Into the belly of the bee: A closer look at bees' gut microbes

June 14 2021

The team gathered hundreds of honeybees that had been freely foraging from local flowers and fields at sites in Italy and Saudi Arabia. Credit: Morgan Bennett-Smith

Environmental bacteria and fungi that end up in the belly of honeybees may be essential to their survival in a changing world as bee populations dwindle due to pesticides, poor nutrition, habitat destruction and declining genetic diversity.

Like many animals, bees have an internal armory. Their guts are home to

a multitude of microbes that perform vital functions, from aiding digestion to breaking down toxins and fending off parasites. "A healthy gut microbiota makes bees more resilient to threats such as pathogens and climate change," says KAUST research scientist Ramona Marasco, "highlighting the need to understand how different microbes help their host."

Extensive research into the microbiome of the European honeybee (Apis mellifera) has focused on several bee-specific (core) bacteria whose functions and distribution throughout the gut are now well understood. However, overlooked are the minor members of the microbiome, such as bacteria and fungi that the bees inadvertently ingest while foraging.

The team, led by Daniele Daffonchio, gathered hundreds of honeybees that had been freely foraging from local flowers and fields at sites in Italy and Saudi Arabia. The researchers removed the whole gut from each bee and used genome sequencing to analyze the bacterial community in each of the four main gut sections. "The challenge was to separate each gut section without releasing intestinal content that could contaminate the microbial communities of the other sections," says postdoc and co-first author Matteo Callegari, "so we froze the guts at -20 degrees Celsius before carefully cutting them up."

As expected, core bacteria accounted for up to 98 percent of the total bacterial community. However, the small remaining portion included 164 operational taxonomic units (a proxy for species) of bacteria and 118 of fungi, compared to just 32 from the core species.

The team was surprised to find that the diversity and abundance of all three microbial components varied along the gut. "Each gut compartment has different physical and environmental properties, such as pH, sugar concentration and oxygen levels," says Marasco. "Consequently, only bacteria and fungi that can cope with a

compartment's unique conditions can survive and be metabolically active there."

The team used previous taxonomy data to predict how each of the environmental bacteria helps their honeybee host. Possible functions included producing antibiotics, breaking down toxic substances, metabolizing carbohydrates, digesting amino acids and fats, and distributing nutrients. The fungi were largely fermentative yeasts that are often important in digestion.

"Our findings suggest that these rather neglected minor microbes may become important players under unusual environmental conditions, such as climatic stress," says Daffonchio. "We are currently studying their functions so we can understand how honeybees respond in such a variable world."

More information: Matteo Callegari et al, Compartmentalization of bacterial and fungal microbiomes in the gut of adult honeybees, *npj Biofilms and Microbiomes* (2021). DOI: 10.1038/s41522-021-00212-9

Provided by King Abdullah University of Science and Technology