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Influencers in ant colonies revealed by temporal network analysis

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Information transfer is thought to play a key role in adaptive complex systems such as social insects, brain and human society, while epidemic spreading through interactions can impact on survival in the individuals and society. Social insects such as ants and bees are one of the most sophisticated complex systems exhibiting collective decision making, providing us the opportunity of studying how the information transfer and disease spreading occur through the interactions. Recent advances in tracking systems enable us to collect quantitative and massive data of each individual and interactions in a colony. A recent empirical study [1] used an automatic tracking method based on image analysis, and revealed rapid spreading dynamics in honey bee colonies. However, the attributes of each individual including age, caste, and activity were not considered, although such heterogeneity of individuals may be crucial for the adaptability of the colony. Thus, the relationship between the heterogeneity in the colony and the spreading dynamics is less understood. In the present study, we used an image-based tracking system (Bugtag; Robiotec Inc.) to detect the movements and interactions of ants (*Diacamma sp.*). To reveal the relationship between the spreading dynamics and the heterogeneity in individual attributes, we investigated how interactions spread the information or diseases by using temporal networks which are promising tools for understanding spread dynamics, and then quantified heterogeneity in individual attributes such as age. The results show that the spreading was more rapid than randomized data conserving degree sequence, and younger individuals tended to be influencers which promoted the rapid spreading. We will discuss the adaptive significance of the relationship between rapid spreading dynamics and differences in individual attributes.

[1] Gernat, Tim, *et al.* "Automated monitoring of behavior reveals bursty interaction patterns and rapid spreading dynamics in honeybee social networks." *Proceedings of the National Academy of Sciences* 115.7 (2018): 1433-1438.

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