Abstract*

No entry signal in ant foraging (Hymenoptera: Formicidae): new insights from an agent-based model

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Insect societies are complex systems which face the challenge of co-ordinating the activities of their many individuals. Ant trail pheromones increase system performance by attracting foragers to rewarding sections of the colony's trail network. Previous work on social insect foraging has focused on the role of these positive, attractive pheromones. Computer simulation studies indicate that the effectiveness of foraging trail networks could be greatly improved by repellent or negative pheromones (STICKLAND & al. 1999). If foragers marked unrewarding trails with a negative signal, other foragers could avoid these parts of the trail system. The first negative pheromone was found in the Pharaoh's ant (*Monomorium pharaonis* (LINNAEUS, 1758)) (ROBINSON & al. 2005). Foragers mark the unrewarding branch at a trail bifurcation with a signal which greatly increases the probability of other foragers selecting the opposite branch or making a U-turn. Our agent based model investigates decisions at a trail bifurcation, and is parameterised using the real Pharaoh's ant system. We test hypotheses about the complementary roles of attractive and repellent signals. The model predicts that negative pheromone prevents random fluctuations in positive pheromone from being amplified by positive feedback loops. The model shows that when the negative pheromone is removed from the foraging system in a dynamic environment, ants may become locked into a suboptimal foraging pattern (Fig. 1) due to an inability to break out of the positive feedback cycle. We predict that negative pheromone has an important role in conferring flexibility in changeable environments.

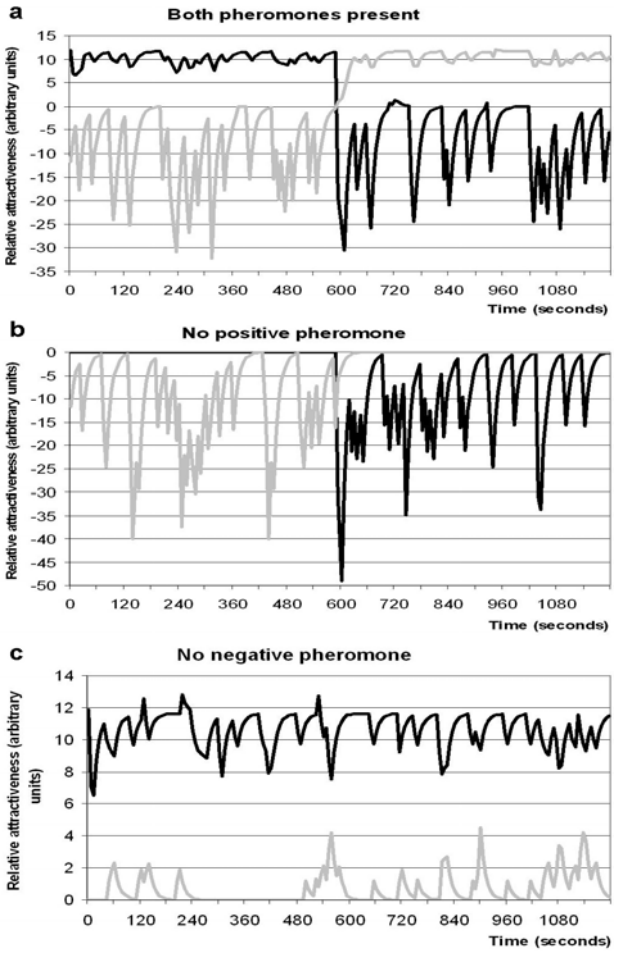

Fig. 1: Attractiveness of the two trail branches over time: example data sets. At 600 seconds, the position of the food has been switched from Branch A (black line) to Branch B (grey line). When both pheromones are present (a) or without positive pheromone (b), a switch in attractiveness occurs so the ants find the new location of the food. Without negative pheromone (c), no switch occurs and the ants continue to visit the old location of the food, causing suboptimal foraging. ➔

References

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