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## Significance of the Oviposition Records of Three Western Ghats Endemics, the Malabar Raven, *Papilio dravidarum* Wood-Mason, Malabar Rose, *Atrophaneura pandiyana* Moore and Crimson Rose, *Atrophaneura hector* Linnaeus (*Lepidoptera: Papilionidae*)

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### ABSTRACT

Observations were made on the biology and bionomics of the three Western Ghats Endemics, the Malabar Raven (*Papilio dravidarum* Wood-Mason), Malabar Rose (*Atrophaneura pandiyana* Moore) and Crimson Rose (*A. hector* Linnaeus). The size of the caterpillar (length and breadth), mode of feeding, pupation and emergence were recorded. The biology took 36-40 days for completion in Malabar Raven, 35-37 days in *A. pandiyana* and *A. hector*. Butterflies found in different habitats tend to show marked differences in their general appearance and biology as evidenced by the “Ecological races” reported in several species of butterflies. Thorough understanding of the life history and their behavioural patterns of immature stages will help in recognizing geographical and ecological races.

**Key words:** Biology, western ghats, endemics, malabar raven, malabar rose, crimson rose, *Papilionidae*

### INTRODUCTION

Papilionidae, which is the smallest butterfly family in the world have only 701 species which represent just 4% of global butterfly diversity. In India, there are about 107 species of Papilionid butterflies, of which 19 species are present in Kerala (Kunte, 2000). The Papilionids show high degree of endemism compared to the members of other families. Out of 19 species, 5 are exclusively endemic to Peninsular India and three species are shared endemics of Peninsular India and Sri Lanka (Goanker, 1996). Swallow-tails have worldwide distribution, occurring in all the major continents except for polar areas (Kehimkar, 2008). Their maximum diversity is recorded from the tropical areas.

*Papilio dravidarum* Wood-Mason a black butterfly having a white spot in the forewing cell which is distinct from the underside is endemic to Peninsular India and the Western Ghats. *Atrophaneura pandiyana* Moore, which is an endemic to the Peninsular India has black forewings and with relatively much larger white patches on its hindwings. *Atrophaneura hector* Linnaeus is very similar to other roses but it is larger, glossy black and has two white bands in the centre of forewings. The tailed hindwings have two series of crimson red spots. This butterfly which is endemic to Peninsular India and Sri Lanka is a protected species under schedule I of the Indian Wildlife Protection Act (GOI, 1972).

Because of the unscientific developmental activities of man, the habitats of many species of butterflies have been altered, threatening their survival of many species of butterflies. Species loss has tremendous implications on the survival of mankind in this universe. Improving the population of larval hosts, rearing of the butterfly and releasing the same into the wild will help restocking their depleting populations and also serve as a conservation measure of the species. This strategy requires complete knowledge of life history, larval performance in respect of food utilization and growth and adult nectar resources and other habitat conditions for its successful implementation (Ramana *et al.*, 2011). Therefore, it need to develop strategies to conserve the biodiversity found in various ecosystems. Recently, various attempts have been made to conserve the butterflies by setting up the nature parks and butterfly gardens. The swallowtails are perhaps the largest and most magnificent of Indian butterflies. They range widely in their choice of habitats. Thorough knowledge of the life history of each species is a prerequisite to frame a comprehensive conservation strategy. In this context, the biology of two Western Ghats endemic Swallowtails viz. *Papilio dravidarum* Wood-Mason, *Atrophaneura pandiyana* Moore and *A. hector* Linnaeus was studied at Peechi and the findings are presented in this study.

## **MATERIALS AND METHODS**

The study was carried out in the Kerala Forest Research Institute (KFRI) campus at Peechi (10.31°N, 76°24'E, 100-150 m altitude). This area is very close to the reserved forest area under Thrissur Forest Division. The area was hilly in nature with steep slopes and with more or less plain ridges under the Peechi-Vazhani Wildlife Sanctuary. Biology of butterflies was studied by rearing field collected eggs. Usually 5-10 eggs were collected for each species. Rearing was carried out in the laboratory in the room temperature and humidity ranging from 28-32°C and 80-90%, respectively. Eggs collected from the field were placed in small sterilized glass jars, 2 cm diameter and 10 cm height, covered with a clean, dry cloth and securely fastened with a rubber band. Containers were kept moist by keeping a small piece of absorbent tissue holding as much water as will evaporate in 24 h. On hatching, the larvae were transferred to sterilized glass containers of 6 cm diameter and 15 cm height. The mouth of containers was closed with sterilized clean dry cloth fastened with rubber band. All frass and excreta were removed daily and the larvae were provided with fresh leaves of the preferred host plant. Towards the final instar, the larvae were transferred to larger containers of 12 cm diameter and 25 cm height. The container was provided with a dry twig so as to serve as a substratum for pupation. The duration of larval instars was recorded based on the moulted shell of the head capsule of the caterpillar that remains in the container after moulting. Larval measurements were recorded within 24 h after moulting. For this, the length of the larva from the anterior to the posterior and as well as its width across the mesothorax were recorded.

**Data analysis:** Data generated on the dimensions of larval instars of each species were subjected to one-way analysis of variance, followed by Duncan's Multiple Range Test (Gomez and Gomez, 1984). Descriptions of the larva, pupa and the adult were made after close examination under a stereoscopic binocular microscope (Fig. 1).

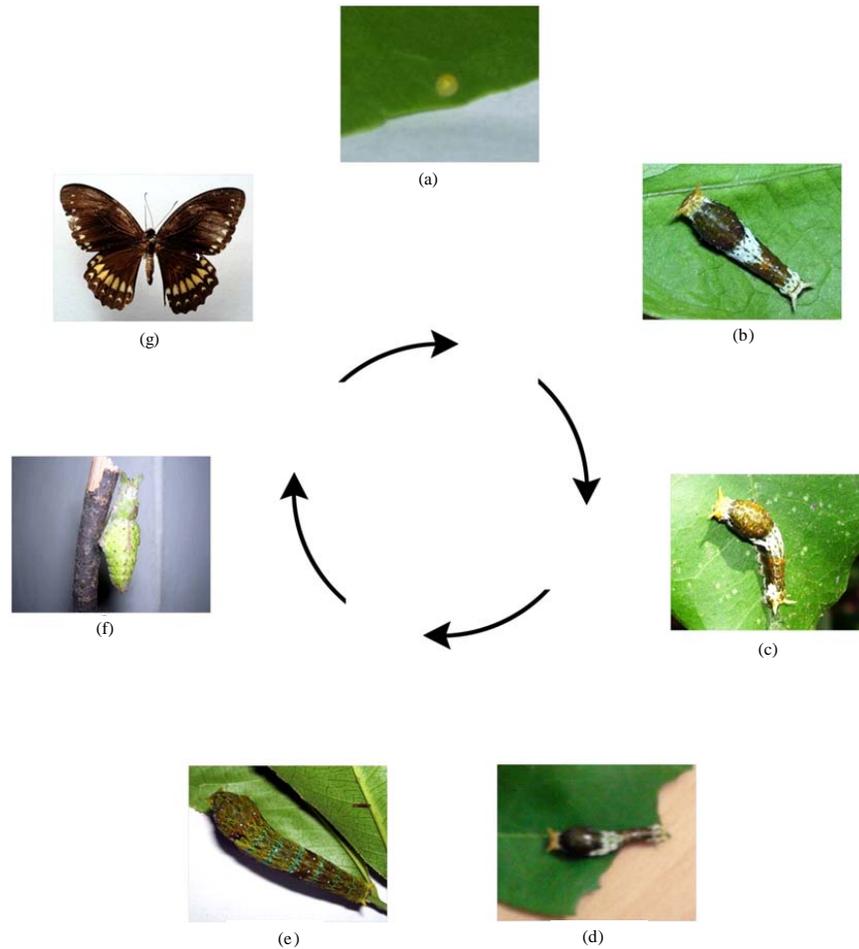


Fig. 1(a-g): Life cycle of *Papilio dravidarum* Wood-Mason, (a) Egg, (b) II instar larva, (c) III instar larva, (d) IV instar larva, (e) V instar larva, (f) Pupa and (g) Adult

## RESULTS

***Papilio dravidarum* wood-mason:** Malabar Raven is an endemic butterfly and is confined to thick forests and sacred groves. They are rapid fliers and regularly seen in mud puddling during drier months. *Glycosmis arborea* (Rutaceae family) is the host plant of this butterfly.

**Adults:** This is a tail-less butterfly, with a wing span of 88.5 ( $\pm 4.45$ ) mm and is blackish brown in colour. A small white spot is present at the end cell on the upper forewing. The dorsal surface of wings is dark velvety brown and a marginal series of white spots which decrease in size and completely disappear towards the apex are present. Upper hindwing is black with a discal series of arrow-shaped white spots and a marginal series of elongated white crescents and fringes white between veins. The underside is more brownish with markings larger than those above. In female dorsal surface is paler with larger white markings. Head, thorax and abdomen dark brownish black with white speckling on the head and thorax.

**Eggs:** The egg is small, spherical, smooth, pale yellow to creamy in colour and lay singly. The mean incubation period is 4.43( $\pm 0.53$ ) days.

Table 1: A comparison of larval instars of *Papilio dravidarum*

Stage	Length			Width		
	Range (mm)	Mean (mm)	SD	Range (mm)	Mean (mm)	SD
First instar	4-5	4.75	0.50	-	1.00	0.00
Second instar	12-14	13.25	0.96	3-4	3.25	0.50
Third instar	24-26	25.25	0.96	5-6	5.25	0.50
Fourth instar	36-37	36.25	0.50	8-9	8.75	0.50
Fifth instar	45-47	46.00	0.82	13-14	13.5	0.58

**Larva:** The duration of various instars are presented in Table 1. Description of each instar is as following.

- **First instar larva:** It measures about 4.75 ( $\pm 0.5$ ) mm in length and 1 mm in width. Generally hatching of the egg takes place in the morning. The larva is light brownish black with dirty white bands on the last and first abdominal segments. Primary setae are present on the head. The thoracic region is slightly projecting. The last two abdominal segments have a row of tubercles on each side. The newly hatched larva feed on the egg shell. The first instar larva feeds exclusively on tender leaves. The instar lasts for about 2-3 days. Towards the end of the first instar, the larva attaches itself to a leaf spins moulting mat.
- **Second instar larva:** The larva measures 13.25 ( $\pm 0.9$ ) mm in length and 3.25 ( $\pm 0.5$ ) mm in width. On the 3rd day, the larva sheds its skin and head capsules. There is no apparent change in colour and behaviour except the difference in size. The whitish band becomes more prominent. This stage lasted for 2-3 days.
- **Third instar larva:** Third instar larva measures about 25.25 ( $\pm 0.96$ ) mm in length and 5.25 ( $\pm 0.5$ ) mm in width. After the second moult, an additional whitish band or thin streak appear on the lateral side of the body and three pairs of spots on the abdominal segments. The body colour changes to greyish green.
- **Fourth instar larva:** Fourth instar larva is 36.25 ( $\pm 0.5$ ) mm in length and 8.75 ( $\pm 0.5$ ) mm in width. The larva feed voraciously on mature leaves.
- **Fifth instar larva:** Fifth instar larva is 46 ( $\pm 0.82$ ) mm in length and 13.5 ( $\pm 0.58$ ) mm in width. There is a drastic change in colour, appearance and behavior of the caterpillar. The body becomes greenish in colour with two bands on the head. There is also a band in between the eyes and another on the first thoracic segment. Two arch-shaped wide bands are present in the middle of the abdominal segments. There are whitish stripes present on the legs and prolegs and throughout the body.

**Pupae:** Pupae measures 22.2 ( $\pm 0.92$ ) mm in length. Pupae is smooth, arch-shaped, curved inwards mid-ventrally and green in colour. Two light green patches are present on the mid-dorsal side. Before eclosion pupae turns black in colour. Pupal stage lasts for 16-18 days after which the adult hatches out.

**Life cycle:** The life cycle is completed within 38.89 ( $\pm 1.67$ ) days in laboratory conditions. The duration of various stages is given in Table 2.

***Atrophaneura pandiyana moore:*** The red-bodied swallowtail *Pachliopta pandiyana* is an endemic butterfly to Western Ghats. The caterpillars were reared in the host plant *Thottea siliquosa* (Fig. 2).

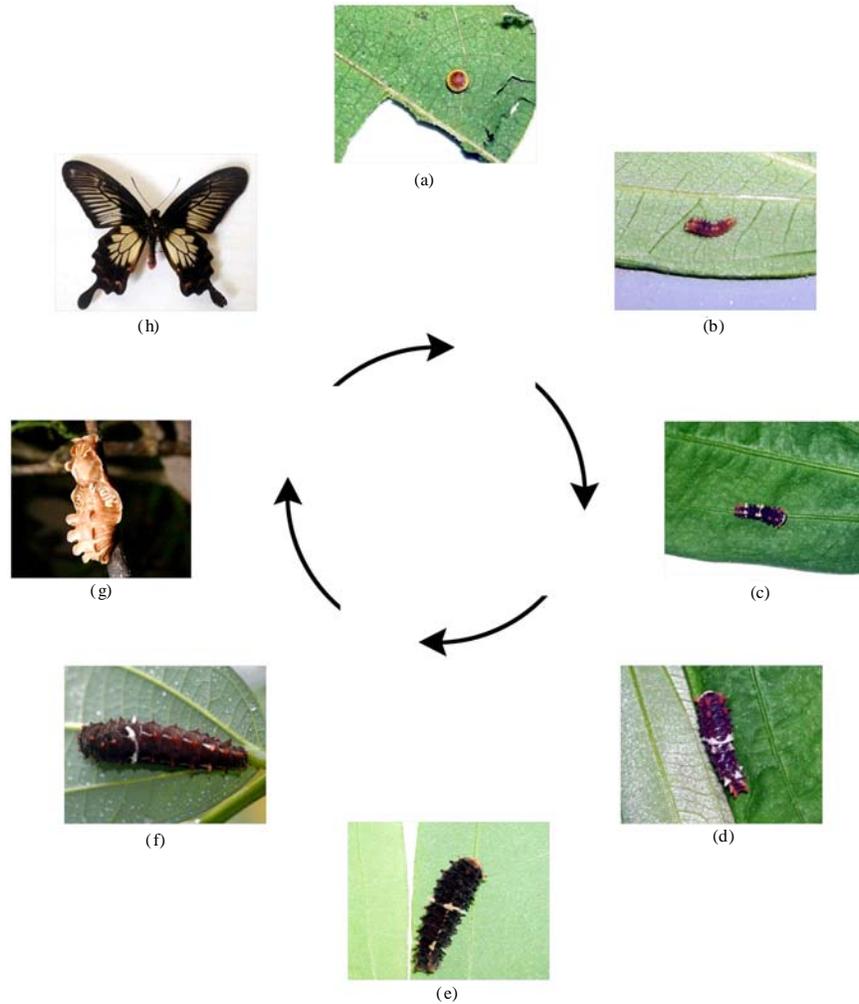


Fig. 2(a-h): Life cycle of *Atrophaneura pandiyana* Moore, (a) Egg, (b) I instar larva, (c) II instar larva, (d) III instar larva, (e) IV instar larva, (f) V instar larva, (g) Pupa and (h) Adult

Table 2: Duration of various stages in *Papilio dravidarum*

Developmental stage	n	Range (days)	Mean (days)	SD
Egg	4	4-5	4.43	0.53
Larva	4	20-23	21.90	0.99
Pupa	4	16-18	17.00	0.82
Duration (egg-adult)	4	36-40	38.89	1.67

**Adult:** The Malabar Rose measures a wing span of 108.7 ( $\pm 11.16$ ) mm. Both sexes have tailed hindwings, which in the female is spatulate. They are very similar to common rose except the Malabar rose have larger white patch on the hindwing and broader forewing. The upper side of the forewing is black with prominent white streaks between the dark veins. Hindwing have a white patch of pale yellow in colour in 4-5 cell surrounded by a series of elongate white spots. A fringe of dirty red, crescent-shaped spots present in the discal area of hindwing which is more prominent in the female than in the male.

Table 3: A comparison of larval instars *Atrophaneura pandiyana*

Stages	Length			Width		
	Range (mm)	Mean (mm)	SD	Range (mm)	Mean (mm)	SD
First instar	4-6	4.90	0.57	-	1.0	0.00
Second instar	13-15	14.00	0.67	3-4	3.4	0.52
Third instar	25-27	25.90	0.74	5-6	5.6	0.52
Fourth instar	34-37	35.40	1.08	7-8	7.4	0.52
Fifth instar	44-47	45.50	1.08	9-10	9.4	0.52

**Eggs:** Eggs are spherical in shape and brick red in colour, measuring 1-2 mm in diameter. The basal part is slightly flattened at which it is attached to the leaf or stem. The eggs are laid singly on the underside of tender leaves. A gravid female may lay 8-10 eggs at a time on different leaves of the host plant and within a time span of 5 min. In the absence of suitable tender leaves, the female preferred to oviposit on tender shoots. The mean incubation period was 4 ( $\pm 0.49$ ) days.

**Larva:** The duration of various instars is presented in Table 3. Detailed description of each instar is as following.

- **First instar larva:** The first instar larva grows up to a maximum length of 4.9 ( $\pm 0.57$ ) mm and the body width of 1 mm. The freshly emerged larva is brown in colour with minute pale orange coloured fleshy spines. The duration of first instar is  $\pm 2$  days
- **Second instar larva:** The larva grows up to a maximum length of 14 ( $\pm 0.67$ ) mm and the body width measures 3.4 ( $\pm 0.52$ ) mm. Body is brownish black bearing 12 pairs of fleshy spines on both dorsal and lateral sides and the dorsal spines are longer than the lateral ones. The thoracic spines are pale orange in colour while the 3, 4 and 7 abdominal spines are white in colour and in the 3rd segment of abdomen, the paired dorsal and lateral spines were joined by a thin white line. The last 2 pairs of spines are pale orange in colour. With the growth of the larva, the fleshy spines becomes more prominent. The duration of the second instar larva is  $\pm 3$  days
- **Third instar larva:** The larva grows upto a maximum of 25.90 ( $\pm 0.74$ ) mm in length and 5.6 ( $\pm 0.52$ ) mm in width. There is no change in body characteristics except that the body is dark maroonish brown in colour
- **Fourth instar larva:** The larva attains a maximum length of 35.40 ( $\pm 1.08$ ) mm and breadth of 7.4 ( $\pm 0.52$ ) mm. The larva has a dark velvety brown body with the fleshy spines turning dark brown in colour. In the 3rd and 7th segments, dorsal and lateral spines are creamy white in colour. All the spines are become more prominent with the progression of growth. Larval duration lasts  $\pm 6$  days
- **Fifth instar larva:** The larva attains a maximum of 45.50 ( $\pm 1.08$ ) mm in length and 9.4 ( $\pm 0.52$ ) mm in width. The larva has dark velvety brown body with fleshy spines having bright orange tips. There is a thin white band present in the 3rd segment

**Pupae:** Light brown in colour with a mixture of white, orange and dark brown markings on the dorsal side. The ventral side is light brown with faint white stripes. The anterior end of the pupae is produced into a frontally flattened broad projection with a pair of flattened flaps on either side.

**Life cycle:** Life cycle is completed within 35.89 ( $\pm 0.78$ ) days under laboratory conditions. The duration of various stages is given in Table 4.

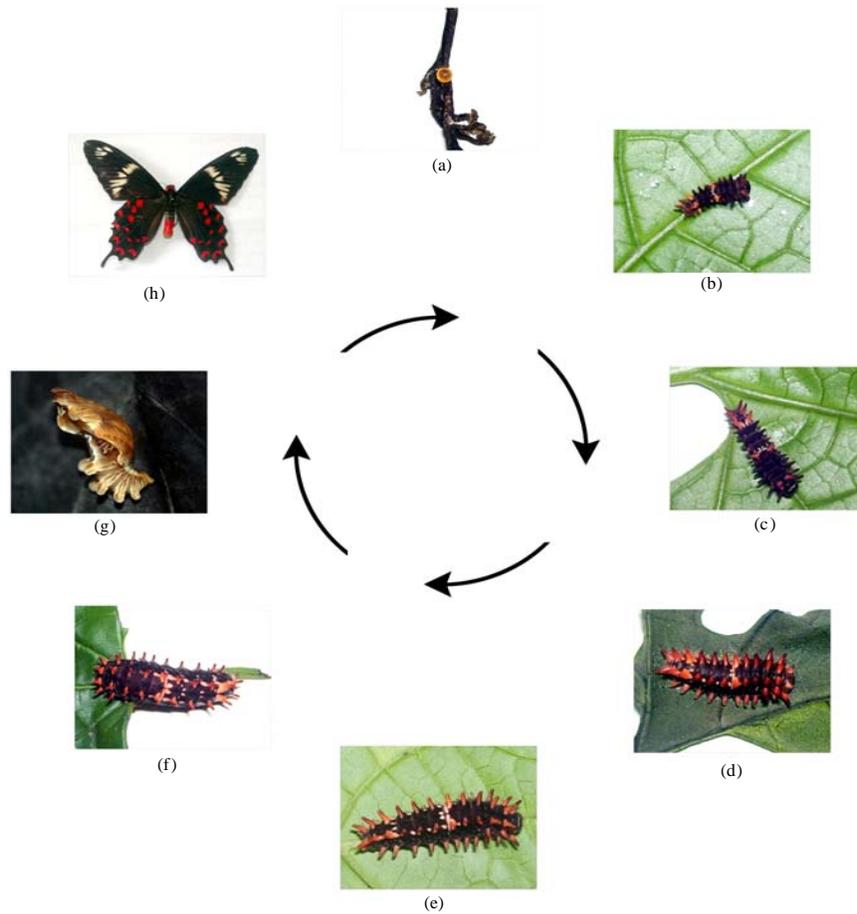


Fig. 3(a-h): Life cycle of *Atrophaneura hector* Linnaeus, (a) Egg, (b) I instar larva, (c) II instar larva, (d) III instar larva, (e) IV instar larva, (f) V instar larva, (g) Pupa and (h) Adult

Table 4: Duration of various stages in *Atrophaneura pandiyana*

Developmental stages	n	Range (days)	Mean (days)	SD
Egg	10	4-5	4.29	0.49
Larva	10	20-22	21.33	0.71
Pupa	10	13-16	14.67	1.00
Duration (egg-adult)	10	35-37	35.89	0.78

***Atrophaneura hector* linnaeus:** Crimson Rose, *Pachliopta hector* Linn. is one of the spectacular species of swallowtails and they breed throughout the year. They lay eggs singly on the lower surfaces of young leaves of *A. indica* and *A. tagala*. Six to eight eggs are laid in a sequence, preferably on different leaves (Fig. 3).

**Adult:** Adults measuring 99.8 ( $\pm 4.28$ ) mm in expanse and the upper side of wings are glossy, bluish black with the forewing have prominent interrupted and irregular discal and apical white bands. Hindwings bearing nearly round and marginal rows of bright crimson crescent spots and submarginal series of crimson lunules. Female is duller with large crimson crescents and spots on hindwing. The body has bright red in colour.

**Egg:** Eggs are round with longitudinal ridges extending from base to apex. They are orange red in colour and 1-2 mm in diameter. The eggs hatch in about 4.43 ( $\pm 0.53$ ) days and the larva has five instars.

**Larva:** There are five larval instars. The duration of various instars are presented in Table 5. Description of each instar is as followings.

- **First instar larva:** The larva measures as 5 ( $\pm 0.82$ ) mm in length and 1 mm in width. It is a reddish brown in colour and has several spines in orange red colour. This instar lasts for 2-3 days
- **Second instar larva:** Larva grows to 12.6 ( $\pm 0.84$ ) mm in length and 3.6 ( $\pm 0.52$ ) mm in width. The middle segmental spines of the body become orange. Spines also begin to appear on other segments of the body. It lasts for 3-4 days
- **Third instar larva:** Larva grows to 22.70 ( $\pm 0.82$ ) mm in length and 5 ( $\pm 0.53$ ) mm in width. A pair of red stripes is present on the ventral side of the body between the last thoracic and first abdominal segment. All spines of the body turn to dark orange. This is lasts for 3-4 days
- **Fourth instar larva:** The larva grows to 27.50 ( $\pm 0.52$ ) mm in length and 6.7 ( $\pm 0.48$ ) mm in width. There is no change in physical appearance except the body is dark brownish black in colour with bright crimson spots. This stage lasts for about lasts 4-5 days
- **Fifth instar larva:** Larva attains a maximum of 41.60 ( $\pm 1.08$ ) mm in length and 10.4 ( $\pm 0.52$ ) mm in width and this stage lasts 6-7 days. At the end of this instar the larva thickens itself by shortening and enters the pupal stage. It attaches to the substratum with the help of head and tail

**Pupae:** It is flattened dorso ventrally and has two lateral projections appear in the thoracic region and in the abdominal region. It stage lasts for 13-15 days. The duration between oviposition and adult emergence is 39-47 days. The entire life cycle was completed within 36 ( $\pm 0.63$ ) days in laboratory conditions.

**Life cycle:** The life cycle was completed within 36 ( $\pm 0.63$ ) days in laboratory conditions. The duration of various stages is given in Table 6.

Table 5: Larval body measurements of *Pachliopta Hector L*

Dimensions	Length			Width		
	Range	Mean	SD	Range	Mean	SD
First instar	4-6	5.00	0.82	1-1	1.0	0.00
Second instar	12-14	12.60	0.84	3-4	3.6	0.52
Third instar	22-24	22.70	0.82	5-6	5.5	0.53
Fourth instar	27-28	27.40	0.52	6-7	6.7	0.48
Fifth instar	40-43	41.60	1.08	10-11	10.4	0.52

Table 6: Developmental period of different stages in *Pachliopta Hector L*.

Developmental period	n	Range	Mean	SD
Incubation period	10	4-5	4.43	0.53
Larval period	10	21-23	21.83	0.75
Pupal period	10	13-15	14.17	0.75
Total period (egg-adult)	10	35-37	36.00	0.63

## DISCUSSION

Investigations on the biology of 3 species of Papilionid butterflies both in the laboratory as well as under field conditions have revealed that survival of butterflies in the wild depends on the availability of foraging area, freedom from natural enemies and availability of conducive environment for courtship. This highlights the significance of site amelioration programmes in enhancing butterfly population in specific habitats. Because of the relative immobility of caterpillars, the selection of oviposition site is a crucial process. A complex sequence of behaviour, utilizing a range of different stimuli, may be involved in a female butterfly finding the right oviposition site (Courtney and Chew, 1987). In the case of above described species, the females were observed to repeatedly visit the host-plants and tried to probe the leaves for ascertaining their suitability for egg laying like the tender nature of the leaves and availability of shade. After repeatedly flying around the host plant for about 5-8 min, a female was observed to lay eggs, one in each of the tender leaves. During egg laying, the forewings were observed to be continuously fluttering and it took about 5 sec to lay a single egg. The female repeatedly tested similar-shaped leaves before finally selecting the underside of suitable tender leaves in a shady damp place for egg laying. These 3 species of Papilionids were observed to lay their eggs singly as is the case with most papilionid butterfly species (Stamp, 1980). The single egg-laying habit has an advantage in that it averts the possibilities of larval saturation by resource exhaustion and enables effective utilization of isolated plants (Davies and Gilbert, 1985).

Many species of Papilionidae are relatively specialized on certain tropical and subtropical plant families (Slansky Jr., 1972). Feeding patterns of the Papilionidae range from strict monophagy in which a single species of food plant is utilized to wide polyphagy in which many species, genera or families may be utilized (Brues, 1920; Dethier, 1954). Among these, the species such as *Pachliopta pandiyana* Moore and *Papilio dravidarum* Wood-Mason are monophagous specialists (feed on a single plant species), *Pachliopta hector* L. is Oligophagous generalists (host plants belongs to one family). In South-East Asia, the Papilionids were known to utilize eight plant families and Aristolochiaceae was the most important host plant family, followed by Rutaceae and Lauraceae (Scriber *et al.*, 1995; Fiedler, 1998).

Mathew (2001) studied the biology of 20 species of butterflies in order to assess their suitability for captive breeding programmes in Kerala. Atluri *et al.* (2001, 2002a, b) studied the life history of *Pachliopta aristolochiae*, *Papilio demoleus* and *Graphium agamemnon* in Andhra Pradesh. The life cycle of *P. aristolochiae* was completed within 40-48 days and there were 5 instars over a period of 18-23 days. The short life cycle facilitates 6-7 broods yearly. In *G. agamemnon*, the eggs took 3-4 days to hatch. The larvae go through 5 instars over a period of 15-16 days and the pupal period was 13-14 days. The total period from egg to adult emergence spans over 33-36 days. Susanth (2005) recorded the biology of *Papilio liomedon* Moore on the larval food plant *Evodia roxburghiana*. The Malabar Banded Swallowtail is a brownish black butterfly with a prominent cream yellow band on its wings is among the rarest papilionid butterflies in South India. It is endemic to the Western Ghats and an inhabitant of semi-evergreen and evergreen forests. The incidence of parasites and predators is an important aspect to be considered while rearing the immature forms because the original stock is invariably taken from field. In the field condition, various predatory birds and garden geckos were also found to affect the butterfly population. Usually the palatable species (mostly belonging to genus *Papilio*) were found to suffer maximum attack since the unpalatable ones (especially the *Atrophaneura*) were avoided by the predators.

Observations on the life history of these 3 species have shown that these butterflies required a duration of 35-40 days to complete their life cycle (Egg-adult). Butterflies, having short life cycle are the good candidates for the topics such as genetics, insect-plant interactions and co-evolution and most of them have more or less continuous generations throughout the year.

Since butterflies visit flowers for nectar, they are valuable pollinators. They are very fragile in nature and have even slight perturbations may affect their composition. As a result they are looked upon as good indicators of environmental quality. Because of their short life cycle, they are good candidates for the topics such as genetics, insect – plant interactions and co-evolution. However, due to large scale destruction of habitat, due to various developmental activities of man, many species of butterflies are on the verge of extinction. It has been estimated that there has been a loss of 50% forest cover in the past 50 years in the Western Ghats (Goanker, 1996). Therefore, we need to generate information on the impact of habitat disturbances on the survival of butterflies. Varshney (1986) has reported that 2 species of Papilionid butterflies are threatened in India. Due to the large scale ecological disturbances, many more species are facing extinction. Information on the biology and ecology of butterflies are essential in order to develop appropriate conservation strategies. Since the biology of various species differ in different eco-climatic zones, location wise data has to be generated. Information generated in this study will be useful in future conservation programmes.

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