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Advanced farming ants rear polyploid crop fungi

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Polyploidy is common in plants, presumably because advantages of increased functional heterozygosity often surpass costs of destabilized mitosis or epigenetic instability, but rare in fungi, where 'diploid' cells retain the two parental haploid nuclei rather than merging them into a zygote. Such dikaryotic mycelia are actively maintained in Basidiomycota where clamp connections ensure honest propagation of nuclei during cell division, but the same mechanism may constrain the evolution of multinucleate cells. Previous research has indicated that the domesticated basidiomycete crop-fungus of leafcutter ants, which lacks clamp connections, is a functional polyploid, but without pursuing this further. We microscopically estimated the mean number of nuclei per somatic cell for 42 fungal symbionts reared by 14 species (eight genera) of fungus-growing ants in Panama, and mapped these numbers on a fungal symbiont phylogeny. This showed that all higher attine ants that rear specialized fungi without free-living close relatives had 7-17 nuclei per cell, whereas non-specialized fungal crops of the basal attines were dikaryons. Analysis with ten microsatellite markers revealed that almost 40% of the additional nuclei represented novel haplotypes, yielding an estimate of average ploidy in higher attine crop fungi of 5-6. We hypothesize that functional polyploidy in crop symbionts evolved because benefits of increased heterozygosity outweighed costs that could be met by the farming ants. Polyploid crops may thus represent a form of symbiont chimerism for the sake of enhanced genetic diversity, similar to multiple queen-mating that evolved in the leafcutter ants to generate higher genetic diversity among colony workers. The transition to crop-polyploidy coincided with at least an order of magnitude increase in colony size of farming ants.