Acquisition of chemical recognition cues facilitates integration into ant societies

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Abstract

Background: Social insects maintain the integrity of their societies by discriminating between colony members and foreigners through cuticular hydrocarbon (CHC) signatures. Nevertheless, parasites frequently get access to social resources, for example through mimicry of host CHCs among other mechanisms. The origin of mimetic compounds, however, remains unknown in the majority of studies (biosynthesis vs. acquisition). Additionally, direct evidence is scarce that chemical mimicry is indeed beneficial to the parasites (e.g., by improving social acceptance).

Results: In the present study we demonstrated that the kleptoparasitic silverfish Malayatelura ponerophila most likely acquires CHCs directly from its host ant Leptogenys distinguenda by evaluating the transfer of a stable-isotope label from the cuticle of workers to the silverfish. In a second experiment, we prevented CHC pilfering by separating silverfish from their host for six or nine days. Chemical host resemblance as well as aggressive rejection behaviour by host ants was then quantified for unmanipulated and previously separated individuals. Separated individuals showed reduced chemical host resemblance and they received significantly more aggressive rejection behaviour than unmanipulated individuals.

Conclusion: Our study clarifies the mechanism of chemical mimicry in a social insect parasite in great detail. It shows empirically for the first time that social insect parasites are able to acquire CHCs from their host. Furthermore, it demonstrates that the accuracy of chemical mimicry can be crucial for social insect parasites by enhancing social acceptance and, thus, allowing successful exploitation. We discuss the results in the light of coevolutionary arms races between parasites and hosts.

Background

Host-parasite interactions are often regarded as coevolutionary "arms races" in which a host and a parasite species exert reciprocal selection pressures on one another over long periods of time [1]. Under coevolution, parasite species adapt towards encountering a host and exploiting it successfully, whereas host species in turn adapt towards an avoidance of parasite encounters or a successful defence against them [2]. Accordingly, hosts have evolved a great variety of defence mechanisms to prevent all sorts of exploitative attacks [3,4].

Since social insects are widespread and extraordinarily abundant [5] they are subject to exploitation. As a consequence, they have evolved sophisticated recognition systems to protect their colonies, their brood, and their resources from competitors, predators and parasites, thereby maintaining the integrity of their societies [6]. The recognition of group members in social insects is mainly based on chemical cues [7-9]. Individuals compare the chemical cues expressed by a counterpart with an internal template, which is the chemical signature expected in all members of the society [10]. Complex blends of cuticular hydrocarbons (CHCs) seem to comprise all essential information necessary for nestmate recognition in ants, wasps and termites [11]. Due to effective recognition systems, invaders are frequently recognized, attacked, expelled or even killed by social insect workers.

Nevertheless, a multitude of organisms, particularly invertebrates, are known to exploit social insect societies [12-14], for example, by preying directly on the host, by stealing their food, or merely by inhabiting a well-protected habitat with a stable microclimate [6]. Many of these organisms, commonly known as myrmecophiles, are more or less permanently associated with ant colonies [15].