FUNGI FORAGERS

No. 19, April 2020

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

FUNGI GO A WANDERING!

Cairns Fungi Foragers (CFF) No. 18 (February 2020) had an article about how Gondwana came to be and how it split up over a long period carrying some fungi with it. This prompted a couple of readers to ask about the next step in that process and to ask what fungi were carried where.

Firstly, there are really ancient groups that arose when Pangaea was still kicking about. *Mycena* is probably one of those genera, because it occurs all over the world, although individual species may be restricted to Europe, Asia, North America, Africa, Australia or South America.

Laetoporus portentosus (left) is a bracket-pored fungus that occurs in Australia, New Zealand, Chile and Argentina and is almost certainly a Gondwana species.

Phaeotrametes decipiens is a weird polypore which seems unrelated to most other polypores. It is found in Eastern and Western Australia, Brazil, Uruguay, Madagascar, and the east African mainland. (Photograph Fran Guard, reproduced with thanks)

The common, well-known Coppercup or Pixie-cup fungus (*Microporus xanthopus*), is found throughout Australia and tropical Africa and Asia but does not occur in the Americas or in Europe.

There are also many species in common between Australia, Papua-New Guinea and Indonesia into south-east Asia and Africa; such as the common *Lentinus sajor-caju* (right)

Even some of the common species such as the Stinkhorn *Phallus indusiatus* (left) can have interesting distributions. This species is found in Africa (Congo, Nigeria, Uganda, and Zaire), South America (Brazil, Guyana and Venezuela), Central America (Costa Rica, Tobago and Mexico), Indonesia, Nepal, Malaysia, India, southern China, Japan and Taiwan as well as Australia – a true cosmopolitan species mostly in the Gondwana continents and perhaps carried into the northern hemisphere by human activity.

HOW DO MUSHROOM SPECIES EVOLVE?

The following article is derived, modified, paraphrased, summarised and generally mutilated from "How do mushroom species evolve?", by Andrus Voitk (2012). Formal approval to use the article has not been obtained and it or any part of its contents are to be used for thought-provocation only. The original source is: *Omphalina*, described by the authors as "*the lackadaisical newsletter of Foray Newfoundland & Labrador. Issues of* OMPHALINA *are archived in: Library and Archives Canada's Electronic Collection http://epe.lac-bac.gc.ca/100/201/300/omphalina/index.html, and Centre for Newfoundland Studies, Queen Elizabeth II Library, where a copy is also printed and archived at http://collections.mun.ca/cdm4/description.php?phpReturn=typeListing.php&id=162.*

In Darwin's "survival of the fittest" evolutionary theory, just as in our society, fitness is not the result of jogging or pumping iron, but the ability to thrive in a given set of conditions. Not all members of a species are identical. Some members may be better suited to the environment, others less so. Those that cope well will survive and reproduce, while those that wither under the same conditions will eventually die out.

New species evolve from old in response to changes or differing conditions. Let us consider a theoretical model of how a fungus genus called *Whatsis* might evolve when exposed to the different conditions of North Queensland, New South Wales and Victoria. Let us suppose that *Whatsis satu,* growing in Victoria, has elliptical spores, a bit longer than they are wide. Just like us, not all individuals are exactly alike: some have wider spores, almost round, while the spores of others are a bit more elongated and narrower. Now suppose that for various reasons *Whatsis satu* spreads north from Victoria to both the warmer winter-wet habitats of New South Wales and to the hot, humid summer-wet areas of North Queensland. In the warmer New South Wales, let us speculate that much of the nutrition needed for spores to grow into mycelia lies on top of the ground, and the underside of this superficial layer is frequently moistened by rainfall in winter. Rain may force narrow spores deeper into the earth between granules of sand and organic matter.

Fat, round spores would tend to stay relatively close to the surface. The round spores, lodged in the most nutrient-rich upper layers of the substrate, would produce robust fungal networks. The more deeply penetrating narrow spores would be disadvantaged and find growing difficult, made more so by the need to compete with their stronger sisters. Over the course of hundreds of years of reproduction, these conditions would select the plump-spored members as the "fittest", while the individuals of *Whatsis satu* arising from elongated spores would eventually fail to thrive and disappear. Thus, after hundreds of years, the spores of mushrooms that started as *Whatsis satu* will look quite different in New South Wales from the spores of the original *Whatsis satu* back home in Victoria. If spore width is genetically determined, then the selection process in New South Wales will have weeded out from the gene pool organisms with genes that produce narrow spores and kept only those with genes that produce plump spores.

While this went on in New South Wales, things were quite different in summer-wet North Queensland. Suppose that the mycelium of *Whatsis satu* is intolerant to thick compacted mats of fallen leaves. Therefore, while the spores of plump-spored individuals germinated well, the acidic matted leaves killed the mycelium that developed. The spores of narrow-spored members washed through the litter and deeper into the ground, below the leaf-layer. While they did not have as much available nutrients as the plump spore, when they did germinate, any mycelium that did develop was much more likely to survive the intense wet seasons as it was protected by the litter layer. Since these organisms did not have to compete with more robust superficial sisters, they were able to survive. After hundreds of years the original *Whatsis satu* of Victoria will differ both structurally and genetically from its offspring in Queensland.

Next, suppose that the different conditions also favoured other character traits. For example, let's assume the original *Whatsis satu* had a tan-coloured cap. Of course, not all were the same shade, and individuals within the species had caps varying from off-white to medium brown or darker. In New South Wales, winter warm spells were a problem, and over the years those individuals with darker caps that absorb heat, failed to thrive. The opposite happened in North Queensland, where, although they were in a hotter environment it was also very humid, wet-season temperatures were usually not excessive and the dark caps help to hide the fungi from predators in the dense rainforest. After centuries, almost all progeny of the original *Whatsis satu* of Victoria produced light-coloured and plump-spored mushrooms in New South Wales and dark-coloured ones with elongated spores in North Queensland.

Now it is easy to imagine additional characteristics that might be favoured in one habitat or the other, so that selection in each region will eventually produce entirely different looking mushrooms from each other and from *Whatsis satu,* their original species. Since these characteristics are genetically determined, and since some genetic lines will be retarded and others encouraged, the groups in the different locations will, over time, evolve into different species. We, who were not party to this development over thousands of years, only see that we are dealing with three sister species, quite different from each other: *Whatsis satu* in Victoria, *Whatsis dua* in New South Wales and *Whatsis tiga* in North Queensland. When we compare the DNA of their genetic make-ups, we discover, to nobody's surprise, that these also differ.

Enotake-form (left) and wild form (right) of *Flammulina velutipes.* A perfect example of how species can look different when they adapt to different habitat conditions. Internet pic. from Kuo, M. (2013, February). *Flammulina velutipes.* From *MushroomExpert.Com* Web site: http://www.mushroomexpert.com/flammulina_velutipes.html

The above illustrates the possible fate of isolated stable populations. If, for some reason, winds blew spores back and forth across the three states there would be continual mixing of genetic material. The selective processes would still be operational, but their effect would be less evident because of constant genetic mixing. The combined population of both Victoria and New South Wales would eventually differ somewhat from the original *Whatsis satu*, possibly expressed on one extreme in Victoria and another in New South Wales, but the overlap would be so great and the differences so small, that much more time would be required before two distinct populations would emerge, if ever. Coming late on the scene, we may be able to detect only one species, *Whatsis dua* in both Victoria and New South Wales—a species complex well worth keeping our eye on, for it might change just about any millennium now!

But wait, there's more! We have seen how species might evolve in response to different environments. Our overly simplified model also allows us to understand the process of extinction. Adjusting to a habitat allows the most efficient use of existing conditions. This gives one species a clear edge over other competing species with a less perfect fit to the habitat. However, the advantage can also become a major disadvantage, should the habitat change.

Suppose that summer-wet North Queensland undergoes warming resulting in lower summer rainfall. Now poor *Whatsis tiga*, who had taken centuries to adjust itself to thrive in local conditions, would be in trouble. Having shed any coping mechanisms it didn't need; it would suffer in the new conditions. Its dark fruit bodies would absorb more heat under thinning forest canopies and may wither before setting spores. What spores were shed would be washed down into the deeper soil with less nutrients, giving an edge to competitors that thrive in the richer upper leaf-mulch layers. If the habitat change were sufficiently sudden and severe, say over tens of years rather than hundreds of years, *Whatsis tiga* would become extinct in short order. That is evolution: species come and species go. Whether they thrive or die, depends on how well they fit their living conditions. "Fitness" does not mean brawn or stamina, but the ability to utilize what is on hand. In the shorter term, organisms with the best fit to their environment survive and others die out. Over the long term, however, ability to survive requires adaptability; an ability to adjust to environmental changes, not unlike our definition of intelligence. Organisms able to adjust to change survive, whereas those that have become too specialized are at greater risk of dying out, should there be a change in their environment. It is just like life in our society – have a think about the coronavirus impacts.

FOOTNOTE:

Those of us working in Tropical North Queensland frequently find that the fungi we are studying ***almost*** fit the taxonomic descriptions, but not exactly. This is because we are looking at intermediate stages in the evolutionary process, as are all mycologists everywhere. The problem for us is that the fungi of this region are poorly known and so the full range of variability in species has not been recognised and incorporated into the taxonomic descriptions. That is why it is vital for us to collect good specimens and send them to herbaria where, over time, they can be studied and modified descriptions prepared.

Other aspects are, firstly, the tendency for "new" species to be found so regularly up here. They may just be variations of already known species that are simply adapted to local conditions. That is why we should not rely on photographs on the Internet for identifications. The fine degree of variation between "species" is not apparent in a photograph and we thus *assume* that a fungus is the same as the one in the picture. It may not be! Collect, preserve and send to an expert is the *only* way to be sure. Many a new species has been discovered by this simple procedure. The experts, of whom there are very few in Australia, may be too busy to get back to you but at least the specimen is preserved for future studies.

Additionally, don't believe that DNA studies can clarify the situation. If the DNA of a specimen differs by, say, 2% from another specimen it may still be considered the same species. A different specimen may differ by, say, 5% and be considered a different species. Two questions – (1) what do you do with the ones that differed by 3 % or 4%? Are they the same or not? (2) Why is 5 % difference considered enough to define a different species? Why not 10%; why not 20%? The whole thing is quite arbitrary (but generally uses 3% as a guideline) and is guided by "accepted procedures", whatever they are, because many taxonomists seem to have definitions of their own. As one scientist has said "*N*o genus, species or variety of a fungus, plant, animal or anything else exists in the physical world; none ever have, and none ever will. They are simply mental constructions by us fallible humans in a vain attempt to put names on everything we encounter…it seems to be a human foible". (Mann, H.,2012: Taxonomy, Madness and Life. Omphalina (Reference above).

Let me give you a possible example. *Mutinus bambusinus* is one of the stinkhorn fungi found in several places around the world. If one looks at spore size of this species there is an interesting problem, illustrated in the table below.

REFERENCE	MINIMUM LENGTH (µ)	MAXIMUM LENGTH (µ)	MINIMUM WIDTH (µ)	MAXIMUM WIDTH (µ)
Verma, RK, Verma, P. & Mishra, Y. (2016). Headless Stinkhorn Fungi (*Mutinus* spp) with Special Reference to Indian Species. Indian J. Trop. Biodiv. Soc. for Promotion of Trop. Biodiv, Jabalpur	4	7	2	3
Gogoi, G & Parkash, V (2014). Some New Records of Stinkhorns (Phallaceae) from Hollongapar Gibbon Wildlife Sanctuary, Assam, India. J. Mycology Vol 2014, Article ID 490847	4	7	2	3
Das, K, Hembrom, ME & Pariha, A. (2013). Two interesting species of stinkhorns from India. NeBIO, Vol 4 (4), pp1 -6.	4	4.8	1	1.5
Kuo, M. (2019) *Mutinus bambusinus*. Retrieved from MushroomExpert.com	3	4.5	1	1.5

I have examined the descriptions of this *Mutinus* in the four references listed. The spore minimum length in all four references is quoted as 3 or 4 micron – no worries. But look at the maximum length, minimum width and maximum width and the bottom two references give numbers half (blue panels) or two-thirds (green panels) of the upper two. Is this just chance, or are the upper two references describing a **different species** to the lower two references? Although many characters are used in fungal taxonomy, a great deal is made of spore size, so 100% is a significant difference, or is it?

Mutinus bambusinus (Cairns Botanic Garden)

There are also dangers in genetic definition of species, although I don't yet know of any examples in fungi. However, in 1973, the endangered Dusky Seaside Sparrow, a small bird once found in Florida USA, missed out on potentially helpful conservation assistance by being reclassified, using DNA, as a subspecies of the much more common Seaside Sparrow. Less than two decades later, the Dusky Seaside Sparrow was extinct. (Panko, B., 2017. What Does It Mean to Be a Species? Genetics Is Changing the Answer. smithsonianmag.com)

If you want to learn more about the (at least) seven definitions of a species look up "Species" in Wikipedia.

Disclaimer: we have tried to use only original material in preparation of this newsletter. Any text, photographs or other material used herein, and from other sources, is for research, educational and/or non-profit purposes only and is thus not limited by copyright. References have been provided or can be provided upon request.

Editorial Contacts:
Barry Muir, correspondence PO Box 15003, Edge Hill, Queensland 4870; or email unit57.may@gmail.com