INSIDE JEB

Damaged honey bee guts recover impressively after heat waves

Honey bees attending to a honey comb. Photo credit: James Casey.

Honey bees in the USA face a plethora of challenges that are taking them down. Parasitic infections, insecticides, loss of habitat and heat waves are all placing these formidable labourers under stress. 'Honey bee colonies in the United States have suffered from a higher than usual rate of die-off in the last few years [rising] to over 40% in recent years', says Jonathan Snow from Barnard College, USA. Fortunately, many individuals seem to be quite robust, mobilising an impressive response – known as the heat shock response – which offers protection to cells in the body when the mercury rises. But Snow and his colleagues were curious to find out why honey bees cope so well with heat, but struggle when faced with additional stresses. Knowing that the insect's gut is likely to be particularly vulnerable to ingested insecticides and infections, Snow, Dunay Bach (Barnard College) and their colleagues wondered how the organ would react when honey bees experience a brutal heatwave, to find out how well they are defended from the prospect of climate change.

Warming the insects to 45 deg for 4 h, Bach and Snow then painstakingly collected the bees' midgut, as well as the head, thorax and abdominal wall, to analyse which genes had been activated by the heatwave and which had been turned off. Remarkably, the hot bees had increased expression of 1393 genes, while partially or largely deactivating 535 genes. Focusing on the genes that were activated particularly strongly immediately after overheating, many of the usual heat shock culprits cropped up, including *Hsp70AB*. The team also identified 22 strongly activated genes from two cell signalling pathways (the Hippo and JNK pathways), which are well known for regulating tissue regeneration. In addition, one particular gene – which they identified as gene 102655202 – really stood out, increasing its expression level 164-fold after the heat wave. And, when the team compared the protein produced by the gene with the proteins from other organisms, they realised that it was one of the essential trigger proteins, called unpaired proteins, that activate the JAK/STAT pathway, which controls how gut stem cells develop into mature cells to replace damaged tissue.

Realising that the overheated bees had successfully mobilised a set of mechanisms that repair injured tissue, the team wondered what damage they would find when they took a closer look at the insects' intestines. Scrutinising the bees' guts, they discovered that the lining was dying and that the insects were sloughing the cells almost as soon as they began to perish. However, when the team checked how well the insects were recovering 8 days later, they seemed as healthy as insects that had not experienced the intense heat. 'These results suggest that the tissue regeneration response is capable of returning the midgut to normal function before detrimental effects on medium-term survival occur', says Snow.

Individual honey bees have strong protective mechanisms and are well prepared to recover from brief periods of intense heat, although they rarely face extreme temperatures within the hive. Maintaining the temperature of the collective at a balmy 32–35 deg, honey bees are generally well protected from the external environment. However, Snow warns that the insects will have to pull together to keep their colonies cool as climate change takes hold and he is keen to discover why the insects become more vulnerable when additional stressors impact on their communal lives.

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