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# Consumption and Utilization of Food by Different Instars of Oak Tasar Worm *Antheraea Proylei* (Jolly) Fed on *Quercus Lucotricophora* Plant

**Pashupati Nath, PC Joshi, Sanjay Kumar, Vinaya Kumar, Dalip K Mansotra, MC Joshi**

## Abstract
The indoor rearing of Oak tasar silkworm *Antheraea proylei* (Jolly) (Lepidoptera: Saturniidae) was carried out in order to study its nutritional parameters viz. consumption, assimilation and tissue growth by feeding them oak twigs. During this study the ecological efficiencies of *Antheraea proylei* (Jolly) was studied in the lab condition. Total duration of instar stages was found as 4.80±0.418, 4.00±Nil, 4.80±0.418, 8.00±Nil, 11.66±0.723 days for 1st, 2nd, 3rd, 4th and 5th larval instars, respectively. The recorded food consumption was 0.5841± 0.4051, 1.0174 ± 0.253, 1.6289 ± 0.344, 4.4205± 1.602 and 6.4945 ± 1.503g insect$^{-1}$ day$^{-1}$ in 1st, 2nd, 3rd, 4th and 5th larval instars respectively. The values of leaf assimilation were 0.5779 ± 0.405, 0.9984± 0.250, 1.5656 ±0.3145, 4.050 ± 1.599 and 5.4992± 1.539 g insect$^{-1}$ day$^{-1}$, respectively. The tissue growth was 0.0103± 0.0058, 0.0514±0.0436, 0.2158 ± 0.089, 0.5165 ± 0.241 and 0.4453 ± 0.219g insect$^{-1}$ day$^{-1}$ in all respective stages. The 1st instars larvae showed maximum approximate digestibility (98.9634 ± 0.396), while the minimum value (84.7489± 1.972) was recorded for fifth instar larvae. They indicate the negative correlation of approximate digestibility against food Consumption. The ECD value was minimum (1.8152±0.330) in 1st instar, while maximum (13.6596±2.596) in 3rd instar larvae. However, the ECI was also minimum value (1.7972±0.334) in 1st instar larvae, while maximum values (13.1477±2.688) in 3rd instar larvae.

**Keywords:** *Antheraea proylei; Q. lucotricophora*, Consumption; Approximate digestibility; Conversion of ingested food; Conversion of digested food.

## Introduction
Study of nutritional parameters of sencigenous insects is considered to be an important field of work for better management and development of the sericulture industry apart from its physiological importance. The oak tasar silk is produced in large scale by the countries viz. China, India and Japan. In India *Antheraea proylei* is more commercially exploited silk moth. Oak tasar silkworm *Antheraea proylei* is a bivolitine sencigenous insect and largely reared by the farmers of western Himalyan region of Uttarakhand. In recent years the farmers of several other states viz. Manipur, Himanchal Pradesh, Meghalya, Jammu & Kashmir. Order Lepidoptera is the most diverse and large group of insects and includes butterflies and moths. It is among the most successful groups of insects and inhabits all terrestrial habitats (*viz.* desert to rainforest, lowland grasslands, montane plateaus).These insects are associated with higher plants or flowering plants (Gullan *et al,* 2004) [8]. Lepidoptertans except some species are a serious pest of various plants causing a great damage to them, which are economically essential for human. Mostly the moths are the most injurious active feeder responsible for maximum damage but many species of this order are highly valuable as a part of biological research comprising studies on physiology, systematic, ecology, biogeography and genetics. Factors like quantity and quality of food, various climatic conditions and presence of predators, parasites and disease can be regarded as the index of the physiological potential of life performance of the insect (Slansky *et al*. 1985) [16]. Consumption and various efficiency of utilizing of consumed food greatly influence the vital physiological activities viz. Metabolism, enzyme synthesis, nutrient storage etc. several workers carried out Studies on ecological energetic and feeding potential of different insects (Slansky *et al*., 1985, Kaushal and Joshi, 1991, Kaushal, *et al* 1988, Joshi *et al.*, 2003, Sharma and Joshi 2010, and Sudhansu 2010) [16, 10, 11, 9, 15, 17]. Tasar, the commercial silk is produced by a variety of species of *Antheraea*. In the present study, energy budget of *Antheraea proylei* has been studied using its natural food plant, *Quercus lucotricophora.*

## Materials and Methodology

The eggs of *Antheraea proylei* were collected from Regional Tassar Research Station, Bhimtal. Eggs were transferred to different petridishes, covered with plastic sieves of 12 meshes/cm at room temperature (20-25 $^0$C) and relative humidity of (60-65)% in order to maintain a stock culture in the laboratory. On emergence, each larvae was weighed and kept in petri dish covered with plastic sieves and were allowed to feed on preweighed portion of oak leaves *Quercus lucotricophora* (local banjh) for 24 hrs, while the remaining portion of leaves and feces were dried to a constant weight at 80 $^0$C. A wet/dry mass ratio was determined from the leaves and the amount of leaves ingested by each larva was estimated. At the end of the experiment, food consumption was calculated as the difference between the initial weight of the leaves provided and the unconsumed leaves. Ecological efficiency of 1st, 2nd, 3rd, 4th and 5th instar of oak tasar moth were determined. Ecological efficiency was calculated using Waldbauer's (1968) [20] expressions:

$$\text{Approximate digestibility (AD)} \frac{\text{Assimilation}}{\text{Consumption}} = \times 100$$

Tissue growth efficiency or

$$\text{Efficiency of conservation of digested food (ECD)} = \frac{\text{Tissue growth}}{\text{Assimilation}} \times 100$$

Ecological growth efficiency or

$$\text{Efficiency of conversion of ingested food (ECI)} = \frac{\text{Tissue growth}}{\text{Consumption}} \times 100$$

Different parameters of energy budget viz. food consumption, assimilation and tissue growth of, *Antheraea proylei* were studied in the laboratory. Being a bivolitine insect two crops are obtained during March- April and October – November, completing the life cycle in 40-42 days. Eggs are nearly spherical in shape, hatch in 5-6 days. There are five instars in complete life cycle of this month. At the time of hatching, the larvae were about 2 mm in length, brownish in color, bearing numerous long hairs over the entire length of the body. During this stage, and the subsequent instars, larvae feed on the leaf surface. Second to fifth instar larvae appears greenish in colour.

## Results and Discussion

The relative values of assimilation and tissue growth as percent of consumption have been presented in Tables 1, 2 and Figs. 1- 2.

**Duration of instars:** During this study total duration of instar stages was 4.80±0.418, 4.00±Nil, 4.80±0.418, 8.00±Nil and 11.66±0.723 days for 1st, 2nd, 3rd, 4th and 5th larval instars, respectively. The 2nd instar stage (4.00±00days) being shorter, while longest instar stage is fifth stage (11.66±0.723days). Total duration of all instars was found 42± 10 days. A study has also founded that total duration of instars stages is 4.80±0.418, 4.00±Nil, 4.80±0.418, 8.00±Nil, 11.46±1.12 days for 1st, 2nd, 3rd, 4th and 5th larval instars, respectively (Nath and Joshi, 2015).

**Food Consumption:** The food consumption was calculated to be 0.5841± 0.4051, 1.0174 ± 0.253, 1.6289 ± 0.344, 4.4205 ± 1.602 and 6.4945 ± 1.503g insect$^{-1}$ day$^{-1}$in 1st, 2nd, 3rd, 4th and 5th larval instars, respectively. A report has also founded that 0.612±0.33, 1.05±0.155, 1.405±0.2383.212±0.789 and 5.923±1.38 g insect$^{-1}$ day$^{-1}$ in 1st, 2nd, 3rd, 4th and 5th larval instars, respectively (Nath and Joshi, 2015)

**Assimilation:** During all stages leaf assimilation was found 0.5779 ± 0.405, 0.9984± 0.250, 1.5656 ±0.3145, 4.050 ± 1.599 and 5.4992± 1.539 g insect$^{-1}$ day$^{-1}$, respectively. There was a progressive increase in assimilation from 1st instar (0.5779 g insect$^{-1}$ day$^{-1}$) to 5th instar (5.4992g insect$^{-1}$ day$^{-1}$). There are 75% assimilation occurred in the last two instars (4th and 5th). A positive linear relationship was obtained between consumption and assimilation (Fig.1).

An increase in amount of food assimilation with increased food consumption as reported by earlier workers (Bailey and Mukerji 1976, Bailey and Singh 1977, Bisht *et al* 2012, Delvi and Pandian 1971, Axellson *et al* 1975, Kohler *et al* 1987, Vats and Kausal 1981, Vats *et al* 1977, Nath and Joshi, 2015) [3, 4, 5, 6, 1, 12, 18, 19, 22]. Goel *et al* (2005) [7] had studied food energy budget in 4 Lepidopteran pest namely (*Lymantria marginata*, *Trabala vishnou*, *Spilosoma obliqua* and *Plusia orichalcea*) and showed that the approximate digestibility decreases, while the efficiencies of conversion of ingested food and digested food increased from first to last instar larvae. They further reported that later instars are more efficient in transforming assimilated energy into the caterpillar biomass. Kumar and Ahmad (2000) [13] reported decrease in ECI from first instar (28.60±1.84) to fifth instar (0.72±0.02) in Orgyia postica (Walk.) (Lepidoptera: Lymantriidae) larvae on *Paulownia* leaves.

**Tissue growth:** In all respective stages the value of tissue growth recorded was 0.0103± 0.0058, 0.0514 ±0.0436, 0.2158± 0.089, 0.5165± 0.241 and 0.4453 ± 0.219g insect$^{-1}$ day$^{-1}$. There was progressive increase in Tissue growth with increased consumption, production of egesta and assimilation. 1st instar larvae showed minimum tissue growth (0.0103± 0.0058), while the maximum tissue growth (0.5165±0.241) in fourth instar stage. Tissue growth results were in conformity with Yadava. *et al* (1983) [21]. A linear regression was obtained when tissue growth was plotted against food consumption (Fig. 2).

Bisth *et al* (2005) had reported 70%, 67.37% and 71.64% tissue growth in fourth and fifth instar of *Pieris brassicae* (Lepidoptera: Pieridae) on cabbage, cauliflower and mustard, respectively.

**Approximate digestibility (AD):** 1st instar larvae showed maximum approximate digestibility (98.9634 ± 0.396), while the minimum (84.7489±1.972) by the fifth instar larvae.

Waldbauer (1968) [20] reported that approximate digestibility (AD) declines with age in *Bombyx mori* (Linn.). Sangha

(2011) [14] carried out on feeding performance of *Clostera fulgurita* (Walk.) (Lepidoptera: Notodontidae) on three clones of *Populus deltoids* (Bartram) and reported a gradual decline in AD in successive instars. He also recorded the maximum value of AD in third instar (55.28%), followed by fourth instar (52.48%) and 5th instar (48.05%). Bisht *et al* (2005) have studied energy budget of *Pieris brassicae* (Linn.) (Lepidoptera: Pieridae) and reported, the maximum values of approximate digestibility (AD) for the first instar and minimum for the fourth instar larvae.

**Efficiency of conservation of digested food (ECD):** The ECD gives a measure of the efficiency with which absorbed food material is used in promoting growth by expressing the increase in dry weight as a proportion of the weight of food assimilated.
1st instar larvae showed minimum ECD (1.8152±0.330) while, the maximum ECD (13.6596±2.596) for 3rd instar larvae. The minimum ECI value (1.7972±0.334) was recorded in 1st instar larvae, while maximum ECI value (13.1477±2.688) in 3rd instars larvae. Nath and Joshi (2015) [22] has also reported the value of ECD as minimum (1.899±0.99) in 1st instar and maximum (16.126±1.320) for 3rd instar larvae of *Antheraea proylei*.
Vats (1977) [19] had reported a gradual increase in ECD for young fifth instar larvae of *Pieris brassicae*. Sangha (2011) [14] in his study revealed that efficiency of conversion of digested food (ECD) increased with increase with age of the larvae. He also reported minimum ECD value (37.42%) for 3rd in star and maximum ECD value (41.54%) for 5th instar larvae.

**Efficiency of Conversion of Ingested food (ECI)**: The efficiency of conversion of ingested food to unit of body substance (ECI, also termed "growth efficiency") is an index measure of food fuel efficiency in animals. The ECI is a rough scale of how much of the food ingested is converted into growth in the animal's mass. It can be used to compare the growth efficiency as measured by the weight gain of different animals from consuming a given quantity of food relative to its size. The ECI effectively represents efficiencies of both digestion (Approximate Digestibility or AD) as well as metabolic efficiency, or how digested food is converted to mass (Efficiency of Conversion of Digested food or ECD).
In present study, the minimum of ECI value (1.7972±0.334) was recorded in 1st instar larvae, while maximum ECI value (13.1477±2.688) in 3rd instar larvae. Nath and Joshi (2015) [22] have also reported the minimum value of ECI (1.863±0.97) in 1st instar larvae, while maximum value (15.243±1.09) was recorded in 3rd instar larvae.
Baily and Singh (1976) [3] studied the energy budget of *Mamestra configurata* (Walk.) (Lepidoptera: Noctuidae) and reported no set pattern for ECI. Sangha (2014) had studied the feeding performance of *Clostera fulgurita* on clones of *Populus deltoids* and reported that efficiency of conversion of ingested food (ECI) decreased with the increase in the age of the larvae. Sudhansu (2010) [17] studied food utilization efficiency in *Anthraea mylitta* fed on *Terminalia arjuna* leaves and reported absolute values for dry matter ingested, digested, efficiency of conversion of digested food and biomass gain were increased with the advancement of larval development, while, decline in relative consumption rate. He also reported that the relative growth rate was maximum in 2nd instar (0.488) and declined significantly thereafter.

**Table 1:** Consumption, assimilation and tissue growth in *Antheraea proylei*

| S. N. | Stage | Duration (Days) | Consumption ($g\ insect^{-1}\ day^{-1}$) | Assimilation ($g\ insect^{-1}\ day^{-1}$) | Tissue growth ($g\ insect^{-1}\ day^{-1}$) |
|---|---|---|---|---|---|
| 1. | 1st instar | 4.80±0.418 | 0.5841± 0.4051 | 0.5779 ± 0.405 | 0.0103± 0.0058 |
| 2. | 2rd instar | 4.00±Nil | 1.0174 ± 0.253 | 0.9984± 0.250 | 0.0514 ±0.0436 |
| 3. | 3rd instar | 4.80±0.418 | 1.6289 ± 0.344 | 1.5656 ±0.3145 | 0.2158± 0.089 |
| 4. | 4th instar | 8.00±Nil | 4.4205 ± 1.602 | 4.050 ± 1.599 | 0.5165± 0.241 |
| 5. | 5th instar | 11.66±0.723 | 6.4945 ± 1.503 | 5.4992± 1.539 | 0.4453 ± 0.219 |

**Table 2:** Efficiency of food utilization in *Antheraea proylei*

| S. N. | Stages | A.D. | E.C.D. | E.C.I. |
|---|---|---|---|---|
| 1. | 1st instar | 98.9634 ± 0.396 | 1.8152±0.330 | 1.7972±0.334 |
| 2. | 2nd instar | 98.1289±0.103 | 5.1852±0.627 | 5.0884±0.617 |
| 3. | 3rd instar | 96.0609±1.518 | 13.6596±2.596 | 13.1477±2.688 |
| 4. | 4th instar | 91.6459±1.233 | 12.7549±1.034 | 11.6829±0.828 |
| 5. | 5th instar | 84.7489± 1.972 | 8.1021±0.553 | 6.8688±0.536 |

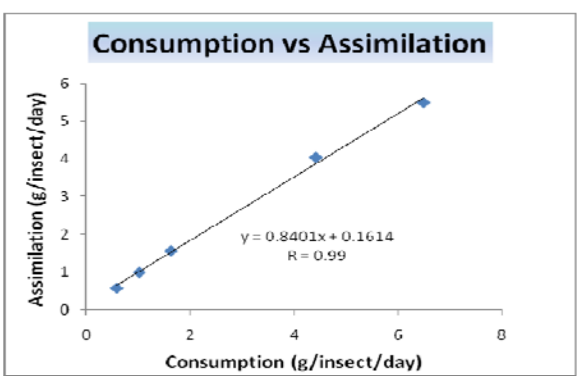


**Fig 1:** Relationship between Food Consumption and Assimilation
Y=0.8401x+0.1614 (r = 0.99, $P < 0.05$)

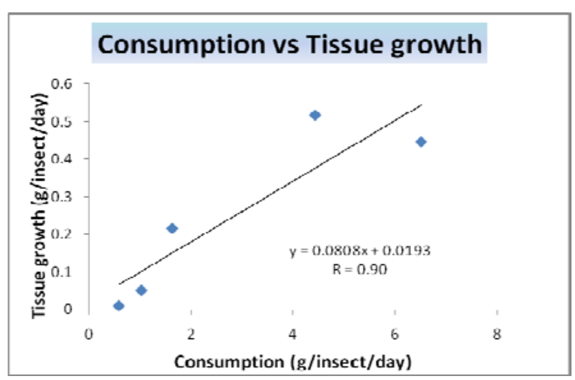


**Fig 2:** Relationship between Food Consumption and Tissue growth
Y=0.0808x+0.0193 (r =0.90, $P < 0.05$)

**Summary**

The energy budget of *Antheraea proylei* fed on *Quercus lucotricophora* leaves was obtained by quantitative determination of food consumption, assimilation and tissue growth values. The last instars showed best result attaining maximum values in each parameter. There was a decline in approximate digestibility, while there was random increase and decrease in ecological growth efficiency and tissue growth efficiency with respect to age.

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**References**

1. Axellson B, Lohm U, Pearson T, Tenow O. Zoon, 1975; 3:71.
2. Barah A, Goswami MC, Samson MV. Consumption and utilization of food in different instars of muga silkworm *Antberses assama* Westwood. *Proc.* Indian Acad. Sci. (Anim. Sci.), 1989; 98(2):99.
3. Bailey CG, Mukerji MK. Consumption and utilization of various host plants by Melanoplus bivittatus (Say) and M. Femurrubrum (De Gedr) (Orthoptera: Acrididae). Canad. J Zool. 1976; 54:1044.
4. Bailey CG, Singh NB. An energy budget for Mamestra configurata (Lepidoptera: Noctuidae). Canad. Entomol.; 1977; 109:687.
5. Bisht NS, Bhandari K, Tripathi R, Kaushal BR. Energy budget of Pieris brassicae (Linn.) larvae (Lepidoptera: Pieridae) fed on three host plant species. J Envir Biosc. 2012; 26(2):93.
6. Delvi MR, Pandian TJ. Ecophysiological studies on utilization of food in paddy field grasshopper Oxya velox. Oecologia (Berl.), 1971; 8:267.
7. Goel SC, Kumar A, Singh J, Kumar V, Rao PK. Food-energy budget for different Lepidopteran moths. In: Advances in Indian entomology: productivity and health (a silver jubilee supplement 2005; 3(I):187-194. ISBN-81-900101-7-9.
8. Gullan PJ, Cranston PS. 7. The insects: an outline of entomology (3rd Ed.). Wiley-Blackwell. 2004, 198-199. ISBN 1-4051-11135.
9. Joshi PC, Lockwood JA, Vashishth N. Food consumption and assimilation efficiency in *Oxya velox* (Fabr.) (Orthoptera: Acrididae). Himal. J Envi Zool. 2003; 17(1):39.
10. Kaushal BR, Joshi PC. Energy dynamics of grasshopper population in a temperate grassland ecosystem. Aust. J Ecol Aust. 1991; 16:295.
11. Kaushal BR, Joshi Rajiv, Kalia Shamila, Joshi PC. Energy budget of Antheraea proylei Jolly fed on Q. floribunda Lindle (Lepidoptera: Saturnidae). Himalayan J Env and Zool. 1988; 2(1):24.
12. Kohler G, Brodhum HP, Schaller G. Ecological energetic of central European Grasshoppers. Oecologia (Berlin). 1987; 74:112.
13. Kumar M, Ahmad M. Consumption and utilization of leaves of Paulownia fortunei by the larvae of Orgyia postica Walker (Lepidoptera: Notodontidae). Annals of For., 2000; 8(2):192.
14. Sangha KS. Feeding performance of Clostera fulgurita on three clones of Populus deltoids. J Fores Res. 2011; 22(1):83.
15. Sharma PK, Joshi PC. Biology of a predatory coccinellid *Coccinella* septumpunctata Linn. (Coleoptera: Coccinellidae). J Envi Biosci. 2010; 24(2):239.
16. Slansky FJR, Scriber JM. Food consumption and utilization: comprehensive insect physiology, biochemistry and pharmacology Regulation digestion, Nutrition, Excretion, Eds. Kerkut, G. A. and L.I. Gilbert, Peragamon Press, Oxford, 1985; 4:87-163.
17. Sudhansu SR. Food utilization efficiency in Antheraea mylitta fed on Terminalia Arjuna leaves. Acad. J Entomo. 2010; 3(1):23.
18. Vats LK, Kausal BR. Population dynamics, secondary productivity and energy budget of Paraheiroglyphus bilineatus Bol. (Orthoptera: Acrididae) *Acta* Oecol./Gener., 1981; 2(4):355.
19. Vats LK, Singh JS, Yadava PS. Food energy budget of Pieris brassicae a pest of cruciferous agro-ecosystems. Agro-Eco., 1977; 3:303.
20. Waldbaur GP. The consumption and utilization of food by insects. Adva. Insect Physi. 1968; 5:229.
21. Yadava PS, Bhattacharjee N, Kakati LN. Food consumption assimilation, tissue growth and ecological efficiencies in the larvae of Antheraea proylei jolly. Proc. Sym. Ecol. and Resource. Manage. 1983, 204-214.
22. Pashupati nath, Joshi PC. Consumption and utilization of food by different instars of oak Tasar worm Antheraea proylei (Jolly) led on Quercus serreta (Thunb) leaves. New York Science Journal. 2015; 8(8):92-96.