

ORIGINAL ARTICLE

Comparative study of life history and food energetics of *Danaus chrysippus* (The plain tiger) in the environs of Tummalapalle Uranium mining area and Lankamala forest area, Andhra Pradesh – India

D. Sowbagya and S.P. Venkata Ramana**

Department of Zoology, Yogi Vemana University, Kadapa – Andhra Pradesh – India

**Corresponding Author: S.P. Venkata Ramana

Email: spvramana.butterfly@gmail.com

ABSTRACT

Danaus chrysippus, sometimes referred to as the Plain Tiger, was a year-round member of the Danaidae family of butterflies. In the vicinity of the Tummalapalle Uranium Mining area (14°19'15.794" N 78°16'26.854" E) surroundings and the Lankamala forest area (16.0131° N, 78.9717° E), the larval behavior and life history of *Danaus chrysippus* were studied during the year 2023-24. Utilizing *Asclepias curassavica* and *C. gigantea* leaves as the larval host in the Lankamala forest area and the natural environment of the mining region used *C. gigantea* as the host plant. In the Lankamala forest area and in the mining region at 28°–30° and the behavior and morphological characteristics of eggs, caterpillars, pupae, and adult emergence were noted. In a lab setting, the life cycle took 24 – 31 days, whereas in a mining area, it took 27–35 days. Three eggs hatched into larvae in 7-8 days and pupae in 7-8 days. In comparison to the larvae from the Lankamala forest area, the consumption index (CI) and growth rate (GR) values in the larvae from the Tummalapalle mining area were lower. The larvae from Tummalapalle mining area also had reduced approximate digestibility (AD) values. However, there were differences in the values of the efficiency of conversion of ingested food (ECI) and efficiency of conversion of digested food (ECD) between the two locations, with certain instars exhibiting a fall in values and others showing an increase. Overall, the Tummalapalle mining area larvae and the Lankamala forest area larvae differed in the values of food utilization indices.

KEYWORDS: *Danaus chrysippus*, *Calotropis gigantea*, Tummalapalle, Lankamala forest, Life cycle and Food indices.

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INTRODUCTION

When assessing forests for the purpose of conserving biological resources, insects were especially helpful (1), (2). Insects that feed on plants such as butterflies were known to be phytophagous and assist human society both environmentally and economically. Butterflies engage in intricate feeding connections with green plants and were reliant on vegetation as adults and larvae. Because of its ability to settle in sandy soils, stop soil erosion, reproduce naturally, and be used in the weaving, rubber, and medical industries, *C. gigantea* plays a significant ecological function. This species of amphibian flourishes in locations that were open and sometimes deteriorate, such as gardens or agricultural areas (3). The availability of adult nectar plants and larval host plants determines the diversity of butterflies in a given area (4). In their larval stages, almost all butterflies were herbivores most of them were host-specific and have intimate ties to the plants that serve as their hosts (5). Intricate feeding interactions exist between butterflies and green plants, as they rely on foliage for both their adult and larval needs. The variety of nectar sources that butterflies use had been shown to vary (6), (7). The reproductive production of butterflies was reliant on the combined influence of nutrients or energy derived from both adult and larval sources because they were holometabolous animals with discrete developmental stages as egg, larva, pupa, and

adult. Butterflies use chemical cues to choose which host plants to oviposit on. Typically, females only oviposit on plants that were conducive to the growth and survival of larvae. They typically choose newly emerging food plants for larvae that were connected to their typical host plants (8). In order to protect themselves against vertebrate predators, *D. chrysippus* larvae may isolate and hold onto toxins found in their milkweed host plants. These toxins can then be transferred to the pupa and adult butterflies. Studying adult nectar sources, larval food plants, and larval food consumption and utilization were necessary in light of these findings. Nectar-feeding butterflies were known to be influenced by floral characteristics (9). A wide variety of butterflies can be found on many flowering plants, which they exploit as nectar sources (10). The traditional applications of *A. curassavica* were reported by (11), (12). To better understand the biology, ecology, and conservation of the butterfly fauna found in Tummalapalle and its environs, research was being conducted at Lankamala forest area and the mining zones nearby. This study focuses on the plain tiger, *Danaus chrysippus* (L.) (Lepidoptera: Rhopalocera: Danaidae), and reports on its life history, including the length of the early life stages, oviposition, and larval host plant, *Asclepias curassavica* (L.).

MATERIAL AND METHODS

Study Region

The current study was conducted in the Tummalapalle (14°19'15.794" N 78°16'26.854" E) mining sector of the Pulivendula region and Lankamala forest area (16.0131° N, 78.9717° E) between 2023 and 2024. The climate in the area was tropical monsoonal. The majority of the precipitation occurs between June and November, with total annual rainfall ranging from 564 to 600 mm. During May/June, the average temperature reaches its highest point (39 - 45°C).

Laboratory study

Twenty to thirty specimens of each biological stage (eggs, larvae, pupae, and adults) were chosen for the morphological investigations. Every stage was inspected and recorded with photos. Between 2023 and 2024, information was gathered from Tummalapalle in southern Andhra Pradesh. Weekly sampling was conducted using the two-stage cluster sampling approach in the natural world. The material was then placed into Petri dishes measuring 10 cm in diameter and 1.5 cm in depth. To keep the inside of each Petri dish moist, damp blotting paper was used. The samples were sent to the Department and incubated in the laboratory at $28 \pm 2^\circ\text{C}$ and $80 \pm 10\%$ humidity. The petri plates were placed in a clean, capacious cage of 60 x 50 x 30 cm and lined with wire gauge. The light condition was consistent indirect sunshine, but its duration fluctuated throughout the year. It varied from a low of roughly 11 h in November-January (winter) to a high of about 14 h in June-July. To determine the phenology of early life stages, comprehensive searches were conducted three times each month for the presence of eggs, larvae, and pupae on the ovipositor host *C. gigantea* as well as adult frequency. All parameters were studied using five replications. Fresh weight measurements were used for this purpose. The formation of pupa from fully formed larvae, as well as pupa characteristics such as colour, shape, size, weight, and the timing of adult eclosion was documented. Measurements were taken using millimeter graph paper.

Distribution

This butterfly thrives in tropical to subtropical climates, but can even be found in sheltered hot temperate locations. The butterfly was spotted in the surroundings of the Tummalapalle mining area in Southern Andhra Pradesh. *Calotropis gigantea* plants have been widely recorded in the Tummalapalle mining areas of Southern Andhra Pradesh, and they occur commonly in the tropical Southern Andhra Pradesh. The early phases of this butterfly's breeding populations were documented.

Food Consumption And Utilisation:

The larvae constitute the primary feeding stage. Quantitative data on food consumption and utilization were collected for each instar of the butterfly species under study using the gravimetric method (13). The larvae and host leaves were weighed separately and placed in Petri dishes. The larvae were allowed to eat on the leaves for 24 hours before the weights of the larvae, leftover leaf material, and faeces in the Petri dish were measured. Fresh food was supplied, and weights were taken every 24 hours. These fresh weight measurements were used to calculate growth and food utilization indices. These variables comprised consumption index (CI), growth rate (GR), approximate digestibility (also known as assimilation efficiency) (AD),

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

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

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

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

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

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

RESULT

Habitat

This butterfly was well known to everyone. This bird flutters around gardens from dawn to dark, resting on flowers for nectar. In the evening, it flutters low amid bushes, seeking a night's rest. Males sail to attract mates, preferring open land but can also be found in forests. They appeared in open areas, primarily near their Oviposition host plants (milk weed). Slow flight near the ground. Prefers open land, although can be found in forest

Nectar host plants:

Nectar-rich host plants for *Danaus chrysippus*, also known as the Plain Tiger butterfly, include: *Calotropis gigantea*, *Lantana camara*, *Asclepias curassavica* (also known as Milkweed), *Buddleja davidii* (also known as Butterfly Bush), *Zinnia spp.* *Verbena bonariensis* (also known as Purpletop Vervain) and *Echinacea spp.* (Coneflowers), *Tithonia diversifolia* (Mexican Sunflower). These plants provide the nectar needed for adult butterflies to feed on and sustain themselves. It was essential to have a diverse selection of nectar-rich plants to support butterfly populations.

Ovipositional host plants:

The butterfly's larval hosts were plants from the Asclepiadaceae family. This butterfly's documented oviposition host plants include *Asclepias curassavica*, *Calotropis gigantea*, *Calotropis procera*, *Cryptostegia grandiflora*. In the research region, the butterfly ovipositor on *C. gigantea*.

Adult Description:

Both sexes were pale orange with black marginal borders, and black upper side forewing tips with a sub-apical white band of elongated dots. Similar to Striped Tiger, but without the prominent vein edges. The abdomen was tawny brown in color, while the thorax was black with white markings. In general, males were smaller than females and may have more vivid colors. With a wingspan of roughly 7-8 centimetres. Three or four tiny black discal dots on either side of the hind wing. Underside was significantly paler. The male had a pouch with scent scales on the underside of the hind wing and a patch of scent scales on the upper side of the hind wing. Upper side was reddish brown, with black margins in both wings and a black apex in the forewing. Forewing with varying numbers of white specks on the costa and apex. The underside was dull orange. Fore wing dark brown in the upper part, with white specks in the black.

Life history of *Danaus chrysippus* (L) (Plain Tiger) in both study areas:

Egg stage: The newly laid egg was dome in shape and has longitudinal ridges that run the entire length. The freshly laid eggs were white in colour, but they turn creamy white after a day. The eggs were 0.8 - 1.4 (1.34 ± 0.06) mm in length and 0.6 - 1.19 (1.2 ± 0.01) mm in width in Tummalapalle and in Lankamala it was 1.4 - 1.38 (1.37 ± 0.01) mm in length and 0.8 - 1.18 (1.13 ± 0.05) mm in width. The incubation period was varied from 3 - 4 days after which the larvae were hatched out. The larva ingested its eggshell, revealing shiny, longer, and wider eggs compared to radiation-affected eggs.

Instar I: It grew for 2 - 3 days, reaching a length of 3.4 - 3.65 (3.8 ± 0.15) mm and a width of 1.0 - 1.29 (1.3 ± 0.01) mm. It was yellow in colour and had fluffy feathers on its body and head. The head was black in colour and had two black horns on it. In Lankamala forest it measures more compare to mining area length of the larva was 4.4 - 4.46 (4.31 ± 0.15) and width 0.9 - 1.96 (1.8 ± 0.16) mm. There were distinct yellow lines that ran longitudinally along the dorsal part of the body.

Instar II: It lasted for 3 - 4 days and was 6.5 - 7.2 (7.08 ± 0.12) mm in length and 1.6 - 1.8 (1.78 ± 0.02) mm in width. Tummalapalle and in Lankamala forest it measures more compare to mining area length of the larva was 8.5 - 8.7 (8.6 ± 1.0) and 1.97 - 2.29 (2.2 ± 0.09) mm in width. Body color was green with two forked horns on head. Anal spines were black. There were distinct longitudinal yellow lines on the dorsal side of the body, as well as a pair of narrower yellow lines on each lateral side.

Instar III: It lasted for 3 - 4 days. It was measured 10.9 - 12.99 (13.1 ± 0.11) mm in length and 2.6 - 2.95 (3 ± 0.05) mm in width in Tummalapalle and in Lankamala forest it measures more compare to mining area length of the larva was 8.8 - 14.01 (13.94 ± 0.07) and 2.3 - 2.55 (2.51 ± 0.04). The head was hairy and black, with white marks on it. The dorsal and lateral yellow lines on the body were well-marked. Radiation and temperature might affect the larva so the larva growth was reduced.

Instar IV: It lasted for 3 - 4 days. There were no notable variations seen in the fourth-instar larvae aside from the body becoming lighter in Tummalapalle and brighter in Lankamala forest area. In Tummalapalle, 14.8 - 18.37 (18.5 ± 0.13) mm long and 3.3 - 3.57 (3.6 ± 0.03) mm in width. In Lankamala forest it measures more compare to mining area length of the larva was 14.2 - 20.86 (20.71 ± 0.15) and 2.56 - 2.93 (2.88 ± 0.05) mm in width. The head's horns turned reddish brown, head width increased, white marks became cream, triangular, and orange, and food intake decreased, revealing poorly developed larvae.

Instar V: It lasted for 4 - 5 days. It reached a final length of 18.38 - 24.01 (24.2 ± 0.19) mm and 3.62 - 4.1 (4.01 ± 0.09) mm in width. The head's width increased, with a black tip on the orange anal spine, and covered in hair with a rough dorsal side and soft ventral side. Three pairs of orange and dark blue to green colored dots were visible on the dorsal yellow pair of lines. In Lankamala forest it measures more compare to mining area length of the larva was 20.87 - 26.2 (25.86 ± 0.14) and 2.94 - 3.05 (2.98 ± 0.06) mm in width.

Pre-pupa: The fifth instar, it was fully grown stopped eating and shrunk down to begin the pupal stage. This process was completed in less than a day.

Pupa: This stage lasted for 9 - 10 days. Pupa was measured between 17.3 - 17.51 (17.6 ± 0.11) mm in length and 7.5 - 7.9 (7.87 ± 0.03) mm in width in Tummalapalle. In Lankamala it was 19.5 - 20 (19.88 ± 0.12) mm. The pupa, initially bright green, later pale brown, with cream and red spots, eventually dies due to inability to complete the pupa.

Duration of life cycle: There were five larval instars from developmental stage egg to adult throughout the life history it takes about 27-34 days at Tummalapalle mining zone area and 24-31 days at Lankamala forest area, Kadapa.

Development success of eggs, larvae and pupae:

The success rate of larval development ranged from 45 - 78%, with July through November seeing the highest rate. The percentage of pupae that developed ranged from 50 to 80%, with the greater rate being noticeable from July to October (Table 1&2).

In the study area, every step was observed during the course of the year. Nonetheless, the life stages from July to November and March to June occurred more frequently, which was consistent with the warmer weather.

Figure 1: Life cycle of *Danus chrysippus* in Lankamala forest region



DANAUS CHRYSIPPUS

Life cycle of *Danaus chrysippus* conducted in the region i.e. Lankamala forest area (Figure 2)(14.6248°N 78.8836° E) Kadapa region.

A. Adult; B. Egg; C. Instar I; D. Instar II, E. Instar III, F. Instar IV; G. Instar V; H. Pupa.

Figure 2: Life cycle of *Danus chrysippus* in Tummalapalle mining region



DANAUS CHRYSIPPUS

Life cycle of *Danaus chrysippus* conducted in the region i.e Tumalapalle mining area surroundings (Figure 2)(14°28'24.573"N 78°42'45.447"E) Pulivendula region.
A. Adult; B. Egg; C. Instar I; D. Instar II, E. Instar III, F. Instar IV; G. Instar V; H. Pupa.

Figure 3: Mortality life cycle stages in Tummalapalle Uranium mining area



Table 1: Population indexes of different life stages of *Danaus chrysippus* on *Calotropis gigantea* leaves in the Lankamala forest area from June 2023 to May 2024.

Calendar months	Number of eggs incubated	number of larvae hatched	Number of pupae formed	Number of adults emerged
Jun	26	20	14	8
Jul	22	18	20	15
Aug	26	22	16	14
Sep	30	28	26	24
Oct	34	25	22	21
Nov	46	28	21	20
Dec	14	8	4	2
Jan	10	6	4	2
Feb	12	14	8	6
Mar	13	16	12	6
Apl	22	16	14	11
May	18	18	18	13

Table 2: Population indexes of different life stages of *Danaus chrysippus* on *Calotropis gigantea* leaves in the field (Tummalapalle)

Calendar months	Adults abundance	number of eggs	Number of larvae	Number of pupae
June	Rare	06	16	12
July	Abundance	24	14	18
August	Common	20	20	14
September	Very common	32	24	24
October	Very common	31	26	22
November	Very common	35	22	20
December	Common	13	6	10
January	Common	10	5	6
February	Common	11	13	5
March	Rare	12	15	6
April	Rare	18	16	2
May	Rare	12	14	00

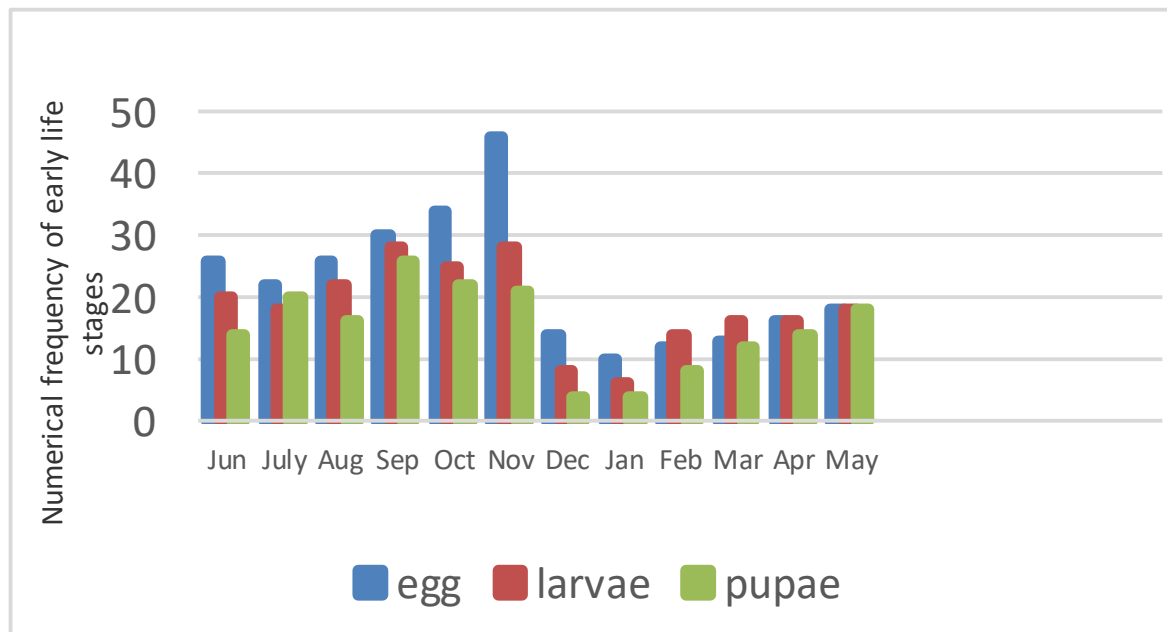
Table 3: Food consumption and utilization, growth and food utilization efficiencies of *Danaus chrysippus* on *C.gigantea* in Lankamala forest area

Instar number	Wt.of food ingested (mg)	Wt.of faeces (mg)	Wt. gain by larvae (mg)	GR (mg/day)	CI (mg/day)	AD (%)	ECD (%)	ECI (%)
I	21.6±0.34	0.015±0.09	2.2±0.10	0.57	7.47	99.12	11.21	7.7
II	88.5±0.84	3.42±0.18	18.0±0.18	0.49	3.48	95.32	15.02	19.3
III	1397±8.40	1105±0.91	222.6±1.80	0.55	3.11	92.45	25.2	15.9
IV	2371.6±11.20	194.5±1.90	3213±2.40	0.25	1.86	91.76	62.3	13.3
V	3497.3±16.40	528±5.30	678.2±3.80	0.18	0.97	84.98	34.3	19.3

Table 4: Food consumption and utilization, growth and food utilization efficiencies of *Danaus chrysippus* on *C.gigantea* in Tummalapalle mining area surroundings

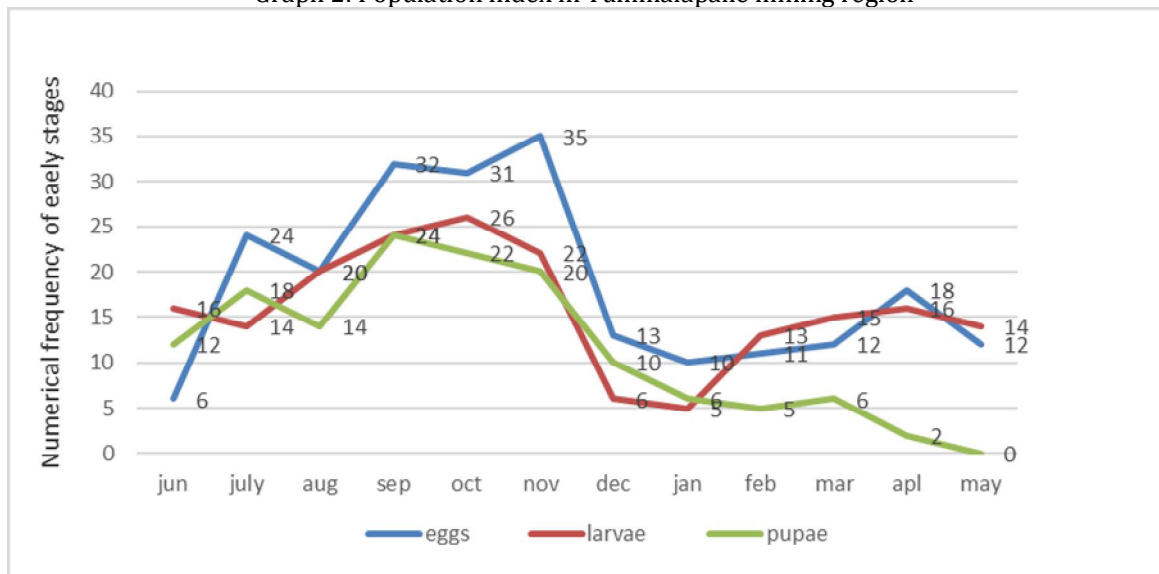
Instar	Wt. of food ingested (mg)	Wt. of faeces (mg)	Wt. gain by larvae (mg)	GR (mg/day)	CI (mg/day)	AD (%)	ECD (%)	ECI (%)
I	17.6±0.14	0.06±0.06	1.0±0.10	0.34	5.86	94.12	10.11	5.68
II	80.5±0.82	2.01±0.17	10.0±0.12	0.33	2.68	80.49	12.74	12.4
III	296±7.40	59.6±0.61	56.6±1.10	0.31	1.74	79.86	25.2	19.12
IV	619.6±10.20	138.2±1.40	138.8±1.10	0.22	1.16	77.67	28.3	22.4
V	1546.3±14.40	406±4.10	518.2±2.20	0.12	0.99	73.74	31.3	33.5

Efficiency of conversion of digested food (ECD), Efficiency of conversion of ingested food (ECI), Growth rate (GR), Consumption index (CI), Approximate digestibility (AD)

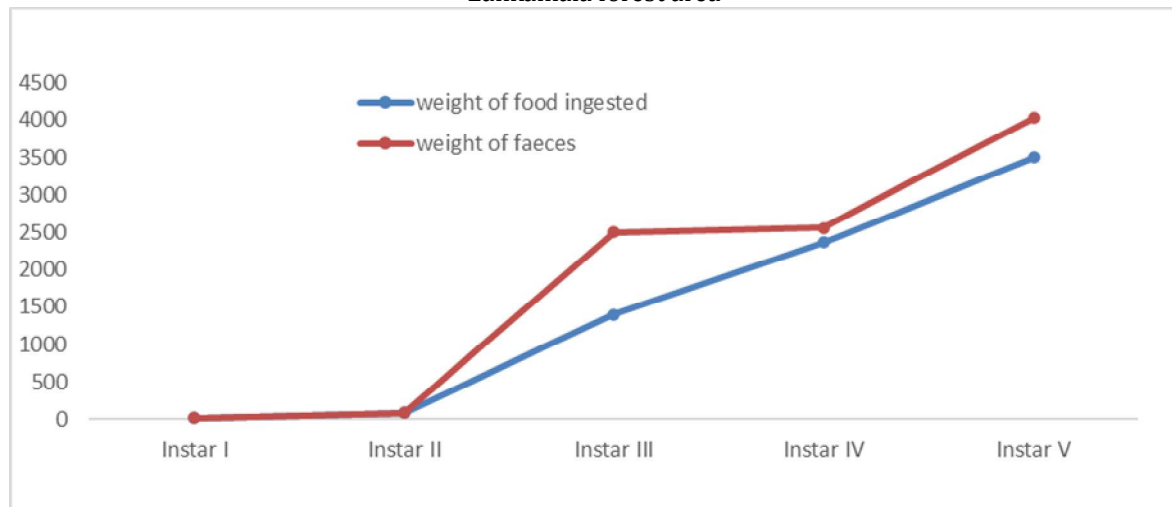


Graph 1: Population index in Lankamala forest region

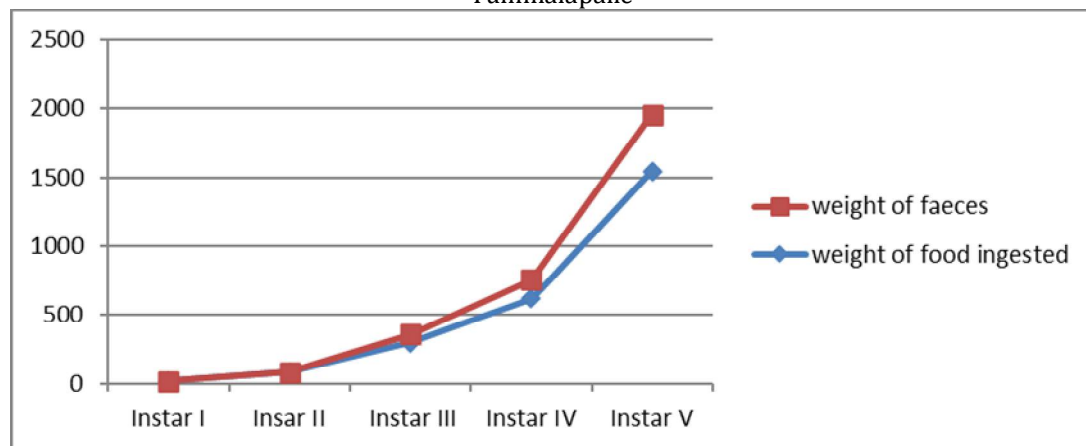
Graph 2: Population index in Tummalapalle mining region



Graph 3: Relationship between food consumption and growth in *Danaus chrysippus* on *C. gigantea* in Lankamala forest area



Graph 4: Relationship between food consumption and growth in *Danaus chrysippus* on *C. gigantea* in Tummalapalle



Food Consumption and Utilization:

Growth and Consumption of Food Tables were updated with information on the weight of food consumed and the weight the larvae gained on the host plant. It was discovered that the *Danaus Chrysippus* larvae eat the shell first, making the important nutrients readily available to them. The larvae proceeded to feed on the immature leaves of the *C. gigantea* oviposition host plants after completing the cell. As a result, the larvae were raised in a lab and fed daily with young, fresh leaves from their natural host plants. Compared to older leaves, younger leaves promote better larval growth ^{(14), (15)}.

The information gathered about *D. chrysippus* food consumption and growth in terms of larval body weight, as well as the values of the consumption index (CI) and growth rate (GR), revealed a clear trend of rising absolute and falling relative rates of the two variables under studied.

Table 3 provides information on the amount of food that each of the four instars consumed as well as the matching information on the weight gain experienced by the various instars. The percentage shares of the subsequent instars total food intake were increased and their respective weight growth percentages were also increased in laboratory results. Therefore, the third and fourth instars together accounted for nearly 84% of the overall food consumption and 94% of the total weight gained. A direct correlation between food consumption and growth across the five instars was observed. (CI) dropped from the initial to the final instar. Growth rate (GR) values rose from the first to the last instar. The GR values varied from 0.57 to 0.18 mg/day/mg, whereas the CI values ranged from 7.47 to 0.97mg/day/mg.

In Table 4 the total values and the amount of food that each of the five instars consumed was decreased and weight gain experienced by the various instars. The percentage shares of the subsequent instars total food intake were somewhat decreased compared to laboratory and their weight growth percentages were also declined. Therefore, the third and fourth instars together accounted for nearly 67% of the overall consumption and 74% of the total weight gained. Here an indirect correlation between food

consumption and growth across the four instars were observed (Graph 4)(CI) dropped from the initial to the final instar. Growth rate (GR) values rose from the first to the last instar. The GR values varied from 0.34 to 0.12 mg/day/mg, whether the CI values ranged from 5.86 to 0.99 mg/day/mg. Comparatively the CI values for early and late instars found in this study area were in good agreement with those published for a few other species of butterflies from the study area (the environs of the Tummalapalle mining area) (16), (17). Similar to food consumption, the last two instars accounted for a greater percentage of the larva's overall growth in terms of body weight. Therefore, there was a pattern of declining absolute weights as the instar larvae developed, but there was also a general fall in relative rates, or values of GR (Table 4). Since GR was most likely size dependent, its values decreased as the instar larvae developed and became larger and heavier. The GRs corresponds with the declining trend in growth rate from penultimate to final instar of the butterfly species studied in this study.

DISCUSSION

Reviews of insects' use of food revealed that ECD and ECI could either increase or decrease from early to late instars(18). In contrast to this general trend of ECD and ECI, the ECD and ECI percentage of *D. Chrysippus* showed first an increasing trend, followed by a decrease and then again an increase. Some workers reported a gradual rise of both indices from first to fifth instars (19), while others observed increased ECDs and ECI up to the fourth instar and then a decline in the fifth stage in various insects (20). ECD and ECI percentages were lowest in the first instar (11.21% and 7.7%, respectively), and greatest in the last instar (34.3% and 19.3%, respectively). ECD's percentage average was 29.4, whereas ECI's was 15.1. The above data was clearly shown that the increase in Approximate Digestibility, ECD and ECI in the Lankamala forest area. These values are in line with the stated range of values for foliage (18). Food quality had an impact on food use efficiency. Age determines a leaf's nutritional quality; younger leaves have higher nutritious content than older leaves. A mistake in the supply of leaves of a similar age throughout the larval period may be the cause of the minor decrease in both ECD and ECI values in the third and fourth instars compared to the values of the second instar. The details regarding the oviposition, the length of the life cycle from egg to adult, the larval host, and the larval performance in terms of feeding, growing, and using their resources. The present study's eclosion of *D. chrysippus* may be profitably applied to the effective conservation management of this species of butterfly, either in the field or in parks, zoos, and butterfly houses. Butterfly houses are common zoo exhibits with great educational and conservational potential (21), (22). ECD and ECI percentages were lowest in the first instar (10.11% and 5.68%, respectively), and greatest in the last instar (31.3% and 33.5%, respectively) (Table 4). ECD's percentage average was 21.5, whereas ECI's was 11.9. The above data was clearly shown that the decrease in Approximate Digestibility, ECD and ECI in the Tummalapalle mining area. This decline in ECD and ECI indicates a decline in larval biomass conversion, indicating slow growth and poor development. ECD and ECI decrease from instar I to V, indicating slow growth and poor development due to inverse relationship with food consumption. Tummalapalle mining area larval stages show slower growth and food consumption for larvae, possibly due to low food sources and energy requirements.

CONCLUSION

The study examines the food indices of the *Danaus chrysippus* butterfly in the Tummalapalle mining region and Lankamala forest area. The Lankamala forest had a high diversity of nectar sources, indicating a high floral diversity(Table 1). However, the Tummalapalle mining region has lower food indices, possibly due to degraded natural habitats. This could impact the butterfly's survival and population dynamicst(Table 2). There were five larval instars from developmental stage egg to adult throughout the life history it takes about 27-34 days at Tummalapalle mining zone area and 24-31 days at Lankamala forest area, Kadapa. The study emphasizes the importance of protecting natural habitats and floral diversity to sustain butterfly populations. The information supplied demonstrates how larvae in the Tummalapalle mining region consume food. From I to V, the number of instars increases, signifying the larvae's poor growth and delayed development phases. From instar I to instar V, the weight of food consumed drops dramatically, with instar V containing the least amount of food consumed. This implies that the larvae's food intake reduces as they move through the instars. The larvae exhibit poor weight variation across the instars, with instar IV showing the lowest weight and poorest activity. The radiation effect of the larvae could be responsible for this (Table 4). The rate of growth (GR) While the consumption index (CI) values ranged from 6.27 to 0.47 mg/day/mg, the GR values varied from 0.47 to 0.12 mg/day/mg. drop as the number of instars rises, signifying a decline in the larvae's rate of growth and food intake as they descend through the instars. The apparent digestibility and approximate digestibility of larvae decrease from instar I to V, with an inverse relationship with food consumption (Graphs 3 & 4).

Later stages show decline due to resource rivalry and environmental hazards. Tummalapalle mining area's population decline was attributed to fewer food sources, competition, and radiation impacting larvae's growth and survival, affecting their absorption and conversion efficiency (Graph 4). Lankamala forest offers a healthy population of larvae due to reduced radiation exposure, better growth rates, and absorption efficiency compared to mining regions (Graph 3). Radiation in Tummalapalle impacts food availability and population dynamics of larvae (Graph 2), requiring conservation efforts to maintain a balanced ecosystem and mitigate the negative effects of mining operations.

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