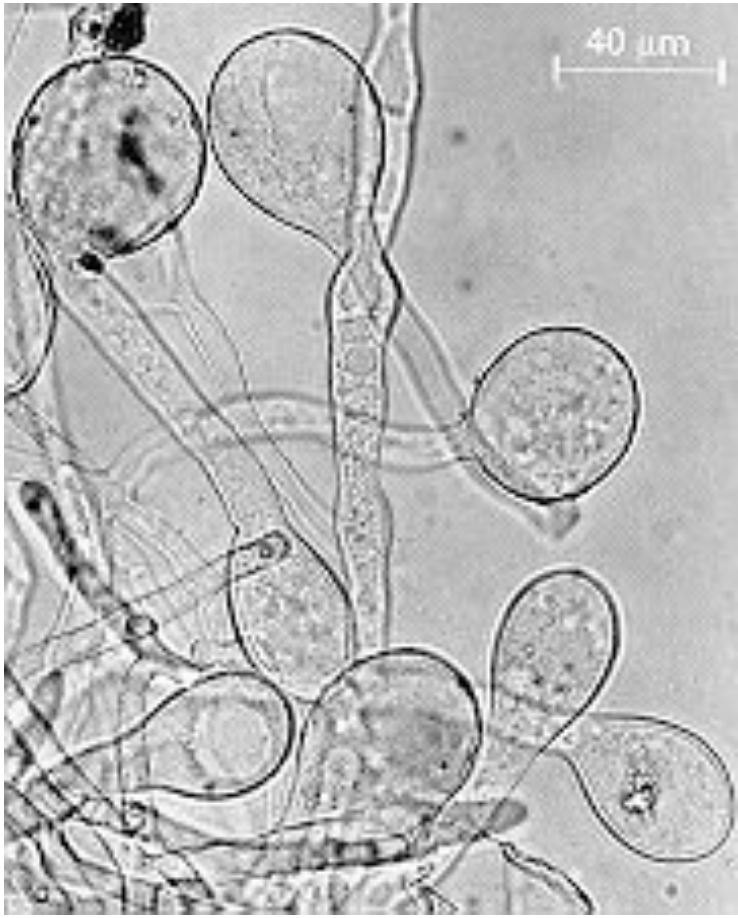
Fungi cultivated by leaf cutter ants are sterile and depend on the ant colony for survival. Closely related to the agaric genera *Lepiota* and *Leucoagaricus*



Tips of hyphae are swollen to form nutritive gongylidia that the ants feed on

Leucoagaricus leucothites, Rosablättriger Egerlingsschirmling © www.mykonet.ch

Ant fungi are related to *Leucoagaricus* and *Lepiota*, but ant cultivated species are not reproductively fertile. Some form sterile basidiocarps.

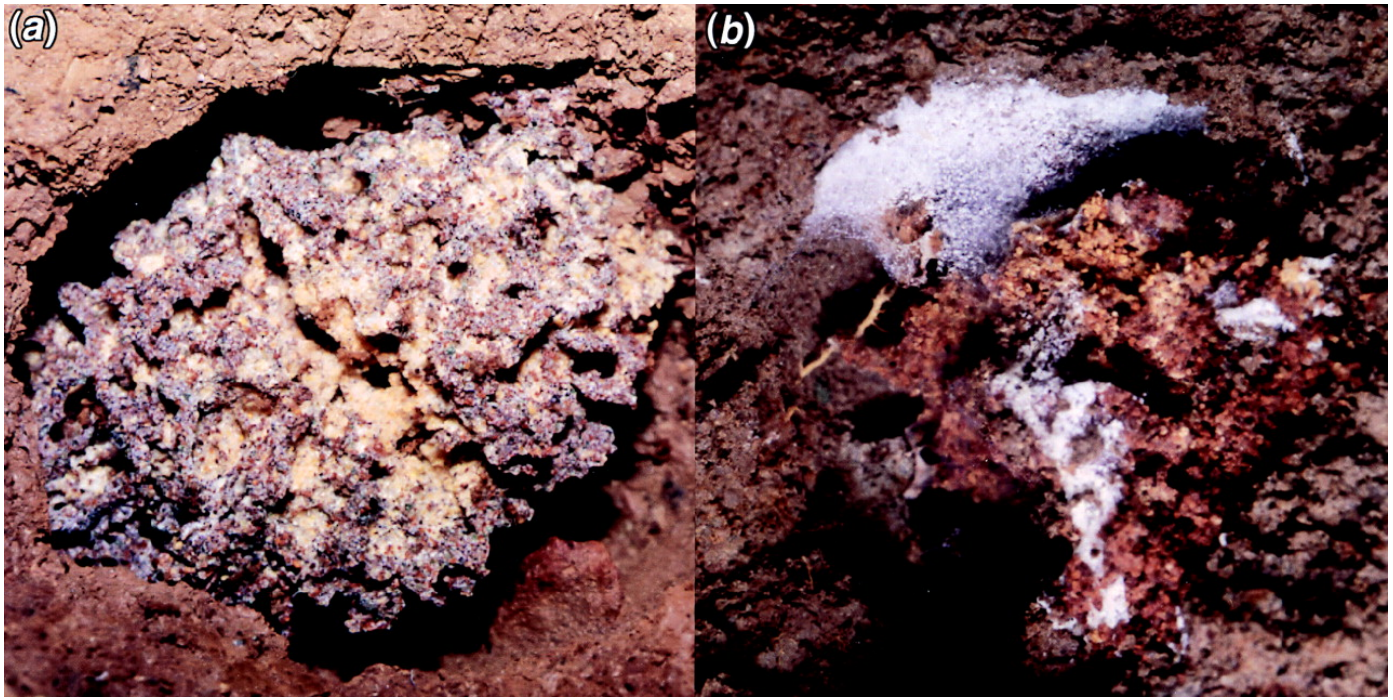
Fungus is propagated clonally by queens when they establish new colonies. Some of the cultivated clones are several million years old.

Like human agriculture, ant agriculture has pathogens. The significant pathogen of ant gardens is a fungal parasite, *Escovopsis* (an ascomycete)

Escovopsis aspergilloides

Escovopsis is a specialized fungal parasite found only in the nests of Attine ants

Fig. 2. (*a*) A healthy *Trachymrymex* sp. garden. (*b*) A completely devastated *Trachymyrmex* sp. garden overgrown by the parasite *Escovopsis*.

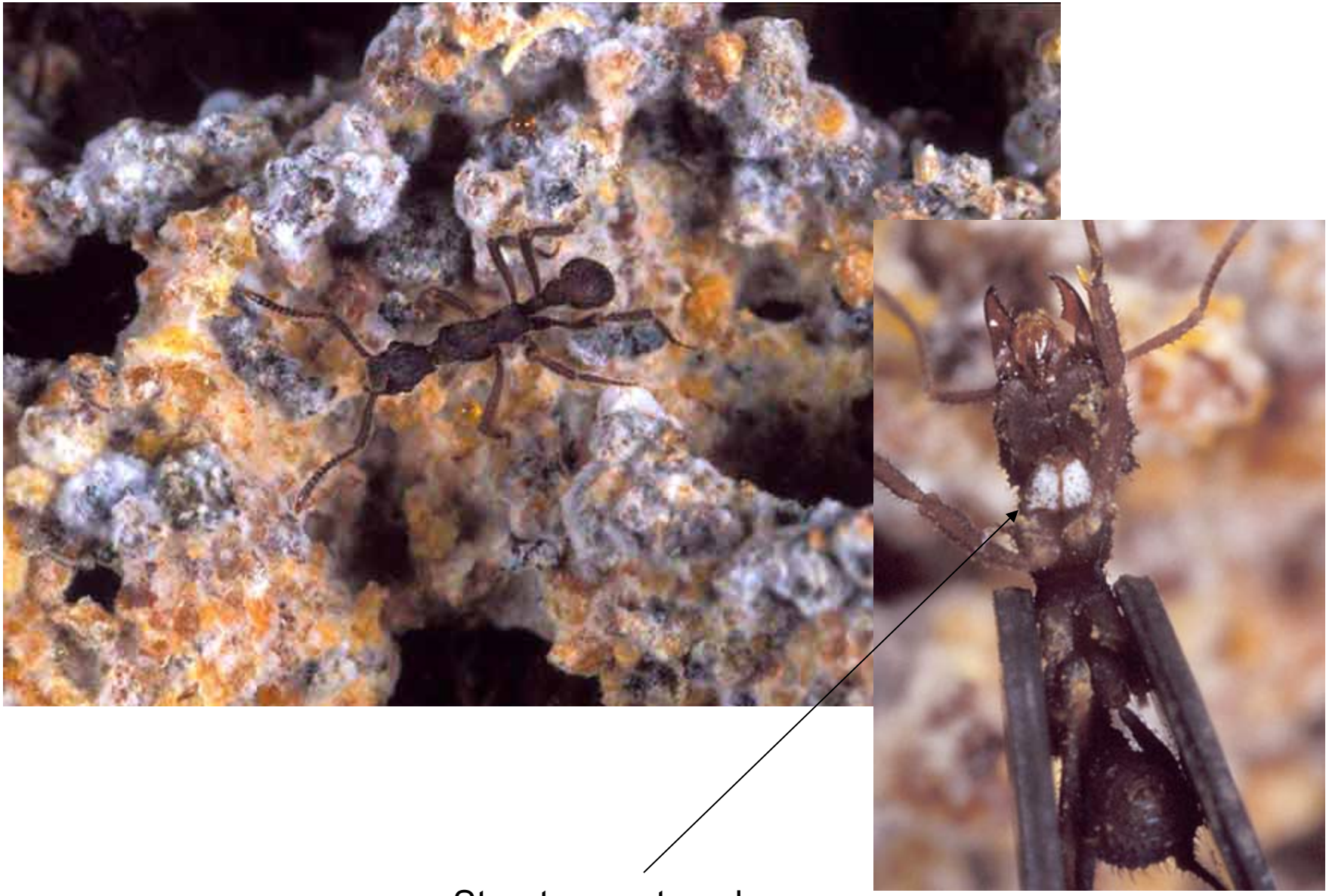


Escovopsis is highly destructive to the fungus cultivated by the ants

Currie, Cameron R. et al. (1999) Proc. Natl. Acad. Sci. USA 96, 7998-8002

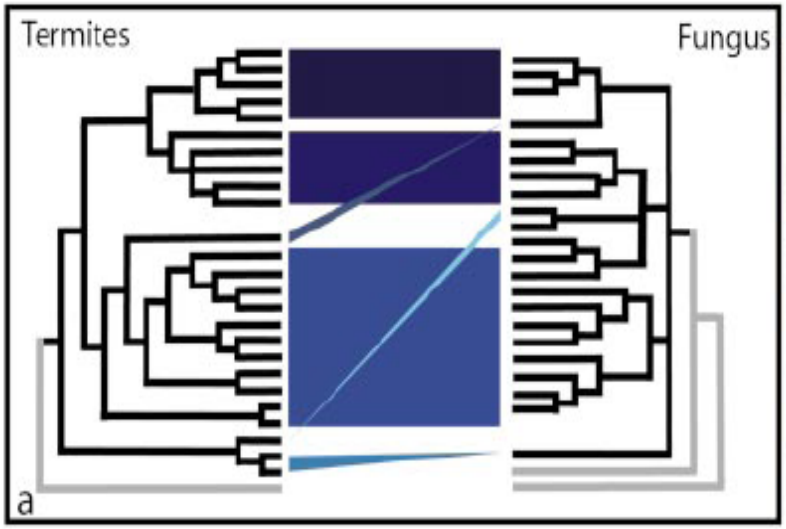
Ants also use the oldest form of biological control to manage the *Escovopsis* in their gardens. The workers groom the nest, spread the spores of a *Streptomyces* that they maintain in a special organ.

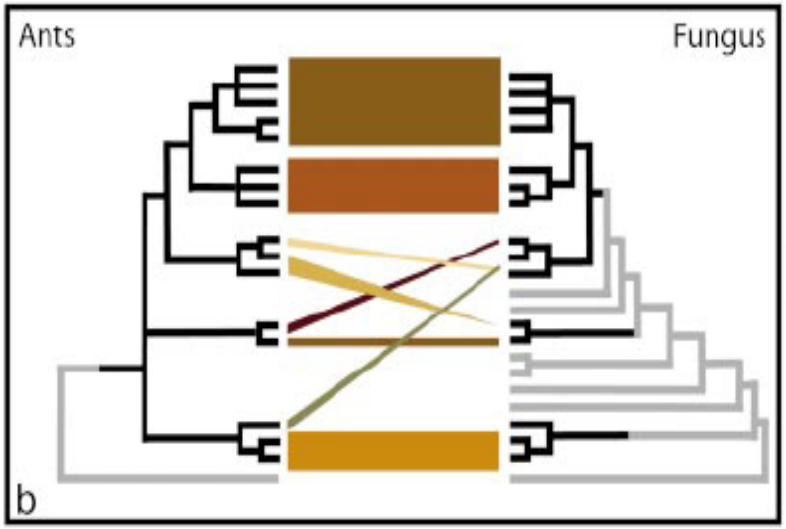
The *Streptomyces* (bacterium) is inhibitory to the *Escovopsis* but not the cultivated fungus.



Streptomycete colony

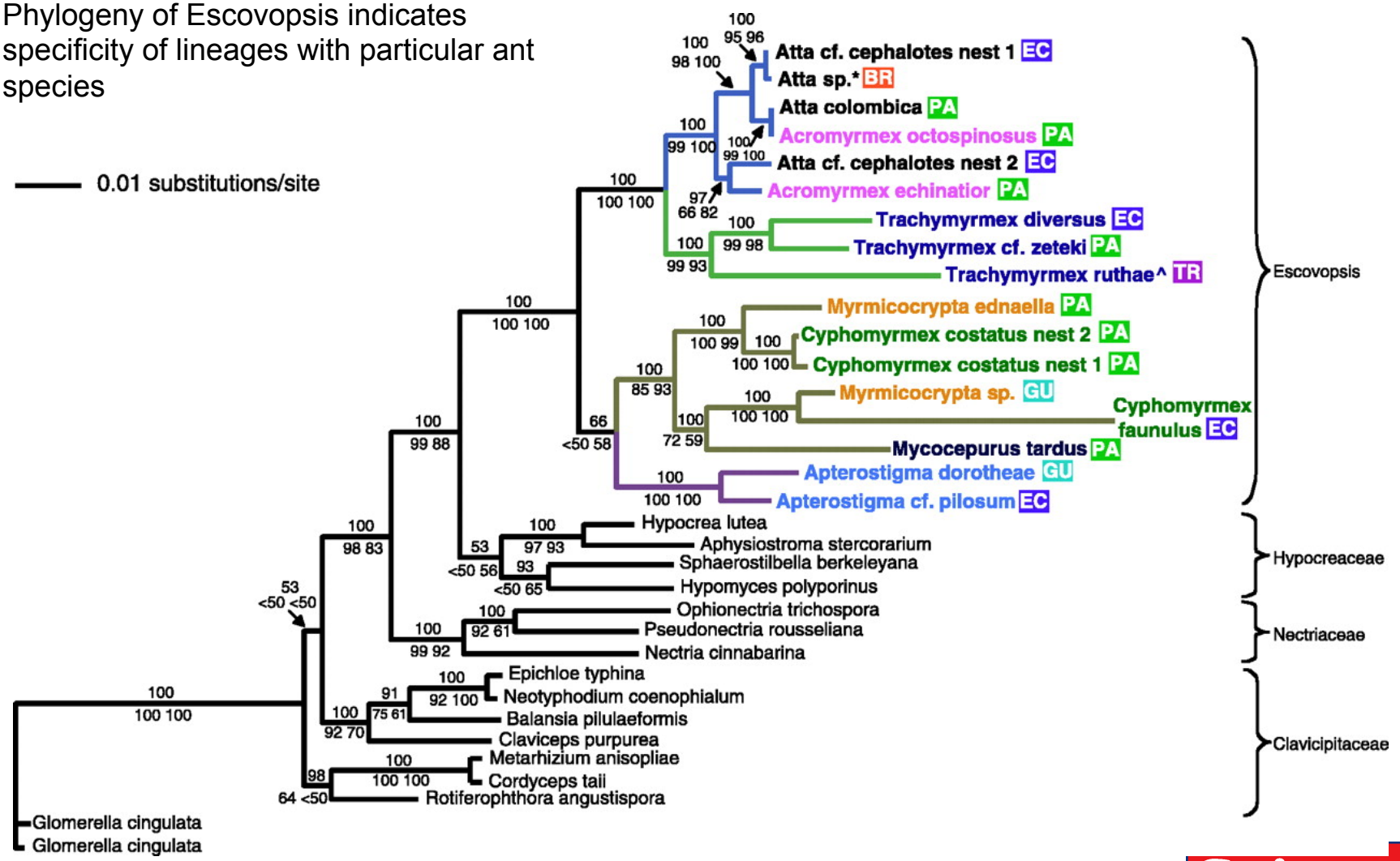
Ant fungiculture also apparently resulted from a single evolutionary event and subsequent radiation, like termite fungi but the fungi cultivated by ants are more phylogenetically divergent





Escovopsis has evolved together with the fungus gardening ants

Phylogeny of Escovopsis indicates specificity of lineages with particular ant species



C. R. Currie et al., Science 299, 386 -388 (2003)

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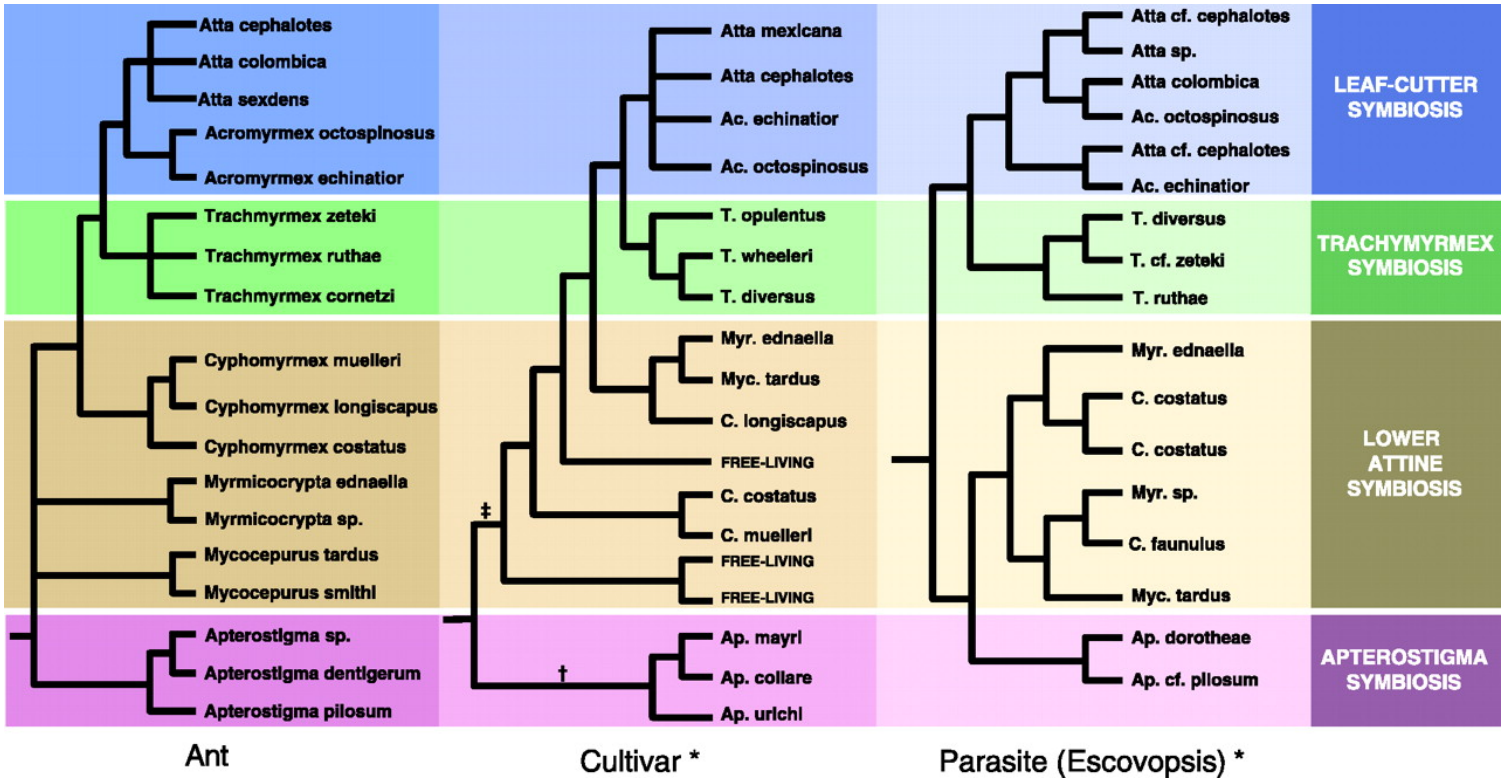
Congruent rDNA phylogenies for 3 symbionts -- coevolution

Figure 2. Phylogenetic reconstruction of the ancient tripartite coevolution of fungus-growing ants (left), their fungal cultivars (middle), and the garden pathogen *Escovopsis* (right). The phylogenies of fungus-growing ants and their fungal cultivars are based on previously published work (5, 6, 8, 21, 22). Colors indicate congruent phylogenetic groups of the three symbionts. *Cultivar and *Escovopsis* strains are indicated by the name of the ant species' host garden from which they were isolated. The symbol indicates that the derived members of the attine ant genus *Apterostigma* secondarily switched from lepiotaceous fungiculture to fungi in the family Tricholomataceae (5). The symbol indicates that cultivars associated with the lower attine ants are not monophyletic but instead are part of a group that also includes free-living species of Lepiotaceae (5, 8).



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“pseudo mycorrhizal’ fungi
Boletinellus and Phlebopus

Boletinellus merulioides grows in association with ash trees
Not mycorrhizal
Root –feeding aphid secretes carbohydrates

Phlebopus species associate with scale insects

Phlebopus giganteus, a large Australian bolete

Sirex noctilio wood wasps and Amylosterum areolatum

Female *Sirex* ovipositing in a living tree

Sirex native to Europe, Asia, has been introduced to S. Africa, New Zealand
Major pest of North American pine species grown as forest plantation crop