Interactions Between Beetle Larvae and Their Termite Hosts
(Coleoptera; Isoptera, Nasutitermitinae)

by

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ABSTRACT

Nests of the Neotropical mound-building termite *Cornitermes cumulans* (Kollar) are frequently invaded by other species, but the mechanisms that allow such an invasion are not completely understood yet. Due to the costs involved in nest building and maintenance, one could suspect that, in the event that the builder is not able to defeat the intruder, selection would not favor strongly negative interactions between the intruder and the builder. Therefore, the purpose of this paper was to test the hypothesis that neutral or positive interactions can be found between *C. cumulans* and some of their termitophiles. To do so, we have tested whether the presence of an intruder would affect the mortality of its termite hosts, once these are confined together in a Petri dish. Larvae of Coleoptera: Melolonthidae found in such nests were taken as the model termitophiles. Fake larvae made out of plasticine were used in another treatment in order to account for disruption of termite’s social facilitated survival which could be caused by the mere physical (as opposed to biological) presence of a strange body in the Petri dish. Survival of termites confined with a larva (real or fake) did not differ from survival of termites without it. Such results seem point out that termites did not profit either directly from any exudate from the beetle larva, neither from the mere physical presence of it. Moreover, this shows also that the beetle larva did not present any negative interaction to the termites.

Keywords: *Cornitermes cumulans*, Melolonthidae, interactions, termitophiles, nest intruders.

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INTRODUCTION

An impressive range of vertebrate and invertebrate species can be associated to termites’ epigeous nests, either cohabiting with the nest builders, or living in the nest’s cavities without direct contact with the builders. Such species are normally referred to as ‘termitophiles’, and can be as diverse as microorganisms, plants, insects, amphibians, reptiles, mammals, among others (Grassé 1986). Termite species which live in other termites’ nests are normally referred to as ‘inquilines’ (Kistner 1969) to distinguish them from other termitophiles.

Unlike the ecology and behaviour of intruders of ants’ nests, which have been well studied since the beginning of last century (or before, see Thomas et al. 2005), the processes determining the interactions between termites and their cohabitants have only recently received attention. It is now known that some termitophiles seem to hold a mutualistic interaction with termites, as is the case with some beetles (Coleoptera: Staphylinidae) which possess exocrine glands whose exudates are licked by termite workers in exchange for stomodeal regurgitations to the beetles (Pasteels & Kistner 1971). Several other termitophiles do not present such an obvious positive interaction to their hosts, and it is generally agreed that a wide variety of interaction patterns can be found, from outright predators to social parasites to scavengers (Kistner 1990).

The Neotropical mound building termites *Cornitermes cumulans* (Kollar) are no exception to this: their mounds are well known to shelter an enormous diversity of intruders, either vertebrates or invertebrates (Redford 1984; Lacher Jr. et al. 1986), but so far the interactions between the builder species and its termitophiles have been inferred more than explicitly tested.

Nest construction by termites requires a great amount of time, energy and building materials, but brings the benefit of providing a safe environment to the colony that builds it. Therefore, it is plausible to suspect that, in the event that the builders are not able to defeat the intruder, selection would favour neutral or positive (rather than negative) interactions between them. The purpose of this paper is to test the hypothesis that neutral or positive interactions can be found between *C. cumulans* and some of their termitophiles.
MATERIAL AND METHODS

The experiment was performed using workers (third instar and beyond) collected from one field nest of *C. cumulans* (Isoptera, Termitidae), in Viçosa, state of Minas Gerais, in southeastern Brazil. *Cornitermes* spp. are Neotropical termite species occurring in several habitats, including forests, ‘cerrados’ (Brazilian savannas) and man-modified habitats, such as pastures or even gardens within cities, where they feed on living and dead grass and herbs (Cancello 1989). Several species of this genus (among them *C. cumulans*) build large epigeous nests which are simultaneously inhabited by inquilines, such as other termite genera, ants, beetles, birds, snakes, etc (Redford 1984). Larvae of Coleoptera: Melolonthidae found in such nests were taken as the model termitophiles.

Termites and termitophiles were collected in 23 June 2007, within a 195 ha plot of a tropical rain forest remnant of Brazilian Atlantic Forest, located at 20°48′07″ S and 42°51′31″ W. Termite identification followed the literature of Cancello (1989), being subsequently confirmed by comparison with the collection of the Termite Section of the Entomological Museum (UFVB) of the Federal University of Viçosa (http://www.insecta.ufv.br/museum) where voucher specimens were deposited. Beetle identity was kindly provided by F. Vaz-de-Melo.

The experiment aimed to inspect whether the presence of the beetle larva guests would affect the mortality of their termite hosts, once these are confined together in a Petri dish (9.8 cm diameter × 1.4 cm high), in the absence of food and water. To accomplish this, the following treatments were arranged, each of them with 20 termite workers in the Petri dish: (I) termites plus one beetle larvae; (II) termites plus a ‘fake larvae’ made out of atoxic plasticine; and (III) termites only. The ‘fake larvae’ treatment was included to allow us to discriminate between biological (the beetle larva itself) and physical (the plasticine fake larva) effects of confining termites with a strange ‘body’. That is, because termite survival depends strongly on inter-individual contacts (DeSouza et al. 2001), the mere presence of a physical obstacle in the Petri dish could increase termite mortality due to diminished social facilitation. Such mortality could be wrongly interpreted as a negative biological interac-
tion between the beetle larva and the termites if a fake larva treatment was not included in the analysis.

Every treatment was replicated four times. Petri dishes were kept in a controlled temperature chamber under controlled temperature conditions (25°C ± 0.5) in the dark, from where they were taken out for no more than 5 min, each time observations were made. Observations consisted of counting the number of dead termite workers every 12 hours, until everyone was found dead. The data was subjected to survival analysis, under Weibull distribution, in R (R Development Core Team 2006).

RESULTS

Survival of *C. cumulans* workers confined in Petri dishes was not affected by either the presence of Coleoptera: Melolonthidae larvae, nor by the plasticine fake larvae, since survival curves for these treatments did not differ from that for termites confined in the absence of larvae (Fig.1; *p* = 0.23). During the experiments, some workers were spotted presenting agonistic behavior towards beetle larvae, but this did not result in any injury to either of them.

Taken together, such results seem point out that while termites did not profit directly from any exudate from the beetle larva, neither were they affected by mere physical presence of it. Moreover, this also shows that the beetle larvae did not present any negative interaction to the termites.

DISCUSSION

The interactions between termites and their cohabitants still need deeper study. At least two general questions can be posed regarding this: (I) why do termitophiles look for termite nests? ; and (II) why do termites allow intruders in their nests?

In theory, intruders would break into termite nests in search of enemy-free space, food, or for shelter from environmental harshness, which seems to explain the immature termitophiles frequently found in nests (Redford 1984; Kistner 1969). In addition, termitophiles may be simply acting as scavengers, feeding on the garbage found in nest chambers, as suggested by Costa *et al.* (1988) for myrmecophile and termitophile Aphodiinae, Cetomiinae and Dynastinae Coleopterans. Specifically for termitophiles, Noirot (1970) states that the termites' nest walls would present a rich source of nutrients. On the
other hand, termite hosts may tolerate their guests because they can not defeat them, because the guest rewards termites, or even because such guests are simply not noted. Negative interactions of the kind ‘defeated tolerance’ have not been reported for termite-termitophiles, as far as we are aware. Rewarding in the form of exudates are already reported for Coleoptera: Staphylinidae inhabiting termite nests (Pasteels & Kistner 1971), a kind of interaction extensively reported for some myrmecophilic lepidopterans (Thomas et al. 2005). Similarly, disguising, in the form of morphological mimicry, is well

Fig.1. Proportion of a group of 20 C. cumulans workers still alive as a function of the time they have been confined in Petri dishes in the presence of one Coleoptera: Melolonthidae larva (‘Beetle’); one a plasticine fake larva (‘Plasticine’); or without any larva (‘Control’).
reported for termiteophile staphylinids (Abdelgalil & Kistner 1987, and papers therein) but not for other beetles.

Our results provide a first glance at parts of the above questions. The absence of any effects of beetle larva on the survival of termite workers reported here, combined with the observed harmless aggressivity of these workers towards such an intruder, seem to suggest that *C. cumulans* workers do not interact negatively with the beetle larva nor do they profit directly from this guest’s presence. It is therefore plausible to suspect that while these termites do not feed on nutritious exudates from the larva, neither do the larva pose a threat to the termites. That is to say, termites, albeit detecting such an intruder, do tolerate it. Our data do not answer whether aggressivity towards beetle larvae occurs naturally in reference to *C. cumulans* or whether it was observed here only as a consequence of the stress inflicted by experimental conditions. Despite that, one can state that some intruder recognition is in place, because termites attacked the larva but not their nestmates. That may indicate that no chemical disguise is involved.

In conclusion, such results support the hypothesis that *C. cumulans* and their beetle larvae guests tend to interact more in a neutral or positive manner rather than engaging in strongly negative contests.

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**REFERENCES**


