Social insects put the 'I' in team to fight disease

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Associate professor Rebeca Rosengaus studies the immune systems of social insect species like ants and termites. Credit: Thinkstock

Social insects such as ants, termites, and some bees and wasps live in a sort of eternal "airplane environment," according Rebeca Rosengaus, an associate professor in Northeastern's Department of Marine and Environmental Sciences. That is, they live in confined quarters, sharing the same air, food, and even microbes for their entire lives.

Like jetsetters, she said, "social insects are exposed to pathogens just like everybody else in the world, but have the added handicap of being social."

Following the airplane analogy, one might suspect that sociality would increase the risk of infection, as microbes readily pass from one individual to the other. But, in fact, Rosengaus' work has shown the exact opposite: social insects deal with disease much better when they're in groups than when they're isolated.

In previous research, Rosengaus' team showed that the so-called "social stomach" of individual ants, which produces droplets of liquid food to be passed from one adult ant's mouth to the next, doesn't just ensure the delivery of nutrients to the entire group. It also promotes the transfer of immune proteins from immunized to non-immunized members of the colony.

In a paper published in the journal *Biology Letters*, Rosengaus' team has expanded that research to include an examination of ant larvae. Given the meticulous grooming that ant larvae receive from workers, as well as the transfer of fluids from the workers' "social stomachs" to the larvae, Rosengaus hypothesized that the immature larvae may receive less natural immunities and instead focus their energy on growing faster.

"It's costly to produce immune proteins, because it takes energy away from you," Rosengaus said. "If you're a little larva that wants to grow fast and get plump, why should you produce your own immune proteins if you're getting the immune goodies from somebody else?"

Rosengaus explained that if social transfer of immune protection via mouth-to-mouth regurgitation were enough, then evolution should have reduced the work young ant larvae put into building their own immunity. To test this, her team vaccinated larvae by injecting them with killed bacteria (the same way humans are vaccinated) or a saline solution and then placed them with workers who tended to the larvae. On the third day, the team exposed the larvae to live, more destructive bacteria. They found that the vaccinated insects were five times more likely to survive the challenge than those unvaccinated.

This confirmed that ant larvae have retained their individual immune systems throughout millions of years of evolution despite the fact that workers provide extensive brood care, Rosengaus said, and that immature larvae are indeed capable of immune priming.

The findings point to yet another method by which social insects deal with disease. In the age of phenomena such as colony collapse disorder among bees and invasive fire ant populations in the southern United States, understanding the multiple mechanisms of social insect immunity is critical, according to Rosengaus.

"We're trying to understand the interaction between group living and immunity at the different levels of biological complexity, from the molecules, to the proteins, to the individual, to the group, to the society," she explained. "At every step as you go up the hierarchy of complexity, you could expect different emergent properties of an immune system."

This new research shows that ant larvae can generate an immune response. This individual capability, together with the social transmission of immune function via mouth-to-mouth regurgitation from workers, helps the entire colony survive pathogenic challenges.

Interestingly, Rosengaus believes that the social nature of the insects, and the ability to transfer immune proteins from one ant to another, may have shaped the physical attributes of the immune proteins themselves. Immune proteins, to be effective when shared among nestmates, need to be robust. They should not degrade easily during the exchanges and should retain antimicrobial activity during and after their transfer. She said the ability to generate immunity at the individual level and the exchange of immune protection between individuals in a colony may be one reason why social insects are so geographically widespread and so ecologically dominant.

More information: rsbl.royalsocietypublishing.or … t/9/6/20130563.short

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