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Parasitic worm manipulating ants into zombie-like behaviour the focus of recent U of L study

A new study co-authored by the University of Lethbridge's Dr. Cam Goater and graduate student Dr. Brad van Paridon (BSc '10, PhD '17) is beginning to unlock the evolution of one of the most captivating and complex parasite life cycles in nature.

In a paper published in this week's issue of Proceedings of the National Academy of Sciences (PNAS), Goater, van Paridon , Dr. John Gilleard (University of Calgary) and collaborator Dr. Charles Criscione (Texas A&M University) assess the genetic relationships of a parasitic worm to help explain how they take over the brains of ants, effectively manipulating them into zombies as they seek to complete their life cycle.

PNAS is widely considered one of the top three science journals in the world and Goater is quick to praise van Paridon's work during his PhD studies as a driver of the latest research findings.

"His focus on integrating approaches in animal ecology, molecular biology and evolutionary theory is really what pushed this paper forward," says Goater. "It's a testament to the talent of our graduate students and the high level of research being done in our graduate programs."

The parasite, known as the lancet liver fluke, Dicrocoelium dendriticum, is one of the most well-known and least understood parasites in nature. It infects ants and causes them to cling to vegetation and wait to be eaten by animals, including cattle and sheep. Consuming the parasite can cause the animals to develop liver diseases that are difficult to diagnose and treat, costing farmers time and money. They are prevalent in the Cypress Hills area of southeastern Alberta and southwestern Saskatchewan.

“When these ants ingest larvae of the fluke, they crawl to the tops of flowers that are adjacent to their nests,” says Goater, a researcher in the Department of Biological Sciences who has been studying the ants and observing their bizarre behaviour for years. “Once they have settled on a flower, they firmly attach with their mandibles. A few hours later, if not eaten by a grazing mammal, the infected ants detach from the flower and return to their nest. They repeat the same attach/detach sequence the very next day — often on precisely the same flower petal.”

The natural world is ripe with examples of hosts changing their behaviour and even appearance at the bequest of a parasite, but researchers still do not fully understand how parasites cause these alterations or how they evolve.

Their paper, Clonemate cotransmission supports a role for kin selection in a puppeteer parasite, emphasizes that to understand the evolution of this absurd manipulation, it is important to understand how ants are exposed to these parasites, their fate inside an ant, and the genetic relationships between individual parasites. The life cycle starts as a microscopic egg in the dung of a grazing mammal such as a cow or deer before infecting and multiplying in snails and being released in tiny slime balls. Ants love to eat these slime balls but when they do, they become exposed to myriads of minuscule larvae that pass into the ant’s abdomen. Those in the abdomen reside there for the rest of the ant’s life, awaiting ingestion by a cow. One lone larvae, however, heads to the brain where it initiates the zombie-like behaviour — knowing it will die upon ingestion by a grazing mammal. Thus, the parasite in the brain sacrifices its life for its mates that live in the abdomen — a classic case of altruistic behaviour.

“Unlike equivalent stages of similar parasites, there is a very close genetic relationship between the parasite in the brain and those in the abdomen. In fact, they tend to be perfect clones,” says Goater. “This means that in sacrificing itself, the ‘brainworm’ facilitates the movement of close relatives into the next host where they can reproduce.”

The evolutionary explanation for why some animals appear to sacrifice themselves for others is a subject of much debate. The theory of kin selection seeks to explain altruistic behaviour as a mechanism by which individuals can increase the chance of their genes being passed to the next generation by improving chances of survival and reproduction of genetically related family members.

“By demonstrating the close genetic relations between brain- and abdomen-dwelling parasites in manipulated ants, we’ve been able to demonstrate the key role of kin selection in the evolution of this puppet master parasite.”

To view online: https://www.uleth.ca/unews/article/parasitic-worm-manipulating-ants-zombie-behaviour-focus-recent-u-l-study

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