© 2022. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2022) 225, jeb245403. doi:10.1242/jeb.245403

INSIDE JEB

# Cold-raised fruit flies are harder to paralyze

A fruit fly (*Drosophila melanogaster*). Photo credit: Heath MacMillan.

As winter nears, the days and nights grow colder in many parts of the world, and lots of mammals and birds keep themselves warm by donning their winter coats or plumage. But for animals that don't generate their own body heat, such as insects, life in the winter can be much harder. When insects get too cold, an interesting phenomenon occurs: they experience a spreading depolarization in their brain, paralyzing them and causing them to go into a chill coma. Generally, climate change causes the temperature to rise, but it also results in an increase in severe weather and cold snaps. Because of the unpredictability of their environment, the ability of insects to tolerate colder temperatures may give species an advantage. But could something as simple as being raised in a cooler environment help protect insects from the chill coma? Mads Andersen and Heath MacMillan of Carleton University, Canada, show that raising fruit flies (*Drosophila melanogaster*) in colder environments helps their brains function better when the temperature drops because of changes to the sodium/potassium ($Na^+/K^+$) pump.

Working with R. Meldrum Robertson from Queen's University, Canada, Andersen and MacMillan raised some fruit flies at 15°C and tested whether growing up in this colder climate gave the insects some protection against the paralysis-inducing event. Normally, spreading depolarization would happen at 9°C, but they found that if the flies were raised in the cooler environment, it didn't occur until the temperature was down to 5°C. Not only that, but the magnitude of the paralysis-inducing event wasn't as large for the cold-raised flies, suggesting that these flies were able to maintain their brain cells' ion balance.

The team knew from previous research that the paralyzing effects of the spreading depolarization are the result of imbalances in the $Na^+$ and $K^+$ levels in the fluid between the brain cells. Andersen blocked the molecular pump ($Na^+/K^+$-ATPase) that maintains this balance to see whether the paralyzing event could be caused chemically at different temperatures. For the cold-acclimated flies, it took longer for a paralyzing event to happen, and it occurred at lower temperatures than in fruit flies raised at room temperature.

Based on this, the team thought that the $Na^+/K^+$ pump must be working harder in the brains of cold-acclimated flies. Instead, they found these cold-raised fruit flies had lower $Na^+/K^+$ pump activity, but it worked better at lower temperatures than it did for normal fruit flies. This suggested that growing up in a cold environment allowed the pump to function even as the temperature dropped.

Another possibility then occurred to Andersen: raising the flies in cooler temperatures could also have increased the number of the pumps in the brain cells, allowing the flies to better maintain the balance of $Na^+$ and $K^+$. However, when the team tested this, the cold-acclimated flies had a similar amount of $Na^+/K^+$ pumps to their more temperate fellows.

Andersen points out that given the role of the $Na^+/K^+$ pump in maintaining the levels of ions on each side of the cell membrane, it isn't surprising that the activity of this molecular pump is important for preventing the paralyzing events that cause chill comas in the diminutive flies. Andersen and colleagues go on to highlight the impressive importance of a single molecular pump in setting the temperature limit to the insect's activity. So, as climate change causes more drastic deviations in the normal weather, being raised in the cold might just save the life of a fruit fly when the temperature unexpectedly drops.

10.1242/jeb.245403

**Andersen, M. K., Robertson, R. M. and MacMillan, H. A.** (2022). Plasticity in $Na^+/K^+$-ATPase thermal kinetics drives variation in the temperature of cold-induced neural shutdown of adult *Drosophila melanogaster*. *J. Exp. Biol.* **225**, jeb244923. doi:10.1242/jeb.244923

**Jarren Kay**
**jarren.kay@biologists.com**

Inside JEB highlights the key developments in Journal of Experimental Biology. Written by science journalists, each short report gives the inside view of the science in JEB.