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# Ant colonies shed light on metabolism

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Ants are usually regarded as the unwanted guests at a picnic. But a recent study of California seed harvester ants (*Pogonomyrmex californicus*) examining their metabolic rate in relation to colony size may lead to a better appreciation for the social, six-legged insects, whose colonies researchers say provide a theoretical framework for understanding cellular networks.

A team of researchers led by James Waters of Arizona State University in Tempe, Ariz. conducted a series of experiments designed to measure the components of ant metabolism, such as oxygen and carbon dioxide, in individual ants and in colonies of ants. The team studied 13 colonies of seed harvester ants taken from a nearby desert and housed in the university's research lab. By using flow-through respirometry and factors such as growth rates, patterns of movement, behavior and size, the team measured standard metabolic rates (i.e., energy expenditures) of the functioning colonies as well as in individual ants.

The researchers found that the metabolic rate of seed harvester ant colonies could not be predicted by adding and dividing the by-products of the metabolisms of all individual colony members. In fact, the colony as a whole produced only 75% of the by-products that its individual members would produce individually if each ant lived alone. Thus, the colonies' metabolism was less than the sum of all the individual ants' metabolisms.

The team also found that the larger the colony, the lower its overall metabolic rate. "Larger colonies consumed less energy per mass than smaller colonies," said Mr. Waters. "Size affects the scaling of metabolic rate for the whole colony."

Colony size appeared to influence patterns of behavior and the amount of energy individual ants spent. "In smaller colonies, more ants were moving fast, and there was a more even distribution of fast-moving ants," said Mr. Waters. "But in larger colonies, there were more ants that moved more slowly, and fewer that were moving really fast."

That the distribution of individual walking speeds became less uniform as colony size increased suggests that disparities in effort among individuals increased with colony size.

The 0.75 scaling exponent for colony metabolic rate strikes Mr. Waters as important because it indicates that colony metabolism is influenced in a way similar to what most individual organisms experience.

"As creatures go from small to large, their mass-specific metabolic rate decreases. It's a broad pattern in biology," he said. "When you graph these patterns, you can see how metabolism decreases as a creature gets bigger, and the exponent is usually near 0.75."

Yet a colony of ants experienced this decline as though it was one single "super-organism". Mr. Waters noted that the team isn't sure why this is so, but he has a few ideas.

"Ants need to stay in contact with each other in a colony, and it's possible that in larger colonies, certain ants take on the role of a network hub to keep the other ants in the colony more in touch with each other," he said. "That would relax the demand placed on the other ants."

He added that a larger size might afford a colony a division of labor not possible in a smaller colony. Individuals in a smaller colony would have to work harder to satisfy basic energy demands.

According to Mr. Waters, because ant colonies behave metabolically like individual organisms, studying how a colony's size changes its metabolism could offer useful insight for developing theories about medication dosage in humans.

"It's hard to figure out how size affects metabolic rate in individuals because it's not easy to change an individual's size," he said. "With an ant colony, it's as easy as adding or removing individual ants."

This is not to say that ant colonies function like individual humans. Rather, ant colonies could serve as a model for testing theories about the role of networks among cells in human metabolism.

"We've got this pattern where the larger an organism is, the slower its metabolism, and we don't really understand why," said Mr. Waters. "It's important to find out because we really don't have any sort of theoretical basis for deciding the right dose of medication. We can do charts on weight, and we can run tests on animals, but it's really more alchemy than science."

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