FUNGI FORAGERS

No. 14, April 2019

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

Barry Muir, Editor Jenn Muir

LAUNCH OF POCKET FIELD GUIDE "*Australian Tropical Mushrooms & other Fungi*"

The official launch of the Australian Tropical Mushrooms & other Fungi field guide took place in Innisfail on 15 March, hosted by the Johnstone Ecological Society. This was followed by regional launches at TREAT at Lake Eacham, Kuranda Envirocare, then at Cairns Botanic Gardens (Flecker Garden) on 25 March. The launch in the Flecker Garden was followed by a tour in the Garden and, although primarily about plants, several *Phallus indusiatus*, *Gymnopus* sp and *Crepidotus* sp were found during the walk. The Guide is on sale for $10 a copy at "Friends House" in Flecker Garden and at the Cairns Regional Council's Botanic Gardens Information Centre.

Sapphire McMullan-Fisher and Fran Guard, the prime-movers of the guide, present information on how the guide is used.

Photo: Jenn Muir

19 people attended the launch in the beautiful tropical Flecker Botanic Garden, Cairns.

Photo: Jenn Muir

IN SEARCH OF FOXFIRE FUNGI: THE GLOWING FOREST

by Linda Reinhold

I once saw glow-in-the-dark mushrooms whilst working in the Conondale Ranges in the most westerly part of the Sunshine Coast hinterland in the late 1990s. We were walking to an old gold mine at night to look for bats and were stunned to see a cluster of tall-stemmed mushrooms glowing on the forest floor. I remember them as having a bluish luminescence, but my co-worker remembers it as greenish. Back then I didn't have a camera that could capture such a spectacle. I was astonished that there were such things on Earth. We marvelled at them for some time, then continued with our work. As a zoologist, I have spent thousands of nights traipsing about after various nocturnal animals, but I hadn't seen glowing mushrooms since… Until I moved to Cairns.

Glowing mushroom on the Lake Eacham expedition, in darkness and in partial light.

In May last year, the Malanda Falls Visitor Centre put out a flyer advertising "Things to look out for in May". One of them was bioluminescent fungi. Seizing on this, I planned an expedition, doing a reccy of suitable tracks (the Rainforest Walk, Tulip Oak Walk and Curtain Fig) in the daytime, then waited for nightfall. Every few metres we'd turn off our torches and look around. Lots of things glow in the forest at night; single point fungi, little insects and whole rotting logs. I'd read in a 2002 *Tropical Topics* newsletter that the mycelia of *Mycena chlorophos* glows. Indeed, wood covered in glowing mycelia lit up the forest floor. The whole experience made me feel like we were in the fictional forests of *Pandora*. But there was not one mushroom a-fruit. By mid-May it was already too dry.

The Malanda Falls Visitor Centre advised, "The best time to see them is after the rain, but cold can affect them". In the meantime, people told me they'd seen them in February, seen them at Cape Tribulation, seen them on the Green Arrow Trail at Mt Whitfield, in Barron Gorge, at Lake Placid and at the Cairns Botanic Gardens. People probably have them in their backyards! It seemed they were everywhere around Cairns and everyone had seen them. But considering the frenzy of tourism these fungi create in southern states, I was surprised there wasn't more buzz surrounding them. There was nothing to do but wait until the next wet season.

On March 25th (2019) I went to the Queensland Mycological Society's Tropical Fungi brochure launch, in Cairns Botanic Gardens, with one pressing question: "Where can I go to see glow-in-the-dark fungi?" They were currently glowing all over Kuranda, but on people's private properties. The mycologist helpfully said she'd previously seen them along the Jum Rum Creek Track.

Two days later, up we went. There were a lot of promising sites on the daytime reccy, but none of these glowed at night. Scouting the track in the daytime is useful to familiarise yourself with the lay of the land, but useless to find glowing fungi if you are clueless to the species. They are far easier to spot glowing out of the dark forest.

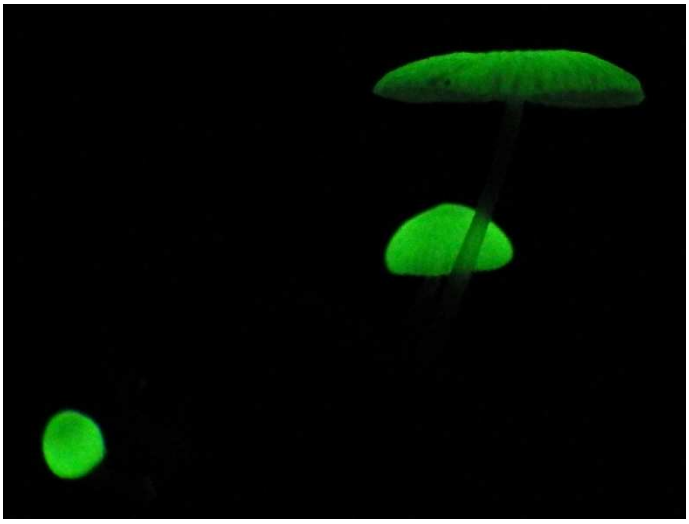
A Jum Rum specimen, about 1.3 cm across.

During one of the expeditions, I dashed back to the car to get something to sit the camera on for a couple of mushrooms that were higher up on a log. I noticed that when you are charging through the forest with your head torch on, you don't notice the glowing mushrooms. You have to be *looking* for them. You can't have your torch up high as the torchlight will reflect back at your eyes and wash out the glow. Hold the torch down in your hand, pointed downwards, and only allow as much light to spill as you need to see the track.

That night, a *Mixophyes shevelli* (northern barred frog) met us at the start of the track. Its mates were calling down by the creek, "Wahk!".

I walked along in the dark and my partner walked ahead with a torch calling out, "Stairs!", so I wouldn't fall down the many short flights of steps. And success! There were glowing mushrooms fruiting everywhere! These were mushrooms I hadn't even noticed on the daytime reccy. In full light the mushrooms have no green hue but are translucent white. They were much tinier than I expected, perhaps a tenth the size of the Conondale specimens. The tiniest ones, only a few mm across, were shaped like miniature cocktail parasols, fine and long-stemmed and all white. Others were comparatively squat with thicker, glossy caps with brown over the top. There were hundreds of them: hundreds of actual mushrooms quietly glowing in the forest!

Tiny Jum Rum mushroom, in the light then in darkness on night-time tripod mode.



The whole of the caps glow, and the stems are translucent.

The same cluster, for scale.

Following a tantalising lead from a website about dragonflies, I was also keen to check out Lake Eacham for glowing fungi. The 8th of April seemed like good conditions, a nice dry night after good rains through the preceding week. We didn't do a daytime reccy for the Eacham expedition, as we knew our way around the lake, and you can't get lost if you keep the lake on your right. You don't have to worry about falling down stairs, but you want to be careful to stay on the track as there are steep drops off to the lake side. A crescent moon was setting, leaving a star-filled sky reflecting off the lake, a worthy sight in itself. I used a dull torch, just bright enough to see the track, but not affect my periphery night vision. My co-expeditioner walked ahead with a brighter torch, and could still see most glowing fungi quite well, calling out to me when he'd come across one.

The fan shaped species that was lighting up a whole tree.

We started to notice the usual glowing things, most small, the occasional firefly. There were little things glowing on the forest floor, up on branches and vines, both close to the track and into the forest. Then we came across glowing mushrooms like from the Jum Rum, but bigger. They weren't quite glowing bright enough for the camera though. Further on and at the edge of the track there was an entire tree covered with another species of glowing fungi. It was a wondrous display to stand there in the dark and behold, but despite several attempts I couldn't get my cameras to pick up on the greenish glow. The gills were populated by

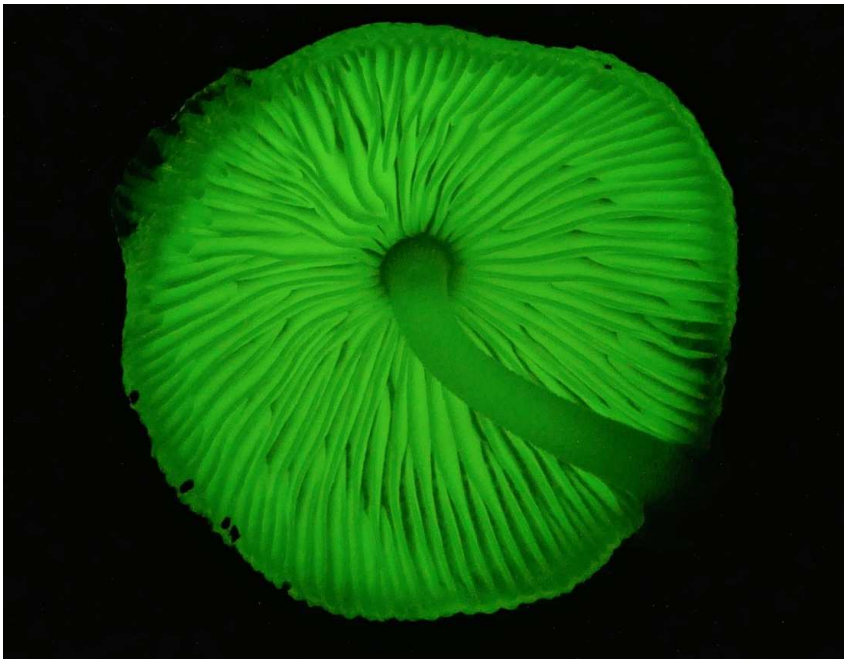
staphylinid (rove) beetles. These fungi were fan shaped and much larger than the mushrooms. They matched some descriptions of the variable ghost fungus, *Omphalotus nidiformis*. Ghost fungi are supposed to grow at the base of trees or on stumps, yet these went some metres up the trunk. The 2002 *Tropical Topics* newsletter observed that species of ghost fungus don't glow in the tropics. The 2019 *Australian Tropical Mushrooms & other Fungi* field guide, however, lists the same species from southern climes as also glowing here. A little further along there was a stunningly bright cluster, large size and at peak luminosity, but way too high up a tree to get to.

We found the best specimens of mushroom, glowing brightly and visible from way down the track, at the map sign where the track branches. They were conveniently on wood at ground level, a couple of cm across the cap, and at full luminosity. We walked the rest of the 3 km around the lake, passing lots of little glowing things and glowing logs, the wood of entire small trees in some cases (also too dull to be picked up by a camera), but only came across one other rotting log hosting brightly photographable fungi.

The largest mushroom on the second Jum Rum expedition, at 1.7 cm across the cap

A springtail investigates a glowing mushroom on the other side of Lake Eacham.

Some of the glowing mushrooms at Lake Eacham and at Kuranda were attracting a range of invertebrates, including staphylinid beetles, other beetles and springtails. Most were amongst the gills, while others crawled around the cap.



I tried my luck one more time with a solo expedition on 23rd April. I headed back up to Kuranda, along the Jungle Walk (where there was nothing glowing, *nothing*) and the Jum Rum Creek Track again. The Jum Rum delivered, with single point fungi, some small foxfire logs and a smattering of tiny mushrooms glowing out of logs on the forest floor. The night was warm and starry and during the longer camera exposures I watched the fireflies flit through the canopy, sometimes flying down right beside me. Down by the creek, the night air was filled with the calls of *Papurana daemeli* (wood frogs), sounding like so many squeaking little rubber boots. The *Mixophyes* were silent on this night.

Most of the glow photos in this article were photographed with my Ricoh WG-4 “Adventure Proof” camera, set to 1 cm macro, mostly on automatic mode with only a couple of seconds of exposure. The two glow photos on the previous page from the last Jum Rum expedition are from my Panasonic Lumix TZ80 camera on a 60 second exposure. The camera was stabilised on a bag of rice, with the self-timer set on two seconds to eliminate movement.

Dr David Britton identified the invertebrates.

Luminescent fungi were already well-known to Aboriginal Australians, with people of some regions associating the strange glow with spirits and the supernatural activities of Dreamtime ancestors. The first written record of glowing fungi was by Aristotle in 382 BC, though at the time it was thought to be a cold fire burning in logs. The light is called “foxfire”, though some call it “fairy fire”. In 1555 the Swedish scholar Olaus Magnus wrote of luminous mushrooms. Researchers have since described how the fungal metabolite hispidin creates luciferin and the luciferase enzyme, which oxidise to create bioluminescence. For the latest science on fungal oxyluciferin, read: Kaskova et al. 2017, *Mechanism and colour modulation of fungal bioluminescence*. Science Advances **3**:4.

A Question of Taxonomy

Although the Cairns Fungi Foragers (CFF) newsletter is primarily ecological, occasionally a taxonomic (classification) question arises. In CFF No. 13 page 4, there was a picture of a clump of large mycorrhizal mushrooms that were labelled *Amanita* species. Several people contacted me and said that they were more likely to be *Chlorophyllum* or *Macrolepiota.* Fair enough – I also thought they were *Macrolepiota* when I first saw them. The answer then comes down to comparison of some distinguishing characters of the three genera: *Amanita, Chlorophyllum* and *Macrolepiota.*

Feature	**Amanita**	**Chlorophyllum**	**Macrolepiota**	**CFF No. 13 page 4**
Spore germ pore	None	Broad	Narrow or broad	None
Reaction to Meltzer’s Reagent	Starchy or non-starchy	Containing dextrin	Containing dextrin	Strongly starchy
Odour	Often chemical	Mushroomy	Mushroomy	Strong odour of bleach

Based on these criteria, the CFF No. 13 page 4 specimens were *Amanita* rather than the other two genera. This is not too surprising – we find many species of fungi in Tropical North Queensland that do not fit the accepted criteria, primarily because they have not been studied in detail. The second lesson from this is that the three criteria that indicate it was an *Amanita* are not visible in a picture and so identification of TNQ fungi based solely on a picture is a risky business.

For those interested: the spore germ pore is a tiny pore on the end of the spores that is the point where the hypha pushes through when the spore germinates. Meltzer’s Reagent is an iodine-based chemical that reacts with starch to produce a blue colouration. With some fungi the spore reaction with Meltzer’s Reagent is with dextrin sugar in the spore and turns the spores a golden-brown colour.

DECAY FUNGI

Part 2 – FUNGI THAT ATTACK ANIMALS

In the February 2019 Cairns Fungi Foragers (CFF) No. 13, we discussed fungi that grow on plants and decay their wood. Fungi can also grow on, and in, invertebrate animals (animals without backbones such as insects and nematode worms - see CFF No. 10 August 2018) and vertebrate animals (animals with backbones like fish, cattle and us). Fungi which attack insects and nematodes, for example, play an important role in keeping populations of these animals under control.

A wide range of fungi attacks insects. Some of the best-known and most spectacular belong in the Ascomycota (sac fungi) group. These fungi infect and consume insects such as grass-hoppers, moths, caterpillars and ants, and then form conspicuous fruiting bodies that emerge from their victim's corpse

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A "Zombie Ant" with the fruit body of the fungus growing out from its head

These fungi can also alter the insect's behaviour. The well-known "Zombie Ant" fungi infect insect brains, directing the victim to climb up plants to a high point and bite into the plant tissue in a "death grip", preventing it from falling off. The fungus then fruits from a stalk that grows behind the Ant's head and releases its spores above the ground, greatly enhancing spore dispersal. Marks have been found on fossilised leaves that suggest this ability to modify the Ant's behavior evolved more than 48 million years ago.

Interestingly, humans have been using one of these specialised fungi, *Ophiocordyceps sinensis*, reputedly for thousands of years (although there is no documented proof further back than the 15th Century) as a medicine to treat a wide range of ailments. It is also an important component of traditional Asian medicine. The supposed benefits include anti-tumour, anti-viral and many other properties, although if one searches the literature there is very little documented proof that the extract does anything at all.

Dead caterpillars infected with *Ophiocordyceps*. waiting to be sold as Chinese medicine.

Another fungus, *Beauveria bassiana,* reproduces by tiny fragment-like structures called conidia instead of spores. It also is in the Ascomycetes (sac fungi) group and closely related to *Cordyceps* – in fact it may be *Cordyceps* in a non-spore producing form. *Beauvaria* is so effective in killing insects that it is used as a biological control agent for insect pests.

Beauveria growing on a dead grasshopper

Colony Collapse Disorder (CCD) is destroying honey bee colonies worldwide and has been associated with co-infection by a virus (Invertebrate Iridescent Virus, or IIV6) and a fungus, *Nosema ceranae.* Neither the fungus nor the virus alone kills the bees but the two combined will, wiping out whole bee hives. So far as I

can find out, CCD has not been found in Australia and this is one of the reasons that Quarantine Services won't allow tourists to bring honey into Australia.

Some fungi are specialized parasites of nematodes, rotifers, and microscopic animals in the soil. A common nematode predator is *Arthrobotrys oligospora,* a fungus that has evolved sticky networks of hyphae for trapping nematodes. Once the nematode is immobilized, the fungus invades and consumes its body. More information was provided in CFF No. 10 August 2018.

There are probably about 200-300 fungal species that attack higher animals. Fungi can become a problem if fish are stressed[1] by disease, by poor environmental conditions, poor nutrition, or are injured. An example of a common fungus that attacks fish is *Saprolegnia* which is a pest among fish kept in aquariums. If a fish gets injured, such as losing a scale for example, the fungus gets into the fish's flesh and spreads through the body, eventually killing it.

Saprolegnia growing on a goldfish

Another is *Branchiomyces* fungus or "Gill Rot". The disease is a problem in Europe and the USA but may also be in Australia. Fish with infections are usually suffering from environmental stress, such as water that is too acid, too low in dissolved oxygen, or when there are algal blooms (situations where algae have become too abundant, usually caused by fertiliser entering creeks and ponds).

Batrachochytrium dendrobatidis is a member of the fungal group Chytridiomycota and causes "Chytrid Disease" of frogs. It has had a devastating effect on many frog populations throughout Australia and the world. The fungus doesn't invade the frog's body, but it disrupts the frog's body chemistry, killing it by heart failure.

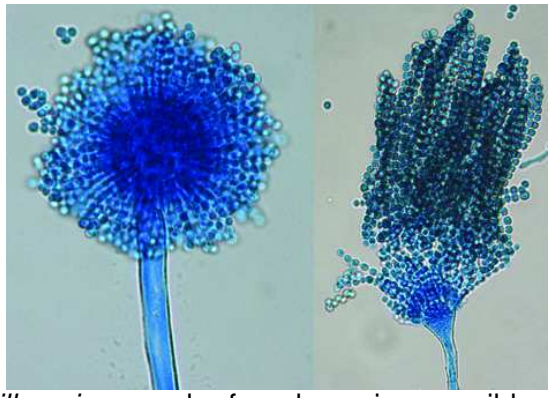
Fungus infection of the skin is common in reptiles, especially lizards. Organisms include *Basidiobolus, Geotrichium*, *Paecilomyces* and others, including *Aspergillus.* Typically, the fungi invade when the skin is damaged, therefore infection is more common in animals from habitats that are damp and have limited sunlit areas, such as rainforests, even if the animals may be adapted to those damp environments. Areas where the animals are under stress, such as where land clearing or logging are occurring also have higher risk of infection.

Crocodiles spend much of their lives in water so are exposed to and attacked by many fungi. Most croc fungi affect the skin, especially through bite wounds because they fight and take chunks out of each other. One of the fungi, *Fusarium* also attacks crocodile eggs and kills them. These sorts of diseases are important in crocodile farms where crocs are hatched and grown for meat and skins. The young crocs are especially prone to fungal disease. Crocs also get *Aspergillu*s fungi in their lungs (as do turtles) and some are affected by *Beauveria,* a fungal infection also known to kill silkworms. *Beauvaria* has also been recorded on a human, so it is obviously not too fussy what host it uses.

About 10 fungi commonly attack birds, and *Aspergillus*, probably the commonest, is a major pest where birds are kept close together such as in pigeon roosts and chicken sheds. *Aspergillus* can be found naturally on damp ground and hence on seed from grasses, etc., in damp situations. It is especially common at feeding stations where well-meaning people put out food to attract wild birds. These feeding stations are among the main sources of disease in wild birds because sick birds mix closely with healthy birds and sometimes poop in the feeding trays. The poop can then be picked up on food or directly by other birds while feeding. Throwing uneaten food on the ground makes the risk of disease even higher. *Aspergillus* spores inhaled into the lungs and air sacs of birds eventually cause pneumonia and bronchitis. Sick birds experience laboured breathing, weakness, and diarrhoea, but will continue to take food at feed stations until they die. Wild birds are perfectly able to look after themselves, so feeding stations are strictly for our pleasure, not that of the birds.

[1] Stress is not limited to animals being disturbed or moved. Overly hot or cold temperatures, poor lighting in aquariums or cages, and other environmental factors, all register as "stress" to the animal's immune system. Other diseases also tax the immune system and thereby assist fungi in becoming established – in fact, secondary infection is perhaps the most common form of fungal attack.

Aspergillus (microscope pictures)



You will have noticed from the text above that *Aspergillus* keeps cropping up. *Aspergillus* is a very common fungus that mostly reproduces by conidia, rather than by spores. Conidia are simple little particles produced in the same way as spores but they contain only one set of DNA. The fungi have the ability to grow where high concentrations of sugar or salt exist. *Aspergillus* species are found in almost all oxygen-rich environments, where they commonly grow as moulds on the surface of a substrate rich in carbon. Thus, they often contaminate starchy foods such as bread and potatoes. *Aspergillus niger* can be found growing as mildew on damp places in the home such as ceilings in poorly-ventilated bathrooms and laundries, or in the cracks in tiles in shower recesses. It is only our immune system that stops it growing in us – most of the time. Most humans are thought to inhale thousands of *Aspergillus* spores daily, but they do not affect most people's health due to their having effective immune systems. Most infections occur in people with underlying illnesses such as tuberculosis or chronic obstructive pulmonary disease (COPD) caused by cigarette smoking, or immune system diseases such as Acquired Immune Deficiency Syndrome (AIDS). Nonetheless, Aspergillosis is thought to account for around 600,000 human deaths annually worldwide.

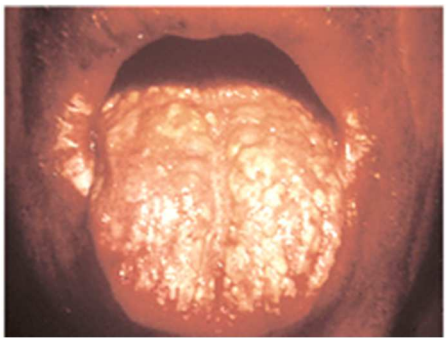
A devastating fungus parasite of animals in colder parts of North America and Europe is *Pseudogymnoascus destructans* which causes 'white-nose syndrome' in bats. This fungus colonizes the skin on the muzzles, ears and wing membranes of some types of bats while they are hibernating and eventually kills them. So far it has had major impacts on eleven species of Northern Hemisphere bats, many of which were already endangered by habitat destruction. Because the bats cluster tightly together in caves during the cold hibernating period it is very easy for the fungus to spread from one bat to another.

Some of our microbats such as the Little Bentwing Bat (*Miniopteris australis*) and some of our larger fruit bats, live in colonies. If a disease such as *Pseudogymnoascus* ever got into Australia it would be disastrous. The microbats consume millions of insects such as mosquitos and midges, so are essential to human health. The fruit bats eat fruit and drop the seeds in their poops in other parts of the rainforest, so they are vital in maintaining the health of the rainforest on which we depend for clean water and tourism.

A tightly packed cluster of several dozen Little Bent-wing Bats

Fungal diseases also affect cats, dogs, sheep, cattle, horses and pigs. Cats get a fungus disease called *Sporothrix* which infects the skin, lungs, bones and sometimes the brain. It gets into the cat through abrasions of the skin or by the cat breathing it in. The fungus is naturally found in soil and on plants but can transfer between different animal species, and between animals and humans. Cats are the highest risk for transmitting the infection to people, especially male cats that roam outdoors and fight, getting wounded in the process. Animals exposed to soil rich in decaying organic debris appear to be at higher risk of catching the disease. *Aspergillus* infection also affects cats and dogs, causing nose infections, lethargy, depression, vomiting, and diarrhoea. It may also cause strange symptoms such as protruding eyeballs. The risk of transferring some of these fungal diseases to us humans is high and that is why we shouldn't let cats or dogs lick our faces - quite apart from what part of their body they were licking just a few minutes before!

In humans, there are several different types of fungal infections, known as "mycoses." The most common colonize skin, fingernails and toenails and we can catch many of them by walking around in bare feet where animals and infected people have been walking (see picture at right). Ringworm (not a worm, and also called Tinea or Athlete's Foot) is a fungus (*Microsporum gypseum)* that can be contracted from garden soil, or from dogs and cats *(Microsporum canis*), or from other people who have the fungus. While generally harmless, ringworm is highly contagious to humans, especially to children, the elderly and anyone with a compromised immune system (e.g. people undergoing chemotherapy). It causes unsightly and difficult to treat red rashes on the skin but is rarely serious.



Some fungi are normal on and in healthy people but become dangerous in people with weak or compromised immune systems. *Candida* species (thrush – shown left growing on an adult's tongue) cause yeast infections in the mouth of many healthy people but can also cause diseases collectively called candidiasis in babies and individuals of poor health.

Some fungi are inhaled as spores and may infect the lungs. These fungi include *Coccidioides* Disease and *Histoplasma capsulatum* (Histoplasmosis) which is a disease sometimes contracted by cave explorers breathing in dust from caves inhabited by bats, although it is also common in chicken coops and old pigeon roosts. The fungus is also found in soil contaminated by bird or bat droppings, so farmers and landscapers, and people doing demolition work on old buildings, are at a higher risk of contracting the Disease.

Despite all the issues with fungal diseases, very few among the millions of fungal species fulfil four basic conditions necessary to infect humans:

1. the fungus must be able to tolerate a high temperature because humans and other mammals maintain their body temperature quite closely and this is too warm for most fungi. In fact, when we get ill our temperature rises even higher, increasing the likelihood that bacteria and fungi will not be able to survive;
2. the fungi must have the ability to invade the human host – if we are careful to wear shoes in the garden and don't let animals lick our faces, for example, we greatly reduce the risk of infection;
3. the fungus must have the chemistry necessary to attack and consume human tissue. Most of the plant decay fungi, for example (perhaps with the exception of *Schizophyllum commune*), do not have that ability; and
4. they must be able to resist the human immune responses when our bodies are trying to kill the infection.

Ever stopped to think?

The word 'fungus' was originally derived from the Greek *sphongos* (σφόγγος "sponge") used by the Greek writers Horace and Pliny around the time of Christ's birth, and later into the Latin *fungus* meaning mushroom.

The word '*mycology*, ', meaning the scientific study of fungi, is derived from the Greek *mykes* (μύκης "mushroom") and *logos* (λόγος "discourse"). The Latin form of "mycology" (*mycologicæ*) appeared in 1796 in a book on the subject by Christiaan Hendrik Persoon.

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