Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2015; 3 (1): 92-99

Received: 18-12-2014
Accepted: 15-01-2015

P. Harinath
Research Scholar, Department of Zoology - School of life Sciences - Yogi Vemana University Kadapa– 516 003 - Andhra Pradesh, India

K. Suryanarayana
Research Scholar, Department of Zoology - School of life Sciences - Yogi Vemana University Kadapa– 516 003 - Andhra Pradesh, India.

V. Prasanna Kumar
Research Scholar, Department of Zoology - School of life Sciences - Yogi Vemana University Kadapa– 516 003 - Andhra Pradesh, India

S.P. Venka Ramana
Assistant Professor, Department of Zoology, School of life Sciences Yogi Vemana University Kadapa – 516 003 - Andhra Pradesh, India

Correspondence:
S. P. Venkata Ramana
Assistant Professor, Department of Zoology, School of life Sciences Yogi Vemana University Kadapa – 516 003 - Andhra Pradesh, India

Autecology of the yellow pansy butterfly *Junonia hierta* Fabricus (Lepidoptera: Rhopalocera: Nymphalidae) from Southern Andhra Pradesh

P. Harinath, K. Suryanarayana, V. Prasanna Kumar, S.P. Venka Ramana

Abstract
The life history of the yellow pansy butterfly *Junonia hierta* (Fabaricus) and its larval performance in terms of food consumption and utilization, length of life cycle on its host plant *Barleria montana* are described for the first time. The Yellow Pansy, *Junonia hierta* is a species of Nymphalid butterfly usually seen in open scrub and grassland habitats. The study was conducted during January to December 2013 at Sri Lankamalleswara reserve forest (79^0 07' – 78^0 80' E) and Kadapa (14^o 47' N and 78° 82' E) of Southern Andhra Pradesh. *Junonia hierta* completes its life cycle in 20-26 days (eggs 3, larvae, 15 – 16, and pupa 5 – 7 days). The values of nutritional indices across the instars were AD (approximate digestibility) 43.75 – 95.49%; ECD (efficiency of conversion of digested food) 1.32 – 33.85%; ECI (efficiency of conversion of ingested food) 1.50 – 14.80%, measured at the temperature of 28 ± 2^0 C and RH of 80 ± 10% in the laboratory. These relatively high values of ECD and ECI explain partially the ecological success of *Junonia hierta* in the present study environment.

Keywords: Life history, *Junonia hierta*, captive rearing, immature stages, food utilization indices.

1. Introduction
Butterflies are known for the incontestable beauty of their wing colours, and contribute to the aesthetic quality of the environment. They constitute an important pollinator resource, and on this account their conservation management has become a global risk [1, 2]. Little has been said by conservationists about the conservation of butterflies, which are worthy of protection [3]. To consider any conservation management programme accurate life history information of all butterflies in an area is required. Such knowledge in most cases of Indian butterflies is seriously inadequate [4, 5]. Sincere efforts in this direction have been in action for the butterflies of South India [6, 7, 8]. We describe here the details of immature stages, larval performance on its host plant *Barleria montana* L. and the length of the life cycle from egg to adult emergence for the Yellow pansy butterfly *Junonia hierta* (Fabricus).

2. Materials and Methods
The present study was carried out at (Fig. 1) Sri Lankamalleswara reserve forest (79^0 07' – 78^0 80' E) and Kadapa (14^o 47' N and 78° 82' E) during the calendar year 2013 (January – December). Sri Lankamalleswara reserve forest has an average elevation of 138 meters (452 ft). The basic protocol for captive rearing is to collect eggs from wild-mated females, rear larvae to adult butterflies in captivity, and release adult butterflies and/or pupae back into wild populations [9]. The reproductive activity of the yellow pansy butterfly, *Junonia hierta* was observed regularly during 0800 to 1500 h at two sites of Sri Lankamalleswara reserve forest, Yogi Vemana University campus and the Botanical garden with an area of 5 km radius. Once adult butterflies were located detailed observations were made in order to observe the period of copulation and oviposition. After detecting oviposition, the leaf with eggs was collected in Petri dishes (4 x 9 cm) and brought to the laboratory. The leaf piece with eggs was then placed in a smaller Petri dish; that was lined with moistened blotter to prevent leaf drying. Such Petri dishes were kept in a clean, roomy cage fitted with wire gauge. 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 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 change in instars, and characters including length, width and weight measurements. As the larvae grew, they needed more space. Hence, 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 the formulae given by Waldbauer [10].

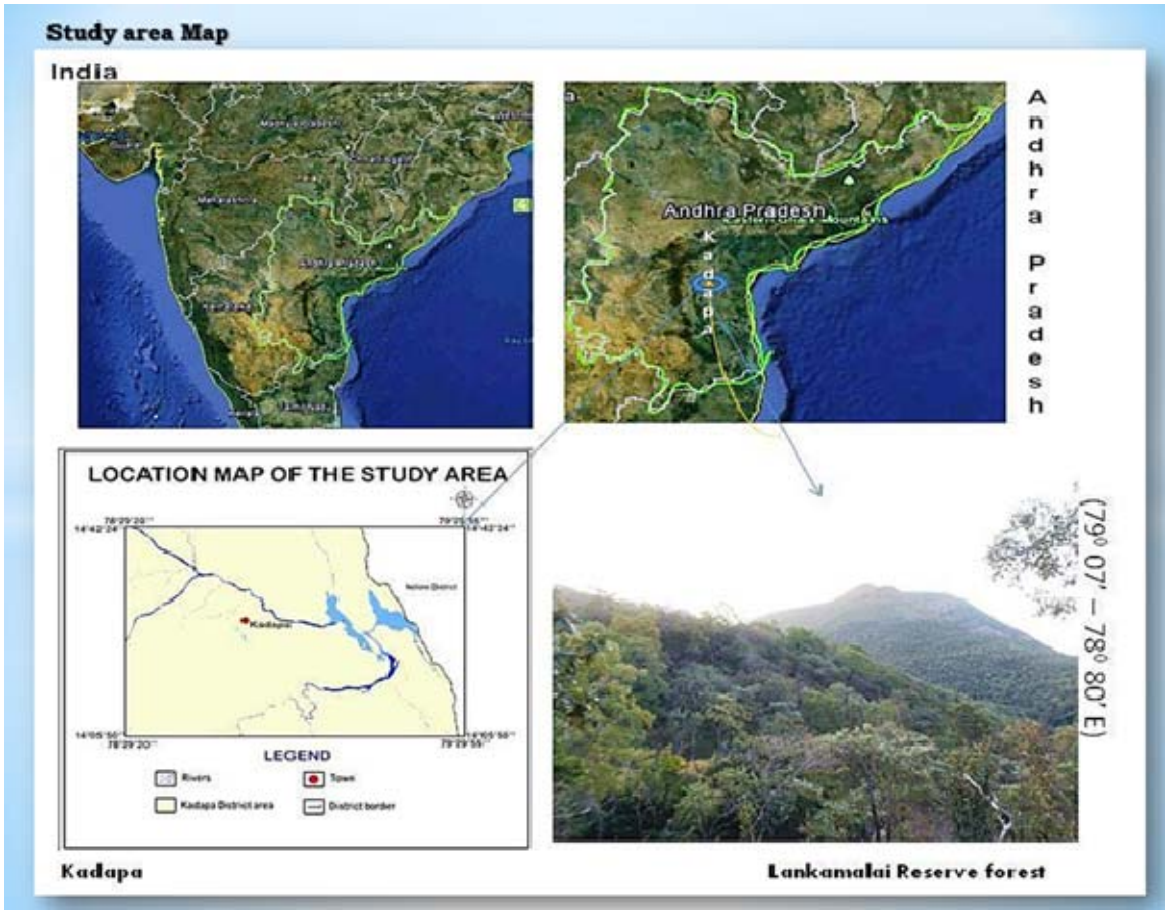


Fig 1: The study area

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

$$\text{GR (Growth rate)} = \frac{\text{Weight gain of instar}}{\text{Mean weight of instar} \times \text{Number of feeding days}}$$

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

$$\text{ECD (Efficiency of conversion of digested food)} = \frac{\text{Weight gain of instar}}{\text{Weight of food consumed} - \text{weight of faeces}} \times 100$$

$$\text{ECI (Efficiency of conversion of ingested food)} = \frac{\text{Weight gain of instar}}{\text{Weight of food consumed}} \times 100$$

Five replications were maintained for the study of all parameters. Fresh weight measurements were used for the purpose. The development of pupa from full grown larva and particulars of pupa and the time of adult emergence were also recorded. Millimetre graph paper was used for taking measurements. 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.

3. Description

The male **(**Fig. 2a**)** upper side was bright yellow. The Costa of the forewing has a broad triangular jet-black projection

downwards at the disco cellular's, and the dorsum has a triangular projection upwards near the tornus; this black margin narrows near the middle of the termen and bears on the apex two short transverse preapical white streaks crossed by the black veins. Below these an obscure ocellus that was sometimes absent. http://www.biolib.cz/en/taxon. The anterior half and the terminal margin of the hind wing was black, and the dorsum was broadly shaded with brown while the anterior black area has a large brilliant blue spot [11]. The cilia of both fore and hind wings are white alternated with brown.

The underside of the forewing was pale yellow. The celli's was crossed by three laterally black-margined orange-yellow bars, beyond that was a short, broad, irregular jet-black oblique band from costa to base of vein 4. The hind wing was grayish yellow. With a prominent transverse brown discal fascia, its margins are highly sinuous. There was a brownish broad shade on the middle of the termen and some obscure lunular marks on the basal area. The antenna was pale, and the head, thorax and abdomen are dark brownish black; beneath that a dull ochraceous white. The female was similar, although the colours are duller. The cell of the upper side fore wing has a more or less complete transverse black fascia and another at the disco cellular's. A blue-centered well-marked ocelli was in interspaces 2 and 5 on the disc of the fore wing, and smaller ocelli in interspaces 2 and 5 on the disc of the hind wing. The fore and hind wings have a fairly well-defined pale sub terminal line, though the blue spot on the anterior black area on the hind wing was small and ill-defined; the rest was as the male. The underside was also as the male, but generally has heavier and more clearly defined markings [12].

4. Results and Discussion

4.1 Adult stage (Fig. 2a)

Upper side of both wings tawny. There are two large eye-spots near the apex of hind wings, and two smaller spots on each of its forewings. Spots are also found on underside of the wings. Margins of the wings are dark brown and wavy. Head, thorax and abdomen are orangish brown. Wingspan was between 60 – 65 mm. Mating and oviposition took place during 0900 – 1400 h.

4.2 Adult female behaviour during oviposition

The gravid female laid eggs singly on the underside of the young and mature leaves of *Barleria Montana.* About 8 – 12 eggs were laid at a time but on different leaves. Adults were found probing for nectar on the *Pterocarpus santalinus* L.F, *Bauhinia purpurea* L, *Caesalpinia pulcherrima* L, *Cassia fistula* L.

4.3 Egg stage (Fig 2b)

The eggs were green, spherical with longitudinal ridges and shining. Measured 0.90 – 1.00 (0.91 ± 0.05) mm in height. They hatched in 3 days of incubation. Immediately after hatching, the larva ate its egg-shell. It passed through five distinct instars over a period of 15 – 16 days.

4.4 stage (Fig. 2c-g)

Larval stages completes in five instars. Instar I lasted for 1– 3 days. On the first day of hatching, the instar measured 2.00 – 2.45 (2.12 ± 0.11) mm in length. It was grow to 2.69 – 3.39 (2.89 ± 0.25) mm in length, and 0.76 – 0.85 (0.83 ± 0.04) mm in width. Head capsule was black in colour and measured 0.65 – 1.80 (1.10 ± 0.42) mm in diameter. The body was light chocolate in colour and covered with black hairs. Body was clearly segmented. Instar II lasted for 2 – 3 days. The larva attained a length of 3.95 – 7.25 (4.96 ± 1.23) mm and a width 1.00 – 1.45 (1.10 ± 0.21) mm. Head capsule measured 2.18 – 2.38 (2.23 ± 0.12) mm in diameter. The body colour changed into thick chocolate and shining. Instar III lasted for 3 days. The larva attained a length of 6.15 – 13.50 (8.25 ± 2.96) mm and a width 1.19 – 3.75 (2.61 ± 0.61) mm. Head capsule measured 3.00 – 3.75 (2.52 ± 0.65) mm in diameter. Body was cylindrical and shining. Hairs were clearly visible and black in colour. Instar IV lasted for 3 days. The larva attained a length of 8.95 – 16.90 (12.56 ± 2.63) mm and a width 1.54 – 3.10 (1.23 ± 0.56) mm. Head capsule was black and hairy and measured 3.80 – 4.25 (4.05 ± 0.15) mm in diameter. No change in body colour. Hair bases on the body were surrounded by orange coloured ring like spots. Instar V lasted for 3 - 4 days. The larvae reached to a length of 27.50 – 30.65 (27.56 ± 1.52) mm and a width of 3.40 – 4.45 (2.56 ± 0.68) mm. Head capsule measured 6.95 – 8.05 (6.85 ± 0.75) mm in diameter. Colour of the body turned into black and at later stage blackish-grey. Hairs also turned into greyish. There was a light black mid-dorsal streak. The bases of the hairs were grey in colour. Just behind the head there was a band of creamy yellowish colour. Larva stop feeding and body contracted before pupation.

4.5 Pupal stage (Fig. 2h)

Pupal stage lasted for 5 – 7 days. It was 15.00 – 18.50 (16.95 ± 1.35) mm in length and 5.15 – 5.95 (5.05 ± 0.27) mm in width at its broadest point. Pupa was thick chocolate in colour. On wing cases there appeared black and cream coloured markings. On dorsal side 3 longitudinal rows of small spiny projections with 8 spiny projections in each row. The colour of these projections was half thick chocolate and another half cream coloured. Pupa was rough to touch. Its weight was about 301.80 – 413.56 (356.89 ± 40.18) mg.

4.6 Duration of life cycle the total development time from egg to adult emergence ranged 'between' 20 – 26 [Egg: 3; Larva: 12-16; Pupa: 5-7] days.

Fig 2: Photographs of the sequential stages in the life history stages of *Junonia hierta*
a) Adult (**F***) b)Adult (**M***) c) Host plant d) Instar I e) Instar II f) Instar III g) Instar IV h) Instar V I) Pupa
***F – Female, *M – Male**

4.7 Population Index (Fig. 3)

The numerical frequency of the natural occurrence of the life stages – eggs, larvae, pupae and adult on the host plant are given in fig-2. All the stages (Table -1) were spotted out throughout the year in the study locality. However, there was a higher frequency of occurrence of the life stages during June to September which corresponds with the Monsoon season. 50 – 100% survival rate from egg to larvae and 50 – 75% of survival rate from larvae to adult were recorded.

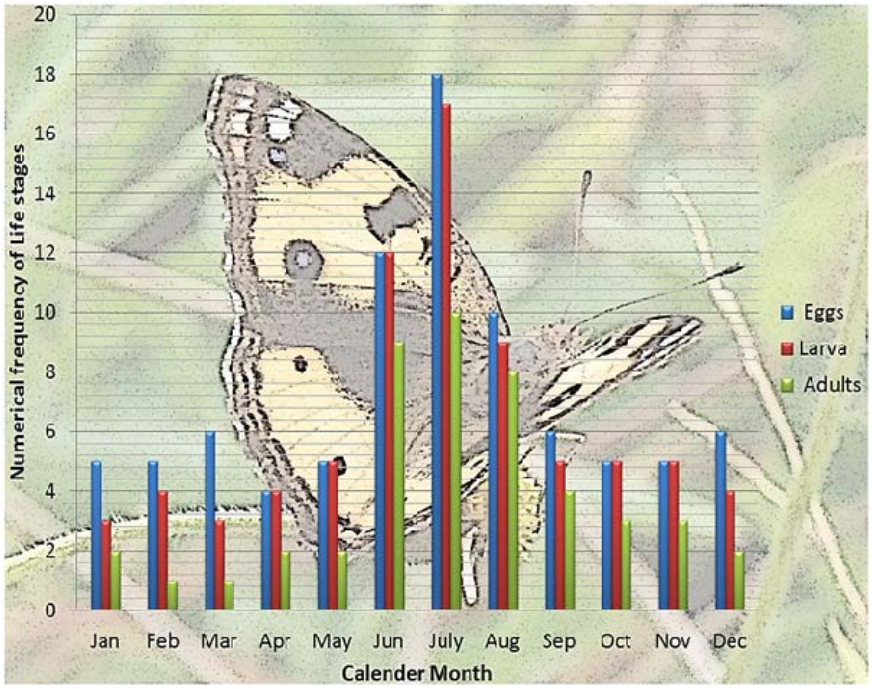
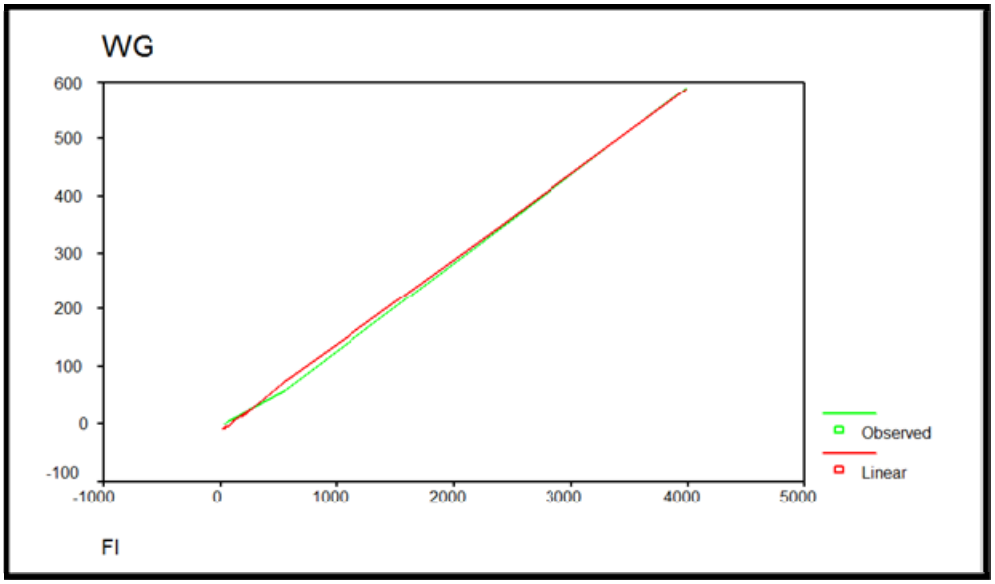


Fig 3: Population index of eggs, larvae, pupae of *Junonia hierta* based on the searches of 50 *Barleria montana* plants.

4.8 Food consumption, growth and utilization (Fig: 4 and Fig: 5)

Table 1 gives the data on the amount of food consumed by each of the five instars and the corresponding data on weight gained by different instars. The quantity of food consumed increased from instar I to V. The weight gain increased from instar I to instar V. Thus, there was over 92% of the total food consumption and 95% of total weight gained in the fourth and fifth instars together. There was a direct relationship between food consumption and growth across the five instars. Regression of weight gained by larva against the food consumed per day showed a straight line relationship between these two variable with r value (r =0.999) and t value (t= - 2. 156) at 0.01 level correlation (Fig. 3). The values of growth rate (GR) increased till instar III and then decreased to instar V, and consumption index (CI) progressively decreased from I instar to V instar. The values of GR varied between 0.12 – 0.33 mg/day/mg and those of CI between 1.09 – 09.10 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 95.49% in first instar to a low of 43.75% 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 1.32 – 33.85% and those of ECI from 1.50 – 14.80%. Thus there was an inverse relationship between the values of AD and those of ECD and ECI.



WG - Weight gain by larva **FI – Food ingested**

Fig 4: Relationship between food consumption and growth in *Junonia hierta*

Table 1: Food consumption, growth and food utilization efficiencies *Junonia hierta* larva fed with *Barleria montana*

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	45.76 ± 07.49	2.06± 00.89	0.69 ± 0.04	0.12	9.10	95.49	01.32	1.50
II	66.72 ± 08.68	6.26 ± 01.21	5.09 ± 0.49	0.32	08.41	90.61	03.75	7.62
III	245.68 ± 21.08	76.79 ± 03.89	26.56 ± 2.35	0.33	03.23	68.74	09.48	10.81
IV	568.52 ± 19.16	265.83 ± 10.23	58.96 ± 2.12	0.27	02.24	53.24	19.47	10.37
V	3981.79 ± 95.33	2239.56 ±80.48	589.52 ± 6.86	0.15	01.09	43.75	33.85	14.80

Growth rate (GR), Consumption index (CI), Approximate digestibility (AD), Efficiency of conversion of digested food (ECD), Efficiency of conversion of ingested food (ECI) (Weight by *mean ± SE)*

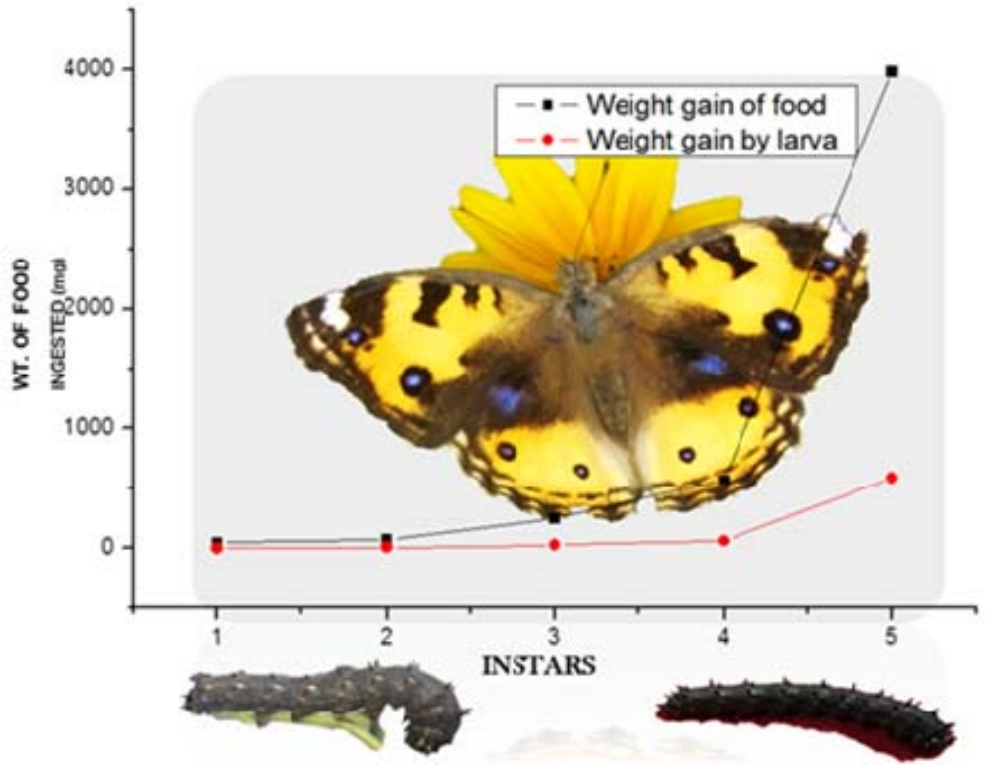


Fig 5: Food consumption, growth and food utilization efficiency of Junonia *hierta*

The total development time from egg laying to adult emergence was 23 - 27 days. This behavior was in line with the expectations of short life cycles in tropical butterflies [3]. Since temperature influences instar duration and the overall development time [13-16], the duration of life cycle may vary from our records depending on the prevailing temperatures and relative humidity (Fig. 6) (Table 2). As no temperature extremities occur at Kadapa, the duration of life cycle did not vary much over the overlapping seasons.

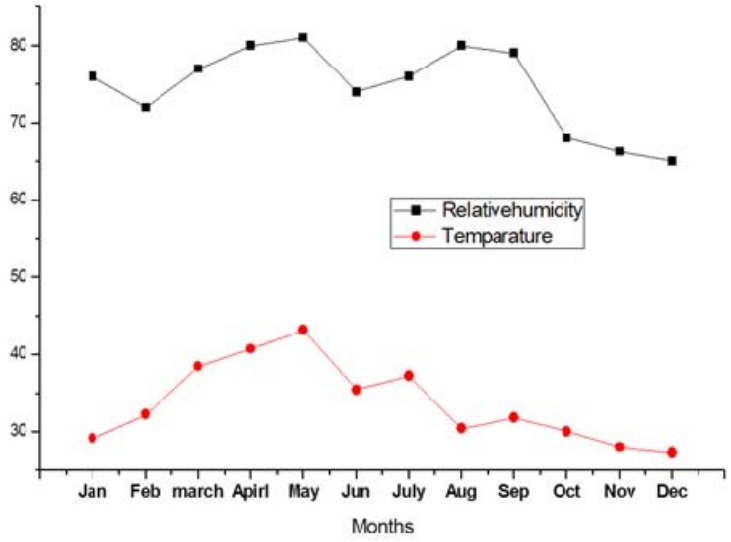


Fig 6: Relative humidity and temperature month wise data at Kadapa

Over the entire period of its growth, a larva consumed on average over 4.75 g of leaf material, with increased consumption in the last two instars, this tendency of greater consumption by the last two instars has been reported in lepidopterous larvae in general [10, 13, 14, 17– 19] and it compensates the energy expenditure of non-feeding pupal stage [20]. The values of CI are near to the range (0.27 – 6.90) predicted for forb foliage chewers [21]. 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 [21]. In this sense, the high CI value (9.10) of instar I was 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 than with final instars [22]. The GRs of penultimate and final instars of *Junonia almana* are in line with the above decreasing trend.

Table 2: Mean Temperature, Relative humidity and the length of photoperiod during study area.

Life cycle stage ↓	Calendar month											
	J	F	M	A	M	J	J	A	S	O	N	D
Early life stages	6	6	8	7	22	41	115	60	32	20	13	15
Adults	*	*	*	*	**	***	***	***	***	**	**	*
Temperature	29.15	32.24	38.45	40.7	43.21	35.45	37.23	30.41	31.81	30.03	28.05	27.31
Relative humidity	76	72	77	80	81.05	74	76.02	80.02	79.08	68.03	66.25	65.03
* Rare, ** Common,*** Very common												

The values of AD that were obtained in this study are comparable with the range of AD values (19 – 81%) for lepidopterous larvae [23].The average AD percentage is over 70.36 and this high AD substantiates the statement of Slansky and Scriber [21] that foliage chewers often attain high AD values. Such high AD values also are expected when food item was rich in nitrogen (and also water) [23]. Similar results were repeated with *Pieris brassicae* [24], *Euploea core* [25] and *Ariadne merione merione* [8].

The values of ECD increase from early to last instar [22]. Such trend is observed with the ECDs of *Junonia almana*, 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 was indicative of low efficiency of conversion of digested food to body tissues. This poor utilization of food was often attributed to deficiency in some essential nutrient in food [26] or a factor causing an increase in energy expenditure on metabolism [27]. The pattern of ECI values followed closely the pattern of ECD. The values (1.50 – 14.80) obtained are comparable with the range of values expected for forb foliage chewers (1 – 78%) [21]. the pattern of ECI followed that of AD as suggested by Waldbauer [10]. The values of ECD and ECI, particularly those of the last two instars, are also relatively high (19.47, 33.85; 10.37, 14.80), thus indicating tissue growth efficiency respectively, and ecological growth efficiency, which enabled *Junonia almana* to thrive successfully in the present study environment.

The 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 emergence of *Junonia hierta* in the present study may be profitably utilized in the successful conservation management of this butterfly species either in parks, Zoos and butterfly houses well planted with flowering plants and with patches of shades.

http://www.iucnredlist.org/details/159898/0 [28]

5. Acknowledgement

The corresponding author Dr. S.P. Venkata Ramana, Assistant Professor, Department of Zoology, Yogi Vemana University, greatly acknowledge to UGC, New Delhi for financial support through a major research project and also sincere thanks to Andhra Pradesh forest Department for giving permission to periodical survey in the forest field areas.

6. References

1. New TR, Pyle RM, Thomas CD, Hammona PC. Butterfly conservation and management. Annu. Rev. Entomol 1995; 40:57.
2. Withgott J. Pollination migrates to top of conservation agenda. Bioscience 1999; 49:857.
3. Owen DF, Tropical Butterflies, Clarendon Press, Oxford, 1971, 205
4. Gay T, Kehimkar I D, Punetha JC. Common Butterflies of India (Oxford University Press, Bombay), 1992.
5. Gunathilagaraj K, Perumal TNA, Jayaram K, Ganesh Kumar M. Field guide of Some South Indian Butterflies. Nilgiri Wildlife and Environment Association, Udhagamandalam, India, 1998.
6. Atluri JB, Subba Reddi C, Venkata Ramana SP. Life history parameters and larval performance of some south Indian butterfly species. J Bom Nat Hist Soc 2004; 101:96.
7. Samatha B, Bhupathi Rayalu M, Atluri JB, Subba Reddi C. Life history and larval performance of the Psyche butterfly *Leptosia nina* (Rhopalocera: Pieridae). Natl Acad Sci Lett 2008; 31:45
8. Atluri JB, Samatha B, Bhupathi Rayalu M, Sandhya Deepika D, Subba Reddi C. Ecobiology of the common castor butterfly *Ariadne merione merione* (Cramer) (Lepidoptera: Rhopalocera: Nymphalidae), J Res Lepi 2010; 42:13.
9. Crone EE, Pickering D, Schultz CB. Can captive rearing promote recovery of endangered butterflies? An assessment in the face of uncertainity, Bio. Conserv 2007; 139:103
10. Waldbauer GP. The consumption and utilization of food by insects, Advances in insect physiology, Academic Press, London and New York, 1968, 229.
11. Kunte K. Nymphalidae, Butterflies of peninsular India. University Press, Hyderabad, 2000, 254.
12. Kehimkar I. The book of Indian Butterflies, Bombay natural history society, Oxford University press, Oxford, New York, 2008, 497.
13. Mathavan S, Pandian TJ. Effect of temperature on food utilization in the monarch butterfly *Danaus chrysippus*. *Oikos* 1975; 26:60.
14. Palanichamy S, Ponnuchamy R, Thangaraj T. Effect of temperature on food intake, growth and conversion

efficiency of *Eupterote mollifera* (Insecta: Lepidoptera). Proc Ind Acad Sci (Animal Science), 1982; 417
15. Pathak M, Pizvi PQ. Age specific survival and fertility table *Papilio demoleus* at different set of temperatures and host plants. Ind J Ento, 2003; 65:123.
16. Braby MF. Effect of temperature on development and survival in *Delias nigrina* (Fabricius) (Lepidoptera: Pieridae). Aust J Ento 2003; 42:138
17. Scriber JM, Slansky FJ. The nutritional ecology of immature insects. Annu Rev Ento 1981; 26:183.
18. Selvasundaram R, Food utilization and bioenergetics of *Caloptilia theivora* (Walsingham) (Lepidoptera: Garcillariidae) infesting tea. *Hexapoda* 1992; 4:119
19. Gosh D, Gonchaudhuri S. Biology and food utilization efficiency of *Pericallia ricini* (Fab.) (Lepidoptera: Arctiidae) in Tripura UP J Zool, 1996; 16:109.
20. Pandian TJ. Food intake and energy expenditure patterns in two insect primary consumers. Cur Sci 1973; 42:423.
21. Slansky F, Scriber JM. Food consumption and utilization in Kerkuit. I. Comprehensive Insect Physiology, Biochemistry and Pharmacology (Pergamon, Oxford), 1985; 85.
22. Scriber JM, Feeny P. Growth of herbivorous caterpillars in relation to feeding specialization and to the growth form of their food plants. Ecology, 1979; 60:829.
23. Pandian TJ, Marian MP. Prediction of assimilation efficiency of Lepidopterans, Proc Indian Acad Sci (Animal Science) 1986; 95:641
24. Yadava PS, Vats LK, Kaushal BR. Food consumption on assimilation and growth in the larvae of *Pieris brassicae* Linn. J Anim Physiol 979; 261:257
25. Venkata Ramana SP, Atluri JB, Subba Reddi C. Autecology of the Common crow butterfly, Ecol Envi and Conserv 2001; 7:47.
26. Bailey CG, Mukerji MK. Consumption and utilization of various host plants by *Melanoplus bivittatus* (Say) and *M. femurrubrum* (DeGeer) (Orthoptera: Acrididae), Cana J Zool, 1976; 54:1044.
27. Muthukrishnan J. Bioenergetics in insect-plant interactions. Proc Indian Acad Sci (Animal Science) 1990; 99:243.
28. Larsen TB. *Junonia hierta*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.