

MORPHOMETRICS AND LIFE CYCLE STUDY OF CABBAGE BUTTERFLY, *Pieris brassicae nepalensis* (DOUBLEDAY) IN ILAM, NEPAL

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ABSTRACT

Cabbage butterfly, *Pieris brassicae nepalensis* is an economic pest of crucifer crops. Morphometrics and life cycle study of *P. brassicae* was carried out in room condition at Barhabasti, Ilam, Nepal to understand their general morphology and life cycle. Based on the results of morphometric parameters, the mean length of egg, larva (I - V instars), pre-pupa, pupa and adult was measured 1.28 mm, 3.97 mm, 8.50 mm, 20.78 mm, 33.6 mm, 38.72 mm, 39.32 mm, 26.04 mm, and 24.08, respectively. The adult wingspan of female was greater than male wingspan. The adult butterflies were pale white with dense hairs and the females contain two small (black) dots in the central area of each forewing and one (black) dot in males. Egg, larval (I to V instars), pre-pupa and pupal life durations were 4 to 5 days, 3-5 days, 4-6 days, 4-5 days, 4-5 days, 4-6 days, 1-2 days, 8-10 days, respectively. The total development period from egg to adult was 32 to 44 days. This information's are useful for ecologist and to develop an integrated pest management protocol.

Keywords: Cabbage butterfly, life cycle, morphometrics, *Pieris brassicae nepalensis*

INTRODUCTION

Insect pests are the major crop limiting factors in crucifers (Bhavani et al., 2009). Insect herbivores alone can cause 40 % of the yield loss annually (Ali & Rizvi, 2007; Hasan & Ansari, 2010; Sood & Bhalla, 1996). *Pieris brassicae nepalensis* (Doubleday) are commonly known as cabbage white, cabbage moth, large cabbage white, or large white butterfly, is the most widely dispersed lepidopteran pest of crucifers (Ansari et al., 2012). The common name cabbage white butterflies are designated to these butterflies owing to the colour of their wings, and cabbage as their main host (Wilbur, 2011). The pest is responsible for causing serious damages at all the growing stages of the crucifers crops from seedling to flowering stages (Bhandari et al., 2009). Loss from this pest ranges from 27 to 41% in various conditions (Ali & Rizvi, 2007; Atalay & Hincal, 199; Eichler, 1948; Shapiro, 1975). This pest is distributed worldwide from Asia, Europe and North Africa to the North America (Scudder, 1887; Howe, 1975). *Pieris brassicae nepalensis* is also

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abundantly present crucifer crops from January to May in India, Bhutan, and Nepal and in other Asian countries (Piya & Khatiwada, 2004; Joshi, 1994; Thapa, 1987).

According to the morphological parameters as suggested by Wilbur (2011), the eggs were spindle-shaped with length and width of 1.23 and 0.61 mm, respectively. The mean length of I to V instars larvae was 4.4 ± 1.20 mm, 12.3 ± 0.38 mm, 15.9 ± 1.07 mm, 27.6 ± 2.47 mm, 39.74 ± 1.98 mm, respectively (Bhubaneshwari et al. 2012). The pupal length was measured as 20.0 - 25.0 mm as suggested by Bhowmik and Gupta (2017) while the adult male mean length was 20.7 mm and female length 24.98 mm, respectively (Bhubaneshwari et al. 2012).

The development period of *P. brassicae nepalensis* consists of four stages which include the egg, larval, pupal, and adult where the larval stages include five instars and the pupal stage includes a pre-pupa and pupa (Bhowmik & Gupta, 2017). The adult *P. brassicae nepalensis* butterflies are non-damaging, and are attractive with pale white wings and smoky shade on the dorsal side of the body (Bhowmik & Gupta, 2017). The caterpillars are the damaging stage that feeds glucosinolate rich crucifers such as cabbage, cauliflower, and mustards (Hopkins et al., 2009). They feed gregariously during the early instars and disperse as they mature, leading to the severe economic losses (Bhandari et al. 2009; Moore & Bill, 2010). At the curd formation stage, late instars *P. brassicae nepalensis* damages the curd that reduces the yield and quality of cabbage head (Lal & Ram, 2004). Moiseeva (1984) reported that a single larva can consume 74-80 cm² of leaf area during the development stage, 80 to 87% can consume by the fifth instar. Morphometric and life cycle of insect species can be influenced by the location, environmental parameters as well as their potential host. Here, morphometric and life cycle study of *P. brassicae nepalensis* is conducted in the eastern hill sides of Nepal. These findings are useful to the ecologist as well general biologist to compare the *P. brassicae nepalensis* found in eastern hill regions to the other ecological regions of Nepal in future. Also, life cycle study can be useful to develop an integrated pest management strategy in crucifer crops.

METHODOLOGY

Morphometric observations such as length of the larval instars, pre-pupa, pupa & adult were measured using a simple measuring ruler (10 mm scale size). Morphometric observations of eggs were taken for the field collected eggs. Individual egg was carefully observed keeping them in Petri dishes (9 cm diameter) and under stereo microscope. All observations were based on 50 individuals (n = 50). The newly emerged adults were differentiated as male and female and the length of the adult wingspan of both males and females

were recorded. There were 10 number of observations to study adult morphometric (n = 10).

Biology study was carried out at a room condition at Barhabasti, Ilam (26.9094° N latitude and 87.9282° E longitude and an altitude of 1020 m from the mean sea level). The leaves with freshly hatched larval masses and part of unhatched eggs were collected from farmer's field. Ten rearing plastic containers (23 cm height and 12 cm diameter) were used and cleaned properly keeping the moist cotton ball (3 cm diameter) on the bottom of each container. The mouth of the jar was covered using a muslin cloth. The newly hatched larvae were then transferred to the plastic containers using camel hair brush and fresh cauliflower leaves were supplied in each container. Each plastic jar contained 5 first instar larvae. The containers were cleaned and food residues were removed daily and replaced with new cauliflower leaves for the initial instars (I, II & III) and twice a day for subsequent instars (IV and V) to maintain hygienic conditions and this was continued until pupation.

The larvae kept in the rearing containers were carefully observed each day. The morphological change of instars was noted in each molt. Any changes in the shape, size, and color during different life stages were noted. The maximum and minimum room temperature during study period was 21.8°C and 3.8 °C, respectively, with a relative humidity of 75-80%.

RESULTS AND DISCUSSION

A. MORPHOMETRICS OF *PIERIS BRASSICAE NEPALENSIS* VARIOUS LIFE STAGES

Egg, larva and pupa

The length (mm) of eggs varied from 1.25 -1.3 mm with a mean of 1.28 mm (Table 1). The first, second, third, fourth and fifth instar larvae were measured at range of 3-5 mm (mean 3.97 mm), 6.5 - 9.5 mm (mean 8.50 mm), 17 - 24 mm (mean 20.78 mm), 29 - 37 mm (mean 33.60 mm), 37 - 41 mm (mean 38.72 mm) respectively. The length of the pupa was smaller than the larvae, and measured 26.04 mm (Table 1). These findings are similar with the result proposed by Bhowmik & Gupta, 2017.

Adult

The wingspan of female butterflies was measured 57.1 ± 0.95 mm and male butterflies measured 52.5 ± 0.4 mm while they had the body length of 24.08 ± 0.26 mm (Table 2). The female has two dots in the central area of each forewing and one in the case of males. These findings are similar with the findings reported by Bhubaneshwari et al. (2012).

Table 1: Morphometric of various life stages of *P. brassicae nepalensis*

Life stages	Length (mm)	
	Mean (mm) ± SE	Range (mm)
Egg	1.28 ± 0.03	1.25 - 1.30
I instar larva	3.97 ± 0.06	3.00 - 5.00
II instar larva	8.50 ± 0.09	6.50 - 9.50
III instar larva	20.78 ± 0.25	17.00 - 24.00
IV instar larva	33.6 ± 0.27	29.00 - 37.00
V instar larva	38.72 ± 0.17	37.00 - 41.00
Pre pupa	39.32 ± 0.02	37.00 - 43.00
Pupa	26.04 ± 0.22	23.00 - 30.00
Adult	24.08 ± 0.26	21.00 - 27.00

Measurement of the larval stage to the adult stage is the means of 50 observations.

Table 2. Size of wingspan of adult *P. brassicae nepalensis*

	Mean (mm) ± SE	Range (mm)
adult wingspan (female)	57.1 ± 0.95	53 - 62
adult wingspan (male)	52.5 ± 0.4	51 - 55

Measurement of adult wingspan are the means of 10 observations each.

B. *PIERIS BRASSICAE NEPALENSIS* LIFE CYCLE OBSERVATIONS

Eggs

Pieris brassicae nepalensis eggs are yellowish during hatching and they change their color to darker yellow within twenty-four hours of oviposition (Das et al., 2018). The female butterfly laid eggs in masses, the smallest egg mass with 2-3 eggs and the biggest consisting of 116 eggs firmly glued to the leaf surface which turned greyish before hatching. Similar observation was also noted by Das et al. (2018) and Hasan et al. (2008).

Larva (I, II, III, IV and V instars)

The eggs soon after hatching developed first instars which were yellowish-green in color with dark green bands. The larva underwent four moultings developing five instars which grew in length and width, became cylindrical, robust, and fed gregariously on the leaves. Similar results were also reported by Hasan et al. (2008) and Gupta et al. (1984). All the larval stages except the first instar had a narrow yellow line running along the center of the back along with a broken yellow line or a series of yellow spots on each side. Similar findings were also reported by the study conducted by Das et al., 2018.

Pre-pupa and pupa

The fully matured larva stopped feeding and moved to the walls of glass jars. Similar behavior also reported by Hasan et al. (2008). They are slightly fattened and measured about 37- 43 mm in length and turned into a pupa. The pupa is sharply angled consisting of keel like projection dorsally on the thorax and dorso-laterally on each side of the abdomen. This non-feeding stage are yellow, grey, green, and speckled brown in color. Same observations are also observed by Bhubaneshwari et al. (2012) and Wilbur (2011).

Adult (male and female)

The adult emergence from the pupa usually takes place in about 8-9 am from the anterior end by protruding the legs first and gradually pushing itself out of the pupal skin. Similar morphological changes are also reported by Chahil & Kular (2013). The adult butterflies are pale white covered by dense hairs with a black spot on the anterior edge of the hind wings. The male can be differentiated from the female due to the dots present on the forewing. These various male and female morphological features are explained by Wilbur (2011).

Life duration

In the present studies, the egg incubation period varied from 4 to 5 days (4.60 days) whereas the duration of the first, second, third, fourth, and fifth instar larva varied from 3-5 days (3.7 days), 4-6 days (4.48 days), 4-5 days (4.48 days), 4-5 days (4.54 days), 4-6 days (4.92 days) respectively (Figure 1). The pre-pupal period lasted for 1-2 days (1.52) and the pupal period for 8-10 days (8.7 days). So the total development period from egg to adult was found to vary from 32 to 44 days. This result is supported by Pandey et al. (2015) who reported that the duration of the first, second, third, fourth, and fifth instar larva was 3.70 days, 3.34 days, 3.74 days, 3.79 days, and 4.09 days, respectively. The studies also support the findings of Hasan et al. (2008) who reported that the pre-pupal period lasted for 1-2 days (1.6 days) and the pupal period for 9- 10 days (9.4 days). Bhowmik and Gupta (2017) in their laboratory life cycle study reported that the duration of the first, second, third, fourth, and fifth instars ranged from 4-6 days (5.40 days), 4-5days (4.40 days), 4-5 days (4.60 days), 4-5days (4.60 days) & 6-7 days (6.60 days), respectively, with the total pupal period of 7-9 days (7.90 days). The total development period was found to vary from 32- 44 days (Figure 1).

Most of the results of the present studies are in agreement with the studies carried out by many workers; however slight variations in different parameters have also been noted. This could be due to the difference in the host plants, the difference in their nutrient content, their growing conditions, or due to the variations in temperature at the time of rearing (Das et al., 2018; Hasan et al., 2010; Slansky, 1990; Singh & Sandhu, 2016).

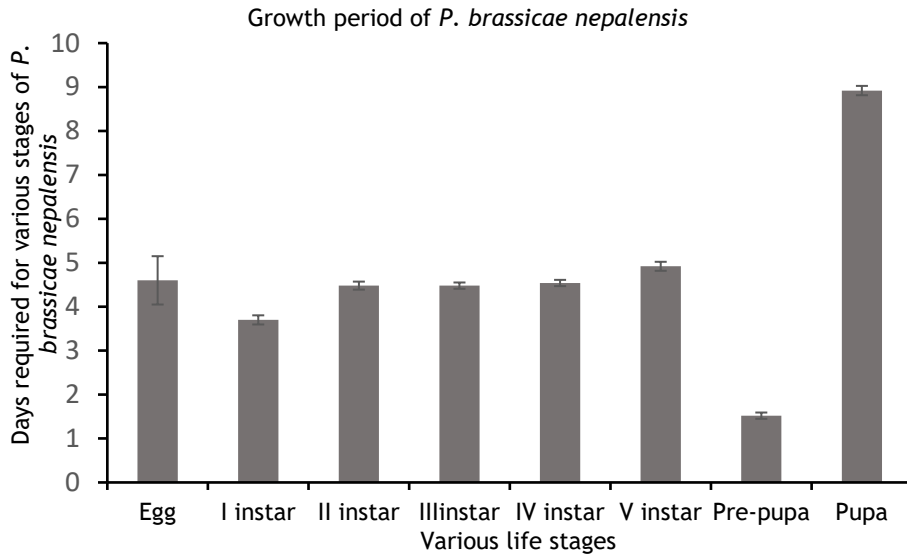


Figure 1. Life duration of various life stages of *P. brassicae nepalensis*.

CONCLUSION

Cabbage butterfly, *P. brassicae nepalensis* is one of the serious economic pests of crucifers attacking all their growth stages and cause a severe yield loss. The life cycle is completed consisting of the egg, larval, pupal, and adult stages where the larval stage includes five instars, and the pupal stage include a pre-pupa and pupa. It takes about 32 to 44 days from egg to adult development. The larval stage is the damaging stage that affects the plant at all stages of growth. The first instars larva feed the cabbage leaf by scraping the leaf surface and the gregarious feeding nature increases in subsequent larval instars. This morphometrics and life cycle study can be helpful for their proper identification of species and also support to develop an appropriate pest management strategy.

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