



Do Animals Get Lost?

Ornela de Gasperin explains how organisms orientate themselves on a vast planet

WHERE IS NORTH, where is South? Finding our way home is no easy task. Humans started building maps over 10,000 years ago, and today's technology has made it easier to find our way around, but how do other organisms manage without? Anyone who has found themselves in a foreign city without a map will understand the challenge. The remarkable abilities of animals to orient themselves have fascinated scientists and naturalists for centuries, from the tiny hummingbird which journeys 1500 miles from South to North America, to the monarch butterfly which covers 2000 miles as it flies from Canada to Mexico - without getting lost. How do animals navigate, how do they know where they are, and where they should go?

For centuries scientists have tried to find the answers to these questions. Perhaps unsurprisingly, different animals have different skills to navigate across the world. Some use environmental cues like smells, or landmarks like rivers and trees, others use the sun, the sky and the stars to find their way, other communicate among groups to find their ways, and others use the Earth's electromagnetic field to orient themselves.

Karl Ritter Von Frisch was an Austrian ethologist, or animal behaviour scientist, who was fascinated by how bees' societies communicate and make collective decisions. Among other things, Karl Von Frisch showed how bees find their way in the world. He revealed that they have three orientating mechanisms: the sun, the earth's magnetic field, and the polarization pattern of the blue sky, with the sun being its preferred mechanism, but using the other two under clouded days or inside their dark beehive. Furthermore, not only can bees find their way around, they can also tell their mates about what they have found. Bees forage for food like pollen and propolis, and when they find a good source of food they go back to their colony and tell their mates.

They do so by dances, a dance called the 'waggle dance'. The dance consists on movements with their whole bodies which seems like the number eight, and that's why it's also called a figure-eight dance. The dancing bee starts by moving forward on the vertically hanging honeycomb in the hive, and while they do this they 'waggle' their abdomen. She then returns to her starting point by doing a semi-circle, and starts again. The other bees gather information by being in close contact to their dancing friend. The distance to the food is encoded by the speed of the dance, and the direction of her dance provides information of the location to the food. The angle between the straight line in her dance and the angle of the vertical honeycomb show the angle where the



Robins can 'see' magnetic fields, but only out of one eye

direction of the flight towards the food is in position to the sun. This way, other bees in the nest can go and look for the food without getting lost.

Some nocturnal birds use the night sky to orient themselves. The Swedish scientist Ronald Lockley showed that some small birds oriented themselves with the night sky. In order to do this, he placed Warblers inside a planetarium, and saw that the birds used the sky to orient themselves towards the south. He slowly rotated the sky, and the birds kept their direction. Lockley's findings have been groundbreaking. He not only showed that birds can read and remember patterns in the sky, but that they also have a 'clock' that allows them to use these patterns according to the time of the day.

One of the most astonishing ways in which animals orient themselves is by using the Earth's magnetic field. The Earth's magnetic field is thought to originate thanks to a process known as 'dynamo' in geophysics. The Earth's core is divided in two: the inner solid core, and the outer liquid core. The outer liquid core is in motion as a result of Earth's rotation movement, and by the heat flow generated by the inner solid core. The heat of the solid inner core of the earth puts the magma of the fluid core into motion, which creates circulating electrical currents. The magnetic field is then produced as result of these moving electrical charges. At any given point, a magnetic field can be described by two factors: its direction and magnitude, or strength. The magnetic compass, the oldest instrument built for orientation during navigation, exploits these features of the Earth's magnetic field. The Earth's magnetic field causes any magnetised needle to align itself with the north-south axis of the magnetic field.

Just like compasses, many organisms use Earth's magnetic field to orient themselves. Animals including birds, molluscs, sharks, turtles, fruit flies, and mammals have this ability. Surprisingly, a large number of bacteria orient themselves using Earth's magnetic field too. These bacteria were first described

in 1963 by Salvatore Bellini. While looking at some bacteria under the microscope, he realised a group of them oriented themselves in a peculiar way. He then grasped that they were aligned towards the north pole of the Earth, and therefore called them 'magneto-sensitive bacteria'. Further studies have shown that within their cells these bacteria have special structures with a high density of magnetite, the most magnetic of all minerals known on Earth. Thanks to this structures bacteria can orient themselves according to Earth's magnetic field. Just as bacteria, some algae have also been shown to parallel to the magnetic field.

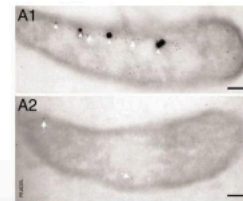
Perhaps more surprisingly is the fact that plants and fungi can also perceive and use the Earth's magnetic field. Several studies have shown that many plant species use the magnetic field to orient their roots and to germinate according to the Earth's magnetic field. Besides, plants that are grown deprived of a magnetic field generate abnormalities. Likewise, the magnetic field can stimulate or inhibit growth and reproduction in fungi. How does the Earth's magnetic field affects these organisms is still a topic of debate, but it is likely that it affects them in an indirect way, for example, by altering the properties of solutes.



Magnetic fields can inhibit seedling germination

Whatever nature's purposes of having compasses, we have also been able to take advantage of this talent for our benefit. Horses and camels have long been known take their riders back home, or in search of water in the desert. Homing pigeons have been used to deliver messages since the 1100s. During both world wars, hundreds of pigeons carried messages around, and they were so efficient at doing this that the messages did not even need to be encoded. There was one little fellow, 'Cher Ami', who in the first world war was awarded the French Croix de guerre for delivering 12 messages despite being injured. Although pigeons have been used by humans for centuries thanks to their ability to navigate using the Earth's magnetic field, it still remains unclear how they actually detect it and use it. 📍

Some bacteria contain magnetic particles, (large dots), or the genes to make them (small dots)



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