© 2019. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2019) 222, jeb206185. doi:10.1242/jeb.206185

INSIDE JEB

Firebugs fight infection with egg yolk protein

A firebug (*Pyrrhocoris apterus*). Photo credit: Jan Sula.

Fighting off an infection is never easy, but insects are prepared. By releasing antimicrobial peptides (mini-proteins) from the fat body – the insect equivalent of the liver – and mobilising specialised cells that target invading infections in the haemolymph (insect blood), insects are able to defend themselves when wounded or at risk of infection. However, Dalibor Kodrík and colleagues from the Biology Centre of the Czech Academy of Sciences, wondered whether a group of proteins known as vitellogenins – which are usually produced by female animals and go on to create egg yolk proteins – might also contribute to insect immunity. Kodrík says, 'Studies in the silkworm and honeybee reported strong antibacterial activity of vitellogenins'. Could the proteins contribute to the immunity of his favourite insects, firebugs (*Pyrrhocoris apterus*)? Knowing that the nematode *Steinernema carpocapsae*, which infects insects with toxic *Xenorhabdus* bacteria, and the lethal *Isaria fumosorosea* fungus are used to control insect numbers, Kodrík decided to investigate whether either biological control agent triggers vitellogenin production in firebugs and whether the proteins offered any protection from these infections.

After injecting one group of firebugs with the toxic nematodes and a second group with the fungus, Emad Ibrahim and Umesh Guatam collected the infected insects' haemolymph and fat bodies several days later to find out whether the insects were producing vitellogenins to combat the infections. When they measured the levels of vitellogenin mRNA and protein, Radmila Čapková Frydrychová, Andrea Bednářová and Pavel Jedlička discovered that the nematode infection significantly boosted the males' vitellogenin mRNA production 7.7-fold and protein 1.5-fold. However, the infection caused the females' vitellogenin mRNA levels in the fat body to crash, dramatically dropping 150-fold, while their haemolymph vitellogenin protein levels also plummeted.

In contrast, the male firebugs' response to the slower developing fungal infection was only modest, while the females experienced the same haemolymph and fat body reductions in vitellogenin that the scientists had discovered in the nematode-infected insects. In addition, when the team tested the mortality rates from both infections, it seemed that the female firebugs were better protected than their male counterparts. And when Václav Krištůfek treated the nematode's toxic *Xenorhabdus* lodgers with vitellogenin, the bacteria succumbed, although the protein made little impact on the fungal infection.

So, it appears that vitellogenin does contribute to the insect's immunity, offering some protection from nematode and fungal infections. Kodrík also suspects that the reduction in vitellogenin levels experienced by infected females may not be as unexpected as it first appears. 'One can speculate that the vitellogenin level sufficient for effective defence against pathogens might be much lower than that required for nutritional supply of developing eggs', says Čapková Frydrychová, who suggests that infected females may shut down non-essential processes, such as egg development, at times of crisis to invest energy in fighting the infection. And Kodrík is keen to discover whether the essential egg protein is also a key player in the immune response of other insects, including *Drosophila*, which could allow him to begin unravelling vitellogenin's antibiotic mechanism.

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Kodrík, D., Ibrahim, E., Gautam, U. K., Čapková Frydrychová, R., Bednářová, A., Krištůfek, V. and Jedlička, P. (2019). Changes in vitellogenin expression caused by nematodal and fungal infections in insects. *J. Exp. Biol.* **222**, jeb202853. doi:10.1242/jeb.202853

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