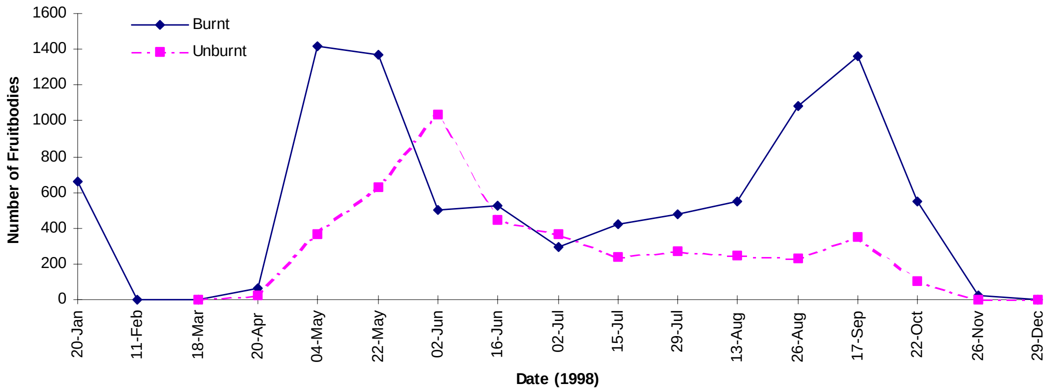

Figure 2. The number of fungal fruitbodies recorded in burnt and unburnt karri regrowth plots in 1998.

Figure 3 shows the rainfall registered at Manjimup (CALM), Pemberton (CALM) and Shannon (WA Bureau of Meteorology). These three centres are located around the perimeter of the study area. Figure 4 shows the soil dryness index (SDI) for Manjimup on each collection date for 1998. The SDI was calculated as per Burrows (1987). The late summer-early autumn rainfall event initiated an increase in soil moisture in the study area. The initial flush of fungi, some 4-6 weeks later in April-May, coincided with the rising winter rainfall. The peak in fruitbody production in September coincided with the peak rainfall period for the area (Fig 3). Both fruitbody production and rainfall rapidly declined in the October-November period coinciding with an increase in the SDI.

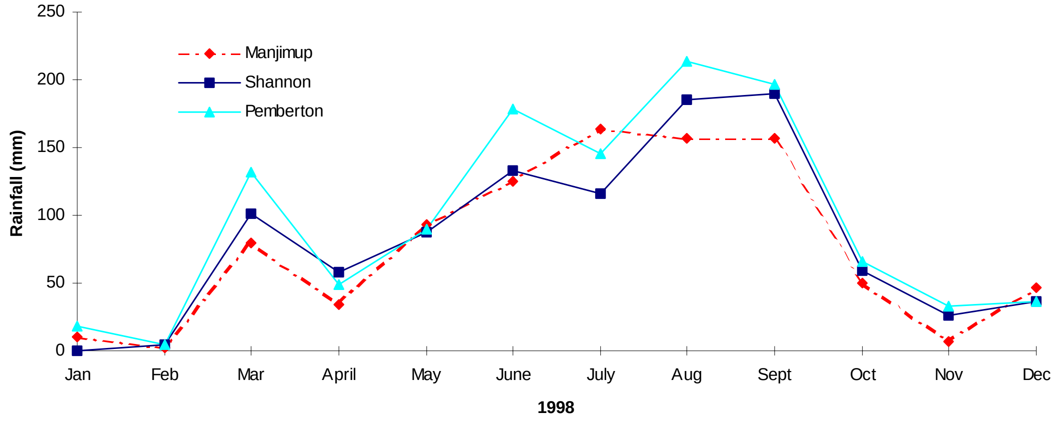

Figure 3. The monthly average rainfall registered in 1998 at Manjimup, Pemberton and Shannon.

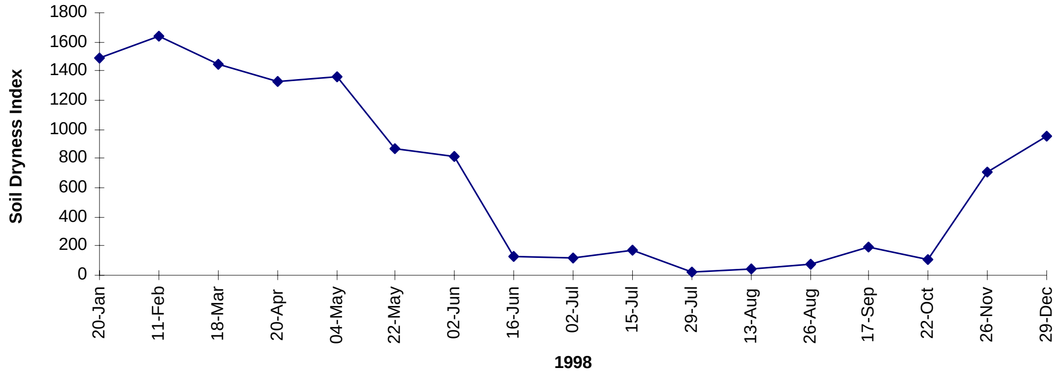

Figure 4. The soil dryness index for Manjimup on each collection date for 1998.

Within a week of the fire, common on all burnt sites were several species of "subterranean wood rotting" fungi which appear to fruit only after fire. Three such species, *Polyporus mylittae*[*], *P. tumulosus*[*] and *Neolentinus dactyloides*[*], form large underground sclerotial structures. These structures appear to be a nutrient source for the production of fruitbodies (Macfarlane 1975) and may be an adaptation to fire (Wills 1983). *Polyporus tumulosus* has been associated with the rot of fallen jarrah and possibly karri logs (Wills 1983), *N. dactyloides* has been associated with the rot of karri railway sleepers (Cleland 1935) and *P. mylittae* is thought to be saprophytic on karri (Macfarlane 1975) and is constantly found fruiting along side and in ash beds left from burnt karri logs (Robinson unpubl.). None of these fungi have been reported fruiting on decaying logs above the ground, however, all fruit prolifically from sclerotia within the soil below where decaying logs have been burnt away during wildfire. This lends weight to the theory that the sclerotia may be an adaptation, similar to lignotuber formation in eucalypts and other plant species in fire-prone environments, to survive fire. The mechanism triggering fruiting is not known, however, it is likely related to the fire itself. *Polyporus tumulosus* can produce large clusters of fruitbodies within 2-3 days following fire (Robinson unpubl.) when summer temperatures are high, soil moisture is extremely low and before any rain fall.

While still fresh, the fruitbodies of *N. dactyloides* were heavily grazed on some sites. Kangaroo tracks were clearly evident in ash beds and on blackened soil. Many caps had been chewed around the margin leaving only the stem protruding from the soil.

A fourth species, *Polyporus sclerotinus*[*], which fruits from small (2-3 cm diameter) sclerotia, was also found to be common on the burnt sites. *P. sclerotinus* began fruiting in mid Autumn and persisted in low numbers until the spring (Fig. 5). It is not known whether this species is associated with wood decay.

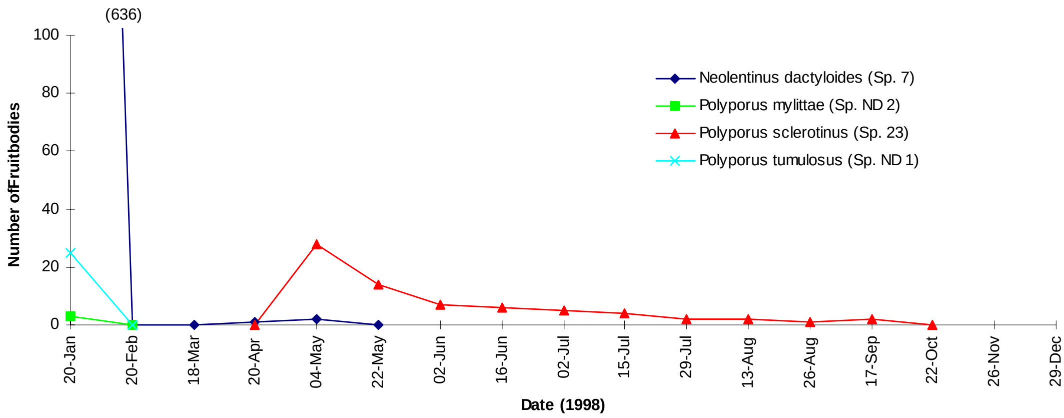

Figure 5. The number of fruitbodies produced by sclerotial fungi recorded in burnt karri regrowth plots in 1998.

Fruiting by pyrophilous fungi may be related to soil pH. Many species of Dicsomycetes and Basidiomycetes which fruit on burnt ground are favoured by, or at least tolerate, alkaline conditions (Warcup 1981). Following a fire, species of fungi will change over time as the pH varies from alkaline soon after the fire to a more acidic condition as the ash minerals leach out (Warcup 1981). Following the initial response from the subterranean sclerotial fungi, species of Ascomycetes belonging to the Pezizales were most common (Fig. 6). *Peziza* spp. and Discomycetes such as *Anthracobia* and *Pulvinula* spp. have been recorded elsewhere as being prolific following fire (Jarmie and Rogers 1996, Warcup 1981, 1990). In this study the species responsible for the peaks in fruit body production were *Peziza tenacella*[*] (Species 21) and Species 22[*] (Peziza "light brown") in the autumn and Species 88 (Disc fungi "orange, 3 mm"), and 196[*] (Peziza "black-brown, tangled hairs) in late winter-early spring (Fig 6). The double peak shown by Species 88 in figure 6 is probably due to two species being recorded as one. The small peak in autumn is most likely due to *Anthocobia muelleri*[*], while the large peak in late winter-early spring may be due to a morphologically similar *Pulvinula* sp.[*] Such situations will become clearer as taxonomic investigation and data analyses continues. Species belonging to the Pezizales may be either mycorrhizal or saprophytic. Warcup (1990) demonstrated the ability of three pyrophilous discomycetes, collected following a wildfire in South Australia, to form mycorrhiza on *Eucalyptus obliqua* and *Melaleuca uncinata*.

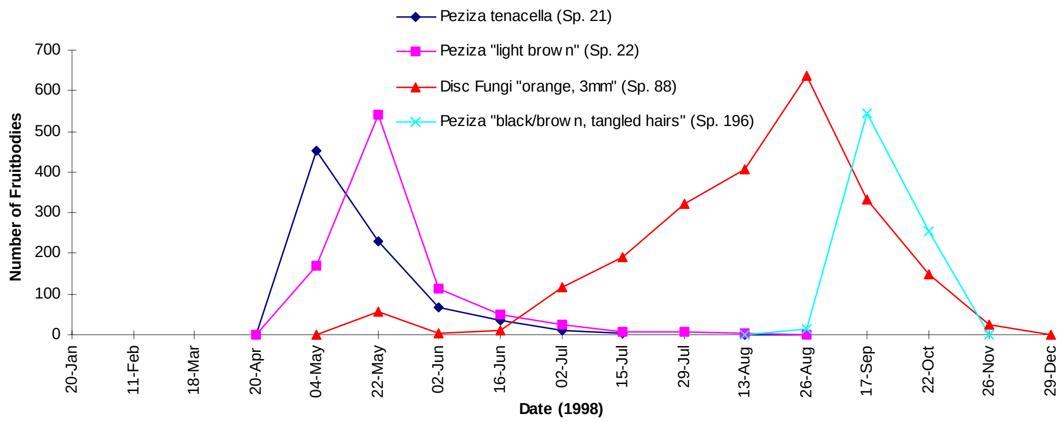

Figure 6. The number of fungal fruitbodies produced by pyrophilous Ascomycetes in burnt karri regrowth plots in 1998.

Morchella elata[*] (Species 181) was found fruiting in abundance in the burnt plots during early spring (Fig. 7). *Morchella* spp. belong to a group of Ascomycetes commonly referred to as morels, which are highly regarded as culinary delicacies throughout the world. *Morchella elata* can be locally abundant in eucalypt forests following wildfire (Warcup 1981, Bougher and Syme 1998), fruiting from resting sclerotia in the soil (Volk 1991). When morels fruit following a bushfire, spores are released and germinate in the soil to form mycelia and then form sclerotia. Sclerotia may be up to 5 cm in diameter and are composed of large thick-walled cells which allow it to survive adverse conditions (Volk 1991). In the spring the sclerotium will either germinate to form new mycelium or produce a fruitbody. Generally, however, the fungus will exist in the soil in the sclerotial stage or cycle between sclerotial and mycelial stages and will not fruit again until stimulated by the next fire (Volk 1991).

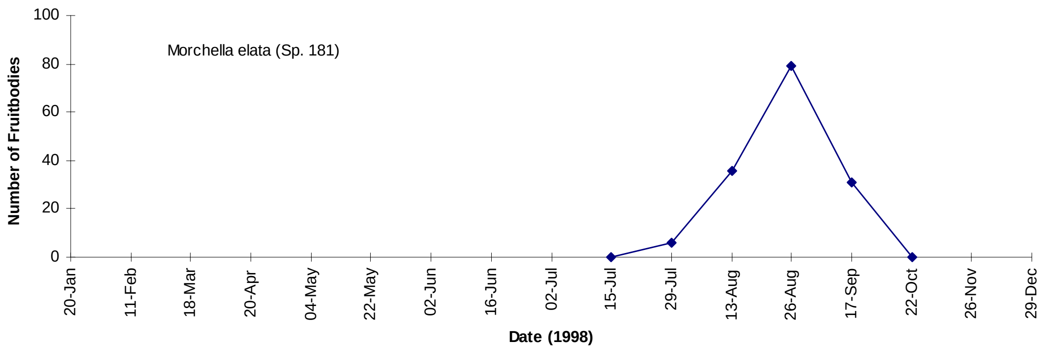

Figure 7. The number of *Morchella elata* fruitbodies recorded in burnt karri regrowth plots in 1998.

Several species of gilled Basidiomycetes (commonly referred to as agarics) fruited in large numbers in the burnt plots (Fig. 8). *Coprinus* aff. *domesticus*[*] (Species 72) belongs to a group of cosmopolitan species which are saprophytic. It fruited in large numbers on small burnt stumps and on the surrounding soil. Several other species of *Coprinus* were also collected from the burnt plots (see Appendix 1). Macroscopically Species 73 and 74 are very similar to *C.* aff. *domesticus* except they were somewhat larger. Species 182 also had a larger cap than *C.* aff. *domesticus*, which was totally covered with a light brown scaly meal.

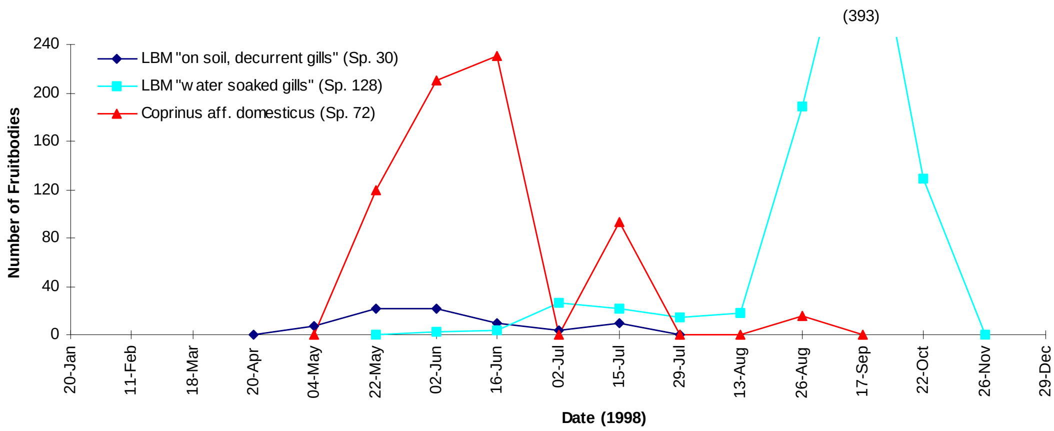

Figure 8. The number of fruitbodies produced by several species of agarics recorded in burnt karri regrowth plots in 1998.

Small, brown, inconspicuous mushrooms are often referred to as LBM's (little brown mushrooms). Two such species fruited continually through the winter in the burnt plots (Fig. 8). Species 30* (LBM, "on soil, decurrent gills") fruited in low numbers, while Species 128* (LBM, "water soaked gills") fruited in low numbers through the winter then suddenly produced a large flush to peak in the spring. It is interesting to note that as the fruiting season progressed the size of the fruitbodies of Species 128 gradually increased from 9-14 mm diameter in June to 48 mm in August. Both Species 30 and Species 128 were found fruiting singly or gregarious on bare soil. Tentative identification of Species 128 suggests it may be a species of *Inocybe*. Species of *Inocybe* are mycorrhizal.

Other species worth noting which fruited in the burnt plots were several species of coprophilous (growing on dung) fungi and a species of *Ramaria*. These included *Psilocybe coprophila* (Species 65) which was found on kangaroo scats in low numbers from May to September, and Species 33 a small lemon-yellow Discomycete which fruited profusely on emu dung in one plot in May. Species of *Ramaria*, commonly referred to as Coral Fungi, are very common in eucalypt forests and woodlands. Species 43 (*Ramaria* "light yellow-brown") fruited from May to July in the burnt plots. Species of *Ramaria* are mycorrhizal.

Species of Hypogean fungi are an important part of the diet of several species of mammals (Christensen 1980, Claridge *et al.* 1996) and several authors have suggested that their fruiting may be stimulated by fire (Cleland 1934, Christensen 1980, Taylor 1991, 1992). Although no digging or other disturbance was undertaken, 29 fruitbodies of *Mesophellia* sp.* (Species 129) were recorded in the burnt plots. However, there is no direct evidence to suggest that the fruiting of hypogeous fungi is stimulated by fire. Claridge (1992) suggests that fire is likely to be deleterious to most hypogeous fungi which fruit just under the soil surface or at the litter-soil interface. It has also be shown that hypogean fungi, including *Mesophellia* spp., do not need fire to fruit in large numbers (Claridge *et al.* 1993, Johnson 1994). It is more likely that the *Mesophellia* fruitbodies found in this study survived the fire, aided by their hard, soil encrusted outer layer, and were exposed after the litter and a shallow covering of soil was removed by the fire and subsequent rain. Immediately following the fire there was an increased level of digging activity by animals, which appeared to last for several weeks. Dell *et al.* (1990) suggest that *Mesophellia* fruitbodies take several months to mature, therefore the animals were most likely digging for fruitbodies which had already developed and more easily found once the litter had been removed by the fire.

Cortinarius is a genus with a very large number of species (most as yet undescribed in Australia). Cortinars are very common and ecologically important because many are mycorrhizal on the roots of eucalypts. Ten species of *Cortinarius* were recorded fruiting in the unburnt plots (Appendix 1). Of these species, *C. (Myxacium) rotundisporus* (Species 173, illustrated on cover) is of interest because it is believed to have originated as either an obligate or facultative ectomycorrhizal fungus in *Eucalyptus-Leptospermum* forests (Horak and Wood 1990) which began their development during the Tertiary (see Christensen 1992, p.47). However, it is not known if the present myrtaceous mycoflora represents adapted strains of species which successfully completed a host change from *Nothofagus* (Horak 1983).

The genera of agarics producing the most fruitbodies on the unburnt plots were *Mycena* (27 species, 492 fruitbodies) and *Marasmius* (6 species, 1331 fruitbodies). Both are saprophytic. *Mycena* comprises a very large number of species of very small to small mushrooms usually with a conical to bell-shaped cap. They are fragile, often fruiting in troops in the litter or in caespitose clusters on wood. Figure 9 shows the four most common species of *Mycena* recorded. All are saprophytic on leaves or small twigs and all had peak fruiting during the wet winter months. *M.* aff. *rorida*[*] (Species 109) fruited on rotting leaves and was easily recognised by a thick glutinous coating on the stem. *Mycena alcalina* (Species 50) also fruited on leaves and was distinguished by its faint bleach odour. Species 9 ("tiny white/yellow stem") was one of several minute, white species of *Mycena* found fruiting on small twigs and leaves. It was recognised by its small (2-4 mm diam.) white cap and long thin yellow stem. Species 153 (*Mycena* sp. "buff umbrella", illustrated on cover) was distinguished by its distinctive light-brown, umbrella-like cap fruiting in small groups on leaves and twigs. Other species such as *M. subgalericulata* (Species 147) were found fruiting in clusters on wood and understorey stumps such as *Acacia europhylla*. Several species of *Mycena* also fruited in low numbers on the burnt plots (Appendix 1).

Figure 10 shows the fruiting pattern of three species of *Marasmius*. *Marasmius elegans*[*] (Species 28) fruited on the ground in well rotted leaf litter, *M. crinisequi*[*] (Species 27) fruited only on dead eucalypt leaves. *M. crinisequi* is commonly referred to as the horsehair fungus and is recognised by its very small (3 mm) grey cap atop a long (to 10 mm) thin horsehair-like stem. It frequently produces hair-like rhizomorphs which form tangled masses in the litter. Careful examination reveals minute caps on the tips of some rhizomorphs. Species 80 ("white wheels") was found fruiting on thin strips of karri bark either on the ground or hanging from near the base of trees. Like the *Mycenas*, species of *Marasmius* displayed their peak fruiting in the wet winter months. Species of *Marasmius* can be generally recognised by their tough texture and often hair-like stem. In addition, some have the ability to be revived by rain after they have dried and shrivelled. This may explain the continued low numbers of *M. crinisequi* recorded well into the spring.

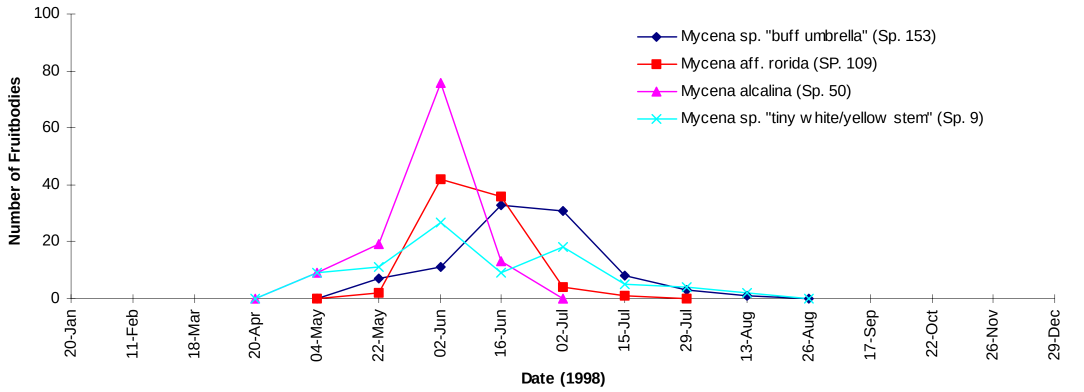

Figure 9. The number of fruitbodies produced by selected species of *Mycena* recorded in unburnt karri regrowth plots in 1998.

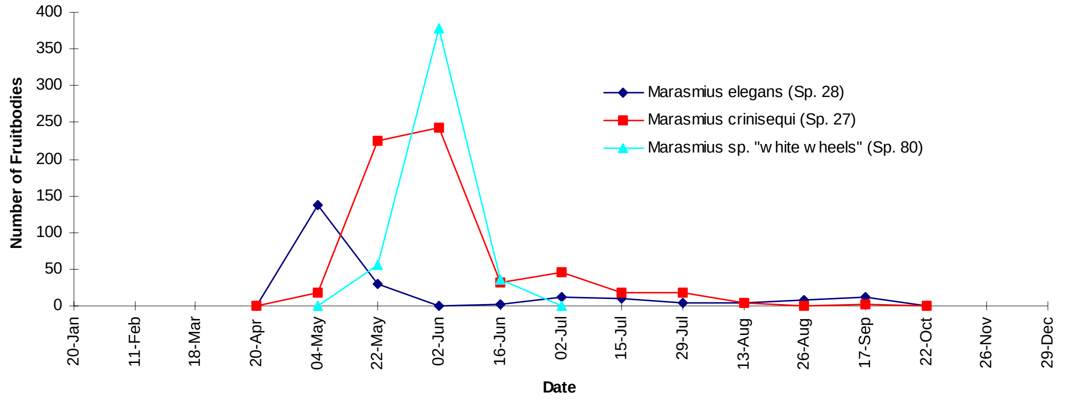

Figure 10. The number of fruitbodies produced by species of *Marasmius* recorded in unburnt karri regrowth plots in 1998.

Species of fungi in the Clavariaceae are commonly referred to as Coral and Club Fungi. They are either mycorrhizal or saprophytic. In the unburnt plots, coral- and club-shaped fungi fruited constantly in the period May to September (Fig. 11). The most common being species of *Clavulinopsis* and *Clavulina*. *Clavulinopsis aurantia** (Species 114) and *Clavulinopsis* sp. (Species 113 “white clubs”) form simple club-shaped fruitbodies. *Clavulina amethystina** (Species 96) and *Clavulina* sp.* (Species 95 “pink-buff”) form multi-branched fruitbodies which closely resemble small *Ramaria* fruitbodies. Species of *Ramaria* are generally multi-branched but arise from a common base. Many species of Coral Fungi have a very similar morphology and microscopic characters are used to distinguish some genera.

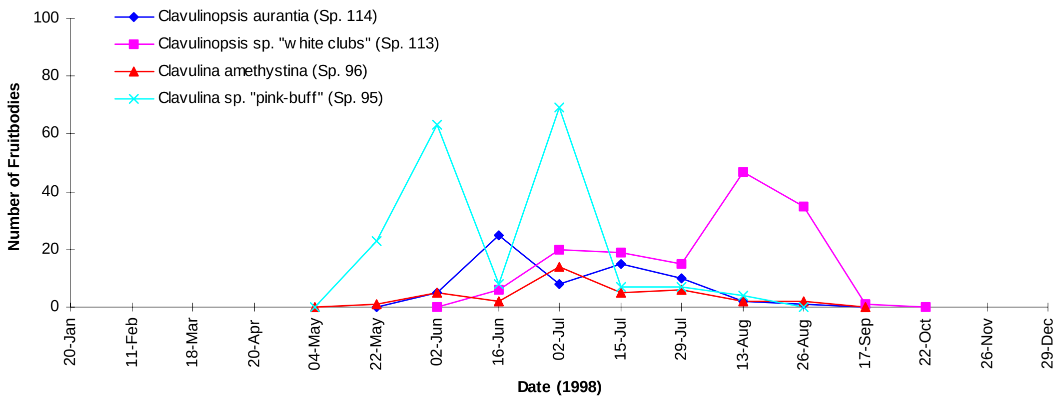

Figure 11. The number of fruitbodies produced by species of Coral and Club fungi recorded in unburnt karri regrowth plots in 1998.

A range of Ascomycetes were also recorded in the unburnt plots. Figure 12 shows the fruiting pattern in a selection of very diverse species. *Geoglossum* sp.* (Species 166) has a very distinct black spear-shaped fruitbody. It is easily recognised by its black colour and enlarged "head". Species of Geoglossum are saprophytic on humus, soil, moss or sometimes rotten wood. Several species of saprophytic Cup Fungi were also recorded fruiting on rotten wood, soil, and leaf and twig litter. Species 51* has a small (5 mm diam.), black disc-shaped cap with a slender stem buried into its substrate, a well rotted log. Species 189* ("small brown hairy cup") has a small, brown cup-shaped fruitbody with a stout stem extending into the soil. The outer surface has a dense covering of short white hairs. It fruited *en masse* on bare soil. *Plectania* sp.* (Species 190) has a very distinct black, cup-shaped fruitbody. When immature it resembles a decaying karri capsule. When mature the cap expands to reach a size of 25 mm diam. It is attached to its substrate, leaf and twig litter, by a well formed network of mycelial threads extending from the base of the "cup" well into the litter. *Plectania* sp. fruits either singly or in clusters of up to 10 or more individuals.

Nine species of fungi were recorded on both the burnt and unburnt plots (Table 2). In addition, one specimen of *Morchella elata* was collected from within a fire break adjacent the unburnt site at Lockyer Road. These species represent a range of mycorrhizal (*Amanita xanthocephala** and *Tricholoma eucalypticum**), coprophilous (*Psilocybe coprophila**) and saprophytic on soil (*Entoloma* sp. and *Macrolepiota konradii**), wood (*Hypholoma australe*, *Tubaria rufofulva* and Species 51 (Discomycete "black stalked")) and bark (Species 92 (LBM)) fungi. *P. coprophila* was recorded fruiting on kangaroo droppings. The high number of specimens recorded in the burnt plots is likely due to higher numbers of kangaroos coming into the burnt sites to graze on the new sprouts and shoots resulting from the fire. Only one specimen was found in the unburnt plots.

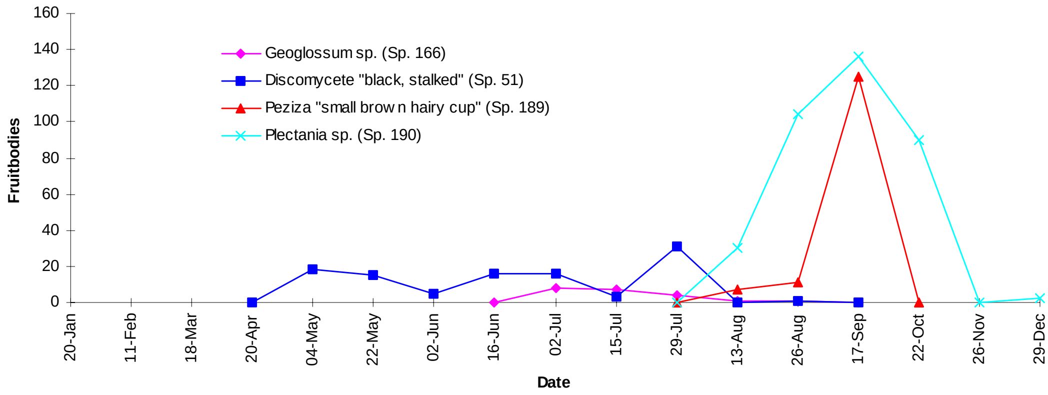

Figure 12. The number of fruitbodies produced by species of Ascomycete fungi in unburnt karri regrowth plots in 1998.

Table 2. Species of fungi fruiting in both burnt and unburnt karri regrowth plots in 1998.

ID #	Fungus Species	Nº of Fruitbodies Burnt	Nº of Fruitbodies Unburnt
ND 6	*Amanita Xanthocephala*	10	2
167	*Entoloma* sp. "dark brown-black/pink-buff/olive-grey, shiny"	1	2
ND 28	*Hypholoma australe*	8	33
92	LBM "karri bark 4, free rim"	3	59
ND 13	*Macrolepiota konradii*	1	2
65	*Psilocybe coprophila* "on 'roo dung"	26	1
101(131)	*Tricholoma eucalypticum*	20	30
ND 23	*Tubaria rufofulva*	3	18
51	Discomycete "black, stalked"	15	105

Figure 13 shows the fruiting pattern of the two mycorrhizal species, *A. xanthocephala* and *T. eucalypticum*. Both are quite common species in eucalypt forests and woodlands. Initially the *Tricholoma* was thought to be two species, *T. eucalypticum* fruiting on the unburnt sites (Species 101) and *Tricholoma* sp. on the burnt sites (Species 131). On the unburnt site *T. eucalypticum* fruited in deep litter. The cap was viscid and rarely extended above the litter layer, with the stem extending 10-15 mm into the soil. In contrast, on the burnt site the cap appeared to begin expanding below ground level, pushing its way through the soil, rarely emerging more than 10-15 mm above the soil level. The cap appeared to be dry with adhering soil on the surface. The stem extended up to 50 mm into the soil. More detailed examination showed that the species on the burnt sites in fact had a viscid cap, which had dried and was likely the reason for the adhered soil. It was microscopically the same as *T. eucalypticum* found on the unburnt sites. *A. xanthocephala* is widespread in southern Australia. It has been reported as being common in urban bushland in WA (Bougher and Syme 1997), however, in this study it was more common on the burnt sites where it fruited from May-July.

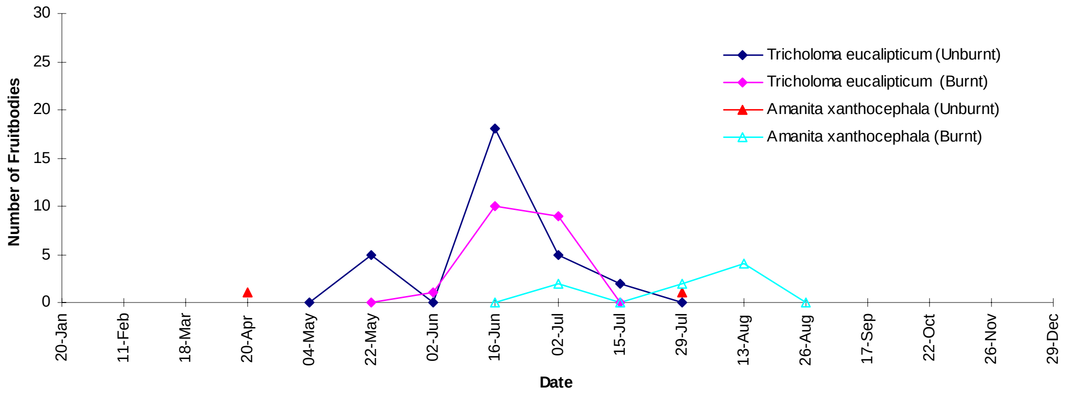

Figure 13. The fruiting pattern of *Amanita xanthocephala* and *Tricholoma eucalypticum* on burnt and unburnt karri regrowth plots in 1998.

CONCLUSION

Two hundred and twenty six (tentative) species of fungi were collected in 1988. Species diversity was higher on the unburnt sites, however, fruitbody production was higher on the burnt sites. Four to six weeks after a late summer rainfall event, the fruiting season coincided with an increase in rainfall from April to June. A second peak in fruitbody production in September coincided with the peak rainfall period for the year.

Species diversity on the burnt sites reached its peak in May, and was dominated by pyrophilous alkaline-loving Ascomycetes, such as *Peziza* spp. and several species of Discomycetes, which produced large numbers of fruitbodies. Despite a 66% decline in the number of species present in the plots in the spring, a second fruiting peak, again dominated by Ascomycetes including *Morchella elata*, was observed in September which equalled that experienced in the autumn. On the unburnt sites species diversity was highest in May and the maximum fruitbody production was observed in June. The higher number of species on the unburnt sites can be attributed to the presence of leaf and twig litter decay fungi, such as species of *Mycena* and *Marasmius*, mycorrhizal fungi, such as *Cortinarius* spp., and numerous species of Coral Fungi. Only nine species were recorded in both burnt and unburnt plots, with *Tricholoma eucalypticum* occurring in good numbers in both.

The data collected so far show there is a vast difference in the fungal population which inhabits recently burnt areas compared to that found in unburnt forest. The results agree with other studies and show that certain species of fungi only fruit after fire. However, the factors which trigger the fruiting have not been investigated. Several species of polypores fruit from pre-formed subterranean sclerotia. For most of the species which fruit after fire, however, it is not known whether they fruit from pre-existing mycelia in the soil of from newly germinated spores. Some pyrophilous species of Discomycetes can form mycorrhiza on the roots of eucalypts and *Melaleuca* and therefore may play an important role in the rehabilitation of burnt sites. With time the species composition on the burnt sites will change to resemble that of the unburnt site. Continual monitoring of these sites will allow the change to be documented. The results of this experiment highlight the effect events such as fire have on the fungal community. As fire is a forest management tool, the question of how quickly fungal communities in karri regrowth stands recover from fuel reduction and slash burning needs to be investigated. Penttilä and Kotiranta (1996) showed that the diversity and composition of wood decay fungi was considerably depleted in the first year following prescribed burning in a Norway spruce stand in Finland. Future research into the relationships between fungal ecology and forest management should be a priority.

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APPENDIX 1. Fungi collected, following a wildfire in Dec. 1997, from burnt and unburnt plots in karri regrowth in 1998.

ID #	Fungus Species	[1] Life Mode	Nº of Fruitbodies Burnt	Nº of Fruitbodies Unburnt
	BASIDIOMYCETES			
	AGARICS			
171	*Amanita* sp. "brown-grey/creamy white/creamy white"	M		4
52	*Amanita* sp. "grey-brown/white/white"	M		o/s (1)
ND 17	*Amanita* sp. "small white/white/white" (Flybrook Con 21, 6/5/98)	M		1
ND 44	*Amanita* sp. Unknown (Flybrook Con 23, 28/7/98)	M		1
ND 6	*Amanita Xanthocephala*	M	10	2
ND 3	*Anthracophyllum archeri*	S		79
ND 15	*Armillaria luteobubalina (*Flybrook Con 21, 6/5/98)	P		2
150	*Armillaria luteobubalina* ?	P	o/s (1)	
ND 26	*Cantharellus* aff. *cinnabarinus* var. *australiensis*	M?		73
185	*Clitocybe* sp.	S		1
ND 43	*Clitocybe* sp.? (June Rd Con 9, 29/7/98)	S		2
197	*Collybia/Marasmius* sp.	S		4
182	*Coprinus* sp.	S	57	
ND 20	*Coprinus* sp. "unknown" (Flybrook 17, 6/5/98)	S	6	
111	*Coprinus* sp. 2?	S	2	
72	*Coprinus* aff. *domesticus*	S	688	
74	*Coprinus* sp.2 "large"	S	24	
73	*Coprinus* sp.3 "medium"	S	121	
158	*Coprinus* sp.4	S	3	
173	*Cortinarius* (*Myxacium*) *rotundisporus*	M		1
138	*Cortinarius* sp.1 "purple hued Dermocybe"	M		9
140	*Cortinarius* sp.2 "light brown, red-brown centre"	M		4
143	*Cortinarius* sp.4 (*C. vinaceolamellatus*?) "purple hues"	M		6
162	*Cortinarius* sp.5	M		3
175	*Cortinarius* sp.6 "orange-brown viscid cap/white dry stem"	M		2
163	*Cortinarius* sp.7	M		2
179	*Cortinarius* sp.8 "covered with soil"	M	1	
	Cortinarius sp. (o'side Curtin 1, plot 4, 7/5/98)	M	o/s (1)	
ND 35	*Cortinarius* sp. (Cripple Con 5, 16/6/98)	M		1
ND 41	*Cortinarius* sp. (Cripple Con 8, 15/7/98)	M		1
ND 42	*Cortinarius* sp. Unidentified (Cripple Rd Con 6, 29/7/98)	M		1
122	*Crepidotus* sp. "buff caps on karri bark"	S		33
81	*Crepidotus* sp. "light yellow, tomentose"	S		25
184	*Crepidotus* sp. "white"	S		16
ND 24	*Crepidotus* sp. "br cap, br gills" (Lockyer Con 17, 20/5/98)	S		10
136	*Entoloma* sp.	S		7
180	*Entoloma* sp. "brown/pinkish-buff/dark brown"	S	2	
167	*Entoloma* sp. "dark brown-black/pink-buff/olive-grey, shiny"	S	1	2
183	*Entoloma* sp. "grey-brown/pinkish-brown/grey-brown"	S		o/s (6)
174	*Entoloma* sp. "silver-grey/creamy-pink/silver-grey"	S		2
ND 45	*Entoloma* sp. Unknown (Flybrook Plot 13, 28/7/98)	S	1	
ND 48	*Entoloma* sp. Unidentifiable (Cripple Rd Con 7, 13/8/98)	S		1
132	*Galerina* sp "small"	S		1

ID #	**Fungus Species**	**[1] Life Mode**	**Nº of Fruitbodies Burnt**	**Unburnt**
107	*Galerina* sp. (*G. unicolor*?)	S		8
104	Gilled Bracket "grey gill edges"	S		10
178	*Hydnum* aff. *repandum*	M		1
ND 19	*Hygrophorus conicus*	S		2
ND 28	*Hypholoma australe*	S	8	33
133	*Hypholoma* sp. "tomentose cap"	S		20
58	*Inocybe* sp.	M	6	
103	*Inocybe* sp. "brown scaly cap".	M		6
120	*Inocybe* sp.	M	4	
29	*Laccaria* sp	M	13	
67	*Laccaria* sp.	M	1	
155	*Laccaria* sp.	M		8
ND 9	Laccaria ? (Gobblecannup 10, 20/4/98)	M	2	
ND 10	Laccaria sp (Cripple 1, Con 2, 4/5/98)	M		1
ND 11	*Laccaria* sp. (Cripple 1 Con 3, 4/5/98)	M		1
6	*Lactarius* sp.	M		3
42	LBM	?	1	
89	LBM	?	1	
177	LBM "brown wooly cap/flesh coloured stem"	S	1	35
199	LBM "brown-buff/white/dark brown"	?	10	
16	LBM "karri bark 1"	S		11
85	LBM "karri bark 2"	S		86
47	LBM "karri bark 3"	S		68
92	LBM "karri bark 4, free rim"	S	3	59
125	LBM "Laccaria-like, on bark at base of karri tree"	S		2
164	LBM "olive gills"	S		239
30 (93,116)	LBM "on soil, decurrent gills"	?	73	
108	LBM "red gills"	S?		3
79	LBM "tomentose cap"	S		2
128	LBM (*Inocybe* sp) "water soaked gills"	M?	795	
165	LBM "white wooly cap/flesh coloured stem"	S		8
188	LBM (*Inocybe* sp?)	M?	4	
ND 49	LBM Unidentifiable (Flybrook Plot 16, 11/8/98)	?	1	
25 (3,17)	*Lepiota cristata*	S		12
ND 13	*Macrolepiota konradii*	S	1	2
27	*Marasmius crinisequi*	S		603
28	*Marasmius elegans*	S		215
19	*Marasmius* sp.	S		4
18	*Marasmius* sp. "orange-red"	S		37
80	*Marasmius* sp. "white wheels"	S		470
134	*Marasmius* sp? "brown velvet"	S		2
109 (118)	*Mycena* aff. *rorida*	S		85
50 (121)	*Mycena alcalina*	S		117
53 (119)	*Mycena pura*	S		7
ND 21	*Mycena sanguinolenta*	S		1
97	*Mycena* sp	S		2
4	*Mycena* sp.	S	32	
8	*Mycena* sp.	S	2	

APPENDIX 1....cont.

ID #	Fungus Species	[1] Life Mode	Nº of Fruitbodies Burnt	Unburnt
11	*Mycena* sp.	S		12
13	*Mycena* sp.	S		10
14	*Mycena* sp.	S		1
57	*Mycena* sp.	S	1	
115	*Mycena* sp.	S		4
124	*Mycena* sp.	S		3
135	*Mycena* sp.	S		1
157	*Mycena* sp.	S	2	
170	*Mycena* sp.	S	1	
186	*Mycena* sp.	S		1
87	*Mycena* sp.	S		1
105	*Mycena* sp.	S		5
151	*Mycena* sp.	S	2	
ND 39	*Mycena* sp. "brown, 3mm/smokey grey/light-dark brown" (Lockyer Rd Con 18, 2/7/98)	S		3
ND 27	*Mycena* sp. (Unidentifiables from all plots)	S	11	5
ND 14	*Mycena* sp "grey-brown/white/tan" (Lockyer Con 18 4/5/98)	S		1
153 (102, 106,117)	*Mycena* sp. "buff umbrella"	S		74
76	*Mycena* sp. "dark brown cap/brown gill edges"	S		12
84	*Mycena* sp. "dark brown/smokey/silver-white"	S		3
98	*Mycena* sp. "golden-buff"	S		1
123	*Mycena* sp. "Golden-orange"	S		22
198	*Mycena* sp. "pinkish-buff/pinkish with red edge/steely-brown"	S		2
91	*Mycena* sp. "reddish-buff/cream with brown edges/white"	S	1	
146	*Mycena* sp. "tiny white scaly cap"	S		23
9 (24)	*Mycena* sp. "tiny white/yellow stem"	S		85
195	*Mycena* sp. "tiny, white/white/white"	S		3
147	*Mycena subgallericulata*	S		8
5	*N. dactyl*/ *Cort.* sp	S?	3	
7 / 68	*Neolentinus dactyloides*	S	521	
2	*Omphalina* sp.	?	11	
201	*Omphalina* sp. "on thin karri bark"	?		2
99	*Omphalina* sp. "orange, brown scales"	?		1
100	*Omphalina* sp. "yellow-orange"	?		1
156	*Panellus ligulatus* "gilled, orange soft bracket"	S		14
168	*Pholiota* sp. "red-brown scales on cap and stem"	S		8
1	*Pleurotus* sp.	S	5	
55	*Pleurotus* sp.	S	1	
70	*Pleurotus* sp.	S	1	
77 / 154	*Psathyrella* sp? "split gill attachment"	S		17
94 / 65	*Psilocybe coprophila* "on 'roo dung"	S	26	1
83	*Russula* sp "creamy white/creamy white/creamy white"	M		16
75	*Russula* sp. *R.* aff. *adusta*?	M		2
86	*Russula* sp. "grey-brown/creamy white/grey-brown"	M		4
82	*Russula* sp. (*R. clelandii*) "burgandy/white/pinkish"	M		4
ND 18	*Russula* sp. "dk brown/white/white" (Flybrook Con 23, 6/5/98)	M		1
ND 33	*Russula* sp. Unknown (Lockyer Con 20, 2/6/98)	M		1

ID #	**Fungus Species**	**[1] Life Mode**	**Nº of Fruitbodies Burnt**	**Unburnt**
ND 36	*Russula* sp. Unknown (Cripple Con 7, 16/6/98)	M		1
137 (161)	*Tricholoma* sp. "salmon-buff, scaly stem"	M		6
101 (131)	*Tricholoma eucalypticum*	M	20	37
ND 34	Tricholoma ? "fishy" (Flybrook Con 23, 3/6/98)	M		1
ND 23	*Tubaria rufofulva*	S	3	18
ND 37	Unidentifiable (from all plots)	?	3	2
20	Unknown "brick red/yellow/brick red + scales"	S		1
45	Unknown (*N. dactyloides* ?)	?	o/s (1)	
139	Unknown "black, black scales"	?		1
200	Unknown (*Entoloma* sp?) "blue-black/white with blue tinge/blue-black"	S		1
110	Unknown "burgandy (scales)/yellow/yellow"	S		o/s (1)
49	Unknown "cinnamon, gilled bracket"	S		4
130	Unknown "dark grey-brown (slimy)/white (waxy)/long buried stem"	S/M?	1	
194	Unknown "phleboid, red-brown/yellow/yellow"	S		1
64	Unknown "split margin/twisting stem"	S/M?	29	
59	Unknown "wavy margin/long rooting stem"	S/M?	o/s (7)	
12	Unknown "White Spikes"	S		69
159	Unknown (*Inocybe* sp?)	M?		2
172	Unknown (*Inocybe* sp?)	M?		1
	BOLETES			
46	*Boletus* sp. "purple-black"	M		6
10	*Paxillus* sp. "yellow, brown scales"	M		7
	CORAL FUNGI			
78	*Clavicorona piperata*	S		2
96	*Clavulina amethystina* "mauve"	M?		37
26	*Clavulina* "creamy tan"	M?		1
95	*Clavulina* "pink-buff"	M?		181
176	*Clavulina* sp. "slender grey-brown"	M?		40
144	*Clavulinopsis amoena* "yellow single clubs"	M?		6
114	*Clavulinopsis aurantia* "orange-yellow clubs"	M?		66
126	*Clavulinopsis* sp. "grey-buff, simple or branched club"	M?		3
141	*Clavulinopsis* sp. "grey-white"	M?		2
113	*Clavulinopsis* sp. "white clubs"	M?		147
ND 47	Coral fungus Unidentifiable (June Rd Plot 19, 29/7/98)	?	1	
145	*Macrotyphula/Clavariadelphus* sp "cream-white candles"	S		2
43 (127)	*Ramaria* sp."light yellow-brown"	M	14	
169	*Ramaria* sp. "bright yellow"	M		3
ND 32	*Ramaria* sp. Unknown (Lockyer Rd Con 19, 2/6/98)	M		1
ND 38	*Ramaria* sp "yellow-orange" (June Plot 19, 16/6/98)	M	2	
	GASTEROMYCETES			
61	Hypogean "orange-brown gelatinous core"	M	2	
129	*Mesophellia* sp.	M	29	
148	Nidularales sp. "bird nest fungi"	S	2	

ID #	Fungus Species	[1] Life Mode	Nº of Fruitbodies Burnt	Unburnt
	JELLY FUNGI			
ND 25	*Calocera* sp. "yellow" (Lockyer Con 17, 20/5/98)	S		1
ND 29	*Heterotexus peziziformis*	S		8
ND 30	*Tremella fuciformis* (Lockyer Con 17, 2/6/98)	S		5
ND 22	*Tremella mesenterica* ?	S		5
	POLYPORES / THELEPHORES			
193	*Coltricia* sp. "miniature"	S	6	
142	*Coltricia* sp. (*C. oblectans?)*	S		9
ND 52	*Merulius* sp (Flybrook Con 22, 3/6/98)	S		1
ND 5	*Piptoporus australiensis*	S		2
ND 40	Polypore "beige, resupinate" (Flybrook Con 23, 1/7/98)	S		1
ND 8	Polypore - yellow/cream, resupinate	S		1
15	Polypore "creamy-yellow, soft"	S		82
54	Polypore "toothed resupinate"	S		1
ND 50	*Polypore* (Flybrook Con 21, 24/8/98)	S		1
ND 2	*Polyporus mylittae*	S?	9	
23	*Polyporus sclerotinus*	S?	71	
ND 1	*Polyporus tumulosus*	S	30	
44	*Polyporus* sp. "decurrent pores/rooting stem"	S	o/s (1)	
ND 7	*Stereum hirsutum*	S		30
203	*Trametes* sp	S		1
	ASCOMYCETES			
112	*Aleuria rhenana* "stalked orange cup fungus"	S	9	
149	Cup Fungi "light orange"	S	268	
152	Cup Fungus "small orange/light orange"	S	87	
ND 46	*Daldinia concentrica* (Flybrook Plot 18, 28/7/98)	S	7	
66	Disc Fungi "bright-orange, decorated rim, black hairs, 3mm, on bare soil"	S	87	
48	Disc Fungi "lemon-yellow on 'roo dung"	S		25
60	Disc Fungi "lemon-yellow on bare soil"	S	109	
33	Disc Fungi "lemon-yellow, on emu dung"	S	100	
88 (66b)	Disc Fungi "orange, 3mm"	S	2245	
35	Disc fungi "orange, ornamented rim" *Melastiza* aff. *chateri*	S	122	
51	Discomycete "black, stalked"	S	15	105
166	*Geoglossum* sp.	S		21
ND 4	*Hypoxylon* sp. (Wallace Rd - on karri branch)	S/P?		2
192	*Hypoxylon* sp. "on *Acacia europhylla*"	S/P?		12
181	*Morchella elata*	M?	152	o/s (1)
196	Peziza "black/brown, tangled hairs"	S	815	
40	Peziza "black/brown-grey, pimples" *Peziza* aff. *badia*	S	14	
36	Peziza "brown/black, pimples"	S	67	
34	Peziza "brown/khaki"	S	4	
187	Peziza "creamy-white cup fungus"	S	2	
160	Peziza "dark brown-black, on rotton wood"	S	65	
32	Peziza "dark brown/black"	S	10	
90	Peziza "dark brown/brown-khaki"	S	87	

APPENDIX 1....cont.

ID #	Fungus Species	[1] Life Mode	Nº of Fruitbodies	
			Burnt	Unburnt
41	Peziza "dark brown/buff"	S	272	
37	Peziza "dark brown/tan, pimples"	S	42	
191	Peziza "large brown cup on bark of karri"	S	3	
71	Peziza "light brown (flesh coloured)"	S	13	
22	Peziza "light brown"	S	910	
63	Peziza "light brown"	S	32	
38	Peziza "light brown" *Peziza* aff. *succosa*	S	34	
39	Peziza "maroon"	S	8	
31	Peziza "maroon/brown"	S	2	
62	Peziza "maroon/buff"	S	o/s (2)	
69	Peziza "maroon/tan"	S	23	
189	Peziza "small brown hairy cup"	S		146
21	*Peziza tenacella*	S	803	
190	*Plectania* sp.	S		362
ND 31	*Xylaria hypoxylon*	S		1
56	*Xylaria* sp. "small grey"	S	106	
	SLIME MOULDS			
ND 51	Myxomycete *Lycogala epidendrum* ? (Flybrook Plot 16, 21/10/98)	S	1	

[1] **Life Mode**: M = mycorrhizal, S = saprophytic, P = parasitic

APPENDIX 2. Photographs of fungi.

Neolentinus dactyloides (Sp. 7)

Polyporus mylittae (Sp. ND2)

Polyporus tumulosus (Sp. ND1)

Polyporus sclerotinus (Sp. 23)

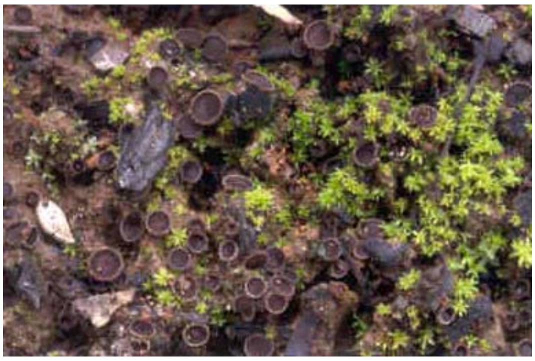
Peziza tenacella (Sp. 21)

Peziza sp. (Sp. 22)

Anthrocobia muelleri (Sp. 66)

Pulvinula sp. (Sp. 66b)

APPENDIX 2. Photographs of fungi.



Peziza sp. (Sp. 196)

Morchella elata (Sp. 181)

Coprinus aff. *domesticus* (Sp. 72)

LBM (Sp. 30)

LBM (*Inocybe* sp., Sp. 128)

Mesophellia sp. (Sp. 129)

🡐 *Mycena* aff. *rorida* (Sp. 109)

Marasmius elegans (Sp. 28)

APPENDIX 2. Photographs of fungi.

Clavulinopsis aurantia (Sp. 114) ➔

Marasmius crinisequi (Sp. 27)

Clavulina amethystina (Sp. 96)

Clavulina sp. (Sp. 95)

🡐 *Geoglossum* sp. (Sp. 166)

Discomycete (Sp. 51)

Peziza sp. (Sp. 189)

Plectania sp. (Sp. 190)

APPENDIX 2. Photographs of fungi.

Tricholoma eucalypticum (Sp. 131)

Amanita xanthocephala (Sp. ND6)

Macrolepiota Konradii (Sp. ND13)

Psilocybe coprophila (Sp. 65)