

Hot temperatures limit the spread of disease, but not enough to stop epidemics

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Most organisms – including disease-causing pathogens – have an ideal temperature where they function best. Colder or warmer temperatures can limit their ability to cause infections. Additionally, most animals tolerate heat better than their pathogens. That's why many animals use fever to fight infections: high body temperatures can kill pathogens. Fevers are triggered by immune system chemicals in warm-blooded animals like humans. Many coldblooded animals create 'behavioral fevers' by basking in the sun.

We study disease in water flea zooplankton – comma-sized crustaceans – that live in freshwater lakes. When water fleas accidentally eat spores of a deadly fungus, the fungus grows inside and eventually kills them, releasing new spores into the water for other water fleas to eat. Outbreaks of this fungus happen every fall in lakes in the Midwestern US, starting as lake water cools after warm summer conditions. Based on this pattern, we thought hot summer temperatures might prevent the fungus from successfully causing infections, like an 'environmental fever.'

We used laboratory experiments to measure how hot temperatures affect five steps of the infection process. The warmest temperatures that water fleas experience during the summer reduce the ability of the fungus to infect them. However, this environmental fever could not completely prevent disease



An uninfected water flea (right) and an infected water flea filled with fungal spores (left). Credit: Meghan Duffy.

or explain why there are no summer epidemics. Additionally, medium-warm temperatures actually made the fungus more successful, because water fleas eat faster when it's warmer, so they swallow more spores. But hot temperatures might combine with other factors – like intense UV radiation from the sun that kills the fungus – to limit disease spread during the summer. This idea matters in a changing climate because warmer temperatures will extend later in autumn. This means the water fleas could be eating more spores when there is less UV radiation, a recipe for huge epidemics! Hopefully our work will help people think about how warm temperatures and climate change might affect the spread of other infectious diseases.