BIOLOGY OF *Danaus chrysippus* L. (LEPIDOPTERA: DANAIDAE): FEEDING POTENTIALS IN THE LARVAL HOST PLANTS AND ADULT NECTAR PLANTS

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Abstract

The biology and feeding potential of plain tiger butterfly, *Danaus chrysippus* L. (Lepidoptera: Danaidae) were examined in both field and laboratory conditions from July 2011 to June 2012. Field collected singly laid eggs on host plant (*Asclepias curassavica*) were reared in the laboratory at room temperature (25 ± 3 °C) and 70 ± 5% RH. Various life stages of the butterfly, viz. egg, larvae, pre-pupa, pupa and adult have been described. The egg incubation period was 4.6 ± 0.8 days; the duration of larval stages from 1st to 5th instars were 1.7 ± 0.2, 2.2 ± 0.2, 2.5 ± 0.3, 2.7 ± 0.2 and 3.1 ± 0.4 days, respectively; pre-pupal period was 1.4 ± 0.4 days; pupal period was 8.6 ± 1.1 days; the longevity of the adult females was 7.8 ± 0.3 days and of the males was 10.4 ± 0.7 days. The larval lengths of each of the five instars were 3.7 ± 0.84, 8.7 ± 1.09, 14.3 ± 1.20, 23.2 ± 2.36 and 38.5 ± 2.54 mm, respectively. The feeding potential rates of the five instar larvae were 5.5 ± 1.11%, 22.8 ± 2.96%, 67.7 ± 2.99%, 96.8 ± 4.09% and 293.6 ± 15.9%, respectively. The weights (in gram) of the excreta of five larval instars were 0.06 ± 0.02, 0.13 ± 0.03, 0.54 ± 0.06, 0.81 ± 0.06 and 1.96 ± 0.09, respectively. A total of 187 individuals was observed on 16 potential nectar plants in the Butterfly Research Park (BRP), Gazipur. These were *Lantana camara, Asclepias curassavica, Duranta plumeri, Hibicus rosa sinensis, Duranta repens, Tagetes patula, Ixora chinensis, Heliotropium indicum, Cosmos bipinnatus, Wedelia calendulaca, Punica hybrida, Spilanthes calva, Leucas linifolia, Helianthus annus, Euphorbia pulcherrima* and *Gomphera globosa*. Among these, *L. camara was* visited most frequently (16.58%) and *L. linifolia* was least frequently (1.60%) by this butterfly. No *Danaus chrysippus* was observed visiting *H. annus* and *E. pulcherrima* plants.

Key words: Life stages; *Danaus chrysippus*; *Asclepias curassavica*; Nectar plants; Feeding Potential.

INTRODUCTION

Insects are particularly useful in the evaluation of forests for biological resource conservation (Kim 1993 and Samways 1994). Almost all butterflies are herbivores in their larval stages, majority of them are host specific and have close relationships with their host-plants (Price *et al.* 1991). The plain tiger butterfly, *D. chrysippus*, is widespread and common throughout Southeast Asia and scarce in Southern Honshū, Japan (Evans 1932). Butterflies select host plants for oviposition using chemical cues. Females usually oviposit only on those plants, which are suitable for larval growth and survival. They usually select new larval food plants, which are related to their usual host plants (Kunte 2006). The larval milkweed host-plants of *D. chrysippus* often contain poisons, which the larva is able to isolate and retain in its body as a protection against vertebrate predation; these poisons can be passed on to pupa and adult butterfly. Although a significant majority of butterflies has strong interactions with flowers, plants and other biotic components of any ecosystem, however, the information about butterfly species and their nectar-host plant relationships in Bangladesh are scanty (Ehrlich and Raven 1964 and Huffaker *et al.* 1999). Floral attributes are well known to influence nectar-feeding butterflies (Bell 1909). The diversity of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants (Ilse 1956). Many of the flowering plants are used by butterflies as nectar plants and support a rich diversity of butterflies (Harish 1996). Butterflies have been found to differ in the range of available nectar sources used (Ashish *et al.* 2006 and Nair *et al.* 2014). The present experiment was carried out to investigate the biology and feeding potential of *D. chrysippus* in both field and laboratory

conditions. The study was undertaken with a view to analyze the association of the butterfly with its related plants to understand the butterfly-colonization process.

MATERIAL AND METHODS

The host plant culture

Different types of seed beds were prepared for the maintenance of *A. curassavica* in the Zoological garden of Dhaka University (ZGDU) and Butterfly Research Park (BRP) at Bhawal National Park, Gazipur. Initially the seeds were sown in the ZGDU. The immured seedlings were transferred to reach maturation in the BRP. Various types of beds, viz. Composite-1, Children corner, Milkweed, Master bed-3 and T-shaped were prepared (Fig. 1 a-f) by mixing of sand, cow dung, green manure and compost. The size, shape, colour of stem, leaf arrangement and type of plants were studied during the experimental period. The arrangement of different parts of inflorescence, flowers, fruits and seeds were described by following the methodology of LeRoy (1997). The traditional uses of *A. curassavica* were described according to Oliver-Bever (1986) and Kalidas *et al.* (2009).

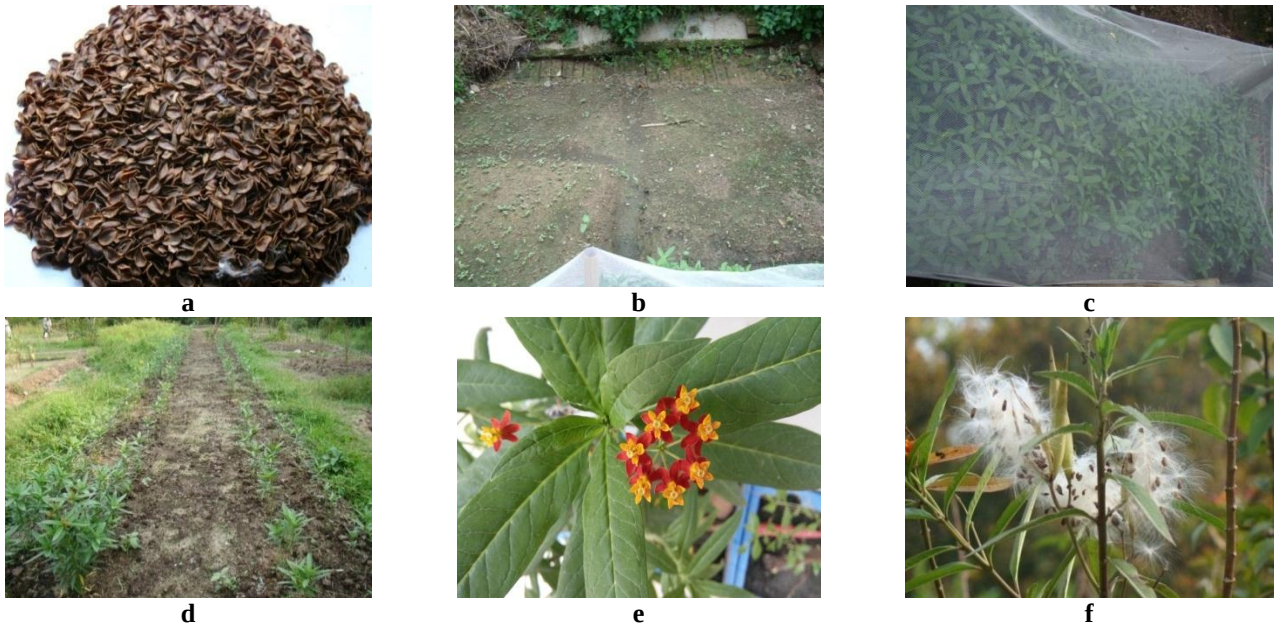

Fig. 1. Development of the host plant, *A. curassavica* in the Butterfly Research Park: **a**. seeds; **b**. seed beds; **c**. net covering of immature seedlings; **d**. seedling transplantation; **e**. flowering plant and **f**. explosive seeds from mature fruits.

The life stages of *D. chrysippus* were studied during the monsoon in ambient environment (25 ± 3 °C and 70 ± 5% RH) in the Environmental Biology and Biodiversity Laboratory (EBBL), Department of Zoology, University of Dhaka. Female *D. chrysippus* laid eggs on the leaves of the host plant *A. curassavica.* The plants were planted for butterfly colonization in the BRP. The female laid eggs singly, usually on the underside of the leaves of the host plant; sometimes she laid eggs on the other softer parts of the plant. The eggs were collected with the leaves of the plant on which the eggs were laid; these were then brought to the EBBL for rearing. The eggs were kept in a 3-layered larval rearing plastic cage.

For assessing the feeding potential rate of the larvae, 10 fresh young leaves of the plant were provided to the larvae hatched from the eggs in laboratory experiment. The similar number of leaves was provided 24 hours interval to the subsequent larval stages of the butterfly during the larval duration. Sometimes, water was sprayed on the leaves to prevent these from desiccation.

The feeding potential rates of the larvae were calculated by following the formula used by Alam *et al.* (2014):

$$TLSA = L_1SA + L_2SA + \ldots\ldots\ldots\ldots\ldots\ldots + L_{10}SA$$

Where, TLSA = Total Leaf Surface Area consumed per 24 hours,
L_1SA = 1st Leaf Surface Area = 10% of TLSA
L_2SA = 2nd Leaf Surface Area = 20% of TLSA
$L_{10}SA$ = 10th Leaf Surface Area = 100% of TLSA

The feeding potential rate of larvae was calculated in percentage. Total 10 fresh young leaves were supplied in the larval rearing cage. If the larvae consumed single leaf out of 10 leaves per 24 hours, it was considered as 10% consumption of total supply. The first consumed leaf was treated as L_1SA. If two leaves were consumed out of 10 leaves, it was considered as 20% consumption of total supply. The 2nd consumed leaf was treated as L_2SA. If 10 leaves were consumed out of 10 leaves, it was counted as 100% consumption of total supply. The 10th consumed leaf was treated as $L_{10}SA$. Successively the consumed leaf was added and designated as L_1SA (10%) + L_2SA (20%) +……..+ $L_{10}SA$ (100%). If the larvae consumes gradually from 1st leaf to 10th leaf that means 100% supplied leaf in laboratory experiment termed as Total Leaf Surface Area (TLSA).

Fig. 2. Life stages of *D. chrysippus* on the host plant, *A.* curassavica: **a**. adult butterfly; **b**. male and female in mating; **c**. egg laying; **d**. egg; **e.** 1st instar larva; **f**. 2nd instar larva; **g**. 3rd instar larva; **h**. 4th instar larva; **i**. 5th instar larva; **j**. pre-pupa; **k**. pupa; **l**. adult emerging.

The larval excreta of the butterfly species were collected daily and weighed in an electronic balance. The developmental stages in the life cycle of the butterfly were studied following the methods of Barua and Slowik (2007). Experiments were repeated five times, results were analyzed statistically following Ashish *et al.* (2006), Tudor *et al.* (2004) and Erhardt (1991).

RESULTS AND DISCUSSION

Mating behaviour of D. chrysippus

The mating of *D. chrysippus* was observed mostly during morning and evening hours and the copulating pair stays at a place (Fig. 2b). The breeding female laid eggs mostly during 7.30-11.30 am in the morning and 2.30-5.00 pm in the evening.

Oviposition behaviour of D. chrysippus

In the field, it was observed that a gravid female of *D. chrysippus* laid 10-12 eggs at a time on different leaves of the host plant and took 5-6 minutes for egg laying at each occasion. The females were observed to visit the host-plants repeatedly, to probe leaves for examining, to ascertain the tender nature of the leaves, and to search for the availability of shade for egg laying. After flying repeatedly around the host plant for about 5-8 minutes, a female was found to lay one egg in each of the tender leaves. During egg laying, the forewings were continuously fluttering and it took about five seconds to lay a single egg. The female under observation laid only two eggs within a time span of 30 seconds. Similar oviposition behaviour of the butterfly was reported by Swailem and Ismail (1972), Smith *et al.* (1988), Wadnerkar *et al.* (1979), Sharma and Verma (2005) and Kunte (2005).

The freshly laid egg was white shiny in color, then gradually changed into creamy colour and in the end it became brownish in colour. The egg was dome shaped, with 20-22 longitudinal ridges, and with numerous indistinct lateral ridges. The egg pits were rectangular shaped. Each egg was 1.7 ± 0.5 mm in length and 0.5 ± 0.1 mm in diameter (Fig. 2d). During oviposition, a butterfly first settles on a leaf, then turns its abdomen to underside and lays one egg on one leaf of the host plant (Fig. 2c). The incubation period was 4.6 ± 0.8 days (Fig 3).

a **b** **c** **d**

Fig. 8. *Danaus chrysippus* butterfly utilizing nectar plants in BRP, Gazipur. a. *Lantana camara* (F: Verbenaceae); b. *Asclepias curassavica* (F: Asclepiadaceae); c. *Heliotropium indicum* (F: Boraginaceae); d. *Chromolaena odoratum* (Asteraceae).

Larval instars

1st instar: Its body was yellow, with minute hairs on head and body. Head was black 1.20 – 1.30 (1.22 ± 0.04) mm wide with a pair of black horns. Yellow longitudinal lines were present on the dorsal side of the body (Fig. 2e).

2nd instar: Body became totally green with black square shaped head, 2 (2.00 ± 0.00) mm wide. Anal spines were black. There were well-developed longitudinal yellow lines dorsally, and a pair of thinner yellow lines present on each lateral side of the body. Body and head were rough and hairy (Fig. 2f).

3rd instar: Head was black, hairy, with two forked horns. It had white marks. Head wide was 3.4 – 3.5 (3.48 ± 0.04) mm. There were well-developed dorsal and lateral yellow lines on the body, the dorsal pair extending up to the black anal spines. Segmentation was clear. There were no changes in other characters from the previous instar (Fig. 2g).

4th instar: Head width grew to 4.30 – 4.6 (4.6 ± 0.13) mm and turned to reddish brown in colour along with the head horns. The white markings on head turned to cream in colour, well developed and triangular in shape. Anal spines developed orange colour dorsally. There were no changes in other characters from the previous instar (Fig. 2h).

5th instar: Head grew to a width of 5.80 – 6.70 (6.48± 0.38) mm. Anal spines were orange coloured with black tips. Body was completely hairy. It was rough dorsally and ventrally soft and light green in colour. Orange and dark blue to green coloured spots (three pairs each) were seen on the dorsal yellow pair of lines. There were no changes in other characters from the previous instar (Fig. 2i).

Larval duration and larval size

The larval durations of 1st, 2nd, 3rd, 4th and 5th instar larvae were 1.7 ± 0.2, 2.2 ± 0.2, 2.5 ± 0.3, 2.7 ± 0.2 and 3.1 ± 0.4 days, respectively (Fig. 3). The lengths of the five instar larvae were 3.7 ± 0.84, 8.7 ± 1.09, 14.3 ± 1.20, 23.2 ± 2.36 and 38.5 ± 2.54 mm, respectively (Fig. 4). The larval size depends on the availability of food sources. The later instar larva quickly metamorphosed into pre-pupa when foods were not available to them. In this condition, the larvae could not make pupal covering (cocoon) properly and took a longer time than required, and the emergence rate of adult from pupa was poor. The size of larval instar was also reduced (Alam *et al.* 2014). Environmental factors, moderate supply of larval food and different host plants caused the variation of larval length as reported by Smith *et al.* (1988).

Feeding potentiality of larvae

The feeding potential rate of five instar larvae were 5.5 ± 1.11%, 22.8 ± 2.96%, 67.7 ± 2.99%, 96.8 ± 4.09% and 293.6 ± 15.9%, respectively (Fig. 5). The 1st, 2nd and 3rd instar larvae usually preferred to feed on the tender parts of *A. curassavica* (Fig. 2e-g); the 4th and 5th instar larvae usually preferred young and mature leaves, flowers and fruits of the host plants (Fig. 2h-i). The feeding potential of the early instar larvae was less than later instar larvae, which were, in fact, voracious feeders. More energy was required to be metamorphosed into pupa and that's why 90-100% supplied leaves were consumed by later instar larvae (Alam *et al.* 2014).

Larval excreta

The weights of the excreta of all instar larvae were 0.06 ± 0.02 g, 0.13 ± 0.03 g, 0.54 ± 0.06 g, 0.81 ± 0.06 g and 1.96 ± 0.09 g, respectively (Fig. 6). The excretory product of the larvae was proportionate to the feeding potential rate of the larvae. It was calculated that the excretory products of the early instar larvae were less compared to later instar larvae, because the feeding potential rate of 3rd, 4th and 5th instar larvae were more in comparison to 1st and 2nd instar larvae. Alam *et al.* (2014) stated that before pre-pupation, last instar larvae usually excreted large sized droppings and more amount than previous larval instars. Larval excreta were in liquid form primarily at hatching, but became solid after 2-3 days.

Pupa

During pre-pupal period, the larva stopped feeding and settled down motionlessly. Its color changed from grey to brown (Fig. 2j). The pre-pupal duration was 1.4 ± 0.4 days (Fig. 3). The pre-pupa was moulted into a pupa which was large, stout, mostly smooth, about 20 mm long (including the cremaster),

the posterior end was rounded and slightly rugose, and ended in a short black cremaster. Rounded anteriorly, but with a pair of apical protuberances, the wing bases were slightly protuberant, and there was a finely beaded slightly raised transverse ridge dorsally on the abdomen (Fig. 2k). The pupae change colour, either pale green, bluish-green, pink or yellowish-brown. There was a series of paired dorsal yellow marks on pupal body. The pupa was 17.4 ± 0.4 mm in length and 7.5 ± 0.4 mm in wide. The pupal duration was 8.6 ± 1.1 days (Fig. 3). Duration of larval, pre-pupal and pupal was found 12.5 ± 0.2, 1.5 ± 0.1, 9.8 ± 0.3 days, respectively (Ramana *et al.* 1998); 7.20±0.44, 1.3±0.1, 7.40±0.54 days, respectively (Sharma and Verma 2005), and 19.1 ± 0.4, 2.4 ± 0.1, 14.6 ± 0.7 days, respectively (Wadnerkar *et al.* 1979). The main reasons for these differences could be due to variety in subspecies, hosts and climates (Smith *et al.* 1988). Pupa was found in pale green and pale brown colors; the same colours were observed by Swailem and Ismail (1972) and Sharma and Verma (2005), but different by Ramana *et al.* (1998) and Braby (2000) who observed just one color in the pupal period. The color variation in pupa was controlled by the greening hormone in the larval head (Smith *et al.* 1988).

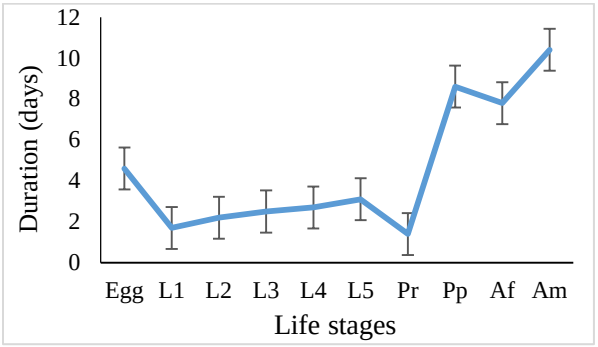

Fig. 3. Duration of life stages of *D. chrysippus* (L1=1st, L2=2nd, L3=3rd, L4=4th, and L5=5th instar, Pr=Pre-pupa, Pp=Pupa, Af=Adult female, Am=Adult male)

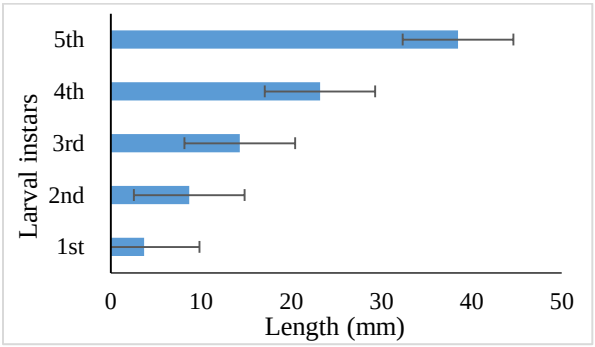

Fig. 4. Length of different larval instars of *D. chrysippus* when fed on the host plant (*A. curassavica*) leaves.

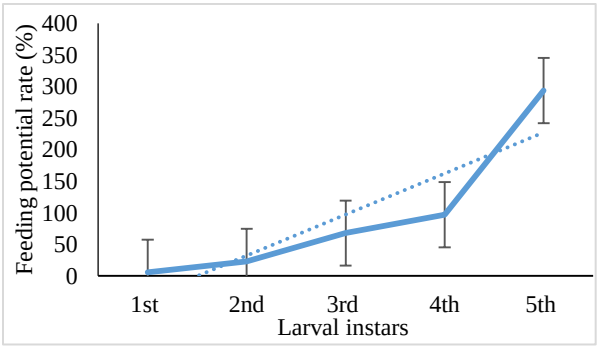

Fig. 5. Feeding potential rate of different larval instars of *D. chrysippus* butterfly on the host plant.

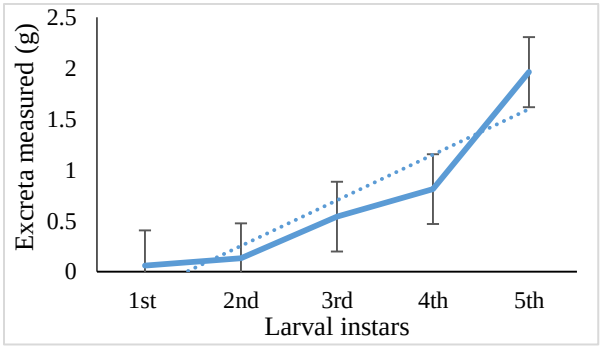

Fig. 6. Amount of excreta of larval instars of *D. chrysippus* when fed on leaves of host plant.

Adults

Both sexes of adults were similar, but males could be distinguished by the presence of a single, small raised black sex pouch in the lower-centre of each hindwing. The males had a pair of grey "hairpencils" enclosed near the tip of their abdomens, which they can protrude and expand into a feathery like mop and dispense a characteristic scented pheromone, which was required for successful courtship. The adults were shiny butterflies with orange and brown colors. The main difference between males and females was the presence of spots on the hind wings. Each hind wing of the males had four black spots while the females had only three black spots (Fig. 2a). The male and female adult's longevity were 10.4

± 0.7 and 7.8 ± 0.3 days, respectively (Fig. 3). The total development time from egg to adult was 35.9 ± 0.6 days. A total of 26 to 37 days was taken for development from egg to adult as reported by Swailem and Ismail (1972), Wadnerkar *et al.* (1979), Sharma and Verma (2005) and Ramana *et al.* (1998).

Nectar plants utilization strategy of D. chrysippus

A total of 187 individuals of plain tiger butterflies was observed in the BRP, Gazipur on 16 potential nectar plants, viz. *Lantana camara, Asclepias curassavica, Duranta plumeri, Hibiscus rosa sinensis, Duranta repens, Tagetes patula, Ixora chinensis, Heliotropium indicum, Cosmos bipinnatus, Wedelia calendulaca, Punica hybrida, Spilanthes calva, Leucas linifolia, Helianthus annus, Euphorbia pulcherrima* and *Gomphera globosa*. Among these *L. camara was* visited highest (16.58%) and *L. linifolia* was lowest (1.60%) by *D. chrysippus.* None of *D. chrysippus* visited *H. annus* and *E. pulcherrima* (Fig. 7, 8).

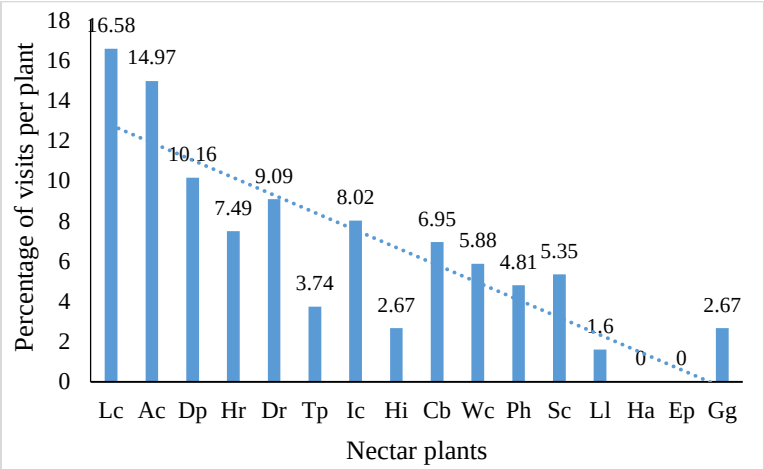

Fig. 7. Foraging behaviour of *D. chrysippus* observed on sixteen different nectar plants in the year of 2011-2012 at BRP, Gazipur (as indicated by percent visitors). *Lc=Lantana camara*; *Ac=Asclepias curassavica*; Dp=*Duranta plumeri*; *Hr=Hibiscus rosa-sinensis*; Dr=*Duranta repens*; Tp=*Tagetes patula*; Ic=*Ixora chinensis*; HI=*Heliotropium indicum*; Cb=*Cosmos bipinnatus*; Wc=*Wedelia calendulaca*; Ph=*Punica hybrida*; Sc=*Spilanthes calva*; Ll=*Leucas linifolia*; Ha=*Helianthus annus*; *Ep=Euphorbia pulcherrima*; Gg=*Gomphera globosa*.

It has been assumed that butterflies had no specific flower preference, and that their feeding behaviour was governed by the distribution and abundance of available nectar plants (Dosa 1999). Butterflies do not select the nectar plants randomly. The choice of nectar plants by butterfly is correlated with flower structure and their proboscis size and adaptability (Erhardt 1991). Population size of butterfly in selected species increases as the number of special nectar plant diversity increases (Schultz and Dlugosch 1999).

Nectar-feeding mechanism could play a significant role in the reproductive success and longevity for adult butterflies. Floral nectar is highly variable because different plant species produce different quantities and qualities of nectar (Baker and Baker 1983). Caterpillars are often limited to a single host plant, but adult butterflies utilize a wide variety of plants as nectar sources. For many holometabolous insects, the quality and availability of nutrient resources during the adult stage correlates with fecundity, egg weight, and longevity as reported by Boggs (1997), MeviSchutz and Erhardt (2003) and O'Brien *et al.* (2004).

Enhancement of plant population sustenance

The *A. curassavica* is related with *D. chrysippus* both as host and nectar plants. The plants exposed to butterflies are found to produce more fruits and seeds than those of the plants not exposed to butterflies. On the other hand, the non-exposed plants produced seeds with low quality and less weight compared to the seeds produced by the plants exposed to the butterflies. Similar results were also obtained when experiments were conducted with other two plants, viz. *Aristolochia indica* and *D. plumeri*. It is evident that butterflies can bring significant results in the case of healthy seed production (Bashar *et al.* 2015). The healthy seed production can also enhance the production of genetically more viable plants and can sustain good population size in the ecosystem where the colonizing process is practiced. As each of the butterfly species was related with each respective plants for foraging, egg-laying, resting and pupating, and other activities, and if through the activities they bring healthiness to the related plants, they can help in answering the questions of their conservation in the same ecosystem (Bashar *et al.* 2015, 2006).

Morphophenology of the plant, Asclepias curassavica

It is a perennial herb, an erect, glabrous that grows up to 1.2m tall. It has a milky exudate throughout. The stem is smooth, round, dull green or suffused with dull red. The leaves are simple, opposite, shortly petioled, lanceolate of oblong-lanceolate, acuminate and measures 7-13cm long and 6-25cm wide. The base is narrowed. Inflorescence in the form of an umbel with 6-15 flowers on terminal or axillary peduncle. The flowers are perfect, radially symmetrical or irregularly shaped, bright red or orange with yellow centers. There are five sepals, deeply divided, reflexed, and green. Five petals are linear with base united to a fused corolla. The corolla lobes are red, reflexed, oblong and approximately 8mm long. The corona scale is orange in colour, 5-lobed and measures 3.5-4.0mm long. The corona is hood-shaped with inwardly curved horns; stamens 5 in number; anthers with two pollen sacs; pollen aggregates into masses called pollinia or pollen sacs. The style filaments are united with pistils 2-carpelled. The fruit is a pair of dry dehiscent, spindle-shaped follicels, measuring 5-15cm long, many seeded, splitting lengthwise on one side at maturity. The seeds are ovate, flat, winged, measures 4-6mm long and 2.2-4.0mm wide, brown in colour, minutely ridged, with a pappus of fine white silky hairs at the apex, measures 23cm long (LeRoy 1997). *Asclepias curassavica* is used in China to disperse fever (clears heat), improve blood circulation and to control bleeding. Entire plant is dried and decocted as a cardiac tonic, for tonsillitis, pneumonia, bronchitis, urethritis and external and internal bleeding (Oliver-Bever 1986 and Kalidass *et al.* 2009).

Basking and foraging behaviour of the adults

The butterflies may need the sun to warm their wing muscles so they can fly. They fly best when air temperatures range from 75-90 degrees; so when it's cooler, they bask, using the sun's heat to warm their bodies. A large, flat rock in the butterfly garden provides a warm spot for basking when the temperatures are cool. When temperatures get too warm, butterflies seek shade. The final form of basking is known as reflectance and this is used when the butterfly want to reflect the sunlight to their body versus just their wings (Baliant *et al.* 2004).

Feeding habit of butterfly is bisidal in function and very characteristic in their lifestyle. In one side it helps in taking energy directly from the flowers. In other hand, it carries great role in the gene-flow of the plant to which it is related. Butterflies feed primarily on nectar from flowers (Gilbert 1972, Singer and Parmesan 1993, Singer 1984). During foraging it is very often found to visit flowers of different plants by a single species in different pattern and posture (Bashar 2015). The butterflies have to visit the plants because of their nutritional requirements in the adult stage, for egg-laying supports of copulated

females, and host plants for larval food materials. Proboscis is very adaptive and vital organ in the adult. It is used by the adult strategically in relation to the flower structure in different butterfly families (Fig. 8). The modifications and interrelations in between the nectar containing flowers and the nectar-sucking organ the proboscis itself in the butterflies are the most important biotic-biotic adaptabilities (Boppre 1984).

Coevolutive observations in butterfly and plants

Correlation coefficient between the *Danaus chrysippus* butterfly and nectar plant species have been found ($r = 0.96$) and is significant at 1% level ($p = 0.01$), shows strong correlation between butterfly diversity in relation to nectar plants. Hence, greater number of nectar plant species attracts significant number of butterflies (Fig. 7). It is evident that the insect interaction with plants (especially the phytophagous pollinating insects and the flowering plants with entomophilous pollens) establishes strong gene-flow mechanism in the forest ecosystem. Then the ecosystem becomes healthy and gave more functional services. Consequently the ecosystem becomes suitable and compact home for the successive trophic levels which provided fruitful services to all the wild animals living in the forest ecosystem (Bashar *et al.* 2015). Coevolutive aspect between the two is vital for the conservation of butterflies and their related plants.

To conserve the plain tiger butterfly *D. chrysippus*, the host-plants and nectar-plants of these species must be protected and conserved in nature according to Wiklund and Ahrberg (1978). A sustainable harvest of the butterfly in breeding houses will not only help in maintaining the recovering populations in the wild, but the dead stock having good commercial trade value will also contribute to the trade in butterflies. Captive breeding will also help in a better understanding of its biology and an effective conservation strategy through the creation of local awareness, particularly amongst school children and local villagers living near protected and unprotected forests can prove to be the most effective method for the conservation of butterflies as described by Barua and Slowik (2007).

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