

Biodiversity of *Chaetothyriales* in recently discovered symbiotic tropical ant-fungus associations

Hermann Voglmayr

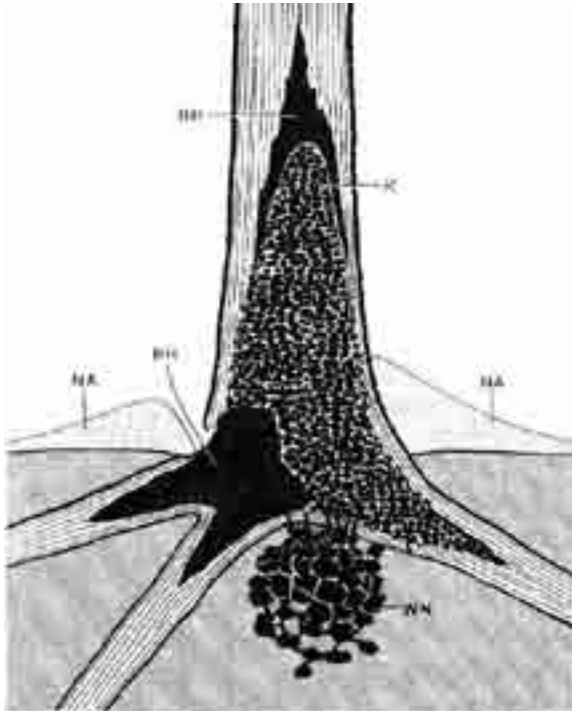
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Introduction



Schematic drawing of *Lasius fuliginosus* carton nest in hollow tree base (left, from Hölldobler & Wilson 1990); part of carton nest colonised by fungal symbiont (right)

§ various ant groups form carton structures (nests, runway galleries) from plant material. Rare in the temperate zone, but common in the tropics.

§ well known example for fungus-growing on carton nests in the temperate zone: *Lasius fuliginosus*

§ fungal symbiont described by Lagerheim in 1900 as *Cladosporium myrmecophilum*

§ recent DNA data place *Lasius* symbiont fungi near *Venturiaceae*

§ until recently the only investigated ant - carton fungus symbiosis

Tropical ant symbioses involving *Chaetothyriales*

§ for long time ignored - only recently recorded and investigated in detail

§ widely distributed and important component of numerous plant-ant-fungus networks

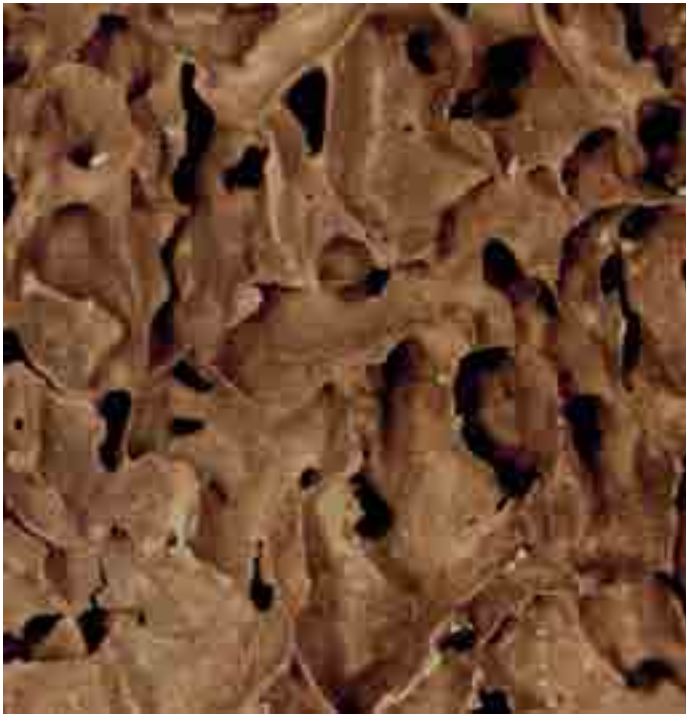
§ independently acquired by several ant lineages in Old and New World

§ investigations on biodiversity and ecological role

Ant – fungus symbioses involving *Chaetothyriales*

§ two common symbiosis types in the tropics:

carton structures of nest



in domatia in living plants



Chaetothyriales in ant domatia



conidiophores from fungal patch

- § ants cultivate fungi in domatia
- § present in various ant lineages
- § several undescribed fungal species involved, forming a complex network
- § indications that fungi serve as food (under investigation)

Chaetothyriales on carton: case study from Azteca tunnels



§ case study from Costa Rica:
Tetrathylacium (*Salicaceae*) -
Azteca (*Formicidae*) –
Chaetothyriales (Mayer & Voglmayr
(2009), *Proc. Roy. Soc. B* 276: 3265-
3273.)

§ carton tunnels built externally
on branches of *Tetrathylacium*

§ holes in tunnels for exit and
for insect prey capture

§ carton stabilised by a complex
assemblage of fungi, all
belonging to *Chaetothyriales*

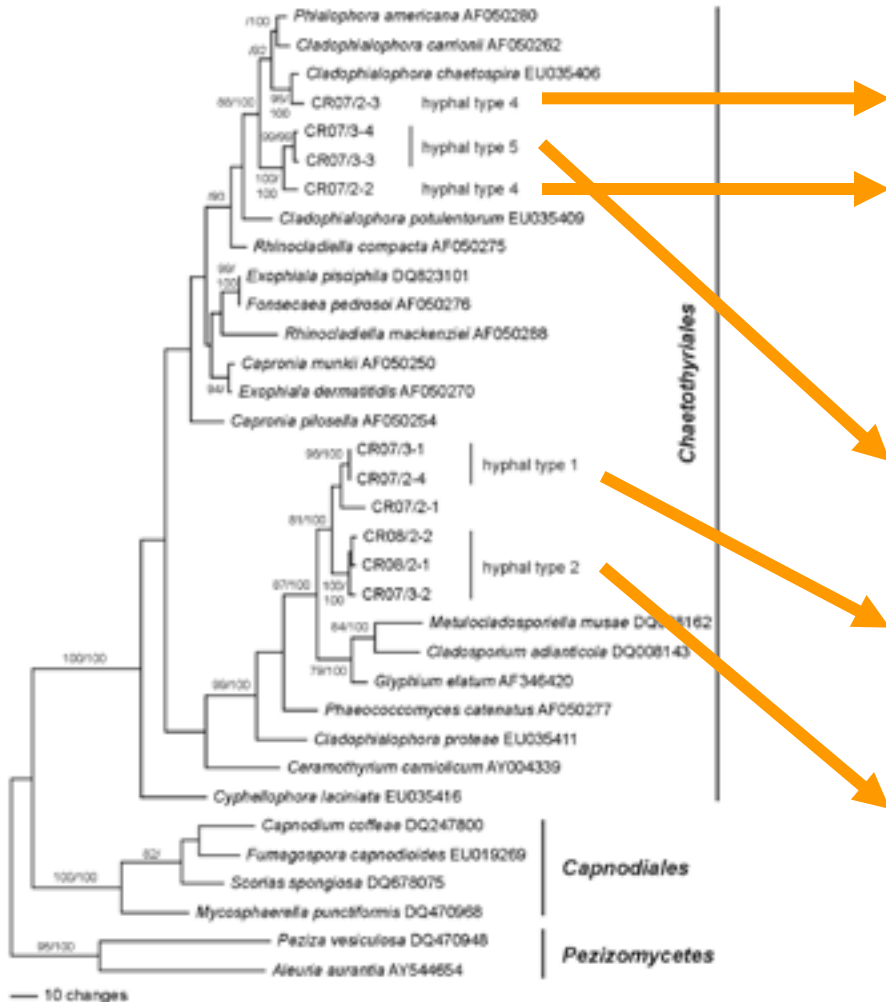
§ rapid colonisation by fungi,
but detailed process unknown

Chaetothyriales on carton: case study from Azteca tunnels



§ various different *Chaetothyriales* grow intermingled on carton – at least 5 different hyphal types present, correspond to different species

Chaetothyriales on carton: case study from Azteca tunnels



hyphal type 4



hyphal type 5 & 2 (middle)



hyphal type 1



hyphal type 2 (most common)

4 of the 5 hyphal types isolated in pure culture

Characteristics of *Chaetothyriales* involved

§ carton fungi

- § complex association of several species, often with one dominant
- § dark walled monilioid hyphae, colouring carton blackish
- § not ingested by ants, ecological role: increase of carton stability
- § mostly sterile, no sporulating structures – difficult to classify

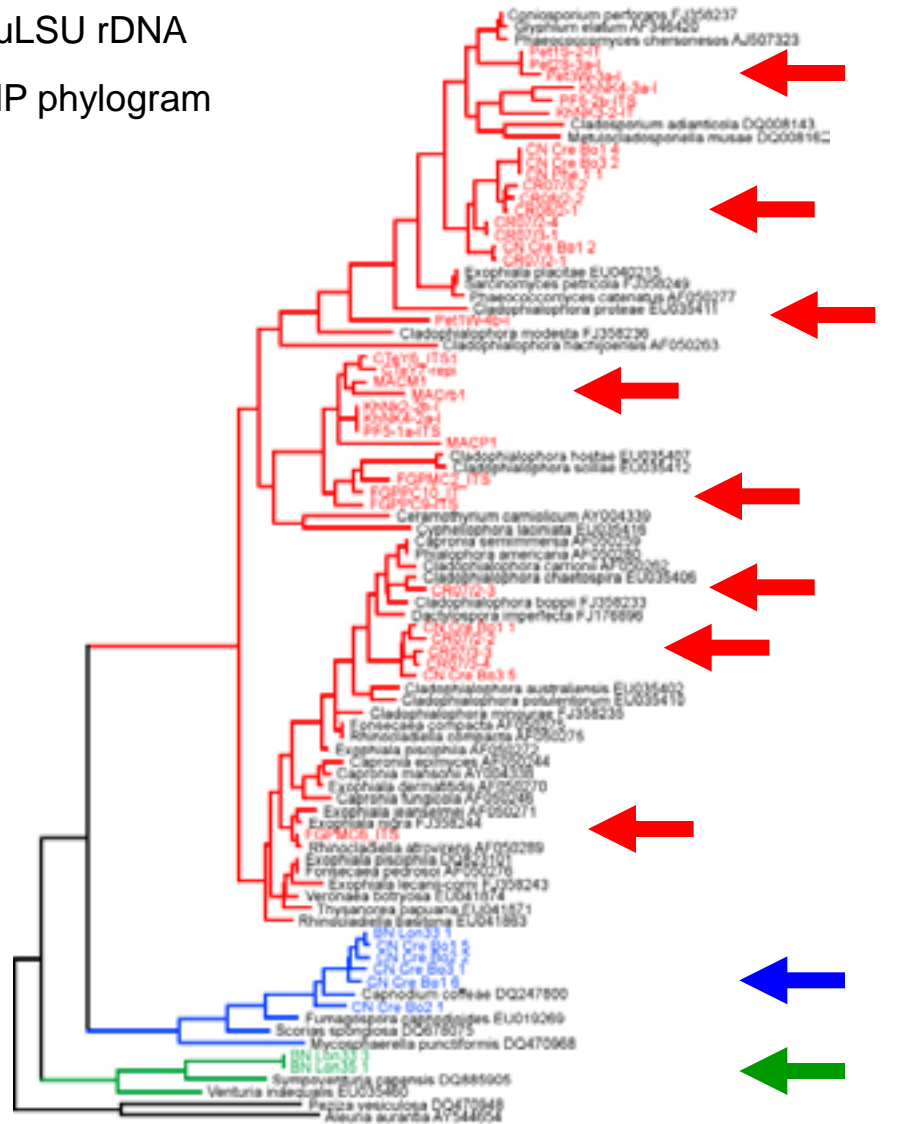
§ domatia fungi

- § usually a single or two fungal species producing a dense layer on living host tissue in domatia
- § hyaline or light brown thin-walled hyphae
- § commonly sporulating
- § often producing yeast-like stages in pure culture

marked morphological and ecological differences between the carton colonizers and the domatia fungi

Fungal carton & domatia symbioses in tropical ants – three fungal lineages

nuLSU rDNA
MP phylogram



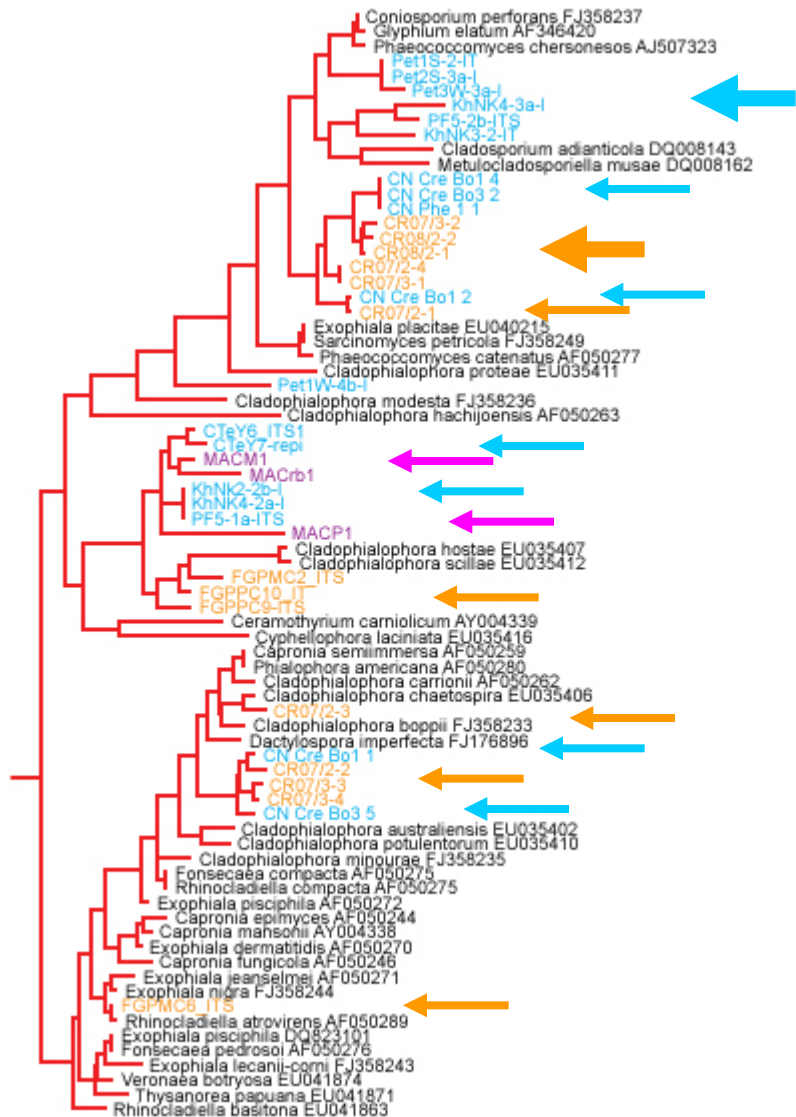
§ biodiversity of fungal symbionts high
 § contains members from various lineages of *Chaetothyriales*
 § most species likely to be undescribed

Chaetothyriales (black yeasts):
 carton & domatia

Capnodiales (sooty moulds): carton

Venturiaceae: carton

Chaetothyriales: continental distribution of carton & domatia symbionts



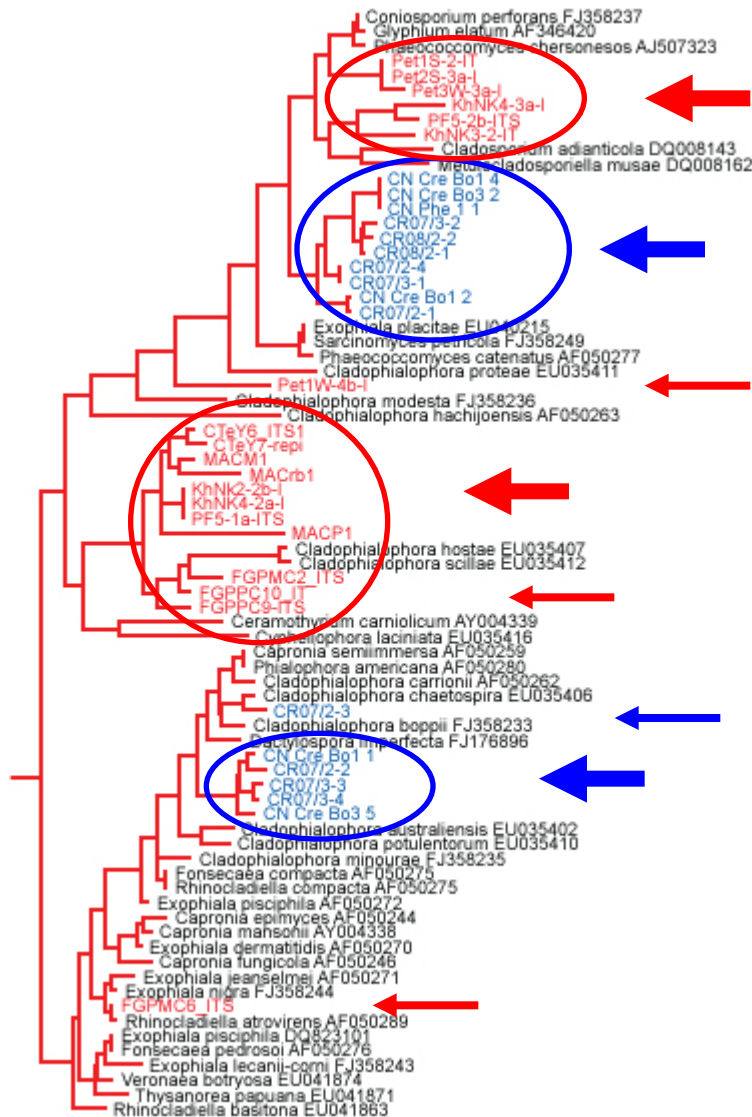
- ← Africa
- ← America
- ← Asia

§ samples from tropical Africa, America and Asia

§ no clear geographic pattern

§ most tropical areas completely understudied

Chaetothyriales: phylogenetic affiliations of carton & domatia symbionts



← carton

← domatia

§ two main groups of closely related domatia fungi

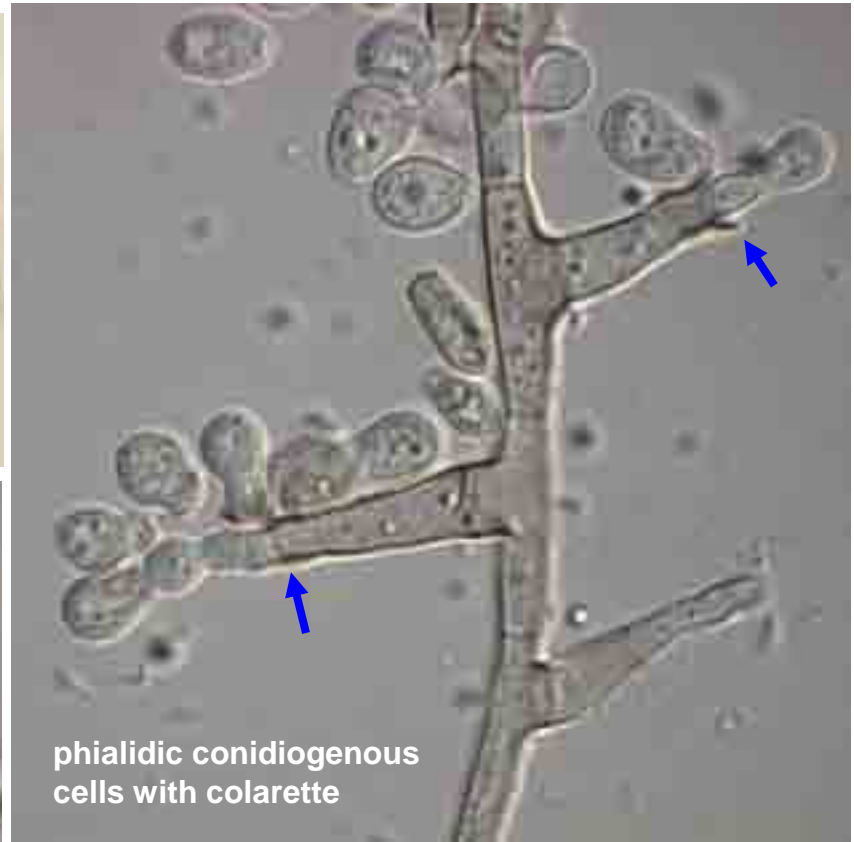
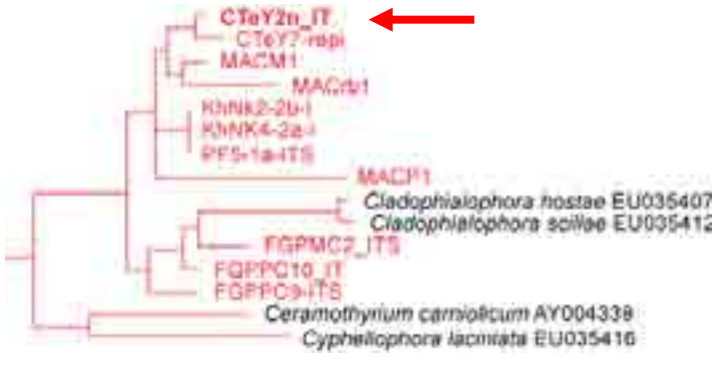
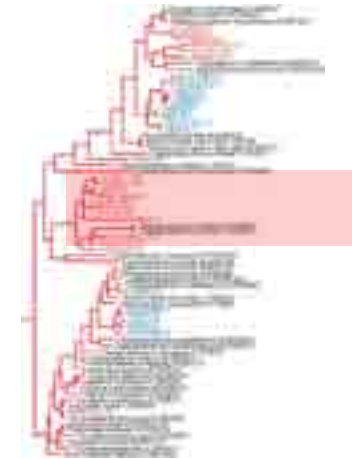
§ two main groups of closely related carton fungi

§ selection of fungi from different phylogenetic lineages for carton and domatia

§ species outside of main clades likely contaminants (mostly fast-growing)

Some examples...

Fungi of *Tetraponera* in *Barteria domatia* (Africa): species 1



phialidic conidiation, pyriform-ellipsoid conidia, yeast like growth in early stages, distinctly yellow granular content in older hyphal cells

Fungi of *Tetraponera* in *Barteria domatia* (Africa): species 1



day 1 after inoculation



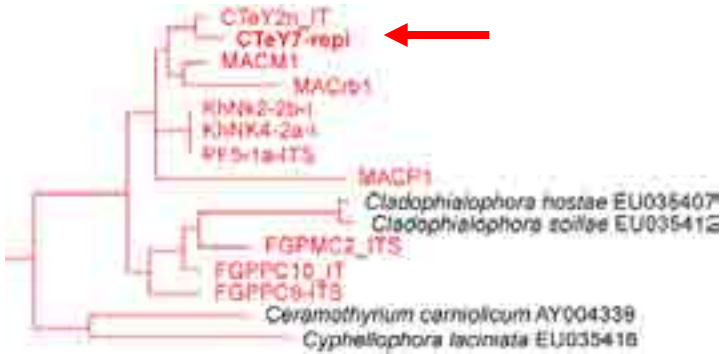
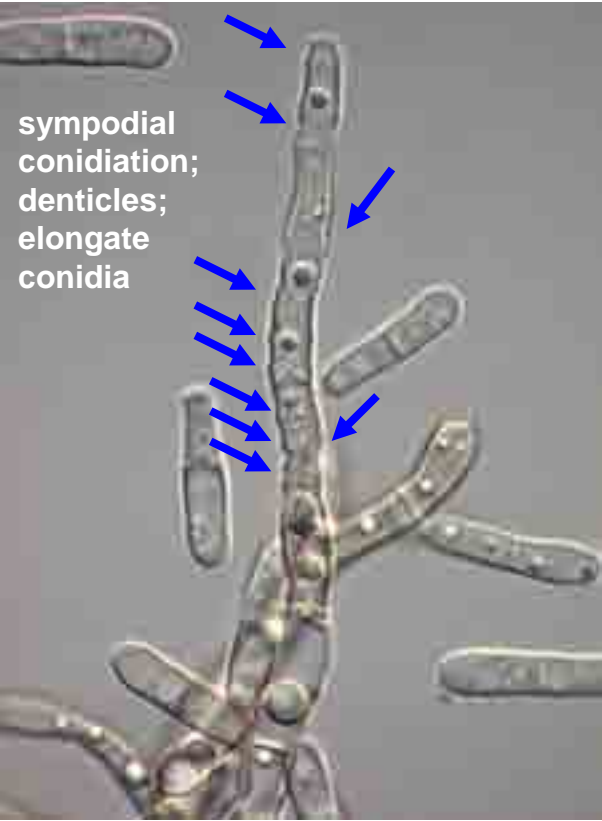
day 2 after inoculation



day 3 after inoculation

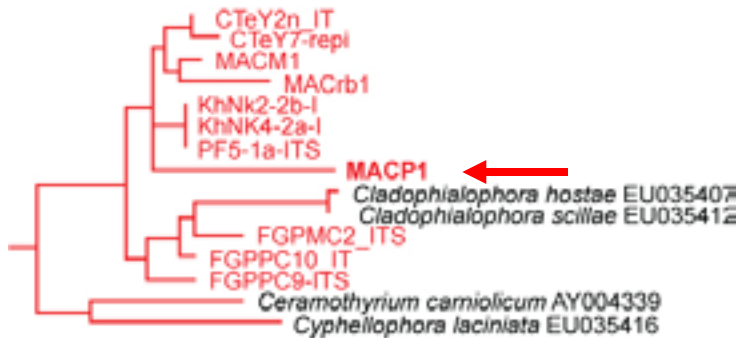
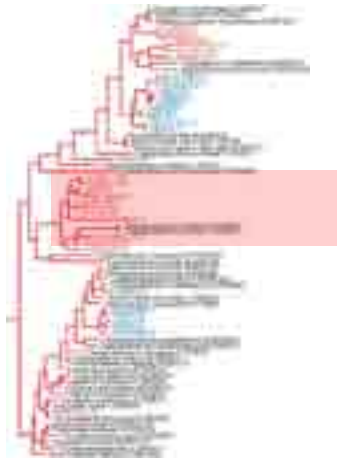
isolation of previous species in pure culture from yeast-like budding cells

Fungi of *Tetraponera* in *Barteria domatia* (Africa): species 2



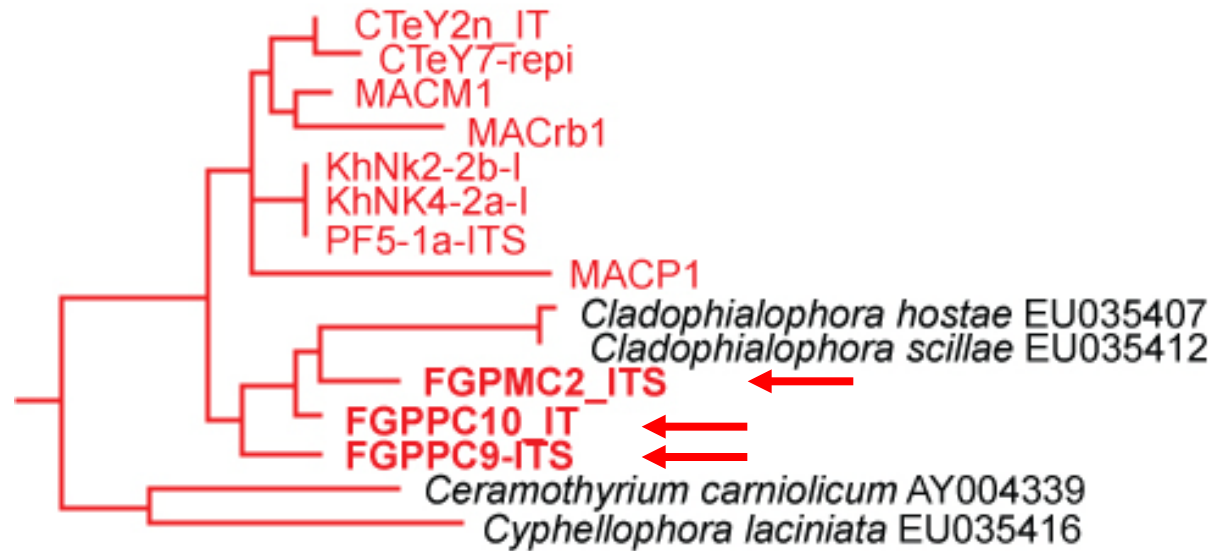
Veronaea-like sporulation, 2-celled cylindrical conidia, yeast like growth in early stages, distinctly yellow granular content in older hyphal cells, closely related to & co-occurring with the previous species

Fungi of *Cladomyrma petalae* in *Saraca domatia* (Asia)



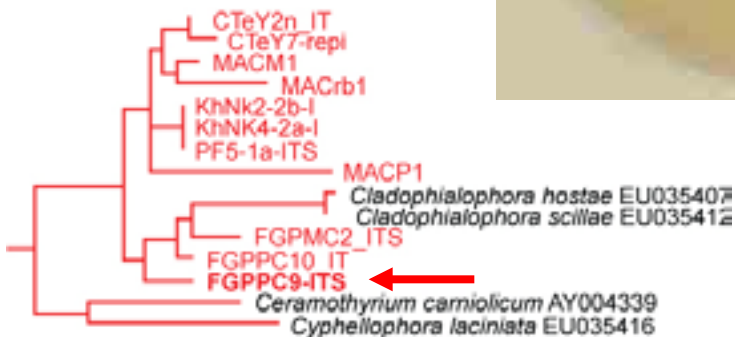
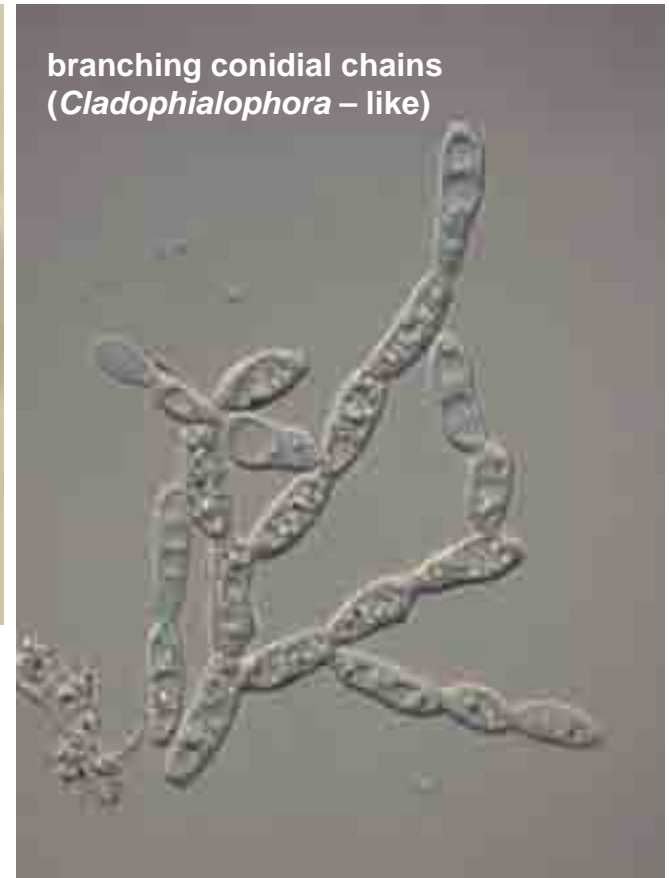
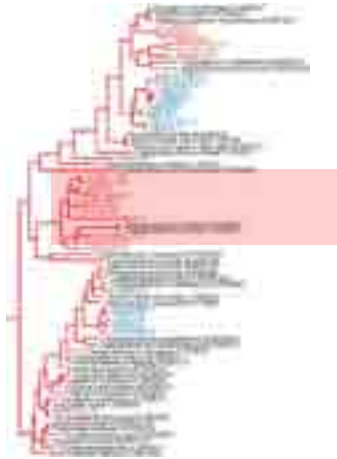
***Rhinocladiella*-like sporulation, cylindrical aseptate conidia, brown hyphae**

Fungi of *Pseudomyrmex* in *Tachigali* domatia (South America)



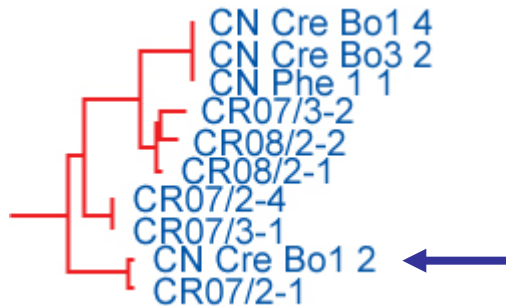
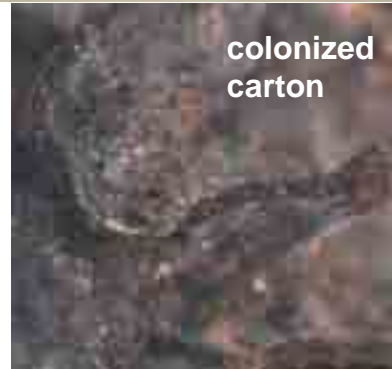
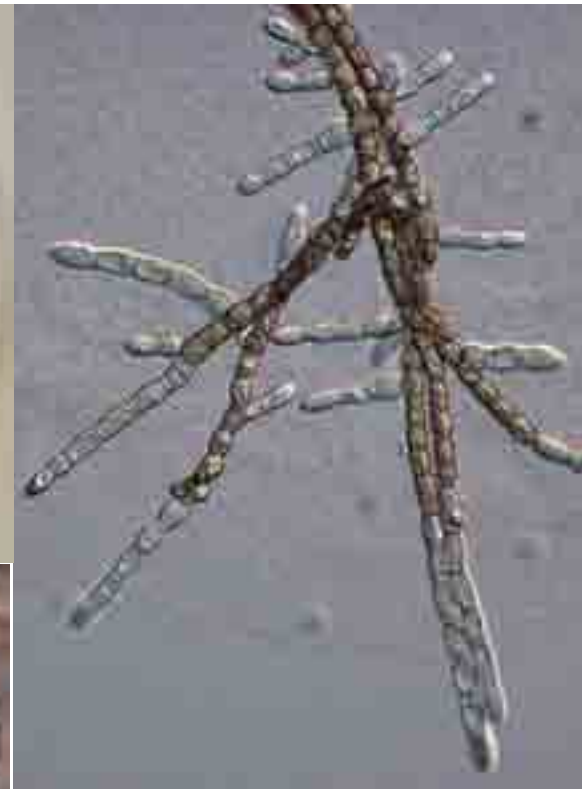
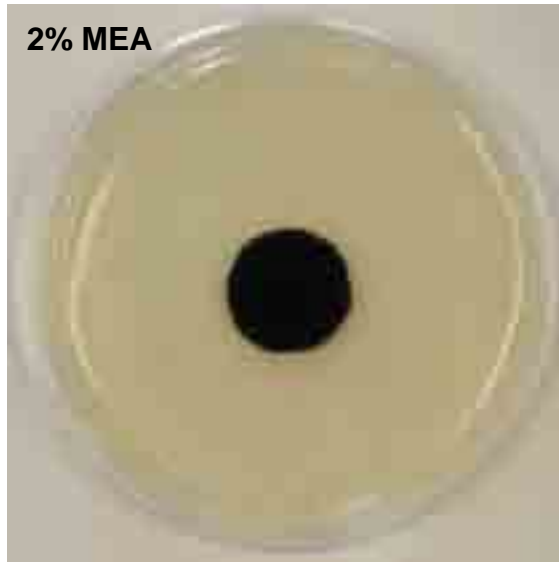
three closely related main fungal species present in domatia

Fungi of *Pseudomyrmex penetrator* in *Tachigali domatia* (South America)



***Cladophialophora*-like sporulation, cylindrical conidia**

Fungi of *CreMATogaster* carton nest (Africa)



germinating hyphae
(from isolation plate)

hypha
(plate)

no sporulation, dark brown thick-walled hyphae with incrusted wall – very similar in all isolates of this clade which originate from various ant nests!!!

Conclusions

- § ant – fungus symbioses involving *Chaetothyriales* common in the tropics in various ant lineages on all continents
- § carton fungi loosely associated with the ants; several species co-occurring on carton
- § carton fungi improve stability of the carton
- § domatia fungi more specific – likely to serve as food
- § carton fungi difficult to assign to anamorph genera as most lack of conidia
- § domatia fungi commonly sporulating
- § carton and domatia fungi stem from different phylogenetic lineages within *Chaetothyriales*
- § most fungal species undescribed
- § biodiversity of fungal ant symbionts understudied

Acknowledgements

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