Social insects and their diverse colony organizations elucidate principles of microbiome-inheritance, differential microbiome-cycling, and microbiome-engineering

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Social insects and their diverse colony organizations offer unique research opportunities to understand basic principles for optimization of microbiome functions. A challenge in host-microbiome research is elucidation of such microbiome functions. To address this challenge, I co-opted a method practiced by fungus-growing ants to differentially propagate host-microbiome associations and thus engineer microbiomes with specific beneficial properties (Trends in Microbiology 23:606-617). Other experimental tricks were bio-inspired by other social insects, particularly by species with unique microbiome transmission pathways that are constrained by partitioned nest architecture, by modular or serial interaction networks, or by reproduction via colony-fission. In essence, social insects evolved microbiome-transmission pathways to generate tunable microbiomes that help them to overcome stress (e.g., toxins, disease, or nutrient stress). I will outline several experiments as proof-of-concept that differential microbiome cycling can improve microbiomes within a few cycles of differential microbiome propagation, then conclude with a summary of rules that helped me optimize microbiome propagation and microbiome inheritance in my experiments. Social insects and their diverse colony organizations therefore offer unique research opportunities to test and elucidate principles of microbiome-inheritance, differential microbiome-cycling, and microbiome-engineering.