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The Food Consumption, Utilization and Life History Traits of some Endemic & Endangered Butterflies in the Eastern Ghats - Southern Andhra Pradesh

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Abstract

Life history parameters such as pattern of egg laying, hatching, larval &pupal period and the total period from egg to emerge adult of 11 butterfly species distributed at Seshachalam Bio-reserve forest, Thalakona, Sri Lankamalleswara wild life sanctuary and Yogi Veman University, Kadapa are described during the period from 2013 -2016. Larval performance with respect to consumption index (CI) growth rate and estimation of nutritional indices like approximate digestibility (AD), efficiency of conversation of digested food (ECI) was presented.11butterfly species lay single eggs. The hatching, larval and pupal periods and eventually the total period for the growth of egg to the emergencies of an adult are longer (39-43 days) in *Grapium nomious* than other Papilionids and taxonomic groups. The larvae of each of the 11 species pass through five instars and the last two instars have a major share of total consumed over the entire larval period. The consumption index (CI) values of these instars ranged from 0.60 to 3.50. Among the five instars, the first shows the highest CI in all the 11 butterfly species and the values tend to decrease progressively through the successive instars. The AD value was highest in the first instar and lowest in the fifth instar. The values ranging from 86 to 99.5%. The ECD values show a general decrease from the early to the last instars. The ECI values range from 11-70% for *Hasora chromus* and from 03-64% for others, with most falling between 10% and 20%.The under-representation of invertebrates in defence efforts was well conventional. Inherent in this bias are issues concerning funding, agency staff expertise, political priorities, and public perception all of which generally do not favour insects, even popular groups such as butterflies and moths. Effective coordination, cooperation, and involvement between major stakeholders are essential to achieving actions that significantly benefit wildlife in these situations. Variation in food stoichiometry affects separable performance and population dynamics, but it was also likely that species with altered life histories should differ in their compassion to food stoichiometry. To address this question, we investigated the ability of the 11feeding butterflies food energetics to find out its larval performance.

Keywords: Food consumption, Life history traits, Endemic and Endangered, Eastern Ghats

1. INTRADUCTION

Of the estimated 20,000 – 30,000 species of butterflies occurring globally, nearly 1501 species flourished in our continent (Gaonkar 1996). A list of the works giving the descriptions of the life histories was given by Pant & Chatterjee, of which those of Bell 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. 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 was 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 holometabolus with distinct developmental stages as egg-larva-pupa-adult, their reproductive output was 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. There numerous organisms' ore, efforts are being made in all the study areas to the biology, ecology &conservation of butterfly fauna available in the surroundings of Eastern Ghats of Southern Andhra Pradesh.

Past history reveals biological frame work of innumerable creatures. However, as human progresses advanced and flourished, considerable trouble and destruction of habitations of numerous organisms resulted in the decline & death of several species. Butterflies considered as insects are no exception to the adverse effects of human developments. They are important natural sources as they help in cross-pollination a vital process in natural spread are significant environmental indicators as they are closely related with plants both as adults and as larvae have an important place in the web of life and enhance the aesthetic value of the environment by their attractive wing colours. Hence there was growing global interest in conserving & managing butterflies (New et al., 1995).

They are holo meta boles and their life cycle and larval food energetics are very much required. Here we presented 11 butterfly species food indices with detailed studies from our Yogi Vemana University lab, kadapa, Andhra Pradesh, India

Study area:
The study was conducted during 2013-2016 at Yogi Vemana University, Kadapa, Eastern Ghats of Southern Andhra Pradesh, India. The climate was typically inter changes, dominated by two monsoons, the southwest (June-September) and the northeast (December - February). The total annual rainfall ranges between 90-120 cm with most of the precipitation occurring during June-October.The maximum temperature various between 35-44^{o}C experienced mostly in May-June, and the maximum between 18-20^{o}C experienced mostly in January-February. During the rainy season, many herbs and shrubs appear, and the suburban vegetation was mainly forest biome.

Mating, breeding season, ovipostion at all study areas were recorded. Yogi Vemana University campus spread over 10 km, it enjoy the both wild and cultivated flora, and botanical garden its neighbourhood with semi-protected forest area, spread over 6 sq. km. represented samples of butterflies were collected at 10 day intervals from both the sites, by stalking or chasing the fast flying species or by gently sweeping the low flying species. The specimen's collected were identified from Wynter -Blyth (1957); Varshney (1980, 1985) was referred for nomenclature. Egg laying and larval plants were recorded for the all 11 butterfly species.

2. METHODS AND MATERIALS

Groups of intact larvae of *Zizeeria karsandra* (Fig: 3 & Table: II.1, Graph 1), *Castalius rosimon* (Fig: 9 & Table: II.2, Graph 2),*Tarucus nara* (Fig: 6 & Table: II.3, Graph 3), *Lampides boeticus* (Fig: 8 & Table: II.4, Graph 4), *Chilades lajus* (Fig: 6 & Table: II.5, Graph 5), *Junonia hierta* (Fig: 6 & Table: II.6, Graph 6), *Byblia ilithyia* (Fig: 6 & Table: II.7, Graph 7), *Tirumala septentrionis* (Fig: 6 & Table: II.8, Graph

8),*Colotisetrida* (Fig: 6 & Table: II.9, Graph 9), *Hasora chromus* (Fig: 6 & Table: II.10, Graph 10), *Graphium nomius* (Fig: 6 & Table: II.11, Graph 11) were taken from the second generation of a culture founded from wild insects taken field areas, and were reared in the laboratory on one of the following species of *Asclepid* host plants (plate: 1 & 2): *A. curassavica, A. synaca, A. incarnata*, or *A. tuberosa*. Newly molted 4th-instar larvae were placed individually in glass Petri dishes (Pyrex, 100 mm x15mm) lined on the bottom with a piece of Whatman No. I filter paper. Mature and uninjured leaves of the native species were gathered in the field each day from plants growing in open sunlit areas, and leaves of *A. curassavica* were collected from plants grown in the greenhouse. All leaves were sealed in plastic bags and used within 2 hours. These randomly collected leaves were split along the midrib, one-half weighed and offered to the larvae and the other half used to determine the percent dry matter in the leaf material (Waldbauer 1960, 1964). Leaves were replaced and faeces collected every 24 hours.

The dry weight of food ingested was estimated following the techniques of Waldbauer (1960, 1964), except that plant material was lyophilized instead of oven-dried. The dry weight of the food utilized or assimilated was assumed to be the dry weight of the food ingested minus the dry weight of faeces. An additional group of larvae was reared along with the experimental larvae, and these were sacrificed to determine the dry weights, and thus, the percentage dry matter of the larvae. Indices of food utilization were determined following the methods of Waldbauer (I960, I964, 1968). Many terms have been used both by ecologists and by physiologists to describe various measures and indices of food utilization and efficiency. Relationships between many of these terms are discussed by Waldbauer (1968).As an index of digestibility the ratio of the amount of food assimilated to the amount of food ingested, referred to as the Assimilation Efficiency' (Odum, 1971) or the 'Coefficient of Digestibility'(Waldbauer 1964, 1968, House 1959) was used. In practice, this measure was only an approximation since the numerator (as determined by the standard gravimetric technique) does notquite represent the amount of food actually assimilated (Waldbauer1968). This slight error was due to the presence of metabolic wastes in the faeces in addition to the undigested food (Lafon 1951), but Hiratsuka (1920) and Waldbauer (1964, 1968) point out that this difference between true and measured assimilation efficiencies was negligible.

The efficiency with which ingested food was converted to biomass was calculated by dividing the dry weight of food ingested into the dry weight gained by the larva. This index referred to by physiologists as the 'Efficiency of Conversion of Ingested Matter' (Waldbauer1968) and by ecologists as the 'Ecological Growth Efficiency' (Odum 1971)) was an overall measure of an animal's ability to utilize for growth the food ingested. The efficiency with which digested food was converted to biomass was calculated by dividing the dry weight of food assimilated into the dry weight gained by the larva. This index, referred to by Waldbauer (I968) as the 'Efficiency of Conversion of Digested Matter' and by Odum (1971) as the 'Tissue Growth Efficiency', decreases as the proportion of digested food absorbed for energy and maintenance of physiological functions increases (Waldbauer 1968).The relative growth rate was calculated by dividing the mean dry mass of the larva times the duration of the instar in days into the dry weight gained by the larva during the study (Waldbauer1968). This index reflects the rate at which biomass was added by a larva corrected for any size differential between groups of larvae. The 'Respiratory Coefficient' was described as the ratio of respiratory and maintenance loss to the net secondary production or biomass increase. This coefficient was calculated by dividing the total calories lost through respiration and maintenance by the total calories added to the insects' biomass. This ratio was may be termed an 'Energy Production Cost Ratio'; the smaller the coefficient or ratio, the more efficient the larva was at allocating of calories lost through respiration and maintenance per calorieal located to biomass. Of general interest to ecologists was the 'Principle of Allocation' described by Williams (1964). Organisms have a limited amount of energy to spend and will be selected to partition this energy in different ways depending upon changing biological or environmental conditions. Any activity of an organism, or more precisely, the energy outflow for that activity, can be viewed only in relation to all other demands for energy.

3. RESEARCH LABORATORY STUDY

Life Antiquity: The breeding females were watched during the breeding season and the fresh eggs laid were collected in Petri dishes (9.5 cm diameter) along with plant material on which they were laid. These were incubated at room temperature (28^{o}C) in the laboratory. Irrespective of the number of eggs laid, only one leaf was kept in each Petri dish and watched at 6-hour intervals to record the hatching time. The intervals were shortened if necessary after preliminary observations. The larvae that hatched were also observed at fixed intervals for molting until they pupated. Based on the number of molts, the number of instar for each species was determinate. As the larvae completed their first or second in star stage, each was maintained in a large petri dish (15.5 cm) to facilitate free movement. The eggs to adult duration were recorded. Five replicates were maintained for each species. In the laboratory at around 27°C, development from egg stage to the emergence of adult required 39-47 days and this relatively short life cycle are characteristic of the tropical butterfly species(1-2). *Graphium nomius* has the habit of laying eggs singly as the case with most Papilionidae butterfly species.

Food consumption and utilization:
Food was changed daily and Petri dishes were kept clean by removing the food remains and faecal matter, which were later weighed and disposed of for every instar, its initial and final weight was taken and the weight gain noted. After preliminary observations of food consumed by the larvae 5-10 leaves were weighed and given to the larvae. The total food consumed by larvae was calculated at the end of each instar. Mean and standard deviations were estimated for food consumed weight of faecal matter and weight gained by the larvae. The food energetics was estimated by using Waldbauer (1968).

Consumption Index (C I):

$$\frac{\text{Weight of food consumed}}{\text{Weight of Instar X Number of feeding days}}$$

Growth rate (G R):

$$\frac{\text{Weight gain of Instar}}{\text{Mean Weight of Instar X Number of feeding days}}$$

Approximate Digestibility (A D):

$$\frac{\text{Weight of food consumed} - \text{weight of faeces}}{\text{Weight of food consumed X100}}$$

Efficiency of conversion of digested food (E C D):

$$\frac{\text{Weight gain of instar}}{\text{Weight of food consumed} - \text{weight of faeces X100}}$$

Efficiency of conversion of ingested food (E C D):

$$\frac{\text{Weight gain of instar}}{\text{Weight of food consumed}}$$

4. RESULTS AND DISCUSSION

The studied 11 butterfly species eggs (Table 1) and comparative life cycles (Table 2) and food energetics were placed in table 3–8Of the 11 species of butterflies studied, 11 species lay single eggs and the no clusters. Single egg laying habit dominates over cluster laying habit among butterfly species of most topographical areas (Thompson and Pellmyr 1991). Through the number of species observed in the present study was low, this study recommends a comparable tendency. Based on the information provided by Ford (1957), estimated that 2.5% of the butterfly species in India are cluster layers, while the others lays single eggs (J. B. Atluri et al., 2004). However, some reports show the influence of environmental conditions on egg laying pattern (Larsen 1988: Davies and Gilbert 1985). As such, a closer study was required on the pattern of egg laying in different ecological situations.

The maturation period was 3-4 days in 9 of the 11 species, 4-5 in 3 species, and 6-7 days in 2 species. In temperate species, the hatching period was reported to differ between the cluster and single egg layers, the former being longer (stamp 1980). Such a difference was not apparent in these 11 tropical species. In fact, *Graphium nomious* lay eggs have a longer incubation period of 6-7 days. It thus appears that the incubation period may depend on the size of the egg rather than on the egg laying pattern, the bigger eggs taking a relatively long period. This requires being tested under a similar condition of incubation.

The duration of the different instars of the 11 butterfly species (Table: I & III) appears to be similar. The duration of instar I varied between 2-3 days, of II instar and III each 2-4 days, of instar IV 2-5 days, and instar V 3-7 days. Only the fifth instar of Papilionidae *Graphium nomius* have a relatively longer duration of 6-7 days. The total larval period ranged between 11-20 days. The pupal period of 10 species namely *Zizeeria karsandra, Castalius rosimon, Tarucus nara, Lampides boeticus, Chilades lajus, Junon iahierta, Byblia ilithyia, Tirumalas eptentrionis, Colotis etrida, Hasora chromus,* was short ranging from 6-8 days, and the remaining two species had a longer period of 20- 30 days and the other a longer period of 24-26 days (Table: 2) . The longest period was for *Graphium nomius* (31-40), and shortest period of 21-24 days was observed in *Chilades lajus*. In Papua New Guinea, the world's largest butterfly *Ornithoptera alexandrae* (Papilionidae) enjoys a life cycles of 122 days (Parsons 1984a). The present studies agrees with several workers in this line (Owen 1971), suggested short life cycles in tropics (Palanichamy et al., 1982)

Food Consumption and Utilization

The data on the proportion of food consumed by the five instars of each of the 11 butterfly species indicates that the fourth or fifth instar had a major share of the total amount of food consumed over the entire larval period. Similar findings have been reported for other species (David and Gardiner 1962: Scriber and Slansky 1981: Palanichamy et al. 1982: Selvasundaram 1992: Ghosh and Gonchaudhuri 1996). The increase in consumption might be a strategy to compensate for the energy requirement in the non-feeding pupal stage (Delvi and Pandian 1972: Pandian 1973).

The consumption index (CI) of instar I was high in all the 11 butterfly species and it decreased progressively across the instars (Slansky and Scriber 1985).

The values of GR of the 11 butterfly species decreased progressively in general and were highest in instar 1, and lowest in instar V (Table :V). A similar trend has been recorded for the moth *Pericallia ricini* (Ghosh and Gonchaudhurib1996). Penultimate instars had a higher growth rate than the final instars in some swallowtails and moths (Scriber and Feeny 1979). The GRs of penultimate and final instars now obtained are in line with the above decreasing trend. The larvae reared on tree foliage show higher growth rates than the larvae maintained on herbaceous foliage (Scriber and Feeny 1979). The host plant *Polyalthia longifolia* utilized by *Grapium nomious*.

The AD values are inversely related to the food consumed by different instars. It was highest in instar I, the corresponding percentages of each of the 11 butterflies are *Zizeeriakarsandra* 0.30,98; *Castaliusrosimon*,0.76,77.5;*Tarucus nara* 0.25,81.5; *lampides boeticus* 0.51,96.07;*Chilades lajus* 0.29,96.07;

Junonia hierta 0.12,95.4; *Byblia ilithyia* 2.25,88; *Tirumala septentrionis* 0.78,96; *Colotis etrida* 1.00,96.2; *Hasora chromus* 0.75,96; *Graphium nomius* 0.57,99. The AD was lowest in instar V, the corresponding percentage are *Zizeeria karsandra, Castalius rosimon, Tarucus nara, Lampid esboeticus, Chilade slajus, Junonia hierta, Byblia ilithyia, Tirumala septentrionis, Colotis etrida, Hasora chromus, Graphium nomius*. Such relationship between approximate digestibility and food consumption was also evident from the data compiled by Waldbauer (1968). The approximate digestibility values of all the studied species shown 86.0 to 99.5 (Pandian & Marian, 1986, Ghosh & Gonchaudhuri 1996). The leaves utilised rich in nitrogen & more efficiency of conservation of digested food, produced an increase from first to last instars and the values are low compared with AD values (Table. 7)

The values of the efficiency of conversion of consumed food (ECI) (Table: 8) of *Hasora chromus* ranged between 11-70% and those of the other 10 species varied between 3-64%; most of these values between 10% to 20%. These values indicate low conversion efficiency but are comparable with the ECI values reported for swallowtails (Scriber and Slansky 1981). The excised foliage was used for rearing the larvae, and such foliage was likely to be deficient in water. Since leaf water content was directly related to conversion efficiency (Muthukrishnan 1990). The larvae had to spend energy to produce metabolic water may have resulted in low conversion efficiency. While it was indicated that the ECI values across the instars, thus supporting the predicted inconsistency in ECI pattern (Slancky and Scriber 1985) also recorded in the moth *Pericallia ricini* (Ghosh and Gonchaudhuri 1996). The various nutritional indices of the 11 butterfly species will enable a proper understanding of the tropic interactions of these species .

Table: 1. Ovipostion plants and egg laying patterns of the 11 butterfly species studied

S.No.	Family	Butterfly species	Ovipostion plants	Pattern of egg laying
1	Lycanaidae	*Zizeeria karsandra*	*Amaranthus spinosus*	Single
2		*Castalius rosimon*	*Zizyphus jujube*	Single
3		*Tarucus nara*	*Zizyphus jujuba*	Single
4		*Lampides boeticus*	*Vigna trilobata*	Single
5		*Chilade slajus*	*Citrus aurantifolia*	Single
6	Nymphalidae	*Junonia hierta*	*Barleria montana*	Single
7		*Byblia ilithyia*	*Tragia plukentii*	Single
8		*Tirumala septentrionis*	*Wattakaka volubilis*	Single
9	Pieridae	*Colotis etrida*	*Cadaba fruiticosa*	Single
10	Hespridae	*Hasora chromus*	*Pongamia pinnata*	Single
11	Papilinodae	*Graphium nomius*	*Polyalthia longifolia*	Single

Table 2: Instar wise food energetics in the life history of the 11 butterfly species.

1. ***Zizeeria karsandra***:

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	12.0 ± 0.22	0.56 ± 0.04	0.51 ± 0.03
II	19.14 ± 1.21	3.10 ±01.17	1.07 ± 2.02
III	33.12 ± 3.40	6.84 ± 01.72	3.52 ± 0.17
IV	82.05 ± 5.90	29.05 ±0 2.91	34.00 + 2.40

2. ***Castalius rosimon*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	0.1510±0.98	0.005±0.02	0.002±0.18
II	0.2550±1.90	0.06±0.310	0.015±1.41
III	0.2810±2.70	0.081±0.92	0.032±1.41
IV	0.3270±5.10	0.164±1.21	0.056±2.30

3. ***Tarucus nara*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	0.1810±0.28	0.007±0.02	0.004±0.17
II	0.2650±1.6	0.07±0.42	0.016±0.52
III	0.2910±2.3	0.089±0.8	0.042±1.53
IV	0.3470±4.1	0.180±1.3	0.059±2.3

4. ***Lampides boeticus*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	14.0 ± 01.5014	4.5 ± 00.78	0.75 ± 0.10
II	17.0 ± 02.02	07.5 ± 0.23	13.89 ± 1.90
III	92.0 ± 3.16	3.9 ± 01.65	9.4 ± 2.78
IV	100.0 ± 03.30	4.0 ± 01.10	10.80 ± 1.35

5. ***Chilades lajus*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	12.80 ± 01.24	0.48 ± 00.04	0.41 ± 00.05
II	19.94 ± 05.28	4.20 ± 01.33	2.08 ± 00.72
III	32.17 ± 05.07	6.44 ± 01.52	3.36 ± 03.16
IV	85.84 ± 07.21	29.17 ± 02.05	37.00 ± 02.35

6. ***Junonia hierta*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	45.76 ± 07.49	2.06± 00.89	0.69 ± 0.04
II	66.72 ± 08.68	6.26 ± 01.21	5.09 ± 0.49
III	245.68 ± 21.08	76.79 ± 03.89	26.56 ± 2.35
IV	568.52 ± 19.16	265.83 ± 10.23	58.96 ± 2.12
V	3981.79 ± 95.33	2239.56 ±80.48	589.52 ± 6.86

7. ***Bybliab ilithyia*:**

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	0.0552	0.006	0.011
II	0.064	0.013	0.042
III	0.0832	0.037	0.067
IV	0.092	0.077	0.089
V	0.161	0.119	0.128

8. *Tirumala septentrionis*:

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	30.0 ± 0.22	0.64 ± 0.03	2.81 ± 0.09
II	192.0 ± 1.20	4.90 ± 0.15	10.6 ± 0.10
III	550.0 ± 3.20	50.0 ± 0.62	61.0 ± 0.14
IV	1315.0 ± 3.90	219.0 ± 2.41	338.0 ± 2.00
V	3850.0 ± 12.2	684.0 ± 5.01	739.0 ± 2.20

9. *Colotis etrida*:

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	0.0552	0.006	0.011
II	0.064	0.013	0.042
III	0.0832	0.037	0.067
IV	0.092	0.077	0.089
V	0.161	0.119	0.128

10. *Hasora chromus*:

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	15.0 ± 0.28	0.4 ± 0.01	1.2 ± 0.06
II	136.0 ± 0.40	0.06 ± 0.12	13.5 ± 0.18
III	502.5 ± 4.50	16.2 ± 0.20	60.0 ± 0.24
IV	1052.5 ± 8.5	128.5 ± 0.82	152.5 ± 0.90
V	2642 ± 16.5	380.0 ± 2.90	402.0 ± 3.1

11. *Graphium nomius*:

Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larva (mg)
I	21.6±0.34	0.015±0.09	2.2 ± 0.10
II	88.5 ± 0.84	3.42 ± 0.18	18.0 ± 0.18
III	1397 ± 8.40	1105 ± 0.91	222.6 ± 1.80
IV	2371.6 ± 11.20	194.5 ±1.90	3213 ± 2.40
V	3497.3 ± 16.40	528 ± 5.30	678 ± 3.80

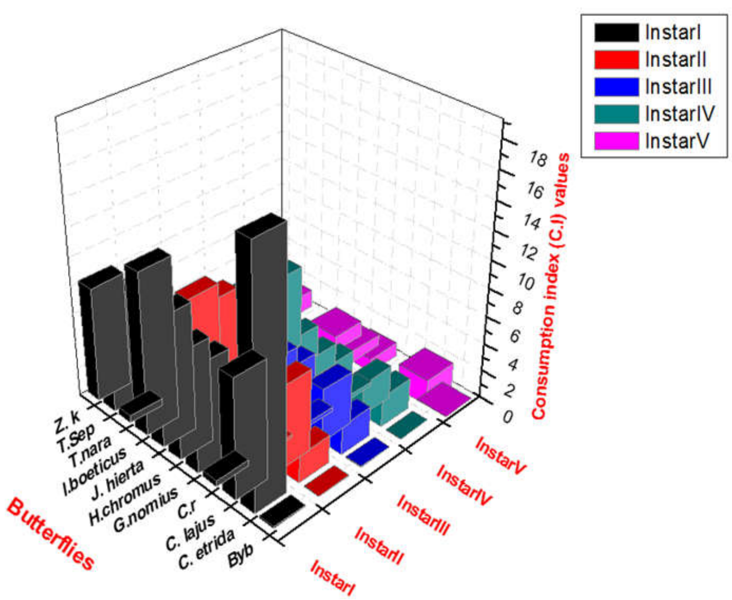
Table 3: Instar wise duration and growth of 11 butterfly species up to adult emergence:

S.No.	Butterfly species	Hatching period	Instar duration					Larval duration	Pupal duration	Egg to adult development
			I	II	III	IV	V			
1	*Zizeeria karsandra*	3-4	2 – 3	2 - 3	2-3	2 - 3	-	16 - 21	6 – 7	26 – 31
2	*Castaliu srosimon*	2-3	2-3	2-3	2-3	2-3	-	21-25	5 - 6	28 – 30
3	*Tarucus nara*	3-4	2-3	2-3	2-3	1-2	-	22-27	6-7	27 – 31
4	*Lampides boeticus*	3-4	3-4	2-3	2-3	3-4	2-3	19-22	6-8	26 – 30
5	*Chilades lajus*	2-3	2-3	3-4	2-3	2-3	2-3	17-21	3-7	21-24

6	*Junonia hierta*	2-3	1– 3	2 -3	2-3	3-4	2-4	20-26	5 -7	28-30
7	*Byblia ilithyia*	3-4	2-3	2-3	2-3	3-4	2-3	22-27	4-5	29-30
8	*Tirumala septentrionis*	3-4	2-3	2-3	2-3	2-3	3-4	21-28	10-11	30- 31
9	*Colotis etrida*	3-4	2-3	2-3	2-3	2-3	3-4	17-20	5-6	23 -30
10	*Hasora chromus*	2-3	2-3	3-4	2-3	2-3	2-3	16- 20	5-6	18 – 24
11	*Graphium nomius*	3-4	2-3	3-4	2-3	3-4	3-4	16-22	10-12	31-34

Table 4: Consumption index (CI) for successive instars of 11 butterfly species

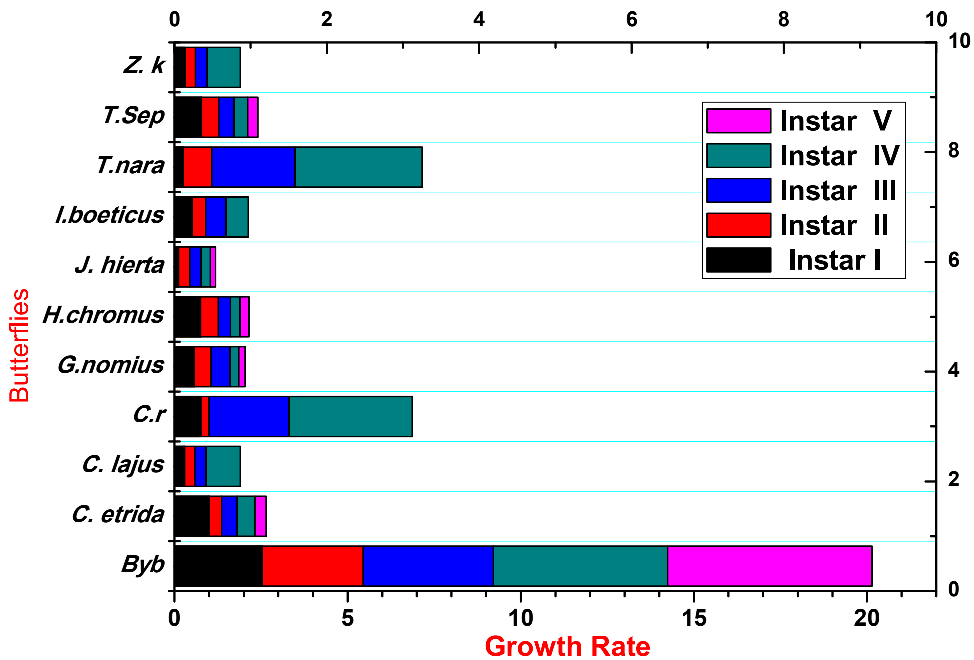
S.NO	Butterfly species	Instars Consumption index (C.I)				
		I	II	III	IV	V
1	*Zizeeria karsandra*	8.16	4.50	3.10	2.16	-
2	*Castalius rosimon*	0.44	0.28	0.33	0.35	-
3	*Tarucus nara*	0.52	0.29	0.39	0.42	-
4	*Lampides boeticus*	11.54	07.94	05.61	05.95	-
5	*Chilades lajus*	8.48	5.84	3.81	2.32	-
6	*Junonia hierta*	9.10	08.41	03.23	02.24	01.09
7	*Byblia ilithyia*	0.092	0.048	0.030	0.019	0.026
8	*Tirumala septentrionis*	8.10	4.20	2.90	2.06	1.30
9	*Colotis etrida*	17.77	2.05	2.07	2.26	1.83
10	*Hasora chromus*	7.45	2.20	3.20	1.60	0.80
11	*Graphium nomius*	7.47	2.41	3.48	1.86	0.97



T1 Graph: Values of consumption index (CI)

Table 5: Values of Growth rate (GR) for successive instars of 11 butterfly species

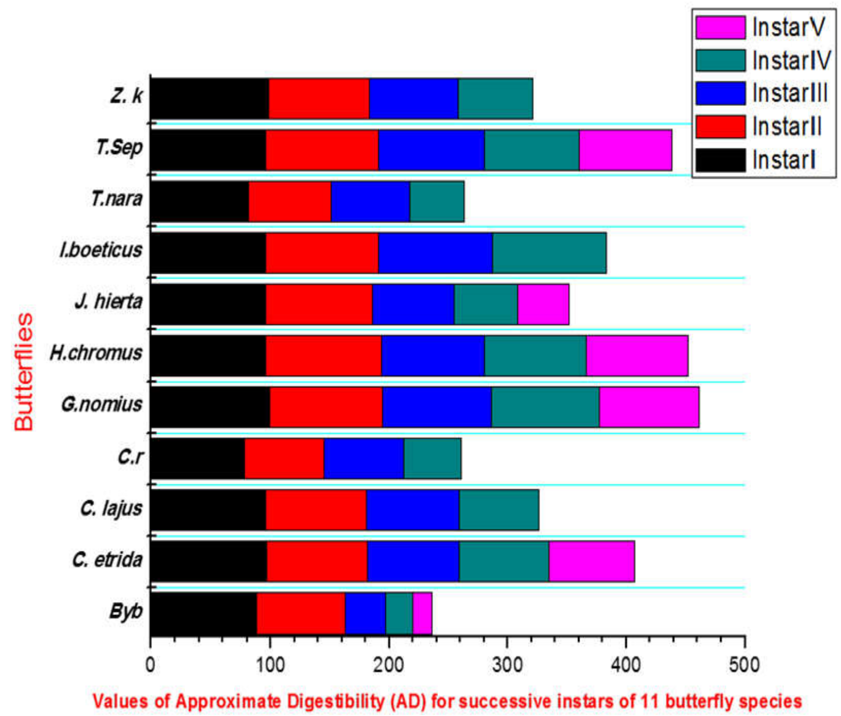
S.NO	Butterfly species	Instars Growth rate (GR)				
		I	II	III	IV	V
1	*Zizeeri karsandra*	0.30	0.31	0.34	0.95	0
2	*Castalius rosimon*	0.763	0.236	2.315	3.55	0
3	*Tarucus nara*	0.254	0.823	2.41	3.67	0
4	*Lampides boeticus*	0.51	0.39	0.59	0.64	0
5	*Chilades lajus*	0.29	0.30	0.32	0.99	0
6	*Junonia hierta*	0.12	0.32	0.33	0.27	0.15
7	*Byblia ilithyia*	2.526	2.928	3.761	5.022	5.906
8	*Tirumala septentrionis*	0.78	0.50	0.44	0.39	0.30
9	*Colotis etrida*	1.00	0.36	0.45	0.52	0.32
10	*Hasora chromus*	0.75	0.52	0.35	0.27	0.26
11	*Graphium nomius*	0.57	0.49	0.55	0.25	0.18



T2 Graph: Values of Growth rate (GR) for Successive instars

Table 6: Values of Approximate Digestibility (AD) for successive instars of 11 butterfly species

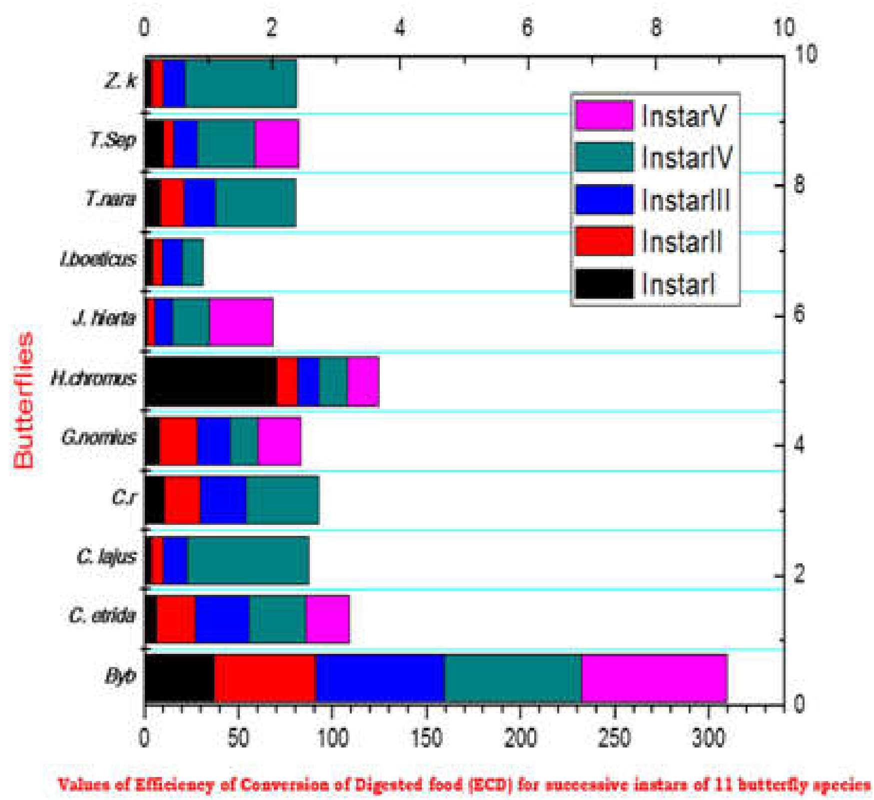
S.NO	Butterfly species	Instars Approximate Digestibility (AD)				
		I	II	III	IV	V
1	*Zizeeria karsandra*	98.00	85.20	74.50	63.43	-
2	*Castalius rosimon*	77.5	67.67	67.23	48.24	-
3	*Tarucu snara*	81.5	69.72	65.72	46.41	-
4	*Lampide sboeticus*	96.07	95.05	96.00	96.00	-
5	*Chilades lajus*	96.10	84.72	78.23	66.64	-
6	*Junonia hierta*	95.49	90.61	68.74	53.24	43.75
7	*Bybli ilithyia*	88	75	34	22.5	16
8	*Tirumala septentrionis*	96.00	95.00	89.00	80.00	78.00
9	*Coloti setrida*	96.25	85.33	77.16	76.05	72.00
10	*Hasora chromus*	96	97	87	86	86
11	*Graphium nomius*	99	95	92	91	84



T3 Graph: Values of Approximate Digestibility (AD) for successive instars

Table 7: Values of Efficiency of Conversion of Digested food (ECD) for successive instars of 11 butterfly species

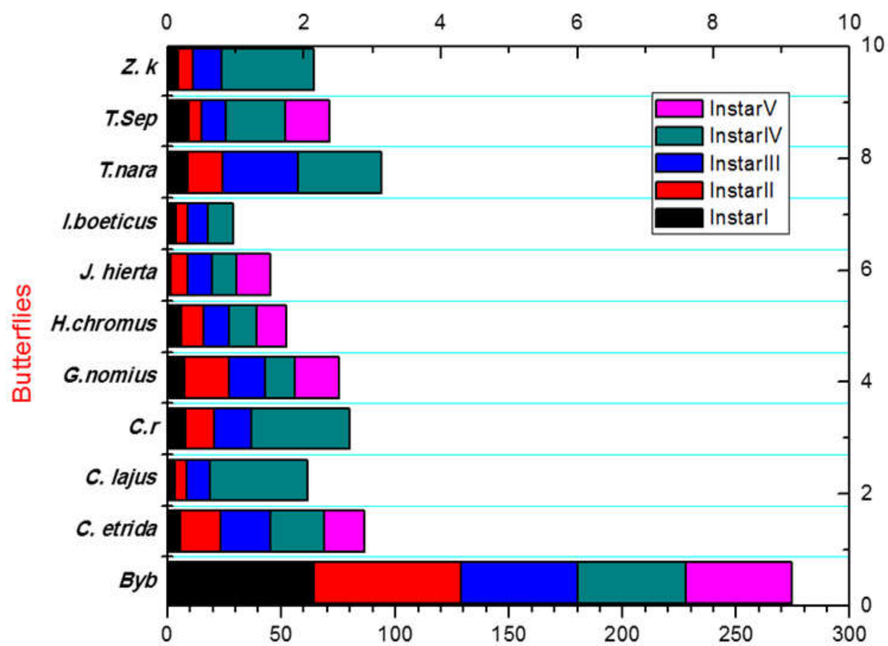
S.NO	Butterfly species	Instars Efficiency of Conversion of Digested food (ECD)				
		I	II	III	IV	V
1	*Zizeeria karsandra*	03.52	06.20	11.60	59.45	-
2	*Castalius rosimon*	10.15	19.01	24.3	38.8	-
3	*Tarucus nara*	7.86	12.86	16.33	42.83	-
4	*Lampides boeticus*	03.98	05.12	10.51	11.25	-
5	*Chilade slajus*	03.53	06.09	12.94	64.77	-
6	*Junonia hierta*	01.32	03.75	09.48	19.47	33.85
7	*Byblia ilithyia*	36.75	54.25	68.24	72.75	77.5
8	*Tirumala septentrionis*	9.57	5.70	12.2	30.84	23.35
9	*Colotis etrida*	5.84	21.09	28.36	30.24	23.00
10	*Hasora chromus*	70	11.0	11.5	15.5	16.0
11	*Graphium nomius*	07.7	20.3	17.2	14.7	22.8



T4 Graph: Values of Efficiency of Conversion of Digested food (ECD)

Table: 8: Values of Efficiency of Conversion of Ingested food (ECI) for successive instars of 11 butterfly species

S.NO	Butterfly species	Instars Efficiency of Conversion of Ingested food (ECI)				
		I	II	III	IV	V
1	*Zizeeria karsandra*	05.00	06.40	12.30	40.80	-
2	*Castalius rosimon*	7.86	12.86	16.33	42.83	-
3	*Tarucus nara*	9.13	15.42	32.97	36.29	-
4	*Lampide sboeticus*	03.85	04.90	09.21	10.80	-
5	*Chilade slajus*	03.39	05.16	10.12	42.77	-
6	*Junonia hierta*	1.50	7.62	10.81	10.37	14.80
7	*Byblia ilithyia*	64.37	64.62	51.12	47.62	46.62
8	*Tirumala septentrionis*	9.37	5.52	11.1	25.70	19.20
9	*Colotis etrida*	5.62	18.00	21.88	23.00	17.83
10	*Hasora chromus*	6.0	10.0	11.0	12.5	13.0
11	*Graphium nomius*	07.7	19.3	15.9	13.3	19.3



Values of Efficiency of Conversion of Ingested food (ECI) for successive instars of 11 butterfly species

T5 Graph: Values of Efficiency of Conversion of Ingested food (ECI)

Larval host plants:
Plate: 1

Plate: 2

Life cycles stages:

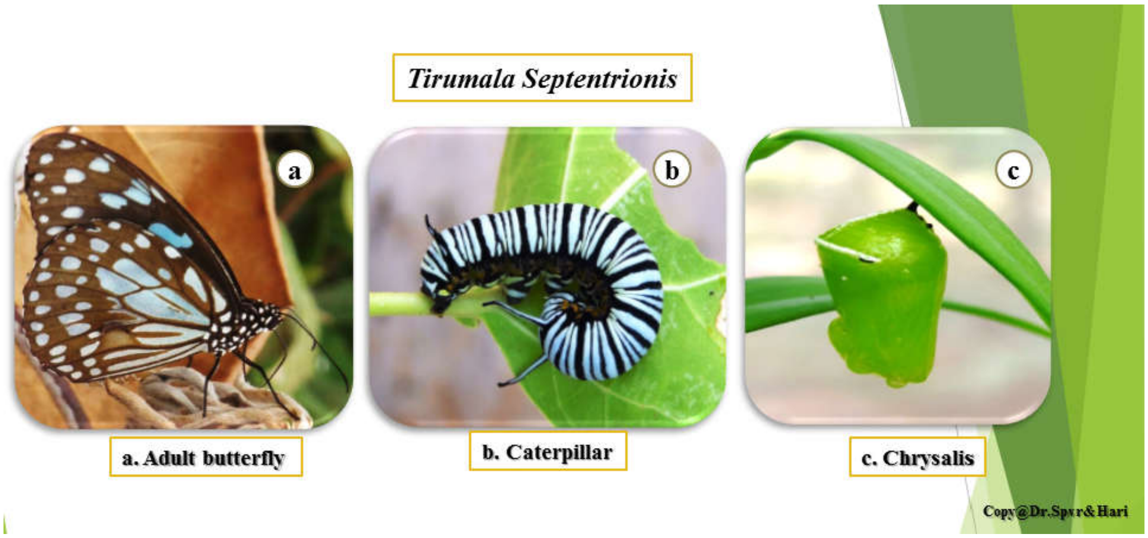


Fig. 1: Life cycle stages of *Tirumala septentrionis*

Fig. 2: Life cycle stages of *Graphium nomius*

Fig. 3: Life cycle stages of *Zizeera karsandra*

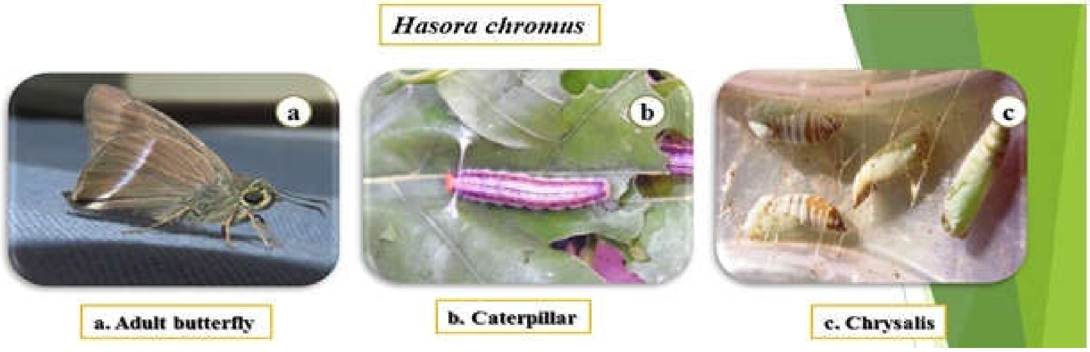


Fig. 4: Life cycle stages of *Hasora chromus*

Fig. 5: Life cycle stages of *Junonia hietra*

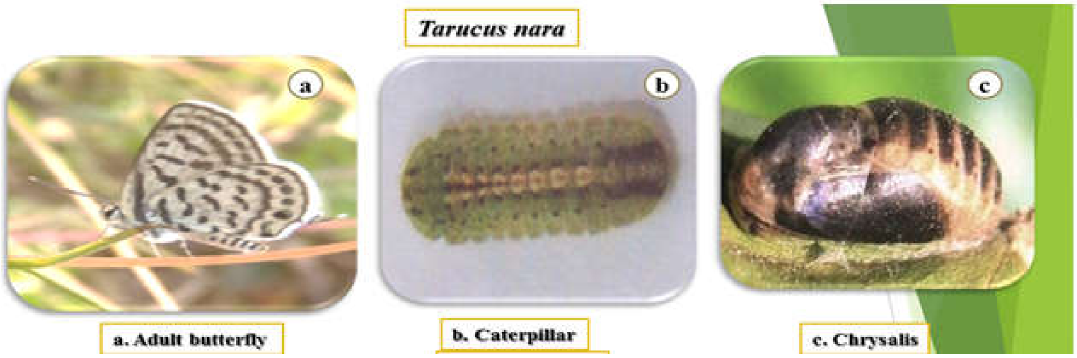


Fig. 6: Life cycle stages of *Tarucus nara*

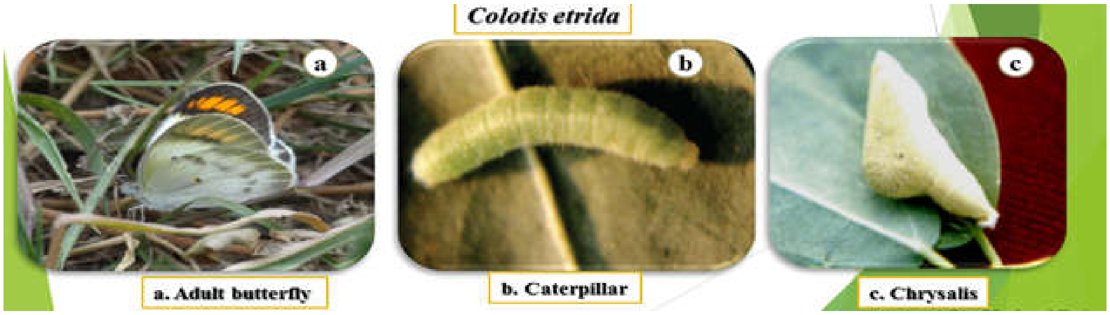


Fig. 7: Life cycle stages of *Colotis etrida*

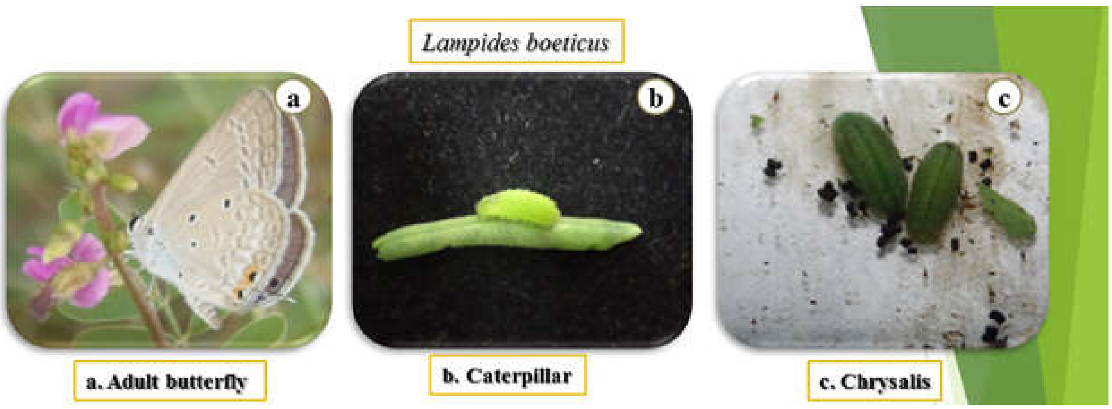


Fig. 8: Life cycle stages of *Lampides boeticus*

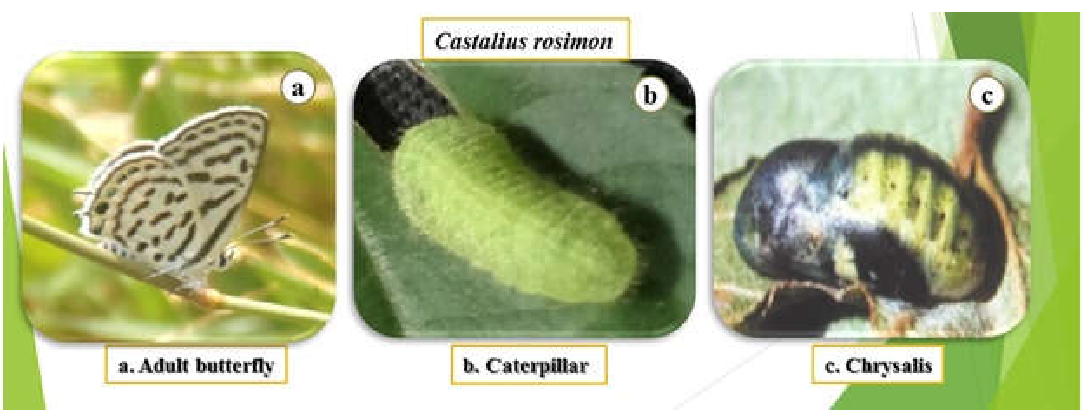


Fig. 9: Life cycle stages of *Castlius rosimon*

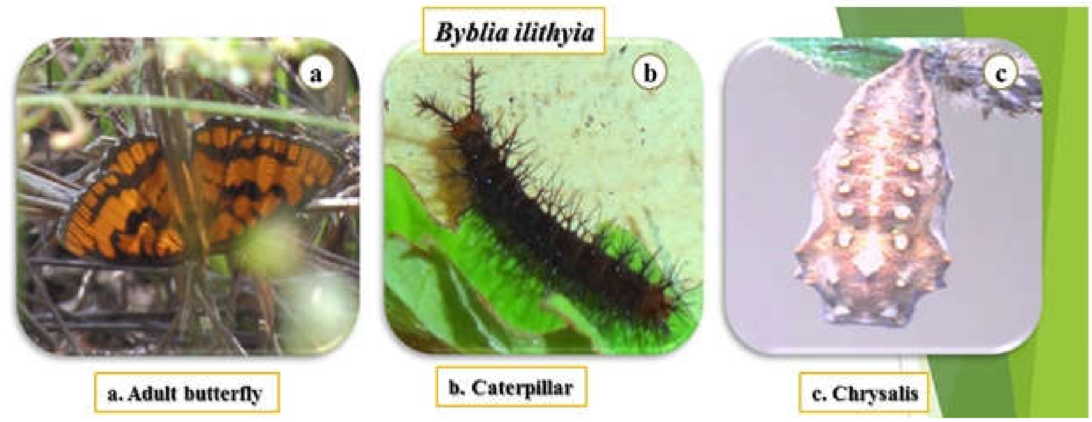
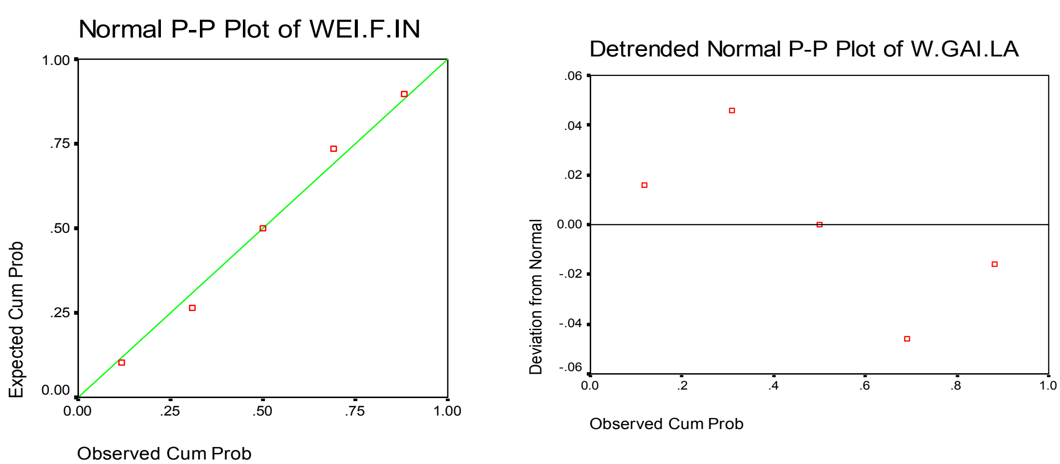
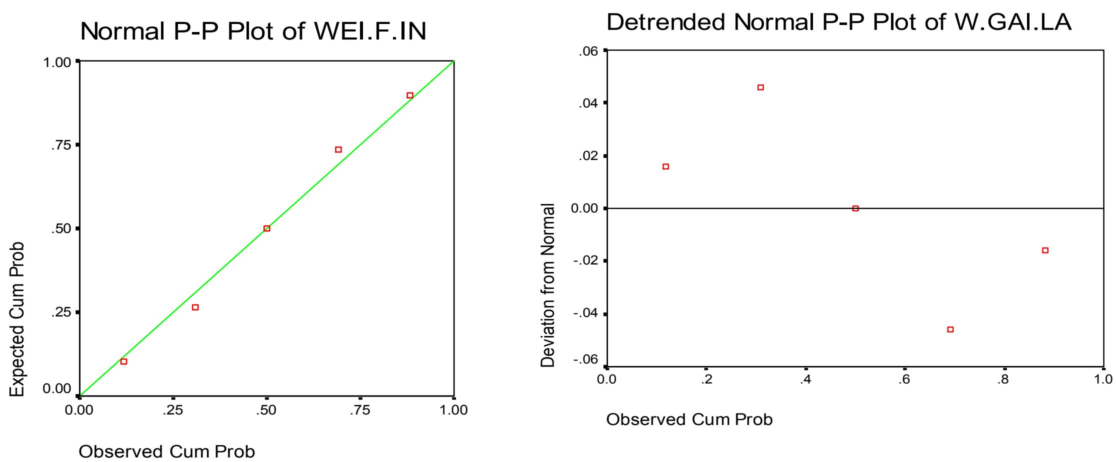


Fig. 10: Life cycle stages of *Byblia ilithyia*

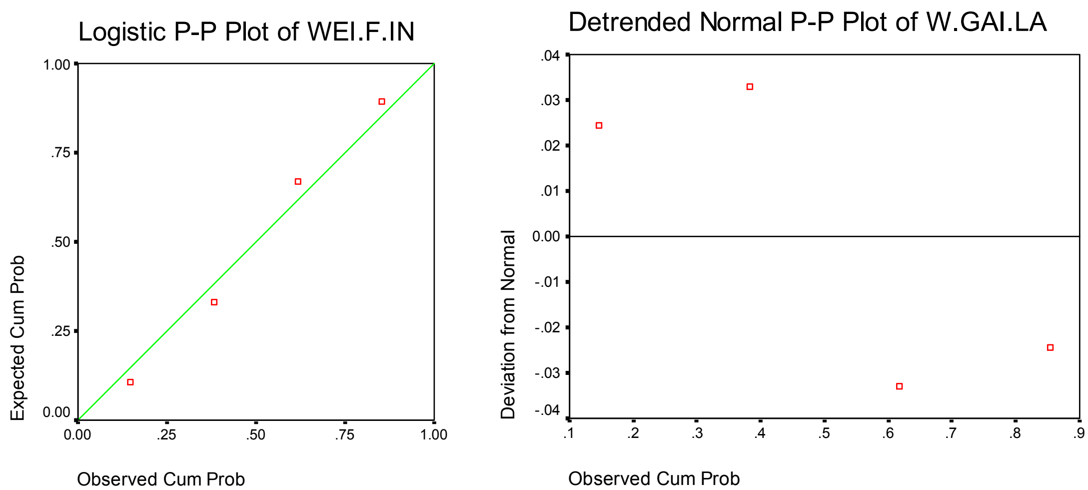
Fig. 11: Life cycle stages of *Chilades lajus*



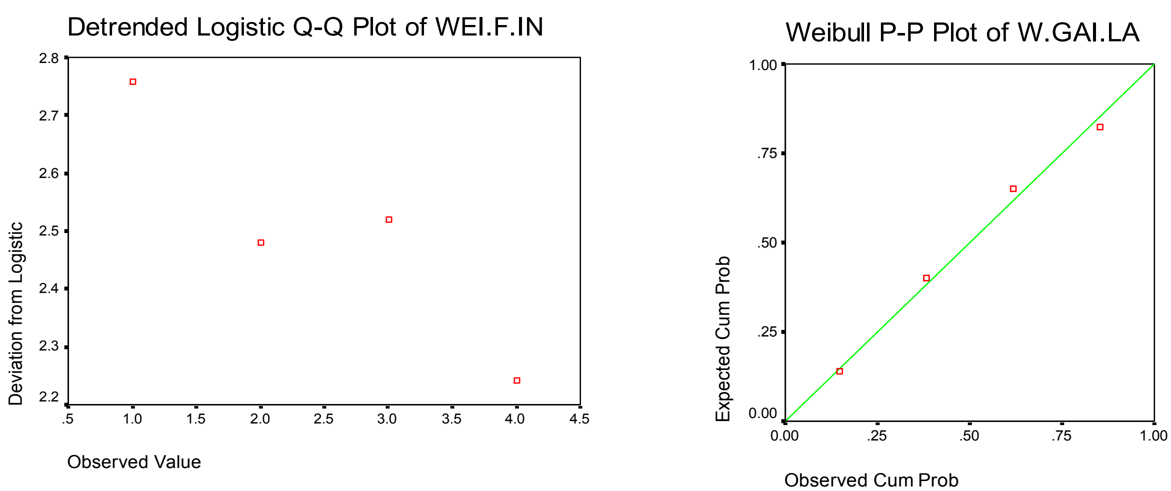
Graph 1: Relation between food consumption and growth in *Zizeeria karsandra*



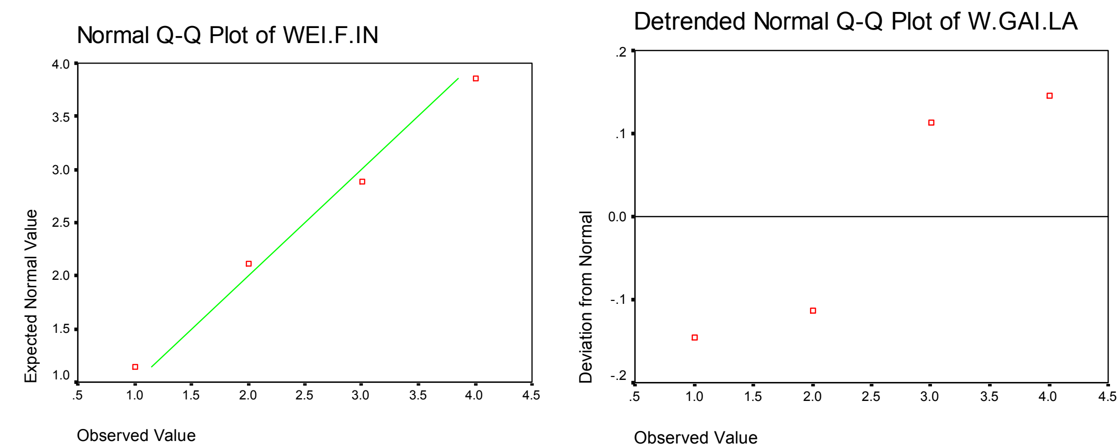
Graph 2: Relation between food consumption and growth in *Castalius rosimon*



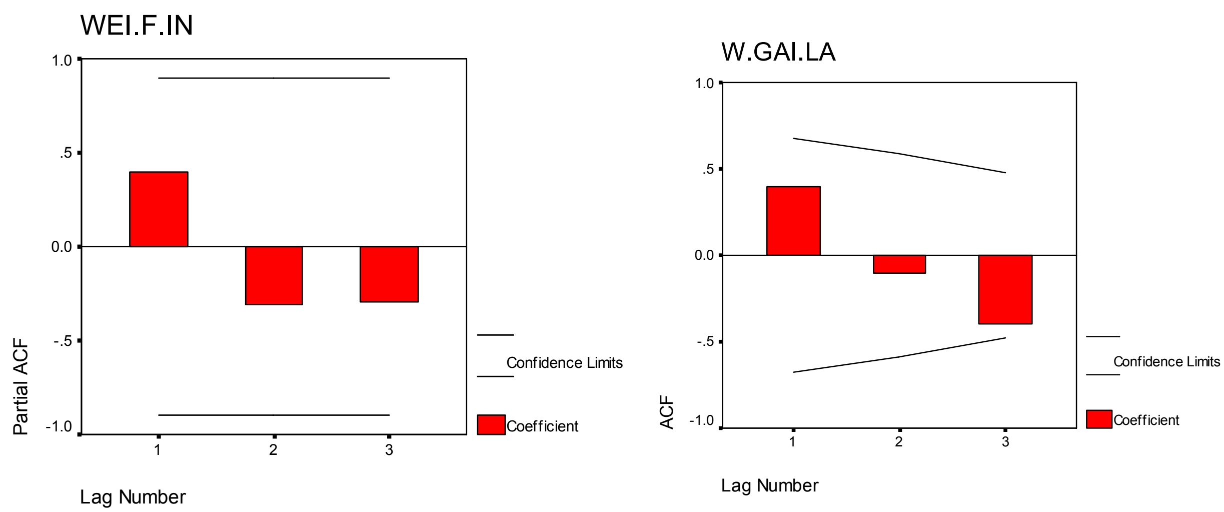
Graph 3: Relation between food consumption and growth in *Tarucus nara*



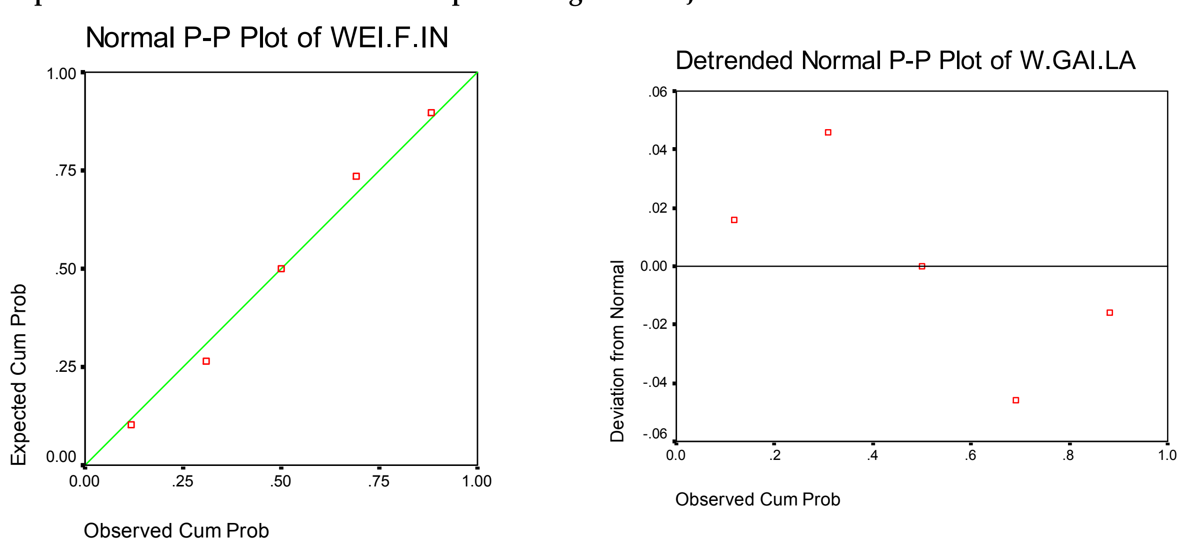
Graph 4: Relation between food consumption and growth in *Lampides boeticus*



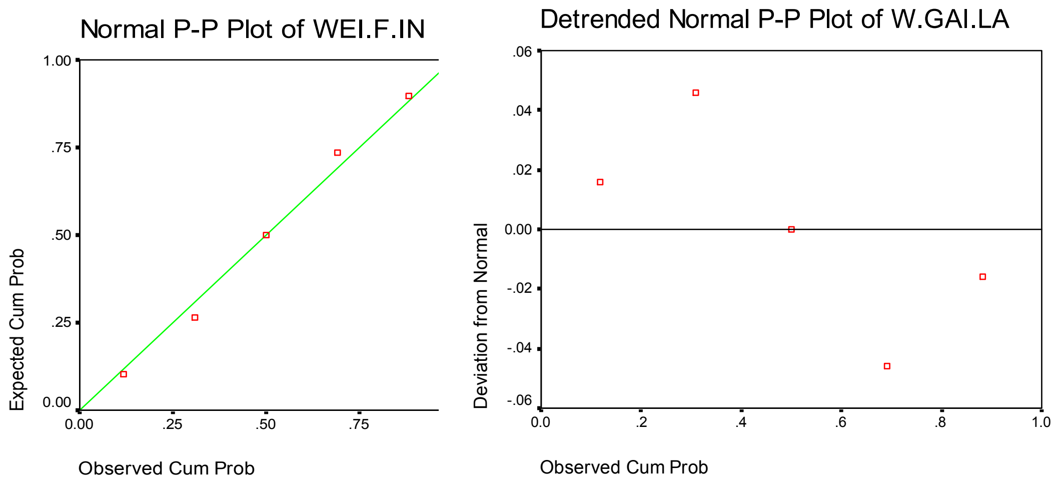
Graph 5: Relation between food consumption and growth in *Chilades lajus*



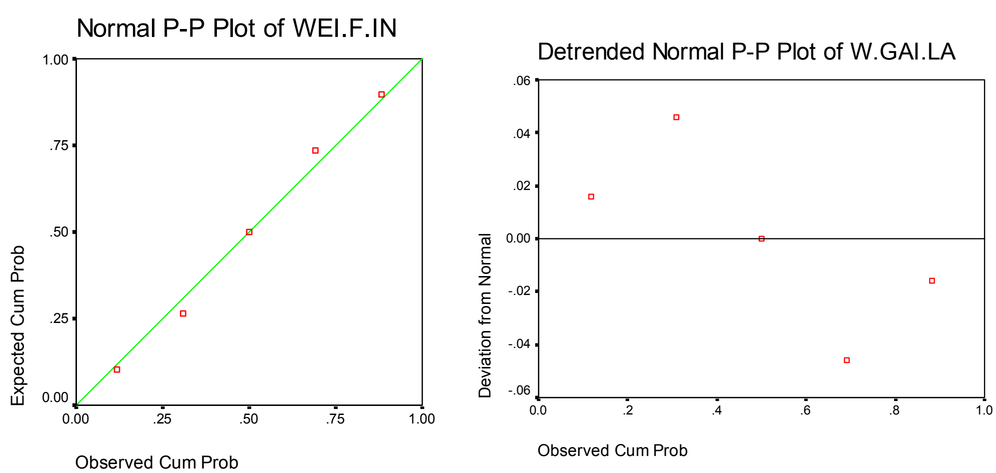
Graph 6: Relation between food consumption and growth in *Junonia hietra*



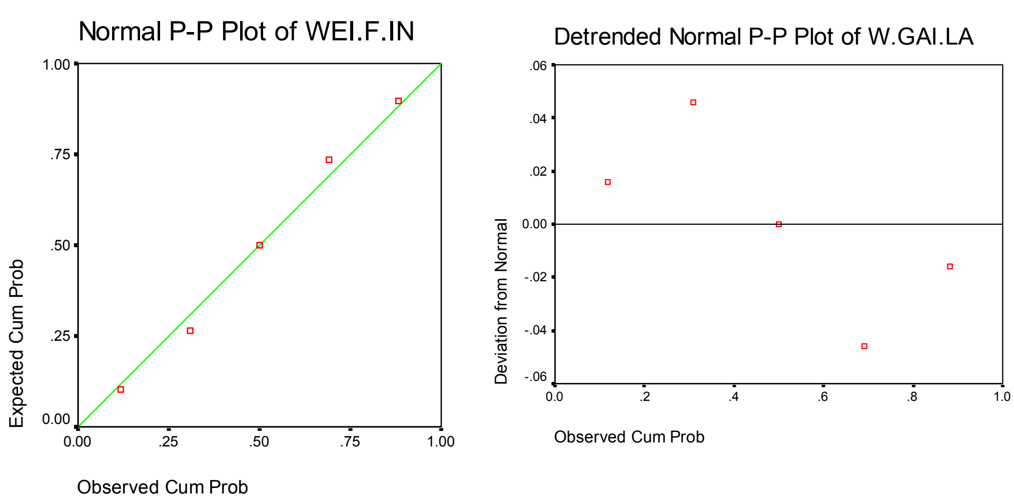
Graph 7: Relation between food consumption and growth in *Byblia ilithyia*



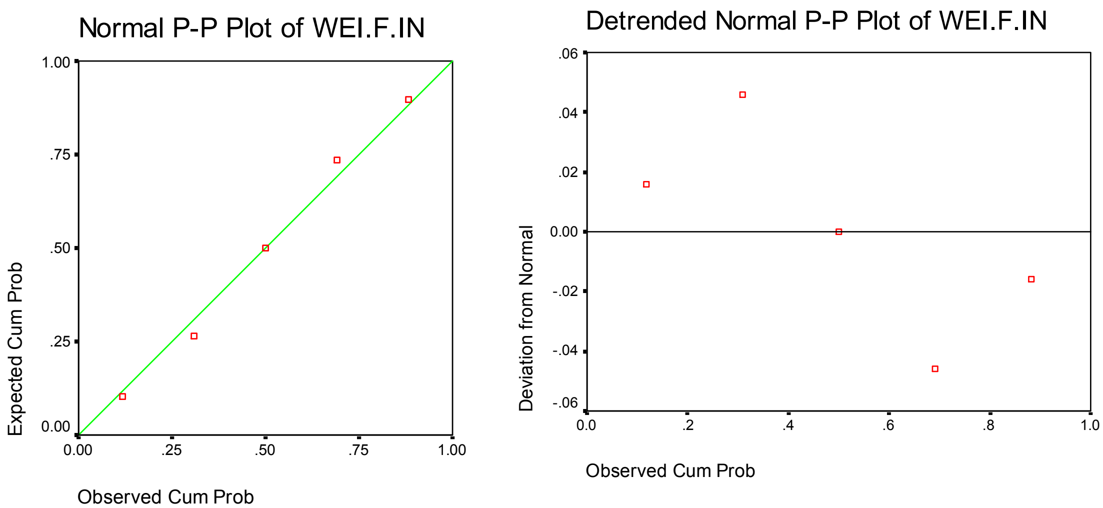
Graph 8: Relation between food consumption and growth in *Tirumala septentrionis*



Graph 9: Relation between food consumption and growth in *Colotis etrida*



Graph 10: Relation between food consumption and growth in *Hasora chromus*



Graph 11: Relation between food consumption and growth in *Graphium nomius*

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