

GENERAL ARTICLE

Space, Sight and Uzi Fly Parasitism in Muga Culture: A Conceptual Overview

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Abstract

Muga sericulture, an age-old tradition in Northeast India, is a vital cultural and economic practice, with Muga silk considered the most prized of all silks. However, outdoor rearing of Muga silkworms faces significant threats from the Uzi fly (*Exorista sorbillans*), an endoparasitoid whose infestations severely reduce crop yield. The parasitism strategies of tachinid flies are strongly influenced by host dynamics, including larval movement, density, and habitat conditions, as well as visual and olfactory cues. Studies reveal that female tachinids utilize movement, shape, and color cues in host detection, with preferences for moving larvae and specific visual contrasts. Habitat fragmentation and sparse host plant distribution further exacerbate parasitism risks in Muga ecosystems. This article explores heuristic approaches linking host behavior, larval aggregation, and habitat management with tachinid parasitism. Understanding these interactions provides valuable insights for developing eco-friendly, behavior-based pest management strategies to safeguard Muga sericulture against Uzi fly infestations.

Keywords: Muga, Uzi fly, Tachinid, Parasitism, Host–parasitoid interactions

Introduction

Muga culture, a traditional practice among the rural population of Northeast India, has been deeply intertwined with the region's society and culture for centuries. Muga silk, the most valuable of all silks, is a source of pride for the Indian state of Assam. However, the outdoor rearing of Muga silkworms makes them vulnerable to natural fluctuations, which can negatively affect crop yields. Among the major threats to Muga silkworms is the endoparasitoid, Uzi fly (*Exorista sorbillans*

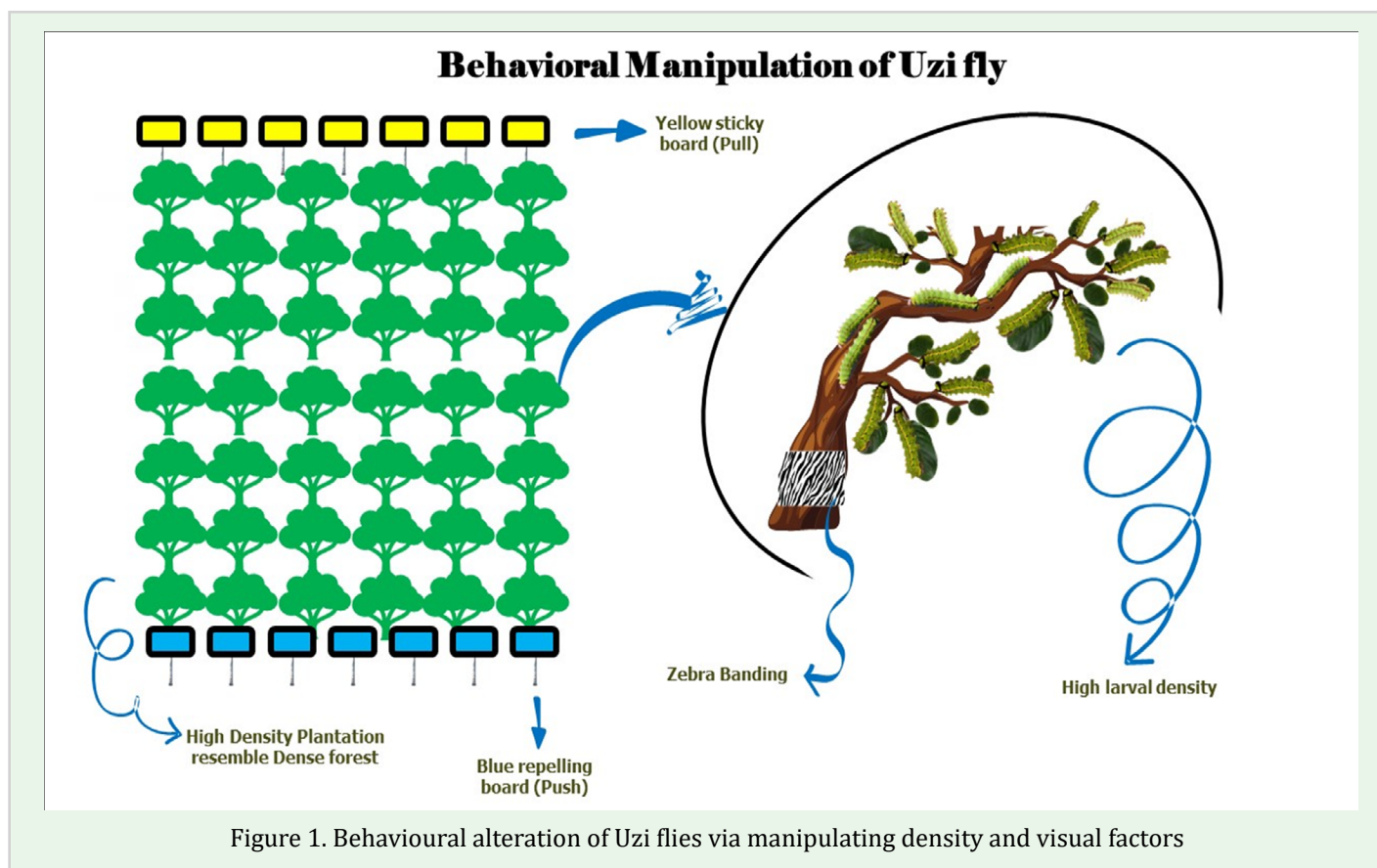
(Louis) (Diptera: Tachinidae). The infestations caused by Uzi fly typically begin in April and persist until October, primarily affecting 3rd, 4th and 5th instar Muga larvae. Tachinid flies exhibit intricate behaviors influenced by host movement and visual cues, which are crucial for their parasitism strategies. Several studies have shown that host location behaviour by female tachinids can be elicited by tactile-chemosensory cues associated with the host, and by the host's food plants (Stireman *et al.*, 2006). Females use chemosensors present on their front tarsi, which may function

similarly to the chemosensors on the long antennae of many hymenopteran parasitoids. In addition to tactile-chemosensory cues, visual cues are also important in the final stages of the tachinid host location process, especially for species that use the direct strategy. In this article, a few heuristic approaches are presented to better understand the influence of host dynamics and visual signals on the parasitism rates of Tachinids, particularly the Uzi fly.

Host movement and parasitism

Tachinid flies, such as *Exorista japonica* (Tachinidae: Diptera), utilize a range of visual cues to locate their hosts. When encountering a host, *E. japonica* females display a sequence of behaviors: they initially exhibit 'fixation' by turning towards the host, then proceed to 'approach' by moving within 1 cm, and finally, they 'pursue' the crawling larva (Yamawaki *et al.*, 2002). The flies' 'examination' behavior involves facing and touching the host with

their front tarsi (Nakamura, 1997). However, the pursuit of the host is primarily controlled by visual stimuli at close range (Yamawaki *et al.*, 2002). The stimuli may include movement, shape or colour of the object *per se* the host larva. In support, in one of the studies, females responded to moving artificial stimuli, such as a black rubber tube, suggesting that larval movement is a key attractant (Yamawaki and Kainoh, 2005). This preference for moving targets is not unique to *E. japonica*; for instance, *Drino inconspicua* females walk directly towards moving objects over distances of 9–10 cm (Dippel and Hilker, 1998). Similarly, *Compsilura concinnata* (Weseloh, 1980) and *Exorista mella* (Stireman, 2002) exhibit a behavioral preference for moving objects over stationary ones. Interestingly, *Drino bohémica* shows a preference for moving feathers in a Y-tube olfactometer, even when odors from larvae are present (Monteith, 1956). Field observations also reveal that *Bessa parallela*



prefers to lay eggs on actively moving larvae of the Euonymus leaf notcher, *Pryeria sinica* (Ichiki *et al.*, 2006). In the Muga ecosystem, the movement of larvae significantly increases during the later instar stages, which may lead to a higher likelihood of infestation by Uzi flies. However, this needs to be confirmed by conducting behavioural assay and field studies.

Parasitism in dense larval aggregations

The tachinids also show sophisticated temporal host preference based on the larval aggregation. In one of the investigations, flies were more likely to parasitize in areas with higher larval densities of western tussock moth, although the rate of parasitism per individual fly decreased with increasing larval numbers (Umbanhowar *et al.*, 2003). Flies tended to gather in dense patches, which helped maintain high levels of parasitism. However, it was unclear whether this clustering happened because more flies were arriving in those areas or because they were staying there longer. However, Roland and Taylor (1997) also revealed that parasitism by larger parasitoid flies was positively related to caterpillar density but exhibited negative delayed density dependence. This means that while parasitism increased with caterpillar numbers, the rates eventually declined as densities continued to rise. In the Muga ecosystem, the larval density during the later instar stages will be sparse as the larvae disperse across the trees in search of food. This dispersion may increase the likelihood of Uzi flies being attracted to them. Thus, increasing the larval density per tree and frequently transferring larvae from consumed foliage to fresh foliage may help reduce the risk of Uzi fly attacks (Fig. 1).

Impact of habitat fragmentation on parasitism

Nowadays, urbanization is advancing rapidly, which is having a devastating impact on biodiversity. This trend is also leading to significant forest fragmentation. As urban areas expand, natural habitats are increasingly divided into smaller, isolated patches. Roland and Taylor (1997) investigated the effects of forest fragmentation on parasitism rates of the forest tent caterpillar, *Malacosoma disstria* in central Canada. Their study highlighted that forest fragmentation significantly affected parasitism rates. Larger tachinid parasitoid species (*Patelloa pachypyga* and *Leschenaultia exul*) which lay eggs on leaves that are subsequently ingested by the larvae were more impacted by fragmentation across broader spatial scales, while smaller tachinid species (*Carcelia malacosomae*) which attack host larva directly performed better in fragmented patches. This suggests that habitat fragmentation can differentially affect parasitoid species, with larger species potentially struggling due to greater distances between habitat patches. In North-East India, where Muga sericulture is practiced extensively, Som and Soalu plantations are distributed sparsely. This sparse distribution can resemble forest fragmentation, which may contribute to an increased prevalence of parasitism by Uzi flies. The fragmented landscape disrupts the natural habitat and can make it easier for Uzi flies to locate and infest the larvae. To address this issue, it is important to explore strategies for more efficient plantation management such as high-density planting of Som and Soalu tree or others, and habitat conservation to reduce the impact of parasitism and ensure the sustainability of Muga sericulture (Fig. 1).

Visual cues for host location

In addition to olfactory cues, tachinid females also use various visual cues, such as the shape and color of the larvae or their associated habitat, to locate host-infested plants. These visual indicators help them identify suitable sites for oviposition. Ichiki *et al.* (2011) found that *E. japonica* females showed a significantly higher landing rate on green paper plant models (84.6%) compared to yellow (53.8%), blue (38.5%), or red (30.8%) models when host-infested plant odors were present. This preference indicates that visual cues such as plant color play a significant role in host detection. Furthermore, there is an intriguing evolutionary aspect related to the repellence of dipteran flies. The alternating white and black bands observed in some animals, such as zebras, appear to deter the landing of dipteran flies, including tabanids (Caro *et al.*, 2019; Chandrakumara *et al.*, 2022). This effect is thought to be related to the polarization of light caused by the varying colors and the width of the bands. The hypothesis is that the contrasting bands disrupt the visual patterns that flies use to locate hosts. Incorporating such alternating banding patterns might also help deter Uzi flies from infesting Muga silkworms. However, studies are necessary to explore and confirm the effectiveness of this approach in practical pest management (Fig. 1).

Conclusion

Tachinid flies demonstrate complex behaviors influenced by visual and movement cues in their parasitism strategies. Considering these behaviors, alongside the impacts of environmental factors like habitat fragmentation, provides valuable insights into their ecological roles and informs pest management practices. Understanding these cues can enhance our ability to manage and mitigate

infestations by improving monitoring and control strategies for pests, especially when the host is reared outdoors. All of the alternative strategies mentioned could potentially be effective in the Muga culture to mitigate the nuisance of the Uzi fly (Fig. 1). However, extensive studies are needed to confirm their efficacy and ensure their practical application in managing the pest. Further research will help determine which approaches are most successful and how they can be best implemented. Effective integration of both olfactory and visual cues into pest management practices could lead to more targeted and efficient control measures. Future research should also continue to explore these dynamics to further refine our understanding of parasitoid-host interactions.

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