Advances in Bioresearch
Volume 3 [4] December 2012: 03 - 08
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[ISO 9001: 2008 Certified Organization]
Website: http://www.soeagra.com/abr/abr.htm

A B R
ISSN 0976-4585

Original Article

Life History and Larval Performance of the Tiny Grass Blue Butterfly, *Zizula hylax hylax* Fabricius (Lepidoptera: Lycaenidae)

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ABSTRACT
The life history of the Dark grass blue butterfly, Zizula hylax hylax Fabricius and larval performance in terms of food consumption and utilization, and the length of life cycle on its host plant Desmodium triflorum (L.) DC. are described for the first time. The study was carried out at Kaikaluru (16° 34' N and 81° 12' E), Andhra Pradesh, India during the monsoon months (June – August) of the current calendar year. Zizula hylax hylax completes its life cycle in 16 – 18 (17.20 ± 0.84) days (Egg: 3; Larva: 8-10; Pupa: 5 days). The values of nutritional indices across the instars were AD (Approximate Digestibility) 66.64 – 96.10%; ECD (Efficiency of Conversion of Digested food) 3.53 – 64.77%; ECI (Efficiency of Conversion of Ingested food) 3.39 – 42.77%, measured at the temperature of 28 ± 2° C and RH of 80 ± 10% in the laboratory. These relatively high values of ECD and ECI explain at least partially the ecological success of Zizula hylax hylax in the present study environment.
Key words: *Life history, Zizula hylax hylax, captive rearing, immature stages, food utilization indices.*

INTRODUCTION

Of the estimated 20,000 – 30,000 species of butterflies occurring globally, at least 1,500 species occur in India. Several field guides for the identification of the Indian butterflies are available [1-5]. A list of the works giving the descriptions of the life histories was given by Pant & Chatterjee [6], of which those of Bell [7] are important. However, review of these early works indicated that for many species data, particularly on the duration of immature stages, are either absent or incomplete.

For the development of effective breeding/rearing programs and conservation management of butterflies, information on the life history and exact habitat requirements is essential. Further, immature stages of butterflies are increasing importance as sources of systematic characters, and often give important clues as to the placement of species in major groups [8, 9]. Haribal [2] noted that such information is lacking for 70% of the Indian butterflies. In this context the present study furnished the necessary information about immature stages, larval performance on its host plant *Desmodium triflorum* (L.) DC., and the length of life cycle from egg to adult eclosion for the Tiny grass Blue butterfly, *Zizula hylax hylax* Fabricius. This species is distributed throughout tropical and sub-tropical Africa, Asia and Oceania.

MATERIALS AND METHODS

The present study was carried out at Kaikaluru during the monsoon months (June – August) of the current calendar year. Kaikaluru (16° 34' N latitude and 81° 12' E longitude) is one of the major gram panchayats in the Krishna district of Andhra Pradesh, India. The present study site is located very proximity to Kolleru lake, which was declared as a wildlife sanctuary under India's wildlife protection Act, 1972 and also designated as a wetland of international importance under the international Ramsar convention. The natural plant community of the area is regularly searched during 0800 to 1700 h for the reproductive activity of the Tiny grass blue butterfly, *Zizula hylax hylax.* Adult butterflies were seen mostly near the larval host plant *Desmodium triflorum*. Once adult butterflies were located detailed observations were made in order to observe the period of

copulation and oviposition. After detecting ovipositions, the leaves with eggs were collected in Petri dishes (15 cm × 2.5 cm depth) and brought to the laboratory. The leaf piece with an egg was then placed in a smaller Petri dish (10 cm × 1.5 cm depth), that was lined with moistened blotter to prevent leaf drying. Such Petri dishes were kept in a clean, roomy cage fitted with wire gauge. Since ants were never detected, no special protection device was tried to avoid predation of eggs. They were examined regularly at 6 h interval for recording the time of hatching. Each of the freshly emerged larvae was transferred to a clean Petri dish inside of which lined with moistened blotter with the help of a camel hairbrush. The larvae were supplied daily with weighed quantity of tender leaf pieces of the host plant. The faeces and the leftover of the food was collected and weighed each day (24 h). The growing larvae were observed regularly to note the instar change and characters including length and weight measurements. As the larvae grew, they needed more space. Increased space was provided by transferring the growing larvae to bigger Petri dishes (15 cm × 2.5 cm depth). Larval performance in terms of food utilization indices were calculated as described by Waldbauer [10] as:

GR: Growth Rate

$$= \frac{\text{Weight gained by the instar}}{\text{Mean weight of instar} \times \text{Number of feeding days}}$$

CI: Consumption Index

$$= \frac{\text{Weight of food ingested}}{\text{Mean weight of instar} \times \text{Number of feeding days}}$$

AD: Approximate digestibility (also called Assimilation Efficiency)

$$= \frac{\text{Weight of food ingested} - \text{Weight of faeces}}{\text{Weight of food ingested}} \times 100$$

ECD: Efficiency of Conversion of Digested food
(also called Net Conversion Efficiency)

$$= \frac{\text{Weight gained by the instar}}{\text{Weight of food ingested} - \text{Weight of faeces}} \times 100$$

ECI: Efficiency of Conversion of Ingested food
(also called Gross Conversion Efficiency)

$$= \frac{\text{Weight gained by the instar}}{\text{Weight of food ingested}} \times 100$$

Fresh weight measurements were used for the purpose. Five replications were maintained for the study of all parameters. The preparation of full grown larvae to pupate, particulars of pupae including color, shape, size, weight and the time of adult eclosion were also recorded. Millimetre graph paper was used for taking measurements. The laboratory temperature was 28 ± 2^0 C and relative humidity 80 ± 10% with normal indirect sunlight conditions that varied in duration between 12 h during November/ January and 14 h during June/July.
In describing the details of adult characters, the butterflies that have emerged from the pupae in the laboratory, and those caught in the wild were used.

RESULTS

Adult Stage (Figure: 1a)

The adult butterflies on the top are dark brown fading toward the bases, the male wings have purple iridescence. Underside both sexes are pale grey, with multiple arcs of brown dashes. Antennae black; head, thorax and abdomen are dark brown, with a little violet pubescence on the

head and thorax. This violet pubescence is not found in the females. Beneath the thorax and abdomen it is grayish white. Wing span is between 15 - 20 mm. Adults were found probing for nectar on the *Cleome viscosa* L.*, Gomphrena procumbens* Pav. ex Moq.*, Sida acuta* Burm. f. and *Lippia nodiflora* (L.) Michx.

Adult female behavior during oviposition:

The gravid female laid eggs singly on the undersurface of the both young and mature leaves of its host plant. About 6 -10 eggs were laid at a time but on different leaves. There was no bias for the age of the leaf. Oviposition took place during 0900 – 1600m h.

Egg stage (Figure: 1b)

The eggs were sky blue in color, and flattened round disc like shape, and measured 0.30 (0.30 ± 0.00) mm in height. They hatched in three days of incubation. It passed through four distinct instars over a period of 8 – 10 (9.20 ± 0.84) days.

Larval stage (Figure: 1c-f)

Larva was onisciform (slater shaped). Instar I lasted for 2 – 3 (2.40 ± 0.55) days. On the first day of hatching, the instar measured 1.10 – 1.70 (1.46 ± 0.23) mm in length. It grew to 1.60 – 1.90 (1.76 ± 0.15) mm in length and 0.70 – 0.90 (0.82 ± 0.08) mm in width. Head capsule black in color and measured 0.40 – 0.50 (0.46 ± 0.05) mm in diameter. Body cream colored. Larva mainly chooses to reside on the underside of leaflet. It feeds mainly on the epidermal layer of the leaves. By the next day larval body turned into light green. Instar II lasted for 3 – 4 (3.26 ± 0.45) days. The larva attained a length of 3.00 – 4.20 (3.44 ± 0.45) mm and a width of 1.20 – 1.60 (1.34 ± 1.15) mm. Head capsule greenish and measured 1.00 (1.00 ± 0.00) mm in diameter. Body was greener than previous instar. There was a thick green colored streak along the mid-dorsal surface of the body. Body was fully covered with minute transparent hairs. Segmentation was clear. Instar III lasted for 2 – 3 (2.60 ± 0.55) days. The larva attained a length of 6.80 – 7.30 (7.10 ± 0.20) mm and a width of 2.10 – 2.90 (2.48 ± 0.32) mm. Head capsule measured 1.10 – 1.50 (1.36 ± 0.15) mm in diameter. Instar IV lasted for '1' (1.00 ± 0.00) day. The larva attained a length of 8.00 – 9.00 (8.30 ± 0.41) mm and a width of 2.80 – 3.00 (2.96 ± 0.09) mm. Head measured 1.90 – 2.20 (2.02 ± 0.11) mm in diameter. In their characteristics both Instar III and Instar IV resembles Instar II. Body contracted before pupation.

Pupal stage (Figure: 1g)

Pupal stage lasted '5' (5.00 ± 0.00) days. It was 7.00 – 8.00 (7.30 ± 0.45) mm in length and 2.30 – 2.80 (2.54 ± 0.21) mm in width at its broadest point. It was green in color and without any ornamentation or markings. Its weight was about 19.20 – 36.80 (26.46 ± 6.57) mg.

Duration of life cycle The total development time from egg to adult eclosion ranged between 16 – 18 (17.20 ± 0.84) days. (Egg: 3; Larva: 8-10; Pupa: 5 days).

Food consumption, growth and utilization

The data on the amount of food consumed by each of the four instars and the corresponding data on weight gained by different instars are given in Table 1. Of the total amount of food consumed, the percentage shares of the successive instars were 7.58, 13.44, 21.94, and 57.04% and the proportions of weight gained by the successive instars were 0.93, 2.51, 8.06, and 88.49%. Thus, there was over 78% of the total food consumption in the third and fourth instars together and 96% of total weight gained in the third and fourth instars together. There was a direct relationship between food consumption and growth across the four instars (Fig. 2). The values of consumption index (CI) decreased from first to final instar. The values of growth rate (GR) increased from first to final instar. Values of CI ranged between 2.32 – 8.48 mg/day/mg and those of GR between 0.29 – 0.99 mg/day/mg. Table 1 also included the data on AD, ECD, and ECI. The values of AD from instar to instar decreased from a high of 96.10% in first instar to a low of 66.64% in the last instar.The values of ECD and ECI increased progressively from the first instar to the last instar. The values of ECD varied from 3.53 – 64.77% and those of ECI from 3.39 – 42.77%. Thus there was an inverse relationship between the values of AD and those of ECD and ECI.

DISCUSSION

The total development time from egg laying to adult eclosion was determined as 17.20 ± 0.84 days at about 28 ± 2^0 C. This behavior is in line with the expectations of short life cycles in tropical butterflies [11]. Since temperature influences instar duration and the overall development time [12 – 15], the duration of life cycle may vary from our records depending on the prevailing temperatures. As no temperature extremities occur at the study site, the duration of life cycle did not vary much over the overlapping seasons.

Over the entire period of its growth, a larva consumed on average over 0.16 g of leaf material, increasing consumption in the last two instars. This tendency of greater consumption by the last two instars has been reported in lepidopterous larva in general [10, 12, 13, 16 – 18], and it compensates the energy expenditure of non-feeding pupal stage [19]. The values of CI are near to the range (0.27 – 6.90) predicted for forb foliage chewers [20]. Food consumption rate depends on the conversion efficiency of ingested food to biomass (ECI), the rate increasing as the conversion efficiency decreases or vice versa [20]. In this sense, the high CI value (8.48) of instar I is probably due to low conversion efficiency and this character is reflected in the low values of ECI for instar I compared to other successive instars. Higher growth rates occur with penultimate and final instars [21].

Table 1. Food consumption, growth and food utilization efficiencies of *Zizula hylax hylax* larva fed with *Desmodium triflorum* leaves.

Instar number	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gained by larva (mg)	GR (mg/day/mg)	CI (mg/day/mg)	AD (%)	ECD (%)	ECI (%)
I	11.80 ± 01.24	0.46 ± 00.04	0.40 ± 00.05	0.29	8.48	96.10	03.53	03.39
II	20.94 ± 05.28	3.20 ± 01.33	1.08 ± 00.72	0.30	5.84	84.72	06.09	05.16
III	34.17 ± 05.07	7.44 ± 01.52	3.46 ± 03.16	0.32	3.81	78.23	12.94	10.12
IV	88.84 ± 07.21	30.17 ± 02.05	38.00 ± 02.35	0.99	2.32	66.64	64.77	42.77

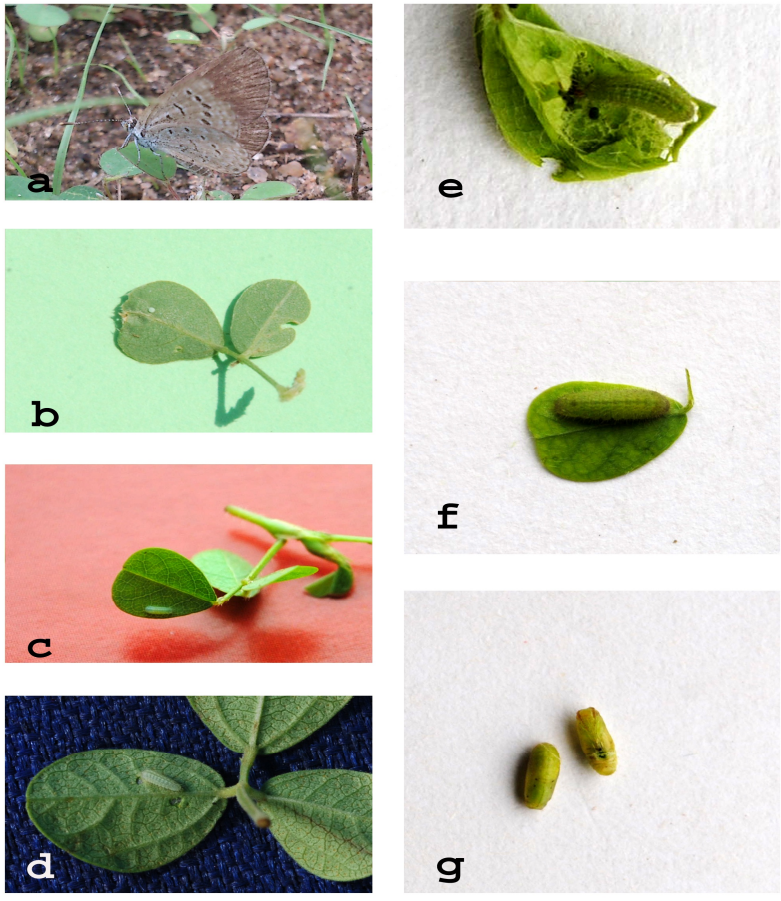

Fig-1: Life stages of *Zizula hylax hylax*
(a)Adult (b)Eggs (c)Instar I (d)Instar II (e)Instar III (f)Instar IV (g)Pupa

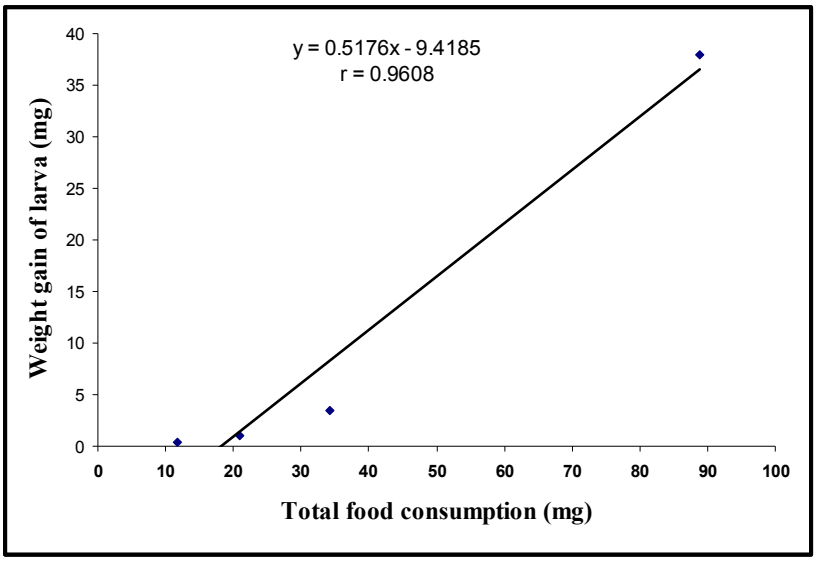

Figure 2. Relationship between food consumption and growth in *Zizula hylax hylax* on *Desmodium triflorum*

The values of AD that were obtained in this study are comparable with the range of AD values (19 – 81%) for lepidopterous larvae [22]. The average AD percentage is over 81.42% and this high AD substantiates the statement of Slansky and Scriber [20] that foliage chewers often attain high AD values. Such high AD values also are expected when food item is rich in nitrogen (and also water) [22]. Similar results were repeated with *Pieris brassicae* (L.) [23], *Euploea core* (Cramer) [24], *Ariadne merione merione* (Cramer) [25], *Danaus genutia* Cramer [26], and *Byblia ilithyia* Drury [27]. The values of ECD increase from early to last instars [20]. Such a trend is also observed with the ECDs of *Zizula hylax hylax*, with the lowest value in instar I and the highest in instar V. The ECDs obtained are low compared to the ADs and such low values are not unusual [10]. This is indicative of low efficiency of conversion of digested food to body tissues. This poor utilization of food is often attributed to deficiency in some essential nutrient in food [28] or a factor causing an increase in energy expenditure on metabolism [29]. The values of ECI (3.39 – 42.77) obtained are comparable with the range of values expected for forb foliage chewers (1 – 78%) [20]. The values of ECD and ECI, particularly those of the last two instars, are also relatively high (12.94, 64.77; 10.12, 42.77), thus respectively indicating tissue growth efficiency and ecological growth efficiency, which enabled *Zizula hylax hylax* to thrive successfully in its habitat.

Thus, the present study provides information on the oviposition larval host and larval performance in terms of food consumption, growth and utilization, and the length of life cycle from egg to adult eclosion of the Tiny grass blue butterfly, *Zizula hylax hylax.* The present data may be profitably utilized in the successful conservation management of this butterfly species either in parks, Zoos and butterfly houses or in the field. Butterfly houses are popular exhibits in Zoos and have an immense educational [30] and conservational potential [30, 31]. The present study also indicted that captive rearing the larvae at about 28 ± 2^0C permits enough stock of adults for restocking the areas poor in populations of the Tiny grass blue butterfly.

ACKNOWLEDGEMENT

We are most grateful to Shaik Meera Mohiddin, Principal, Y.V.N.R. Govt. Degree College, Kaikaluru for providing facilities and encouragement for the study.

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[Received: 22.09.12; Accepted: 18.11.2012]