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RESEARCH ARTICLE

LIFE CYCLE OF JUNONIA LEMONIAS (L.) ON BARLERIA PRIONITIS (L.) AND DIPTERACANTHUS PROSTRATUS (POIR.)NEES AT ANDHRA UNIVERSITY CAMPUS, VISAKHAPATNAM.

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Abstract

The Nymphalidae butterfly Junonia lemonias Linnaeus(Lemon Pansy) was found throughout the year at Andhra University campus. The larval host plants available at the study site include Barleria prionitis and Dipteracanthus prostratus. In the present paper the life cycle duration and larval performance observed on the leaves of Barleria prionitis and Dipteracanthus prostrates is presented. In natural conditions at Andhra University campus the host availability, oviposition, pairing and egg deposition were observed. The behavior and morphological characters of eggs, caterpillars, pupae and adult emergence were observed in the laboratory at 28^{o}-30^{o}c. The life history was completed in 21-31 days with egg hatching 3, larvae 12-19 and pupae 6-9 in the former and 23-32 days with egg hatching 3, larvae 13-20, and pupae 7-9 days in the case of latter. The values of consumption index (CI), growth rate (GR), and approximate digestibility (AD) across the instars decreased as the larvae aged. The average values of the CI and GR are 9.2, 1.29 in former and 8.9, 0.93 in latter respectively, and that of AD is 99.1and 99.2. In contrast the values of both efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) either increased or decreased from instar to instar.

Introduction:-

The phytophagous insects like butterflies are closely related with the plants and provide economic and ecological benefits to the human society. Butterflies are dependent on vegetation both as adults and larvae and involve themselves in complex feeding relationships with green plants. As larvae, they feed chiefly on the foliage of plants and they are typically host specific and often show a 'botanical instinct' in that closely related plant.

If the requirements of the butterfly species in the wild are thoroughly understood, it is possible to conserve them in captivity or wild. A suitable habitat for butterflies should include mating site(s) for the adults, nectar sources for adults and, larval food plants for oviposition. As butterflies are holo-metabolous with distinct developmental stages as egg-larva-pupa-adult, their reproductive output is dependent on the combined effect of larvae-derived and adult-derived nutrients or energy. These findings require a study of adult nectar resources, larval food plants, and food consumption and utilization by the larvae. Therefore, efforts are being made in the Andhra University to study the biology, ecology and conservation of butterfly fauna available at Visakhapatnam and its surroundings.

The present study relates to the Lemon Pansy- Junonia lemonias (Lepidoptera: Rhopalocera: Nymphalidae) and describes its adult food resources, oviposition and larval host plants Barleria prionitis and Dipteracanthus prostratus egg deposition pattern, life history including the duration of early life history stages. Also the effect of different potential host plants on the offspring in terms of the larval performance is studied.

Material and Methods:-

Study Region & Site:-

The present study was carried out at Visakhapatnam during 2012 and 2013. Visakhapatnam (17o 42' N latitude and 83 o 20' E longitude) is located on the east coast of India in the State of Andhra Pradesh. The climate of the area is tropical monsoon type. Most of the precipitation during the year is June to November, and the total rainfall, though varies from year to year, normally ranges between 1000 – 1500 mm. The mean temperature is at its maximum on some days (38 - 45°C) during May/June. The mean temperature relatively high through October and thereafter decreasing to a minimum (18–20°C) in January/February. The present study was conducted at Andhra University campus which spreads over an area of 168 hectares and is in proximity to the coastline. The wilderness on the Andhra University Campus was searched for the reproductive activity of the butterflies. A large number of tree and herbaceous species occur on the Campus. Some of the plants occurring on the campus are heavily foraged by adult butterflies for nectar. Many herbaceous taxa serve as the larval hosts for the butterfly species distributed on the vast campus.

Field Study:-

Regular walks in different patches of the study site were undertaken at 10-day intervals or when required even at shorter intervals or even daily. Butterflies are day active mostly during 0830 – 1500 h. Hence walks were made during these hours of the day to record the flight behaviour, foraging, and ovipositing activity of the Junonia lemonias chosen for the present study. These activities were observed during the entire period of adults on wing. Nectar resource plants and oviposition plants used by this species were recorded.

Laboratory Study:-

Life History Study:-

After noting the period of breeding season and the oviposition plants close and prolonged observations were made of the breeding females laying eggs on its host plants. Freshly laid eggs were spotted, and the plant material (leaves/twigs) on which they were laid, was plucked without causing any damage. The date and time of day of collection were noted. Then the material was transferred to Petri dishes of 10 cm diameter and 1.5 cm depth. The inside of each of these Petri dishes was lined with moist blotting paper to provide moist conditions. They were brought to the Department and incubated in the laboratory having a temperature of 28 ± 2°C, and relative humidity of 80 ± 10%. The Petri plates were kept in a clean, roomy cage (60 x 50 x 30 cm) covered with wire gauge. The light condition was the normal indirect sunlight, but its duration was not uniform throughout the year. It varied from a low of about 11 h during November – February (winter months) to a high of about 13 h during May – June.
The eggs thus incubated in the laboratory were examined at 6-hour intervals daily for recording their incubation period and hatchability. The eggs were treated as hatched when the larvae came out from them.

In order to assess the total larval period and the number of instars that may be produced, the newly hatched larvae were transferred individually into the Petri dishes with the help of a camel hairbrush. Fresh young leaves were offered as food to the growing larvae. Moulting was noted, and thus the number of instars produced was recorded. Observations as color, shape and size of each instar was maintained. As the larvae grew, they needed more space. Increased space was provided by transferring the growing larvae to bigger Petri dishes (15 cm diameter; 2.5 cm depth). The full grown larvae pupate, and particulars of pupae including color, shape, size, weight and duration were also recorded. Millimeter graph paper was used for taking measurements. Taking the number of eggs studied, their developmental success (%) was calculated. 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.

Food Consumption And Utilisation:-

The larvae represent the main feeding stage. Quantitative data of food consumption and utilization were recorded for each instar of the butterfly species under study using the gravimetric method of Waldbauer (1968). The larvae and the host leaves were weighed separately and then placed in Petri dishes. The larvae were allowed to feed on the leaves for 24 h and then the weights of the larvae and the remaining leaf material, and faecal matter in the Petri dish were determined. Fresh food was supplied, and the related weights were also taken every 24 h. From these fresh weight measurements, growth and food utilization indices were calculated. These indices included Consumption Index (CI), Growth Rate (GR), Approximate Digestibility (also called Assimilation Efficiency) (AD), Efficiency of Conversion of Ingested Food (also called Gross Conversion Efficiency) (ECI), and Efficiency of Conversion of Digested Food (also called Net Conversion Efficiency) (ECD). The formulae of Waldbauer (1968) used in the calculation of these indices are:

$$\text{CI (Consumption index)} = \frac{\text{Weight of food consumed}}{\text{Weight of instar x Number of feeding days}}$$

$$\text{GR (Growth rate)} = \frac{\text{Weight gained by the instar}}{\text{Mean weight of instar x Number of feeding days}}$$

$$\text{AD (Approximate digestibility)} = \frac{\text{Weight of food ingested} - \text{Weight of faeces}}{\text{Weight of food ingested}} \times 100$$

$$\text{ECD (Net conversion efficiency)} = \frac{\text{Weight gained by the instar}}{\text{Weight of food consumed} - \text{Weight of faeces}} \times 100$$

$$\text{ECI (Gross conversion efficiency)} = \frac{\text{Weight gained by the instar}}{\text{Weight of food ingested}} \times 100$$

The weights are expressed in units of milligrams (mg). The values are based on five different observations for each parameter; standard deviations were also calculated.

Statistical Analysis:
The relation between the food consumed and the weight gained per instar by the larvae of each of the butterfly species under study was statistically analyzed on the basis of Legenders principle by fitting a straight line. Larval weights are represented on Y- axis, and the food consumed on X-axis. Correlation coefficient was calculated in each case along with_t'value.

Results:-

Field observations on the adult habits nectar resources, oviposition host plants, egg laying pattern and the laboratories results on hatching egg, larval characters, instar duration, pupal characters, pupal period, success rate of development of eggs, larvae and pupae, food consumption and utilization indices of each instar are all described here for the butterfly **Junonia lemonias (Linnaeus) (Lemon pansy)** in the present study.

Adult Habit (Plate. A):-
Field characters:
The adult's measure 45-60mm in wing spread. Upper side of both male and female is dark brown. Wing margins are wavy; two black and two yellow margin lobes are alternatively arranged. On forewing lemon yellow spots present along with two ocelli, the lower one is larger and prominent. Hind wing bears a large apical red ocellus.

Adult Food Resources:-
Adults of J.lemonias feed on floral nectar. In the study area the plants utilized as nectar hosts include Anacardium occidentale, Antigonon leptopus, Duranta repens, Lantana camara, Santalum album, Spermacocoe hispida, Stachytarpheta jamaicensis, Tectona granidis, Tridax prcumbens and Ziziphus oenoplia. These plants produced yellow, pink, violet, pink and orange, brownish purple, pink, blue, white, yellow and pale green flowers respectively in that order. The frequency of visits made by the butterfly to different coloured flowers varied.

Oviposition Host Plants:-
The recorded oviposition host plants include Asystasia gangetica(Acantha)(C), Acanthus (Acantha), Asteracantha longifolia (Acantha) (H), Barleria prionitis (Acantha) (S), Hygrophila auriculata (Acantha) (H), Lepidagathis prostrata (Acantha) (H), Nelsonia canescens (Acantha) (H), Rostellularia crinita (Acantha) (H), R. procumbens (Acantha) (H), Ruellia prostrata (Acantha) (S), Ipomoea batatas (Convolvula) (C), Gloxinia (Gesneri), Osbeckia (Melastomat), Sida rhombifolia (Malva) (H), Antirrhinum orontium (Scrophula) (H), Corchorus capsularis

(Tiliaceae) (H), Phyla nodiflora (Verbena) (H). Of these plants, in this for present study Barleria prionitis and Dipteracanthus prostratus were taken. The host plant Barleria prionitis and Dipteracanthus prostratus were mostly used for egg laying in the study area. The egg laying female displays fast movement after locating the host plant, it lands on the plantand tastes the suitability of the leaf with its front leg tarsi it flutters and bends the abdomen ventrally to deposit the egg. Both sides of the leaves are used for egg laying, but mostly the upper surface is used. Sometimes egg may layed on the twigs also The eggs laid on this plant were collected and used in the study of life history and consumption and utilization on both host plants of the family belonging to Acanthaceae. The following description relates to the observations made on the above on both plant species.

Egg Stage (Plate. B):-
Mating and oviposition occurred during fore noon hours of the day (9- 12 noon). Eggs are laid singly. Breeding female can lay 6-10 eggs at a time but on different leaves. Eggs are cream coloured, dome shaped, slightly ridged and measure 0.8 - 0.9 (0.84 ± 0.05) mm in diameter. They hatched in 3 days of incubation in the both host plants. Immediately after hatching the larva ate its egg- shell. The larvae passed through five distinct instar over a period of 12-19(12.8±1.09) days Barleria prionitis and 13- 20(14.2±1.30) days on Dipteracanthus prostratus.

The characters of the early stages on each of the host plant are described separately
Barleria prionitis Linn. (plate.1):-
The plant is a branched perennial herb. The leaves are elliptic; spines are present in the leave axils. The flowers are oranges yellow and are arranged in terminal spike with the lower flowers solitary in the axils of the leaves. The corolla of the flowers is two lipped, the upper lip is four lobed and the lower lip entire it produces a singly seed capsule bearing two seeds.

Larval Stage (Plate. C, D, E, F, G):-
Instar I:-
The larva is cylindrical and uniformly thick from the head to the abdominal tip. The head is pale black (grey) in colour while the body is snuff colour. The larva bears spines on its entire body. It grew for 1-2 days and attained a length of 3- 4 (3.3± 0.27) mm and the width of 1-1.5 (1.04±0.08) mm in diameter.

Instar II:-
This stage larva does not differ from the first instar in its colour and the pattern of spines. It grew for 2-4 days and attained a length of 4-9 (6.24± 1.23) mm and the width of 1-2.5 (1.56±0.35) mm in diameter.

Instar III:-
Head and thorax are clearly distinguishable and the junction is marked with pale yellow colour. Spines are black, body is snuff colour and the origin of spines is indicated by the glistening dots. Ground colour of the body is pale yellow. It grew for 1-2 days and attained a length of 8-15 (11.3± 2.22) mm and the width of 2-3 (2.34±0.42) mm in diameter.

Instar IV:-
Other body characters are similar are those of instar III. It grew for 2-4 days and attained a length of 12- 26 (18.6± 1.79) mm and the width of 2.5-4.5 (3.42±0.42) mm in diameter.

Instar V:-
Body becomes stout, spines are thick and branched; its colour is black with a faint blue sheen. The central line on the back is darker. A distinct orange ring behind the head on the second segment is present. It moves fast. It grew for 3-4 days and attained a length of 24-38 (33.06± 1.60) mm and the width of 4.5-7 (5.76±0.32) mm in diameter.

Pupa (Plate. H):-
The larva eventually stops feeding to entire the pupal stage. Its body becomes short by contraction and this process takes place for a day. It attaches to substratum with the help of head and tail. It is brown in colour, hairy with pale brown patches. The pupa developed on B. prionitis remained at this stage for 6-9 days and attained a length of 15-17 (16.1± 0.74) mm and the width of 5-6.5 (5.6±0.41) mm in diameter. The particulars of all these biological observations is given in table.1

Duration Of Life Cycle:-
The time taken for the development of adult from egg on B. prionitis ranged between 21-31(23.4± 1.14) days. (Egg 3; Larva 12-19; Pupa 6-9 days).

Hatching Success, Pupal And Adult Development:-
Hatching success on this host plant is 70%.

Food Consumption And Growth:-
The data on the amount of food ingested, weight of the feaces, weight gained in larvae, growth rate and consumption index determined for each of five instars on B. prionitis, is given in the tables.2. The weight of food ingested increased as the larvae grew from one instar to the other instar in sequence. Of the total amount food consumed during the entire larval period, the proportions of food consumed by successive instars were 0.34,2.42,10.6,18.8 and the last instar consumed a greater amount of food 67.7%.corresponding with their increase in food consumption, there was an increase in instar growth, the weight proportion of each instar being,. Thus, the last instars consumed a more food and gained greater weight than other instars. Plotting the weight gained against the food consumed (Figure.1); a direct relationship between food consumption and growth across the five instars could be seen. The values of growth rate (GR) increased till instar III and decreased to instar, and the consumption index (CI) progressively decreased from instar to instar. The values of GR varied between 0.15-1.29 mg/day/mg and those of CI between 0.8-9.2.

Indices Of Food Utilization:-
The data on AD, ECD and ECI are also included in the table.2. The values of AD from instar to instar decreased from a height of 99.21% in first instar to a low of 52.23% in the last instar. The values of ECD and ECI increased progressively from first to second instar and there was no progressive decrease or increase in these values from third to fifth instar. The values of ECD ranged between 5.9-26.0 and ECI between 5.19-21.9.

Dipteracanthus prostratus (Poir.) Nees (Plate.2):-
The plant is a prostrate perennial herb, with stems often rooting at the nodes. Leaves are ovate, flowers occurs single in the leaf axils. Flowers are violet blue to occasionally nearly white, the petals slightly spreading.

Larval Stage (Plate. C, D, E, F, G):-
Instar I:-
The colour and shape of the larva is same as in B. prionitis. On D. prostrates. This stage lasts for 2 – 3 days and attained a length of 3-5(4.1±0.22) mm and width of 1- 1.2(1±0.00) mm.

Instars II:-
This stage larva does not differ from the first instars in its color and the pattern of spines. It grew for 2 – 4 days and attained a length of 6-11(8.04±0.91) mm and width of 1.5-2(1.62±0.10) mm.

Instars III:-
The color and shape of this stage larva is same as in B. priorities. It grew for 1-2 days and attained a length of 8-14(12.4±0.89) mm and width of 2- 2.50(2.18±.20) mm.

Instars IV:-
Other body characters are similar are those of instars III. It grew for 2 – 3 days and attained a length of 13-22(17.44±1.90) mm and width of 2-3.5(2.68±0.34) mm.

Instars V:-
The color and shape of this stage larva is same as in B. priorities. It grew for 3-5 days and attained a length of 19-37(29.16±1.90) mm and width of 2.5-6.5(4.54±0.59) mm.

Pupa (Plate. H):-
The larva eventually stops feeding to entire the pupal stage. Its body becomes short by contraction and this process takes place for a day. It attaches to substratum with the help of head and tail. It is brown in colour, hairy with pale brown patches. The pupa developed on D. prostrates lasted for 7-9 days and attained a length of 15-18(16.4±1.14) mm and width of 5.4-6(5.68±0.29) mm. The particulars of all these biological observations are given in table.3.

Duration Of Life Cycle:-
The time taken for the development of adult from on D. prostrates ranged between 23-32(24.6± 2.07) days. (Egg 3; Larva 13-20; Pupa 7-9 days).

Hatching Success, Pupal And Adult Development:-
Hatching success on this host plant is 100%

Food Consumption And Growth:-
The data on the amount of food ingested, weight of the feaces, weight gained in larvae, growth rate and consumption index determined for each of five instars on D. prostrates is given in the table.4. The weight of food ingested increased as the larvae grew from one instar to the other instar in sequence. Of the total amount food consumed during the entire larval period, the proportions of food consumed by successive instars were 0.52, 3.28, 8.2, 21.5 and the last instar consumed a greater amount of food 66.35%.corresponding with their increase in food consumption, there was an increase in instar growth, the weight proportion of each instar being,. Thus, the last instars consumed a more food and gained greater weight than other instars. Plotting the weight gained against the food consumed (Figure.2); a direct relationship between food consumption and growth across the five instars could be seen. The values of growth rate (GR) increased till instar III and decreased to instar, and the consumption index (CI) progressively decreased from instar to instar. The values of GR varied between 0.18-0.93 mg/day/mg and those of CI between 2.1- 8.9.

Indices Of Food Utilization:-
The data on AD, ECD and ECI are also included in the table.4. The values of AD from instar to instar decreased from a height of 99.2% in first instar to a low of 87.2% in the last instar. The values of ECD and ECI increased progressively from first to second instar and there was no progressive decrease or increase in the values of ECD and ECI from third instar to fifth instar. The values of ECD ranged between 6.32-40.17 and ECI between 6.2-39.1.

Discussion:-

Data were obtained with reference to Junonia lemonias on nectar, oviposition, larval host plants, egg-laying patterns, hatching period, the number of instars the larva passed through, their duration, and pupal period, and development success of eggs to adult in the laboratory. In addition, data were collected on larval performance on the basis of growth rate GR, food consumption index CI, approximate digestibility of food AD, efficiency of conversion of digested food ECD and efficiency of conversion of ingested food ECI. These different aspects of biology and food utilization are discussed below in the light of the relevant information available from temperate and tropical regions of the world. It is generally understood that the gravid females directly deposit their eggs on the plants on which their larvae later feed. Janz et al. (1994) the larval survival, growth rate, development time, pupal weight and the nutritional indices AD, ECI, and ECD have been estimated for Junonia lemonias on its natural oviposition host plants and the effect of potential host plants on the offspring. The potential host plants chosen for this butterfly species was Barleria prionitis and Dipteracanthus prostratus.

Based on the spectrum of plant species utilized by the larvae for feeding (Opler and Krizek 1984). Kunte (2000). The present report of the host plants of the butterfly species under study in the context of the above concept of food plant utilization indicated that, Junonia lemonias could be treated as oligophagous and it shown wider range of potential host plants suitable for larval growth than the range of plants now used for oviposition. While Kitching (1981) recognized three categories of butterflies on the basis of their egg-laying habit, most authors considered only two categories: (1) the cluster or batch layers, and (2) those laying eggs singly. The species of the present study exhibited single-egg laying habit. Also the larvae of single-egg laying species are less likely to be exposed to adverse environmental conditions of heat and desiccation because single larvae are less likely to defoliate. The basic life cycle of a butterfly from egg to adult varies from 3 weeks to 2 years (Opler and Krizek 1984). Most butterfly species in the tropics have short life cycles (Owen 1971). As is the case with of Junonia lemonias: average of 21-32 days.

Food Consumption And Utilization Across The Instars:-
The young leaves support better larval growth than older ones (Feeny 1976; Watanabe 1979). Young leaves are known to be rich in nitrogen content (Muthukrishnan 1990). Mature leaf water contents of most annual/biennial

forbs generally range from 75-95 %, grasses from 65-80 % and shrubs and trees from about 45-75 % (Slansky and Scriber 1985). The leaf water contents of the host plants of Junonia lemonias ranged between 51.57-83.75% and tallied with the values given by Slansky and Scriber (1985). Barleria prionitis, 59.00 with least percentage of water and Dipteracanthus prostratus had the highest percentage of water with 70.20. Butterflies are short-lived forms, the larval growth is rapid, and such rapid accomplishment of full growth of larva lowers the risk of mortality due to predation, disease and physical factor (Price et al. 1980). The data obtained with respective to J.lemonias on the quantity of food consumed and growth achieved in terms of larval body weight, and the values of consumption index (CI) and growth rate (GR) showed a definite trend of increasing absolute and declining relative rates of CI and GR with J.lemonias under study. There is a straight line relationship between food consumption and growth (Figures 1, 2). Of all instars, the penultimate and final instars together consumed a greater amount of food: Barleria prionitis 86.5 and Dipteracanthus prostrates 87.9 of total food consumed over the entire larval period. The strategy of increased food consumption with the progression of larval age appears to be characteristic of all Lepidoptera and the same has been reported in other Lepidoptera in general (David and Gardiner 1962; Ghosh and Gonchaudhuri 1996; Atluri et al. 2004a; Samatha 2006). Consumption index (CI) of instar I was the highest and the values decreased as the instars progressed (Table.5). This decline in CI as the larvae aged may be related to the increase in body size of the larvae or to the increase in conversion efficiency of ingested food to body mass (ECI). When the values of ECI increase, the values of CI decrease or the vice versa (Slansky and Scriber 1985). So the high consumption index of early instars is due to the low conversion efficiency. The values of conversion efficiency (ECI) showed an increasing trend as the values of CI decreased across the instars (Tables.5&6**).** The values of CI obtained in the present study for early and late instars agree well with the values reported for some other butterfly species from the study area (Atluri et al. 2004a; Samatha 2006). Like food consumption, a larger proportion of total growth in terms of larval body weight took place during the last two instars. Thus as the instar larvae progressed there was a trend of increasing absolute weights, but the relative rates (values of GR) generally declined (Table. 2&4). Probably GR is size dependant, and therefore its values declined as the instar larvae progress to gain of weight and size (Ghosh and Gonchaudhuri 1996). The GRs of penultimate and final instars of the butterfly species of the present study is in line with the decreasing trend in growth rate from penultimate to final instars.

The AD values of the present study ranged between 16.2- 22.1% (Table.7). These values appear to be on the higher side of the range 19 – 81% given for 60 species of lepidopteron larvae by Pandian and Marian (1986), and the range 28.7 - 84.6% for Pericallia ricini (Ghosh and Gonchaudhuri 1996), (72.0 - 98.0%) of Appala Naidu (2005) and those (39.40 – 97.25%) of Samatha (2006). An inverse relationship is expected between assimilation efficiency AD and efficiency of conversion of digested food or net conversion efficiency ECD. The ECD values (6.6 – 46.9%) are low compared to AD values (16.2- 22.1%), but are mostly within the range of 2 - 87% and 2 - 93% estimated for Lepidoptera feeding on forb and tree foliage respectively (Slansky and Scriber 1985). The values of ECD across the instars showed no definite trend in the increase or decrease (Table.8) Slansky and Scriber (1985), remarked that it is rather difficult to determine the causes of such reduction in ECD. The ECI values in the present study varied between 6.4 – 45.9% (Table.6). This showed a continuous increase from first instar to final instar .In line with the opinion of Slansky and Scriber (1985), it may be said that because both age and size of larvae are increasing during development, and because feeding habits may also be changing, it is frequently difficult to interpret the causes of the changes in performance values of the larvae.

Table 1: Biological observations of early life stages of Junonia lemonias on Barleria Prionitis

Stage	Length(mm)			Width (mm)			Duration (days)	
	Min.	Max.	AV.±S.D.	Min.	Max	AV. ±S.D.	Range	AV.±S.D.
Egg	0.80	0.90	0.84±0.05	0.80	0.90	0.84±0.05	3	3.00±0.00
I	3.00	4.00	3.30±0.27	1.00	1.50	1.04±0.08	1-2	1.6±0.54
II	4.00	9.00	6.24±1.23	1.00	2.50	1.5±0.35	2-4	2.40±0.89
III	8.00	15.00	11.30±2.22	2.00	3.00	2.34±0.42	1-2	1.40±0.54
IV	12.00	26.00	18.60±1.79	2.50	4.50	3.42±0.42	2-4	3.00±0.70
V	24.00	38.00	33.06±1.60	4.50	7.00	5.76±0.32	3-4	3.40±0.54
Total larval Period							12-19	12.80±1.09
Pupa	15.00	17.00	16.1±0.74	5.00	6.50	15.6±0.41	6-9	7.20±1.30

Table 2: Food consumption, growth and food utilization efficiencies of Junonia lemonias larva fed with Barleria Prionitis.

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gained by larva (mg)	GR (mg/day)	CI (mg/day)	AD (%)	ECD (%)	ECI (%)
I	30.1±0.01	0.10±0.01	2.10±0.480.19	1.29	9.2	99.21	8.2	9.1
II	212.7±0.61	5.19±0.32	37.00±0.35	1.01	5.9	97.1	10.6	11.4
III	932.12±6.30	54.2±0.42	351.0±0.94	0.59	2.3	92.91	5.9	5.69
IV	1653.0±11.32	239.2±0.81	719.2±5.79	0.22	1.1	89.34	26.0	21.9
V	5932.0±21.21	738.2±7.12	938.4±8.24	0.15	0.8	87.1	18.1	17.1

Table 3: Biological observations of early life stages of *Junonia lemonias* on *Dipteranthus Prostrates*.

Stage	Length(mm)			Width (mm)			Duration (days)	
	Min.	Max.	AV.±S.D.	Min.	Max	AV. ±S.D.	Range	AV.±S.D.
Egg	0.80	0.90	0.84±0.05	0.80	0.90	0.84±0.05	3	3.00±0.00
I	3.00	5.00	4.10±0.22	1.00	1.20	1.00±0.00	2-3	2.40±0.54
II	6.00	11.00	8.04±0.91	1.50	2.00	1.62±0.10	2-4	2.40±0.89
III	8.00	14.00	12.40±0.89	2.00	2.50	2.18±0.20	1-2	1.60±0.54
IV	13.00	22.00	17.40±1.90	2.00	3.50	2.68±0.34	2-3	2.40±0.54
V	19.00	37.00	29.16±1.90	2.50	6.50	4.54±0.59	3-5	3.60±0.89
Total larval Period							13-20	8.20±0.83
Pupa	15.00	18.00	16.40±1.14	5.40	6.00	5.68±0.29	11-15	13.20±1.48

Table. 4: Food consumption, growth and food utilization efficiencies of *Junonia lemonias* larva fed with *Dipteracanthus prostrates*.

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gained by larva (mg)	GR (mg/day)	CI (mg/day)	AD (%)	ECD (%)	ECI (%)
I	47.1±0.53	0.41±0.02	4.16±0.19	0.93	8.90	99.20	10.6	9.5
II	295.2±0.82	2.94±0.93	29.30±0.42	1.34	4.40	98.00	11.7	21.7
III	739.1±6.12	59.2±3.13	459.0±0.95	0.58	1.6	93.10	6.32	6.2
IV	1939.1±13.37	239.0±1.74	719.0±5.39	0.24	1.7	89.40	40.17	39.1
V	5958.1±20.12	594.40±5.10	739.0±6.54	0.18	2.1	87.20	19.20	17.0

Table: 5:- Comparative statement of Consumption index (CI) Values for successive instars of the *J.lemonias* on *B. prionitis* & *D.prostratus* host plants.

host plant	instar number				
	I	II	III	IV	V
B. prionitis	9.2	5.9	2.3	1.1	0.8
D.prostratus	8.90	4.40	1.60	1.70	2.10

Table: 6:- Comparative statement of Efficiency of conversion of ingested food (ECI) Values for successive instars of the *J.lemonias* on *B. prionitis* & *D.prostratus* host plants.

host plant	instar number				
	I	II	III	IV	V
B. prionitis	9.1	11.4	5.69	21.9	17.1
D.prostratus	9.50	21.70	6.20	39.10	17.0

Table: 7:- Comparative statement of approximate digestibility (AD) Values for successive instars of the *J.lemonias* on *B. prionitis* & *D.prostratus* host plants.

host plant	instar number				
	I	II	III	IV	V
B. prionitis	99.21	97.1	92.91	89.34	87.1
D.prostratus	99.20	98.0	93.10	89.40	87.2

Table: 8:- Comparative statement of Efficiency of conversion of digested food (ECD) Values for successive instars of the *J.lemonias* on *B. prionitis* & *D.prostratus* host plants.

host plant	instar number				
	I	II	III	IV	V
B. prionitis	8.2	10.6	5.9	26.0	18.1
D.prostratus	10.6	11.7	6.32	40.17	19.20

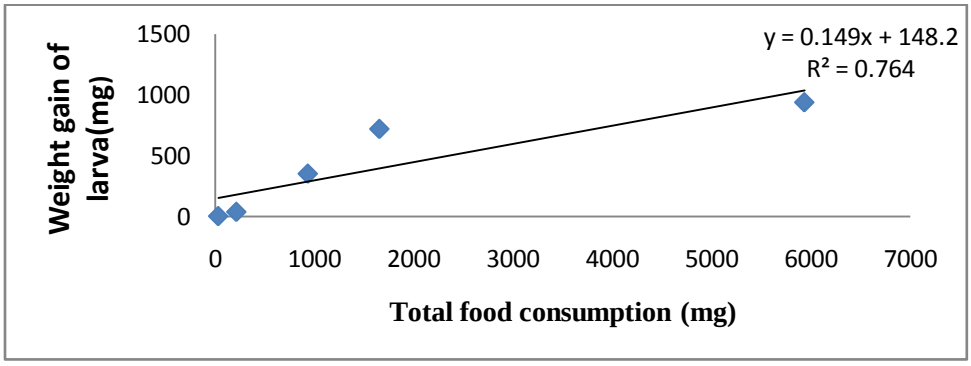


Figure 1:- Relation between food consumption and growth in *Junonia lemonias* on *Barleria prionitis*.

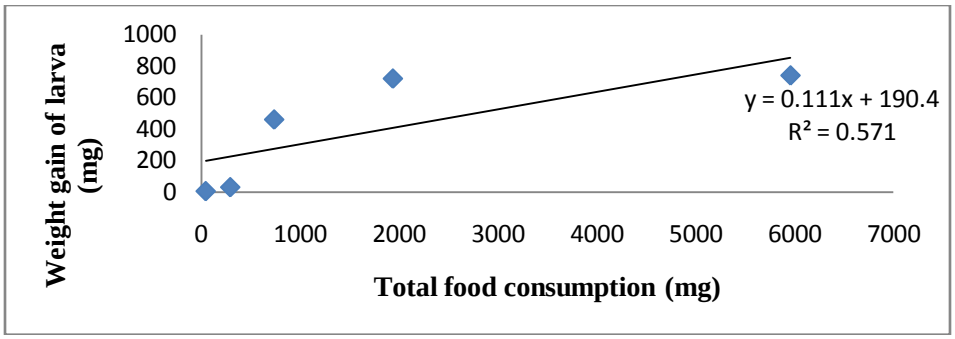
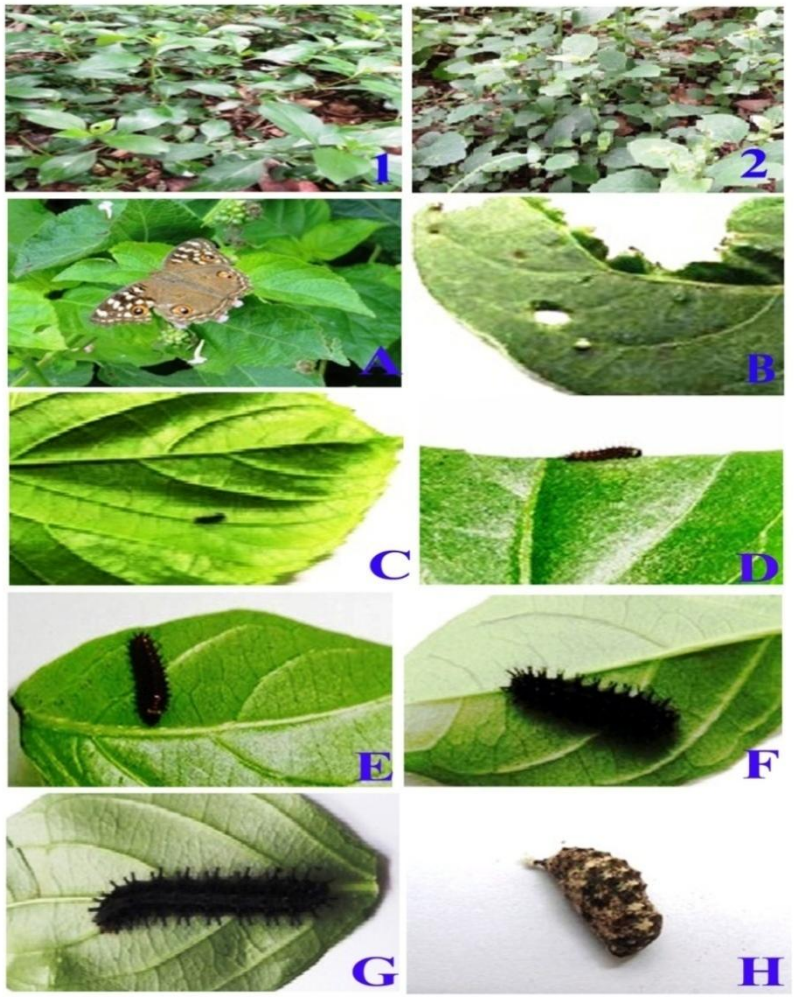


Figure 2:- Relation between food consumption and growth in *Junonia lemonias* on *Dipteranthus prostrates*.



PLATES

Plate:1:- *Barleria prionitis* (L.) host plant; 2. *Dipteracanthus prostratus* (Poir.)Nees. Host plant; A. Junonia lemonias (L.) adult butterfly; B. Egg; C. First Instar (larva); D. Second Instar (larva); E. Third Instar (larva); F. Fourth Instar (larva); G. Fifth Instar (larva); H. Pupa

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