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MANAGING PREDATORY WASPS IN TASAR SERICULTURE: STRATEGIES AND CHALLENGES

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ABSTRACT

Tasar silkworm *Antheraea mylitta* (D.) wild sericigenous insect which produces tropical tasar silk. It reared outside in wild conditions which attracts lots of pests and predators and among them, predatory wasps have become more significant over the past 3-4 years and have been observed in major tasar growing areas like Bankura and Patel Nagar (Suri) in West Bengal, Kathikund, Dumka, and Kharsawan in Jharkhand, as well as Baripada region in Odisha. The major predatory wasps of tasar silkworm are *Polistes olivaceus, P. stigma,* and *P. strigosus*. They are among the commonly observed species in the tasar ecosystem, and they pose a substantial threat to the well-being of the tasar silkworm if left uncontrolled. The Polistes wasps are social insects that reside in colonies comprising drones, workers, and egg-laying queens. They construct paper nests using wood fibers or coarse, papery materials and communicate through the use of pheromones. Polistes wasps exhibit remarkable efficiency and intelligence as versatile predators, covering long distances to find prey and employing a combination of hovering and walking on plants to locate their quarry. They are attracted to plants emitting frass odours and those that have been subjected to herbivore-induced damage. The article provides an overview of the management and challenges associated with controlling predatory wasps in tasar sericulture and it is concluded by emphasizing the need for further research to develop effective management strategies for controlling predatory wasps in tasar sericulture.

***Keywords*:** Tasar silkworm, Predatory wasps, Behaviour and Hibernation

Introduction

The tropical tasar silkworm, *Antheraea mylitta* (D.), belonging to the Lepidoptera family Saturniidae, is an indigenous sericigenous insect found exclusively within the borders of India. This species thrives in the tropical forests of regions such as the Chhota Nagpur Plateau, as well as Central, South, and Eastern India, as documented by Arora and Gupta (1979), Jolly (1974), and Chakraborty *et al*. (2015). The practice of tasar sericulture serves as a vital livelihood for numerous tribal communities and forest residents across India. As an integral part of this practice, these communities engage in the outdoor rearing of *A. mylitta* due to its substantial commercial value.

However, the open-air rearing of silkworms exposes them to various insect pests, notably parasitoids and predators. Among these natural enemies, *Blepharipa zebina* (Tachinidae: Diptera) and *Xanthopimpla pedator* (Hymenoptera: Ichneumonidae) are parasitoids, while *Eocanthecona furcellata* (Pentatomidae: Hemiptera), *Sycanus collaris* (Reduviidae: Hemiptera), *Hierodula bipapilla* (Serville) (Mantidae: Dictyoptera), *Polistes olivaceus* (Vespidae: Hymenoptera), and *Vespa orientalis* (Linnaeus) (Vespidae: Hymenoptera) act as predators. These various pests can cause significant harm to the silkworms and substantially decrease the yield of cocoons (Singh and Thangavelu 1991; Shiva Kumar and Shamitha 2013; Gathalkar and Barsagade 2016).

Predatory wasps were historically considered as minor pests within the context of this tasar sericulture. However, in recent years, there has been a notable increase in crop loss attributed to predatory wasps. Over the past 3-4 years, the impact of these wasps on tasar sericulture has become much more significant. The objective of this article is to give a brief overview of the management and the challenges associated with controlling predatory wasps in tasar sericulture.

Predatory Wasps in Tasar Sericulture

Different predatory wasp species exhibit a propensity to prey upon the tasar silkworm. Notably, *Polistes olivaceus*, *P. stigma*, and *P. strigosus* are among the frequently observed species (Fig.1). These wasp species exhibit a predilection for consuming the larvae of the tasar silkworm, thereby posing a substantial threat to their well-being if left uncontrolled. In some tasar-producing regions like Bankura and Patel Nagar (Suri) in West Bengal, Kathikund, Dumka, and Kharsawan in Jharkhand, as well as Baripada region

in Odisha, have noticed an increase in damage caused by the Polistes species.

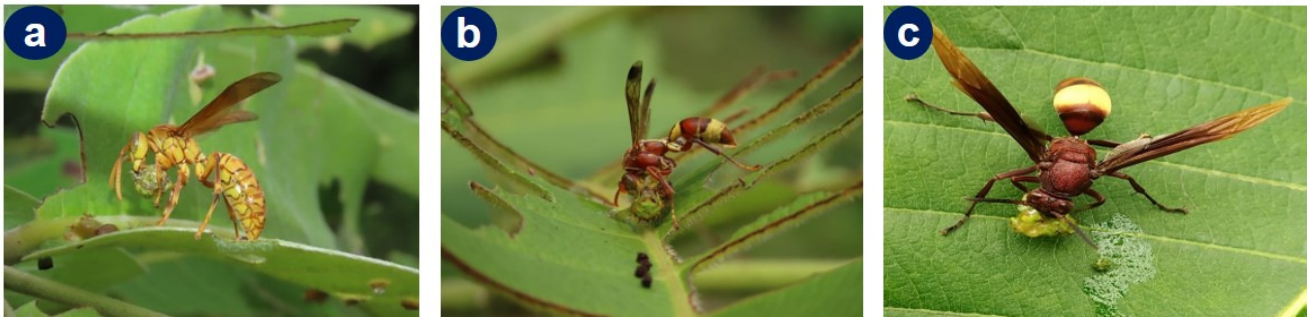

Fig. 1: Commonly observed wasp species in tasar ecosystem a) *Polistes olivaceus.* b) *P. stigma tamulus P. stigma* and c) *Polistes strigosus atratus*

Behaviour and nesting habits of Polistes wasps

Polistes wasps exhibit a remarkable level of social organization and behaviour, residing within colonies that comprise drones (males), workers (females not yet sexually mature), and egg-laying queens (one or more per colony). In temperate regions, these colonies persist for only one season, with workers and drones perishing in the autumn. Throughout the winter, mated queens undergo hibernation, while in the spring, they lay eggs to establish fresh colonies. In tropical climates, colonies persist indefinitely and undergo division when their size becomes unmanageable. Easily identifiable by their distinctive paper nests, Polistes wasps construct these structures using wood fibers or coarse, papery materials (Theraulaz and Bonabeau 1995; Perveen and Shah 2013). These nests are often found on trees, walls, and buildings (Fig. 2).

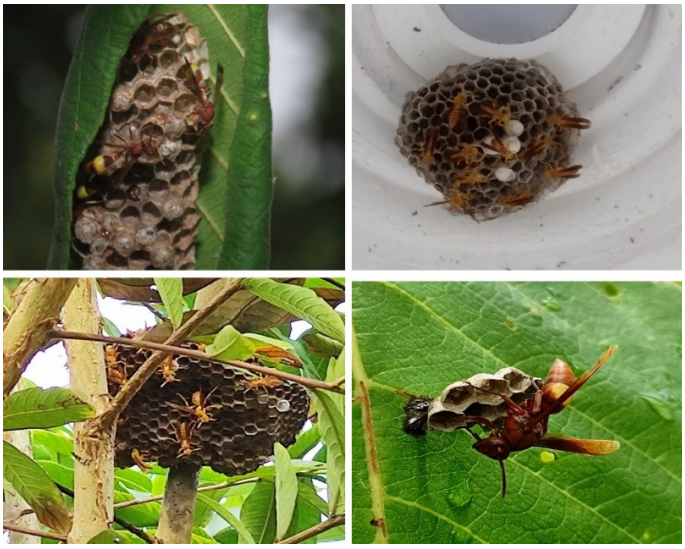

Fig. 2: Predatory wasp nests observed on tasar food plants and nearby buildings

A noteworthy aspect of Polistes wasp's behaviour involves communication through the use of pheromones. Effective communication is essential for social wasps to plan and coordinate with their members in various activities inside the colony. In this sense, social wasps communicate primarily through chemical channels, using pheromones for intraspecific communication and allomones for interspecific communication. Notably, these substances can be employed to signal the presence of food or to call for assistance from nestmates in caring for their offspring (Claudia *et al*., 2010).

Host location and Feeding Behaviour

Paper wasps exhibit remarkable efficiency and intelligence as versatile predators. They possess the ability to cover long distances for the finding of prey. These wasps employ a combination of hovering and walking on plants as they vigorously search the vegetation for their prey (Richter and Jeanne 1991; Nannoni *et al.,* 2001). Moreover, they are drawn to plants emitting frass odours and those that have been subjected to herbivore-induced damage, indicating a keen sense of attraction towards potential food sources (Cornelius, 1993). The searching behaviour of wasps is impacted by the structure of the larval host plant (Geitzenauer and Bernays, 1996). Nonetheless, paper wasps possess a considerable size, which typically prevents them from being discouraged by plant structures (such as leaves covered in wax or having fine hairs) that could hinder the movement of tinier insect predators (Eigenbrode *et al.,* 2000). Polistes wasps engage in predation by first locating their prey, subsequently initiating attacks through repeated biting (without resorting to stinging), then manipulating the prey into a more manageable size. Finally, they transport fragments of the prey back to their nest (Rabb and Lawson, 1957; Richter and Jeanne, 1991, personal observation). After securing a successful prey capture, wasps initiate orientation flights as they depart from the capture site (Richter, 2000). Once they have delivered the prey to the nest and completed this task, the forager promptly heads back to the initial location. This return might involve revisiting the spot where portions of the prey were potentially left or even relocating to an alternative site where fruitful hunting took place. Wasps exhibit a repetitive pattern of revisiting sites where they have successfully hunted, even when these locations are situated tens to hundreds of meters away from their nests (Rabb and Lawson, 1957; personal observation). While these wasps do not engage in recruiting nestmates for hunting, their strong visual acuity and vigilance lead them to be attentive to the actions of their fellow wasps. They are particularly drawn to instances where other individuals are inspecting or processing prey (Richter, 1990; Richter and Tisch, 1999). Predatory wasps exert a major selective force on lepidopteran larvae (Montllor and Bernays, 1993; Richter, 2000). The social paper wasps (Vespidae: Polistes spp.) concentrate on lepidopteran larvae, which they capture to feed to their developing carnivorous larvae. The wasps display a generalist predation strategy, targeting whatever larval prey is both abundant and suitable in taste. Since the adult wasps rely exclusively on nectar as their food source, their hunting patterns for prey are influenced by the nutritional needs of their larvae (Richter, 2000). The decision to accept or reject prey depends on the taste appeal of plant chemical defences stored within the larva's tissues or found in its digestive system (Stamp and Bowers, 1991; Stamp, 1992). The wasp larvae require uninterrupted feeding over a span of several weeks before they undergo pupation. Once the initial generation of adult female offspring emerges, each nest supports numerous foragers engaged in a constant quest for prey to meet the needs of their developing larval siblings.

Seasonal activity

In the tasar ecosystem, the activity of predatory wasps is generally observed between June to August months. During these months generally, seed crops (I^{st} TV and I^{st} BV) will be taken up and these crops generally get affected by the wasp damage, whereas commercial crops are not affected much by wasps. Among the three species of predatory wasps, *P. olivaceus* is the most damaging species whose annual cycle can be divided into five stages as follows: post-hibernant stage, solitary stage, emergent stage, pre-hibernant stage, and hibernant stage as reported by Pham *et al.,* 2015.

Post-Hibernation Stage (7 days):

- This phase begins when the wasps leave their winter hibernation site (hibernaculum) and it lasts for a week (7 days).
- Temperature has a greater influence on the emergence of the queens than does the time the queen may appear in the month of late March, early April, or mid-April.

Solitary Stage (50 days):

- This stage starts from constructing the nest and ends after the first worker appears and this phase accounts for 50 days.

Emergent Stage (170 days):

- This phase begins after the first worker emerges and continues until the emergence of the last worker and lasts approximately 170 days.

Pre-Hibernation Stage (50 days):

- This stage starts from the emergence of the last worker and goes on until the wasps are ready to hibernate. Generally, it takes about 50 days.

Hibernation Stage (80 days):

- Begins with the wasp's entering hibernation and lasts for roughly 80 days. Notably, in the context of tasar sericulture, it has been observed that wasp incidence declines drastically from September onwards (Pham 2014; Sen *et al.* 2022).

Management of Predatory wasps

Tasar Chawki Silkworm Rearing Under Nylon Net: This is one of the technologies recommended by CTRTI, Ranchi to protect the silkworm from various predatory insects (Fig. 3). Generally, it has been observed that maximum damage to silkworms due to wasps predation takes place during 2nd and 3rd instar stage. Hence rearing of silkworms till 3rd instar under a nylon net with a mesh size of 2 mm provides the protection against wasp's predation and minimises the loss by up to 30%.

Fig. 3: Chawki rearing of tasar silkworms under nylon net

Locating and destruction of nests: Locating and destruction of nests in the rearing field is also a crucial measure to minimise the loss (Fig. 4). Since wasps damage the silkworms to feed their grubs. Destroying nests with larvae prevents adults from producing offspring hence it helps to minimise the loss.

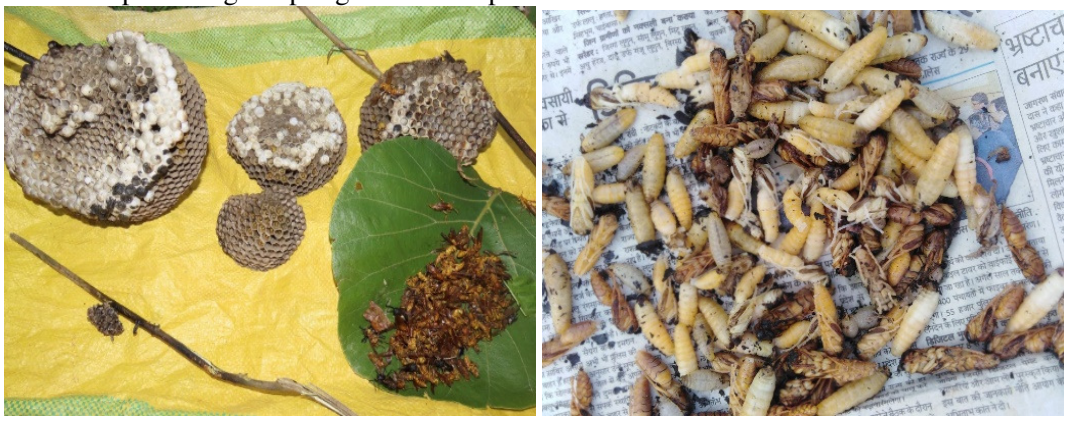

Fig. 4: Destruction of nests and grubs of predatory wasps in tasar rearing fields

Trapping of adults with Gum stick: It is one of the indigenous technologies followed by tasar farmers to protect the silkworm from various predators. With the help of sticky stick farmers trap the adults flying in the silkworm rearing sites. This will be handier during late-age silkworm rearing where rearing under a nylon net is not feasible due to the frequent transfer of silkworms from one plant to another.

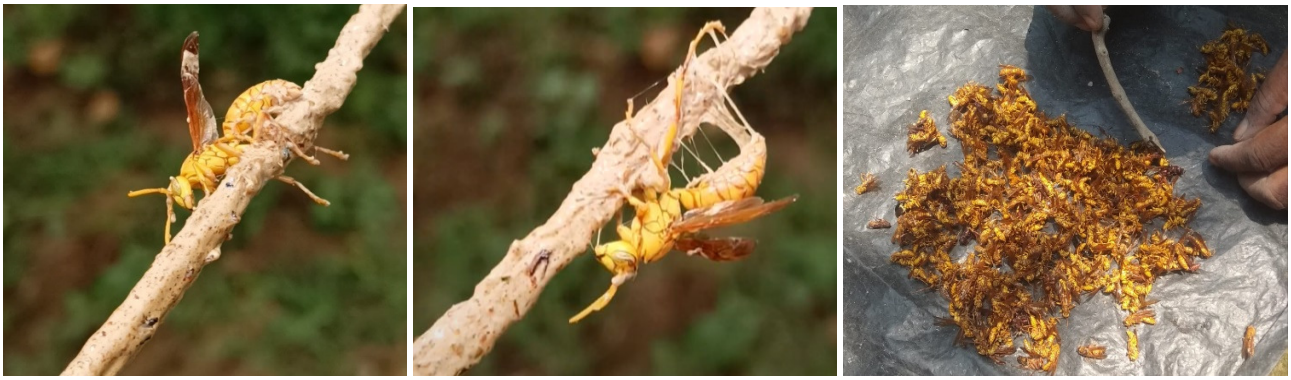

Fig. 5: Trapping of adults with a gummy stick

Exploration of baits and attractants: Many reports suggest that polistine wasps are attracted to various sweet materials and protein baits (Dvorak and Landolt, 2006; & Pereira *et al.,* 2013). Which can be explored as bait with poisonous chemicals to attract and kill the predatory wasps in the tasar ecosystem.

Constraints in management

The management of predatory wasps in tasar sericulture presents several challenges and constraints. Some of these constraints include:

1. **Mass rearing of silkworms:** Generally, tasar sericulture includes rearing of silkworms in mass under outdoor conditions. Due to the abundant protein supply, wasps are drawn to the silkworm larvae as a food source. Consequently, extensive rearing of silkworms alters the scent of the attractant used in the field, rendering the effectiveness of the previously mentioned attractant ineffective in luring wasps in the silkworm-rearing fields.
2. **Forest based rearing:** In the traditional practice of Tasar sericulture within forest plantations, the natural growth of trees is typically allowed to proceed without much intervention. As a result, there is limited control over factors such as the heights of the trees and the density of the plantation. This lack of control can complicate the implementation of certain management practices aimed at optimizing silk production. For instance, it becomes difficult to use the nylon nets to protect the silkworms.
3. **Monitoring Challenges**: Regular monitoring of predatory wasp populations is necessary to assess the effectiveness of management techniques. However, accurately assessing their populations in outdoor settings prior to brushing of worms can be challenging. Considering the fact that predatory wasps, that prey on the tasar silkworm, can fly for kilometres from their nests, locating their nests becomes challenging.
4. **Environmental Impact**: Wasps predating on tasar silkworms are general predators and most of them are considered as beneficial for agriculture and forest ecosystems. Hence extensive management of wasps could disrupt the ecosystem balance and may lead to the outbreak of pests of agricultural crops and forest plants.
5. **Integrated Approach**: Developing integrated pest management (IPM) strategies that combine various methods, such as cultural, biological, and chemical control, can be complex due to the need for coordination and cooperation among different stakeholders as they are beneficial for other ecosystems.

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