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Percent parasitization of *Musca domestica* L. and *Exorista bombycis* pupae by *Nesolynx thymus*

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Abstract
The experiment was conducted at Sericulture Research Unit, VNMKV, Parbhani, during year 2024-25 in completely randomized design with six treatments and four replications for the objective of parasitization. During the study, the months from October 2024 to March 2025 were utilized as treatments. The main objective was to assess the monthly parasitization efficiency of *Nesolynx thymus* on both *Musca domestica* and *Exorista bombycis* pupae.

The study focused on the parasitization potential of *Nesolynx thymus* against *Musca domestica* and *Exorista bombycis* pupae over a six-month period. The pupae showed the highest parasitization rates during the cooler months of November and December. In these months over 90% parasitization was recorded which indicated peak activity. The month January also showed high parasitization while moderate results were observed in October. However, there was a gradual decline in parasitization from February onward with the lowest rates recorded in March. This trend suggests that *N. thymus* is most effective in cooler and more humid conditions while higher temperatures may reduce its parasitic efficiency.

Overall the findings from this study provide important insights into the performance of *Nesolynx thymus* as a biological control agent. These results can be utilized in planning timely pest management strategies in sericulture particularly by focusing the use of *N. thymus* during its peak effectiveness period from November to January.

Keywords: *Exorista bombycis*, *Nesolynx thymus*, parasitization, biological control, sericulture

Introduction
Sericulture is a traditional and profitable rural industry in India and Asia. It requires low capital, provides good returns and supports small-scale farmers especially in rural and tribal areas. Though Maharashtra is not a traditional sericulture state but it has shown great progress by producing mainly bivoltine silk and leading among non-traditional states (Hiware, 2016) [9]. In 2023-24 about 19,005 acres were under sericulture in Maharashtra while India had 256,945 hectares (Ministry of Textiles, Government of India).

Sericulture is also environmentally friendly and generates organic waste like larval excreta, dead larvae and leaf litter. Unfortunately, these wastes are underutilized by tribal farmers. However, they can be effectively converted into organic compost using earthworms (Kalaiyarasan *et al*., 2015) [11].

India produces all five types of silk (Padaki *et al*., 2015) [15] with *Bombyx mori* being the main species used for mulberry silk (Giora *et al*., 2022) [7]. Crop losses in silkworm rearing are often due to pests (Rahmathulla, 2012) [16] with major pests including the Uzi fly (*Exorista bombycis*), earwigs, beetles and ants (Sakthivel *et al*., 2012; Belgumpe and Jadhav, 2017) [17, 3]. The Uzi fly is a serious pest in many states and has also been reported in Maharashtra (Jadhav and Sathe, 2016) [10]. It causes significant losses about 20% or more in the rainy season, 11-15% in winter and up to 3% in summer (Bari *et al*., 2023) [2].

Biological control is an effective and eco-friendly method of pest management (DeBach *et al*., 1971) [5]. Natural enemies like parasitoids, predators and pathogens help control pest populations (Khandagale *et al*., 2023) [13]. Several parasitoids have been identified for Uzi fly control including *Nesolynx thymus* (Nirmala and Veeranna, 1998; Singh and Maheshwari, 2002; Singh and Saratchandra, 2003) [14, 18, 20].

Chemical pest control poses risks to silkworms, farmers and the environment (Singh and Saratchandra, 2002) [19] making it essential to reduce chemical use in sericulture (Karthik and Rathinamoorthy, 2017; Altman and Farrell, 2022) [12, 1]. *Nesolynx thymus* (Girault) is a pupal parasitoid from the family Eulophidae which is effective against Uzi flies. It is known for its short life cycle, high parasitization rate and adaptability (Choudhury *et al*., 2014) [4]. Recognized by the Central Sericultural Research and Training Institute (Hasan *et al*., 2009; Gahukar, 2014) [8, 6] it is widely used in states like Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal and Assam. Adult *N. thymus* lay eggs inside Uzi fly pupae which kills them before they emerge. They are mass reared using *Corcyra cephalonica* pupae and the recommended dose is 50-100 parasitoids per 100 sq. ft of rearing area. Proper storage at 10-15 °C is required for maintaining viability. This study aims to evaluate the effectiveness of *Nesolynx thymus* in controlling *Exorista bombycis* under Maharashtra’s sericultural conditions.

Materials and Methods

The present investigation for given objective was conducted from October 2024 to March 2025. The primary aim of the study was to evaluate the parasitization potential of the pupal parasitoid *Nesolynx thymus* against the pupae of the Uzi fly (*Exorista bombycis*) which act as a significant pest in sericulture. The experiment included controlled exposure trials to evaluate parasitization efficacy.

Maintenance of host flies and cage preparation

The house flies were kept in cages which measures about 2 × 2 feet for the purpose of rearing and observation. These cages were constructed using iron frames and entirely covered with fine mosquito nylon netting to prevent escape and to maintain a hygienic environment and to set them free from outside insects and predators. The netting also helps in proper aeration. These cages served as a limited space for exposing *Musca domestica* L. pupae to parasitization from introduced populations of *Nesolynx thymus*.

Collection and Preparation of House Fly Pupae

Fresh pupae of *Musca domestica* L. were measured using a volumetric approach, where 100 ml of pupae were used per treatment unit. These pupae were then placed into shallow plastic trays, each measuring about 2 feet in length and 1.5 feet in width. A total of four replications were conducted. *Nesolynx thymus* released in trays which serves as mother culture. During the first three days, these trays were covered with a porous cloth material for parasitization. They were maintained at room temperature under standard laboratory conditions. On the fourth day the pupae were carefully removed from the trays and put in a plastic box and transferred into the prepared fly cages for further observation

Observation for Parasitization

Parasitized pupae were kept in the cages for a period of 7 to 10 days. This duration allowed sufficient time for *Nesolynx thymus* parasitoid development within the cages to parasitize the house fly pupae. After the completion of the given period, all pupae were removed from the cages and will be observed for the signs of parasitization. We observed Indicators such as emergence holes, changes in color. After that winnowing is done and we got the actual parasitized pupae that were used to calculate percent parasitization.

Exorista bombycis pupae exposed to *Nesolynx thymus*

In a separate experimental setup, the specific parasitization efficiency of *Nesolynx thymus* was evaluated under laboratory conditions. For this, 20 fresh pupae of *Exorista bombycis* were placed in small, transparent plastic bottles. These pupae were directly kept with adult *Nesolynx thymus* parasitoids for a period of four days. After completion of fourth day Uzi fly pupae carefully removed from trays and kept within the transparent bottles and then kept in the cages for parasitization. They were kept in the cages for a period of 7 to 10 days. This duration allowed sufficient time for *Nesolynx thymus* parasitoid development within the cages to parasitize the Uzi fly pupae. After the completion of the given period, all pupae were removed from the cages and will be observed for the signs of parasitization. We observed Indicators such as emergence holes, changes in color. After that winnowing is done and got the actual parasitized pupae that were used to calculate percent parasitization same as done with the house fly pupae. Each one was replicated four times to check the consistency and reproducibility of the results.

Experimental layout and data recording

The overall experimental layout followed a Completely Randomized Design (CRD) which allowed equal probability of treatment distribution and minimized bias. Upon completion of the exposure period in laboratory condition, each pupa was closely examined. Data related to the number of parasitized pupae were carefully recorded. The parasitization percentage was then calculated by dividing the number of parasitized pupae by the total number of pupae exposed and multiplying by 100.This methodological structure secured both the scientific method and repeatability of the experiment while offering deep understanding into the parasitic behavior and efficiency of *Nesolynx thymus* under laboratory conditions.

Methods involved and materials used are described below

Experimental details

Design	Completely Randomized Design
Treatments	6
Replication	4

Treatment details

The observations were taken for 6 months *i.e.* from October 2024 to March 2025 which act as the treatment**.**

Results

Study on the parasitization of *Musca domestica* pupae (ml*)* by *Nesolynx thymus* in different month of the year 2024-25: The study revealed clear monthly variation in parasitization efficiency of *Nesolynx thymus*. The highest parasitization was observed in December 2024 (92.50 ml) followed by November (90.00 ml) and January 2025 (85.00 ml) indicating peak performance during cooler months (Table 1 and Figure 1). In October 2024 the parasitization was slightly lower at 75.00 ml it was likely due to the early onset of favorable post monsoon conditions.

A noticeable decline was recorded in February (70.00 ml) and March 2025 (60.00 ml) which suggested reduced parasitoid activity with rising temperatures.

These seasonal trends indicate that *N. thymus* performs best in moderate temperatures and humidity. Higher temperatures during late winter and early spring may negatively impact its development, survival and efficiency.

For effective biological control the period from November to January appears optimal for releasing *N. thymus*. Additional control measures or thermally tolerant strains may be required to maintain pest suppression in warmer months.

Study on the parasitization of *Musca domestica* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25: The parasitization percentage by *Nesolynx thymus* varied significantly across different months which showed a clear seasonal pattern. The highest parasitization was recorded in December 2024 (92.50%) followed by November (90.00%) and January 2025 (85.00%) indicating peak parasitoid activity during cooler months (Table 2 and Figure 2).

In October 2024 a moderate parasitization rate of 75.00% was observed which suggested the onset of favorable conditions post monsoon. However, a gradual decline was seen in the warmer months with parasitization dropping to 70.00% in February and further to 60.00% in March 2025.

This decline is likely due to increased temperatures and changing humidity which can negatively affect the parasitoid's ability to locate hosts, lay eggs and successfully develop. These results highlight November to January as the ideal period for using *N. thymus* in biological control programs. In warmer months like February and March additional control methods or alternative biocontrol agents may be needed to maintain effectiveness.

Study on the parasitization of *Exorista bombycis* pupae (No) by *Nesolynx thymus* in different months of the year 2024-25: The number of *E. bombycis* pupae parasitized by *Nesolynx thymus* varied across months. The highest parasitization was observed in December 2024 with a mean of 18.00 out of 20 pupae followed by November (17.00) and October (15.00) indicating that cooler months support peak parasitoid activity (Table 3 and Figure 3).

In January 2025 parasitization remained relatively high at 16.00 pupae which suggested continued effectiveness during winter. However, a decline was noted in February (14.00) and March (13.25) likely due to rising temperatures and changes in humidity that negatively affect parasitoid behavior, survival and reproduction.

These findings suggest that *N. thymus* performs best from October to December with January still being effective. For efficient biological control of *E. bombycis* the parasitoid release should be planned during these cooler months while alternative strategies may be needed during warmer periods.

Study on the parasitization of *Exorista bombycis* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25: The parasitization percentage by *Nesolynx thymus* showed clear monthly variation influenced by seasonal changes. The highest rates were recorded in December 2024 (90.00%) and November (85.00%) indicating that late autumn and early winter are the most favorable periods for parasitoid activity due to ideal temperature and humidity (Table 4 and Figure 4). In October 2024 parasitization was moderate at 75.00% that marked the start of increased activity post monsoon. January 2025 also showed high efficiency at 80.00% which confirmed good performance during winter.

A decline was noted in February (70.00%) and March (66.25%) likely caused by rising temperatures affecting the parasitoid's development, host-searching behavior and reproductive success.

These results suggest that November to January is the most effective period for releasing *N. thymus* in pest control programs targeting *E. bombycis*. In warmer months like February and March additional or alternative control measures may be necessary to maintain effective pest suppression.

The literature on the parasitization of *Musca domestica* pupae and *Exorista bombycis* pupae by *Nesolynx thymus* are not available so results could not be discussed.

Table 1: Study on the parasitization of *Musca domestica* pupae (ml) by *Nesolynx thymus* in different months of the year 2024-25

Sr. No.	Month	*M. domestica* Pupae exposed for parasitization (ml)	Parasitized pupae obtained (ml)				
			RI	RII	RIII	RIV	Mean
1	October 2024	100	75	80	75	70	75.00
2	November 2024	100	90	90	85	95	90.00
3	December 2024	100	90	95	90	95	92.50
4	January 2025	100	80	85	90	85	85.00
5	February 2025	100	65	70	70	75	70.00
6	March 2025	100	60	65	60	55	60.00
	SE ±						1.954
	CD at 5%						5.852
	CV (%)						4.963

Table 2: Study on the parasitization of *Musca domestica* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25

Sr. No.	Month	*M. domestica* Pupae exposed for parasitization (ml)	Per cent Parasitization (%)				
			RI	RII	RIII	RIV	Mean
1	October 2024	100	75	80	75	70	75.00 (60.03)
2	November 2024	100	90	90	85	95	90.00 (71.82)
3	December 2024	100	90	95	90	95	92.50 (74.29)
4	January 2025	100	80	85	90	85	85.00 (67.33)
5	February 2025	100	65	70	70	75	70.00 (56.80)
6	March 2025	100	60	65	60	55	60.00 (50.76)
	SE ±						1.954
	CD at 5%						5.852
	CV (%)						4.963

Figures in parentheses are arcsine transformed values

Table 3: Study on the parasitization of *Exorista bombycis* pupae (No.) by *Nesolynx thymus* in different months of the year 2024-25

Sr. No.	Month	*Exorista bombycis* pupae exposed for parasitization (No)	Parasitized pupae obtained (No of pupae)				
			RI	RII	RIII	RIV	Mean
1	October 2024	20	15	14	15	16	15.00
2	November 2024	20	17	16	18	17	17.00
3	December 2024	20	19	18	17	18	18.00
4	January 2025	20	16	15	16	17	16.00
5	February 2025	20	14	13	14	15	14.00
6	March 2025	20	13	13	14	13	13.25
	SE ±						0.386
	CD at 5%						1.157
	CV (%)						4.972

Table 4: Study on the parasitization of *Exorista bombycis* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25

Sr. No.	Month	*Exorista bombycis* Pupae exposed for parasitization (No)	Per cent Parasitization (%)				
			RI	RII	RIII	RIV	Mean
1	October 2024	20	75.00	70.00	75.00	80.00	75.00 (60.03)
2	November 2024	20	85.00	80.00	90.00	85.00	85.00 (67.33)
3	December 2024	20	95.00	90.00	85.00	90.00	90.00 (71.82)
4	January 2025	20	80.00	75.00	80.00	85.00	80.00 (63.49)
5	February 2025	20	70.00	65.00	70.00	75.00	70.00 (56.80)
6	March 2025	20	65.00	65.00	70.00	65.00	66.25 (54.47)
	SE ±						1.932
	CD at 5%						5.785
	CV (%)						4.972

Figures in parentheses are arcsine transformed values

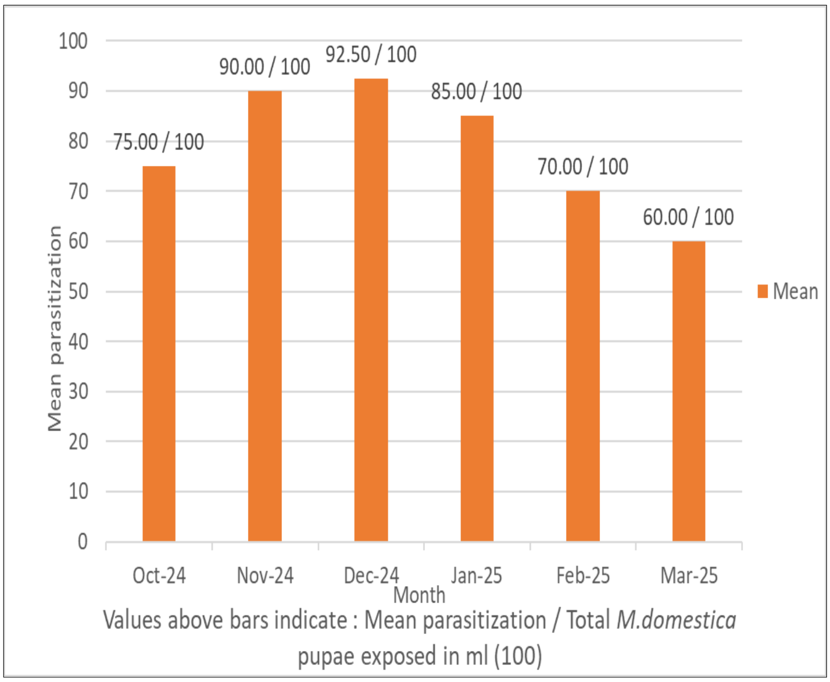

Fig 1: Parasitization of *Musca domestica* pupae (ml) by *Nesolynx thymus* in different months of the year 2024-25

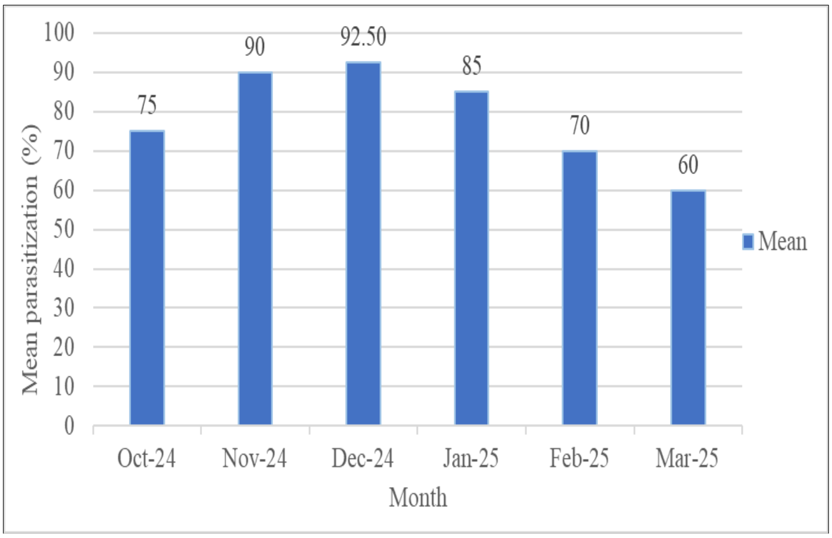

Fig 2: Parasitization of *Musca domestica* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25

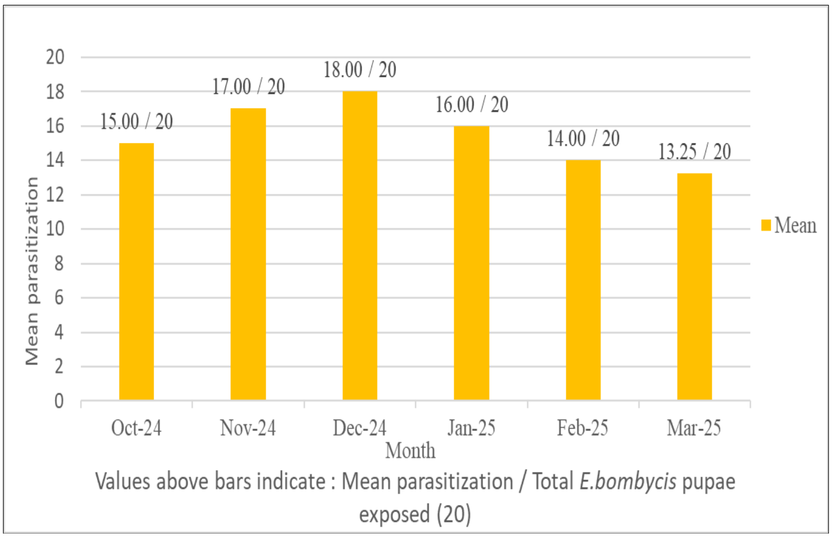

Fig 3: Parasitization of *Exorista bombycis* pupae (No) by *Nesolynx thymus* in different months of the year 2024-25

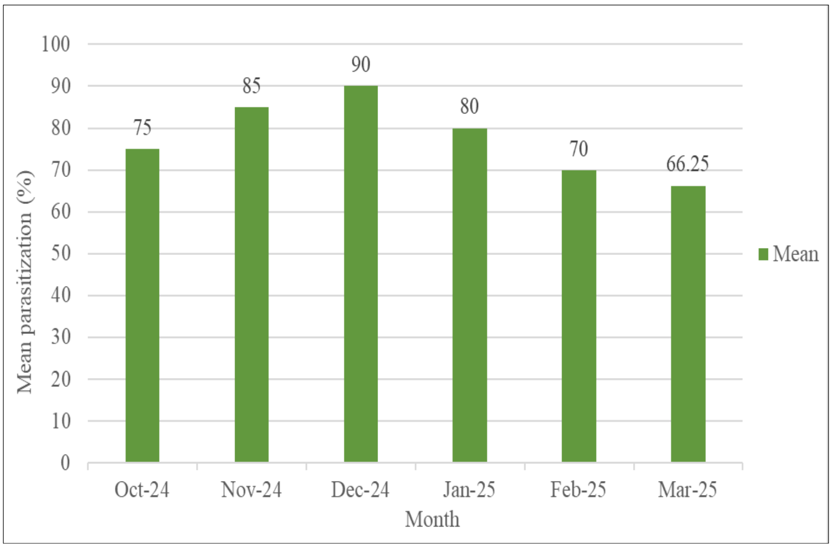

Fig 4: Parasitization of *Exorista bombycis* pupae (%) by *Nesolynx thymus* in different months of the year 2024-25

Conclusion

The parasitization efficiency of *Nesolynx thymus* varied with the seasons showing the highest activity during cooler months. Peak performance was seen in December followed by November and January when environmental conditions favoured its development and host searching ability. A decline in parasitization during February and March was likely due to rising temperatures affecting the parasitoid's biology.

N. thymus was also effective against *Exorista bombycis* with high parasitization rates during winter. The reduced efficiency in warmer months highlights the impact of temperature on its performance. These findings suggest that *N. thymus* is a valuable biocontrol agent especially during late autumn and winter and can be effectively used in pest management programs for sericulture when released at the right time.

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