FUNGI FORAGERS

No.33: December 2022

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

This newsletter 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. **The emphasis is on fungal biology and ecology** rather than identification.

Barry Muir, Editor Jenn Muir

Field meetings to find interesting species of fungi (not necessarily edible species) are known as 'forays', after the first such meeting organized in 1868 by the Woolhope Naturalists' Field Club of Herefordshire, England, and entitled "A foray among the funguses" [*sic*]. The Woolhope Club was an early member of the British Mycological Society founded in 1896. (Wikipedia)

THE APPROACHING WET SEASON

I say it every December, and I will say it again to those of us who live in Tropical Queensland; the wet season is fast approaching, and we have the opportunity to make a few meaningful observations. If you don’t live up here this still applies to you - but think May rather than January. My guess is that many observations made here could, and probably do, apply in cooler climates - we just don’t know until observant people record what they learn.

Observation is the key. Most of us go fungus hunting for interest or photography, or just chance upon them as we bushwalk or garden, but in the process of doing so, we observe. Those observations, no matter how random and perhaps *seemingly* unimportant, can provide a great deal of information. When it’s all put together, patterns begin to emerge. Also have a look at “You can do research on fungal ecology” in Cairns Fungi Foragers (CFF) No.12: December 2018. Just ask if you’d like us to email it to you again.

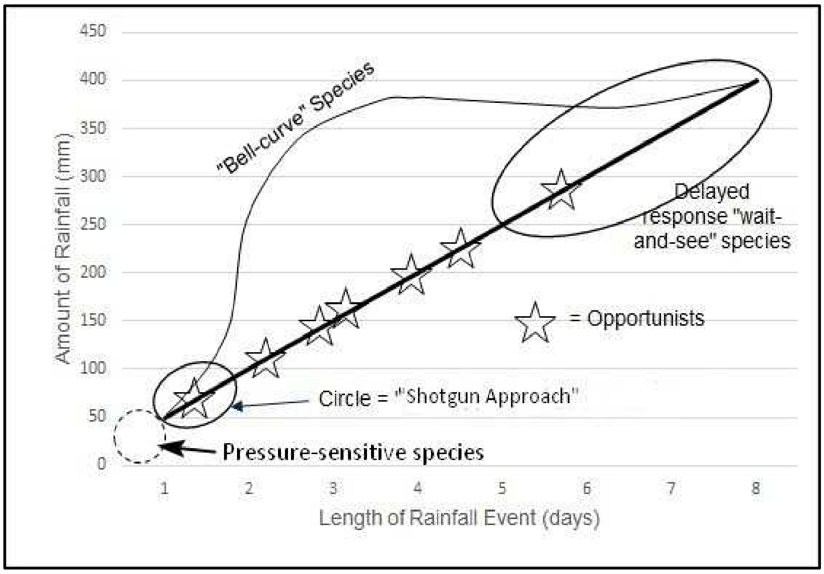
Below I have raised a few questions. I believe readers have made observations that shed light on some of the answers. It doesn’t require statistics or detailed study - just recording the information and emailing it to me, so that I can search for patterns and pass the information on to other researchers. I can be contacted at unit57.may@gmail.com. Go into the garden or bush, take a notebook and camera, and record what you see. **DO NOT** rely on memory.

1. One of the most interesting observations is to look at fungal succession. I now have detailed information on several species, but much more is needed.

   The diagram on the next page is based on real data and was originally presented in CFF No.18: February 2020. It shows five types of fungal fruiting:

   (A) a group of species that detects the reduced air pressure of an oncoming storm, and fruit just *before* it starts to rain;

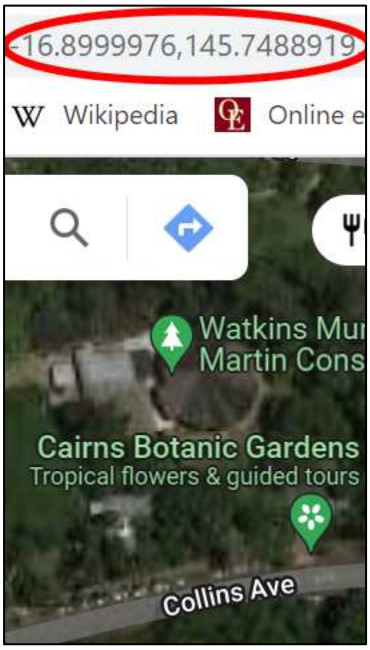
   (B) what I have termed “Shotgun” species. Immediately good rains occur, “Shotgun” species spring up and commence release of spores within a day or so, then disappear for the rest of the rainfall event or season;



(C) "Opportunists" that also appear immediately after rain but then disappear, only to reappear again each time there is a new rain event;

(D) "Bell-curve" species that appear shortly after rains commence, but only in small numbers. They then continue appearing throughout the rain event, gradually increasing in numbers then tailing off to only a few as soil or wood food resources become depleted; and finally

(E) the "Wait and see" species. These do not appear until right at the end of the growing period, be it a single long rainfall event or the wet season in its entirety.



All that's required to record the information is to observe the species and relate them back to when they occurred within the rainfall event or season. If you can't identify the species, email me a heap of pictures of them - upperside **and underside** if they are mushrooms.

Let me know where your nearest weather station is located. However, if you are not sure, locate where you were at the time by using Google Maps; select your study site; and email me the latitude and longitude that appears in the location field (shown by the red ellipse in the partial map on left). I can then find the nearest weather station.

2. When you observe variations in fruit-body colour, say a cluster of a single species growing on a log or on a patch of mulch, or in the garden, ask yourself "do these variations in colour correspond with the intensity, direction, or directness of the light in the environment in which the fungus is growing?" For example, are the ones growing in direct light a different colour to those growing in shade at the hottest (brightest) time of day? In the garden, do they receive reflected light from a wall or window? Of course, all these factors can change in the course of a day or fruiting period. If they fruit for an extended time, such as several days, did light conditions change over that period? If so, is there any change in fruit body colour other than that caused by decay?

There are pink & orange varieties of *Phallus multicolor*

3. If you observe a fungus species in several locations at the same time, such as *Phallus multicolor* that pops up regularly in garden beds, are the ones in one location slightly different in colour than those somewhere else? If so, is the soil different? Is one area fertilised and the other not? Is one area shaded and the other not? Does one area receive more water than the other? Observe the fungi closely. If the colours are intended to attract insects that will disperse the spores of that fungus (we know the smelly gleba is the primary attractant for *Phallus multicolor*), do certain colours or colour intensities attract more insects? How many species of flies are attracted and is one colour consistently more attractive to the flies?

4. Some of the coral fungi are white or pale, but many others are brightly coloured in pink, red, orange or yellow, and there are a couple of blue or purplish ones. Conventional wisdom is that these fungi use wind to disperse their spores. Making pigments of any colour, unless they are purely metabolic by-products, would be a drain on chemical and nutritional resources, so why do it? Make observations on soil or wood conditions (moisture, for example), host wood species if growing on wood, light conditions,

timing in relation to rainfalls. What insects or other small critters, if any, are visiting the fruit bodies? Is one colour favoured over another? How much subtle variation is a result of habitat? As is so often the case, colour is noted but growing conditions ignored or brushed over. I believe there is a connection.

Pictures of 2 coral fungi species: *Clavulinopsis corallinorosacea* (red) & *Clavulinopsis amoena* (yellow) extracted from Grey & Grey (2017). A little book of corals. Field Naturalists Club of Victoria. Photographers acknowledged.

5. Those of you who have tried identifying fungi know there is a correlation between spore colour and genus (within a narrow range of variation) and have probably made spore prints (see CFF No. 20: February 2018) to see what colour the spores are. Many species have white or very pale spores which, logically, saves energy in not having to make pigment. Mushrooms with brown or very dark brown/purple/black spores are common, and maybe these are species that need protection for their spores from UV light. Make some observations on this: when you find any species with black or very dark brown spores, make a note of their degree of exposure to bright sunlight. Are they mostly in paddocks or open gardens where UV protection is important? If shaded, how much of the day is the shade likely to last?

6. The co-occurrence of species is poorly recorded. Have you ever noticed that a cluster of fungus fruit bodies is often of a single species? Do the mycelia of a single species dominate that habitat, preventing mycelia of other species from becoming established? How territorial are fungi? Do fungi 'tell' other fungi 'this is my patch' so the other fungi do not fruit as much or often, even though they are present. This may reduce competition for spore dispersal resources, to the detriment of the dominant species? Is it related to nutritional resources?

***Pluteus petasatus* & *Gymnopus* sp**
growing in close association on mulch

If you observe two (or more) fungal species growing in very close proximity (on soil, wood, or mulch), record the names of the species, or, if you don't know them, take lots of photo-graphs, clearly distinguishing between the species.

Attached to this newsletter is a supplement on how to take fungi photographs specifically for identification purposes.

7. While on the subject of insects and other critters either eating fungi or spreading spores, flowers of plants that attract moths or bats for pollination produce large, often white flowers that are conspicuous at night. Those flowers pollinated by bees have white, blue, yellow, or UV-reflective flowers while those pollinated by butterflies tend to have red or purple flowers. Is there any particular colour aspect to the fungus you are examining which you think might be attractive to insects?

Large numbers of beetles (Staphylinidae) & collembola on a fruit body at night. None were observed during daylight.

8. Likewise, there is every reason to suspect that fungi fruit-bodies may be both evolutionarily adapted, and perhaps physiologically responsive, to predation or exploitation in the same way as flowers. Maybe colour variations (and/or fruit-body shapes?) are associated with particular responses to predation, either to discourage it or to encourage it for spore-dispersal purposes. Perhaps white fungi are more heavily predated on, or visited, at night because they are easier for spore-dispersal vectors or predators to see. There are very few night observations of any kind on fungi. If you are keen, try to identify or collect the critters in attendance.

Please email observations and photographs to Barry Muir at unit57.may@gmail.com
Specimens require special preparation. Please either ask for advice on preparation or take fresh specimens to a museum or a known mycologist.

WHAT IS DIVERSITY?

We often hear the word 'diversity' or 'biodiversity' when scientists and teachers are talking about loss of plant, fungal and animal species resulting from land clearing, climate change and other human-caused impacts. What exactly is meant by 'diversity'? There are, in fact, three different kinds of diversity, which ecologists call alpha, beta and gamma diversity.

Alpha diversity is the term applied to *species richness*, i.e., the number of species in an ecosystem, be it large, like a forest, or small, such as the population of bacteria and animals in a flower vase of stale water. Alpha diversity of a patch of woodland with fungi might be the total number of large fungal fruit bodies we observe. We must remember, however, that we are only seeing maybe a tiny fraction of the species actually present, so making too much of the alpha diversity observations can be misleading.

Beta diversity allows us to compare diversity between ecosystems. If we count the number of large fungi in a forest and then the number in the cleared paddock next door, making sure the measurements are on the same day and done in the same way, then we are measuring the beta diversity. We are comparing the total number of species that are unique to each of the ecosystems being compared and the numbers in common. Again, we must remember that we are only seeing a tiny fraction of the fungi actually present.

Gamma diversity is a measure of the overall **diversity for the different ecosystems within a region**, i.e., at a geographic scale. In the example above, the total number of species for the forest, ***plus*** the cleared paddock, represents the gamma diversity of that region when compared with another region elsewhere.

MEDICINE AND MUSHROOMS

For thousands of years humans survived on foraging and many cultures still do so. They acquired the knowledge about where and when foods and medicines could be located, and in some Asian and African countries, up to 80% of the population still relies on traditional medicine for their primary health care needs. The development of modern medicine greatly reduced the need to forage as drugs were cultured, refined or synthetically manufactured. There is no compelling survival reason to forage for medicines in Australia.

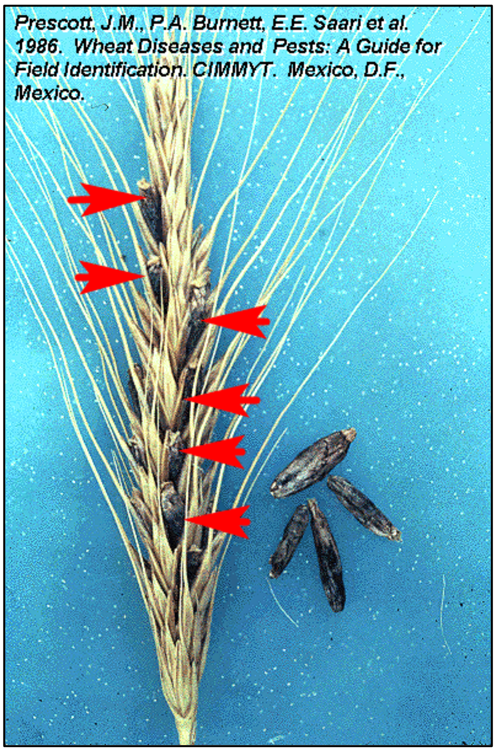
Nonetheless, fungi are amazing critters, producing an incredible array of sugars, enzymes, pheromones (gaseous hormones) and toxins for a huge variety of purposes. We are only just starting to appreciate that there are probably thousands of naturally occurring medicines of which we are, as yet, totally unaware. While plant products, and even endangered animal products (e.g. rhinoceros horn or shark fin), have been used (supposedly) for medicinal purposes, there seems to be a particular interest in fungi, probably because they are often bizarre in shape and colour.

In ancient times (and sometimes even today) it was thought that if something looks like something else, it must have medicinal properties for that ailment. For example, walnut kernels were considered good for the brain because they look like a brain; turmeric was good for the intestines because the root looks like a piece of intestine. The real medicinal value of these products has been greatly emphasised by suppliers because they are profit-making, and mostly harmless. A good number of “granny-cures” are effective placebos (things that are pacifiers), or which make you believe they are working when they are not – chicken soup to treat a cold is a good example.

Naturopathy (also known as naturopathic medicine or natural medicine) is an alternative medical system that favours minimal use of manufactured drugs, and relies on curative agents that occur naturally, before refinement. Naturopathy comprises many different treatments of varying degrees of acceptance by today’s medical community, but almost always includes diet and lifestyle advice which is basically the same as that advice offered by doctors and may help the patient anyway.

A very meaningful picture relating to *Cordyceps*. The image on left is of a *Cordyceps* emerging from the soil (location unknown). The image on the right shows a bagful of *Cordyceps* (the reason they are becoming extinct) & a collector’s hand wearing a very expensive ring, indicating the large payouts from pharmaceutical companies to the fungus collectors. Internet image.

Fungal medicines have an important place in human history. Ancient Egyptians used mouldy bread poultices thousands of years ago to aid in healing of wounds. The healing powers were probably due to penicillin, an antibiotic first recognised by Sir Alexander Fleming in 1928. Discovery and extraction from the mould *Penicillium notatum* was a revolution that changed the quality of human life and initiated the era of antibiotics. Other medicines derived from fungi include cyclosporine from *Tolypocladium inflatum* (enables organ transplants) and lovastatin from *Aspergillus terreus* (lowers cholesterol).



After the discovery of the medical use of penicillin, the search for more antibiotics led to finding a multitude of compounds from *Streptomyces* species, a bacterium, not a fungus, although it shares many traits with fungi. Over 350 useful agents have been derived from *Streptomyces*, so the development of antibiotics from fungi has led to many other discoveries.

Some drugs had dubious beginnings. Ergot alkaloids are produced by the filamentous fungi of the genus *Claviceps*. Originally referenced as a disease of grain in The Bible’s Old Testament (850-550 BC), the first reported ergotism epidemic was recorded in 944-1000 AD. About 60,000 people, almost half the population of the Aquitaine region of France, died of ergot poisoning. Nonetheless, the use of ergots as medicinal compounds was first documented in 1582 as they were administered for “quickening childbirth”. Ergot-derived drugs were the inspiration for numerous modern semi-synthetic substances used in the treatment of migraines, Parkinson’s disease, and reduction of tumour growth.

Ergot fruit bodies (arrowed), & extracted, growing on a head of barley. Internet image.

All that having been said, there are risks in using natural medicines made from fungi (or plants or animals). We know that many fungi accumulate toxic elements such as mercury, lead, cadmium, and arsenic, and that those elements are particularly concentrated in the fungus, much more than in the substrate on which they were growing. The problems associated with distinguishing edible mushrooms from poisonous mushrooms also applies to fungi used to make commercial naturopathic medicines. In more than 95% of mushroom toxicity cases, poisoning occurs because of misidentification of the mushroom by an amateur mushroom hunter. For example, in 2019 there were 2,000 cases of mushroom poisoning reported to poison control centres in France. While most were minor, there were 24 cases of high severity with life threatening prognosis and three deaths. French country folk are regular fungi hunters and many villages have 'professional' fungus identifiers. Clearly, they are fallible.

Local people who collect fungi from forests and fields for the purpose of selling them to naturopathic medicine manufacturers are NOT experts. There is also the risk of adulteration. Most *Cordyceps* in herbal formulations manufactured in USA, for example, are derived from the factory-cultured mycelium, but some Chinese preparations are derived from wild *Cordyceps* that are purchased from collectors for as much as US$1000 for 100 grams, an absolute fortune for country folk. The extremely high lead content in some preparations of *Cordyceps* was reported recently to be due to fine slivers of lead inserted into the mummified larvae to fraudulently increase the weight.

Unscrupulous producers sometimes add modern commercial drugs to their “natural” medicines, such as weight loss agents, cholesterol treatments, stress-relieving and anti-inflammatory agents, or anabolic steroids, to develop or intensify biological effects of dietary supplements or herbal remedies. The presence of such adulterated products in the marketplace is a worldwide problem and their consumption poses health risks to consumers.

Modern medicine is, to some extent, based on early findings of truly useful chemical agents, and has, over time, seen the active ingredients purified and concentrated, and even made synthetically once their value has been realised. Some natural medicines do contain useful chemicals, but they are usually in such low concentrations that huge amounts must be consumed to have much effect. Modern medicine has purified and concentrated these same substances, determined their safety and the amount needed to get the desired effect while not poisoning the patient. Thus, we might take one 50 mg tablet a day rather than consume 5 kg of the natural product each day to get the same benefit. Additionally, the pure product is just that - pure. The same chemical in a natural medicine might be accompanied by literally hundreds of unknown and possibly toxic or allergy-causing impurities.

It is noted that many 'traditional medicine' suppliers and advertisers use weasel words like “this medicine is not to be used as a substitute for medical advice, diagnosis or treatment of any health condition or problem. Users should not rely on information provided on this container or on internet web sites for their own health problems. Any questions regarding your own health should be addressed to your own physician or other healthcare provider”. In other words, before you take “our natural medicine” it would be wise to speak to a modern medical doctor first!

Further reading:

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Bao-qin Lin & Shao-ping Li (2011). *Cordyceps* as an Herbal Drug. Chap. 5. Herbal Medicine: Biomolecular and Clinical Aspects. 2 ed. Boca Raton (FL): CRC Press/Taylor & Francis. Benzie IFF. & Wachtel-Galor S. (eds).

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Wu, TN, Yang, KC, Wang, CM, Lai, JS, Ko, KN, Chang, PY & Liou, SH. (1996). Lead poisoning caused by contaminated Cordyceps, a Chinese herbal medicine: two case reports. Sci. Total. Environ. 182(1-3):193-5. doi: 10.1016/0048-9697(96)05054-1. PMID: 8854946.

BIODEGRADABLE CIRCUIT BOARDS

Many thanks to John Zakarevicius for bringing this paper to my attention.

While investigating the use of mushrooms in applications such as fabric and building insulation, scientists at Johannes Kepler University, Linz, Austria, noted that the reishi mushroom (*Ganoderma lucidum*) has a particularly tough outer skin that protects the underlying pulpy tissue from pathogens and predatory fungi. It was discovered that the skin can be easily removed and then dried, forming a "robust, flexible, and heat resistant" material that can withstand temperatures of up to 250ºC. Nonetheless, when left in the proper environment, the material completely biodegrades. With these properties in mind, it is hoped that the "MycelioTronic" material could one day serve as the substrate for printed circuit boards in flexible electronic devices.

Currently, the substrates in such circuit boards are constructed of polymer plastics which are difficult to separate from the other components, thus making it hard to recycle both the polymers and the components. By contrast, once the mushroom-based substrate had biodegraded, the remaining non-degradable items could simply be plucked out of the mix and recycled.

The MycelioTronic material could conceivably also find use in medical implants, designed to harmlessly dissolve within the body once they're no longer needed. The researchers have already built proximity and humidity sensors in which conventional electronic chips were soldered onto a MycelioTronic substrate. They're now looking into using the material in other components, with the aim of ultimately producing a completely biodegradable circuit board!

Source: Johannes Kepler University, Linz via New Scientist. Coxworth, B., November 14, 2022. Mushroom-derived electronics designed to biodegrade when discarded.

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