

## THE 31<sup>st</sup> NZ FUNGAL FORAY, Opononi, May 2017

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### Introduction

The 31st New Zealand Fungal Foray, was based at the Hokianga Memorial RSA Hall, Opononi, between 7-13 May 2017.

### Sunday 7 May, Kauri Bushmans and Trounson Kauri Park

I drove up from Auckland and stopped at Kauri Bushman's Memorial Scenic Reserve. The reserve was purchased by the Kauri Bushmen's Association, Royal Forest and Bird Protection Society, Otamatea County Council and the NZ Government and on 26 March 1954 dedicated to the memory of pre World War 1 kauri bushmen who worked prior to 1914.<sup>1</sup> The reserve, as the name suggests, was dominated by kauri (*Agathis australis*), with tanekaha (*Phyllocladus trichomanoides*) and a little kanuka (*Kunzea ericoides*). The ground tier had huge *Histiopsis incisa*, hound's tongue (*Microsorium pustulatum*) and a *Blechnum*. Fungi were scarce. *Amanita australis* was growing near the entrance, and inside the reserve there was *Favolaschia claudopus*, *Auricularia cornea*, *Ganoderma* sp., *Clavulinopsis sulcata* and, growing on kanuka, a colony of *Cerrena zonata*.

Continuing northwards I joined some other forayers at the 586-hectare Trounson Kauri Park. This once again was dominated by tall kauri and kahikatea and an understorey of mixed broadleaf. We had to stay on a boardwalk when walking through the kauri forest, so collecting was only really possible around the edges near the entrance. Fungi found here included *Gymnopilus junonius*, *Hypholoma acutum*, *Stereum ostrea*, a *Crepidotus* and a couple of fruiting bodies of *Plurella ardesiaca*.

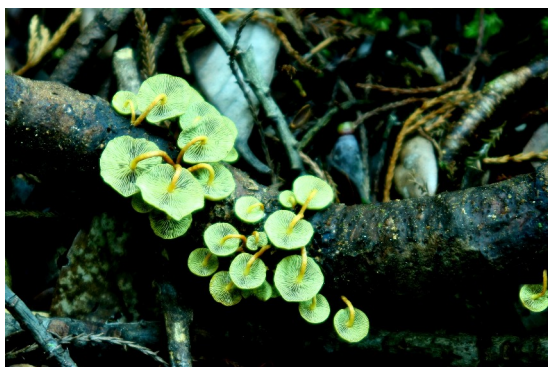


Figure 1 *Hypholoma acutum*



Figure 2 *Plurella ardesiaca*

### Monday 8 May, Waipoua Visitor Centre and Four Sisters Walk

We drove to the Waipoua Forest, stopping firstly to foray the Waipoua Visitor Centre Lookout Walk, a mixed broadleaf forest with emergent kauri and with kauri becoming more common higher up. I was excited to find *Heterobasidion araucariae* growing on a fallen dead kauri. This bracket is host-specific to kauri, but has also been found growing on *Pinus taeda* where this species has been planted to replace kauri. Other fungi found here included *Calvatia* sp., *Hohenbuehelia* sp., *Exidia* sp., *Scleroderma* sp., *Podoscypha petaloides*, *Entoloma hochstetteri* and a resupinate white fungus with spines.

Travelling on we decided to bypass the Tane Mahuta Walk and stop instead at the Four Sisters Walk, named after the ‘Four Sisters’, an impressive stand of four tall and graceful kauri trees growing extremely close together. A viewing platform encircles the trees and protects the habitat from disturbance. The vegetation consisted of kauri, rimu (*Dacrydium cupressinum*), manuka (*Leptospermum scoparium*) and umbrella fern (*Sticherus cunninghamii*). There was not much fruiting here. I recorded *Hypholoma acutum* and *Fomitiporia* sp. ‘Mt Lyford’.



**Figure 3** *Heterobasidion araucariae*.



**Figure 4** A resupinate fungus under *Steccherinaceae*.

### **Tuesday 9 May, Ngawha Springs Domain and Waiotemarama Loop Track**

Our first stop this day was Ngawha Springs Scenic Reserve, eastwards from Kaikohe. It consisted of manuka, gorse (*Ulex europeaus*), mingimingi (*Leucopogon fasciculatus*), *Baumea* and *Gleichenia dicarpa* scrub/sedgeland. There was a lake bubbling with sulphurous smells and not much fungi in evidence. We went on to some power station land, another geothermal area and the site of an old mercury mine, and once again found no fungi of note.

Our last stop was Waiotemarama Loop Track, where we followed a steep track up to a waterfall. This was taraire (*Beilschmeidia tarairi*)-tawa (*B. tawa*) forest with some emergent kauri. Parataniwha (*Elatostema rugosum*) cascaded down the valley walls. Fungi we found on the way included *Leotia* growing from moss on the edge of the track, *Mycena* growing on mamaku (*Sphaeropteris medullaris*), *Ganoderma*, *Russula* and *Parasola*. At the waterfall we found the introduced *Favolaschia pustulosa* growing on a fallen log in the streambed. Back at the track entrance we found what we recorded as *Gloeophyllum trabeum* growing on *Pittosporum tenuifolium*.

### **Wednesday 10 May, 16<sup>th</sup> NZ Fungal Foray Mycology Colloquium – Title, Abstract and Notes**

BRIAN LOONEY – Russulaceae Genome Initiative: What can genomes tell us about an iconic group of ectomycorrhizal fungi

*Abstract:* *Russulaceae* is a diverse fungal family including the genera *Russula*, *Lactarius*, *Lactifluus* and *Multifurca*, and is one of the most widespread and species rich ECM lineages. In a recent collaborative effort, the Joint Genome Institute has sequenced genomes and transcriptions, including a saprotrophic outgroup. We present here an overview of the first insight into the dense genome sampling within the family to capture specific genomic features and investigate i) to what extent genes involved in plant biopolymer degradation have been maintained within a single, diverse, ECM lineage and ii) to examine functional

diversity within this ecologically important clade, specifically focused on their ability to scavenge nitrogen sources from recalcitrant organic matter. Indeed, preliminary evidence suggests that members of this family, though being mutualists, have retained a restricted set of genes coding for lignin peroxidases and copper oxidoreductases which may be responsible for the degradation of lignin derivatives accumulating in soil organic matter.

*Notes:* Order *Russulales* includes the families *Russulaceae* (1,350 spp.), *Stereaceae* (125 spp.), *Auriscalpiaceae* (150 spp.), *Hericiaceae* (12 spp.) and *Peniophoraceae* (88 spp.). Under *Russulaceae* there are 7 genera (*Russula*, *Multifurca*, *Lactifluus*, *Lactarius*, *Gloeopeniophorella*, *Boldinia* and *Pseudoxenasma*) and over 1,350 recognised species. Under *Russula* there are 1,079 species that there is molecular sampling for.

ANDY NILSON – Comparative genomics of truffle-like fungi and their agaricoid relatives

*Abstract:* Truffle-like fungi are a large polyphyletic group that do not forcibly discharge their spores. The emergence of truffle-like fungi has been attributed to past climatic events and herbivory by mycophagous animals. While some environmental drivers correlate to the emergence of truffle-like fungi very little is known about the underlying molecular mechanisms that led to the truffle-like morphology. Truffle-like fungi present an excellent model system to explore the mechanisms behind convergent evolution.

In this study, we will sequence the genomes and transcriptomes of two species pairs, each containing a truffle-like fungus and its closely related mushroom-like fungus. In addition, we will improve the draft genomes of another species pair within the genus *Cortinarius*. With these sequence data, we will identify putative mechanisms that has led to the truffle-like morphology.

*Notes:* Truffle-like fungi come in a secutioid form and a gasteroid form. They were originally in Gasteromycetes but now in mushroom-type fungi. Mushrooms dated from as far back as the mid-cretaceous period have been found in amber. Over time there was a reduction to a closed cap and then to a reduction in stipe length, then to a vestigial stipe.

*Examples:* *Stropharia rugosannulata*, *Clavogaster virescens*, C.'Whakapapa', *Leratiomyces ceres*, *L. erythrocephalus*, *Cortinarius dulciolens*, *C. beeverorum*. Andy is working mainly on mushroom-type form to secutioid form.

EMMA HARROWER – Are sequestrate taxa evolutionary dead-ends? Assessing evolution and diversification of sequestrate *Cortinarius*

*Abstract:* Sequestrate fungi do not forcibly discharge their spores. They evolved from gilled taxa in many different lineages. Harry Thiers<sup>ii</sup> presented the Secutioid Syndrome Hypothesis in 1986 in which the sequestrate state is an adaptation to living in arid habitats, where the lack of moisture limits opportunities for aboveground fruiting body development and spore discharge. Bougher and Lebel<sup>iii</sup> hypothesized that there may be an equal but opposing selection pressure to protect the spore bearing surface from excessively moist conditions. We test these hypotheses in the globally distributed genus *Cortinarius* using both temperate and tropical taxa. We correlate mean annual temperature, mean annual precipitation, and seasonality with the state of the fruiting body (sequestrate vs gilled). We put forward the hypothesis that not all sequestrate species evolved in arid habitats and that some are simply a result of one or several loss-of-function mutations.

*Notes:* Sequestrate means enclosed habit. These fungi are spread by animal ingestion. There are two, opposite, theories as to whether they are found in drier habitats or wetter habitats. The Descolea study<sup>iv</sup> concluded that there is no evidence for either theories.

KARL SOOP – The cousins at the end of the world (Presented by DAVID ORLOVICH)

*Abstract:* When studying the cortinarius of the southern hemisphere you will soon notice that many remind you of certain cortinarius in our area, without being exactly similar. Molecular analyses often confirm our suspicion that they belong to a common group, while in other cases their resemblance turns out to be illusory: cases of convergence.

*Notes:* There are no species of *Cortinarius* that are found in both northern and southern hemispheres. There is, however, pairing of related species from both hemispheres.

DAVID ORLOVICH – Some undescribed *Cortinarius* species

*Abstract:* *Cortinarius porphyroideus*, a secutioid basidiomycete endemic to New Zealand, is distinct from other sequestrate species to having a purple pileus and a long stipe. Phylogenetic analysis of three loci (ITS, LSU and RPB2) found cryptic diversity in this species and provides evidence for two additional lineages of purple secutioid *Cortinarius*. This is a remarkable example of convergent evolution of this particularly colourful sequestrate form. We plan to describe *C. purpureocapitatus* and *C. minorisporus* to accommodate the new species. It is likely more species exist with this morphology. Another undescribed species is a green agaridoid species related to Section *Delibuti*, and the species and its phylogenetic position will be illustrated.

*Notes:* The work described in the abstract has revealed six different sequestrid purple *Cortinarius* - *C. porphyroideus* and *C. purpureocapitatus* (both look similar but former has ornamented spores, the latter not); *C. minisporus*; *C. dulciolens*/*C. beeverorum*; *C. coneae*; *C. aff. austravaginatus* (Tasmanian).

BRANDON MATHENY – Notes on diversity of ectomycorrhizal fungi in the southern hemisphere

*Abstract:* Several synopses are presented of recent works documenting biodiversity of ectomycorrhizal Agaricomycetes in tropical and temperate regions of South America and Australasia. The first of these is an overview of intense collection of fruitbody samples from the *Nothofagus*-zone in temperate South America, a region dominated by hyper-diversity of *Cortinarius*. A second study documents a new lineage of ectomycorrhizal Agaricales, *Guyanagarika* (Biannulariaceae), from northern South America. A third study focuses on the evolution and diversification of sequestrate Agaricomycetes in Australia. Almost all taxa are found to be recently evolutionarily derived with a few exceptions, likely evolving in response to aridification after isolation of Australia from Antarctica, co-diversification of ectomycorrhizal plant associates, and appearance of mycophagous animals. Lastly, the evolution of NZ Inocybaceae is presented within a systematic overview of Australasian Inocybaceae. Several trans-Tasman biogeographic distributions are supported in this work.

*Notes:* South American Cortinariaceae account for one thirds of the ECM species found. Thirteen divergent lineages of sequestrate Agaricomycetes in Australia correspond with Miocene 15mya aridification after Australia separated from Antarctica.

RACHEL SWENIE – Taxonomic and genetic diversity are higher than expected in North American species of *Hydnum* (Cantharellales)

*Abstract:* *Hydnum* is a genus of ectomycorrhizal fungi comprising five morphological species in North America that is harvested and sold in markets worldwide. Commonly known as “hedgehog mushrooms”, they are closely related to another popular wild edible group, the chanterelle mushrooms. Despite this, *Hydnum* has not been closely studied in North America for over 50 years. However, our data indicate the genus is more taxonomically and genetically diverse than anticipated based on morphology alone. We constructed a *Hydnum* phylogeny based on combined ITS and *tefl* nucleotide sequences, which reveals 20 clades in North America, 16 of which appear to be endemic. Two of the three species of *Hydnum* originally described from North America, *H. umbilicatum* and *H. albidum*, show higher than expected genetic diversity with cryptic speciation. Type studies and models to test species delimitation will allow for taxonomic revisions of these groups.

*Notes:* *Hydnum* in North America is closely related to Cantharellales. They are ectomycorrhizal, occur worldwide, edible, have spiny or toothed to cream to orange colour and smooth hyaline spores. They are different to *Sarcodon*, which also has teeth. *H. repandum*, the type species, has a wavy cap margin and creamy colour. *H. refescens* has an orange colour. There are three species described from North America – *H.umbilicatum*, *H. albidum* and *H. albomagnum*.

HAILEE KOROTKIN – Fungal-bryophyte interactions: using stable isotopes to infer the trophic strategy of the fungus *Richenella fibula*

*Abstract:* Fungal-bryophyte interactions exist widely across the fungal tree of life, but in many cases have not been sufficiently studied. The bryophyte-associating *Richenella* clade resolves in the mostly lignin-degrading saprotrophic order Hymenochaetales (Basidiomycota). The small, yet charismatic mushroom-forming fungus, *R. fibula*, is known to associate with the moss *Dicranum scoparium*, in addition to other mosses, where it fruits on stems of senescent gametophytes. However, the nature of the relationship, or more specifically the trophic status of the fungus, has not been clearly established. It is unclear whether fungi in the Hymenochaetales evolved as lignin-degrading saprobes and switched to bryophyte associates or vice versa. Our objectives are to use a novel approach that combines in vitro experiments, genomics, transcriptomics, stable isotopes, and phylogenetics to determine the trophic status of *R. fibula* and if *R. fibula* underwent a loss of the ability to decompose lignin. We hypothesize that *R. fibula* acts as a unique biotroph acquiring carbon and nitrogen directly from its host. In addition, we predict that *R. fibula* has lost the ability to degrade lignin. Current results on stable isotopes will be presented.

PETER BUCHANAN – Mycology for kids–species discovery and resources in te reo

*Abstract:* We have a desire for NZ students to receive education about fungi in addition to the existing science curriculum’s focus on plants and animals. Two projects in fungal education will be outlined. As mycologists one of our most satisfying achievements is discovery of

species new to science. Can such new species discovery be adapted effectively for a student fieldtrip and follow-up classroom work? We sought to find out with 3 different age groups of school students and with yeasts as the taxonomic group for investigation. Secondly, we realised that aspects of Maori traditional knowledge of fungi, known to mycologists, was not available to Maori students or their parents because of intergenerational loss of knowledge. A student and teacher resource for the Putaiao (Maori science) curriculum is in preparation, outlining knowledge and uses of fungi including for food, medicine, fire carrying, and tattooing.

#### Notes: Project 1 – Curious Minds

Involve kids in discovering species new to science. Swab from surfaces onto agar to look for yeast species, describe the taxonomy and then give an epithet to a genus chosen by Landcare scientists. Examples: *Rhodotorula ngohengohe* (humidity), *Candida vespimorsuum* (wounding by wasps), *C. rongomai-pounamu* (name of the class).

#### Project 2 – Maori knowledge and uses of fungi

Tattooing, food, medicine, fire carrying, wood carving, story-telling/proverbs. We know more than Maori do. Te awheto (*Cordyceps* sp.), tattooing (te moutu), te putawa (*Laetiporus portentosus*), te hakeke (edible, e.g. *Auricularia cornea*), te werewere and the story that the blue mushroom *Entoloma hotchstetteri* is the source of the blue colour on kokako (also represented on the \$50 bank note), te harore (*Armillaria* spp.) edible. Nga Hekaheka O Aotearoa (Fungi of NZ) is issued as a teacher resource and student booklet.

#### JUDY GARDNER – *Phytophthora* in New Zealand Ecosystems

*Abstract:* Worldwide there are suggested to be as many as 600 potential *Phytophthora* species, in New Zealand there are 39 known species. Approximately 60% affect agriculture, 32% are associated with exotic forestry and 35% with natural ecosystems. Many of these *Phytophthora* species are believed to originate from outside New Zealand, which is why surveillance programmes such as the Ministry for Primary Industries' High Risk Site Surveillance (HRSS) of which Scion's Forest Healthy Reference Laboratory's diagnostic service contributes to, is essential for helping to prevent the establishment of unwanted pathogens.

Most *Phytophthora* are known to be spread through soil-borne species or root-to-root contact e.g. *P. agathidicida* but some significant species are spread through aerial spores e.g. *P. kernoviae*. Once established understanding the biology of these pathogens, resistance amongst the breeding population and response to potential tools such as phosphate is important for developing effective management strategies. Considerable research at Scion concentrates on early detection of unwanted pathogens and developing appropriate management strategies for those that establish using a wide range of techniques, this includes the Healthy Tree Healthy Future (HTHF) programme. The HTHF programme focuses on three host species including kauri (*Agathis australis*) against a variety of *Phytophthora* species.

*Notes:* *Phytophthora* are water molds not fungi. Examples are *P. infestans* (Irish potato famine), *P. cinnamomi* (affecting *Banksia* in Australia) and *P. agathidicida* (cause of kauri dieback in NZ). *P. cinnamomi* in NZ doesn't cause the widespread devastation it does overseas. *Phytophthora* is detected using an immunostrip, similar to a pregnancy test.

ERIN STROUD – *Agathis australis* associated fungi and the impact of kauri dieback in Auckland Regional forests

*Abstract:* *Phytophthora agathidicida*, an oomycete pathogen, is the causative agent of kauri dieback of *Agathis australis*. North Island *A. australis* are particularly affected by kauri dieback and demonstrate characteristic rapid population decline. Our study aimed to characterise *A. australis* associated fungi in the Waitakere ranges, and the subsequent impact of kauri dieback on these communities.

Root samples were obtained from symptomatic and asymptomatic *A. australis* at a previously studied site at Huia Dam in the Waitakere ranges. Root-associated fungi were isolated and the pure cultures obtained were sequenced to generate comparative ‘profiles’ of the fungi present in symptomatic and asymptomatic trees. One hundred and fourteen cultures were sequenced that represented 28 species.

Our data was then combined with an earlier study to compare the fungal communities of *A. australis* across three distinct sites in Auckland Regional forests. Fungi isolated from root samples at Huia Dam, Oratia and Cascade falls were compared, yielding 92 operational taxonomic units (OTUs) across the three sites. These OTUs clustered based both on location as well as disease state of the host tree, therefore providing a differential fungal profile of symptomatic and asymptomatic *A. australis*.

*Notes:* Symptoms of kauri dieback are yellowing, thinning and bleeding red from the roots.

TERESA LEBEL – Don’t throw it out! Exploring sequence data of fungal contaminants of herbarium material

*Notes:* Teresa conducted a study on non-target spp. from contamination of target specimens and in the process described some *Russula* and *Lactarius* spp. One sequence came out as a fish and in backtracking it was discovered someone who had been cleaning her fish and the water was used, affecting three days of sequencing.

BEVAN WEIR – Pathogen genomics and biosecurity

*Abstract:* Novel plant and animal pathogens present a great biosecurity risk to both primary production and the natural estate of New Zealand. Accurate identification of bacterial and fungal pathogens can be very difficult without DNA sequences, so single or a few genes are routinely sequenced from unknown organisms. However, the rapidly increasing ease and decreasing cost of sequencing entire genomes allows a step change in characterising and managing pathogens..

This talk will cover research spanning from the early days of genomics of plant pathogens in New Zealand to the current state of the art technology, and the importance of maintain reference collections.

Can we move towards the crazy and ambitious goal of routinely sequencing full genomes of all pathogens that are here and cross the border?

*Notes:* Examples – Psa (*Pseudomonas syringae* pv.) on kiwifruit found in November 2010 but there are more virulent strains in Asia and Italy; kakapo crusty bum disease, exudative

cloacitis, which left only 154 birds, from an unknown cause but associated with *E. coli* bacteriophage,

PETER JOHNSTON – Winter fungicide sprays impact the dynamics of *Botrytis* populations in vineyards

*Abstract:* *Botrytis* populations in vineyards often show strong seasonal differences. Early season populations tend to be less pathogens than those that dominate at harvest. This change is assumed to relate to differences in competitive ability in winter versus summer conditions. Such a seasonal pattern was observed in a Waipara vineyard over the years 2008 through to 2012. The population at flowering was dominated by *B. cinerea* low pathogenicity holotype B9, whereas the population at harvest was dominated by high pathogenicity haplotype B1. Over the 2013/14 season there was a sudden change in this dynamic, with the high pathogenicity haplotype dominant at both flowering and harvest during this and subsequent seasons. This change in the dynamic of seasonal populations was confirmed using microsatellite analysis. Data from the HarvestNZ weather station showed the temperature at this vineyard to have increased slightly, and the rainfall to have decreased slightly since 2008. However, a likely explanation for the change in behaviour of the *Botrytis* populations was a change in management practice, with the application of a winter GetSeal spray for control of vascular pathogens. GetSeal is a trizole fungicide effective against *Botrytis*. The addition of this fungicide to the vineyard spray programme may have disrupted the competitive advantage the low-pathogenicity populations previously enjoyed over winter. The impact of this on levels of disease remain unknown. A similar change from low pathogenicity to high pathogenicity populations has been reported with grape powdery mildew in Europe. Vineyards differ in the size of the low pathogenicity populations in spring, and there is a correlation between this and levels of disease at harvest.

#### **Thursday 11 May, HB Matthews Reserve and Waioitemarama Road**

Heading east and then north, we stopped briefly on Horeke Rd and found a *Russula* species under oaks (*Quercus*).

The next stop was Mangamuka Gorge Scenic Reserve, where I found a woody bracket growing on taraire (*Beilschmeidia taraire*) that initially looked like *Ganoderma* but the pore surface bruised purple, not brown. It was later identified as *Nigrofomes melanoporus*, a species that has only ever been found on Taraire in New Zealand.

Onward to our main destination, HB Matthews Reserve, administered by the Royal Forest and Bird Protection Society, outside of Kaitaia. We met with local members of the Society, who took us across farmland to the reserve. I had previously visited the reserve to write the management plan<sup>v</sup>. On the way across the farmland we found *Amanita nehuta*, *Fomitiporia* sp. and *Agaricus* sect. *xanthodermatei*. Inside the reserve species found included *Hebeloma victoriense*, *Hydnum* sp., *Cyptotrama* ‘Waipoua’, *Clavulinopsis sulcata*, *Ileodictyon cibarium*, *Tylopilus formosus*, *Tyromyces* sp., and *Cantharellus wellingtonensis*.



**Figure 5** *Nigrofomes melanoporus*



**Figure 6** *Cyptotrampa* 'Waipoua'

### **Friday 12 May, two private properties**

We visited an interesting and very diverse broadleaf forest that included *Dracophyllum* and kawaka (*Libocedrus plumosa*) but not much fungi to be seen. Our second stop was to kanuka forest where several species of *Russula* were found including *R. horopito*.

### **References**

<sup>i</sup> “Kauri stand in memory of bushmen”, *NZ Herald* 27.3.1954, p.8.

<sup>ii</sup> Thiers, H. D. (1984): “The Secotioid Syndrome,” *Mycologia* 76(1), 1-8. <https://doi.org/10.1080/00278814.1984.12023803>.

<sup>iii</sup> Bougher, N. L.; Lebel, T. (2001): “Sequestrate (truffle-like) fungi of Australia and New Zealand.” *Australian Systematic Botany* 14(3): 439-484.

<sup>iv</sup> Kuhar, F.; Smith, M.E.; Mujic, A.; Truong, C.; Nouhra, E. (2017): “A systematic overview of *Descolea* (Agaricales) in the Nothofagaceae forests of Patagonia.” *Fungal Biology*, 121(10). <http://doi.org/10.1016/j.funbio.2017.06.006>.

<sup>v</sup> White, P (2001): Herbert Bismark Matthews Reserve Management Plan. *Royal Forest and Bird Protection Society*.