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Scaling of energetics and division of labor in harvester ants

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Complex social groups, such as social insect colonies, show striking similarities to organisms in their scaling relationships between body size, metabolism and the organization of work. Organisms and colonies both show a combination of increased specialization (in cell function and worker task performance) and decreased per unit metabolic costs at larger size. One of the central challenges in biology is understanding the causes of the hypometric scaling of metabolism, which appears robustly in individuals, social groups and even cities. We describe recent experiments focused on elucidation of the behavioral mechanisms responsible the hypometric scaling of metabolic rate using harvester ant colonies (*Pogonomyrmex californicus*). We show that larger, intact, functioning colonies of this species (of the same age) exhibit decreased mass-specific metabolic rate, whereas ants in random groups outside of the nest show isometric scaling of metabolic rate. Larger colonies (of the same age, or during ontogeny) also show increased division of labor, specialization of individuals, and a greater focus on maintenance-related tasks. Larger, same-aged colonies also had increased variance in walking speeds, with an increasing fraction of slow-moving ants, consistent with increased division of labor in locomotory activity. Experimental manipulations of colony size reproduced some of these features (such as hypometric metabolic rate scaling) but not all (e.g. no effect on division of labor), so understanding the causal linkages between colony size, metabolic rate and behavior remains elusive. However, studies of scaling in social insect colonies have the potential to provide fundamental information necessary to understand the evolution and ecology of colony size, solutions to the universal paradox of metabolic hypometry, and insights into general organizational principles of social groups. This research was partially supported by NSF grants to JW, JFH, CTH and JF.