Social parasitism in insects

Ants and Their Uninvited Guests

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When one observes an ant colony, it probably seems like an efficient and harmonious community devoid of quarrels and conflicts. Nothing could be further from the truth. The world of ants, it turns out, is full of animosities. For example, there is friction between the queen and the workers over the gender of the offspring, or among workers themselves about laying unfertilized eggs. There are also other hostilities, for instance, between a colony's rightful inhabitants and any unwanted guests

An ant colony offers an excellent place of residence for many organisms, providing shelter and rich supplies of food. Hence, the queens of completely different, parasitic ant species may be tempted to exploit the labor of a colony's workers and have their larvae offspring raised by them. Such organisms hijacking the resources of social insects in this way are referred to as social parasites.

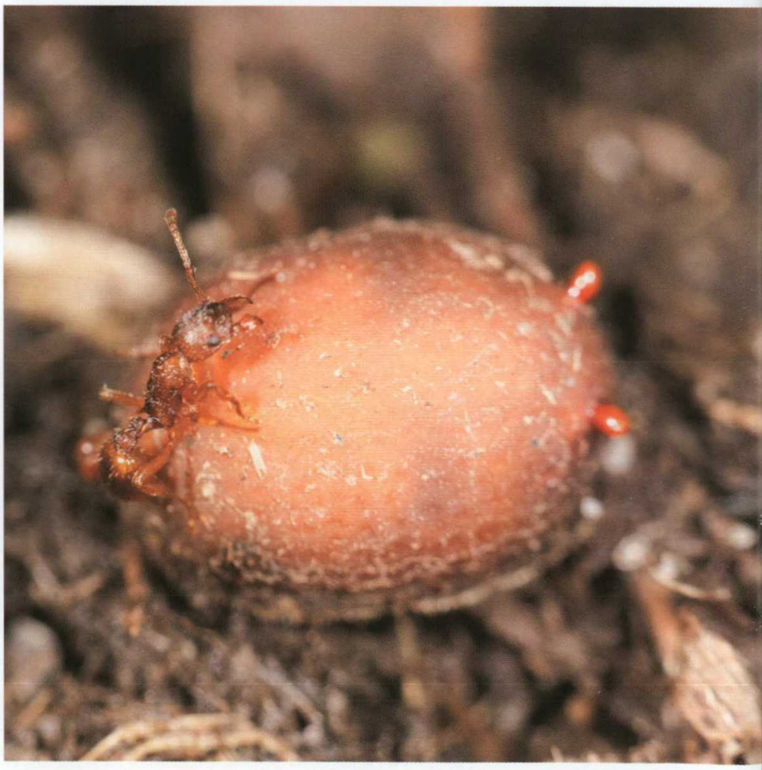
I'll outwit you!

The term "social parasitism" was initially coined to refer to cohabitation of two species of social insects within a single colony, with one of them being dependent upon the other. Recently, however, the meaning of the term has been expanded to include relations between parasitic (i.e. labor-dependent) and predatory myrmecophiles and their social insect hosts. Of course, like in case of other forms of parasitism, only one part benefits from cohabitation, whereas the other one is at a disadvantage. This gives rise to a sort of "arms race": on one side of the conflict are social parasites trying to trick their hosts into allowing them to enter their community, while on other side the hosts are doing their utmost not to let them in.

It turns out that outwitting ants isn't such a difficult task. All a predator needs to do is to break the code that ants use to distinguish members of their own colony from outsiders. To this end, social insects use a mixture of specific substances called cuticular hydrocarbons that produce a scent unique to the members of a given colony. Theoretically, the composition of such a mixture should be restricted to the given community. However, this code may be less specific - and therefore easier to break - if the insects live in more genetically diverse or polycalic colonies. Ants from such colonies are more tolerant to strangers, and they are more likely to let intruders into their home or even actively usher them in. A good example of this can be found in ants of the genus *Myrmica*.

Red ants

Myrmica ants, also referred to red ants, are average-sized insects, red in color, which can be encountered in many different habitats, including xerothermic grass-



Hoverfly pupa with a host ant


Author's files (3)

Scarce Large Blue butterfly larva with a host ant

lands, wet meadows, steppes and forests. In addition, certain species, such as the *Myrmica rubra*, display aggressive behavior and fiercely defend their colony if it is breached.

Despite their combative nature, red ants are frequently fooled by social parasites, and their colonies become a place of abode for other social parasite ant species as well as insects belonging to completely different taxa, such as beetles, butterflies and true flies.

Most social parasite ants belong to the same genus as their hosts, so in many cases we have a situation where queens of one *Myrmica* species are living at the expense of other red ant species. Such an association is very common because closely related species are similar in terms of biology and habitat requirements, and they also use similar identification codes. Certain red ant species use the resources of their hosts' colonies only temporarily and if conditions are favorable they are even able to establish their own colony. Others are completely dependent on their hosts and are incapable of surviving without them. After entering their hosts' colonies, queens of parasitic species devote their entire energy to producing potent female and male specimens that will be raised at the expense of host workers' labor. Unfortunately, we still know very little about the mechanisms which such parasitic queens employ to enter another species' colony and integrate with its community. This may be partly due to the small density of parasitic ant species and their covert way of life, which makes them very difficult to detect under natural conditions. Research on myrmecophilous butterflies and true flies is much easier, and through to their study, we already know what sorts of adaptations must be made by social parasites to deceive their hosts, and by hosts to effectively defend themselves from being tricked.

Flies and butterflies moving in

Colonies of red ants are also sometimes the home of many other species, including the larvae of *Maculinea* butterflies (Large Blues) and the hoverfly *Microdon myrmicae*. Butterflies and flies are faced with the challenge of targeting the right host, managing to get inside its colony, and dwelling there for at least one year or sometimes even two years – all without arising any suspicions on the part of the landlords.

The strategy used by hoverflies is quite simple. After copulation, females lay their eggs on the surface of selected ant colonies. So far we do not know how female hoverflies identify the right ant colonies, but we do know they are more likely to choose ones near where they themselves hatched. They also spend some time sitting on the surface of a nest before deciding to lay eggs there. After hatching, the young hoverfly larvae enter the ant nest, where they begin to feed on ant offspring, mostly eggs and small larvae. Research has shown that hoverfly larvae have scent molecules (cuticular hydrocarbons) in

Dusky Large Blue butterfly

such small quantities that they are practically unnoticeable to their hosts.

Large Blue butterflies employ a different strategy. Females lay eggs on host plants, where the larvae spend the first three weeks of their lives feeding on flower parts. Once they reach the fourth larval stage, they fall to the ground. Now the only way they can survive is to be picked up by ants and taken into an ant colony. Whether adult butterfly females are able to detect ant nests near the host plants they choose, and if so, then how, is still a hotly debated topic amongst researchers. Nevertheless, we do know for certain that this is a critical moment in their lifecycle, because if the larvae are not taken into an ant colony within 24 hours, they will not survive. In addition, during that time they are exposed to predators and other harmful elements. So in order to increase their chances of survival and induce red ants to take them in, butterfly larvae imitate the scent produced by ant larvae and trick their hosts into believing that they are ant larvae lost in the grass. Research on the chemical profiles of cuticular hydrocarbons has shown that, prior to their "adoption," *Maculinea* larvae possess a set of chemicals that is generally reminiscent of those used by all red ant species. But after adoption, when the larvae are integrating with a specific host colony, certain species of blue butterflies, for instance the Mountain Alcon Blue, can synthesize additional hydrocarbons to specially match the scent of the ants from that particular nest. The workers treat the butterfly larvae as the progeny of their own colony, they feed and clean them, and in the event of danger they transfer them to a safe location, sometimes even giving them priority over their own offspring. Furthermore, butterfly larvae can imitate the sounds produced by the ants. For example, the Mountain Alcon Blue can "sing" the "melody" used by the host queen. Thus they can achieve a high status in the colony hierarchy and solicit greater attention from workers.

On my mark: change code!

We might ask: do ants have any weapons or strategies that can help them effectively defend themselves from social parasites? Not much research has been done on that question, but it does seem that ant populations which experience large pressure from social parasites periodically change their cuticular hydrocarbon profiles. So there is a particular kind of "arms race" going on, with hosts constantly changing the access codes, forcing parasites to adapt to find the right keys. Both sides, therefore, force each other to continuously evolve. ■

Further reading:

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