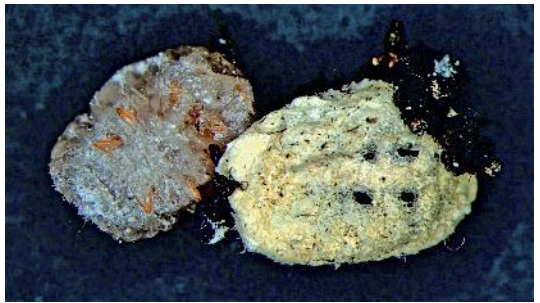
Manaaki Whenua
Landcare Research

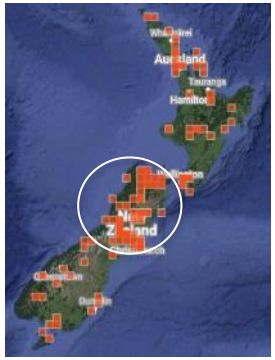
Lifting the Lid on the Black Box of New Zealand Sooty Molds

Jerry Cooper, May 2025

New Zealand Sooty Molds

- Beech forest can be wall-papered and carpeted with a thick layer of black spongy mold
- It grows on the honeydew exudate of the beech scale insect (*Ultracoelostoma spp.*)
- Also known in other NZ biomes but nothing like the quantity in beech forest
- The mold is an enigmatic community of many fungal species unique to NZ



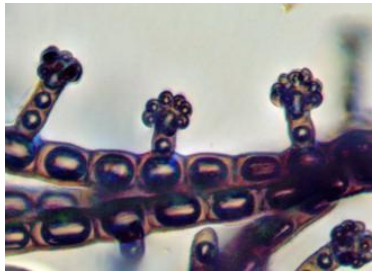


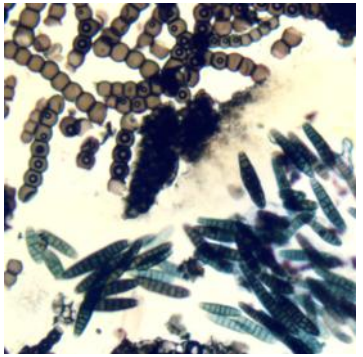
New Zealand Sooty Molds

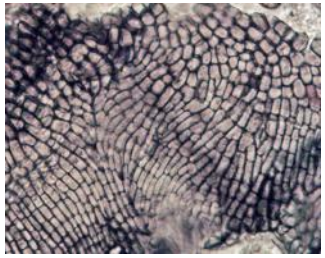
- Sometimes up to 6 species growing intertwined. Each species sometimes producing a sexual state with ascopores, and 2 or 3 different kinds of asexual spores (with their own names). Often a mix of closely related species together, but also including totally unrelated species.

- "*The colonists call it Black Moss*" – 1855, Jospeh Hooker, The Erebus & Terror expedition.

- "*…it was not my intention to get involved with sooty moulds during my stay in New Zealand in 1963. However, they are a dominant feature of the mycological landscape… and there was no escape.*" – 1972, Stan Hughes







Stan Hughes 1918 - 2019

- Born in Wales, started at IMI Kew, but spent most of his working life in Ottawa, Canada
- He established the modern method of classifying asexual fungi by conidial ontogeny
- He spent 1963 in New Zealand at PDD
- In that year he collected over 2,000 specimens including over 100 types
- Over the next 48 years he published 39 papers on New Zealand fungi
- 17 of those papers were on our sooty molds

- Only Stan had the experience & opportunity to decipher our sooty molds

The sooty mold ecology questions

- Why are they all black? (actually many are dark brown)

  An adaptation to survival. They need to grow and disperse in exposed conditions because that's where the food is. They can't hide inside a piece of wood or inside a leaf.

- Ecology 101 - Why are many species co-existing in the same apparent ecological niche with a single food resource?

  - Known to happen when there is super-abundance of food that is patchy and ephemeral.

  - Is honeydew a patchy & ephemeral resource?
    - Maybe.
  - And/or is there hidden niche differentiation?
    - Has been hypothesised that they use different components of the honeydew. That seems unlikely. What else might differentiate?

The sooty mold taxonomy questions

All genera and species were originally described in the so-called sooty-mold order – the Capnodiales (Dothideomycetes)

Stan named many species in *Euantennaria* and *Metacapnodium*, and put them in the families Euantennariaceae and Metacapnodiaceae which he placed in Capnodiales.

Species in the genus *Capnodium* are NOT a dominant part of the common beech sooty mold community. *Capnodium* does dominate tea-tree molds.

Over the last 30 years molecular approaches have led to a massive upheaval of fungal taxonomy for many groups, but the NZ sooty molds have been mostly left behind.

Metacapnodiaceae was moved to the Chaetothyriales only in 2024

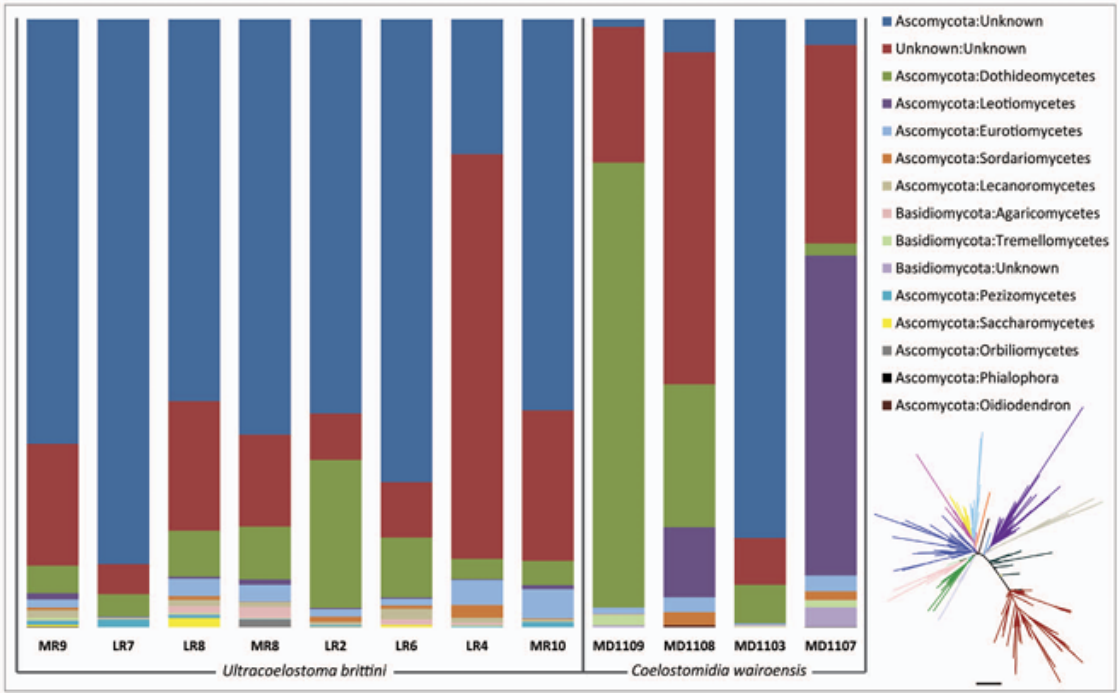
Euantennariaceae remains in Capnodiales due to lack of sequences – but is that correct? [no it isn't – most beech associates are not in the Capnodiales!]

The sooty mold taxonomy questions

- Why no/little sequence data? Because ...
    - Need a pure sample to sequence.
    - Sequencing from the natural colonies is difficult because they grow as intertwined communities
    - NZ sooty molds seem difficult/impossible to grow in pure culture, even in media enriched with honey.
    - Usually, the isolated species are not representative of the colony from which they were derived. (You might think they are, but they aren't).
- Why don't most species grow in culture?

  Perhaps because many aren't simple saprophytes ;-)
- OK – so what about using eDNA techniques on bulk samples to tell us what's there?

eDNA studies of sooty mold communities



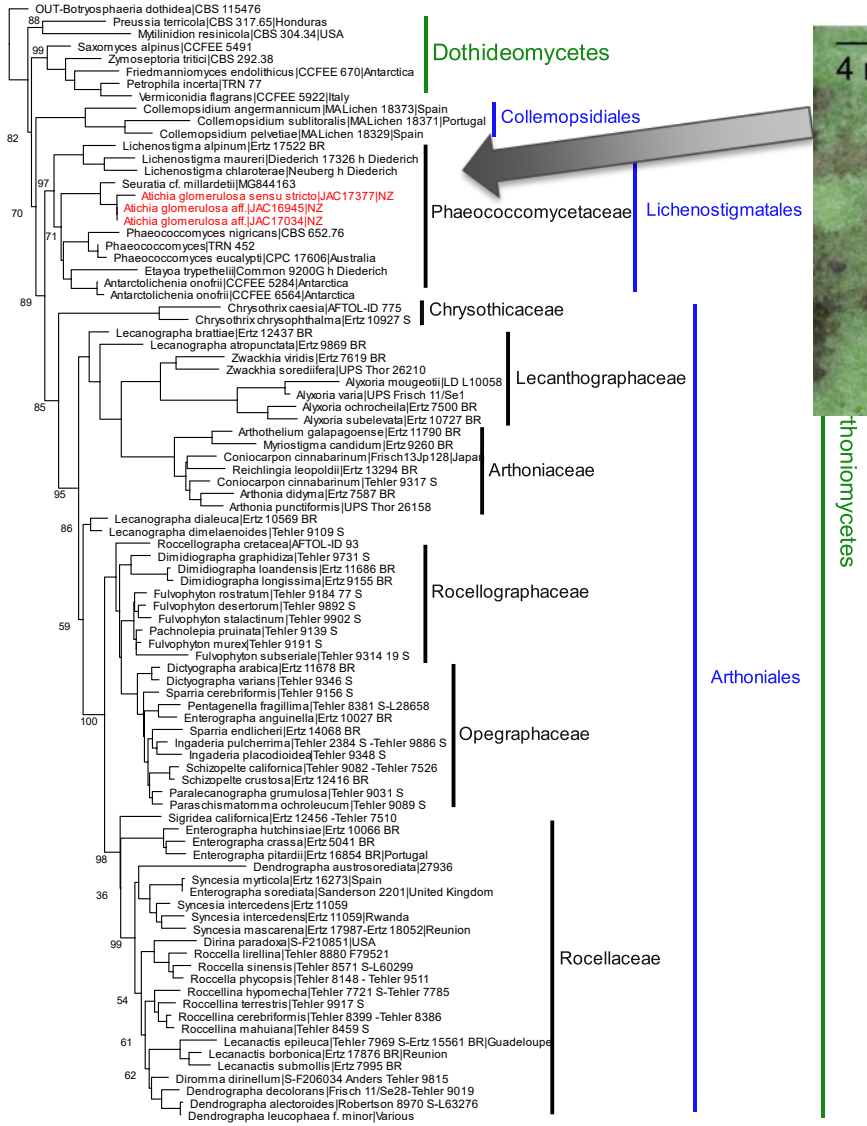
Manpreet Dhami et al, (2013) *Diverse honeydew consuming fungal communities associated with scale insects*. PLoS ONE 8(7):e70316

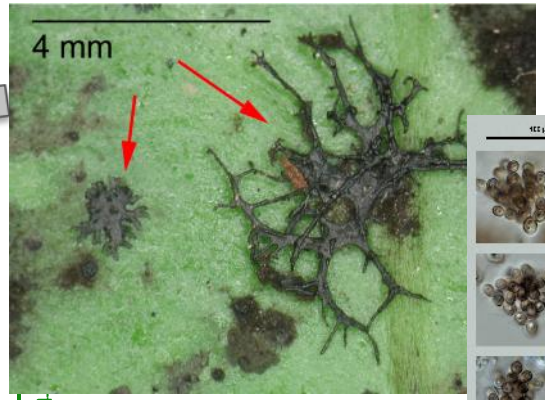
- eDNA sequences need to be matched against reliable species barcodes, and there aren't any for sooty molds
- Not even close matches. Consequently they were mostly classified 'Phylum Ascomycota – Class unknown' !

The phylogenetics of some sooty molds

- Selecting samples for sequencing
    - Select young samples before a mixed community develops, just after the honeydew starts to be produced
    - Very careful picking under a microscope of tissue from single colonies
        - even then often get mixed signals due to multiple species
    - The law of averages – if similar morphological samples give similar sequences then the sequence is probably correct
    - Try growing in culture and compare sequences with natural samples
        - sequences always different

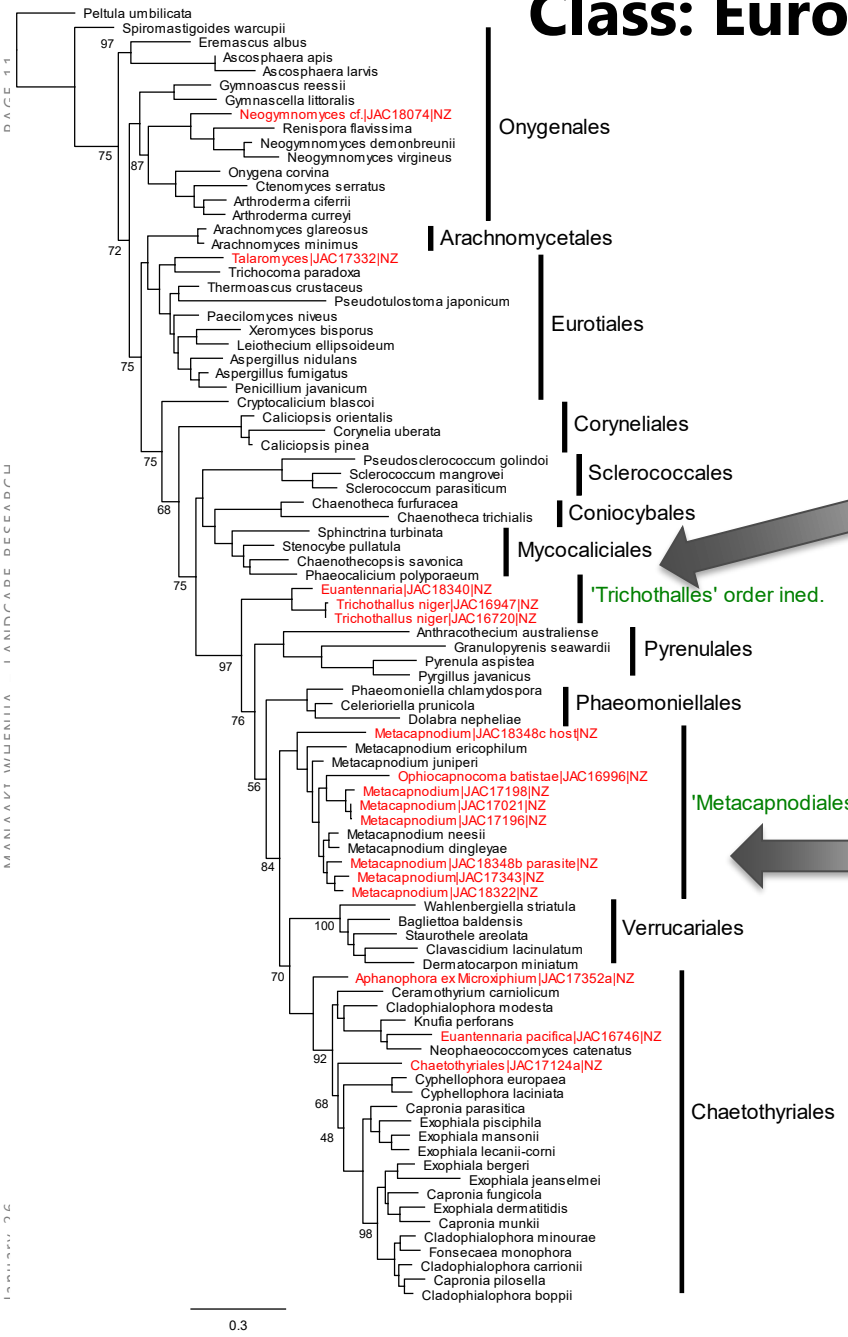
Class: Arthoniomycetes

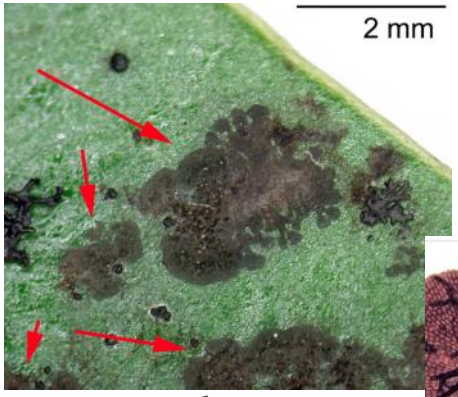




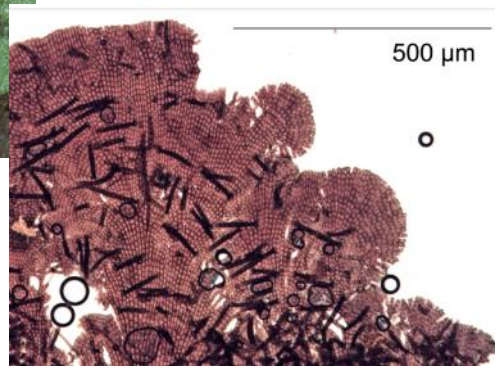
- *Atichia glomerulata* (syn. *Seuratia millardetii*)
- A phylloplane sooty
- Forms gelatinous colonies on leaves
- Globally recorded, but actually a species complex
- It is not lichenised but sits squarely within one of the largest lichen groups
- The related *Antarctolichen* and *Phaeococcomyces* are black yeasts

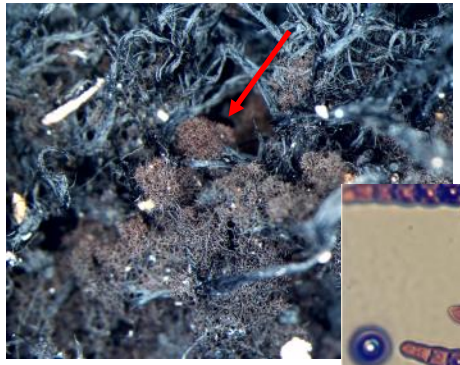
Class: Eurotiomycetes



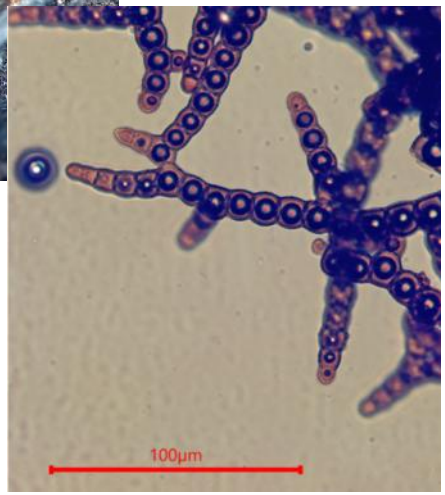


Trichothallus niger
A phylloplane sooty.
Also lichen related

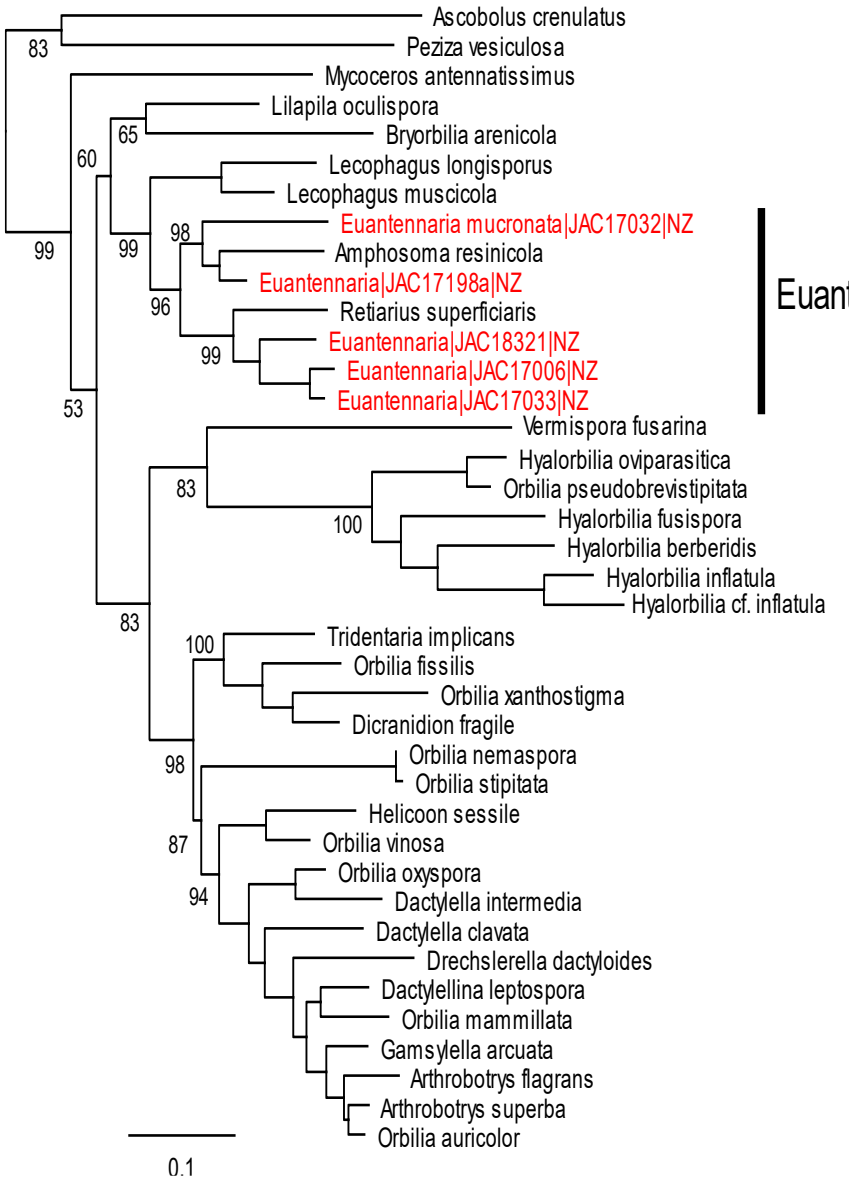




Metacapnodium
A beech sooty.
Brown colonies.
Torulose hyphae.



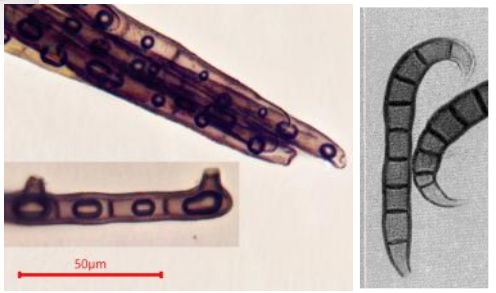
Class: Orbiliomycetes

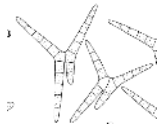


Euantennariaceae

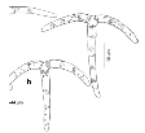
Orbiliaceae

Euantennaria
Sooty with beech & other trees
Hyphae not torulose





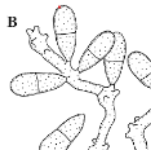
Retiarius
pollen trapper



Amphosoma
tree resin

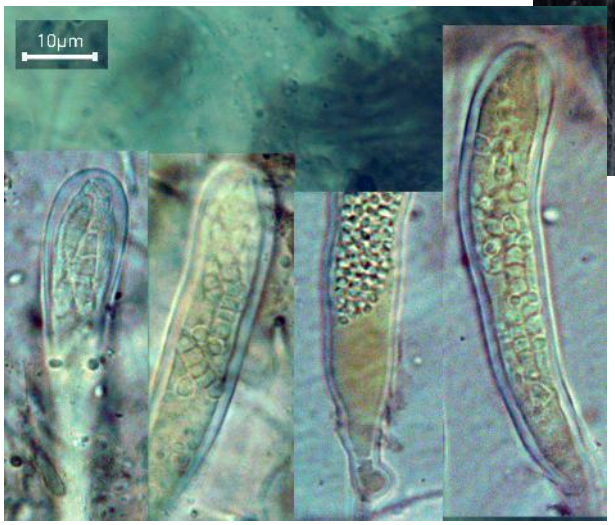
Lecophagus
protozoan parasite

Mycoceros
pollen trapper



Orbilia
nematode trapper

Apothecial species are present



- Dark green apothecia Directly associated with the scale insect bodies in *Euantennaria* cushions
- Is this in the Orbiliomycetes?
- Sequencing gave many signals

Conclusions

- **Distinct communities:**
- **Leaves (phylloplane)** – indirect, aerosol/splash zone
- **Beech** – directly associated with beech scale (*Ultracoelostoma*)
- **Bark/twigs** – indirect, aerosol/splash zone
- **Tea-tree** – directly associated with tea-tree scale (*Coelostomidia*)

- Phylloplane splash zone fungi, like *Trichothallus niger* & *Atichia glomerulosa* are quite different to bark zone species & related to lichens

- Beech scale communities are dominated by *Metacapnodium*-like species in the Eurotiomycetes and they probably represent a new order – Metacapnodiales

- There are many more species than Hughes described

- *Euantennaria*-like species include generalists in all communities. Come out in different orders but some evidence many are in the Orbiliomycetes ... but those don't have apothecia?!

- Are the orbiliales-*Euantennaria*-like species parasites of other sooty molds?

  i.e. hidden niche differentiation allowing at least some species to co-exist. They are in a host-parasite relationship, and potentially a host-parasite-hyperparasite chain.