ScienceWatch – The Delicate Dance of a Ménage à Trois

"These results suggest a new pathway and mechanism, whereby social and other parasites that possess sequential hosts can detect and exploit their successive resources." – D. Petriclli, *et al.*

Social parasites live off social hosts like ants and they are common. About 10,000 beetle species and up to one quarter of all butterfly species parasitize ants in some way (http://hras.org/sw/swseptoct2015.htm). Ant colonies make great hosts because they provide well-protected homes with lots of food so it's not surprising they have a plethora of parasites that gain entry either by providing "honeydew" secretions or masquerading as nest mates.

The Large Blue butterfly (*Maculinea arion*) only parasitizes red ants in the *Myrmica* genus. Myrmica species live throughout Europe and the butterfly lives off whichever ant species inhabits a given region. The butterflies only lay eggs on wild oregano plants (*Origanum vulgare*) that have a nearby ant colony. Upon hatching the young caterpillars briefly feed on the oregano flowers and then drop to the ground where they are picked up by ant workers and carried back to the colony where they spend 11 months gorging on ant grubs and gaining 98% of their weight.

The oregano provides the link between the butterflies and the ants. The ants only build nests near oregano and scientists have long suspected they do this because pungent chemicals, like carvacrol and thymol, known insecticides made by the plants, keep other ants away. The butterfly exploits this by laying her eggs on the plant. But not all plants are surrounded by ants and the ants don't forage when the butterflies deposit eggs. So how does the butterfly know where to deposit her precious few (~50) eggs?

That question and other details of this complex, tripartite relationship have been elucidated by a team of entomologists headed by Dario Petriclli and Emilio Balleto, University of Turin, Turin, Italy, and Jeremy Thomas, University of Oxford, Oxford, UK, and published in the July 7, 2015 issue of the *Proceedings of the Royal Society B*.

In 2009 members of this team showed that the caterpillars get adopted by the ants because they behave like ant grubs and smell like ants. Once in the nest they mimic the sounds made by the queen ant, allowing them to leisurely munch on ant grubs. Eventually, they destroy the colony. Now the team has shown that the butterfly tracks down its ant host by the very chemical the ants use for defense. The ants don't make the chemical. Instead, they chew on the roots of nearby oregano plants, causing them to exude lots of carvacrol, which keeps competing ants away, but it also tells the butterflies where the ants are living.

The team grew oregano in terrariums with and without ants. They found that plants damaged by the ants reacted by exuding twice as much carvacrol. However, in response to increased carvacrol levels certain ant genes became activated, producing chemicals that detoxify the carvacrol. When *Myrmica* and unrelated ants were exposed to high levels of the carcacrol the *Myrmica* ants were six times more resistant.

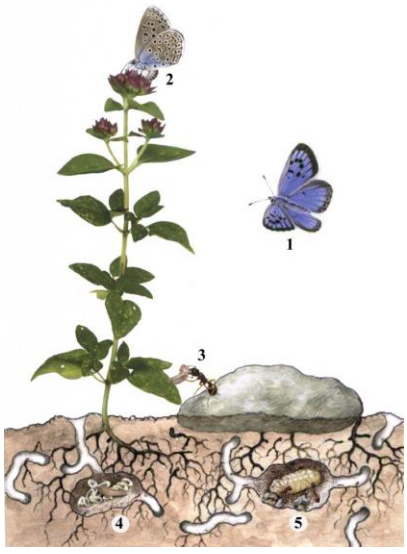
Next the researchers placed gravid female butterflies in the stem of a Y-tube and blew plain air through one arm and air infused with carvacrol through the other. The butterflies entered the carvacrol arm much more often. They also preferred oregano plants chewed by ants over intact plants. These results indicate that the butterflies were well-adapted to finding plants that signaled the presence of their ant host.

As a clincher the scientists showed that excised butterfly antennae connected to a recording electrode were excited by carvacrol air and not plain air. Moreover, the antennae responded strongly to air from oregano chewed by ants and only weakly to air from an ant colony.

"This is the first demonstration of a plant using chemical scents to attract a social parasite as part of an indirect defense strategy," said team member Francesca Barbero. Carvacrol is the keystone in this ménage à trios. It protects the oregano against insect predation, but the *Myrmica* ants co-opt it to protect themselves. The ants in turn are sabotaged by the butterflies, which use the elevated carvacrol levels to detect and destroy them. Consequently, the butterflies protect the oregano even as they feed on it.

Everyone gives a little to get a little.

Saul Scheinbach



In a battle of three armies, Large Blue butterflies (1) are lured to oregano plants where the insect flyers lay their eggs (2). After two weeks, the consequent caterpillars crawl to the bottom of the plant where they exude a scent that tricks Myrmica ants into carrying the butterfly larvae into the underground colony. The caterpillars spend the next 11 months feeding on the ant grubs (4,5) and gaining 98 percent of their body mass, before ultimately killing the colony and escaping. Photo by Patricelli D et al. Proc. R. Soc. B. 2015.