Charles Darwin *In Memoriam*

Evolutionary looks at the why of biological and cultural phenomena.

Is your pizza too big for your box? How would an ant's brain solve the problem?

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ABSTRACT: ***Atta*, a 50 million year old tropical genus of ant has over 15 species and is known for feeding on fungi grown on leaf parts. To move the leaf pieces to the nest, they build large networks of trails, and they "decide" when the maintenance of a trail is too expensive and discontinue it. How do they solve the problem of a leaf piece that is too big for the nest entrance? I saw some *Atta cephalotes* do it, and their brains may not work exactly like ours: instead of cutting the leaf in smaller parts, they enlarge the entrance.**

KEYWORDS: trail maintenance, leaves, colony, productivity, pheromones, *Atta cephalotes.*

The ant brain and the human brain evolved independently, theirs over 150 million years earlier than ours, so I was fascinated when I got a chance of comparing how both brains solve a similar problem.

Ant behavior has occupied scientists for over a century, but in this case I am referring particularly to *Atta*, a 50 million year old tropical genus that has over 15 species and is known for feeding on fungi grown on leaf parts (Bacci et al., 2009).

To move the leaf pieces to the nest, they use large networks of trails that they build, clean and maintain, and they "decide" when the maintenance of a trail is too expensive and discontinue it. In this they are better than humans (Royer, 2003), but we do not know how they do it (Bochynek, Meyer, & Burd, 2017). They also ignore obstacles that are not actually affecting trail flow, but, again, studies have failed to crack the secret of how they take such decisions (Bruce, Czaczkes, & Burd, 2017).

If seedlings are artificially placed on their mounds, they wait a few days and then remove all of them after some rain. Why do they wait, or how do colonies coordinate to do it in the same day, is uncertain (Stephan, Wirth, Leal, & Meyer, 2015). If a short barrier ─that the ants cannot remove─ is placed on the trail, they "decide" that leaves need to be cut in smaller, rounder pieces, which can be more easily transported above the barrier (Dussutour, Deneubourg, Beshers, & Fourcassié, 2009). But this is not enough: to maintain productivity, the colony sends more workers to carry the leaf bits. How can they make such a complex problem analysis? We do not know.

The closest we may be to an idea of how the ant mind works is an experimental work with *Atta cephalotes*, which found that they appear to use IF/THEN logic: for example, when an explorer finds a potential source food, she "smells" it. If she knows that the species is appropriate to grow fungi, she immediately goes back to the nest and marks the trail with pheromones for other workers to follow. If the plant is unknown, she bites it and if it is "acceptable", she marks the trail and informs the colony about its quality; we know this because more workers are sent when the leaves are tender (Roces & Hölldobler, 1994).

While watching *Atta cephalotes* ants returning to a nest, I was lucky to see how they solved a "simple" problem: a carrier arrived with a leaf that was too big for the entrance. I find it similar to a problem I would have if I had a pizza that was too big for its box. Faced with the same problem, what would you do?

My first option would be to get a bigger box, but if this is impossible, I might cut the pizza to make it fit inside. Or I might force bend it into the box, but this seems less desirable.

How did the ants solve the problem?

I expected the worker to simply cut the leaf piece in two smaller pieces; after all, she had just cut it from a leaf and could do it again. But she did not do that.

The photographic sequence shows what these ants did: other ants came to help; they removed a few dirt clumps to enlarge the entrance, and forced the leaf to the point that they bent it (Figure 1).

FIGURE 1. **Time sequence of *Atta cephalotes* ants solving the problem of a leaf piece that is too large for the nest's entrance (start at top left, end at bottom right).**

The problem was indeed solved, but it was the equivalent of the human breaking the box *and* bending the pizza. This solution may not be desirable for pizza, but worked perfectly for ants, which solved the problem in a matter of seconds. How did they work in cooperation to choose not a simple solution, but a combination of two solutions? This can be added to the list of ant "mind" mysteries that future researchers will have the joy to study.

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