Ants can learn to forage on one-way trails

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Ant trails fascinate children and scientists alike. With so many ants traveling in both directions, meeting and contacting one another, carrying their loads and giving the impression that they have a sense of urgency and duty, they pose the following question: how do they organize themselves? A new study published in the open-access, peer-reviewed journal *PLoS ONE* may have some answers.

Pedro Leite Ribeiro and his colleagues at the University of Sao Paulo, Brazil, believe they have found another clue to the processes underlying the collective organization of leaf-cutter ants. In the new study, the researchers show that ants can work around a difficult obstacle that prevents them from returning home via the same route they used to reach a food supply. Unable to return to the nest on their two-way trail (which has most likely been in use for millions of years) they set up a new one-way system, taking two separate unidirectional roads between nest and food.

The researchers used two incomplete bridges to connect the nests to the foraging ground (see related figure, below). The ants had to fall from the end of the outgiong bridge in order to reach the food and then, as they couldn't jump back up onto the end of the bridge, they had to use the inbound bridge, and, at its end, fall onto the nest.

"It's a behavioral check valve device," said Dr Leite Ribeiro. "The foraging ground would become a cul de sac if the ants could not abandon their 'retrace your steps' orientation system."

But they did abandon it. Moreover, they not only managed to go back home, but also continued to use the apparatus and gradually established a routine, foraging effectively for months, showing that they can go on using it indefinitely. As they reach the end of the outgoing bridge, they typically hesitate briefly and then, as more and more ants cluster on the edge, they will fall onto the foraging ground, where they will cut leaves or pick up grains and set out for the returning bridge, which leads them back to the nest area. Random route finding was carefully ruled out by statistical analysis of the direction taken by the ants after leaf cutting. The laboratory experiments were corroborated by a test in the field.

"The next step was to find out how they did it," said Dr Leite Ribeiro.

When using their normal, chemically-marked two-way trails, foraging ants must reverse their orientation responses once they have picked up a food load to take home (or after they decide to go home empty-handed, which often happens). If they traveled east from the nest to the food, they will have to head west to get back. The pheromones they use to mark the way do not tell them to which end of the trail they are heading.

Whichever directional cues the ants may be using, a directional reversal is required when the decision to return is made, just like a sailor, a scout boy or anyone driving or walking in town. Therefore, in order to solve the problem, the studied ants had to switch off these "go backwards" behaviors and instead go forwards to find the new way home.

Initially, the researchers thought the ants might be giving some intricate chemical solution to the problem, but first they had to rule out any possible role of vision. "Their tiny eyes do not seem to be capable of anything except light detection, but as that might be sufficient, we decided to test them in total darkness," said Dr Leite Ribeiro.

And they failed. Further testing led the scientists to believe that the ants cancel their orientation reversal and use light direction to follow the new trail.

The ants' environment is fraught with so many changes and irregularities that any rigid orientation system would not cope and they have therefore evolved a system that meets the complex demands made by collective achievements.

More information: Ribeiro PL, Helene AF, Xavier G, Navas C, Ribeiro FL (2009) Ants Can Learn to Forage on One-Way Trails. PLoS ONE 4(4): e5024. doi:10.1371/journal.pone.0005024, dx.plos.org/10.1371/journal.pone.0005024

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