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RESEARCH ARTICLE

Response to a change in the target nest during ant relocation

Karunakaran Anoop and Annagiri Sumana*

ABSTRACT

Decisions regarding spatial and temporal choices pertaining to a wide range of activities such as mating, feeding and resting are necessary for all organisms. Social species encounter another level of complexity, wherein inputs from multiple individuals have to be consolidated to yield a consensus. One platform on which decision making can be examined is the relocation of animal societies. Relocation is the process by which organisms move from their old dwelling to a new nest along with all the inhabitants. This exposes them to the elements and thus impacts their survival and reproduction. *Diacamma indicum*, the model system for our experiments is a ponerine ant that uses tandem running for colony relocation. In the present study an artificial manipulation was performed to cause a shift in the target nest. The flexibility of the relocation process and, more specifically, the response of tandem leaders to a changed target were studied. A majority of these leaders (N=262) not only re-evaluated and adapted to the change, but did so with negligible error (1.65%). This enabled colonies (N=10) to reunite at the target nest in every case. The only cost to this flexible decision making was paid in terms of additional time. Although considered to be a primitive method of recruitment, we reveal that tandem running allows *D. indicum* leaders to incorporate assessment of the available options at every step. This inherent flexibility in decision making would be a good strategy for organisms that need to function with incomplete information or inhabit environments that change frequently.

KEY WORDS: Decision making, Transport latency, Tandem running, *Diacamma indicum*

INTRODUCTION

Groups of individuals, be it humans, chimpanzees, birds, fishes, locusts or honeybees, perform activities together in a coordinated manner to achieve a common goal. There are many examples of these communal activities across different taxa: migration, roosting, predator avoidance and nesting to mention a few. Achieving this scale of coordinated activity is possible only if the members of these groups can communicate effectively to arrive at a consensus (Conradt and Roper, 2005; Sumpter, 2006). The manner in which individual group members, who each have limited information, compare this to arrive at a consensus has been an active area of exploration (Reebs, 2000; Stroeymeyt et al., 2011).

Nest relocation is one such activity wherein all the members living within a nest need to coordinate their activities and move in a collective manner into their new dwelling. This problem becomes even more interesting to consider in social insects because their nests often contain thousands of individuals and group cohesion is essential. Members left behind or lost have a very small chance of survival. Honeybees represent one such species and their relocation has been well studied. These highly eusocial hymenopterans are known to scout the surroundings for alternative nests and report their findings by means of a waggle dance to their colony mates. Using elegant experiments and modelling it has been shown that the quality of different nests influences a scout's dance performance and attrition of dances to poor quality nests is faster. The persistence for good nests results in the building of a consensus. Subsequently, the colony relocates *en masse* into the new nest (Britton et al., 2002; Camazine et al., 1999; Seeley and Visscher, 2004).

Colony relocation in ants, another subfamily of Hymenoptera, is even more complicated for the following three reasons. They need to transfer their immature young and stored resources together with all the adults. Second, ants cannot communicate the bearings of potential new nests to their fellow members indirectly because they lack the dance language. In addition, their movement to the new nest will be more gradual as the entire colony marches on chemical trails from their old nest. The pheromones used along these trails are complex mixtures, giving information regarding direction and strength; the trail may also include short-lived repellants (Hölldobler and Wilson, 1990; Robinson et al., 2008). Aspects of relocation, including the manner of decision making has been studied in *Temnothorax* species. These ants use tandem running initially to recruit followers, and on reaching consensus, switch to carrying colony members to the new site (Franklin, 2014; Möglich et al., 1974; Pratt, 2005). Studies in *Temnothorax* species and *Monomorium pharaonis* have examined whether ants can make decisions regarding an optimal nest when presented with different choices at the beginning of the relocation process. They found that these social insects are indeed capable of picking the best option in most cases (Evison et al., 2012; Pratt et al., 2002). Furthermore, it is understood that once the quorum is reached at a potential new nest, scouts cease monitoring the nest's contents in any detail, as their visit duration reduces drastically (Pratt, 2005).

How organisms respond to a midway change has hardly been explored (but see Franks et al., 2007). In the present study, we analyse the flexibility of the relocation process. We ask whether ants that have initiated relocation to one destination change their decision when the quality of this destination suddenly changes. In other words, whether evaluation of the destination is a continuous process or a discrete one? We used *Diacamma indicum* as the model system for our experiments. This is a queenless ponerine ant found in the south and east of India and in Sri Lanka. One fertile female who is not morphologically different from other females of the colony, except for the retention of an appendage called the gemma, is termed as the gamergate. She is responsible for the production of all female offspring in the colony (Cuvillier-Hot et al., 2002; Wheeler and Chapman, 1922). Colony relocation in this species has been documented under natural and laboratory conditions. These studies highlight the importance of tandem running and the contribution of tandem leaders while detailing the dynamics of colony relocation (Kaur et al., 2012; Sumana and Sona, 2012, 2013). Tandem running

Department of Biological Sciences, Indian Institute of Science Education and Research, Kolkata, West Bengal 741246, India.

*Author for correspondence (sumana@iiserkol.ac.in)

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