Bees use shark 'supersense' to help find food

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Fine hairs on bees' bodies can sense tiny changes in electrostatic fields, enabling them to sense whether another bee has visited a flower before them. Credit: Unsplash/George Hiles, licenced under Unsplash licence

Flying insects such as bees and moths have secret senses that allow them to 'feel' nearby flowers and navigate over long distances, according to new research.

Armed with sensitive antennae and wide-angled compound eyes, bees have a sophisticated set of senses to help them search out pollen and nectar as they buzz from flower to flower.

But new research is revealing that bumblebees may employ another hidden sense that lets them detect when a flower was last visited by another insect.

Professor Daniel Robert, an expert in animal behaviour and senses at the University of Bristol, UK, has discovered that bumblebees have the ability to sense weak electrostatic fields that form as they fly close to a flower.

"A bee has a capacity, even without landing, to know whether a flower has been visited in the past minutes or seconds, by measuring the electric field surrounding the flower," Prof. Robert explained.

The discovery is one of the first examples of electroreception in air. This sense has long been known in fish such as sharks and rays, which can detect the weak electrical fields produced by other fish in the water. Water-dwelling mammals such as platypus and dolphins have also been found to use electric fields to help them hunt for prey.

But rather than hunting for fish, bees appear to use their ability to sense electrical fields to help them find flowers that are likely to be rich in pollen and nectar.

Charge

Bees develop an electrostatic charge because as they fly they lose electrons due to the air rubbing against their bodies, leading to a small positive electric charge. The effect is a bit like rubbing a party balloon against your hair or jumper, except the charge the bees accumulate is around 10,000 times weaker.

Bees develop a positive electric charge as they fly, which helps them to collect pollen from negatively charged flowers. Credit: Pxfuel.com/DMCA

Flowers, by comparison, are connected to the ground, a rich source of electrons, and they tend to be negatively charged.

These electrostatic charges are thought to help bees collect pollen more easily. Negatively charged pollen sticks to the positively charged bee because opposite charges attract. Once the pollen sticks to the bee, it too becomes more positively charged during flight, making it more likely to stick to the negatively charged female part of a flower, known as a stigma.

But Prof. Robert and his colleagues wondered whether there could be more to this interaction. When they put an electrode in a flower, they detected a current flowing through the plant whenever a bumblebee approached in the air. Their study revealed that the oppositely charged flower and bee generate an electrostatic field between them that exerts a tiny attractive force.

To study whether the bees are aware of this electrostatic field, they then offered bumblebees discs with or without sugar rewards. Those with sugar also had 30 volts of electricity flowing through them to create an electrical field. They showed that the bees could sense electrical field and learn that it was associated with a reward. Without the charge, bees were no longer able to correctly identify the sugary disc.

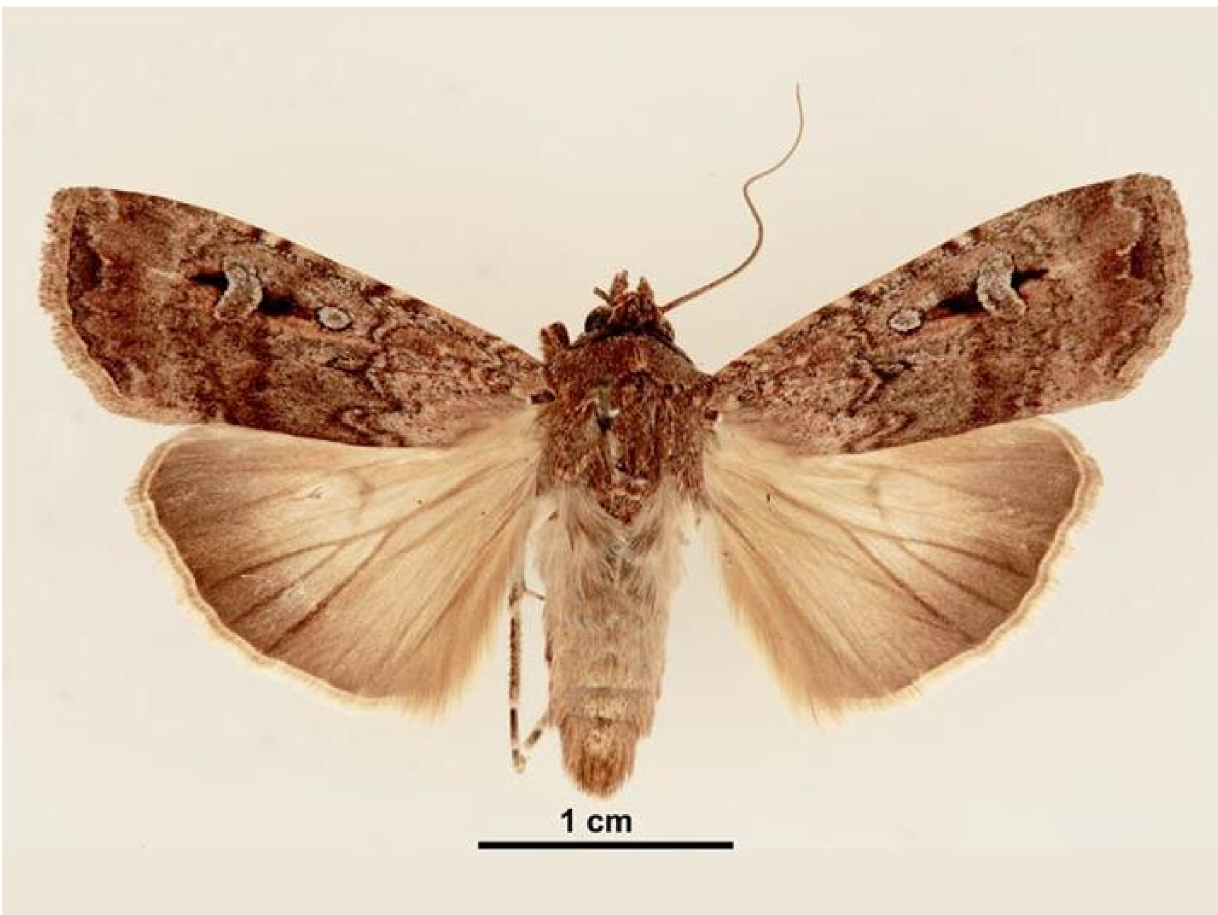
Research by another group published shortly after Prof. Robert's own work also showed that honey bees are also able to detect an electrical field. But exactly how the insects were able to do this remained a mystery, leading Prof. Robert to set up the ElectroBee project.

Hairs

He has discovered that fine hairs on the bees' bodies move in the presence of weak electrical fields. Each of these hairs has nerves at its base that are so sensitive they can detect tiny movements – as little as seven nanometres—caused by the electrical field.

Prof. Robert believes that when a bee visits a flower, it may cancel out some of the negative charge and so reduce the electrostatic field that forms when bees approach. This change in the strength of the electrostatic field could allow other bees flying past to work out whether a flower is worth visiting before they land, helping to save time and energy.

Other signals, such as changes in the colour and smell of flowers, happen in minutes or hours, while switches in electric potential occurs within seconds.



The Bogong moth can travel more than 1,000km to hibernate in caves during the Australian summer. Credit: Lucinda Gibson & Ken Walker, Museum Victoria/Wikimedia, licenced under CC BY-SA 3.0

Prof. Robert and his team are now testing their theory that the electric field helps bees know which flowers to visit by counting visits by bumblebees to flowers in a meadow this summer and measuring electric fields around the flowers.

Their findings could help scientists better understand the relationship between plants and pollinating insects, which may prove crucial for improving the production of many vital fruit crops that rely upon bees for pollination.

Prof. Robert is also investigating whether bumblebees use their electrostatic charge to communicate to their nest sisters about the best places to fly for pollen.

But while bumblebees use their extraordinary sensory power to find food just a few kilometres from their nests, another insect is using another hidden sense to make far longer journeys.

In Australia, Bogong moths (Agrotis infusa) flitter steadily from various parts of the country and make their way towards the Snowy Mountains in the southeast. They fly for many days or even weeks to reach the high alpine valleys of the highest mountain range in the country, sometimes travelling over 1,000km. Once there, the insects hibernate in caves typically above 1,800m for the Australian summer, before making the return journey.

The only other insect known to migrate so far is the monarch butterfly in North America. But while the monarch butterfly relies in part on the sun's position for navigation, the moths fly by night. Professor Eric Warrant, a zoologist at Lund University in Sweden, has been fascinated with how these insects, just a couple of centimetres in length, managed such a feat ever since he was a student in Canberra, Australia.

Moth mystery

He suspected that the moths might use the Earth's magnetic field to find their way, so his team tethered moths to a stalk that allowed them to fly and turn in any direction before surrounding them with magnetic coils to manipulate Earth's magnetic field.

For two years, experiments failed. While the moths did appear to be influenced by the magnetic field, they were using something else to navigate too—their vision.

"It is a little like how we would go hiking," said Prof. Warrant, who is trying to unravel how the moths sense the Earth's magnetic fields in his project MagneticMoth. "We'd take a reading from a compass, then look for something to walk towards in that direction, a tree or mountain peak."

His research has already shown that the moths check their internal compass every two or three minutes and continue to make for a visual cue ahead. But what are the insects able to see at night?

Further research revealed something remarkable. When Prof. Warrant downloaded an open source planetarium programme called Stellarium and projected the Australian night sky above the moths, he discovered they were using the stars.

"Very few animals have the capacity to read the stars and use it to find, north, south, east or west," said Prof. Warrant. "We (humans) learnt how to do it. Some birds do it."

But insect eyes of bogongs mean they don't simply follow one guiding star. Rather they are sensitive to panoramic scenes.

"In the southern hemisphere, the Milky Way is much more distinct than it is here in the northern hemisphere," said Prof. Warrant. "It really is a stripe of pale light in which there are interspersed very bright stars." He believes that the moths are at least in part guided to their cool alpine caves by the light of the Milky Way.

The discovery could also lead to the development of new types of navigation for our own species too. GPS, for example, relies upon a constellation of satellites that are vulnerable to disruption. Prof. Warrant believes studying an insect capable of flying 1,000km to a cave using a brain the size of a rice grain, could help us find alternatives too.

"Animals seem to solve complex problems with little material and low amounts of energy," Prof Warrant said.

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