Research article

Field evidence that host selection by conopid parasitoids is related to host body size

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Key words: Conopids, Bombus, body size, parasitism.

Summary

The body size of the host insect in which a parasitoid develops can have important effects on its development and life history. Large and small host body size have both been suggested to be advantageous to parasitoids, depending on the life-history of the species concerned. We test field data on the bumblebee Bombus terrestris and its conopid parasitoids for evidence of differences in size between parasitised and unparasitised worker bees. Bees acting as hosts for conopid parasitoids are on average larger-bodied than unparasitised bees. This result holds for bees collected in two different years, and whether bees are collected while foraging or from the nest. The results we present demonstrate differential parasitism of hosts of different body sizes, but do not necessarily indicate active host choice by conopids. However, they are in agreement with independent evidence that conopids develop more successfully in large- than in small-bodied hosts.

Introduction

The size of the insect host in which an insect parasitoid develops has long been known to affect aspects of the parasitoids development and subsequent life history (reviews in Salt, 1941; Godfray, 1994). In the extreme, if the host is very small, the parasitoid may lack the resources to develop properly, and may either die or eclose deformed (Salt, 1941; Jackson, 1958; Godfray, 1994). However, even among hosts large enough to allow successful parasitoid development, preference of parasitoids for hosts of certain sizes may exist. Parasitoids developing on larger hosts tend to be larger themselves (Salt, 1941), and as a result may have higher fecundities, longevities, or mating success (reviews in King, 1987; Visser, 1994) than conspecifics developing on smaller hosts. Nevertheless, there also can be advantages to

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developing on smaller host individuals. Idiobiont parasitoids may be able to develop faster on smaller hosts, which may therefore be chosen in preference to large hosts if fast development is advantageous (Salt, 1941; Vinson and Iwantsch, 1980; Kouamé and Mackauer, 1991). Small hosts may also be preferred if large hosts are better able to defend themselves against parasitoid attack, either physically (Schmidt, 1974; Wilson et al., 1974; van Alphen and Drijver, 1982), or physiologically (Salt, 1968; Blumberg and DeBach, 1981; van Alphen and Drijver, 1982).

There are a number of problems with demonstrating specifically size-dependent parasitism by parasitoid species. Primary among them is that host size is usually closely related to the age or degree of development of the host. Thus, it is necessary to be able to distinguish differential parasitism of hosts of certain sizes from differential parasitism of hosts of certain ages. Also, laboratory studies of differential parasitism may not reflect the situation in nature. For example, it may be irrelevant to demonstrate a preference for hosts of large body size in the laboratory if, in the field, hosts are encountered too infrequently for choice to operate, or if the subset of the host population encountered by parasitoids is non-random with respect to body size. Here, we use data on parasitic conopid flies and a species of their bumblebee hosts, Bombus terrestris, to demonstrate parasitism of larger-bodied host individuals by parasitoids in a field population of the host.

**Biology of the conopid-bee system**

Bumblebees (Apidae, Hymenoptera), such as B. terrestris, are primitively eusocial insects with an annual life cycle (e.g. Alford, 1975). An already mated queen initiates a new colony in early spring by rearing a first brood of workers alone. Once the first workers emerge, the queen stays inside the nest while the workers fly out to forage for the colony. The colonies grow by producing more workers and towards the end of the summer young queens and males are reared. The sexuals mate outside the natal nest and the young mated queens enter hibernation in the soil while all other members of the colony die.

Conopid flies (Conopidae, Diptera) are abundant solitary koinobiont endoparasitoids of adult bumblebees in mid summer (Schmid-Hempel and Schmid-Hempel, 1988; Schmid-Hempel et al., 1990). Like their bumblebee hosts they show an annual life cycle. Adult flies appear from June onwards and after mating, female flies attack foraging bumblebee workers, the hosts of their larvae. One larva develops through three instars inside the host's abdomen, finally killing the bee just before pupation, ten to fourteen days after parasitism (Pouvreau, 1974; Schmid-Hempel, 1994; Schmid-Hempel and Schmid-Hempel, 1996). The pupa then overwinters in the dead body of the host. Parasitism cannot be detected in a living bee; either the bees have to be dissected, or one has to wait until they die.

Since conopids are parasites of adult bumblebees, this system thus has two features that make it suitable for testing for size-dependent parasitism. First, host size is not confounded with host age, because the size of an individual adult bumblebee is effectively constant. Second, and for the same reason, the size of the host at parasitism is equal to the size of the resource for the parasitoid larva.