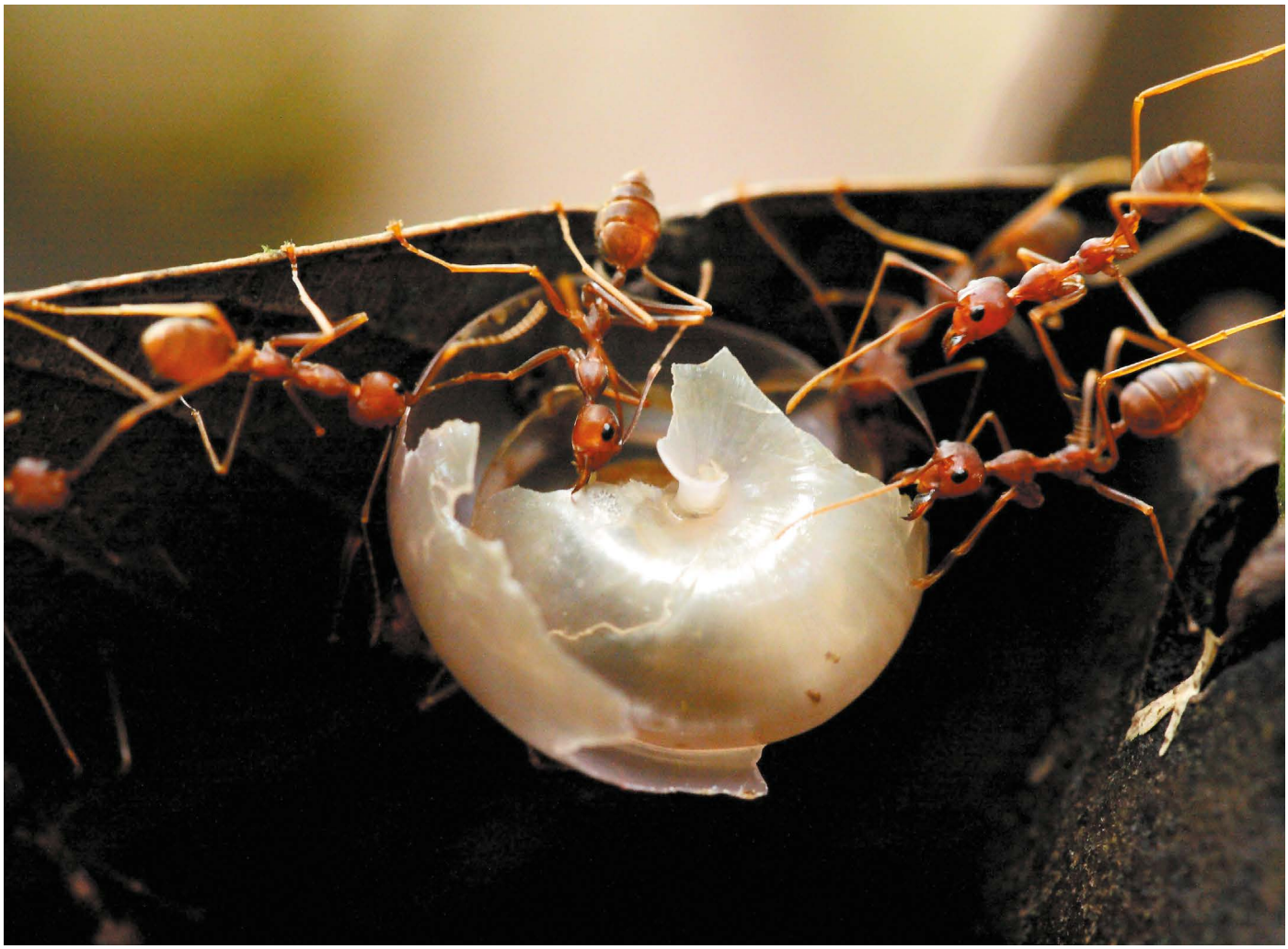
Books & arts



AGEFOTOSTOCK/ALAMY

Weaver ants, of the genus *Oecophylla*.

Wayfinding wonder: how an ant navigates the desert

A sumptuous book reveals the location-sensing secrets of a driven insect. **By William A. Foster**

The fear of getting lost and being unable to find our way home is woven into the stories we hear as children: it can haunt us for years. Humanity's navigational skills are poor and increasingly rarely used, leaving us to view feats of animal navigation with a mixture of envy and admiration. How do Atlantic salmon find their way back to the streams where they were born, after up to three years at sea? How do Arctic terns find their breeding sites in the far north after excursions of more than 70,000 kilometres to the Antarctic?

Desert Navigator is the story of how a tiny ant (*Cataglyphis* spp.) became the ideal model organism for the study of animal navigation. It begins 50 years ago in a vast Saharan salt pan, where a lone, shiny black ant caught the eye of neuroethologist Rüdiger Wehner as it scuttled across the sand. Eventually, it discovered the corpse of a large fly, gripped it firmly in its mandibles, and then performed the manoeuvre that launched Wehner's field of research.

The ant set off in a straight line, crossing more than 100 metres of the barren ground to disappear into an inconspicuous hole – the entrance to its underground colony. The only plausible explanation is that the ant knew all along exactly where it was in relation to its home nest. But how does *Cataglyphis* manage this, with a minute brain and no mobile phone?

Wehner unspools the answer over the book's seven chapters, describing the astonishing subtlety, intricacy and diversity of the techniques used both by the ants in finding their way home and by researchers in discovering how they do it. The ants plot their compass

direction using patterns of polarized light and gradients of colour and light intensity in the sky, along with the position of the Sun, backed up by cues from Earth's magnetic field and the wind direction. They know where they are by counting the steps they have taken and keeping track of the direction they were following at the time. They can memorize panoramic 'snapshots' of landmarks, such as boulders, around their goals. Somehow, their brains integrate all this information so that their foraging journeys can be optimally organized.

The central message is that the ant's sophisticated repertoire of navigation behaviour actually emerges from a large number of relatively simple elements, which Wehner calls the ant's toolkit. These are combined in different ways, depending on the problem. This bottom-up, modular approach provides the key to understanding the ants' navigational prowess and how it might have been honed during their development and evolutionary history. Wehner sees no need to introduce the further complication of a mental map, often invoked, for example, in studies on rodents: the ant can find its way around simply by cunning use of its toolkit's components.

The toolkit concept underpins the investigative protocols used by Wehner and his team. The basic approach is to change a stimulus with surgical precision. The researchers carefully measure the resulting mistake the ant might make when performing a particular task, compared with an unmanipulated control ant. The exact behavioural consequence of the change in that particular stimulus is now revealed, although the physiology of how this effect is produced is usually not investigated, basically because the ant's brain is so minuscule.

For example, to prove that the ants could measure distance travelled by counting the number and length of strides taken, the team added stilts to the insects' legs. An ant that arrived at the food source and then was given a set of stilts took the correct number of strides back to the nest. But it overshot its destination to the extent predicted by the increase in stride length. Even more astonishingly, the ants can allow for the extent to which they move up and down over bumps during a journey: they turn their 3D experience into an accurate 2D measurement. The researchers established this by forcing ants to take an outward foraging trip on a long 'roller coaster': a sawtooth track across the desert. On the return journey over flat ground, the ants predicted accurately where the nest should be. How they do this is not known.

MICHEL ROGGO/NPL

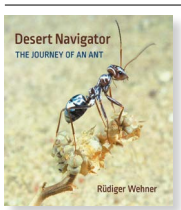
Atlantic salmon (*Salmo salar*) can return to spawning sites after years away.

"The ant's sophisticated navigation behaviour emerges from a large number of simple elements."

A hugely important aspect of this research is that the intricate experiments on the desert navigators are carried out under natural field conditions. This is unusual. Experimental studies on navigation in rats, for example, are routinely carried out in small-scale laboratory enclosures. Chapter 2, the longest in the book, is devoted to an absorbing account of the biology and ecology of the desert ants. This embodies a key lesson that Wehner would like to give to all students of animal navigation: "start out as a naturalist", he says, and "let the animal guide your way of investigation".

My only reservation is that this is a demanding book for its intended audience – the general reader. Wehner explains everything clearly and concisely, but only once. There are more than 100 detailed figures of the results of individual experiments, some of which might involve up to 10 variables, such as which part of an ant's eye was covered; each figure requires several minutes of detailed concentration. A glossary, chapter summaries and a little more time spent on explanation would have helped. Wehner's prose is precise and sometimes quite idiosyncratic, but his respectful admiration for these "elegant, skilled, and vivacious little runners" always shines through.

This sumptuously produced book is a triumph both of natural history and of science, with lessons that reach well beyond the study of animal navigation. Understanding how this wonderful eusocial insect can accomplish its apparently miraculous feats of navigation has required imagination, intelligence and decades of disciplined application. Here, in one place, we can at last savour the full glory of this remarkable achievement.



Desert Navigator: The Journey of an Ant
Rüdiger Wehner
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Correction

Wayfinding wonder: how an ant navigates the desert

In this book review, a caption incorrectly identified the pictured ants as *Cataglyphis*. They belong to the genus *Oecophylla*.

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