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Editorial: Biology of giant honeybees

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Editorial on the Research Topic
Biology of giant honeybees

Research on systematics, ecology and social behavior of bees within the subgenus *Megapis* is still in its early stages. The six recent studies in the Research Topic "*Biology of Giant Honeybees*" have contributed to all three areas.

The report in this Research Topic by Kitnya et al. using traditional morphological taxonomy, identified diagnostic morphological differences between *Apis dorsata* of mainland Asia and *Apis binghami* from the Philippines/Sulawesi. Bhatta et al. applied mitochondrial DNA sequencing in their genetic analysis, further dividing the *Apis dorsata* complex into four geographic lineages: Mainland Asia, Sulawesi, Philippines, and South India. Both studies recognized *Apis laboriosa* as a valid species. These contributions have advanced our understanding of species diversity and phylogeny of the subgenus.

Otis et al. revised the distribution of *Apis laboriosa* and significantly expanded its range to include northeastern Vietnam, central Myanmar, northwestern Thailand, western Nepal and northeastern Pakistan (Kitnya et al., 2022). Its distribution now spans >3300 km from west to east, south of the Himalayan massif and higher-elevation regions of China. They found that the species inhabits both subtropical broadleaf and coniferous forests, with new evidence of migratory strategies, such as following river valleys northward out of India and Nepal into China. In Vietnam, colonies often nest on tree branches, a behavior not previously documented.

Rehel et al. reviewed studies of *Apis dorsata* in the Western Ghats of South India. They provide valuable insights into nesting sites and colony abundance. However, differing methodologies and lack of coordinated nationwide studies hinder more comprehensive understanding and conservation efforts for these bees.

Raffiudin et al. is the first study to compare the foraging behavior of *Apis dorsata* across two habitats: an oil palm plantation and a mixed forest–agriculture area. The findings indicate that the bees preferentially forage in sites with abundant flowering plants, suggesting a migratory behavior to exploit mass flowering events. Consistent with expectations, they foraged on a broader diversity of plants in the forest–agriculture area.

Kastberger et al. expanded on their previous work (Kastberger et al., 2024) on the collective decision-making processes during mass flight activity (MFA) in *Apis dorsata* colonies. Their infrared heat analyses, combined with motion profiles and spectra, measured how a nest—normally quiescent most of the day—enters a state of restructuring during MFA. This restructuring temporarily impairs the colony's ability to defend itself, as shown by its response to dummy wasp attacks. The study revealed a negative correlation between heat production and movement, suggesting a temporary social paralysis, which could be interpreted as social thanatosis—a phenomenon not previously documented in the animal kingdom.

Discussion and future research directions

Species status of taxa in the *Apis dorsata* complex

Genetic differences greater than 5% between the four lineages identified by Bhatta et al. suggest these may all merit species designation. Additional morphological studies are needed to resolve the taxonomy of *Apis breviligula* and *Apis dorsata*-South India. Future analyses using ultra-conserved elements (UCEs) or whole genomes are expected to further clarify the phylogeny of the giant honeybees.

Geographic distribution and introgression

Further sampling and analyses of both nuclear and mtDNA are necessary to clarify the extent of introgression between mainland Indian and South Indian lineages of *A. dorsata.*

Conservation concerns

Conservation studies on *Apis dorsata* in Sumatra (Raffiudin et al.) and South India (Rehel et al.) suggest that each genetically distinct lineage faces unique threats that require targeted conservation efforts. In addition, researchers often encounter restrictions in protected areas and collecting specimens. Nationwide initiatives are essential to promote collaborative research and conservation efforts for giant honeybees, similar to those dedicated to large "charismatic" vertebrates.

Pollination role

Despite their ecological importance, no papers in this Research Topic addressed the role of giant honeybees in pollination. Future research should explore their contributions to both natural and agro-ecosystems (Warrit et al., 2023).

Migratory behavior

Giant honeybee migrations are still poorly understood, although evidence of their return to previous nest sites has been demonstrated (Paar et al., 2000; Neumann et al., 2000). Key questions include what triggers migration, how far swarms travel, and how weather and floral resources influence their movements. Future studies should track colony births and deaths, and explore their navigation and stopover patterns. The precise role of scout bees and dancing bees in directing colony movement both from the nest and from bivouacs needs further research.

Shimmering behavior and defense

Although the role of shimmering in defending nests from wasps has been described in several studies (Kastberger et al., 2008, 2014), the mechanisms which involve three-dimensional wave processes in the bee curtain and generally in the nest are still unclear (Kastberger et al., 2011, 2013). Future research should focus on examining how the dynamic movements involved in shimmering influence predator behavior.

Nest restructuring during MFA

The restructuring of the nest and bivouacs (Robinson, 2021) during MFA is not fully understood (Robinson, 2021; Kastberger et al., 2024), as discussed by Kastberger et al. It remains unclear which bees are involved and how the process is regulated. Demographic studies of worker bees and colony populations could provide valuable insights. Focusing observations on the "mouth zone," which appears to play a key role in controlling nest activity, may provide deeper insights into colony behavior.

Asynchrony of MFA in colony aggregations

Mass flights within larger nest aggregations occur asynchronously, with little overlap between colonies (Kastberger et al., 1996). This lack of colony synchronization remains unexplored but may be crucial for understanding colony dynamics during MFA. An enduring question is why MFAs occur at all.

Outsmarting avian predators?

The giant honeybee's defense mechanisms, including shimmering and mass counter-attacks (Kastberger et al., 2014), are effective against wasps and mammals but less so against avian predators like bee-eaters and honey buzzards (Kastberger, 1999; Kastberger and Sharma, 2000). This raises an intriguing question: How have giant honeybees (*Apis dorsata*) survived for over 5 million years despite these birds circumventing their defenses? One key factor may lie in the bees' migratory behavior, which may create a dynamic that challenges traditional predator–prey models—such as the Lotka-Volterra "fox–rabbit" model (Shakil, 2015).

Conclusion

In conclusion, while substantial progress has been made in understanding the biology, ecology, and behavior of giant honeybees, there is still much to learn. Collaborative research on genetics, migration, ecological roles, and defense strategies, as well as nest organization, is essential for furthering knowledge and ensuring conservation efforts.

Author contributions

GO: Writing – original draft, Writing – review & editing. WR: Writing – original draft, Writing – review & editing. AB: Writing – original draft, Writing – review & editing. GK: Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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