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Modelling food storage management in ants: mechanisms and social implications.

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As a consequence of work division in ants only a few workers, the foragers, leave the nest for food gathering. Foragers return to the nest and provide food to other workers through a trophallaxis network. Here we first develop a computational model of collective food management on the basis of previous empirical works on food flow dynamics and storage. The core of the model includes two types of workers: foragers (food collection) and domestics (food receivers, inside the nest) and considers several states for each individual where the evolution from one state to another is determined by a set of individual behaviour/empirically based parameters. We explore a model based on these simple rules, deriving the number of feeding domestics during foraging after different periods of starvation. Results of the model are in rough agreement with empirical data. Confronting and analysis experimental results and theoretical predictions of the model reveals key mechanisms involved in food flow adaptation to the colony's needs, particularly a negative feedback modulating foragers' activity and numbers during food collection. Theoretical exploration of set parameters reveals an optimal ratio of foragers and domestics that minimizes the time to fill up the colony's needs. Surprisingly, a maximum number of foragers is under optimal. Based on these insights on foraging modulation we then developed an individual based model in order to investigate the question of social network organization and functionality in the nest. It is well known that interaction networks operate through ant nests, however our simulations allowed us to better understand how determinant factors of food flow regulation (e.g., foragers/ domestics ratio) and individual behaviour affect the structure of interaction networks and how this ensures an effective and optimal collective management of food resources.