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Natural enemy fauna of mulberry leaf roller, *Diaphania pulverulentalis* (Hampson) in Tumkur district of Karnataka

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Abstract
Mulberry being an evergreen perennial plant with luxuriant foliage, afford an unlimited source of food and shelter for a variety of insects causing serious economic loss and severely hampering the sericulture industry**.** The leaf roller, *Diaphania pulverulentalis* (Hampson) is one of the key pests of mulberry. The present study was aimed at identifying the natural enemy complex of leaf roller in the mulberry ecosystem of Tumkur district. The results revealed that, a total of 9 species of parasitoids and predatory insects belonging to 3 orders and 7 families were found to attack three different stages (egg, larva and pupa) of leaf roller. The incidence of parasitoids and predators was ranged between 12.09 - 22.15% and 6.08 - 12.89%, respectively. Among parasitoids highest incidence was noticed among *Apanteles sp.* followed by *T. chilonis* and *Xanthopimpla sp.* The predator, *E. furcellata* showed highest incidence of 12.89 per cent followed by *M. sexmaculatus* (11.05%). Therefore, the study highlights the role of natural enemies in regulating leaf roller pest in the mulberry ecosystem.

Keywords: Mulberry, leaf roller and natural enemy

Introduction
Mulberry (*Morus* sp.) is a perennial, deep rooted, high bio-mass producing and protein rich foliage plant; the sole food plant of mulberry silkworm (*Bombyx mori* L.). It also forms an unlimited source of food and shelter for a variety of pests, which cause considerable damage to foliage in varying intensities. Although more than 300 species of pests (insect & non-insect) have been reported to infest mulberry, a few soft bodied insects such as pink mealybug, papaya mealybug, thrips, whitefly etc. and defoliators such as leaf roller & Bihar hairy caterpillar are considered as major pests causing significant qualitative and quantitative damage. Among the various pests, the leaf roller, *Diaphania pulverulentalis* (Hampson) (Lepidoptera: Pyralidae) causes damage to the mulberry plant by infesting the apical portion and it occupies the key position in reducing the mulberry leaf yield and quality (Pachiappan *et al.*, 2018) [3]. Leaf roller is one of the key pests of mulberry in southern sericulture states *viz.*, Karnataka, Tamil Nadu and Andhra Pradesh causes a leaf yield of 12.80% with an average incidence of 21.77 per cent (Sharma *et al.*, 2024) [5].

The negative impact of pesticides on human health and the environment is leading to renewed interest in developing biological pest control methods as alternative for sustainable crop yields. Further, there is little scope for using chemicals towards crop protection in sericulture, owing to harmful effects of pesticides on silkworms. In nature balance is maintained by certain biotic and abiotic factors and population dynamics of an organism is regulated by their natural enemies. Natural enemies play a very significant role in regulating populations of all pest classes (Singh *et al.*, 2002) [6]. Thirty seven parasitoids and six predators are known to naturally regulate the leaf roller at its different life stages and ten entomo pathogenic fungi were found to be minimize the incidence of leaf roller (Srinivasa Gowda *et al.*, 2001) [7]. Keeping this in view, present study was undertaken to explore the biodiversity of natural enemies of *D. pulverulentalis* in mulberry ecosystem of Tumkur district and their possibility of exploiting for the management of pest.

Materials and Methods

The present study was undertaken in the Tumkur district at the fields of Adopted Seed Rearers (ASR'S) of CSB-SSPC, NSSO, Bengaluru for two consecutive years from 2023-2024. Tumkur (located at 13.34°N 77.1°E) is a city located in the southern state of Karnataka, India and is a major hub for mulberry sericulture. It is situated at an altitude of around 800 meters above sea level and is located about 70 kilometres northwest of the state capital, Bengaluru. The variety of mulberry plant that was used during the research period is Victory-1 (V-1). The cultural operations and chemical fertilizer application were followed as per the recommended norms. The incidence of the leaf roller, *D. pulverulentalis* and its natural enemy complex (predators and parasitoids) was monitored at fortnightly intervals.

To record the incidence of the pest, 100 plants were monitored randomly. The incidence of predators was recorded based on the populations of both the adults and immature stages found on the 100 leaf roller infested apical shoots. Similarly, the incidence of parasitoids was noted based on the emergence of their adults from the parasitized larvae of the pest.

Results and Discussion

The incidence of natural enemies complex of *D. pulverulentalis* was studied in the fields of Adopted Seed Rearers (ASR'S) of CSB-SSPC, NSSO, Bengaluru at Tumkur during 2023 -2024 cropping seasons. The natural enemies associated with the leaf roller in mulberry ecosystem were shown in Table 1. Nine species of natural enemies were found *viz., Trichogramma chilonis* (Hymenoptera: Trichogrammatidae), *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae), *Apanteles sp.* (Hymenoptera: Braconidae), *Bracon hebetor* (Say) (Hymenoptera: Braconidae), *Xanthopimpla* sp. (Hymenoptera: Ichneumonidae), *Campoletis sp.* (Hymenoptera: Ichneumonidae), *Eucanthecona furcellata* Wolff (Heteroptera: Pentatomidae), *Solenopsis* sp. (Hymenoptera: Formicidae) and *Tetrastichus howardii* Olliff (Hymenoptera: Eulophidae). In all, 6 parasitiods and 3 predators were observed as natural enemies of *D. pulverulentalis*.

The incidence of parasitoids and predators was ranged between 12.09 - 22.15% and 6.08 - 12.89%, respectively. Among parasitoids highest incidence was noticed among *Apanteles sp.* (Fig. 1) followed by *T.* chilonis, *Bracon hebetor* (Fig. 2) and *Xanthopimpla sp* (Fig. 3). The predator, *E. furcellata* showed highest incidence of 12.89 per cent followed by *M. sexmaculatus* (11.05%). The results are in close proximity with the findings of Samuthiravelu *et al.*, (2010) [4] who observed an increase in natural enemies, particularly the ladybird predator *Cheilomeness exmaculata*, and the braconid parasitoids *Bracon hebetor* and *Apanteles taragamae*, in response to pest infestations, especially the leaf webber in mulberry. *Apanteles* sp. has been recorded as apredominant parasitoid on the leaf roller and leaf webber in Karnataka and Kashmir, respectively (Nighat *et al.*, 2002) [2]. Manjula *et al.*, 2023 reported that hymenopteran parasitoids such as *Apanteles obliquae*, *Chelonus carbonator*, Ichneumonid wasp, and the coccinellid predator *Cheilomeness exmaculata* were identified as potentially active natural enemies against mulberry leaf roller.

Table 1: Natural enemies of *Diaphania pulverulentalis* (Hampson) in mulberry ecosystem

Host Stage	Natural Enemy	Family	Order	% incidence*
Egg	**I. Parasitoid**			
	Trichogramma chilonis	Trichogrammatidae	Hymenoptera	20.11 ± 5.19
	II. Predator			
	Menochilus sexmaculatus	Coccinellidae	Coleoptera	11.05 ± 6.25
Larva	**I. Parasitoid**			
	Apanteles sp.	Braconidae	Hymenoptera	22.15 ± 12.30
	Bracon hebetor	Braconidae	Hymenoptera	17.17 ± 9.13
	Xanthopimpla sp.	Ichneumonidae	Hymenoptera	16.32 ± 7.36
	Campoletis sp.	Ichneumonidae	Hymenoptera	12.09 ± 7.27
	II. Predator			
	Eucanthecona furcellata	Pentatomidae	Heteroptera	12.89 ± 7.28
	Solenopsis sp.	Formicidae	Hymenoptera	6.08 ± 2.24
Pupa	**I. Parasitoid**			
	Tetrastichus howardii	Eulophidae	Hymenoptera	21.81 ± 7.36

* Mean ± SD values

Fig 1: *Apanteles sp.*

Fig 2: Pupae of *Bracon hebetor.*

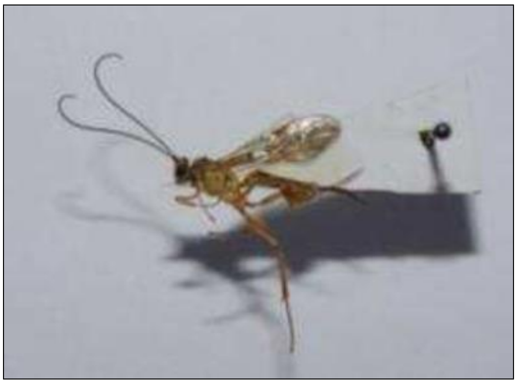

Fig 3: *Xanthopimpla* sp.

Conclusion

Chemical control pose serious unwanted problems like air, soil & water pollution, health hazards, killing of beneficial insects, secondary pest out-break, pest resurgence, pest-resistance etc. Therefore, biological control serves as a potential weapon in avoiding these problems. In the present study, a total of 9 species of parasitoids and predatory insects belonging to 3 orders and 7 families were found to attack three different stages (egg, larva and pupa) of leaf roller, which can be exploited as a bio-control agent of the pest in the mulberry ecosystem.

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