The comparative advantage of worse workers in bumble bee colonies

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Body size is a key life-history trait, thought to be under selection. Why then is body size often variable within species or groups? In social insect colonies, size variation at the group level may increase group efficiency because different sizes can specialize on different tasks and thus achieve better performance (‘efficient specialists’). However, an alternative explanation for the size variation in cooperative groups is that while larger size comes with higher performance, this trades off with the cost of producing and maintaining such larger individuals, and the optimal trade-off level may vary across tasks such that cheaper, smaller workers are the best solution for some tasks (‘comparative advantage’). Finally, it is also possible that different body size workers vary in their robustness, such as to starvation, such that larger individuals are more productive in terms of performing tasks but less robust to suboptimal conditions. This might select for a group-level strategy of producing workers of mixed body sizes (‘robustness tradeoff’). We test which of these three hypotheses may be important for maintaining body size variation in bumble bees (Bombus impatiens). We created colonies with more and less worker body size variation and measured colonies produced the most biomass either under stable or fluctuating environmental conditions. We also used literature data to estimate size-dependent task performance and costs of workers. Our results indicate that more body size variation increases colony efficiency and this like due to the comparative advantage small workers provide. From this work, we hope to show that the economic principle of comparative advantage, combined with investigation of cost-benefit tradeoffs, can lead to better explanations of the evolution of variation in natural systems.