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Parasitization of fifth instar tasar silkworm, *Antheraea mylitta*, by the uzi fly, *Blepharipa zebina*; a host–parasitoid interaction and its effect on host's nutritional parameters and parasitoid development

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Abstract

The uzi fly, *Blepharipa zebina*, is a well-known larval endoparasitoid of the tropical tasar silkworm, *Antheraea mylitta*. The present study dealt with the effect of the number of maggots developing per host on host nutritional parameters, parasitoid development and reproduction. Nutritional indices for ingestion, digestion, approximate digestibility, relative consumption rate, relative growth rate, and gain in body weight declined significantly with the increase in parasitoid burden, but the efficiency of conversion of digested food recorded a significant increase. The efficiency of conversion of ingested food remained little affected. The developmental period was significantly extended in larvae parasitized with 5 and 10 maggots per larva (mpl). Cocoon shell weight decreased by 27–63.5% in parasitized groups (1, 2, and 5 mpl) while larvae parasitized with 10 mpl could not spin cocoons. The maggot development period, recovery percentage, and fecundity of the uzi fly declined significantly with the increase in number of maggots developing per host.

Keywords: *Antheraea mylitta*; *Blepharipa zebina*; Host–parasitoid interaction; Nutritional parameters; Parasitoid development

1. Introduction

The tasar silkworm, *Antheraea mylitta*, is free-living and exposed to attack by various natural enemies during its larval stages. Besides the protozoan disease caused by *Nosema* sp., the insect is attacked by two insect endoparasitoids, namely *Blepharipa zebina* (a tachinid commonly called the uzi fly), and *Xanthopimpla pedator* (an ichneumonid known as the yellow fly). The insect is severely affected by the uzi fly, which alone can cause up to 40% loss in the silk crop. The biology of this fly was reported earlier. The female parasitizes the host larvae directly by ovipositing on the integument. First instars bore through the cuticle leaving a black scar. The maggot period consists of three instars and develops over 20–25 days (Singh et al., 1993); the larva emerges from the host and then from the cocoon by making a small pore at the distal end. The environment plays an important role in fluctuation of parasitoid populations and maggot development (Patil and Govindan, 1984; Singh et al., 1993).

Many hosts exhibit physiological alterations when parasitized, resulting in growth inhibition (Brooks, 1993; Nakamatsu et al., 2001; Slansky and Scriber, 1985; Strand and Wang, 1991; Thompson, 1982b; Thompson et al., 2001). For example, decrease in food ingestion, digestion, and growth was reported in the silkworm *Bombyx mori* following parasitization by the uzi fly (Nath et al., 1990; Srikanth et al., 1988). Nutrition depletion in host has been reported following parasitization (Thompson, 1982a). A significant reduction in total protein, free amino acids, carbohydrates, glycogen,

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glucose, and trehalose was reported in the fifth instar larvae of *B. mori* upon uzi parasitism (Reddy et al., 1992). Amino acid content in healthy unparasitized larvae of *A. mylitta* was significantly higher compared to those parasitized by the uzi fly (Sinha et al., 1997).

Parasitized larvae also show altered dietary nutrient intake to maintain metabolic homeostasis and make the larvae glucogenic (Thompson et al., 2001, 2002). Insects may not obtain sufficient nutrients for development following adverse physiological and ecological conditions (Raubenheimer and Simpson, 1999). *A. mylitta*, which is a generalist feeder, when treated as a specialist on *Terminalia tomentosa* leaves (the natural diet), reaches its intake target by ingesting the balanced nutrients present in leaves in an optimal amount and successfully achieves growth targets (Rath, 2000; Rath et al., 2003b). In a previous study, we have shown that uzi parasitism has a significant effect on growth, nutritional parameters, and silk production in *A. mylitta* (Rath et al., 2000), which may result from the host's inability to reach intake and growth targets. In nature, the parasitoid is known to lay up to 50 eggs on a single host of *A. mylitta*, which might have a profound effect on host physiology. The host–parasitoid interaction at different levels of parasitoid burden and its effect on nutritional parameters, growth and silk production in the host, as well as the effects on parasitoid development and fecundity are still unknown, which is the aim of the present study.

2. Materials and methods

2.1. Insect, parasitization, and bioassays

Fifth instar larvae of *A. mylitta* (Lepidoptera: Saturniidae) were selected for study because growth of the larval endoparasitoid *Blepharipa zebina* is rapid owing to higher consumption and utilization of food during this instar (Rath et al., 1999; Singh et al., 1993).

A culture of *B. zebina* Walker (Diptera: Tachinidae) was maintained in the laboratory by collecting maggots from grainage until adults were emerged. Adult flies were kept inside a nylon mosquito net enclosure ($45 \times 30 \times 30$ cm) and fed on sugar cubes and water ad libitum (Rath et al., 2000).

Antheraea mylitta larvae were reared outdoors at 26 ± 5 °C, 73 ± 7% RH, photoperiod 11 h L:13 h D on the host-plant, *T. tomentosa* until they molted to the fifth instar. Larvae were then shifted into a rearing room at 28 ± 2 °C, 75 ± 2% RH, photoperiod 11 h L:13 h D and fed on fresh and pre-weighed leaves of *T. tomentosa* (Rath et al., 2003a). Larvae were introduced into a cage on the third day of fifth instar with impregnated female uzi flies for host–parasitoid interactions. After oviposition contact by a fly, the larvae were scanned through a powerful magnifying glass (10×) to ascertain oviposition. During experimentation, four different levels of parasitization such as 1 maggot per larva (mpl), 2, 5, and 10 mpl were studied, as larvae parasitized with more than 10 maggots were rare. First instars eclosed and entered the host within 63–70 h. The percent successful parasitism ranged from 88 to 97.

Ten replications with 10 larvae each were used for all the parasitization and control groups. Rearing of the larvae (both parasitized and control) was carried out separately in indoor condition in large plastic tubs ($60 \times 45 \times 30$ cm). Host larvae were fed a sufficient quantity of *T. tomentosa* leaves twice a day. Larval populations were maintained by replacing them from buffer stocks to compensate for mortality and larvae used for dry weight determinations (Rath et al., 2003a). After completion of feeding, larvae were allowed to spin the cocoons outdoors, and thereafter respective cocoon shell weight was recorded.

The data were recorded on dry weight basis for computation. Dry weight of larvae, feces, and leaves were determined as described earlier (Rath et al., 2003a). Weight of the parasitized larvae was the sum of the weights of parasites and the host (Rath et al., 2000).

Indices of growth, food consumption, digestion, and conversion efficiencies are followed as per Waldbauer (1968): relative growth rate (RGR) $= P/TA$, relative consumption rate (RCR) $= E/TA$, approximate digestibility (AD%) $= 100(E - F)/E$, efficiency of conversion of ingested food (ECI%) $= 100\,P/E$, efficiency of conversion of digested food (ECD%) $= 100\,P/(E - F)$ [where A is mean dry weight of larva during the feeding period; E, dry weight of food eaten; F, dry weight of feces produced; P, dry weight gain of larva; and T, duration of feeding (days)].

2.2. Determination of specific gravity of hemolymph

After cessation of feeding, 10 larvae from each of the parasitized and control groups were collected and hemolymph was obtained and subjected to specific gravity determination. Hemolymph specific gravity was determined using calibrated density gradient column prepared following the procedure described by Patton (1962).

2.3. Parasitoid development and reproduction

The date of host death, maggot emergence, maggot development period, maggot recovery percentage, and date of maggot pupation, adult fly emergence, and sex of the adult fly were also recorded. Within 24 h of pupation, pupal length and width were measured with an ocular micrometer and pupal weight determined. Numbers of maggots per host and percent parasitism were also determined.