FUNGI FORAGERS

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OUR PURPOSE: TO RAISE AWARENESS AND INTEREST IN FUNGI OF THE CAIRNS REGION

This newsletter is not formally published and is not associated with any club or organisation, but is emailed free of charge to anyone who may be interested. Anyone who wishes to contribute to the newsletter with observations, anecdotes, corrections, comments or photographs is welcome to do so. Although this "newsletter" is science-based we try not to make it too "scientific". We recognise that there are school children, bush-walkers and others just interested in fungi, and we hope this leaflet will become a medium for furthering that interest.

Barry Muir, editor Jenn Muir

News - Truffles

In the previous Cairns Fungi Foragers (CFF) we mentioned that Professor Jim Trappe from Oregon State University in the USA had visited north Queensland during June to study truffles. It was Jim's 35th visit to Australia, where he has been studying truffle taxonomy and ecology for many years. This expedition was organised by the Queensland Mycological Society (qldfungi.org.au) and was attended by ten enthusiasts, including the authors of CFF. Brisbane Herbarium representatives were present and specimens collected have been lodged in that institution.

Truffles are not a specific fungal group in themselves, but are highly specialised underground fruiting bodies that have evolved in several fungus families, including *Russula* (Brittle-gill Toadstools), *Cortinarius* (Web-cap Toadstools), the bolete fungi (toadstools with pores rather than gills under the cap), the Stinkhorns, and the Cup Fungi (Ascomycetes).

An attractive orange truffle found in rainforest near Lake Eacham. Photo Barry Muir

It is believed there are about 2000 species of truffles in Australia, of which only about 300 have been described scientifically. So far, none of the Australian truffles have been found to have any commercial value, being small and tasteless or unpleasant. The large truffles with which some of us are familiar have all been introduced for commercial growing.

To understand the importance of truffles it is necessary to have a knowledge of mycorrhizae (from the Greek mykos, "fungus", and rhiza, "root"). They were discussed briefly in CFF No. 1, February 2017). Mycorrhizae are a close association between a fungus and a plant to the mutual benefit of both. It is believed these associations have been around for at least 400 million years and that the symbiosis of the fungi probably allowed the first plants to begin to colonise land from the sea. It is also thought that plant roots may have evolved to provide suitable accommodation for the fungi, because many of the primitive plants do not have roots, only “holdfasts” which help them to cling to the soil or rock.

Basically, the fungus extracts minerals and water from the soil and passes them to the plant, and the plant passes sugars that it has made using photosynthesis, back to the fungus. Fungi also store nitrogen and pass this to the plant during hard times. Both benefit from the arrangement and, although most plants will grow without the mycorrhizal fungus, many struggle to survive. Mycorrhizae also play other roles: these were discussed in greater detail in CFF No. 1, February 2017.

Most of the native truffles are small and white like these. Photo Barry Muir

One particular type of mycorrhiza (there are several), are known as ectomycorrhizae (abbreviated EcM and from the Greek ektos, "outside"). EcM are especially important because they form truffles. EcM fungi do not penetrate their host’s cell walls. Instead, they form between the cells of the plant and consist of highly branched fungus hyphae forming a latticework between the root cells. Hyphae from the fungus form a dense network extending up to several centimetres into the surrounding soil from the host plant roots. This hyphal network aids in uptake of water minerals. The hyphal network trapping nutrients has been likened to using a net to catch fish rather than a line and hook which only catches one fish at a time.

Ectomycorrhizal fungi covering the surface of roots.
Picture from
http://archive.bio.ed.ac.uk/jdeacon/mrhizas/ecto1.jpg

Many EcM fungal fruiting bodies are well known, including the edible truffle, and the deadly Death Cap toadstool (*Amanita* species). It is now recognised that many plants grow very poorly or not at all if they are deprived of their associated EcM fungi. Advances in this knowledge have led to increased application in ecosystem management and restoration, forestry and agriculture, where EcM may be added if natural ones are insufficient.

Truffles are specifically the fruiting bodies of EcM fungi. Because they fruit underground they can save energy by not developing proper stalks and caps. The downside is that they cannot disperse their spores by letting them blow in the wind. Instead they depend on small mammals to dig them up and eat them. To attract the animals they produce distinctive odours which then seep through the soil and are easily sensed by dogs and pigs as well as Australian native truffle-eaters.

White-tailed Rat (*Uromys caudimaculatus*). Picture borrowed with thanks from Wet Tropics Management Authority website

Truffles are sought out in other countries by squirrels, deer and other animals, and in Australia several species eat the truffles, especially the Potoroos and Bettongs, but also the White-tailed Rat so common in Cairns rainforest, and the Northern Bandicoot, common in suburban gardens and parks. Once eaten, the spores then travel through the specialised truffle-digesting gut of the animal and are distributed in its droppings, sometimes a long way from where the truffle was eaten. This digging for truffles is vitally important in the Australian eucalyptus forests as it breaks up the surface soil, helping rainfall to penetrate the soil rather than run off and cause erosion. It has been estimated that one species, the Western Potoroo of south-west Western Australia, can move up to four tonnes of soil per animal per year, by digging up to 100 truffles per night.

Northern Brown Bandicoot (*Isoodon macrourus*). Photo Barry Muir

Another factor is that, after fire in the eucalypt forests, truffles may be the only food available to many mammals because the truffles survive the fire by being underground. The fire may damage the upper surface of the truffles, making them easier for the mammals to smell, but the more deeply buried parts usually survive the heat.

We mustn't forget the "secondary" distributors of truffle spores. Owls, eagles and native Quolls that catch truffle-eating prey then carry them away to eat them and, thus, in turn, help to distribute the truffle spores that were in the gut of their prey.

Unfortunately, introduced foxes, wild dogs and cats are destroying many of our small mammals such as potoroos, bandicoots and wallabies. This reduces the number of animals available to dig in the forest and this, in turn, increases water runoff. In addition, less truffle-feeding animals means less truffle fungi being distributed and the truffle mycorrhizae are what the plants depend on for their nutrition. Thus, indirectly, feral animals are increasing erosion and causing loss of native forests.

Did you know? – and a question

Some fungi have been found in the laboratory to be sensitive to electric fields. Spore germination, the direction of hyphal extension and frequency of branching may be affected, sometimes in different ways in different species. Do overhead powerlines or underground electricity cables also affect fungi?

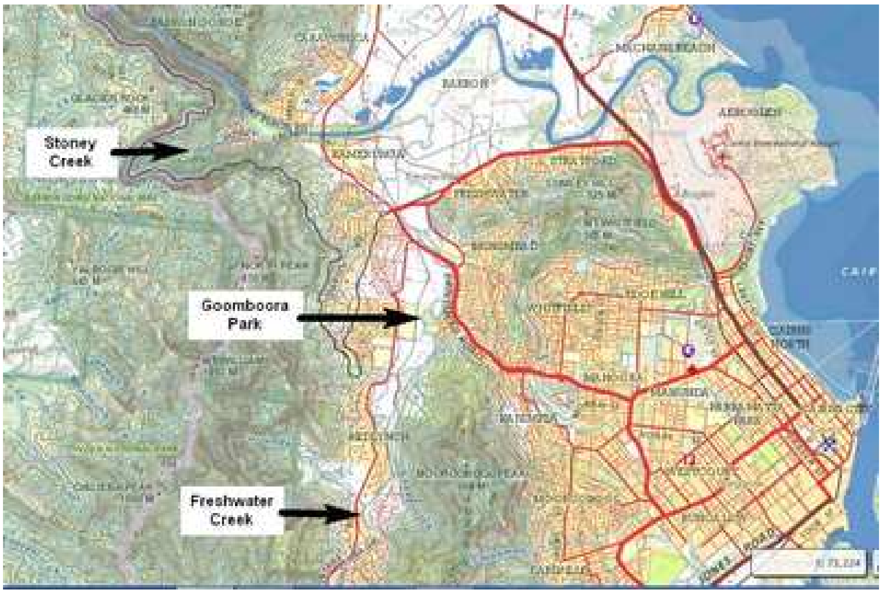
Climate and Fungi (part 2)

In the last Cairns Fungi Foragers newsletter was an article called **Climate and Fungi near Cairns.** It discussed the two major weather systems that influenced rainfall; the Trade Winds which bring short, light, showers during the so-called "dry" season and the monsoon which brings extended periods of often high rainfall during the "wet" season.

While these weather systems provide an overview of conditions that influence fungal fruiting, it is, as so often in nature, not that simple. There are smaller-scale influences, termed meso-climate (meso = middle or intermediate) and microclimate (micro = small) that also determine when and where fungi fruiting bodies appear. This article discusses some features of meso-climate.

The meso-climate around Cairns is controlled by topography (hills and plains) and vegetation. In the December to March monsoon season, there is usually an over-arching regional rainfall which affects all the Cairns Region, regardless of local topography or degree of nearby land clearing. Nonetheless, even in these conditions, some of the cloud layers are of low altitude (frequently as low as 50 m Above Sea Level (ASL) but sometimes at ground level), well below the height of the ranges around Cairns which vary from around 360m (Mt Whitfield) up to over 1000 m ASL (Mt Williams). These clouds, when distinct (as compared to general fog), can be seen to travel across the cooler vegetated parts of the landscape, passing around the hotter city centre, and moving up the valleys, causing high humidity and additional ground-moisture. There are thus, in effect, two “types” of rainfall during the monsoon season: the regional broad-scale monsoon rainfall events; and a smaller-scale localised rainfall that I shall call, for convenience, valley rainfall.

From May to October Cairns is under the influence of the south-east Trade Winds. Valleys also strongly influence these winds, funnelling them between the mountains. This may produce quite localised rainfalls, with one site receiving several millimetres of rain while the adjacent valley or suburb gets none. Stoney Creek in Kamerunga, for example, is a west-east trending valley and low-altitude clouds are channelled up this valley, creating a wet local environment within the valley. Similarly, Crystal Cascades (upper Freshwater Creek in Redlynch) lies in a south-north trending valley and receives rainfall both from clouds channelled up the valley as well as rain from clouds that pass over Mooroobool Peak and drop moisture on its western side. The Freshwater Creek area therefore receives more rain than does Stoney Creek. This greatly influences the fungal species that can be found in either valley. In addition, steep-sided valleys that run north-south remain more humid during the day because there is less sunlight penetration in the early morning and late afternoon. They are also cooler at night because they have less time to be heated by the direct rays of the sun.



By contrast, Goomboora Park in Brinsmead, for example, is not in a valley but is located at the western edge of the Cairns coastal plain (altitude *ca* 0 – 50 m ASL). It is only affected to a limited extent by valley rainfall but does receive the rain that falls broadly on the plain from the on-shore Trade Winds rain as well as from the monsoon rains. Its rainfall is thus closer to the “average” for the Cairns region and less than either Stoney Creek or Crystal Cascades. Goomboora Park produces less species of fungi than do either Stoney Creek or Crystal Cascades and generally has only the common species while the wetter sites have more of the rarer types.

Did You Know - How Fungi Grow so Fast

We all know that fungi can suddenly appear, often quite large ones and almost overnight. Green plants, on the other hand take many days, weeks, months or years to show even slight growth. How do fungi do it?

Cells are the minute building blocks of which most living things are made. Plants and animals grow by cells dividing and then being added to their structure. This is a slow, energy-consuming process, adding a few cells at a time, often over long periods – a bit like building a wall by adding one brick at a time. Fungi, on the other hand, are also made of cells but use a different method of growth. Fungi do not grow by dividing their cells but simply enlarge their existing cells by pushing water into them – a bit like blowing up a balloon. You still have only one balloon, but now it is bigger. In fact, just about as soon as it starts to develop, a fungus fruit has almost the same number of cells that the mature fruit will have.

Water is pulled into the fungus cells because the inside of the cells are at lower pressure than the water outside and the fungus tries to equalise that pressure by pumping water in; this is termed “osmosis”. Once cells get big enough, the fungus creates a cell wall across the expanded cell and the process starts again. Very little energy is required for this and hence a mushroom can increase in size as fast as water can be pumped into its cells.

The fastest growth I have personally observed was the giant puffball *Calvatia cyathiformis*. I measured growth rates of 110 mm in height and 80 mm in diameter in 24 hours and 180 mm in height and 140 mm in diameter in 48 hours. Growth rate was thus about 3 – 4 mm/hour.

Jenn with a *Calvatia cyathiformis*

Did You Know – Air Pressure and Fruiting

Several people I have spoken to or corresponded with over the years have pointed out that fungi seem to "know" what is going to happen, in advance, with the weather. Examples are how some fungus species can suddenly appear when the weather is dry yet the following day it rains and they then flourish. Others fruit in wet weather continually for days and then suddenly stop, and, sure enough, there is a sudden change; the rain stops and the following day is hot and dry. How do they "know"?

My guess is changes in air pressure. In fungi, the main component of growth and development is the hypha (hyphae also make up the fruit body as well as the mycelium in the soil or rotting wood). Hyphae elongate from the tip, not by adding cells like plants and animals do, but by simply extending their cells by forcing water into them under pressure. This means, of course, that the pressure outside the cells will affect the amount of "push" the cells need to have inside them in order to elongate. Changes in outside pressure, i.e. air pressure, may then affect the fungal cells.

When wet weather is coming the air pressure drops (seen by the barometer reading falling) and when drier weather is coming after a rainy period, the air pressure begins to rise (seen by the barometer reading rising). My guess is that these changes in pressure are "felt" by the fungus because the pressure on its cells changes. This happens in advance of the actual change in weather, so the fungi "know in advance" that things are changing.

If this is correct, it may also explain why it is very difficult to deliberately grow fungi, for example, by putting water on a log in your backyard that you know has fungi on it when it rains. Soaking with water by us will not have the associated change in air pressure, so the fungi are not fooled – they "know" it is not a rainstorm.

Did you know – spores versus rockets?

The NASA Space Shuttle accelerates at about three to five times the force of gravity, allowing it to escape the bonds of Earth. By comparison, a spore fired off the gill of a gilled mushroom or toadstool accelerates at about 25,000 times the force of gravity. In addition, the spore loses about 1% of its weight in this process. The Space Shuttle, however, uses about 50% of its own weight in fuel during the first two minutes after launch. Fungi win again!

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