



THE QUEENSLAND MYCOLOGIST

**Bulletin of
The Queensland Mycological Society Inc.**

The Queensland Mycologist is issued quarterly. Members are invited to submit short articles or photos to the editor for publication. The deadline for contributions for the next issue is February 1, 2009.

Please ensure that the Secretary (fungiqld@yahoo.com.au) always has your current email address.

The Secretary, Queensland Mycological Society Inc, PO Box 295, Indooroopilly Qld 4068

SOCIETY OBJECTIVES

The objectives of the Queensland Mycological Society are to:

1. Provide a forum and a network for amateur and professional mycologists to share their common interest in macro-fungi;
2. Stimulate and support the study and research of Queensland macro-fungi through the collection, storage, analysis and dissemination of information about fungi through workshops and fungal forays;
3. Promote, at both the state and commonwealth levels, the identification of Queensland's macrofungal biodiversity through documentation and publication of its macro-fungi;
4. Promote an understanding and appreciation of the roles macro-fungal biodiversity plays in the health of Queensland ecosystems; and
5. Promote the conservation of indigenous macro-fungi and their relevant ecosystems.

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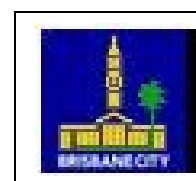
QMS WEBSITE: www.qms.asn.au

Have you logged onto the QMS website lately? If not then it is time you did!! Many thanks to Andrew Kettle for keeping the site up and running. Please provide feedback to the Committee about any ideas you may have for the site.

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QMS acknowledges and appreciates the sponsorship that has been given to the Society by the Queensland Herbarium, SEQ Catchments and Brisbane City Council.



To assist those not in attendance at meetings, notes on the addresses given are included in issues of the Queensland Mycologist. However, the notes never do justice to the topic as they do not reflect the enthusiasm of the speaker or cover the questions and discussions that were raised on the topic. So remember, where possible it is far better to attend the meetings, get the information first hand and participate in the invaluable information sharing opportunity.

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QMS CALENDAR

Meetings are held in the Bailey Room at the Herbarium, Mt Coot-tha, commencing at 7pm on the second Tuesday of alternate months from February, unless otherwise scheduled.

There will be a pre-meeting at 6 pm. at the Herbarium at Mount Coot-tha for those who attended forays and took photographs. They are asked to bring all images preferably renamed according to the QMS naming convention summarised on the next page (see the web site or March 2009 Newsletter for details).

QMS MEETING PROGRAMME

13 October 2009 The Foray - In Detail - How-to guide, The FungiKey - Computer Fungi Identification Tools. There will be no pre-meeting this month.

8 December 2009 Festive season celebration + Foray reports. Bring a plate to share.

MEETING SUPPER ROSTER

Two volunteers are required for each meeting – one to bring something savoury and one something sweet.

QMS FIELD TRIP PROGRAMME

Saturday 31 October 2009. Springbrook Follow up. Leader: Diana Leemon

Saturday 28 November, 2009. Linda Garrett Park, Mapleton. Leader: Gretchen Evans

Proposed future dates (details to be announced):

Saturday, 19 December, 2009.

Saturday, 30 January, 2010.

Saturday, 27 February, 2010

Saturday, 27 March, 2010

Saturday, 24 April, 2010.

Saturday, 29 May, 2010.

Saturday, 26 June, 2010.

Saturday, 31 July, 2010. - Workshop

Saturday, 28 August, 2010. - Workshop

Saturday, 25 September, 2010.

Saturday, 30 October, 2010.

Saturday, 27 November, 2010.

Saturday, 18 December, 2010.

WORKSHOPS

26 September 2009. Shoebox workshop. 10 am at Uniting Church Hall, Maleny, UBD Sunshine Coast 74 F19. Bring the fungi you have collected in the 2008/09 season and put in a shoebox until that rainy day when you planned to get them out and identify them. Even if you have not got a shoebox full of dried fungi, come along to a workshop, there is a big QMS shoebox you can delve in. You will learn how to ID and describe fungi and how to use interactive computer keys, books from the QMS library. The QMS microscopes and chemicals will all be available as well as tutors to give you support. Bring a picnic lunch, tea and coffee will be provided.

Presidents Report

Well the extended wet periods of the last couple of years on the Sunshine coast seem to have finally ended. Having left Queensland during the May floods – we were surprised at how dry things were on our return in August. We were then hit by the record high temperatures, 4 degrees above the previous August maximum! It seems we may have an El Nino Summer which may mean less fungi forays. A slowing of the numbers of new fungi is an excellent opportunity to catch up on our backlog of collections which need identification.

Patrick Leonard led our first 'shoebox' identification workshop, held in August 09, kindly hosted by Ken and Floss. The idea of these workshops is for members to bring one or two fungal collections to try and identify them using the QMS microscopes and get advice on how to find and use taxonomic literature to assist in identifications, rather than depending on just the field guides. One of the exciting fungi that was brought along for identification by Matthea from her local church was a *Battarea* species probably *B. stevenii* as this is the commonly recorded species from Australia. Matthea agreed to write up a Fungi of QLD description sheet (FoQ will be explained more at the next meeting). So we are keen on getting more collections and images of this species, particularly an 'egg' stage and just after stages which will allow us to separate *B. stevenii* from the other species *B. phalloides*, which has a gelatinous volva.

Workshop participants also got to find out how to take photos of some of the microscopic characteristics using our Motic compound microscope. These can be used to help develop our own identification notes which we are calling 'Fungi of Queensland'. Pat and I are keen to get feedback about these workshops to gauge how often we need to have them. We are also wondering if members would like another microscope basics session?

On the subject of identification we have worked out one of the pretty but mysterious fungi from the Springbrook 2008 weekend. After the image of this specimen was seen in the newsletter, both Tom May and Nigel Fechner thought that it may be a species of *Deflexula*. Nigel kindly looked at the specimen in May and was able to determine that it was *Deflexula fascicularis*. This is only the third collection for Australian (according to the Virtual Herbarium) and the first collection for Queensland. The two previous collections are from Victoria. I've included an image of the specimen so you can see what I mean – I think on the weekend we were calling it the 'purple icicle fungus'.

For those of you who haven't seen the website recently there is a new section called 'What is in my garden? An online guide to recognising fungi in Queensland'. Which guides your average gardener through some of the most common garden fungi and their substrates. This wonderful work was put together by Ray and Noreen Baxter. Andrew Kettle has developed a great web design for easy access and understanding. Please take the time to have a look and maybe pass on the website details to others who might take an interest in their garden fungi. If you find a fungus in your garden you might consider writing it up to add to the website.



Deflexula fascicularis © Klaus Querengasser

Also if members would like to see the foray lists and some of the presentations from meetings - many of these are now up in the members section thanks to Pat and Andrew. To find them log on as a member (if you don't have the password yet just email – Andrew), the link for this is at the very bottom of the QMS home page. Return to the QMS home page and select Field Trips – now that you are logged in a tab should appear near the top left saying 'field reports'. Select 'field reports' and you can now download the field reports and some presentations.

There is news from QMS executive; Kim Nguyen has had to stand down. Kim valiantly accepted the position of secretary, after we failed to fill the position during the AGM. She managed to file the documents in which allowed QMS to continue as a group. I would like to thank Kim for all her efforts when we needed her most. Luckily we have a new possible Secretary Lia Pardoe Mathews a student from QUT. I'm hoping the October meeting will accept Lia as our new secretary. All of our executive and other committee members do a great job but the position of secretary is vital for the ongoing success of community groups like ours.

Bunya Mountains Foray Report – March 2009

Sapphire McMullan-Fisher and Patrick Leonard

A lovely autumnal weekend was spent at the Bunya Mountains. Bunya Mountains NP is renowned for Bunya Pines (*Araucaria bidwilli*). The weekend was attended by Annitta Hearle, Gretchen Evans, James Hansen, Klaus Querengasser, Lil Spadijer, Megan Prance, Noreen and Ray Baxter, Patrick Leonard, Peter and Ronda Warhurst, and Sapphire McMullan-Fisher. Visitors then but new members now were Ross and Wilma Tait from Chinchilla and Daniel Remy from France.

The particular focus of the weekend was to find, photograph and identify specimens which can be included in QMS 'Fungi of Queensland'. To this end a number of the QMS microscopes we brought up and used for fungal identification. The Motic microscopes

have a camera attachment so Pat was able to show people different types of spores and other microscopic structures on a laptop screen. These images were saved and may be used later. The identifications went particularly well due to the enthusiasm and knowledge of Pat and Daniel. It also helped that we were testing Mycokey – which is a multiple access key to the Genera of the gilled fungi of Australia. We hope the commercial version will come out soon.

Despite the dry conditions 100 records were made during the weekend, you can see a list of the fungi on our website. There were problems with keeping track of images and specimens - *Please, can each group and each day be careful NOT to reuse field numbers!!* Thanks to the Noreen, Megan and Sapphire some of the data entry of field sheets were entered during the weekend and Noreen was prompt in entering the Sunday mornings data. Thanks should go to our wonderful recorders Noreen and Gretchen. Fabulous fungal images were also taken by our great photographers some of which were seen in the foray report at April's meeting (a copy of this and the fungal species seen may be found in the members section of the QMS website).

Mycological Highlights



Lentinula lateritia © Ray Baxter

Lentinula lateritia a relative of the shitake was one of the mysteries of the weekend. The pinkish buff gilled mushroom was found on Bunya wood. Now that it has been identified we know that this species has only been collected four times previously in Queensland and three of those collections came from the Bunya Mountains!

Bolbitius variicolor was a small yellow viscid fungus growing on the borer frass is it appears that this is the first record for Australia. *Oudemansiella canarii* was found at least twice. *Daldinia concentrica* was collected rather than the tropical species (*Daldinia eschscholzii*) from which it differs in having smooth not striate spores



Oudemansiella canarii ©Sapphire McMullan-Fisher

Three distinct *Xerula* collections were made, none of which are *Xerula australis* - a Fungimap target which they resemble. Pat suspects two of them, one Daniel thinks is *X. radicata* from Europe, and a much darker one, are colour variants of the same species. The third collection with the dark gill edge is distinctive, having two kinds of cheilocystidia. We need to decide what to do with these next. DNA testing might reveal some interesting variations. (Editors note: see more on this in our last issue)

Other easily recognizable species seen that both happen to be orange were *Mycena leaiana* var. *australis* and *Laetiporus sulphureus*. *Mycena leaiana* var. *australis* is a Fungimap target and has viscid (sticky) cap and stem.



Mycena leaiana var. *australis* ©Sapphire McMullan-Fisher

Laetiporus sulphureus is a fleshy 'Polypore' - the irregular pores may be seen (upper left, with pores turned over). The colour and texture of this species varies as specimens age. Colour may vary from bright sulphur yellow to deep orange, the texture is soft, fleshy velvety when young (top images). As specimens mature they become tougher and less fleshy, often becoming an orange-brown colour (lower images).



Laetiporus sulphureus © Sapphire McMullan-Fisher

Another find was a stinkhorn, *Phallus multicolor*.



Phallus multicolor © Ray Baxter

Lenzites acuta

David Holdom

I am a volunteer in a Bushland Regeneration group in Chelmer (across the river from Indooroopilly)- "Caesar's Place" at 112 Queenscroft St. Early on, a lot of exotic trees were cut down, leaving a nice collection of logs and stumps. I often check the site for interesting fungi, and in July 2009 I found this one, and was struck by the unusual gills. The well rotted stump on which it was found was easy to cut, so I removed the section with the fungus attached and took it home to photograph and then dried it for the Queensland Herbarium.



Lenzites acuta showing the distinctive gills © David Holdom

Patrick took it home from the last QMS meeting and did the requisite microscope and other work to identify it as *Lenzites acuta*, and has prepared the Queensland Fungal Record which appears below. Interestingly *L. acuta* is associated with stumps of *Araucaria cunninghamii* and other species. In this case the stump was too decayed to identify, but discussions with my fellow bush carers indicated that most of the exotic trees cleared in that section of Caesar's Place were Chinese elm (*Celtis sinensis*). A lesser possibility is *Jacaranda mimosifolia*. It was definitely not *Araucaria*.

QUEENSLAND FUNGAL RECORD
© Queensland Mycological Society
Prepared by Patrick Leonard

Species: *Lenzites acuta*

Cap: pileate to semi-circular, broadly attached to substrate; 30 - 80 mm diameter, 30 - 50 mm radius; upper surface furrowed and with a few concentric rings; chalky white; margin acute.

Stipe: absent.

Gills: lamellate; subdecurrent; cream; 3-4 mm deep; forking in a regular dichotomous pattern; corky in texture.

Flesh: corky to woody; 10 - 15 mm thick, creamy white.

Chemical reactions:

Spores: elliptical or slightly curved; hyaline; inamyloid; $4 - 5 \times 2 - 3 \mu\text{m}$; thin walled.

Basidia: clavate; four spored.

Cystidia: none seen

Pileipellis: trimitic with both thin walled generative hyphae and thick walled skeletal hyphae; seemingly aseptate and without clamp connections.

Habitat: in small groups or singly on a variety of hosts including stumps of *Araucaria cunninghamii* and other trees including exotics in parks and gardens.

Notes: the hard flesh, white to cream colours and forking gills identify this readily as a *Lenzites*. There is some disagreement in the literature as to whether there is more than one species present in Queensland.

Collections examined: David Holdom 10709; Caesar's Place Bushcare Site, Queenscrot St, Chelmer, Brisbane. David Holdom, 3 July 2009.



Lenzites acuta © David Holdom

Ganoderma in Queensland - trial key and notes

Patrick Leonard August 2009

The taxonomy of the genus *Ganoderma* has been described as chaotic. Worldwide there are 214 described species, but very few good descriptions exist which might allow accurate recording of these fungi in the field. The only readily available reference to the genus in Queensland is Hood's (2003) Introduction to Fungi on Wood which lists 11 species. But this does not allow reliable identification to species level.

The critical work by Ryvarden & Moncalvo (1997) was published by Fungiflora in Oslo and is not readily available. But, a paper by Smith and Sivasithamparam in 2003 examined Australian species in considerable detail and concluded that only 6 species were present and only 5 of these were found in Queensland. Some of their results are examined in the table below.

Species	Surface	Pores/mm	Spore sizes	In Qld
<i>G. australe</i>	Matt	3.0-4.5	9.1-11.8 × 5.5-9.1	Yes/25
<i>G. incrassatum</i>	Matt	3.6-5.9	6.8-10 × 5-6-8	Yes/1
<i>G. steyaertanum</i>	Laccate	3.4-5.6	7.3-12.7 × 5-9.5	Yes/13
<i>G. cupreum</i>	Laccate	3.4-5.6	8.2-11.8 × 5.5-10	Yes/8
<i>G. boninense</i>	Laccate	3.2-5.0	8.2-13.5 × 5-8.6	No
<i>G. weberianum</i>	Laccate	2.7-5.9	6-10.9 × 4.5-7.3	Yes/2

(Editor's note: Laccate is defined as "polished, varnished, or shining" in my (6th) edition of Ainsworth & Bisby's *Dictionary of the Fungi*).

As Smith and Sivasithamparam point out the morphological differences between *Ganoderma* species are small and indistinct and neither pore density nor spore size provide reliable ways of separating species. It is therefore not surprising that they did not include a key in their 2003 paper. Host and habitat information seems to be particularly poor in the published literature.

Nevertheless they do provide just enough guidance on the differences in morphology and distribution to allow the production of a trial key. *Ganoderma* species are frequently found on QMS forays, but seldom accurately recorded. The aim of this article is to provide a trial key and notes to try to improve our recording.

Trial Key

1. Cap matt 2
1. Cap laccate 3

2. Cap sessile, 50 - 500 mm diameter and spores distinctly truncate ***Ganoderma australe***

2. Cap stipitate, spathulate or occasionally sessile, < 40 mm diameter and spores indistinctly truncate ***Ganoderma incrassatum***

- | | | |
|--|--------------------------------------|----|
| 3. Spores Q > 1.7 on average | <i>Ganoderma boninense</i> | |
| 3. Spores Q < 1.6 on average | | 4 |
| 4. Cap large, 50 - 500 mm diameter, red brown or black, in rainforests or vine forests | <i>Ganoderma steyaertanum</i> | |
| 4. Cap small to medium, 30 - 90 mm diameter, in sclerophyl forests | | 5. |
| 5. Spores truncate, smooth, 8.2-13.5 × 5 - 8.6 μm | <i>Ganoderma cupreum</i> | |
| 5. Spores ovate, finely echinulate, 6 -10.9 × 4.5 - 7.3 μm | <i>Ganoderma weberianum</i> | |

Notes

Ganoderma australe

This is the most frequently seen matt species in South-east Queensland. Large, sessile matt specimens growing on *Eucalyptus* and other hardwood trees in wet and dry sclerophyl forests will almost certainly be this species.

Ganoderma incrassatum

There are several records, but only one collection of this species which appears to have a northerly distribution and to favour rainforest habitats. It is readily distinguished from *G. australe* where the specimens are small and stipitate or spatulate. Where specimens are sessile and small, examination of the spores is a good guide with this species having ellipsoid or indistinctly truncate spores.

Ganoderma boninense

This laccate species has not so far been reliably recorded in Queensland. It has however been found in New South Wales. The distinguishing feature appears to be its elongated spores with a Q-value (Length /width) of 1.7 or greater.

Ganoderma steyaertanum

This laccate species can be readily distinguished in its large, sessile and dark, almost black, capped forms. It also appears to favour rainforest habitats. Specimens that are red brown and stipitate, may be more difficult to distinguish from the two species listed below.

Ganoderma cupreum

Small to medium laccate species which are distinctly stipitate and have smooth truncate spores are most likely to be *G. cupreum*.

Ganoderma weberianum

Small to medium laccate species which are distinctly stipitate and have finely echinulate and smaller spores are most likely to be *G. weberianum*.

Conclusions

Recently published work has not eliminated all the difficulties in identifying species of *Ganoderma*, but it has made it considerably easier, moving the problem from the impossible category to difficult. Better recording of host and habitat information may in time give additional clues to the identity of these common forest fungi.

References

1. Hood, I. A. (2003) An introduction to Fungi on Wood in Queensland. University of New England Press.
2. Moncalvo, J.M. and Ryvarden, L (1997). A nomenclatural study of the Ganodermataceae Donk. Fungiflora. Oslo.
3. Smith, B. J. and Sivasithamparam, K. (2003) Morphological studies of ganoderma (Ganodermataceae) from the Australian and Pacific regions. Australian Systematic Botany, 16, 487-503.



A laccate *Ganoderma* sp, probably *G. steyaertanum* © Fran Guard



Ganoderma australe © David Holdom

The Entomophthoromycota

The Entomophthorales are a group of filamentous fungi characterised in part by the forcible discharge of often quite large conidia in most species. They were previously placed in the Zygomycetes, but that grouping is no longer recognised in light of modern genetic studies which show that the groups within the Zygomycetes are polyphyletic. The Entomophthorales are now placed in their own sub-phylum, the Entomophthoromycota (Hubbert et al 2007).

The Entomophthoromycota can be obligate pathogens of animals (primarily arthropods) or cryptogamic plants, or saprobes. They are occasionally facultative parasites of vertebrates. Human infections are rare but can be serious, even fatal.

The lower level classification is not settled, but according to information given to me by Richard Humber of the USDA, an authority on the group whose opinion I greatly respect, the Entomophthoromycota are most likely to be divided into three orders, with a total of six families:

Order Basidiobolales, Family Basidiobolaceae

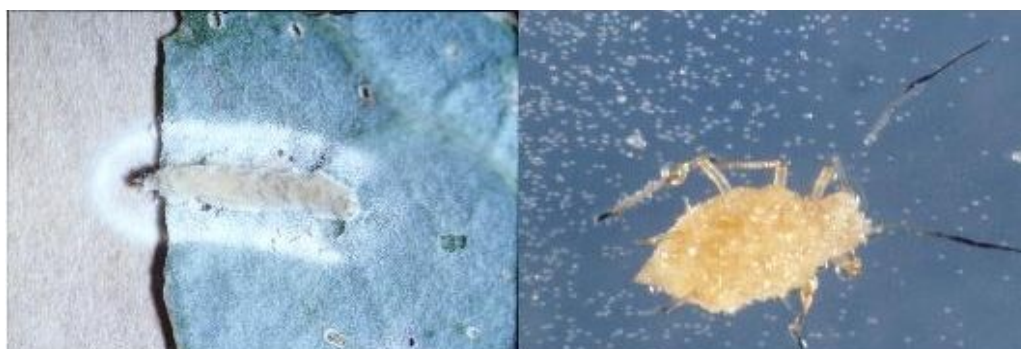
Order Neozygitales, Family Neozygitaceae

Order Entomophthorales, Families Ancylistaceae, Meristacraceae, Completoriaceae, Entomophthoraceae

Most of the insect pathogens with which this article is mainly concerned are in the Neozygitaceae and Entomophthoraceae (all obligate pathogens of insects and mites) and some of the Ancylistaceae. First, a few words about the others.

Basidiobolus ranarum (Basidiobolaceae) was first isolated from frog faeces, and is often found in amphibian guts but members of the genus are also common saprophytes. *B. ranarum* is a rare but sometimes fatal pathogen in humans

The other (also rare) pathogen of humans (and also serious when it occurs) is *Conidiobolus coronatus* (Ancylistaceae), a very common saprophyte, at least in the tropics. Other members of *Conidiobolus* are insect pathogens, but *C. coronatus* has a number of unusual features, and I expect that the insect pathogens will end up in a different genus. *C. coronatus* is often isolated from insects, and is capable of infecting them in the lab, but in my experience is probably not the primary pathogen in most cases. I frequently isolated it from planthoppers in Indonesia that had already been killed by an obligate pathogens from the Entomophthoraceae, and where the specimen was more than 24 h old. On culture plates it grows much more rapidly than the true pathogens and if it gets in will take over completely. Both *Basidiobolus* and saprophytic *Conidiobolus* are often associated with dead arthropods in soil.



© R. Teakle

© D. Holdom

Figure 1: Cabbage moth larva surrounded by conidia, probably of *Zoopthora radicans*, and an aphid surrounded by conidia of *Conidiobolus obscurus*

The Completoiriaceae are rarely found parasites on fern prothalli, and the Meristacraceae are pathogens of nematodes and tardigrades (tiny animals that live in soil, moss etc.). Among the Ancylistaceae, *Ancylistes* is parasitic on algae, and while some *Conidiobolus* species are pathogens of insects, others are common saprophytes found in soil and leaf litter.

The life cycles of the Entomophthorales are often quite complex, with multiple spore types, including secondary conidia (conidia are spores formed without a sporangium) and resting spores. As noted above, forcibly discharged conidia are a feature of the group, and insects killed by one of these fungi are often surrounded by a distinct "halo" of discharged conidia (Figure 1, above). The conidia may land on a new host and infect it, but if they do not they germinate to produce a secondary conidium. In most species at least some of the secondary conidia resemble the primary conidia and are also forcibly discharged. The process may be repeated until a host is found or stores of nutrients are exhausted (Figure 2).

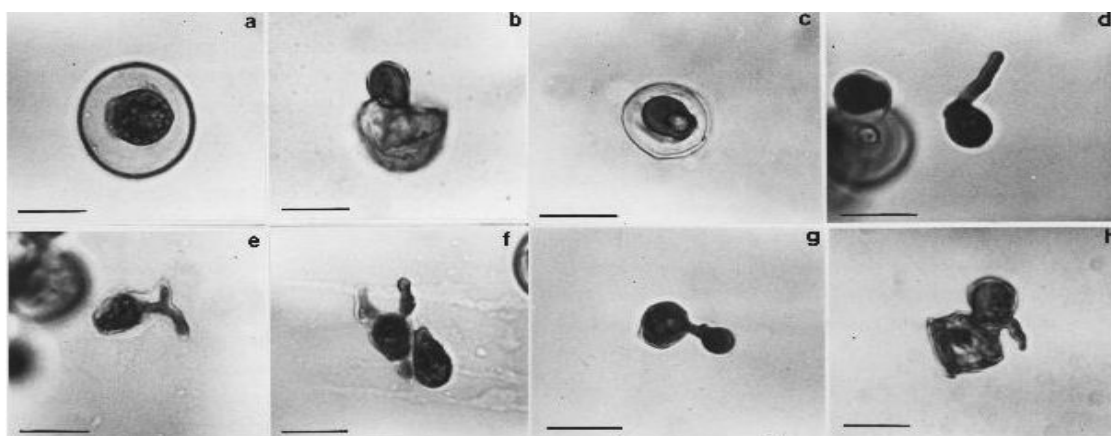


Figure 2: Types of conidia and germination patterns in *Entomophthora chromaphidis*: a) primary with the fluid droplet in which it is discharged; b) germinating to produce a secondary (c); d-f germ tubes; g) secondary germinating to form a tertiary conidium; h) germinating in dry air (a very unusual ability). © D. Holdom

Some species, notably in the genera *Neozygites* (Neozygitaceae) and *Zoopthora* (Entomophthoraceae) can produce another type of secondary conidium, a capillicondium, that can arise from a primary or secondary conidium of either type. In capilliconidia, long conidiophores bear conidia that look quite different from the primary conidia, and are not forcibly discharged. They each bear a drop of sticky material that adheres to an insect that comes into contact (Figure 3). In some species only these secondary, sessile conidia are infective.

Once an infective conidium attaches to a host it germinates to form an infection peg that penetrates the cuticle by means of enzymes and physical force. Inside the insect the fungus proliferates either as mycelial fragments called hyphal bodies, or as protoplasts, which are cells with no cell walls (figure 4). Once the fungus has multiplied enough (typically 3-10 days, depending on fungus and host species) the insect dies. Given moist conditions the fungus then emerges from the insect and releases its conidia. In species with protoplasts, cell walls are laid down at around the time of host death, and can form very rapidly.



Figure 3: Capilliconidia of *Neozygites fumosa*, with remains of primary conidia © D. Holdom

There is a bit more to it than that- in most cases the insect dies at a time of day that depends on the fungus species, and very often the insect climbs to a high point on the plant before it dies. In many species, the fungus can dry out and later revive when sufficient moisture is available, at night or in rainy weather. Sometimes this may be repeated over several days, especially when large insects such as grasshoppers are the hosts. In the case of *Pandora delphacis*, a pathogen of planthoppers on rice, the insects die at the base of plants where it is moist all the time (in paddy fields). That species does tolerate drying. In contrast a species of *Entomophaga* that infects the same host can tolerate drying, and the insects die high up on the rice plants (figure 5) even though when alive they are mostly found low down.

In addition to their short-lived conidia, some species produce thick-walled resting spores that can survive for long periods, and are important for overwintering in temperate climates. Resting spores are formed within the cadavers of infected insects, and are not forcibly discharged. Upon germination they produce conidia that can be the normal (primary) type or capilliconidia, depending on the species.

Identification of the Entomophthoraceae is based on conidial size and shape, the number and characteristics of nuclei in conidia, host, and other aspects of biology and morphology, and nowadays on DNA data. The nuclei of the Entomophthoraceae in particular are large and stain strongly with aceto-orcein. Some genera have one nucleus per conidium (e.g. *Pandora*, *Erynia*, *Zoophthora*) while many others have two or more- often many more. Nuclei stain less clearly in the Neozygitaceae, but are still distinct, with conidia containing either four or eight nuclei (a diagnostic character at genus level). Nuclei of *Conidiobolus* stain relatively poorly, and are smaller, and the large conidia are multinucleate. Conidia of the Entomophthorales are quite large, ranging from 6-8 μ m in some of the species with one nucleus per conidium, to about 80 μ m in *Batkoa gigantea*. Many are in the range 10-30 μ m.

All of this makes the Entomophthorales pretty unusual. In addition many are extremely fastidious about culture conditions (some have never been cultured), and require complex tissue culture media supplemented with serum.



Figure 4: Rice brown planthoppers killed by *Entomophaga* sp. in Indonesia. When alive these insects are mostly found near the base of the rice plants. © D. Holdom

One genus that has lost the habit of forcibly discharging conidia is *Massospora*, which attacks cicadas, filling the abdominal cavity and causing it to slowly disintegrate, releasing conidia from the still-living insects. *Strongwellsea* infects flies, and while it does forcibly eject conidia, it does so through a hole in the abdominal wall, also in living insects that distribute the fungus as they fly about.

The Entomophthorales were my first real introduction to fungi- I did some mycology as part of my 2nd year microbiology course, and was familiar with the seasonal mushrooms, giant puffballs and other fungi on our farm and in nearby forest in New Zealand, but never really took the fungi seriously. I came to Queensland to do a PhD in Entomology, and ended up working on fungal pathogens of lucerne aphids, notably *Entomophthora chromaphidis*, which was at that time identified as *E. planchoniana*. As a result I became hooked on fungi, and have a special affinity for this unusual, interesting and important group, even though I have mostly worked on other groups. I am especially grateful to Bob Teakle for introducing me to the Entomophthorales and teaching me the basics of working with them.

Reference

Hibbett, D. S. et al. (2007). A higher-level phylogenetic classification of the Fungi. *Mycological Research* **111**, 509-47 (2007).

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