Morphology and Biology of Two Butterfly Species, *Graphium sarpedon* Linnaeus, 1758 and *Graphium agamemnon* Linnaeus, 1758 on their Respective Host Plants

Hla Wut Yee*

Abstract

Two butterfly species, *Graphium sarpedon* Linnaeus, 1758 and *Graphium agamemnon* Linnaeus, 1758 belonging to the family Papilionidae were studied both on the morphological and biological aspects during the study period from May 2008 to December 2009. South Okkalapa Township, Yangon Division was chosen as the study area where the host plants for the two studied species were abundant. *Cinnamomum macrocarpum*, C. *tamala* and *C. obtusifolium* were the host plants for *G. sarpedon* whereas *Polyalthia longifolia* and *P. pandurata* were the host plants for *G. agamemnon*. Morphological characters and the life cycle of the two studied butterfly species were depicted in comparative point of view supported by scaled photographs. Duration of the developmental stages from the eggs up to the emergence of the adults in these two species was also mentioned. Behavioural patterns of both species were also described providing with photographs.

Introduction

Of the insects that belong to the class Insecta, butterflies are the most celebrated and the most popular because they are active by day, and are renowned for their beautiful colours, fascinating patterns and graceful flight. Although moths look like butterflies at glance, they have several differences in detail: the antennae of butterflies have clubs or knobs at the tips while those of moths are thread like, feathery or blunt; butterflies are diurnal animals whereas moths are nocturnal; butterflies hold their wings in upright position while moths in spread out position when at rest. There are more than 150,000 described species under the order Lepidoptera, of which about 20,000 species are butterflies (Preston-Mafham, 1999). In Myanmar, over 1,200 butterfly species have been recorded by Kinyon (2004). Butterflies are cosmopolitan and are adapted to survive in varying environmental conditions; deserts, mountain peaks, rain forests, field and woodlands, and in well-established gardens. Most people are familiar with the adult butterflies as they are pleasant sight to the onlookers to watch them while visiting from one flower to another for gathering nectar and pollen.

Many butterfly species stay close to the ground, or spend more time near it and rarely fly higher. On the other hand, some species spend most of their time in the canopy, descending to the ground less frequently. The adult butterflies feed on the different diets. Most of the butterflies suck the nectar from the flowering plants. The nectar is high in sugars that provide energy for flight (Kunte, 2000). Some butterflies are likely to feed on over-ripe fruits and others feed on animal dung and tree sap.

Butterflies are strongly associated with flowering plants. The adult butterfly visits to flowers for nectar and are indeed among the dominant cross-pollinators. The relationship between butterfly species and the plants play an important role in an ecosystem. Flowering plants need butterfly species for pollination and the butterflies require suitable plant species to serve as their host plant to complete their life cycle. Every butterfly species undergoes through four different stages of development; egg, larva, pupa and adult. According to the species, these stages can be seen in different form and colour. After mating, the mated female lays their fertilized eggs on the leaves of its host plant (food plant). The hatched larvae feed on the leaves

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of its host plant. Depending on the leaves of the host plants that the larvae of the butterfly feed on, feeding habits can be categorized as monophagy (larvae only on the leaves of its host plant), oligophagy (larvae feed on the same genus or closely related genera of the host plant from the same family), and polyphagy (larvae feed on numbers of plants belonging to different families) (Kunte, 2000). The occurrence of butterfly species is obligatorily bound up with the occurrence of the host plant.

Kunte (2000) categorized five groups of butterfly as swallowtails, whites and yellows, brush-footed, blues and skippers based on their respective features and habits. Biology and ecology of some swallowtails have been reported to some extent by researchers of Myanmar. Fortunately, *Graphium sarpedon* (Common Bluebottle) and *G. agamemnon* (Tailed Green Jay), though both are found in common, have not been conducted concerned with biology so far.

So the morphology and biology of *G. sarpedon* and *G. agamemnon* were studied with the following objectives.

-To identify the butterfly species and respective host plant

-To record varying developmental stages from the eggs up to the emergence of adults in captive conditions

-To study behaviours and complicated butterfly's life cycle

-To assess the influence of physical factors on the lives of butterflies.

Materials and Methods

Study Area and Study Period

This study was conducted in South Okkalapa Township located within 16° 50', 16° 52' N and 96° 10', 96° 12' E. In these areas, plants such as Kara-way (*Cinnamomum macrocarpum*), Thikya-bo (*C. tamala*), and Na-lin-gyaw (*C. obtusifolium*) of the family Lauraceae are cultivated as spices for flavoring meat and vegetables. In addition, *Polyalthia longifolia* (Thinbaw-te) and *P. pandurata* (Ar-thaw-ka) of the family Annonaceae are widely cultivated for ornamental purpose. The study period lasted from May 2008 to December 2009.

Specimen Collection

The specimens were collected by a butterfly net. Captured butterflies are set free in rearing cage. Some eggs were brought back into rearing boxes and watched up to the emergence of the adults.

Preparation for Species Identifications

Since wing venation was useful in identification of butterflies, the wings of dead specimens were prepared in following procedure. They were placed in 10% potassium hydroxide (KOH) for 2 to 3 days till they became transparent. They were then washed thoroughly with freshwater to remove the KOH. The wings with distinct veins were placed on the transparent sheet for identification followed by Bingham (1907) and Talbot (1939).

Rearing of Collected Specimens

The collected eggs in transparent plastic rearing boxes were checked daily until the larvae were hatched out. The newly hatched larvae were gently transferred into rearing boxes with moistened tender leaves of the host plants. The growth of larvae were recorded when the larvae molted as they increase in size. The residues of leaves and faeces of the larvae were cleaned out before new leaves were substituted. This process was done repeatedly until the larvae stop feeding for prepupating stage. The rearing boxes were cleaned and made dry until the emergence of the adults from the pupae. The morphological characters and duration of the developmental stages of the studied butterfly species were recorded. The various larval stages were measured by metric scales.

Results

Systematic Position of the Two studied Butterfly Species

The systematic position of these species is followed after Talbot (1939).

Phylum	–	Arthropoda
Class	–	Insecta
Subclass	–	Pterygota
Order	–	Lepidoptera
Sub order	–	Rhopalocera
Family	–	Papilionidae
Genus	–	*Graphium*
Species	–	*G. sarpedon* Linnaeus, 1758
Common name	–	Common Bluebottle
Species	–	*G. agamemnon* Linnaeus, 1758
Common name	–	Tailed Green Jay

Adult Morphology of *Graphium sarpedon*

Head is moderately large, brownish-black in color. The head and thorax suffused with greenish grey. The antennae are brownish black and moderately short, 10 mm to 12 mm in length and mostly 40 segments with long club-shaped. Labial palps are small, brownish, and crescent with white hairs except at each base, about 2mm in length. Eyes are dark brown and ovate. Proboscis is moderately long and thick, dark brown in colour and 10mm to 12 mm in length. The thorax is brownish-black, the thorax and abdomen touched with dingy white. Legs are dark brown with greenish grey streak along the underside of the femur. Abdomen has two whitish lateral lines. The upper surface of body has brownish-black with dark gray hairs and the most part of the lower surface with gray-white hairs.

The Colouration and Markings of the Wings

Both sexes are very similar in size and coloration but paler and slightly broader wings in female. The wings are black with greenish blue bands. A beautiful greenish blue band set in opaque black starts a dot near the apex of the upperside of fore wing. It goes down discally in square and rectangular patches to the dorsum. The band continued in the hind wing with the last patch making up the band being triangular. A series of greenish blue sub–marginal lunules present on the hind wings. The inner margin of the hind wing is bent upwards, and the edge is

fringed with long hairs. The male has a patch of scent scale and pectin of erectile hairs within this fold. The undersides and the uppersides of the wings have a similar pattern but the greenish blue band on the underside tends to be paler. At the base of the hind wing, a red bar extends from the costa to the cell and is separated from the discal band. There are five red spots just below the middle of each hind wing. (Plate I)

Wingspan : 65–85 mm

Adult Morphology of *Graphium agamemnon*

Head is moderately large, black in color. The head and thorax suffused with greenish grey. The antennae are black and moderately short with long club-shaped; not half the length of the fore wing. Eyes are reddish- brown and ovate. Ocelli are conspicuous. Proboscis is moderately long and thick, dark brown in colour. The thorax is brownish-black with grayish green hairs above and gray beneath. The fine sensory hairs almost uniformly distributed over the proximal part of the underside of each segment. Abdomen is brownish-black with grayish green scales above and gray beneath.

The Colorations and Markings of the Wings

Both sexes are very similar in colorations but paler and slightly broader wings in female. The tail on the hind wings is longer in female. The male has patch of scent scales and an elongated tuft of hairs on the dorsal fold of the hind wings. A faint costal series of spots set on the upperside of the forewing. Another series of cell spots, three out of those five being double. A series of discal spots and series of submarginal spots lied at the base of the wing. On the hindwing, a basal bar extending down half way through the dorsum, a post basal double bar extending to the region below. A series of discal spots and series of submarginal spots present. The underside of the wings is brownish-black in colour. Some areas especially at the apex of the forewing and the post basal areas of the hindwing suffused with pink spots, and bars on the forewing similar to the upperside, but paler. (Plate I)

Distinctive Flight Behaviours of the Two studied Butterfly Species

The Common Bluebottle is an active butterfly, settling seldom and only momentarily. It flies very rapidly round the tops of trees and spends most of its time in the canopy of the trees but it occurs in all the vegetation layers. While sucking the nectar from flowers, it keeps its wings vibrating, never fully settling on the flowers. At rest the wings are kept closed over the back but the hind wings do not cover the fore wings.

The Tailed Green Jay is an extremely restless butterfly, never tired of flying; its flight is straight and dashing. It spends in the canopy of the tree, descending occasionally to feed from flowers of shrubs and small trees. In gardens it usually flies at the level of bushes but at the sight of any attacking predators, it darts swiftly and strongly to the tree-tops where in flight-speed.

Life cycle of the *Graphium sarpedon*

Egg and Larval Stages

The mated female of Common Bluebottle was observed skipping hurriedly from plant to plant, landing briefly to touch leaf and then rapidly flying on to repeat the process. The

female tested the chemical nature of the leaf with her legs, antennae or the tip of her abdomen. Once the host plant was sighted, the female bends the tip of the abdomen down to deposited her fertilized eggs singly on any place of the freshly leaves. The female laid about 17 to 28 eggs after mating within two days.

The egg is spherical, whitish or creamy white in colour. The size of egg is approximately 0.9 to 1.1 mm in diameter. The colour of egg gradually became grayish with a dark spot within 1 to 2 days. The fertilized eggs hatched out about 3 to 4 days after egg laying.

The size of newly hatched larva ranges from 2 to 6 mm in length and 1 to 2 mm in width. The body is dark green in colour with numerous brownish spines. Of these species, those on the thoracic region are longer than others. A pair of yellowish spines lies on the last abdominal segment. The head is pale yellow. The first larva usually lies on the upper surface of the tender leaf. The larva molts into second stage within 2 to 3 days after hatching.

The size of the second larva ranges from 7 to 14 mm in length and 2 to 3 mm in width. The colour of body is dark green in the thorax and paler in abdomen. The larva becomes hump-backed in the thoracic region with a pair of spines on each thoracic segment. The thoracic spines are yellow in colour, and a pair of the last abdominal spines becomes white. The head is pale orange. The larva molts into third larval stage within 2 to 3 days as it increased in size.

The size of the third larva ranges from 15 to 20 mm in length and 3.5 to 4.5 mm in width. The body colour is dark green in thoracic region and paler towards posterior. Pale yellow spotted bands lie on each segment in the abdomen. Pale green transverse dotted lines present between the abdominal segments. The third larva molts often 2 to 3 days to transform into the fourth stage.

The size of the fourth larva ranges from 19 to 27 mm in length and 5 to 6 mm in width. The body colour is olive green in the thoracic region and paler in abdomen, with pale green transverse dotted lines. Pale yellowish line just above the prolegs presents on either side of the body started from seventh abdominal segment.

The size of fifth larva ranges from 25 mm to 36 mm in length and 6 mm to 8 mm in width. The body colour is velvety green with faint cream spots in abdomen, camouflaging the colour of the leaf of the host plants. A pair of white spine presents on the last abdominal segment. The head is pale green in colour. The thoracic legs, prolegs, and claspers are pale green. The fifth larva usually rests in the middle of the leaf on the upper surface. The fifth larva stops feeding after 3–5 days and searches suitable place to prepupate.

The fifth larva selects a place undersurface of the leaf of the host plant when ready to prepupate. The colour of the larva becomes light green. The larva begins by spinning a small pad of silk upon the undersurface of the leaf. It crawls forward until its claspers can grip this pad. It lies head–upwards and bends its head. At first, few segments are situated side–ways and still bent. It fastens a silk thread to the leaf on each side of the body. This process is repeated, the front of the body swaying it from side to side, until a girdle of sufficient strength encircles it. It twists round and passing the thread over its back, and fixed it to the leaf. The size of the prepupa ranges from 22 mm to 24 mm in length and 5 to 7 mm in width. The duration of the prepupa lasted about 28 to 32 hours before the pupating process. (Plate II)

Pupal Stage

When the prepupa starts to pupate the larval skin bursts behind the head and bulges out of the rent and gradually become as a projection. The larva pushes its old skin under the girdle by a series of alternate swelling and constriction of the body. It pushes the old skin back to the

end of the body. Supported by the girdle, the pupa with draws its clasper from the shriveled skin which falls and with a twist engages its cremaster in the silken pad. The last molting took about 5 minutes to be entirely out of the old larval skin. The colour of pupa is grassy green with a slender pointed projection and longitudinal yellowish bands from the tip of projection to the cremaster. The green coloured of pupa coat with yellowish bands make the pupa for camouflage with the background leaf surface. The size of pupa ranges from 23 to 34 mm in length and 5 to 7 mm in width at its widest portion. The duration of the pupa lasted about 9 to 15 days in captivity.

Adult Stage

The pupa normally takes about 9 to 15 days to emerge for the adult butterfly. When the pupa is ready to emerge, the colours begin to appear in the wings and can be seen through the pupal case in which they are enclosed. Finally, the colours and patterns of the adult wings are seen perfect but in miniature through the pupal case. The skin of the pupa splits at the tip of projection behind the head and the adult begins to crawl forth, drawing out its antennae, legs and wings. The adult butterfly moves to a position nearby where its wings can hang downwards. The suspended adult slowly spreads their wings. About this time, it expels a few drops of yellowish fluid. The whole process of emergence and spreading of the wings took about one and half hours in this studied species. The complete life cycle takes about 29 to 37 days. (Plate III)

Life Cycle of the *Graphium agamemnon*

Egg and Larval Stages

The mated female of Green Tailed Jay searches hurriedly the host plant for laying her eggs. Once the host plant was sighted, the female laid her fertilized eggs singly on any place of the tender leaves. The female laid about 15 to 25 eggs after mating within two days.

The eggs is spherical, greenish yellow in colour. The colour of eggs gradually became grayish with a dark spot within 2 to 3 days. The fertilized egggs hatched out about 3 to 4 days after eggs-laying.

The size of the newly hatched larva ranges from 2 to 4 mm in length and 1 to 2 mm in width. The colour of the body is smoky-black with numerous brownish spines.White markings present on the back of 8^{th}, 9^{th} and 10^{th} abdominal segments. A pair of whitish spines lies on the last abdominal segment. The head is pale yellow. The first larva molts into second stage within 2 to 3 days after hatching.

The size of the second larva ranges from 6 to 12 mm in length and 2 to 3 mm in width. The colour of body is brownish green or dark green in the thorax and paler in abdomen. Mid-dorsal markings on the abdominal segments are whitish yellow. The larva becomes hump-backed in the thoracic region from the head, and then tapers gradually down to the tail. The head is pale green. The second larva molts into third larval stage within 2 to 3 days as it increased in size.

The size of the third larva ranges from 13 to 18 mm in length and 3.5 to 4.5mm in width. The body colour is dark green in thoracic region and paler towards posterior. Whitish yellow markings present on the back of 8^{th}, 9^{th} and 10^{th} abdominal segments. Three pairs of thoracic spines are black and a pair of the last abdominal spines is white. The third larva molts into fourth larval stage within 2 to 3 days.

The size of the fourth larva ranges from 20 to 25 mm in length and 5 to 6 mm in width.The body colour is yellowish green with dark green spots. Three pairs of thoracic spines and the last abdominal spines are lack in colour. Whithish yellow markings on the 8^{th}, 9^{th} and 10^{th} abdominal segments become yellowish green.The fourth larva molts into fifth larval stage within 2 to 3 days.

The size of fifth larva ranges from 25 to 38 mm and 6 mm to 8 mm in width. The body colour is yellowish green or light green with dark green spots. The paired thoracic spines become shorter but the metathoracic spines are longer than others. The head is pale green in colour. All larvae rest in the middle of the leaf on the uppersurface with its head usually pointing towards the petiole. The young larva is found on the reddish green tender leaves of the host plant. Later,when it changes to green colour, it hides among dark-green leaves at the core of the foliage. The fifth larva stops feeding after 4 to 5 days and searches suitable place to prepupa. The size of prepupa ranges from 22 mm to 28 mm in length and 6 to 8 mm in width. The duration of the prepupa lasted about 24 to 32 hours before the pupating process. (Plat IV)

Pupal Stage

When the prepupa starts of pupate the larval skin bursts behind the head and bulges out of the rent and gradually become as a projection. The larva pushes its old skin under the girdle by a series of alternate swelling and construction of the body. It pushes the old skin back to the end of the body. Supported by the girdle, the pupa with draws its clasper from the shriveled skin which falls and with a twist engages its cremaster in the silken pad. The last molting took about 5 minutes to be entirely out of the old larval skin. The colour of pupa is grassy green with a slender pointed projection and longitudinal yellowish bands from the tip of projection to the cremaster. The size of pupa ranges from 25 to 34 mm in length and 6 to 8 mm in width at its widest portion. The duration of the pupa lasted about 10 to13 days in captivity. The time period from egg to adult took about 25 to 35 days.

Adult Stage

The pupa normally takes about 10 to 13 days to emerge for the adult butterfly. When the pupa come to an end, colouration and patterns of wings can be seen through the pupal case. The skin of the pupa splits at the tip of projection behind the head and the adult begins to crawl forth out. The adult butterfly moves to a position close at hand where its wings can hang downwards. The suspended adult slowly spreads their wings. About this time, it expels a few drops of pale reddish fluid. The whole process of emergence and spreading of the wings took about one and half hours in this studied species (Plate.V).

Behaviours of Larvae

Feeding Behaviour

The newly hatched larvae feed on its empty eggshell as a first meal, which is nutrient for it. All the larvae started feeding from the leaf margins, and also fed on the old shed skin after molting. The fifth larva is the most voracious feeder, both on young tender leaves and old leaves as they need sufficient quantity of food energy to store for using in the inactive periods of pupa stage (Plate VI).

Defensive Behavior

The larva of the two studied species has an osmeterium which is a bifurcated process as a special defensive device. The osmeterium of the Common Bluebottle is pale translucent yellow in colour. The osmeterium of the Green Tailed Jay is pale translucent green. When the larva is disturbed, it often rears upon its prolegs, and it extrudes this organ from a dorsal pocket in the prothorax, just behind the head. This organ emits an unpleasant smell, and retracted quickly within two seconds. The unpleasant smell producing by the osmeterium is a very frequent form of protection among the larvae. (Plate VI)

Puddling Behaviour of Adult Butterfly

In hot weather, the *G. sarpedon* puddles on damp soil especially where they are already settled. The mud-puddling males spend a long time sucking up nutrients from the wet soil. The male of *G. sarpedon* often joins mud-puddling assemblages of other species. However, others of the genus, *G. agamemnon* is not found of puddling on wet soil. (Plate VI)

Discussion

Both studied butterfly species are not host plant specific. The Common Bluebottle, *Graphium sarpendon* mainly utilizes the Kara-way plants (*Cinnamomum macrocarpum*) as their host plants, but they also utilize *C. tamala* (Thikya-bo), and *C. obtusifolium* (Na-lin-gyaw). The main host plant of the Tailed Green Jay, *G. agamemnon* is *Polyalthia longifolia* (Thinbaw-Te) but *Polyalthia pandurata* (Ar-thaw-ka) plants are also utilized as their host plants. All butterflies are associated with the host plants and their occurrence depends on the present of plants. A butterfly species may occur throughout the year but the peak and fall of the population is related to foliating and defoliating periods of the plant species. Butterflies are rarely found in the areas with dried up or withering plants. The abundance of butterfly species in an area indicates that the environment is good conditions for the butterfly species.

The time taking for a complete life cycle of both species is not too variable; 29 to 37 days in *G. sarpedon* and 25 to 35 days in *G. agamemnon*. More or less different morphological characters were observed between larval and pupa stages of *G. sarpedon* and those of *G. agamemnon*.

Since all the stages involved in the life cycle of butterfly depend on the plant parts, especially leaves for their shelter and nutrition, host plants are essential for the survival of the butterfly species. Habit and habitat of host plants influence the life of butterflies. Both studied species were found to be oligophagus because the larvae used the leaves of the plants belonging to the same family for their food source, especially when they prepare to molt or pupate. The larvae of *G. sarpedon* feed on the leaves of *Cinnamomum macrocarpum* (Kara-way), *C. tamala* (Thikya-bo) and *C. obtusifolium* (Na-lin-gyaw), all of which belong to the family Lauraceae while those of *G. agamemnon* on the leaves of *Polyalthia longifolia* (Thinbaw-te) and *P. pandurata* (Ar-thaw-ka) belonging to the family Annonaceae.

If the larvae of *G. sarpedon* were fed with the leaves of *P. longifolia*, these larvae shown toxication and death resulted in some cases. This finding was not coincided with Kunte (2000) who reported that the larvae of this species fed harmlessly on leaves of *P. longifolia.*

The green coloured of pupa coat with yellowish bands makes the pupa of *G. sarpedon* for camouflage with the background leaf surface of the leaves of Kara-way plants (*Cinnamomum macrocarpum*).This may be one of the causes for *G. sarpedon* selecting *C. macrocarpum* as their main host plants.

Acknowledgement

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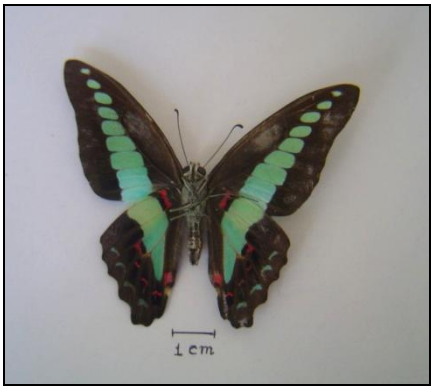
Graphium sarpedon (Upperside)



Graphium sarpedon (Underside)

Graphium agamemnon (Upperside)

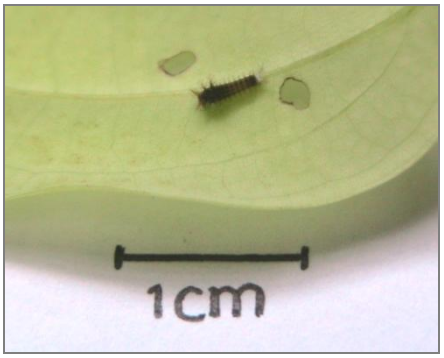
Graphium Agamemnon (Underside)

Sex marking of male *G. sarpedon*

Sex marking of male *G. agamemnon*

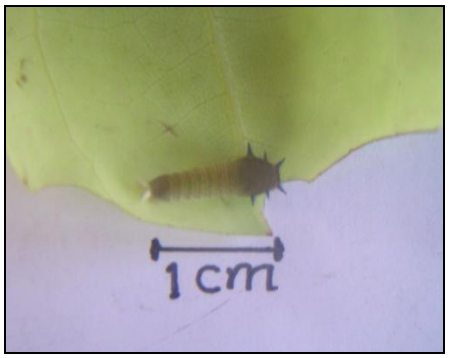
Plate I. External features of the studies species

A. Egg

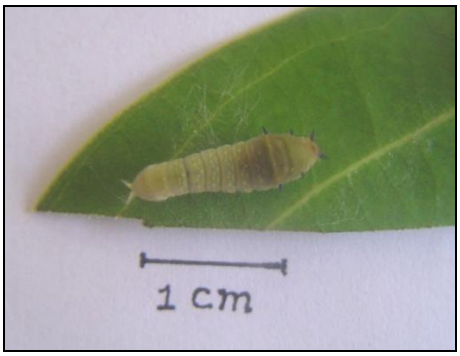


B. First larva

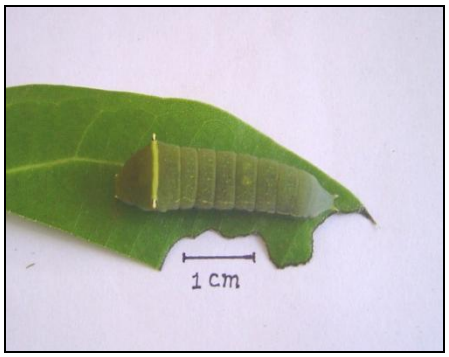
C. Second larva



D. Third larva

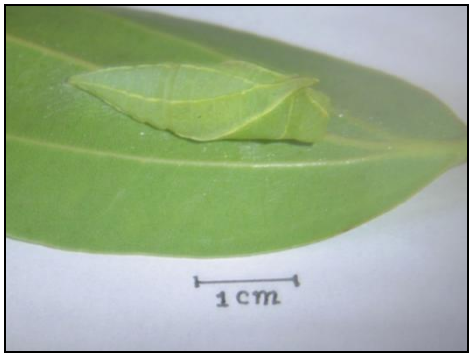


E. Fourth larva



F. Fifth larva

G. Prepupa

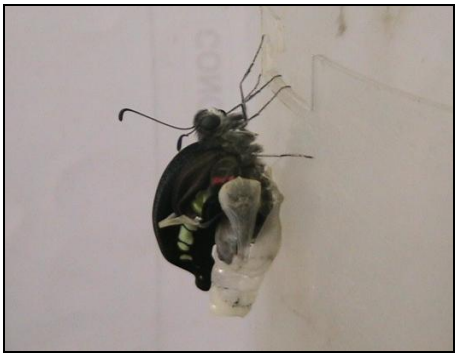


H. Pupa

Plate II. Developmental stages of *G. sarpedon*

A. Pupa ready to emerge

B. Pupal skin begins to split



C. Emerged adult begins to crawl forth

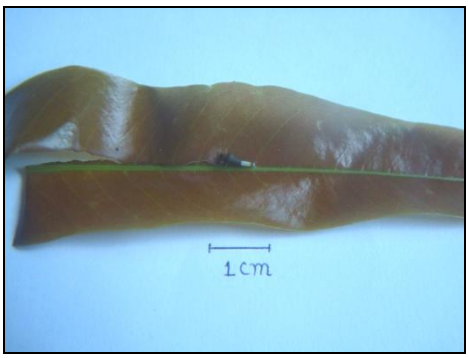
D. Adult with soft folded wings

E. Adult with fully spread wings

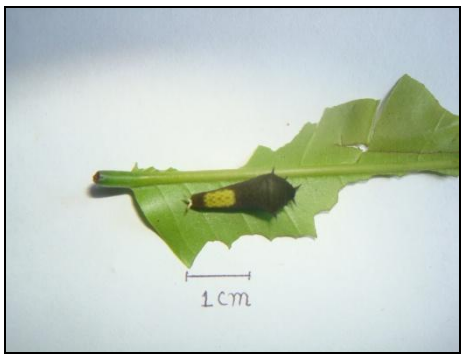
Plate III. Emergence of adult *G. sarpedon*

A. Egg

B. First larva

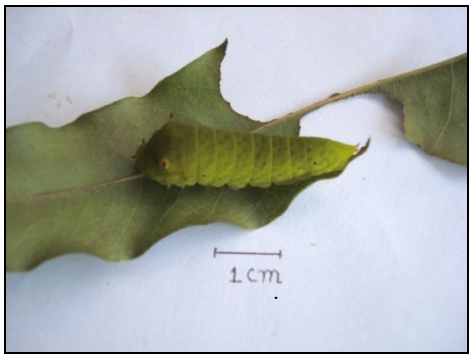


C. Second larva

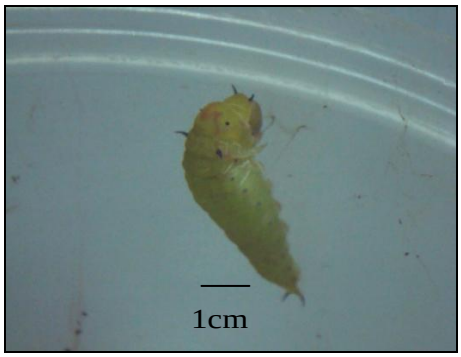


D. Third larva

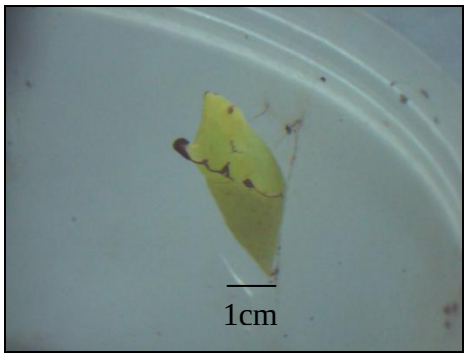
E. Fourth larva



F. Fifth larva



G. Prepupa



H. Pupa

Plate IV. Developmental stages of *G. gamemnon*

A. Pupa ready to emerge

B. Pupal skin begins to split

C. Emerged adult begins to crawl forth

D. Adult with soft folded wings

E. Adult with fully spread wings

Plate V. Emergence of the adult *G. agamemnon*

A. Feeding behaviour of Tailed Green Jay larva

B. Feeding behaviour of Common Bluebottle larva

C. Defensive behaviour of larva

D. Defensive behaviour of larva

E. *G. sarpedon* sucking the nectar

F. *G. agamemnon* gathering the nectar

G. Puddling behavior of *G. sarpedon*

Plate VI. Behaviours of the studied butterfly species