*Int. J. Adv. Res. Sci. Technol. Volume 3, Issue 3, 2014, pp.191-195*

IJARST

*International Journal of Advanced Research in Science and Technology*

journal homepage: www.ijarst.com

**ISSN 2319 – 1783 (Print)**
**ISSN 2320 – 1126 (Online)**

# Life history and larval performance of the Common Leopard butterfly, *Phalanta phalantha* Drury(Lepidoptera: Rhopalocera: Nymphalidae)

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**ARTICLEINFO**

***Article history:***

| | |
|---|---|
| Received | 24 Nov. 2014 |
| Accepted | 10 Dec. 2014 |
| Available online | 15 Dec. 2014 |

***Keywords:***
Life history,
*Phalanta phalantha*,
Captive rearing,
Immature stages,
Food utilization indices.

**ABSTRACT**

The life history of the Common leopard butterfly, *Phalanta phalantha* and larval performance in terms of food consumption and utilization, and the length of life cycle on its host plant *Flacourtia indica*are described for the first time. The study was conducted during 2009 at Visakhapatnam (17$^{o}$ 42' N and 82°18' E), South India. *Phalanta phalantha* completes its life cycle in 19 – 21 (20.20 ± 0.84) days (Egg: 3; Larva: 10-12; Pupa: 6 days). The values of nutritional indices across the instars were AD (Approximate Digestibility) 66.49 – 96.29%; ECD (Efficiency of Conversion of Digested food) 1.95 – 30.12%; ECI (Efficiency of Conversion of Ingested food) 1.88 – 20.03%, measured at the temperature of 28 ± 2$^{0}$ C and RH of 80 ± 10% in the laboratory. These relatively high values of ECD and ECI explain at least partially the ecological success of *Phalanta phalantha* in the urban environment of Visakhapatnam.



## Introduction:

India hosts about 1501 butterfly species (12). But, in the past few decades, butterfly populations in India have declined (13), and it is often suggested that captive rearing/breeding and releasing of butterflies in the wild will help restock at-risk populations and serve as a means of conservation (7,17,20,26). Several zoos and other facilities currently engaged in captive rearing programs for protected butterfly species. For example, the American Zoo and Aquarium Association recently launched the butterfly conservation initiative, which reflects the mandate of 53 zoos and associated organizations to engage in local (North American) conservation efforts by supporting the recovery of 22 butterfly species, largely with captive propagation programs (http://www.butterflyrecovery.org/recovery/). Similarly, for 10 of 25 at-risk British butterfly species with a Species Action Plan, reintroduction, often implemented with captively propagated stock, is a priority (http://www.butterfly-conservation.org/). The basic protocol is to collect eggs from wild-mated female, rear larvae to adult butterflies in captive propagation facilities, and release adults/pupae back into wild populations (7).

For the development of effective breeding/rearing programs and conservation management of butterflies, information on the life history, immature stages (19) and exact habitat requirements is essential (8,9,10). Further, immature stages of butterflies are increasing importance as sources of systematic characters, and often give important clues as to the placement of species in major groups (11). Haribal (15) noted that such information is lacking for 70% of the Indian butterflies. In this sense the present study furnished the necessary information about immature stages, larval performance on its host plant *Flacourtia indica* (Burm.f.) Merr., and the length of life cycle from egg to adult eclosion for the butterfly species, *Phalanta phalantha*Drury.There are only 6 species of *Phalanta* Horsfield present in the world, of which two (*alcippe* Stoll., *phalantha* Drury) occur in India. *P. phalantha* is distributed in entire oriental region, China and Japan.

## Methodology:

The present study was carried out at Visakhapatnam during the calendar year 2009. Visakhapatnam (17$^{o}$ 42' N latitude and 82°18' E longitude) is located on the east coast of India in the State of Andhra Pradesh. The reproductive activity of the Common Leopard butterfly, *Phalanta phalantha*was

observed regularly during 0800 to 1500 h at two sites viz. Andhra University campus and the Zoo Park area, 5 km away from the campus. Once adult butterflies were located detailed observations were made in order to observe the period of copulation and oviposition. After detecting ovipositions, the leaf with eggs was collected in Petri dishes (15 cm × 2.5 cm depth) and brought to the laboratory. The leaf piece with eggs was then placed in a smaller Petri dish (10 cm × 1.5 cm depth), that was lined with moistened blotter to prevent leaf drying. Such Petri dishes were kept in a clean, roomy cage fitted with wire gauge. Since ants were never detected, no special protection device was tried to avoid predation of eggs. They were examined regularly at 6 h interval for recording the time of hatching. Each of the freshly emerged larvae was transferred to a clean Petri dish lined with moistened blotter with the help of a camel hairbrush. The larvae were supplied daily with weighed quantity of tender leaf pieces of the host plant. The faeces and the leftover of the food was collected and weighed each day (24 h). The growing larvae were observed regularly to note the change of instar, and characters including length, breadth and weight measurements. Larval performance in terms of food utilization indices were calculated as described by Waldbauer (32).

Five replications were maintained for the study of all parameters. Fresh weight measurements were used for the purpose. The development of pupa from full grown larva andparticulars of pupa including color, shape, size, weight and the time of adult eclosion were also recorded. Millimetre graph paper was used for taking measurements. The laboratory temperature was 28 ± $2^0$ C and relative humidity 80 ± 10% with normal indirect sunlight conditions that varied in duration between 12 h during November/ January and 14 h during June/July.

In describing the details of adult characters, the butterflies that have emerged from the pupae in the laboratory, and those caught in the wild were used.

**Results:**

**Adult stage** (Fig. 1a)**:**

The male and female look similar. Upperside tawny with rows of black spots and wavy lines. The black spots are slightly larger in females. Underside light brown and markings as upperside but indistinct. Wingspan is between 50 – 60 mm. It is sun loving and avoids shade. Have sharp and active flight movements. A regular basker with wings spread wide –open. It comes out late in the morning, only when the sun is very clear.

**Food resources:**

It kept its wings full spread while foraging at flowers for nectar. In the study area, the nectar host plants included *Lantana camara* L., *Duranta repens* L., *Santalum alba* L., *Carissa carandas* L., *Tridax procumbens* L. etc.

**Adult female behavior during oviposition:**

The gravid female laid eggs singly on the upperside or underside edges of the fresh leaves, which are pinkish. Eggs were also being laid on twigs of these fresh leaves. About 6 – 8 eggs were laid at a time but on different leaves. Oviposition takes place mainly during 0900 – 1400 h.

**Oviposition host plant:**

The plant used for ovipositing in the study area was *Flacourtia indica* (Burm.f.) Merr.

**Egg stage** (Fig. 1b,c)**:**

The eggs were whitish yellow and dome shaped with longitudinal ridges. Measured 0.90 – 1.00 (0.94 ± 0.04) mm in height. Before hatching it turned into bright yellow. They hatched in three days of incubation. Immediately after hatching the larvae ate its egg shell. It passed through 4 instars over a period of 10 – 12 (11.20 ± 0.84) days.

**Larval stage:**

**Instar I** (Fig. 1d):This stage lasted 4 – 6 days. On the first day of hatching, the instar measured 1.20 – 2.10 (1.86 ± 0.37) mm in length. It grew to 2.25 – 3.33 (2.71 ± 0.36) mm in length, and 0.55 – 0.74 (0.63 ± 0.07) mm in width. The head is roughly triangular, smooth and pale black and measures 1.20 – 1.50 (1.34 ± 0.11) mm in diameter. Body was cylindrical, shiny, light brown and fully covered with minute hairs. There was a light black mid-dorsal streak along the length of the body. By the $4^{th}$ or $5^{th}$ day hairs were distinct and arrangement can be clearly seen. There were six rows of hairs along the body length and 12 rows across the body.

**Instar II**(Fig. 1e)**:** This stage lasted 1 – 3 days. The larva attained a length of 4.13 – 7.25 (6.22 ± 1.22) mm and a width 1.16 – 1.35 (1.26 ± 0.07) mm. Head measured 2.00 – 2.30 (2.16 ± 0.15) mm in diameter. The mid-dorsal streak was turned into thick brown color. Hair bases were found clearly at this stage. Segmentation was also clear.

**Instar III**(Fig. 1f)**:** This stage also lasted 1 – 3 days. The larva attained a length of 8.20 – 12.50 (10.53 ± 1.47) mm and a width 1.20 – 1.90 (1.70 ± 0.14) mm. Head measured 3.20 – 4.30 (3.52 ± 0.45) mm in diameter. Body and hairs turned into brownish black. Ventral surface of the body was orange colored. Yellowish-white line was found on the both sides of the body between last vertical row of hairs and prolegs.

**Instar IV**(Fig. 1g)**:** This stage lasted 2 – 3 days. The larva attained a length of 14.33 – 25.00 (18.83 ± 3.45) mm and a width 2.26 – 4.00 (3.05 ± 0.63) mm. Head measured 5.50 – 8.00 (6.10 ± 1.07) mm in diameter. Head at its tips orange colored and remaining part brownish. Hair bases were surrounded by a black ring, which was in turn surrounded by a yellowish ring.

Larva stop feeding and body contracted before pupation.

**Pupal stage** (Fig. 1h)**:**

Thisstage lasted for 6 days. It was 15.00 – 17.00 (16.30 ± 0.87) mm in length and 5.80 – 6.80 (6.28 ± 0.37) mm in width at its broadest point. The surface of the pupa was smooth. The dorsal side is dome-shaped and the ventral side indented. It was green. On wing cases there were crimson-red colored markings and on the dorsal side there were '11' pairs of small spiny projections which are crimson-red in color. Its weight was about 233.20 – 313.70 (280.98 ± 33.41) mg.

**Duration of life cycle:**

The total development time from egg to adult eclosion ranged between 19 – 21 (20.20 ± 0.84) days. (Egg: 3; Larva: 10-12; Pupa: 6 days).

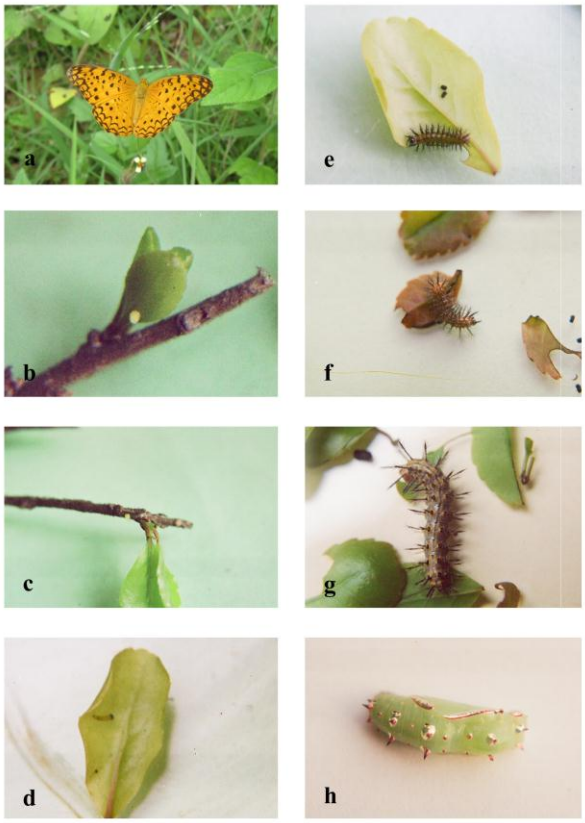


**Fig. 1:** The total development time from egg to adult eclosion

**Food consumption, growth and utilization:**

The data on the amount of food consumed by each of the four instars and the corresponding data on weight gained by different instars are given in Table 1. Of the total amount of food consumed, the percentage shares of the successive instars were 4.83, 6.68, 16.16, 72.33% and the proportions of weight gained by the successive instars were 0.54, 1.99, 11.17, 86.29%. Thus, there was over 88% of the total food consumption and 97% of total weight gained in the third and fourth instars together. Plotting the weight gained against the food consumed (Figure 2), a direct relationship between food consumption and growth across the four instars could be seen. The values of growth rate increased from first instar to second instar and then decreased to the final instar and the values of consumption index (CI) decreased from instar I to Instar IV. The values of GR varied between 0.17 – 0.37 mg/day/mg and those of CI between 1.49 – 9.31 mg/day/mg. Table 1 also included the data on AD, ECD, and ECI. The estimated values of AD ranged between 66.49 – 96.29%. The values decreased as the instars progressed. The values of ECD and ECI increased progressively from the first instar to the last instar. The values of ECD varied from 1.95 – 30.12% and those of ECI from 1.88 – 20.03%. Thus there was an inverse relationship between the values of AD and those of ECD and ECI.

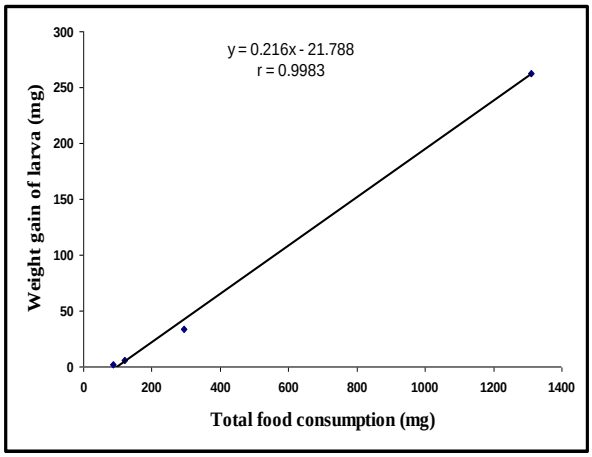


**Fig. 2:** Relationship between food consumption and growth in *Phalanta phalantha* on *Flacourtia indica*

**Discussion:**

The total development time from egg laying to adult eclosion was determined as 20.20± 0.84 days at about 28 $\pm 2^0$ C. This behavior is in line with the expectations of short life cycles in tropical butterflies (21). Since temperature influences instar duration and the overall development time (6, 25), the duration of life cycle may vary from our records depending on the prevailing temperatures. As no temperature extremities occur at Visakhapatnam, the duration of life cycle did not vary much over the overlapping seasons.

Over the entire period of its growth, a larva consumed on average over 1.80 g of leaf material, increasing consumption in the last two instars. This tendency of greater consumption by the last two instars has been reported in lepidopterous larva in general (14, 16, 22, 28, 29, 32), and it compensates the energy expenditure of non-feeding pupal stage (23). Food consumption rate depends on the conversion efficiency of ingested food to biomass (ECI), the rate increasing as the conversion efficiency decreases or vice versa (30).

**Table 1:** Food consumption, growth and food utilization efficiencies of *Phalanta phalantha*larva fed with *Flacourtia indica* leaves.

| Instar number | Wt. of food ingested (mg) | Wt. of faeces (mg) | Wt. gained by larva (mg) | GR (mg/day/mg) | CI (mg/day/mg) | AD (%) | ECD (%) | ECI (%) |
|---|---|---|---|---|---|---|---|---|
| I | 87.40 ± 12.26 | 3.24 ± 01.25 | 1.64 ± 00.53 | 0.17 | 9.31 | 96.29 | 01.95 | 01.88 |
| II | 120.98 ± 15.42 | 12.18 ± 03.09 | 6.06 ± 01.28 | 0.37 | 7.47 | 89.93 | 05.57 | 05.01 |
| III | 292.74 ± 26.87 | 57.86 ± 06.21 | 33.96 ± 04.59 | 0.36 | 3.14 | 80.23 | 14.46 | 11.60 |
| IV | 1309.84 ± 75.52 | 438.92 ± 25.43 | 262.32 ± 32.49 | 0.30 | 1.49 | 66.49 | 30.12 | 20.03 |

In this sense, the high CI value (9.31) of instar I is probably due to low conversion efficiency and this character is reflected in the low values of ECI for instar I compared to other successive instars. Higher growth rates occur with penultimate than with final instars (27). The GRs of penultimate and final instars of *Phalanta phalantha* are in line with the above decreasing trend.

The values of AD that were obtained in this study are comparable with the range of values, 19 – 81%given for 60 species of lepidopteran larvae by Pandian and Marian (24) and the range 28.7 - 84.6% for *Pericallia ricini* (14). The average AD percentage is over 83.23% and this high AD substantiate the statement of Slansky & Scriber (30) that foliage chewers often attain high AD values. Such high AD values also are expected when food item is rich in nitrogen (and also water) (24). Similar results were repeated with *Pieris brassicae* (33), *Ariadne merionemerione* (1), *Byblia ilithyia* (5), *Rathinda amor* (4) and *Junonia iphita* (3).

The values of ECD increase from early to last instars (30). Such trend is observed with the ECDs of *Phalanta phalantha*, with the lowest value in instar I and the highest in instar IV. The ECDs obtained are low compared to the ADs and such low values are not unusual (32). This is indicative of low efficiency of conversion of digested food to body tissues. This poor utilization of food is often attributed to deficiency in some essential nutrient in food (2) or a factor causing an increase in energy expenditure on metabolism (18). The pattern of ECI values followed closely the pattern of ECD. The values (1.88 – 20.03) obtained are comparable with the range of values expected for forb foliage chewers (1 – 78%) (30). The pattern of ECI followed that of AD as suggested by Waldbauer (32). The values of ECD and ECI, particularly those of the last two instars, are also relatively high (14.46, 30.12; 11.60, 20.03), thus respectively indicating tissue growth efficiency and ecological growth efficiency, which enabled *Phalanta phalantha* to thrivesuccessfully in the urban environment.

Thus, the present study provides information on the oviposition larval host and larval performance in terms of food consumption, growth and utilization, and the length of life cycle from egg to adult eclosion of the Common leopard butterfly, *Phalanta phalantha*. The present data may be profitably utilized in the successful conservation management of this butterfly species either in parks, Zoos and butterfly houses or in the field. Butterfly houses are popular exhibits in Zoos and have an immense educational (31) and conservational potential (17, 31). The present study also indicted that captive rearing the larvae at about 28 ± $2^0$C permits enough stock of adults for restocking the areas poor in populations of the Common leopard butterfly.

**Acknowledgements:**

We thank Prof. Milton F. Fingermann, Department of Ecology and Evolutionary Biology, Tulane University, 310 Dinwiddie Hall, New Orleans, Louisiana 70118-5698, USA for appraising our work. This study was supported by the University Grants Commission (UGC), New Delhi, India.

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