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Running Hot with *Cataglyphis fortis*

In the heart of salt flats of Tunisia, where the ground temperature soars past 50 degrees Celsius, life seems almost impossible. The *chott* stretches endlessly in all directions, salt deposits creating a perfectly flat, blindingly white surface. No plants grow here. No rocks break the horizon. Yet, gliding eerily across this expanse is a black ant with legs that seem too long for its frame – the *Cataglyphis fortis*. It is the only ant species to be found here – and it thrives. After zigzagging alone for nearly an hour, it has captured a dried fly and must now navigate home across a kilometre of barren terrain. And it does so without any hesitation, beelining straight to its underground nest.

Among the *Cataglyphis* genus, *C. fortis* inhabits perhaps the most nutritionally impoverished habitat and exhibits the largest foraging distances (Wehner, 2020, p. 70). However, foraging in the salt pans is a dangerous gamble. Every additional second of heat exposure risks death. This extreme lifestyle has driven the evolution of remarkable physical traits. Relative to its body size, *C. fortis* has the longest limbs in its genus (Wehner, 2020, p. 71). These long legs not only elevate the body higher away from the scorching surface but also enables running speeds up to 0.62 m/s (Wahl et al., 2015). At this pace, the ants generate their own cooling system through "forced convection", effectively creating a personal breeze (Sommer & Wehner, 2012). Furthermore, *C. fortis* can raise its gaster to nearly a vertical position, significantly reducing its moment of inertia and allowing it to make much sharper turns – much like a figure skater pulling their arms closer to their body to spin faster (McMeeking et al., 2012). This ability to maintain high speeds while fleeing predators or navigating obstacles can mean the difference between life and death.

But running fast is only half the battle. After a long, erratic foraging trip, the ant must return correctly to its nest – a tiny hole in an otherwise featureless desert. Most ants would simply retrace a pheromone trail it laid on the way, but in the salt flats, pheromones would evaporate almost instantly under the desert sun (Boulay et al., 2017). Instead, *C. fortis* has evolved an entirely different solution, plotting a direct route home by keeping track of their steps, and the sun.

In a series of experiments, Wittlinger et al. (2006) showed that these ants count their steps. When the researchers attached tiny stilts to lengthen the ants' legs, the modified ants overshot their nest location on the return journey. When legs were surgically shortened, the ants stopped short of home. This demonstrated that *C. fortis* maintained a running tally of steps taken on their foraging journeys. But distance information is not enough. For direction, the ants rely predominantly on polarised light of the sun as their compass which they detect through a specialised region of their compound eyes known as the dorsal rim area (Wehner & Müller, 2006). This combination of keeping track of distance and direction information to calculate the way home is known as “path integration”.

In spite of their sophisticated navigation, *C. fortis* workers still face danger when returning from long foraging journeys. Small errors accumulate during path integration, and after a long distance, an ant can find itself lost (Bernhard , 2008). Recent research by Freire et al. (2023) revealed that mortality rates on foraging runs can reach 20%. The researchers found that in order to mitigate this, colonies living deep in the featureless salt pans construct unusually tall nest mounds far higher than those of colonies near the desert’s edge with more visual cues. These mounds act as landmark beacons, guiding returning ants to the nest entrance.

Notably, if artificial landmarks were provided, mound-building efforts declined and without them, ants quickly rebuilt their hills (Freire et al., 2023). Fascinatingly, the foraging ants who need these landmarks are not the ones building them – it is built by other worker ants who rarely venture out instead. This suggests there is some communication between the two groups of ants, although the mechanism remains a mystery.

This collective effort to build mounds highlights the central role of cooperation in *C. fortis*: while foraging is a solitary task for *C. fortis*, it is still deeply embedded in the colony's eusocial organisation. The high risk of foraging is managed through a system of age-based roles known as temporal polyethism (Wehner, 2020). Only after a lifetime of serving the colony do the oldest, most expendable workers of the colony step out and become foragers, facing substantial mortality risk due to high environmental and predatory pressure. This strategy makes the loss of individual ants sustainable for the colony, treating experienced foragers as a high-risk, high-reward resource.

The story of *Cataglyphis fortis* is thus a story told on two scales. The lone forager's navigation system and heat-defying speed would mean little without its colony that builds landmarks and accepts calculated losses. In conquering the impossible, *C. fortis* shows us that the most extreme environments do not just produce remarkable individuals, they forge remarkable societies.

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