

Evaluation of the Gregarious Pupal Parasitoid *Nesolynx thymus* (Hymenoptera: Eulophidae) for Biological Control of Uzi Fly

ABSTRACT

The present study investigated the potential of the gregarious pupal parasitoid, *Nesolynx thymus* (Eulophidae), as a biological control agent against the Uzi fly. The study was conducted during October 2021 to May 2022 in the laboratory of department of Entomology, AAU, Jorhat and in the experimental rearing room of College of Sericulture, Titabor, AAU, Jorhat. The endoparasitic Uzi fly can cause significant crop losses in muga and mulberry silkworm, necessitating effective pest management strategies. A black scar in the silkworm body is the main characteristic symptom of Uzi fly attack. Field observations revealed that *N. thymus* effectively parasitized the Uzi fly pupae, with higher parasitization rates during the autumn season (63%) compared to spring (47%). Notably, younger pupae (1-2 days old) were more preferred for oviposition, with parasitization rates reaching 68.33% and 65%, respectively. The study also documented the presence of predatory ants, *Oecophylla smaragdina*, which preyed upon the Uzi fly maggots and eggs.

Keywords: Muga, Uzi fly; *Nesolynx thymus*; Biological Control; Parasitization.

1. INTRODUCTION

Silkworm is infested by several pests viz., Uzi fly, dermestid beetle, earwigs, ants, etc. The Uzi fly, *Exorista bombycis*, is a major pest in sericulture which belongs to the Dipteran family Tachinidae, particularly infesting the domesticated silkworm *Bombyx mori* Linn. The history of the Uzi fly infestation in India goes back centuries and highlights the ongoing threat to sericulture (1). The female Uzi fly lays eggs on the silkworm larvae. The Uzi fly laid its eggs mostly on the inter-segmental region of the dorsal surface of the silkworm body. When the eggs hatch, they emerge from the operculum which faces the silkworm body, and penetrate the larval body leaving a black scar behind (2). Inside the silkworm body, the maggots complete their three larval instars while feeding on the fat bodies. After full development, the larva hatches from the host and pupates. Adult emerges and the cycle

continues (3). The primary distinguishing features of an infestation with Uzi flies are a black scar on the larval body and an emerging hole on the cocoons.

Uzi fly infestations occur throughout the year, but their intensity varies by season. The rainy season experiences the highest infestation rate. Winter sees moderate levels of infestation. During summer, although lower than other seasons, the incidence of Uzi fly infestation remains significant. The study on Uzi fly infestation during silkworm rearing in West Bengal under different seasons revealed higher infestation in rainy season, followed by summer, with almost negligible infestation in winter (4). This seasonal pattern suggests that environmental factors play a crucial role in the population dynamics of Uzi flies (5).

Uzi fly infestations result in significant economic and biological impacts on silkworm populations. Economically, these infestations can lead to a substantial reduction in silk yield, ranging from 10% to 40% (6). Biologically, infected silkworms exhibit several symptoms. These included reduced mobility and abnormal **behaviour**. The parasitized silkworms may spin cocoon but ultimately die as the Uzi fly larvae develop within their bodies.

Over-reliance on insecticides has led to resistance and environmental residues (7). Integrating cultural and biological control measures can be effective in controlling pests without endangering the environment. This can be achieved through the use of biocontrol agents, botanicals, and behavior-modifying chemicals. *Nasonia* and *Spalangia* species are effective parasitoids for managing houseflies in manure pits and poultry sheds (8,9). The study has revealed that *N. thymus* effectively reduce housefly populations in poultry and dairy units, highlighting its potential as a sustainable biological control agent (10). Biological control can be enhanced by weekly releases of laboratory-reared parasitoids, as well as cost reduction by recycling parasitoids. Keeping all the factors in mind the study has been conducted to evaluate the Gregarious Pupal Parasitoid *Nesolynx thymus* (Hymenoptera: Eulophidae) or Biological Control of Uzi Fly

2. METHODOLOGY

The experiment was conducted during October 2021 to May 2022 in the laboratory of department of Entomology, AAU, Jorhat and in the experimental rearing room of College of Sericulture, Titabor, AAU, Jorhat. Fresh pupa of Uzi fly in a Petri plate was kept outside the rearing room to observe the natural enemy infestation. Observation of pupa was done periodically at a time interval of 4 hours in a day (8 AM, 12 PM, 4 PM). If natural enemies were found on the pupae, they were collected and kept in glass chimneys for further study. Based on three observations, data was collected. Additionally, any natural enemies that attacked the eggs during the incubation period or the maggots when they emerged from the silkworm body in search of a pupation site were also collected and kept in glass chimneys for further observation. Different stages of the pupa of Uzi fly i.e., 1 day, 2 days old, 4 days old, 6 days old, 8 days old, 10 days old, 12 days old and 14 days old

enemies. 20 numbers pupa of each age group were kept in each Petri plate and the data was obtained from 3 observations in each age group.

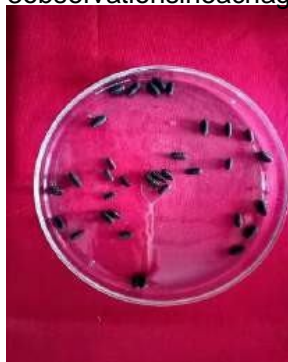


Figure 1. Uzi fly pupa

3. RESULTS AND DISCUSSION

One pupal parasitoid was seen to infest the Uzi fly pupa when the pupae were kept outside the rearing house. They were small hymenopteran parasitoids identified as *Nesolynx thymus* belongs to the family Eulophidae of the order Hymenoptera. They were gregarious. The adult female laid eggs on the Uzi pupa and then the larvae penetrated the pupa and came out as adults. They were seen laying their eggs mainly on the intersegmental region of the Uzi fly pupa. The eggs were creamy white in color. The percent Parasitization was found to be high in autumn season than in spring season and young age pupae were mostly preferred by them for infestation (Table 1 and Table 2).

Table 1: Parasitization of *Nesolynx thymus* on host (Uzi fly pupa) in Different Seasons

Seasons	Mean ± SEM	Parasitization (%)
Autumn	12.60 ± 0.5	63
Spring	9.40 ± 0.5	47

Based on 3 observations in both the season and 20 numbers of pupa in each observation.

Table 2: Percent Parasitization of *N. thymus* depending upon host age (Uzi pupa)

pupa were allowed to oviposit by natural	Age of Uzi pupa (days)

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1	14.50±0.88	68.33
2	13.00±0.57	65.00
4	10.00±0.57	50.00
6	7.33±0.33	35.00
8	4.00±0.57	20.00
10	1.33±0.33	6.66
12	0	0
14	0	0

The adults of *N. thymus*, when allowed to search for host i.e., *B. zebina* pupa, were observed to search the host randomly instead of regular

Based on 3 numbers of observation in each age- old pupa and 20 numbers of pupa in each observation.

In an experiment, Bhat (2012) found that the uzi infestation in mulberry silkworm (*Bombyx mori* L.) reduced from 0.5% to 0.2% by the release of transported *N. thymus* -a bio control agent (11) but also economically viable and Choudhury et al. (2014) found that the pupa of the uzi fly of the muga silkworm, *Antheraea assamensis* (Helfer), was successfully parasitized by the solitary (*Dirhinus* spp.) and augmentative discharge of indigenous gregarious (*Nesolynx thymus*) parasitoids (12). Belgumpe and Jadav (2017) also found that the bio-control agent *N. thymus*, an ecto-pupal parasitoid, was shown to be more suited, accessible and effective for Uzi fly control upto 70% for boosting cocoon yield and profit at the farmer level in Maharashtra (13). In this experiment one pupal parasitoid belonging to the family Eulophidae of the order Hymenoptera was found to be infesting the uzi fly pupa and it was identified as *Nesolynx thymus*. They were gregarious and it was observed that the adult laid eggs on the uzi pupa, the maggot entered the pupa and emerged as an adult. *Nesolynx thymus* infestation rate on uzi pupa was determined to be 63% in the autumn and 47% in the spring. They have been discovered to be more efficient in colder climates, and during the summer they go into aestivation. Additionally, it was found that they parasitized the young pupae and did not prefer the older pupae. The highest Parasitization percentage was found to be in the 1-day old pupa with 68.33% Parasitization followed by 2-day old pupa with 65% of Parasitization.

Host searching behavior of *Nesolynx thymus* (Girault):

manner of searching. They did not go directly for oviposition, instead the adult *N. thymus* first searched their host through a series of random motion and when they found the host, they either accepted it or rejected it. When the host was accepted, they went for a series of action like drumming, tapping and the spent some time in recognizing the host after which they went for oviposition. The oviposition by *N. thymus* females was done by making holes on the surface of the puparium by pointing their ovipositor vertically and puncturing the puparia.

The oviposition behaviour of *N. thymus* exhibits a distinct sequence of responses, including host recognition, drumming, tapping, drilling, oviposition, and withdrawal of the ovipositor. The host recognition phase involves the parasitoid detecting and identifying suitable host insects, while the subsequent drumming, tapping, and drilling behaviors facilitate the location and assessment of the oviposition site (14).

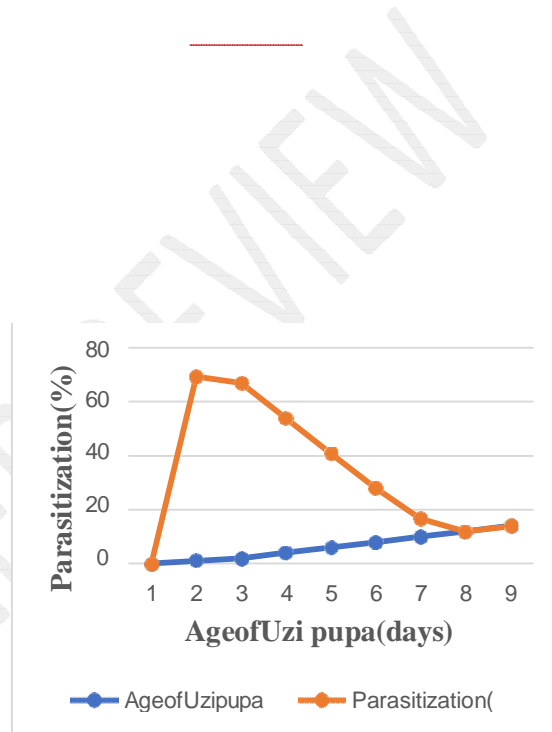


Figure 2. Parasitization of *N. thymus* increases with host age

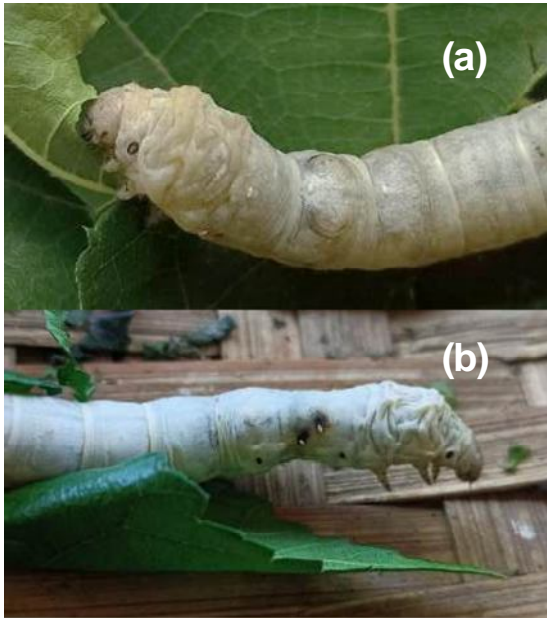


Figure 3. *Bombyx mori* larva infested by Uzi fly (a-b)

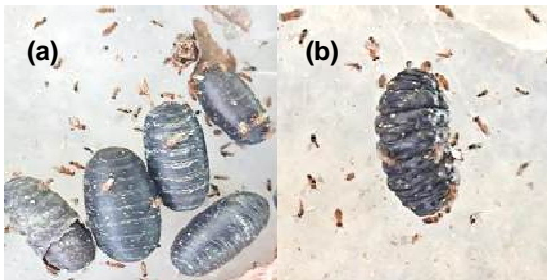


Figure 4. Uzi fly pupa infested by *Nesolynx thymus* (a-b)

4. CONCLUSION

One pupal parasitoid was seen to infest the Uzi fly pupa when the pupae were kept outside the rearing house. They were small hymenopteran parasitoids identified as *Nesolynx thymus* belongs to the family Eulophidae of the order Hymenoptera. They were gregarious. Some small red ants (*Oecophylla smaragdina*) were observed to attack the maggots after they came out of the host. The ants carry the maggots to their nest and feed upon them.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

REFERENCES

1. Sowmya P, Rajitha K. Uzi fly [*Exorista bombycis* (Louis)]- a menace to sericulture industry: a review. *Biochem Cell Arch.* 2021;21.
2. Jadhav AD, Desai AS, TV S. Distribution and Economic Status of Uzi fly *Exorista bombycis* Louis. A parasitoid of Mulberry silkworm *Bombyx mori* L *GJRA-Global Journal for Research Analysis.* 2014;3(7):3-5.
3. Singh A, Kumar V, Majumdar M, Guha L, Neog K. A Comprehensive Review of Insect Pest Management in Muga Silkworm (*Antheraea assamensis* Helfer): Current Scenario and Future Prospects. *Journal of Experimental Agriculture International.* 2024;46(5):47-55.
4. Sarkar K, Biswas M, Das P. Studies on infestation of Uzi fly during silkworm rearing in different seasons in West Bengal at laboratory condition. *J Entomol Zool Stud.* 2020;8(4):1740-4.
5. Chakraborty R, Brahma D, Dutta RB. The Biology of Uzi fly - A dangerous pest of mulberry Silkworm *Bombyx mori* L. 2023;
6. Jadhav AD, Desai AS, TV S. Distribution and Economic Status of Uzi fly *Exorista bombycis* Louis. A parasitoid of Mulberry silkworm *Bombyx mori* L *GJRA-Global Journal for Research Analysis.* 2014;3(7):3-5.
7. Shah RM, Azhar F, Shadi SA, Walker WB, Azeem M, Binyameen M. Effects of different animal manures on attraction and reproductive behaviors of common house fly, *Musca domestica* L. *Parasitol Res.* 2016;115:3585-98.
8. Kaufman PE, Long SJ, Rutz DA. Impact of exposure length and pupal source on *Muscidifurax raptorellus* and *Nasonia vitripennis* (Hymenoptera: Pteromalidae) parasitism in a New York poultry facility. *J Econ Entomol.* 2001;94(4):998-1003.
9. Geden CJ, Hogsette JA. Suppression of house flies (Diptera: Muscidae) in Florida poultry houses by sustained releases of *Muscidifurax raptorellus* and *Spalangia cameroni* (Hymenoptera: Pteromalidae). *Environ Entomol.* 2006;35(1):75-82.
10. Senthoooraja R, Subaharan K, Gupta A, Basavarajappa S, Lalitha Y, Bakthavatsalam N, et al. Host factors influencing the parasitism by *Nesolynx thymus* (Girault) (Hymenoptera: Eulophidae) on housefly, *Musca domestica* L. 2020;

11. Bhat D V. Efficacy of transported biocontrol agent *Nesolynx thymus* in controlling uzi fly infestation in the silkworm *Bombyx mori* L. 2012;
12. Choudhury B, Kumar R, Chutia P, Rajkhowa G. Host infestation Potentiality of *N.thymus* to Control the Uzi fly of muga silkworm, *Antheraea assamensis* (Helfer)- A Bio-control Tool for Controlling Uzi fly. In: Biological Forum. Research Trend; 2014. p. 1.
13. Belgumpe SJ, Jadhav AD. Mass production and utilization of *Nesolynx thymus* Girault for biological control of uzi fly *Exorista bombycis* in Sericulture farming system of Maharashtra. Bull Indian Acad Seri. 2017;21(1):33-6.
14. Siddaiah AA, Danagoudra M. Oviposition behavior of an ectopupal parasitoid *Nesolynx thymus* (Hymenoptera: Eulophidae): A biocontrol agent of the Uzi fly *Exorista bombycis* (Diptera: Tachinidae). 2019;

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