Enzyme activities at different stages of plant biomass decomposition in three species of fungus-growing termites

Fungus-growing termites rely on the mutualistic fungus Termitomyces and gut microbes for plant biomass degradation. Due to a certain degree of symbiont complementarity, this tripartite symbiosis has evolved as a complex bioreactor, enabling decomposition of nearly any plant polymer, likely contributing to the success of the termites as the main plant decomposers in the Old World. Here we evaluate which plant polymers are decomposed and which enzymes are active during the decomposition process in two major genera of fungus-growing termites. We find a diversity of active enzymes at different stages of decomposition and a consistent decrease in plant components during the decomposition process. Furthermore, our findings are consistent with the hypothesis that termites transport enzymes from the older mature parts of the fungus comb through young worker guts to freshly inoculated plant substrate. However, preliminary fungal RNAseq analyses suggest that this likely transport is supplemented with enzymes produced in situ. Our findings support that the maintenance of an external fungus comb, inoculated with an optimal mix of plant material, fungal spores, and enzymes, is likely the key to the extraordinarily efficient plant decomposition in fungus-growing termites. Importance Fungus-growing termites have a substantial ecological footprint in the old world (sub)tropics due to their ability to decompose dead plant material. Through the establishment of an elaborate plant biomass inoculation strategy, and fungal and bacterial enzyme contributions, this farming symbiosis has become an efficient and versatile aerobic bioreactor for plant substrate conversion. Since little is known about what enzymes are expressed, and where they are active at different stages of the decomposition process, we used enzyme assays, transcriptomics and plant content measurements to shed light on how this decomposition of plant substrate is effectively accomplished.