

Comprehensive life cycle and larval morphometrics of *Parasa lepida* (Lepidoptera: Limacodidae): A serious pest of *Terminalia bellirica*

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Abstract

The current research offers comprehensive insights into the life cycle of *Parasa lepida* Cramer (Lepidoptera-Limacodidae). It is the serious pest of *Terminalia bellirica* tree. The larvae are polyphagous, feeding on the foliage of *Terminalia bellirica*. It also documents the existing lengths and widths of larvae of *Parasa lepida* Cramer found in the Dnyanganga Wildlife Sanctuary (DWLS), Buldana. Research findings document the development stages from egg to adult, focusing on the larval dimensional characteristics and instar durations. Data collected from developmental studies carried out in laboratory environments showed that the incubation period for eggs ranged from 4 to 5 days. The first instar duration was between 2 to 3 days. The second instar persisted for 4 to 6 days, while the third instar took 5 to 7 days to complete. The fourth instar required 6 to 7 days before progressing to the fifth instar. The fifth and sixth instars needed 7 to 8 days and 6 to 8 days, respectively, whereas the seventh instar lasted for 5 to 7 days. Upon finishing the larval stage, the seventh instar larva gradually transitioned to a pre-pupal form within 5 to 6 days. The pupal case was characterized by a hard, oval shape, and the pupal duration ranged from 30 to 32 days. Adult longevity varied from 4 to 8 days.

Keywords: *Parasa lepida*, *Terminalia bellirica*, morphometrics, DWLS, nettle caterpillar

Introduction

Terminalia bellirica, belonging to the Combretaceae family, is a sizable deciduous tree commonly found throughout India at altitudes reaching up to one thousand meters, (Row, L.R., *et al.*, 1970) ^[1]. This tree usually reaches a height of 30 to 40 meters, featuring its alternate, broadly elliptical leaves grouped near the tips of the branches. The leaves measuring between 10 to 12 cm in length and 7 to 14 cm in width exhibit a remarkable range of size and shape, reflecting the adaptability of the plant within its environment, (Shankar, M., *et al.*, 2014) ^[2]. It is a significant tree species widely distributed across the India, particularly in states such as Maharashtra, Madhya Pradesh, Uttar Pradesh, and Punjab, (Sharma, P.C., *et al.*, 2005) ^[3]. The tree is popularly known as Beheda or Bahera, which comes from its name in Marathi. In Sanskrit, it is called by several names, including vibhitaki, karshaphala, and kalidruma, (Anand, K.K., *et al.*, 1997) ^[4]. The flowers are small and are characterized by a dirty grey or greenish-yellow color, accompanied by a strong, unpleasant smell, and they are organized in axillary spikes. The fruit has an ovoid shape and features velvety grey drupes that hold a single hard stony seed, exhibiting a subtle 5-angled appearance when dried, (Meena, A.K., *et al.*, 2010) ^[5]. Blooming takes place from March to May, with fruit ripening occurring between December and February. The bark has a brownish-grey colour, (Narendra, K., *et al.*, 2018).

Plants are recognized for generating numerous bioactive compounds and serve as a valuable source of medicinal resources. Herbal products can be isolated and evaluated for their medicinal potential, (Deb, A., *et al.*, 2016) ^[7]. Herbal medicines are crafted from diverse plant parts, including leaves, stems, roots, and bark, (Saraswathi, M.N., *et al.*, 2012; Chanda, S., *et al.*, 2013) ^[8, 9]. The dried ripe fruit of *Terminalia bellirica* has a long-standing history of use in treating diarrhea, cough, dropsy, piles, leprosy, hoarseness,

eye ailments, scorpion stings, and for promoting hair health, (Kumar, B., *et al.*, 2010) ^[10]. Additionally, medicinal plants play a crucial role in the healthcare of people in rural areas, (Abraham, A., *et al.*, 2014) ^[11]. In India, approximately 45,000 plant species have been identified, with around 15,000 to 20,000 possessing significant medicinal properties, (Mallik, J., *et al.*, 2012) ^[12].

Pest infestations on forest flora have become a challenge in the production and use of various forest products, (Rathore, P., *et al.*, 2008) ^[13]. Numerous plants function as hosts for various insect species during their growth and adult stages. Insects from the Lepidoptera order primarily feed on the leaves of wild or cultivated plants, (Panda, N., 1979; Onyenweaku, L.N., *et al.*, 2017) ^[14, 15]. The insatiable appetite of their larvae for the tender foliage of host plants can adversely impact plant productivity and threaten their survival in certain circumstances, (Srivastava, K.M. *et al.*, 1976) ^[16]. *Terminalia bellirica* trees regularly face attacks from different insect pests in the wild, with approximately 150 species reported; however, only a handful of these pests are deemed significantly problematic, (Prabhu, V.V., *et al.*, 2012) ^[17].

The order Lepidoptera ranks as the second largest in the class Insecta and is considered a vital component of biodiversity, (Nakano, K., 2003) ^[18]. Many species within this order are recognized as significant pests affecting agricultural and plantation crops, as well as forest plants, (Yamazaki, K., *et al.*, 1994; Meshram, P.B., *et al.*, 2000) ^[19, 20]. Typically, adult Lepidoptera have short lifespans, feeding on nectar and various fluids, while their immature stages consume foliage and may bore into the shoots, fruits, and trunks of trees. Some species exhibit carnivorous behavior, (Nair, S.S., 2007) ^[21]. *Parasa lepida*, commonly known as the nettle caterpillar or blue-striped nettle grub, belongs to the family Limacodidae. This species is found in

Asia and has been identified as a minor pest of coffee in countries including India, Sri Lanka, Vietnam, Malaysia, and Indonesia, (Chaudhary, N.J., *et al.*, 2017) [22]. The larvae, which are the destructive phase of this insect, primarily consume the lower epidermis of leaves. If accidentally contacted, the public may experience skin irritation and inflammation from this insect, (Kalia, S., *et al.*, 2014) [23]. The larvae are polyphagous, feeding on the foliage of *Terminalia bellirica*, and have also been recorded as pests of mango (Kapoor, K.N., *et al.*, 1985) [24], Kumbha (Mamlayya, A.B., *et al.*, 2015) [25], coffee, and coconut.

Materials and methods

Study area

This study was conducted at the Dnyanganga Wildlife Sanctuary (DWLS), also known as Botha Forest located in Buldana district. The sanctuary is geographically situated between 75°087' to 76°096' N longitude and 19°083' to 21°021' E latitude, in the northern region of Maharashtra, India. The sanctuary hosts a variety of plant species adapted to the dry deciduous habitat. It is characterized by its rich biodiversity and variety of habitats suitable for numerous Lepidopteran species. Beheda trees, valued for their medicinal properties and timber, are abundant in this area, making them susceptible to pest infestations. Investigations were carried out in study areas to observe the reproductive activities of *Parasa lepida*, which were noted to lay eggs specifically on *Terminalia bellirica*. Leaf materials, along with eggs and various larval stages, were collected for the laboratory incubation. Fresh leaves were provided daily to the developing larvae. Observations were made on hatching times and success rates, larval growth and survival, pupal development, and adult emergence, with the larvae's performance being analyzed by instar.

Data collection

Samples were collected systematically across various developmental stages. The life cycle stages were monitored in a laboratory setting to record specific durations of each instar and morphometric data, including lengths and widths of larvae. Measurements were taken using calipers to ensure precision, and the sample size consisted of a range of specimens for statistical reliability.

Observations of larval development

Eggs: The eggs were round and greenish in colour. Female *P. lepida* deposit them in batches of 20 to 30 on the undersides of leaves. The diameter of newly laid eggs varied between 0.4 to 0.6 mm, with an average measurement of 0.5 ± 0.02 mm. The incubation period for *P. lepida* varied from 4 to 5 days, averaging 4.5 ± 0.29 days. The hatching rate of the eggs ranged from 70 to 95%, depending on conditions of approximately 30°C and 65.87% relative humidity.

1st Instar: *P. lepida* larvae progress through seven instars. The newly emerged first instar larva displays a yellowish-green coloration with small spiky setae across its body, and a small parallel green line can be noted on the dorso-lateral side. The larvae's length and width measure between 3 to 4 mm (averaging 3.5 ± 0.28 mm) and 0.47 to 0.49 mm (averaging 0.48 ± 0.01 mm), respectively. The first instar stage lasts between 2 to 3 days, with an average duration of 2.6 ± 0.51 days.

2nd Instar: Second instar larvae are light green with creamy tones, adorned with parallel white stripes on the dorsal side and numerous stinging setae covering the body. These larvae typically feed on the lower surface of mature leaves. The length and width range from 4 to 7 mm (averaging 5.5 ± 0.86 mm) and 0.60 to 0.74 mm (averaging 0.70 ± 0.02 mm), respectively. The second instar period spans 4 to 6 days (averaging 5.0 ± 0.57 days).

3rd Instar: Third instar larvae exhibit a bright green color and are known for their active and voracious feeding habits. They possess poisonous bristle-like hairs that may provoke allergic reactions upon contact with skin. The length and width of third instar larvae are 6 to 8 mm (averaging 7.0 ± 0.57 mm) and 2.65 to 2.79 mm (averaging 2.72 ± 0.04 mm), respectively, with a larval duration of 5 to 7 days (averaging 5.8 ± 0.58 days).

4th Instar: Fourth instar larvae are aggressive and greenish, displaying white lines on their bodies. They are known to defoliate the leaves of the Beheda tree. These larvae feature bristle-bearing protrusions on their body surfaces. The fourth instar larvae measure 8 to 10 mm (averaging 9.1 ± 0.59 mm) in length and 3.15 to 3.23 mm (averaging 3.19 ± 0.03 mm) in width, with a larval period of 6 to 7 days (averaging 6.5 ± 0.30 days).

5th Instar: The fifth instar larvae are visually appealing, exhibiting a light green coloration. They have a prominent self-defense mechanism characterized by four rows of spiny red scoli located at both anterior and posterior ends, which can cause skin irritation and pain to humans. These larvae have a length ranging from 11 to 14 mm (averaging 12.5 ± 0.87 mm) and a width from 4.88 to 4.97 mm (averaging 4.92 ± 0.02 mm), with a larval period lasting from 7 to 8 days (averaging 7.5 ± 0.52 days).

6th Instar: Sixth instar larvae display a cryptic coloration pattern, equipped with protuberances and sting spines along their dorsal surface. They possess the ability to camouflage within their natural environment. Their measurements range from 14 to 15 mm (averaging 14.5 ± 0.29 mm) in length and 5.62 to 6.12 mm (averaging 5.87 ± 0.14 mm) in width, with a larval duration of 6 to 8 days (averaging 7.0 ± 0.59 days).

7th Instar: The final instar is characterized by large, grass-colored larvae that demonstrate unique locomotion techniques. They utilize abdominal sucker appendages for movement and secrete a semi-fluid silk to enhance their adhesion to substrates. The seventh instar larvae measure between 15 to 20 mm (averaging 17.5 ± 1.44 mm) in length and 5.6 to 6.3 mm (averaging 5.95 ± 0.21 mm) in width, with their larval period ranging from 5 to 7 days (averaging 6.0 ± 0.58 days).

Pre-pupal Stage: The pre-pupal stage of *Parasa lepida*, a moth species, represents a significant transitional period before pupation. During this phase, the length and width varied from 12 to 13 mm (averaging 12.6 ± 0.30 mm) and 4 to 6 mm (averaging 5.0 ± 0.57 mm), respectively. Generally, the pre-pupal stage spans roughly 5 to 6 days, with an average duration of 5.5 ± 0.29 days. The larva undergoes notable physical transformations, including a

reduction in body size, alterations in body color or texture, and the preparation of its pupal chamber. The larva may create a pupal chamber by spinning silk or by utilizing pre-existing structures like leaf rolls or twig hollows. Upon completing the pre-pupal stage, the larva transitions into the pupal stage.

Pupal (Cocoons) Stage: Pupae are characterized by a robust, chocolate brown shell-like silken cocoon, which eventually transitions to a dark ash hue. The larvae create oval-shaped cocoons that are flattened on one side, typically found attached to stems or leaves in the field. The cocoons feature a circular line on the front side, from which the pupa pushes off a circular cap just prior to moth emergence. The

length and width of pupae range from 11 to 12 mm (averaging 11.5 ± 0.30 mm) and 5 to 6 mm (averaging 5.5 ± 0.29 mm), respectively. The pupal period for *P. lepida* spans from 30 to 32 days (averaging 31.0 ± 0.60 days).

Adult Stage: The adult moths of *P. lepida*, both male and female, exhibit green and brownish coloration alongside black compound eyes. Their wing expansions measure between 17 to 18 mm (averaging 17.5 ± 0.31 mm) in length and 35 to 38 mm (averaging 36.5 ± 0.87 mm) in width. The lifespan of the adult's ranges from 4 to 8 days (averaging 6.0 ± 1.15 days).

Result and Discussion

Table 1: Morphometric data and duration of different stages of *Parasa lepida*

Stages	Particulars	Morphometric data (in mm)			Duration (in days)		
		Min	Max	Mean + SD	Min	Max	Mean + SD
Egg Incubation Period (EIP)	Diameter	0.4	0.6	0.5 ± 0.02	4	5	4.5 ± 0.29
1 st Instar	Length	3	4	3.5 ± 0.28	2	3	2.6 ± 0.51
	Width	0.47	0.49	0.48 ± 0.01			
2 nd Instar	Length	4	7	5.5 ± 0.86	4	6	5.0 ± 0.57
	Width	0.60	0.74	0.70 ± 0.02			
3 rd Instar	Length	6	8	7.0 ± 0.57	5	7	5.8 ± 0.58
	Width	2.65	2.79	2.72 ± 0.04			
4 th Instar	Length	8	10	9.1 ± 0.59	6	7	6.5 ± 0.30
	Width	3.15	3.23	3.19 ± 0.03			
5 th Instar	Length	11	14	12.5 ± 0.87	7	8	7.5 ± 0.52
	Width	4.88	4.97	4.92 ± 0.02			
6 th Instar	Length	14	15	14.5 ± 0.29	6	8	7.0 ± 0.59
	Width	5.62	6.12	5.87 ± 0.14			
7 th Instar	Length	15	20	17.5 ± 1.44	5	7	6.0 ± 0.58
	Width	5.6	6.3	5.95 ± 0.21			
Pre-Pupal	Length	12	13	12.6 ± 0.30	5	6	5.5 ± 0.29
	Width	4	6	5.0 ± 0.57			
Pupa	Length	11	12	11.5 ± 0.30	30	32	31.0 ± 0.60
	Width	5	6	5.5 ± 0.29			
Adult	Length	17	18	17.5 ± 0.31	4	8	6.0 ± 1.15
	Width	35	38	36.5 ± 0.87			

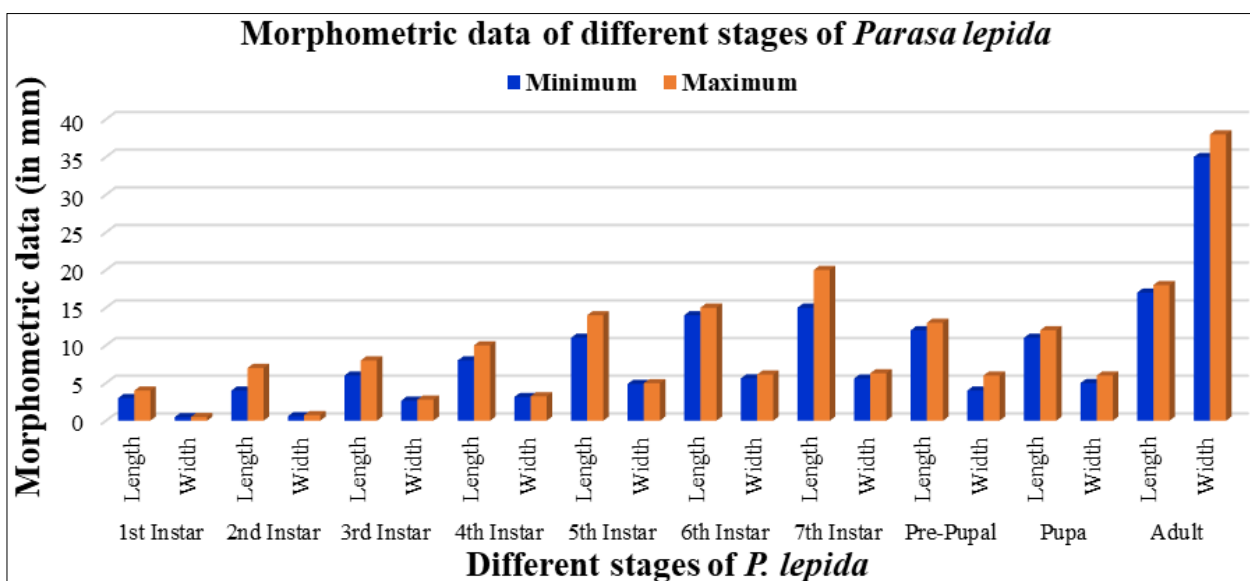


Fig 1: Morphometric data of different stages of *Parasa lepida*

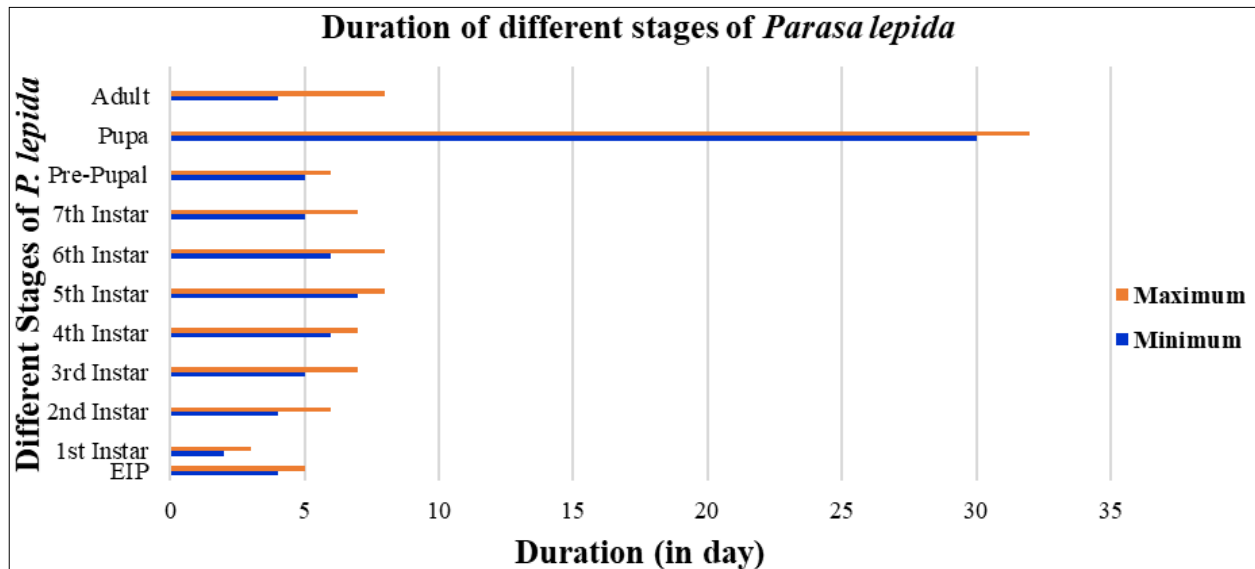


Fig 2: Duration of different stages of *Parasa lepida*

The life cycle insights of *Parasa lepida* provide invaluable data that emphasize the dynamics of its development within the Dnyanganga Wildlife Sanctuary. The variable durations of instars might suggest a level of adaptability to environmental conditions, which can be affected by factors like temperature, food resources, and predation pressures. In the current study, the greenish, round shaped eggs of *P. lepida* are deposited in overlapping clusters on the undersides of leaves. The data presented in Table 1 shows that the diameter of freshly laid eggs ranges from 0.4 to 0.6 mm. The incubation period for *P. lepida* varies from 4 to 5 days, while Beeson (1941)^[26] noted a hatching duration of 6-8 days. Further descriptions by Browne (1968)^[27] indicate that the first instar larvae remain exposed on the outer edges of the eggs for a time before crawling to the leaves to feed exclusively on the epidermis. Subsequent instars feed from the leaf margins inward, avoiding the midvein. It was also noted that all instars, except for the sluggish and dull mature last instar, tend to feed gregariously on the mature leaves. After undergoing seven larval instars, the larvae enter the pupation phase, which takes between 35 to 46 days; Beeson (1941)^[26] reported an average duration of eight weeks. The information in Table 1 and depicted graphically in Fig. 2 illustrates the duration of the various stages of *Parasa lepida*. The larvae are covered in numerous hairs, which are toxic and can cause irritation upon handling. When fully developed, the larvae measure between 2 to 3 cm.

Pupation also occurs in a gregarious manner within hard, rough cocoons. The mature larva spins a whitish silken web, incorporating spiny and irritant exuviae to form its cocoon. This cocoon is typically spheroid in shape and is secured by silken threads, (Sawada, H., *et al.*, 2008)^[28] reported that the pupal stage lasts for 40 to 50 days, with an extended prepupal stage occurring under unfavorable conditions.

Conclusion

The insights gained from the study of *Parasa lepida* Cramer within the Dnyanganga Wildlife Sanctuary significantly contribute to the broader understanding of Lepidopteran life cycles. The documented durations across various life stages, along with larval morphometrics, are crucial for future studies in ecology, biodiversity conservation, and pest management strategies. This study highlights the emergence

of *Parasa lepida* as a serious pest of *Terminalia bellirica* in the sanctuary. The study found that average diameter of freshly laid eggs was 0.5 ± 0.02 mm, with an average incubation period of 4.5 ± 0.29 days observed under laboratory conditions and an average hatching percentage of 82.50%. The total larval duration for *P. lepida* ranged from 35 to 46 days, averaging 40.52 ± 3.18 days. The average pre-pupal length and width were recorded at 12.6 ± 0.30 mm and 5.0 ± 0.57 mm, respectively, with a pre-pupal stage lasting an average of 5.5 ± 0.29 days. The average dimensions of the adult were 17.5 ± 0.31 mm in length and 36.5 ± 0.87 mm in width, with the pupal stage lasting an average of 31.0 ± 0.60 days and the adult stage averaging 6.0 ± 1.15 days.

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