Bushfires, fungi and biodiversity

The little-known world of fungi is slowly being unravelled as new research looks into fungi's relationship with fire.

by Richard Robinson

Almost everyone knows about the plant and animal kingdoms but few realise that fungi also form one of the five kingdoms of life on Earth. Fungi are an important component of the biodiversity of natural ecosystems including eucalypt forests and woodlands. There is a great diversity of species of fungi. They come in a dazzling array of shapes, colours and textures and they play vital roles in maintaining forest and woodland health. For example, decay fungi initiate nutrient recycling by breaking down organic matter such as wood, leaf litter and dung. Other fungi attach themselves to the fine roots of plants to form minute structures called mycorrhizae (literally meaning fungus roots). Through mycorrhizae, plants gain nutrients such as nitrogen and phosphorus from the fungus partner and the fungus receives carbohydrates from the host plant. A large number of mycorrhizal fungi develop underground truffle-like fruit bodies that also form a significant part of the diet of many native animals. In older trees, wood-decay fungi contribute to the development of suitable habitat, including nesting hollows for certain species of birds and animals.

Recent research undertaken by Department of Environment and Conservation (DEC) staff has investigated how fungal communities respond to fire and how fire can enhance the diversity of fungi across a landscape.

Bushfires are a common occurrence during the dry summers typical of south-western Australia. Prescribed fire is used to maintain a mosaic of post-fire stages for biodiversity conservation and to reduce the intensity of unplanned fires ignited by lightning, accidental causes or arson. Forest areas subject to timber harvesting are also burnt to remove logging debris and create conditions suitable for forest regeneration. Most forest fungi inhabit the organic soil layer, litter and woody debris and fire can have a direct effect on fungal communities by partially sterilising soil, altering the availability of soil nutrients and reducing or totally consuming litter and debris. The extent to which these factors are influenced depends on the intensity and season of the fire.

Fire survivors

A number of species are either adapted to persist with fire or depend on fire to produce fruit bodies and therefore to reproduce. Stone maker (*Laccocephalum tumulosum*), native bread (*Laccocephalum mylittae*) and leathery sawgill (*Neolentinus dactyloides*) are among the first organisms to respond

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Main *Marasmius crinisequi.*
Inset top *Plectania* sp.
Photos – Richard Robinson/DEC
Inset bottom Leeuwin-Naturaliste National Park during a prescribed burn.
Photo – Brett Dennis/Lochman Transparencies

Above left *Peziza tenacella.*

Left *Anthracobia muellerii.*
Photos – Richard Robinson/DEC

Above *Mycena* sp.
Photo – Andrew Dovoll/Lochman Transparencies

Right Stone maker fungi.
Photo – Richard Robinson/DEC

following a fire and produce large and abundant mushroom-like fruitbodies within two or three days of even the most devastating bushfire (see 'Fruits of fire', *LANDSCOPE*, Winter 2001). They fruit from underground tuberous or root-like structures and only fruit after fire. In the absence of green feed immediately after fire, western grey kangaroos often consume mushrooms produced by leathery sawgill.

Fire-enhanced fungi

Fire causes a temporary rise in soil pH and alkaline post-fire conditions favour a number of species. In autumn, species of cup and disc fungi are very prolific. Many have colourful fruit bodies and species such as *Peziza tenacella* and *Anthracobia muelleri* can produce hundreds or even thousands of them. The majority of these fungi only fruit in the first autumn after fire. They release their spores, which settle into the soil in recently burnt forest and are capable of surviving until the next fire, after which they germinate and fruit again. Other fungi also fruit in large numbers after fire, and continue to fruit for several years. In each consecutive year, however, they produce fewer fruit bodies. A number of small mushroom-like fungi and the tiny funnel-shaped *Cotylidia undulata* appear on the burnt forest floor among charcoal once the fire moss, *Funaria hygrometrica*, becomes established. *Cotylidia undulata* is also found in Europe, where it is considered to be rare. However, in Western Australia it is quite common which probably reflects the difference in both the natural occurrence and social acceptance of fire in the Australian landscape.

Recovery and recycling

Many species of soil-borne fungi are mycorrhizal, and generally, more mycorrhizae are present on the roots of plants in long-unburnt jarrah forest compared to recently burnt forest. But some mycorrhizal fungi, such as

Tricholoma eucalypticum, are equally common in burnt and long-unburnt forest and may be important in providing germinating seedlings with mycorrhizae to enhance nutrient uptake, which is important for sustaining rapid growth and recovery of plants after fire. The coral fungus, *Ramaria capitata*, can also be found pushing up through soil in recently burnt forest and, in the spring, masses of morels (*Morchella elata*), with their distinct ribbed and pitted conical fruit bodies, may be found.

With increasing time since fire, fire-associated fungi are gradually replaced by those more common in forest that has been unburnt for longer periods of time. A succession of species takes place on the soil, while at the same time increasing numbers of decomposer species contribute to the restoration of the soil's organic layer by breaking down the leaf and twig litter that gradually builds up. As a result, the assemblage of species making up fungal communities in karri forest differs each year after fire for at least five years.

Above *Ramaria capitata.*

Below *Marasmius alveolaris.*
Photos – Richard Robinson/DEC

Fungi that inhabit and decompose litter and wood are vital components of the nutrient cycling and recycling process. If intense wildfire consumes their habitat many of these fungi are also lost. Some may survive in the mineral soil, and be available to colonise and decay litter deposited by the recovering trees. Different species of decay fungi colonise litter and wood through the various stages of decay. Therefore, re-colonisation by many species may depend on spore dispersal from surrounding forest that has not been recently burnt, the rate of litter and wood build-up and the rate and stage of the decay process. There are many species of *Mycena* and *Marasmius* that specialise in decomposing leaf, twig and branch material falling from the crowns of burnt and recovering overstorey trees, while others colonise logs from fallen trees. *Marasmius*

cruisequi and *Mycena mijoii* are two of the first to reappear on and among fallen leaves. *Marasmius alveolaris* fruits on small freshly fallen branch material after about two years, and crust or skin fungi such as *Hyphodontia barva-jovis* can be found on the lower side of small branches after about five years. The peppery coral fungus (*Clavicorona piperata*) prefers well-rotted wood and the black cup fungus (*Plectania* sp.) is found on twigs in deep litter and takes much longer to recolonise. *Panellus ligulatus* fruits on moss-covered wood and is only found in long-unburnt forest in the wetter parts of the south-west.

When enough litter has accumulated and is sufficiently decomposed to enable the upper organic layer of soil to be restored, fruit bodies of *Entoloma* are found once again. Many plants develop fine root mats in the upper organic layer and mycorrhizal fungi, including species of *Amanita, Cortinarius* and *Russula*, return and soon develop an amazing array of colourful mushrooms.

Food for mammals

Truffle-like fungi are found below the ground or on the surface of the soil under the leaf litter. They are often spherical or almost so, with a firm, fleshy texture and are an important food source for small native animals such as woylies (*Bettongia penicillata*) bush rats (*Rattus fuscipes*) and the rare Gilbert's potoroo (*Potorous gilbertii*). Species that fruit in the soil tend to have hard casings and are capable of surviving intense fire. Many have distinct odours which are intensified by heat, making them easier for animals to locate and dig up. However, species such as *Hysterangium* produce soft fleshy fruit bodies directly under litter and don't usually survive fire. They only return when the litter and soil organic layer is restored.

Fire drives biodiversity

Recently burnt forest supports a large number of fungi not found in forest unburnt for five years or more. Although the diversity of fungi on recently burnt sites is lower, their abundance is many times higher and they don't fruit in or inhabit long-unburnt forest. Many fungi that are found at intermediate stages of recovery are not found in either recently burnt or long-unburnt forest. As a result, different communities of fungi are present at varying stages of recovery after fire, and landscapes or large regions with a mosaic of forest and woodland burnt at different times and intensities in the past have the most diverse communities of fungi. No single fire regime is suitable for all the organisms and communities found in the south-west, but it is becoming increasingly accepted that regimes that are diverse in time and space are essential for maintaining biodiversity.

Above Morel fungi (*Morchella elata*).
Photo - Richard Robinson/DEC

Down the track

Fire management in Australia is evolving. Projects within DEC and in cooperation with other research and management partners are helping to solve the difficulties associated with conserving biodiversity while also providing protection from intense wildfire. DEC has an adaptive approach to fire management, and monitoring fungi, along with other organisms, provides information to assist with decision-making about the use of fire. There is still much to learn about native Australian fungi. Most are undescribed and their ecology is difficult to study, but gradually the mystery is being unravelled.

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