

“An evolutionary arms race”

Formicaries not only accommodate ants, but also offer enough space for invaders of different groups of animals or plants. This is particularly due to the size of the nests, the good defense offered by the ants and the rich food resources, which are provided by the ants (Fig.1). Therefore, ants are involved in many interspecific interactions (relationships between species). These interactions are very diverse: ants are involved in mutualistic relationships, predator-prey-relationships and host-parasite relationships. Also different kinds of commensalism can be found in ant colonies. Ant colonies offer a protected environment to



Fig.1: Working ants of *Leptogenys distinguenda* have captured a scorpion.
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other organism who can use it in various ways, if they are able to adapt to life in an ant colony. The colonies of the Southeast Asian army ant *Leptogenys distinguenda* consist of up to 50.000 ants, but also include various species from the orders of other insects, spiders (A), crustaceans (Crustacea), mollusks (Mollusca). It is assumed, that these species adapted to the way of life of the army ants by means of coevolutionary processes. Mostly parasitic relationships evolved, in which parasites use the food resources of the ants or even attack the

hosts. The interactions between the army ants and their numerous parasites are very complex and fascinating.

Volker Witte and his colleagues investigated the different strategies of various parasites based on chemical and behavioral adaptations. Moreover the study also investigated various defense strategies of *Leptogenys distinguenda* against parasites. It is a challenge for parasites not to be identified as invaders during their stay in the colony as well as to find the colony again after relocation or to travel with the ants during relocation. Both can turn out to be very difficult taking into consideration the mobility of the host ant, which changes its nest each 1,5 days on average and thereby covers distances from 5 to 58 meters. The scientists observed the behavior patterns of the parasites and the army ants in a specially constructed ‚laboratory nest‘. They were able to demonstrate that individual parasites live in different and changing locations within the nest. In most cases, mites were discovered among the pupae of the ants,

whereas some beetle species were often found on the larvae and only seldom on the pupae. Spiders, silverfish and snails moved freely within the nest and could be observed everywhere (Fig.2). Furthermore for some fly species and beetle species it was striking that they mainly stayed in protected places of the nest or outside the nest. The study also revealed that worker ants behave aggressively towards some of their parasites when they detect them. Some beetle species, silverfish and spiders belong to these parasites.



Fig.2: The spider *Gamasomorpha maschwitzii* amidst the ants. © Volker Witte, 2010

The parasites of *Leptogenys distinguenda* particularly differ in terms of how their behavior adapted when they travel with their host. They developed different strategies to follow their host on their migrations. Some parasite species independently follow the ants to a new nest (i.e. spiders and some beetles). They follow the pheromone marks, left by ants for the following individuals. Other parasites attach to larvae or pupae of *Leptogenys distinguenda*. They reach the new nests indirectly, because the ants carry them together with pupae to the nest. This is particularly true for mites and some beetle species which are transported to the new nests of the ants this way. In contrast to this, snails are carried directly by the ants.

A further strategy is chemical integration. Ants rely on their antennae for chemical perception, because their eyes are less well developed. They recognize colony members and offspring by the complex chemical profile of their cuticle (surface layer of the integument). The parasites take advantage of this in different ways. On the one hand, one can observe the phenomenon of chemical mimicry, i.e. the cuticles of silverfish, spiders and some beetle species resemble the chemical profile of the cuticle of the host ants. Some beetle species rub against ant cadavers so that the ants' chemical signals camouflage the beetles' signals and the beetles are perceived as ants. Thus, parasites successfully pretend to be members of the colony instead of invaders. Chemical camouflage also occurs among other parasites like, e.g. mites, flies and snails, so that they are not perceived chemically by the ants and cannot be detected as invaders at all. They are chemically invisible to the ants.

So far, the snail *Allopeas myrmekophilos* is the only mollusk species known to live in ant colonies and interact with ants. The snail represents a special case of chemical camouflage, because it pursues two strategies. The individuals of *Allopeas myrmekophilos* live amidst the nests of *Leptogenys distinguenda* and move freely among its hosts; because of the chemical

camouflage they are chemically not perceivable by the ants. Within the nest, the snail is



Fig.3: The snail *Allopeas myrmekophilos* is carried by ant-workers to the new nest.

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chemically invisible. But when the ants leave their nests for a new location, the snails are no longer overlooked by the ants; they are carried by the worker ants in the same way they carry their brood or their prey (Fig.3). This is due to a

foamy substance, which is produced by *Allopeas myrmekophilos* and which actively

misleads the ants. The ants mistake the snails for their offspring and carry them away. The secretion occurs only if the snails meet worker ants, because only these carry them to the new nest. This secretion can be interpreted as an evolutionary adaptation to the hosts' way of life. Without this adaptation the snail would not be able to live in the ant colony as a parasite, because it is much too slow to follow the ants on their migrations.

Literature and links:

Documentary film/ Production: LMU München (2009). *An evolutionary arms race*.

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Exercises

1. Watch the film “An evolutionary arms race”. Afterwards complete the following table (in catchwords)!

Parasite	Preferred location in the formicary	Strategies to stay undetected by the host ants	Strategies to follow the host ants on their migrations
Beetle			
Spider			
Snail			

2. Describe the evolutionary arms race between the different parasites and the host ant. How does the film portray the evolutionary arms race?

Proposal for solution:

1. Watch the film “An evolutionary arms race”. Afterwards complete the following table (in catchwords)!

Parasite	Preferred location in the formicary	Strategies to stay undetected by the host ants	Strategies to follow the host ants on their migrations
Beetle	<i>They stay away from the ants in the nest or outside the nest. Some live between the pupae.</i>	<i>They avoid contact or rub against dead ants, in order to take the odor of the ants.</i>	<i>They follow the pheromone marks by themselves, after the ants relocated. Species, which live between the pupae, attach to the latter and are therefore carried indirectly to new nests.</i>
Spider	<i>They move freely within the nest.</i>	<i>Their body surface is chemically similar to the cuticle and they have contact with the ants.</i>	<i>They join the ants when they migrate to the new nest.</i>
Snail	<i>They move freely within the nest.</i>	<i>They are chemically invisible for the ants because of chemical camouflage.</i>	<i>Only when the ants relocate, they produce a chemically perceivable foam, which makes them smell like the larvae. The ants carry them like larvae or pupae to the new nest.</i>

2. Describe the evolutionary arms race between the different parasites and the host ant. How does the film portray the evolutionary arms race?

In contrast to the spider and the snail the beetle is attacked by the ants because, as a predator, he exerts a higher selection pressure on the ants than spider or snail. The ants migrate after a certain period of time and build a new nest, which can be seen as a defense strategy. It is possible that these behavior patterns have developed through evolutionary arms race. The film is just a snap-shot of these evolutionary processes. However, the film presents parasite-host-interactions. Therefore one can assume coevolution as the underlying process for the development of the different behavioral patterns shown.