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According to new research from the University of Leeds, honeybee colonies do not automatically insulate themselves against the cold.

The findings of a study conducted by Derek Mitchell, a PhD student at the University of Leeds School of Mechanical Engineering, reveal that the insects may be susceptible to thermally induced stress, which may necessitate changes in beekeeping practices.

He is calling for more discussion about the ethical treatment of insects, claiming that his findings appear to contradict the widely held belief that bees' reaction to cold temperatures is to form layers of insulation - an idea that has led to them being housed in hives that are extremely poorly insulated compared to their natural habitat.

The research, published in the Journal of the Royal Society Interface, looked at honeybee "clusters" - where the insects gather together, forming compact discs between the combs, to try to keep some of them above 18°C when the temperature outside drops. The outer layer of honeybees in the winter cluster, known as the mantle, has been claimed to insulate the cluster core - the honeybees at the heart - for over 120 years.

Mr. Mitchell examined this notion using the same techniques used to measure heat loss from buildings. However, his findings suggest that, rather than acting as insulation, the mantle functions as a heat sink, dispersing heat away from the centre. In its conclusion, the report states: "The cluster mantle does not meet any of the four insulation criteria identified and meets all three heat sink criteria."

According to the research, as the outside temperature drops, the heat required to maintain 18°C+ inside the hive rises. If the bees are unable to produce so much heat, the temperature near the hive wall lowers, and the honeybees near it become chilly, and they relocate closer to bees that can still produce heat efficiently. They move closer together, and their overall thermal conductivity rises, increasing heat loss even more.

"My findings are controversial because it has become a tenet of beekeeping - that the mantle insulates the honeybees," Mr. Mitchell said.

"According to this new research, clustering is a survival behavior in response to an existential threat, resulting in increased stress due to cold and exertion." To survive, some honeybees may even consume their own young."

"In anthropomorphic terms, clustering is not a "wrapping of a thick blanket" to keep warm - but rather a desperate struggle to crowd closer to the "fire" or otherwise die," he added.

Raising Awareness

He went on to say: "I want to share my research, to raise awareness of the welfare issues and to help educate beekeepers about the complex interaction of the colony enclosure and thermofluids - heat, radiation, water vapor, air - with honeybee behavior and physiology."

"It's great to see how mechanical engineering can be applied to such a variety of fields and how these findings can potentially help beekeepers in the future," said Harvey M. Thompson, Professor of Computational Fluid Dynamics at the University of Leeds, who supervised the new research.

Mr. Mitchell's investigation began when his wife began beekeeping and he discovered that individuals were still using hives designed in the 1930s and 1940s.

"The hives beekeepers used contradicted what I knew about heat transfer and what beekeepers had told me about honeybees," he stated. I felt I could create better hives, so I began by researching honeybee requirements, only to discover that no one knew in technical terms."

Heat Loss

He returned to mechanical engineering as a PhD student after studying it as a student apprentice. His prior research, which used engineering techniques more often used to solve industrial challenges, revealed that most artificial hives lose seven times more heat than natural nests.

Mr. Mitchell, who also holds a BSc in Physics, an MSc in Microelectronics, and has worked in spacecraft ground control software, believes that misconceptions about clustering stem from observations of the creatures' overwintering behavior in thin (19mm) wooden hives, which have very different thermal properties than their natural habitat of thick walled (150mm) tree hollows.

He claims that long-held views have favored forced clustering, owing to beekeepers' widespread use of "inadequately insulated hives" and, in North America, refrigeration. This is frequently regarded as a benign or even required activity, with beekeeping and academic studies viewing these severe heat loss conditions as natural and typical.

He is urging for improvements in practice to be examined, researched, and promoted as soon as possible, as well as more discussion about the ethical treatment of honeybees and insects.
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