

INSIDE JEB

Can microbial lodgers remote control fly hosts?



Female *Drosophila melanogaster* standing on white paper. Photo credit: Hannah Davis, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons.

Within the gut of every creature there is an unsung army of microscopic helpers beavering away unacknowledged. By contributing to digestion, metabolism and immunity in animals ranging from fish and mammals to reptiles and insects, these microbial communities – known collectively as the gut microbiome – provide essential life support in return for board and lodging. They may even be capable of fine tuning an animal's mood and their ability to learn. Knowing that fruit flies have helped scientists begin to understand how these microbial lodgers influence their host's health, Valeria Silva, Angelina Palacio-Muñoz and John Ewer from the Universidad de Valparaíso, Chile, with colleagues from the UK and the USA, decided to find out how the microorganisms residing in the insect's gut affect their mood and behaviour. But first the team had to rear populations of sterilised fruit flies that never harboured microbes in their bodies.

'It's very easy because the bacteria are on the outside of the eggshell', says Ewer, describing how Silva carefully washed recently laid eggs with dilute bleach, to

remove the outer membrane and sterilize the embryos, before transferring them to sterile bottles stocked with nutritious food to grow and develop microbe-free. Once several populations of bacteria-free fruit flies were established, she compared their activity levels with those of the fruit flies with intact microbiomes. But a full complement of gut flora didn't seem to make any difference to the flies' busyness. If anything, the genetic backgrounds of the different populations had a greater impact on the insects' liveliness. So, what effect, if any, would the flies' gut flora have on their memory?

This time, Zeynep Okray and Scott Waddell from the University of Oxford, UK, tested how well the insects learned to associate two scents – menthol-like 4-methylcyclohexanol and the sweet nutty odour of 3-octanol – with either a sugary treat or an uncomfortable electric shock. Initially, the sterilized flies' memories didn't seem to be impaired; however, the flies struggled to navigate a maze guided by the scents 24 h later. And when Angelina Palacio-Muñoz checked whether the males could learn to give up

wooing disinterested females, the microbe-free suitors had difficulty getting the message when females preferred to be left alone. Without a gut microbiome, the flies struggled with their memory.

In addition, the flies that had no microbiome turned out to be sleepier than untreated fruit flies and didn't seem to be able to catch up on slumber lost when Silva nudged them awake continually through the night. However, when Palacio-Muñoz checked whether the microbe-free flies were particularly nervous after being released into an open arena, the lack of microbiome made little difference: the sterile flies were equally as bold as flies whose gut was packed with friendly microbes.

'This study has identified significant effects of the microbiome on some aspects of learning and memory and sleep homeostasis', says the team's microbiome guru, Angela Douglas from Cornell University, USA. However, Ewer adds, 'Our results suggest that the microbiome has at best modest effects on most other behaviours', advising that the impact of the microbiome could vary between fruit fly populations, with flies from different genetic backgrounds experiencing subtly different outcomes from the interventions of their microbial lodgers. He also suspects that the insects' internal microbial residents could have more of an influence on the insects' choices and behaviours in the real world. In the meantime, the team is keen to discover how chemicals released by the microbiome remote control their hosts in a bid to understand our own delicate relationship with the microbial ecosystems residing in our own intestines.

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