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Life cycle dynamics and biology of *Antheraea mylitta* (Drury) ecorace bhandara daba-bv on *Terminalia arjuna* in Vidarbha

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Abstract
The present study investigates the life cycle and biology of *Antheraea mylitta* (Drury), ecorace Daba-BV, in the Vidarbha region, focusing on its developmental stages and morphometric variations under natural conditions. The research was conducted from November 2023 to March 2024 in tropical dry deciduous forests where *A. mylitta* primarily feeds on *Terminalia arjuna*. The study documents the detailed life cycle, including the egg, larval, pupal, and adult stages, with observations on growth patterns, instar durations, and morphological differences. The incubation period lasted 7 to 10 days with a hatching percentage of 75–80%. The total larval duration ranged from 28 to 37 days, with the fifth instar being the longest, lasting 10 to 13 days. Pupation lasted 20 to 25 days, with significant sexual dimorphism in size and weight. The adult lifespan was recorded as 8–10 days in males and 5–6 days in females, with a total life span varying between 60 to 80 days. The study also provides morphometric data at each developmental stage, showing variations influenced by environmental conditions such as temperature and humidity. The findings align with previous research and contribute to an improved understanding of tasar silkworm biology, crucial for enhancing sustainable sericulture practices. The economic significance of tasar silk production in rural Maharashtra is also highlighted, emphasizing its role in employment generation and financial stability for local communities.

Keywords: Tasar silkworm, *Antheraea mylitta*, life cycle, *Terminalia arjuna*, *sericulture*

Introduction

Sericulture, derived from the Greek word "sericos" meaning silk, is an agro-based industry involving the rearing of silkworms for raw silk production. It plays a significant economic role, particularly in rural areas, as it provides employment and livelihood to many tribal communities (Sheela Patel, 2016; Elumalai *et al*., 2023) [5, 11]. Sericulture is one of the oldest industries known to mankind and has been practiced for thousands of years, primarily in China and India, which are the largest silk-producing nations globally (Taufique & Hoque, 2021) [15]. Among the different types of silk production in India, Tasar sericulture is particularly significant due to its forest-based nature, benefiting economically marginalized communities (Jadhav *et al*., 2011; Mohanty, 1998) [6, 9].

The Tasar silkmoth, *Antheraea mylitta* Drury, is a wild sericigenous insect producing economically valuable silk. India ranks second in Tasar silk production after China (Anitha, 2011) [1]. The ecorace Daba-BV, found in Maharashtra's Vidarbha region, is specifically adapted to *Terminalia arjuna*, making it a crucial species for local sericulture activities (Jayaprakash *et al*., 2002) [7]. The Tasar silk produced from this species is renowned for its rich texture, durability, and unique golden-brown color, making it highly sought after in the textile industry (Bhawane & Kumbhar, 2012) [3]. The significance of *A. mylitta* in the economy is also linked to its adaptability to the semi-arid and tropical conditions of Maharashtra (Rath *et al*., 2011) [14].

This study aims to explore the life cycle and biology of *A. mylitta* Daba-BV in Vidarbha's natural conditions and assess its economic implications for rural communities. Furthermore, understanding the biology and developmental stages of *A. mylitta* can aid in improving silk production efficiency and sustainability, which is crucial for the sericulture industry's long-term viability (Ojha *et al*., 2009) [10].

Materials and methods

This study was conducted from November 2023 to March 2024 in the tropical dry deciduous forests of Arjuni (Morgaon), Gondia district, Maharashtra. The selected region is characterized by black clay soil with a pH ranging from 6.2 to 8.5, making it an optimal habitat for *Terminalia arjuna* and, consequently, for Tasar silkworm rearing. The Tasar silkworm (*Antheraea mylitta* Daba-BV) was collected from its natural habitat, and morphological identification was confirmed by sericulture experts using established taxonomic keys.

The rearing of larvae was carried out in natural conditions on host plants *Terminalia arjuna*. The silkworms were observed throughout their developmental stages, including egg, larva, pupa, and adult. Morphometric measurements such as length, breadth, and weight were recorded at each stage using precise digital instruments. The mating behaviour of moths was also closely studied, with observations on their reproductive cycles under both controlled and natural conditions.

Environmental factors such as temperature, humidity, and seasonal variations were documented using thermometers and hygrometers to assess their impact on silkworm development. Economic data related to Tasar silk production were collected through surveys conducted among local sericulture farmers. Information on silk yield, cocoon weight, and market viability was analyzed to evaluate the financial benefits of Tasar rearing in rural Maharashtra.

The collected data were statistically analyzed to determine variations in growth, reproduction, and silk yield efficiency. The findings from this study contribute to a deeper understanding of *A. mylitta* biology and its potential for enhancing sustainable sericulture practices in the region.

Observations and results

Life Cycle of *Antheraea mylitta*

The life cycle of *A. mylitta* consists of four stages: egg, larva, pupa, and adult. (Photo plate:1). Duration of different stages of life cycle of tasar silkworm, *A. mylitta* is shown in Table 1. The incubation period for eggs ranged from 7 to 10 days, with a mean duration of 8.5 ± 0.6 days and a hatching success rate of 75–80%. The larval stage lasted between 28 to 37 days, with a mean duration of 32.5 ± 1.8 days. The first instar lasted 3–4 days (3.5 ± 0.3 days), the second instar 4–5 days (4.6 ± 0.2 days), the third instar 5–7 days (6.0 ± 0.4 days), the fourth instar 6–8 days (7.2 ± 0.5 days), and the fifth instar 10–13 days (11.5 ± 0.7 days). The pupal stage lasted 20 to 25 days (22.3 ± 1.2 days). The adult stage also varied between sexes; males lived for 8–10 days (9.0 ± 0.6 days), while females survived for 5–6 days (5.8 ± 0.4 days). The total life span for males ranged from 60 to 70 days (65.2 ± 2.3 days), whereas for females, it extended from 68 to 80 days (74.1 ± 2.8 days).

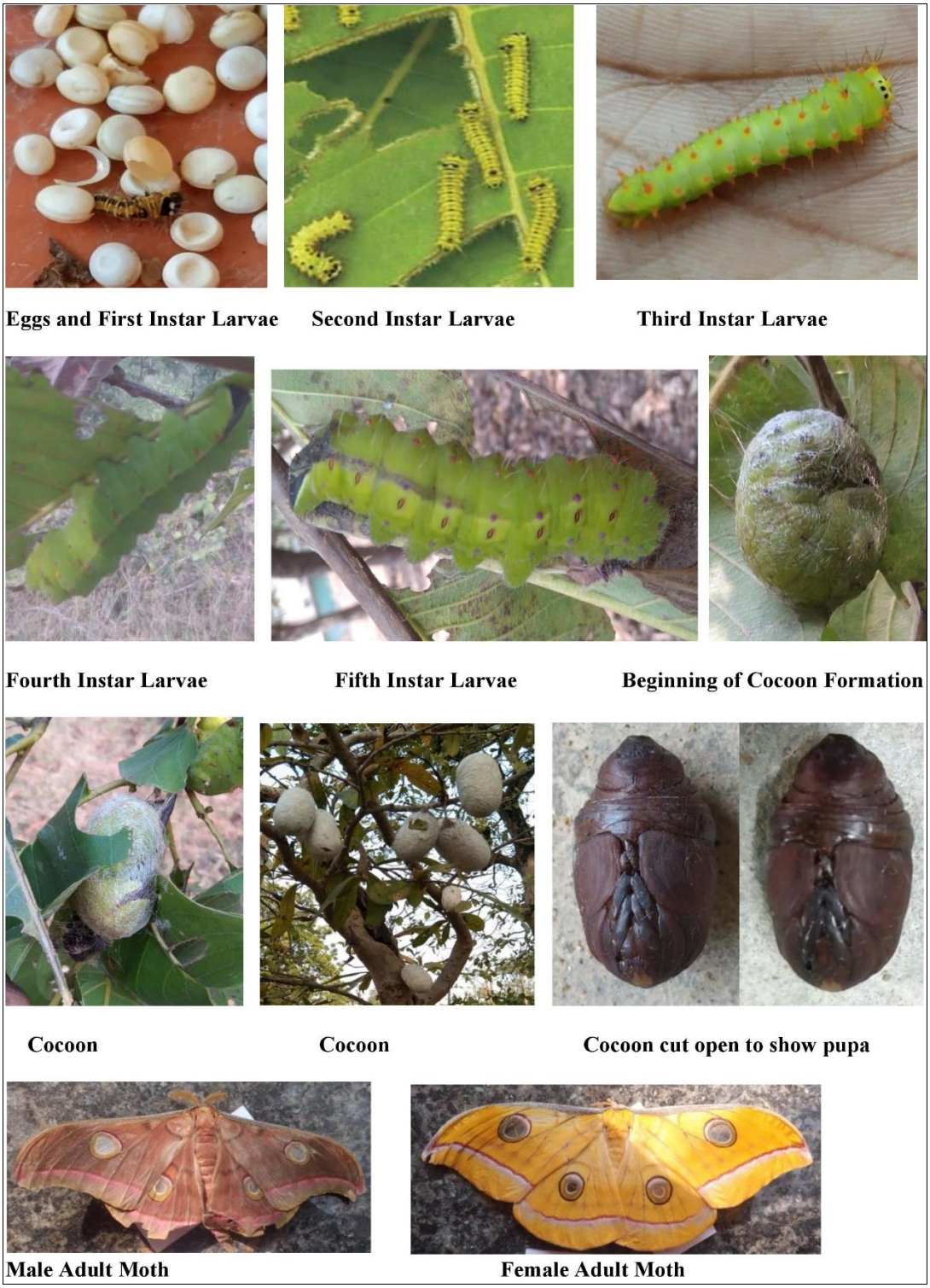

Photo Plate 1: Stages of Life cycle of *Antheraea mylitta*

Table 1: Duration of different stages of life cycle of tasar silkworm, *A. mylitta*

Stages		Duration on days	
		Minimum	Maximum
Egg	Incubation	7.00	10.00
	Hatching percentage	75.00	80.00
Larva	1st Instar	3	4
	2nd Instar	4	5
	3rd Instar	5	7
	4th Instar	6	8
	5th Instar	10	13
	Total Larva Period	28	37
Pupal Stage	Pre-pupa	2	4
	Pupa	20	25
	Sex Ratio- Female: Male	10:13 Ratio 1: 1.3	
Adult Stage	Copulation in hours	24	28
	Pre-oviposition period	1	2
	Oviposition period	1	3
	Post-oviposition period	4	5
	Adult period Male	8	10
	Adult Period Female	5	6
Total Life Span	Male	60	70
	Female	68	80

Morphometric Variation in Length, Breadth, and Weight of *Antheraea mylitta*

Morphometric measurements of *A. mylitta* varied significantly across its developmental stages and shown in Table 2. The egg stage recorded a length of 2.50–2.92 mm (2.73 ± 0.14 mm), a breadth of 2.16–2.58 mm (2.38 ± 0.12 mm), and a weight of 0.007–0.016 g (0.011 ± 0.002 g). In the larval stage, the first instar measured 15–20 mm (17.2 ± 1.4 mm) in length, 1–3 mm (2.1 ± 0.4 mm) in breadth, and weighed 0.06–0.10 g (0.08 ± 0.01 g), whereas the fifth instar ranged from 95–130 mm (112.4 ± 5.6 mm) in length, 20–22 mm (21.1 ± 0.6 mm) in breadth, and weighed 23.10–27.30 g (25.2 ± 1.3 g). The pupal stage showed sexual dimorphism, with male pupae measuring 29.10–40.25 mm (34.5 ± 2.8 mm) in length, 13.50–20.10 mm (16.7 ± 1.5 mm) in breadth, and weighing 5.10–7.50 g (6.4 ± 0.6 g), whereas female pupae ranged from 34.40–41.10 mm (37.8 ± 2.1 mm) in length, 18.30–20.80 mm (19.5 ± 0.9 mm) in breadth, and weighed 5.80–7.85 g (6.9 ± 0.7 g). The cocoon stage also exhibited variations, with male cocoons measuring 35.40–46.90 mm (41.3 ± 3.2 mm) in length, 18.80–28.40 mm (23.7 ± 2.1 mm) in breadth, and weighing 4.75–10.20 g (7.5 ± 1.4 g), while female cocoons ranged from 41.00–53.50 mm (47.6 ± 2.9 mm) in length, 20.80–32.70 mm (26.4 ± 2.5 mm) in breadth, and weighed 5.30–12.80 g (9.3 ± 1.8 g). The adult stage displayed sexual dimorphism, with males having a body length of 47–62 mm (54.2 ± 3.5 mm) and a wingspan of 124–160 mm (142.3 ± 5.8 mm), while females measured 50–72 mm (61.7 ± 4.2 mm) in length with a wingspan of 135–170 mm (152.1 ± 6.3 mm).

Table 2: Showing the morphometric variation in length, breadth and weight of *Antheraea mylitta* during the entire life cycle

Stage		Parameters	Minimum	Maximum	Mean ± SE
Egg		Length (mm)	2.50	2.92	2.73 ± 0.03
		Breadth (mm)	2.16	2.58	2.4 ±0.04
		Weight (g)	0.007	0.016	0.0119 ± 0.001
Larva	1st Instar	Length (mm)	15	20	17.2 ±0.53
		Breadth (mm)	1	3	2.2 ± 0.24
		Weight (g)	0.06	0.10	0.08 ± 0.004
	2nd Instar	Length (mm)	21	30	25.3 ±0.88
		Breadth (mm)	4	7	5.1 ± 0.31
		Weight (g)	0.14	0.28	2.23 ± 0.01
	3rd Instar	Length (mm)	43	59	52.1 ±1.62
		Breadth (mm)	10	15	12.3 ± 0.55
		Weight (g)	1.45	2.50	1.978 ± 0.10
	4th Instar	Length (mm)	66	75	70 ±0.93
		Breadth (mm)	16	19	17.4 ± 0.37
		Weight (g)	6.75	9.10	8.24 ±0.21
	5th Instar	Length (mm)	95	130	111.9 ± 4.00
		Breadth (mm)	20	22	20.9 ± 0.27
		Weight (g)	23.10	27.30	25.5 ± 0.45
Pupa	Male	Length (mm)	29.10	40.25	34.68 ± 1.00
		Breadth (mm)	13.50	20.10	17.19 ± 0.68
		Weight (g)	5.10	7.50	6.56 ± 0.23
	Female	Length (mm)	34.40	41.10	38.01 ± 0.67
		Breadth (mm)	18.30	20.80	19.52 ± 0.23
		Weight (g)	5.80	7.85	6.884 ± 0.21
Cocoon	Male	Length (mm)	35.40	46.90	40.57 ± 1.11

		Breadth (mm)	18.80	28.40	24.24 ± 1.11
		Weight (g)	4.75	10.20	7.43 ± 0.57
	Female	Length (mm)	41.00	53.50	48.73 ± 1.16
		Breadth (mm)	20.80	32.70	26.7 ± 1.88
		Weight (g)	5.30	12.80	9.17 ± 0.70
Adult	**Male**	Length (mm)	47	62	54.88 ± 1.74
		Breadth with wing expanded (mm)	124	160	145 ± 3.48
	Female	Length (mm)	50	72	61 ± 2.13
		Breadth with wing expanded (mm)	135	170	153.2 ± 3.88

Discussion

The eggs of *Antheraea mylitta* are bilaterally symmetrical with an anteroposterior axis, encompassing four stages of embryonic development over a period of 7 to 10 days. These eggs are dorsoventrally flattened, spherical, and measure approximately 2.5–3 mm in diameter. Initially white or creamy yellow, they turn brown at the time of oviposition, with parallel equatorial lines dividing their surface into distinct zones. Our findings align with Mohanty (1998) [9], who recorded egg dimensions of 3.01 mm in length and 2.47 mm in breadth, with an average weight of 9.80 mg. The incubation period, ranging from 8 to 10 days, concurs with previous studies (Bambhaniya *et al*., 2017; Chikkaswamy *et al*., 2007; Jayaprakash *et al*., 2002) [2, 4, 7]. The hatching percentage was observed to be 75–80%, which is consistent with Rath *et al*. (2011) [14], who reported a hatching success rate of 78.99%.

The first instar larvae, upon hatching, exhibit a dark brownish or dull yellow coloration. Their length varies from 15 to 20 mm, while their breadth ranges from 1 to 3 mm, with a weight of 0.06–0.10 g under natural conditions. These measurements are comparable to those reported by Mohanty (1998) [9], who recorded a length of 0.71 cm, a breadth of 0.28 cm, and a weight of 0.08 g. Similarly, our results align with those of Rao *et al*. (2002) [13], who reported the first instar larvae measuring 0.710 ± 0.007 cm in length, 0.180 ± 0.60 cm in breadth, and weighing 0.029 ± 0.003 g.

The second instar larvae exhibit an increase in size, measuring 21–30 mm in length and 4–7 mm in breadth, consistent with observations by Bambhaniya *et al*. (2017) [2] and Jayaprakash *et al*. (2002) [7]. This stage lasts for approximately 4 to 5 days.

The third instar larvae are characterized by the presence of setae covering their bodies. Their length ranges from 43.00 to 59.00 mm, and their breadth varies from 10 to 15 mm. The larval period extends from 5 to 7 days, which is in agreement with findings by Bambhaniya *et al*. (2017) [2], who noted size variations of 41.00–55.00 mm in length, 9.00–13.00 mm in breadth, and a weight range of 1.38–2.38 g. Jayaprakash *et al*. (2002) [7] similarly recorded an average length of 2.40 ± 0.34 cm, a breadth of 0.64 ± 0.045 cm, and a weight of 1.20 ± 0.27 g, confirming the similarity of our results.

The fourth instar larvae appear pale green with dense setae. Their body length ranges from 66.00 to 75.00 mm, while their breadth measures between 16 and 19 mm. Our findings correspond with those of Bambhaniya *et al*. (2017) [2] and Jayaprakash *et al*. (2002) [7]. In the fifth instar, the larvae reach a length of 95 to 130 mm and a breadth of 20 to 22 mm, with a larval period extending from 10 to 13 days. Bambhaniya *et al*. (2017) [2] reported similar measurements, with length varying from 90 to 125 mm, breadth from 18 to 21 mm, and weight ranging from 22.74 to 26.28 g, with a mean of 107.72 ± 10.23 mm, 19.12 ± 0.88 mm, and 24.82 ± 1.12 g. Jayaprakash *et al*. (2002) [7] documented comparable values, with a length of 7.20 ± 0.12 cm, a breadth of 1.2 ± 0.04 cm, and a weight of 9.2 ± 0.64 g.

The total larval period was observed to range from 28 to 37 days, aligning with Thangavelu *et al*. (1991) [16], who recorded larval durations of 32 to 36 days under both indoor and outdoor conditions. Similarly, Ram Kishor *et al*. (1997) [12] reported a larval period of 36.60 ± 0.89 days in *T. arjuna* at Ranchi.

The cocoons of *A. mylitta* show variation between males and females in terms of size and weight. The recorded length, breadth, and weight ranged from 41 to 53 mm, 20.80 to 32.70 mm, and 5.30 to 12.80 g, respectively. Bambhaniya *et al*. (2017) [2] observed a similar range, with female cocoons measuring 40.04–52.97 mm in length, 21.17–32.03 mm in breadth, and 5.56–12.12 g in weight, averaging 47.04 ± 3.64 mm, 27.23 ± 2.58 mm, and 8.80 ± 1.79 g. In contrast, male cocoons ranged from 34.34 to 47.82 mm in length, 18.28 to 27.76 mm in breadth, and 4.80 to 10.09 g in weight, with a mean of 41.13 ± 4.08 mm, 23.8 ± 2.58 mm, and 7.68 ± 1.56 g. Jayaprakash *et al*. (2002) [7] noted that the cocoon exhibited black or brown-colored peduncles and rings. Kumar *et al*. (2013) [8] further reported that cocoon weights averaged 11.671 ± 0.331 g indoors and 12.568 ± 0.448 g outdoors.

The pupal stage is characterized by segmentation into the head, thorax, and abdomen, with a dark brown spindle-shaped body. Sexual dimorphism is evident, as female pupae display fine longitudinal lines on the VIII and IX abdominal segments, while males have a dot on the IX segment. Our results are consistent with Chikkaswamy *et al*. (2007) [4], who recorded pupal weights ranging from 5.4 to 9.2 g, with an average of 6.7 g. Similarly, Ojha *et al*. (2009) [10] noted a pupal weight of 9.02 g.

The adult stage shows sexual dimorphism in size, with males measuring 47 to 62 mm in length and 124 to 160 mm in breadth with expanded wings, while females range from 50 to 70 mm in length and 135 to 170 mm in breadth. Bambhaniya *et al*. (2017) [2] recorded female dimensions ranging from 48 to 74 mm in length and 134 to 171 mm in breadth, with an average of 59.92 ± 8.52 mm and 153.76 ± 9.31 mm, respectively. In males, the length varied from 45 to 60 mm, and the breadth ranged from 125 to 155 mm, with an average of 51.24 ± 3.82 mm and 139.63 ± 8.98 mm. Jayaprakash *et al*. (2002) [7] and Rao *et al*. (2002) [13] reported similar values, further validating our findings.

The observed morphometric variations in *A. mylitta* across different developmental stages are consistent with prior research (Chikkaswamy *et al*., 2007; Jayaprakash *et al*., 2002) [4, 7]. The life span varies between 60 and 80 days, and bivoltine species yield two crops annually (Thangavelu *et al*., 1991) [16]. The variations in larval instars and pupal size suggest that environmental factors such as temperature and

humidity significantly influence growth parameters (Thangavelu *et al*., 1991) [16]. The findings related to adult size, particularly the pronounced sexual dimorphism, further validate studies by Rao *et al*. (2002) [13] and Rath *et al*. (2011) [14]. The insights gained from this study contribute to an improved understanding of Tasar silk production and its role in enhancing the livelihood of rural communities engaged in sericulture. The economic impact of Tasar sericulture in Vidarbha is significant. On 1100 hectares of Silk Development Department land and 7000–8000 hectares of forest department land, *A. mylitta* rearing provides an annual income of ₹30,000–₹35,000 per family. Women play a crucial role in post-rearing activities such as boiling cocoons and extracting spun silk (Taufique & Hoque, 2021) [15].

Conclusion

The study provides comprehensive insights into the life cycle, growth patterns, and biological characteristics of *A. mylitta* Daba-BV in the Vidarbha region, confirming its adaptability to *Terminalia arjuna*. The observed morphometric variations across different developmental stages indicate that environmental conditions play a significant role in influencing growth and survival. The findings are consistent with previous studies and support the viability of tasar sericulture as a sustainable livelihood option. Given its economic importance, tasar silk production contributes significantly to rural and tribal communities in Maharashtra, offering financial stability and employment opportunities. Enhancing scientific knowledge on *A. mylitta* biology can further improve silk productivity and quality, ensuring long-term sustainability in tasar sericulture.

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