Ants' successful combat against epidemics

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Abstract:

Even though ants live and work close together in colonies, their nests are rarely hit by epidemics. Recent research suggests that the reason behind ants' effective disease control is an early recognition of possible infection and prompt actions for prevention, treatment as well as following viable solutions to any adverse situations that can risk the survival of the colony as mentioned in this research article. Various experiments and observations have led to the intense awareness that these "superorganisms", while demonstrating an ideal attitude of working conjointly, being aware of fellow co-worker's health and practical decisions of secluding oneself when ill, unlike some humans, are very much similar to our immune system.

Keywords: Ants, Diseases, Epidemics, Colonies, Animals and plants, Basic research, Survival, Antibiotics, Medicine, Tree sap, Metarhizium, Pathogens.

Ant: A Superorganism

Introduction:

Epidemics rarely strike ant colonies

There seem to be no diseases capable of killing entire ant nests or ant populations, considering that ants live so close together, share the same genetic background, and are in such frequent contact with each other. So it would rather be common for diseases to spread quickly through a nest.

Together they save the infected

The researchers dripped fungal spores onto some of the ants and observed how other ants immediately set about removing the spores from the infected bodies. The Metarhizium fungus grows through the body of the ant one to two days after it is infected. But the other ants start cleaning the infected ant even before it has become ill and before the fungus has grown into the body. The invasive garden ants use their mouths to remove the fungal spores from themselves and others. This way, they minimise the spore dose of exposed individuals and prevent the fungus from spreading from one ant to the whole colony. It's this early discovery of a disease that is decisive in preventing it from spreading through the nest. Cleaning means that the ants have a greater chance of survival than if they had to fend for themselves, simply because more spores are removed from their bodies. And in small doses the fungus is not lethal.

Fungal spore grew on the ant and penetrated its body causing death

Do ants smell disease?

Substances were extracted from the bodies of the ants to examine whether there's a difference between these substances depending on whether the ants are healthy, infected, and the stage of ants disease. Although the analysis is not completed it is noteworthy that ants are already known to identify each other and to communicate using odoriferous substances i.e. ants recognise each other by their smell since it is dark inside ant nests so visual signals are of no use in interaction.

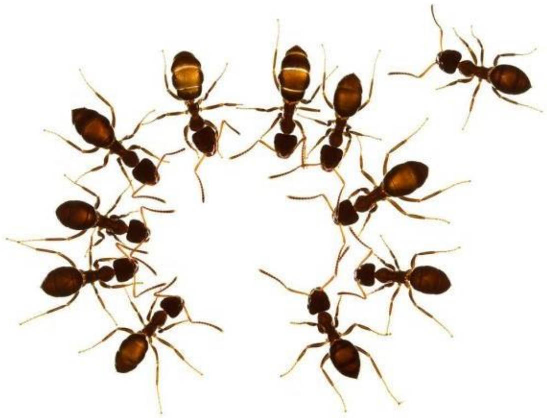
Odoriferous substances can, for instance, indicate whether an ant is a queen or a worker, and it's belonging to the nest. Every ant colony has its unique odour, so if one doesn't give off that smell it gets attacked. Even though the healthy ants expose themselves to infection when they clean their sick flatmates, the cleaning process is worth it for the nest as a whole, since from a statistical point of view cleaning only leads to a small number of deaths in the nest even though the healthy ants expose themselves to infection when they clean the sick (only two per cent of the healthy ants end up dead).

Cleaning makes uninfected ants resilient

When the healthy ants expose themselves to sick ants it minimises the risk of a disease outbreak in the colony, and also vaccinates the helping ants against future fungi attacks. When the ants help to remove the fungal spores from an exposed ant, they may get infected by a small dose of the fungus, which works like a vaccine. Even though ants do not have immune cells as we do, this ant 'vaccination' effectively follows the same principle as our vaccines i.e. it actually seems to strengthen the ants' ability to fight off disease later in life. Previous experiments show that ants that have been in contact with sick individuals become immune to the disease. The same can be observed in people who become resistant to the diseases they have previously suffered from, but it is particularly noticeable in insects because their immune systems work differently than humans.

Good hygiene keeps nests disease free

Ants are ultra-hygienic and constantly keep each other clean to keep disease at bay. At the same time, they have very specific waste-disposal protocols, in which every ant has a role. Ants have a waste disposal site outside their nest. They've organised themselves so that every ant puts leaves and compost on the paths inside the nest, and then the older ants carry the waste and deposit it outside the colony. Ants are the masters of cooperation and shared roles. Basic research into how ants produce antimicrobial substances can help scientists understand antibiotics in humans. In some areas, ants are already used in place of chemical pesticides as a natural form of pest control. In the future, ants could offer a sustainable source of food for humans.



Researchers studying the black garden ant found that the bugs stay away to protect the rest of the colony from deadly infections

Voluntary or forced redundancy

The ants' strategy when it comes to fighting disease is reminiscent of how we humans prevent outbreaks: early action is often decisive when it comes to successfully containing epidemics. If, however, the ants fail to rescue the infected by cleaning it and the fungus has already grown into the ant, then the next step is to extract the sick ants out of the nest and thus prevent the disease from spreading to the others. Apparently, only young ants have to be physically thrown out of the nest, while adult worker ants seem to accept voluntary exclusion from the colony. It's interesting to see how sick ants seem to stay away from areas of the colony where the brood is located. It's as if they instinctively know that the brood have thinner skin and thus are more susceptible to fungal disease. Infected ants go so far as to stay away from the colony as if they sense that there is no chance of survival. Ants can sense when they're about to die. So they leave their home and wait for the end.

Ants vaccinate each other against diseases and make medicine out of tree sap Forest ants use tree sap like we use antibiotics

To reduce the level of parasites in the colony, wood ants collect tree resin and incorporate it into the material for building their nest. Resin has antimicrobial properties and therefore makes it difficult for potentially parasitic microbes like bacteria and fungi to thrive. Ants drag huge quantities of this sticky material back to the colony. Some forest ant colonies have collected up to 20 kilograms of resin. Every time the ants go out to collect the resin, they're almost entirely disinfected, because it contains antimicrobial substances that fight bacteria.

Ant glands contain medicine

Ants also have another inbuilt mechanism to fight disease: a gland that produces chemicals that lay off bacterial and fungal parasites. It's an evolutionary response to protect against disease and protects ants from most infections. Some ants also have a structure on the breast that resembles two white spots, which produces antimicrobial substances. The antimicrobial substances help fungus- growing ants to keep their cultivated fungi free of diseases.

Method:

Researchers at the University of Lausanne in Switzerland used an automated ant-tracking system to study colonies of Lasius niger or black garden ants. The species is found across Europe, as well as parts of North America, South America, Australia and Asia. Their workers are split into foragers, which collect food outside of the nest, and nurses, which care for the brood inside the nest. Foragers are most likely to pick up infections, but interact less with other ants, and come into contact with those inside the nest infrequently. So the researchers infected some of the ants with Metarhizium brunneum, a highly contagious fungus that kills the bugs in less than 48 hours. The spores attach to an ant's cuticle and after a day or two, the fungus gets inside the ant and kills it. Within one day of exposure to the pathogen, before ants became sick, the separation between work groups was reinforced i.e., infected worker ants spent more time outside of the nest, and stayed away from their co-workers. The strategy halts the spread of the disease in order to protect the most vulnerable and important members of the colony from infection. Foragers not exposed to the disease took more care to isolate themselves, and nurses carried the brood deeper into the nest. Simulations show that these changes in behaviour reduce the spread of infections and protect healthy workers and the queen from disease.
Responses like this are to be expected in social insects, since only the queen reproduces, so evolution favours individual behaviour that benefits the whole colony.

Infected ants with Metarhizium brunneum.

Discussion:

Researchers suggested humans could learn a thing or two about quarantine healthcare from social insects like ants and about ways to decrease transmission of disease at the scale of the population. Clearly, detecting infections early and treating them before they can spread is as important in preventing epidemics within ant societies as it is in humans. But here the ants are acting less like humans and more like immune cells in a body. We can think of social insect colonies are being a single organism, made up of lots of individual organisms behaving and functioning as one, in the same way that our bodies consist of lots of cooperating cells. These "superorganisms", just like our bodies, need to prevent pathogens from invading and causing them illness. When a pathogen attacks one of our cells, immune cells detect the threat and respond by piercing holes in the infected cell to administer chemicals that kill it, along with the pathogen.

Result:

Destructive disinfection in ants is remarkably similar and has likely evolved for the same reason: the need to protect the whole over its parts. This means that individuals, be they insects or cells, are sacrificed when necessary to ensure that the colony or body continues to survive and reproduce. This, therefore, raises interesting questions about what common evolutionary processes were at play during the emergence of multicellular organisms and super organismal insect societies.

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