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The Magnetism of Bees

A new study published in Science Advances has investigated the magnetic sensitivity in bees, exploring another frontier in bee science.

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When we think about the senses of bees, we usually imagine their ability to see flowers, detect odors or perceive ultraviolet patterns invisible to humans. But bees may have another ability: they may be able to detect the Earth's magnetic field.

Western honey bees on an iron tool. Also in this species have been found ferromagnetic particles (But they are not attracted by iron). Photo by SSgt Elizabeth Morris, USAF - Wikipedia

A new study published in Science Advances has investigated the magnetic sensitivity in bees, to determine whether magnetic properties were associated with sociality, sex, nesting behavior, or body size in bees and if these properties were restricted to a particular region or body part.

By examining 96 bee species from six different families, researchers found evidence of ferromagnetic material in the great majority of the species they tested. The finding suggests that magnetic sensitivity is not an unusual feature restricted to a few familiar social bees, but may be a much older and more widespread characteristic of bees.

The study detected a ferromagnetic response in 74 of the 96 bee species examined. Even more strikingly, the magnetic signal appeared in representatives of all six bee families included in the research: Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae and Melittidae.

Melipona eburnea *specimens, a stingless bee species with ferromagnetic particles. Photo by: Floro Ortiz Contreras https://www.biodiversity4all.org/observations/189672310*

This means that magnetic material was found in a remarkably diverse collection of bees – not only in domestic honey bees, but also among solitary bees, stingless bees and other groups with very different ways of life.

What is the magnetism in bees

The researchers detected the magnetic properties of tiny particles inside the insects. and propose that these particles are likely iron-oxide nanoparticles, particularly magnetite (Fe_3O_4). Magnetite is a naturally magnetic mineral and is one of the leading candidates for the material involved in magnetite-based magnetoreception.

To investigate the particles, the researchers measured how bee tissues responded to an externally applied magnetic field. Ferromagnetic material does not respond to the magnetic field in exactly the same way when the field is increased and then decreased. It retains some magnetic "memory."

This is very different from simply finding iron inside an insect. The iron-containing molecule hemoglobin, for example, does not produce the magnetic signature observed in the study. The researchers therefore interpreted the measured response as evidence for crystalline magnetic nanoparticles rather than merely ordinary iron-containing biological compounds.

The study then used the strength of the magnetic signal to identify species with what the authors call putative magnetoreception. This distinction is important. Ferromagnetism demonstrates a physical magnetic property. Putative magnetoreception goes a step further: the amount of magnetic material is sufficiently large to be comparable with a previously studied bee species in which magnetically guided behavior has been experimentally demonstrated.

The researchers therefore use the term "putative" because the present study measured magnetic properties rather than testing the behavior of every bee species in a magnetic-navigation experiment.

Which bees species have ferromagnetic responses

There aren’t particular species that are "the magnetic bees." The measurements show that magnetic material occurs across an extraordinary range of bee biology.

Bombus terrestris. *Also this species has ferromagnetic particles. Photo by* *LordToran - Wikipedia*

The researchers sampled species from six major bee families, and ferromagnetic responses occurred throughout the phylogenetic tree. In other words, magnetic bees were not concentrated in one particular branch of bee evolution.

Among the species examined were several honey bees, including the western honey bee *Apis mellifera*, as well as *Apis cerana*, *Apis dorsata* and *Apis florea*. The study also included the stingless bees *Axestotrigona ferruginea* and *Melipona eburnea*, the subsocial bee *Ceratina strenua* and *Bombus terrestris*, and solitary bees including *Centris tamarugales* and *Ptilothrix bombiformis*.

Another result is that the strength of the magnetic signal increased with body size and sociality. This does not mean that solitary bees are nonmagnetic. In fact, the study found ferromagnetism across bees with very different social systems. But, statistically, more social species tended to have stronger magnetic signals.

Distribution of the magnetic particles in the body of bees

The researchers divided selected bee bodies into three major regions: the head, the mesosoma (thorax) and the metasoma (abdomen).

Examining these regions separately in 14 individual bees, the researchers found that the magnetic material was not confined to a single anatomical location.

The major amount of ferromagnetic particles have been found in mesosoma (thorax) in the major part of the bees analyzed. Photo by USGS Bee Inventory and Monitoring Lab from Beltsville, Maryland, USA.

In seven of the 14 bees, all three regions—the head, mesosoma and metasoma—showed some degree of ferromagnetism. In another six, the magnetic response occurred in the mesosoma and metasoma but not the head. And in none of the examined bees was magnetism restricted to just one body region.

However, the mesosoma showed the strongest magnetic signal on average. Its contribution to total saturation magnetization was significantly greater than that of the head and metasoma.

The role of magnetism in bees

The presence of magnetic nanoparticles is consistent with a magnetite-based magnetoreceptive system. Such a system could allow a bee to detect Earth's magnetic field and potentially use that information for orientation.

But the researchers did not demonstrate that every species containing ferromagnetic particles actually uses them as a magnetic compass.

This distinction matters because magnetoreception can arise through different biological mechanisms. One proposed mechanism involves magnetic particles such as magnetite. Another involves light-sensitive proteins called cryptochromes and magnetic effects associated with chemical reactions known as radical-pair reactions.

The present study specifically investigated ferromagnetic material. Its results therefore provide evidence for the widespread presence of a potential magnetite-mediated mechanism, but they do not exclude other forms of magnetoreception.

The researchers also acknowledge another possibility that must always be considered when studying tiny magnetic particles: environmental contamination. Iron-containing particles could potentially come from the environment rather than being deliberately produced by an insect. However, the fact that different body regions showed distinct magnetic characteristics makes simple contamination a less satisfactory explanation for all of the observed signals.

However, the magnetism of the bees changes the way we can think about bee navigation. The possibility that their bodies also contain microscopic magnetic particles adds another invisible dimension to their sensory world.

This study does not give a clear answer about that. It just reveal how widespread the physical basis for a magnetic sense may be, and it leads us toward a new frontier in bee science

References

Russo et al., 2026 - **Broad presence of ferromagnetism in bees and relationship to phylogeny, natural history, and sociality -** *Science Advances vol.12 n. 16*