FUNGI FORAGERS

No. 17, December 2019

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

DECAY FUNGI Part 4

FUNGI THAT GROW ON DEAD ANIMALS AND DUNG

Amanita flavella growing on a Cadaver Decomposition Island (see below) from a dead rabbit

Decomposition of an animal corpse begins at the moment of death, caused by two processes: autolysis and putrefaction. Autolysis is where, once the animal's heart stops, the blood can no longer supply oxygen or remove carbon dioxide from the tissues. The resulting increase in acidity and other chemical changes causes cells to lose their structure, bringing about the release of enzymes capable of breaking down surrounding cells and tissues. Next comes putrefaction: the small amount of oxygen remaining in the body is quickly depleted by bacteria naturally present in the lungs and gut, creating an ideal environment for the growth of organisms that don't require oxygen.

These multiply, consuming the body's carbohydrates, fats and proteins, to produce a variety of substances such as hydrogen sulphide, carbon dioxide, methane, ammonia and nitrogen. Fluids lost from the corpse accumulate around the body and create a Cadaver Decomposition Island (CDI). When the carcass is large (such as a dead kangaroo or sheep) on soil, the CDI surrounding the carcass will display: an increase in soil carbon and nutrients, such as phosphorus, potassium, calcium, and magnesium; changes in acidity; and a significant increase in soil nitrogen, usually as ammonia. The CDI may be visible as a zone with no vegetation, having been poisoned by the substances released or, later, when the toxic chemicals begin to break down, by an increase in plant growth around the corpse.

Some elements, such as nitrogen and phosphorus, are required in large quantities by biological systems; yet they are not abundant in the environment. The action of fungi releases these elements from decaying matter, making them available to other living organisms. Trace elements present in low amounts in many habitats are essential for growth but would remain tied up in rotting organic matter if fungi and bacteria did not return them to the environment via their activity.

Some fungi of the *Coprinus cordisporus* Group growing on a cow pat. The spores may have been in the cow pat when it was deposited or may have landed there afterwards

Ammonia fungi fruit on the forest floor and in grassland after decomposition of an animal body or dung, not on the animal bodies themselves. Thus, it is very rare, if not almost impossible, to find a fungus fruit-body physically growing on a corpse – they occur next to the corpse on the rich soil within the CDI. These corpse decomposer fungi (often *Coprinopsis, Hebeloma, Laccaria, Lepista* or *Lyophyllum*) mainly arise from the rich fungus community already present in the soil. Soils which are rich in clay minerals tend to have slower rates of corpse decomposition. The smaller particles of clay result in a large surface area that can hold water. The higher the water content of a soil, the lower the oxygen content and consequently, the lower the rate of decomposition – opposite to what one might expect. Clay minerals also bind particles of organic material to their surface, making them less accessible to bacteria and fungi. Fungi and bacteria are unique in that their nutrition involves digestion **before** being taken into "the body". This has been likened to going to a restaurant and lying on your plate of food and absorbing it through the skin rather than eating it – sounds yukky, especially with curry!

Lyophyllum connatum growing on Brush Turkey nest with lots of decaying leaves and bird poo – Cairns Botanic Garden

Fungi produce a variety of digestive enzymes to obtain nutrients. These enzymes are either released into the substrate or remain bound to the outside of the fungal cell wall. Large molecules are broken down into small molecules, which are transported into the cell. Because the movement of small molecules and enzymes is dependent on the presence of water on and in the cells, active growth depends on a relatively-high percentage of moisture in the environment, and this allows fungi to degrade many large and insoluble molecules that would otherwise remain trapped in a habitat. **The flush of fungi after the first rain is a result of this sudden availability of large molecules.** Once the rain continues and the soils become waterlogged the rate of absorption of these molecules is inhibited and fruiting slows down. In extremely wet conditions, and in swamps and streams, decomposition may actually stop altogether for a while (see CFF No 10 August 2018 or The Queensland Mycologist 13(3) Spring 2018).

About forty species of ammonia fungi have been recorded. Two dung-fungi species, *Ascobolus denudatus* and *Coprinopsis cinerea,* have been recorded in the Southern Hemisphere as well as in the Northern Hemisphere. It has been suggested that migration of some widely-distributed ammonia fungi has been human-assisted, especially from the Northern Hemisphere to the Southern Hemisphere by early settlers, the animals they imported and, more recently, by tourists.

One mycorrhizal fungus, *Hebeloma aminophilum,* was first collected near a decaying large kangaroo body near Manjimup, Western Australia, but has since been found in New Zealand; Tasmania, in Victoria; and in the Herberton Range area and at Koombooloomba Dam in Queensland.

H. aminophilum has also been reported from a urea-treated plantation forest, indicating that this species can be categorised as a mycorrhizal species, an ammonia fungus and as a fungus associated with corpses, so some can be quite versatile.

Hebeloma aminophilum the Ghoul Fungus, grows where corpses have enriched the soil. This particular one (pictured above) was apparently growing in the CDI of a dead sheep. Photo from Fuhrer, B. (2005). A Field Guide to Fungi of Australia. Blooming Books.

Animal dung provides an environment rich in nitrogen as well as various enzymes from the animal's digestive system. From a fungal point of view, herbivore dung is the more interesting, since bacteria are largely responsible for the breakdown of carnivore dung. Herbivore dung supports a wide variety of **coprophilous** fungi. The word coprophilous literally means "dung loving". Many species of dung fungi have spores with thick walls, which weaken during passage through an animal's gut preparing the spores for germination, once they have been deposited with the animal's droppings. The spores are so hardy that samples of dried dung can later be rehydrated, allowing the fungus to fruit weeks later.

Herbivore dung typically contains plant material digested to varying extents. *Cyathus stercoreus,* one of the Bird-nest Fungi, is widespread in Australia as well as being found in many other countries. While often found on dung, *Cyathus stercoreus* also grows on rich soil such as in gardens receiving fertiliser. There are also various mushroom-producing coprophilous species – especially in the genera *Bolbitius, Conocybe, Coprinellus, Coprinopsis, Coprinus, Cyathus, Deconica, Panaeolus* and *Psilocybe*. If you incubate a dung sample such as a cow pat and observe it for many weeks you will see a sequence of fruiting bodies appearing on it. First come the pioneering species: these change the chemical composition of the dung, breaking it down and producing many types of sugars, etc. This stimulates other spores in the dung to germinate, or mycelia that were already present in the dung to produce fruiting bodies.

At the time the dung drops to the ground there are likely to be a number of fungal species already in it with spores ready to germinate. Many of these germinate at much the same time but the mycelia then grow at varying speeds. Thus, in some cases the sequence of fruiting body appearances reflects the speed of mycelial growth, and how quickly a mycelium can accumulate enough resources to allow the production of fruiting bodies. Some dung fungi, though slow growing, are very antagonistic to other species and are able to destroy or severely inhibit other mycelia using enzymes and antibiotics.

If you are observing dung in the field, some spores may germinate later, spores from elsewhere may land on the dung and then germinate and grow there, or mycelia from elsewhere may move into the dung from the surrounding soil. As well as fungi, various bacteria, nematodes, mites and flies also make use of dung, carrying new spores onto it. In the paddock or forest the moisture content of the dung may vary from hour to hour or day to day. All in all, dung is a complex environment and the interactions between all these organisms (and the weather) will also influence the appearance of fruiting bodies.

Remember that un-germinated spores remaining in the dung will

not produce fruit as it is exhausted as a food source and, in general, grazing animals do not eat dung so the fungus has no opportunity for further distribution. To overcome this, some species have developed means of discharging spores several metres. An example of this is the genus *Pilobolus*, illustrated above and discussed at length in CFF No 6 December 2017. This excellent photograph was taken by Ray Palmer

Ever Stop to Think?

Fungi, e.g. some *Mycena* species, are often observed growing out of wood-borer holes in fallen logs in various stages of decay. The substrate for the fungal mycelia seems to be the frass (powdered wood) left in the holes by the borers' activity, not the wood. The stage of decay of the wood does not seem to matter. Question: are the fungi spores or mycelium transported by the borers or are the fungi just making use of the frass as a more manageable (not as hard) substrate? In some cases, fungi that normally grow directly on the wood seem to preferentially grow out of the holes, e.g. *Pycnoporus* (see picture). Note there are two cracks also in the wood but there is no fungus visible in them so maybe it is not just that the fungus grows in a place of less resistance. Clearly the slug thinks the fungus is yummy!

Did you know - *it's not just ants that can become zombies!*

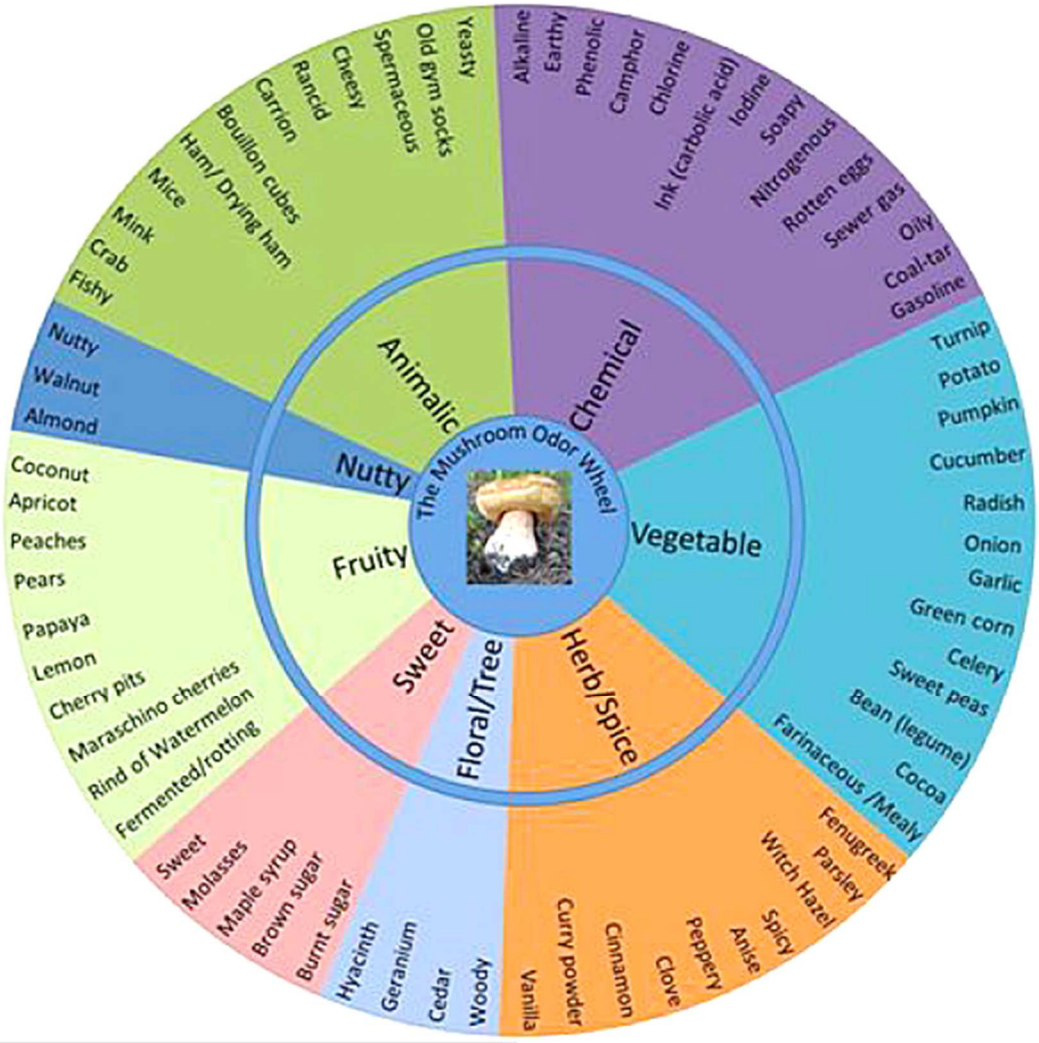
Entomophthora muscae is a species of fungus which causes a fatal disease in many species of flies. Soon after a fly dies from infection with this fungus, fruiting bodies are produced from between the insect's segments. When the spores are mature they are ejected and may fall onto flies resting nearby. Once on a fly, the spores germinate within a few hours and a germ tube begins to penetrate the insect's hard skin (the cuticle). Once this tube reaches the fly's body cavity the fungus flows through the tube and into the fly's blood. The mycelium of the fungus may grow into an area of the brain that controls the behaviour of the fly, forcing it to land on a surface and crawl upwards. The hyphae gradually grow through the whole of the body, digesting the guts, and the fly dies in about five to seven days.

When it is critically ill, the fly tends to crawl to a high point, straighten its hind legs and open its wings, a behaviour that ensures that the fungal spores are dispersed as widely as possible. Some three hours later, new fruiting bodies develop, and a new shower of spores starts. Outbreaks of infection with *Entomophthora muscae* tend to occur in the spring and autumn so this is the time to watch for them although the fungus is mainly found in cooler parts of Australia. The corpses of flies are frequently seen attached to windows or window frames, a place where other flies may easily become infected. In the open, they may be seen

attached to the underneath of leaves, on fences and in places where flies congregate like rubbish tips, walls, in agricultural buildings and poultry houses.

Fungus odour wheel

The odour of fungi is a character that is often ignored, but can be very useful in some identifications. In an attempt to standardise the description of odours the following odour wheel has been created.



Source:https://www.thefriendlyfungus.com/post/fungi-s-odor-related-latin-roots

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