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Study on the life cycle of the butterfly, *Phalanta phalantha phalantha* (Drury, [1773]) (Lepidoptera: Nymphalidae), in the laboratory and natural habitats

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Abstract

The life cycle of the Common Leopard Butterfly *Phalanta phalantha phalantha* was studied under laboratory conditions (RH 34%, Temp. 28.5°C) by providing fresh leaves of Rukam Asam *Flacourtia montana* and in the natural habitat (on plant *F. montana*) during the winter. The life cycle consists of four life stages: egg, larva (five instars), pupa and adult with an average duration of egg: 4 days, larva: 24 days (laboratory condition) /27 days (natural condition), pupa: (lab-8 days and natural-9 days) and adult: 6 days. The life cycle was completed within 42 (lab. condition)-46 (natural) days. The fifth instar larval duration was less by 3 days and the pupal stage was less by 1 day under laboratory conditions than natural conditions. The study concluded that climatic factors greatly impact the duration of each life stage in butterflies.

Keywords: Biology, common leopard, Rukam, Assam, butterflies, natural habitats

Introduction

It is very important to study the organism using its morphology, habit, habitat and most importantly its life cycle ^[1]. Moreover, to study the ecosystem, it is important to study the organisms. Butterflies are an extremely important group of 'model' organisms used for population dynamics study and biodiversity conservation ^[2]. Being a holometabolous insect, the egg, larva, pupa and adult are the four distinct stages of the life cycle of the butterfly. According to The life cycle length of a butterfly varies greatly between species ^[3]. The butterfly, commonly known as the Common Leopard (*Phalanta phalantha phalantha*) belongs to the family Nymphalidae, which is one of the largest families available in all parts of the world ^[4]. It is one of the most common butterflies found up to about 2,000 m in drier and more open areas. Its abundance is more after the rain. It is a beautiful, sun-loving butterfly distributed throughout India, Burma and Sri Lanka ^[5]. It is a fast and quick flier and the flight has jerky movements ^[4]. As the number of butterflies is decreasing day by day, the conservation of butterflies can be done by captive rearing or breeding and then releasing them into their natural habitat ^[6,7,8,9,10]. In the present work, the life cycle of the *P. phalantha phalantha* has been studied under laboratory and natural conditions and the climatic factors during the study have been also given.

Materials and Methods

The present study was carried out in natural conditions at Sahyadri Butterfly Park and in laboratory conditions at the Department of Zoology, Shivaji University, Kolhapur in the year 2023. The eggs were observed on the host plant *Flacourtia montana* and counted. The host plant was identified by expert Dr. M. M. Lekhak, Associate Professor, Department of Botany, Shivaji University Kolhapur. The exact date and time of hatching were recorded by close observation in natural conditions.

Laboratory observations: After hatching larvae were brought to the laboratory and maintained in 23 x 15 cm plastic containers for rearing. For early instar feeding, the succulent twig of *F. montana* was inserted in a water-soaking sponge to keep leaves fresh for longer.

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Later, fresh leaves were provided two times a day. The instar number was confirmed after the collection of the head capsule of each instar.

Natural observations: After observation of eggs, the branches of the host plant were covered with a nylon mesh to avoid predation and spreading of caterpillars to other branches. Observations were made for each life stage.

The climatic factors (temperature and relative humidity) were measured with the help of a digital Hygrometer. The egg, 1st and 2nd instar was photographed using a compound microscope (Olympus CX31) with an attached camera. Photography of other life stages was done using a Canon 550D DSLR camera. The photos were stacked in Helicon Focus 7 software. Stacked photos were edited in Photoshop C53. For the measurement of length IMAGE J software was used.

Results and Discussion

The life cycle consists of four life stages: egg (4 days), larva (under lab. condition-24 days and 27 days in natural habitat), pupa (8 days under lab. condition and 9 days in natural habitat) and adult (6 days under lab. condition). The entire life cycle was completed within 42 (laboratory condition)-46 (natural condition) days. (The details about the duration, biometry of different life stages and relative temperature (°C) and humidity (RH) during each life stage are given in Table 1).

1) Egg stage: Eggs were deposited singly on the upper or lower margin of the tender leaves of the host plant and measured 0.76 ± 0.01 mm in height and 0.66 ± 0.01 mm in diameter. The eggs were whitish-yellow when laid, and became white with a black spot at the tip, at the time of hatching. Eggs were dome-shaped with longitudinal sculptured ridges. The incubation period of eggs was 4 days. The temperature recorded during this stage was 28.13°C in the laboratory and 31.4°C in the natural habitat, while the RH in the laboratory was 39% and in the natural habitat was 25.14%.

2) Larval stage: There are five hairy, varied-coloured larval instars based on collected head capsules throughout the larval duration.

First instar: Body measured 57 ± 0.01 mm long and 0.51 ± 0.01 mm wide. It is black-headed, light brown, shiny and covered with minute hairs. The hair bases with whitish spots. After hatching, this instar ate the eggshell first, and later on fed on tender leaves, mostly the tip of a leaf. A body with three longitudinal rows of branched hairs on each side namely dorsolateral, lateral and ventrolateral with 9, 10 and 12 hair groups respectively. The life duration was 5 days. The temperature recorded during this stage was 27.31°C in the laboratory and 29.9°C in the natural habitat, while the RH in the laboratory was 27.18% and in the natural habitat was 30%.

Second instar: Body 4.71 ± 0.006 mm long and 0.85 ± 0.009 mm wide. It is black-headed and its body is dark brown with branched black coloured hairs in groups. Hair bases and segments are clear. Mid dorsal line was observed from this stage. This instar lasts for 5 days. During this phase, the temperature was 27.18°C measured in the laboratory and

30.28°C in the natural habitat. The RH was 34% in the laboratory and 29.84% in the natural habitat.

Third instar: Body 7.8 ± 0.37 mm long and 1.8 ± 0.37 mm wide. It is black-headed having a central white spot. Body colour turns brown with black-coloured branched hairs. A whitish line was developed at the lateral sides of the body. Hair bases were surrounded by a yellow ring, and around this yellow ring white ring was present. The duration of this instar was 4 days. The temperature recorded during this stage was 28.01°C in the laboratory and 29.5°C in the natural habitat, while the RH in the laboratory was 34.66% and in the natural habitat was 29.16%.

Fourth instar: The third and fourth instars are similar in characters except for their size. It was measured 11.16 ± 0.37 mm in length and 3.16 ± 0.37 mm in width. The Head has a central white spot with an orange-coloured anterior portion and black coloured posterior portion. Hairs on the body were dense, body colour was dark brown. Hair bases were surrounded by black rings first then yellow rings. The duration of this instar was about 4 days. The temperature recorded during this stage was 26.9°C in the laboratory and 29.16°C in the natural habitat, while the RH in the laboratory was 33.83% and in the natural habitat was 30.66%.

Fifth instar: It was measured 15.33 ± 0.47 mm in length and 4.83 ± 0.37 mm in width. The Head had an orange-coloured anterior portion and a black-coloured posterior portion with a central white spot. Hairs remained dense, body colour changed into blackish brown, black rings were dark, and lateral white lines were thick and dark. Before pupation, this instar became whitish dull coloured, stopped feeding and the body contracted for pupation. The larval duration of this instar was comparatively longer than other instars and it was 6 days under laboratory conditions and 9 days in their natural habitat. During this stage, the laboratory recorded a temperature of 28.26°C , while the natural habitat had a temperature of 30.06°C . The relative humidity in the laboratory was 33.5%, and in the natural habitat, it was 30%.

3) Pupal stage: Newly formed chrysalis was green-coloured and smooth with 11 pairs of spiny projections on the dorsal side. It was measured 13.83 ± 0.37 mm in length and 6 ± 0 mm in width. These projections changed into silver colour with red coloured tips in the mature pupa. The mature pupa was green-coloured. The pupa was attached to the leaf from its abdominal side. Before emergence, the pupa became blackish coloured showing wing impressions having orange colour with black spots. The pupal period lasts for 8 days under laboratory conditions and 9 days in natural habitat. During this stage, the temperature of the lab was 26.53°C , while the natural habitat had a temperature of 28.98°C . The RH in the laboratory was 29%, while in the natural environment it was 28.33%.

4) Adult: The colour of the wings was orange-brown with several black spots and wavy lines. The ventral side is light brown and shows the same spots but they are not distinct. Body length was 16-18 mm and wingspan were 42-44 mm. Adults lived for 6 days in laboratory conditions. The observation on adult life duration was not recorded in natural habitat. However, the naturally obtained adults in the nylon mesh also survived for 6 days in the laboratory. At this stage,

the laboratory's temperature measured 27.18 °C, whereas the natural habitat recorded a temperature of 29.9 °C. The relative humidity in the lab was 34.66%, compared to 30.66% in the natural setting.

Climatic factors affect the fecundity ^[11], and rate of development ^[12] of butterflies. Therefore, the life cycle of butterflies can be recorded with shorter and longer periods depending on the climate. Kakati *et al.* ^[5] studied the life cycle of *P. phlanatha phlanatha* from Assam. They have mentioned that the egg period is two days and four larval instars with one mature fourth instar. Similarly, Rayalu *et al.* ^[13], studied the life cycle of the same butterfly from Visakhapatnam. In this, they have recorded an egg period of 3 days, a larval stage of 10-12 days (four instars) and a pupal stage of 6 days. In the present study, slightly different observations regarding duration and the number of instars

have been recorded like an egg: 4 days, larva: 24 days (laboratory condition) / 27 days (natural condition), pupa: (Lab-8 days and natural-9 days) and adult: 6 days are recorded. The five instars of larvae were observed which we determined after collecting the head capsule of each instar in the larval stage.

According to Rayalu *et al.*, ^[13], the total development period from egg laying to adult eclosion was 20.20 days with four larval instars at 28±2 °C temperature and 80±10% humidity from Visakhapatnam, South India. The temperature recorded in the laboratory and natural environment during the study ranged from 26.53±1.77 to 28.26±1.22 and 29.16±1.80 to 31.4±2.65 respectively. Also, the humidity recorded in the laboratory and natural environment was between 27.18±1.69% to 39±6.40% and 25.14±4.76% to 30.66±1.37% respectively.



Fig 1: *Phalanta phalantha phalantha* life cycle – adult: dorsal view A. Ventral view B. Egg C. Larva: First instar D. Second instar E. Third instar F. Fourth instar G. Fifth instar H: Head capsules of first instar I. second instar J. Third instar K. fourth instar L. fifth instar M. Pupa: Early pupal stages N-P. late pupal stages Q-S: fresh dosed adult T: Host plant *Flacourita montana* having caterpillars covered with nylon mesh U

Table 1: Duration and biometry of different life stages of *Phalanta phalantha phalantha* and related climatic factors.

Life stages	Duration (Days)		Biometry				Climatic Factors			
	Laboratory condition	Natural condition	Laboratory condition		Natural Condition		Laboratory condition		Natural condition	
			Length (mm)	Width (mm)	Length (mm)	Width (mm)	Temp (°C)	RH (%)	Temp (°C)	RH (%)
Egg	4	4	0.76±0.01	0.66±0.01	0.76±0.01	0.66±0.01	28.13±1.26	39±6.40	31.4±2.65	25.14±4.76
Larva	5	5	2.57±0.01	0.51±0.01	2.57±0.01	0.51±0.01	27.31±1.28	27.18±1.69	29.9±1.12	30.5±1.80
1 st instar	5	5	4.71±0.006	0.85±0.009	4.71±0.006	0.85±0.009	27.18±1.69	34±4.20	30.28±2.06	29.84±0.54
2 nd instar	4	4	7.8±0.37	1.8±0.37	12±0.57	3.16±0.37	28.01±0.81	34.66±3.81	29.5±3.53	29.16±4.41
3 rd instar	4	4	11.16±0.37	3.16±0.37	13.33±0.47	4.16±0.37	26.9±1.65	33.83±6.74	29.16±1.80	30.66±1.37
4 th instar	6	9	15.33±0.47	4.83±0.37	20.5±1.80	5.16±0.37	28.26±1.22	33.5±3.59	30.06±1.35	30±1.29
5 th instar	6	9	13.83±0.37	6±0	13.83±0.37	6.16±0.37	26.53±1.77	29±3.36	28.98±0.71	28.33±4.45
Pupa	8	9	12.83±2.47	40.33±3.77	12±1	40.33±3.77	27.18±1.69	34.66±3.81	29.9±1.12	30.66±1.37
Adult	6	6								
Total	42*	46*								

* Including caged adult life, n =6

Conclusion

Changes in host plant species, climate and geographical area affect species' life cycle. The present study provides information on the Common Leopard (*Phalanta phlanatha phlanatha*) butterfly's life cycle from egg laying to adults' eclosion. It has completed its life cycle on the host plant *Flacourtia montana* through five larval instars. The developmental period from egg to eclosion of adults was 36 days in laboratory conditions and 42 days in natural conditions.

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Conflict of Interest

The authors declare no conflict of interest.

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