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Effect of Temperature on Growth and Consumption of Larvae of *Danaus chrysippus*

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ABSTRACT

Temperature plays major role in the food consumption and the development of phytophagous insects. The impact of temperature effect the development and feeding ecology of *Danaus chrysippus* (Lepidoptera: Nymphalidae: Danaidae) was studied under controlled laboratory conditions. The study revealed that the optimum range of temperature for the growth of the larvae is between 20^0 C -30^0 C. Both above and below this range the organic growth is hampered. The values of RGR, RCR, ECI are also the highest within these range.

Key words : *Temperature, Phytophagous, Feeding Ecology, Organic Growth, Danaid and Calotropis.*

Introduction

The phytophagous insect like butterflies are closely related with the plants and provide economic and ecological benefits to the human society (Rao *et al*, 2016).

The growth and consumption rates of the phytophagous insects in the field have been found to vary due to differences of microhabitat (Scriber and Slanoky, 1983). Ecological factors are also known to affect their growth rates. Above all temperature affects the metabolic processes. Temperature growth relation have been studied by Mathavan and Pandian, (1975), Couture *et al.*, (2015) and Levesque *et al.*, (2002). Grafius and Anderson (1979), studied the effect of temperature on the values of RGR and RCR. Rao *et al*., (2016) also calculated the ecological indices on *Danaus chrysippus* in Vishakhapatnam, they further studied the ecological indices in *Graphium augamenom* in 2018.

Materials and Methods

The effect of different level of temperature viz 15, 20, 25, 30, 35, 40, and 45°C were seen on growth and consumption of caterpillars.

Constant temperature was maintained in BOD incubator. To see the effect of each temperature level on growth and consumption rates, 5 replicates were studied. The single caterpillar was placed with sufficient food in 5 different petriplates of the same size. The larvae were taken out of the incubators only for weighing at intervals of 24 hours. Aquapics were used to maintain leaves at natural turgidity and filter paper in each plastic petriplates (150x25mm) was moistened to provide a saturated environment for the larvae in all the treatments.

For determining the growth rate of the first instar 0.3cm, 5 larvae were taken out from their petriplate when they had attained the first molting length was determined with the help of a separate experiment. The oven dried weight of these larvae was deter-

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mined separately in each case. The same process was repeated for oven dried weight of second, third, fourth and fifth instar for which the molting length of the larvae was found to be 0.8, 1.5, 2.7, 3.8cm.

The phytomass consumption was determined by using the following formulae,

A) $PC = W_{OD} - w_{OD}$

B) $W_{OD} = w_{OD} \times W_F / w_F$

Where: PC = phytomass consumption, W_{OD} = oven dried weight of unfed leaves,

w_{OD} = oven dried weight of fed leaves, W_F = fresh weight of unfed leaves, and

w_F = fresh weight of fed leaves

The faecal pellets of the larvae were also collected from the polythene bags after every 24h and their O.D. weight was also determined. The relative consumption rate (RCR) and the relative growth rate (RGR) were calculated according to the formulae suggested by Scriber and Slansky (1981).

RCR = Food ingested (mg)/mean larval weight (mg) x days

RGR = Larval weight gain (mg)/mean larval weight (mg) x days

Mean larval weight was calculated as = initial + final / 2

Efficiency of the larvae for converting ingested food in to biomass (ECI), is a function of the following two components:

a) Approximate digestibility (AD) and

b) Efficiency of conversion of assimilated food in the body growth (ECD), was calculated to determine the nutritional index by using the formulae given by Mattson (1980).

AD = mg food ingested – mg faeces x100 / mg food ingested

ECD = mg larval biomass gained x 100 /mg food ingested – mg faeces

ECI = AD x ECD

Observation

Results and Discussion

Present study shows that temperature affects the growth, consumption, RCR, RGR, etc. Optimal tem-

Table 1. Standing crop biomass (MG-OD) for different stages of development of larvae under different temperature regimes

Temp.	n	Instar					Final	Duration of days				
^{0}C		1	2	3	4	5		1	2	3	4	5
20	5	.28±.03	.9±.1	14.5±.4	23.3±.4	78.9±.4	117.2±1.3	2	2		1	1
25	5	.78±.03	.18±.006	18.3±.4	26.2±.4	105.5±.4	150.9±1.2	2	2	2	1	2
30	5	.6±.03	.12±.002	16.4±.4	24.2±.4	56.8±.5	98.1±1.3	2	1.5	1.5	2	1
35	5	.2±.03	.9±.1	14.5±.3	23.6±.4	51.5±.4	90.7±1.2	2	2	1	1	2
40	5	.2±.03	.3±.1	1.4±.2	13.2±.3	14.9±.5	29.9±1.2	2	1.5	1.5	2	1

Results are not significant for P= 0.05 (ANOVA), Values are expressed mean ± S.E.

Table 2. Per day per capita consumption (MG-OD) of phytomass as well as consumption by larval instars under different temperature regimes

Temp.	n	Instar					Final	Day^{-1} Larva^{-1}
		1	2	3	4	5		
20	5	0.6±.09 (6.4±.07)	9.8±.05 (14.7±5.4)	39.4±.03 (98.5±4.2)	24.8±.07 (124.3±.05)	128.2±.08 (192.4±3.3)	82.2±.08	9.6±..09
25	5	.4±.08 (4.6±.05)	7.4±.07 (11.2±5.2)	7.6±.1 (11.1±5.2)	12.3±0.05 (92.5±0.07)	146.8±.07 (220.3±1.4)	83.3±.07	12.2±..03
30	5	.1±.08 (1.8±.05)	2.8±.07 (4.2±1.2)	2.8±.03 (4.2±1.2)	10.7±.03 (80.5±1.5)	61.4±.08 (91.9±1.2)	57.4±.05	12±.03
35	5	.6±.03 (.6±.02)	1.4±.07 (1.4±.2)	1.4±.08 (1.4±.2)	11.2±.03 (84.5±1.6)	61.2±.08 (91.9±1.2)	10.3±.03	2.2±.06
40	5	.1±.03 (.8±.2)	.6±.2 (.6±.2)	5.4±1.1 (2.7±1.1)	5.6±.03 (4.2±1.5)	20.2±.07 (20.2±1.9)	9.4±.03	4.2±.08

Results are not significant for P= 0.05 (ANOVA). Figure outside parenthesis indicates per day per instar consumption, those in parenthesis total consumption. Values are expressed mean ± S.E.

Table 3. Relative consumption and Growth rates, Digestibility and Conversion efficiencies of *Danaus chrysippus* under different temperature regimes

Temp. ^{0}C	Instar	RCR (mg/mg/day)	RGR (mg/mg/day)	ECI (%)	AD (%)	ECD (%)
20	1	2.5±.40	0.2±.1	4.5±.5	19.1±3.1	10.5±1.5
	2	1.1±.14	0.3±.14	5.5±.7	38.8±0.6	14.1±1.6
	3	1.0±.1	0.3±.1	15.2±5.7	40.6±0.8	20.2±2.3
	4	0.8±.2	0.4±.2	14.2±2.4	43.5±0.5	27.5±2.7
	5	0.5±.2	0.4±0.2	40±1.4	55.7±1.4	98.5±0.9
25	1	2.6±.1	0.2±.1	5.5±.7	33.5±1	14.1±1.6
	2	1.7±.4	0.3±.14	12.7±1.0	40.2±1.2	16.2±1.7
	3	1.5±.18	0.3±.1	25.2±1.2	56.1±2	25.6±3.7
	4	1.4±.19	0.4±.2	30.5±1.0	70.9±1.2	82.6±1.2
	5	0.7±.14	0.4±.3	48.5±1.2	74.5±.8	99.5±2.8
30	1	1.8±.10	0.4±.1	12.8±0.5	34.2±1.3	19.1±3.2
	2	1.6±.10	0.5±.2	22.5±0.2	45.3±1.6	36.9±2.1
	3	0.7±.3	0.5±.13	54.5±1.2	54.5±1.2	52.7±±1.5
	4	0.6±.14	0.6±.14	60.6±1.2	58.5±1.4	305±2.1
	5	0.5±.18	0.8±.13	20.8±0.2	62.1±1.8	205±1.5
35	1	1.4±.19	0.4±.12	24.8±0.3	10.2±1.2	45.5±1.8
	2	1.2±.10	.4±.17	23.9±0.5	15.6±3.1	57.2±3.2
	3	0.8±.3	.5±.3	54.8±1.2	18.3±3.2	150±1.5
	4	0.4±.14	.6±.12	70.2±7.2	26.1±1.2	200.5±4.3
	5	0.4±.3	.6±.13	28.9±1.4	28.3±.2	305.1±4.7
40	1	1.8±.18	.2±.14	12.5±1.2	8.5±1.2	10.1±1.2
	2	.8±.14	.3±.12	16.2±1.5	13.6±1.5	14.5±1.3
	3	.7±.30	.3±.1	24.3±2.5	13.3±4.5	7.7±2.3
	4	0.6±.15	.4±.12	51.9±1.4	18.3±2.2	10.9±1.5
	5	0.4±.3	.4±.2	59.5±0.7	15.1±1.4	91.5±3.5

perature for growth and consumption starts at 20 °C and maximum rate of growth and consumptions are found in 25 °C and minimum values are found on 40 °C. The RGR values of instars increases with increase in temperature from 20 °C- 35 °C, although the corresponding RCR values of instars for same temperature decline. The values of ECI and AD increases between range of 20 °C to 30 °C for all the instars, whereas, ECD values increases ascendingly for all the 5 instars between 20^{0}C -35 °C.

In the tropics the temperature effects the growth and metabolism. This is particularly effective among the species of ectotherms. A range of 20 °–30 °C can be considered ideal for the larval growth, food consumption and metabolic activities. These findings were also found by Rao *et al.* (2016). Islam *et al.*, (2019), studied the effect of temperature on larval development of *Papilio demoleus*, they also found that in lower temperature the developmental period is long than other temperatures.

Scriber and Slansky (1981) report the highest RGR values are for herbivores (.37 mg/mg/day) these values generally correspond to the values obtained by us (.3 mg/mg/day) for second and third instar for 20-25^{0}C temperatures.

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Conflict of Interest

We have no conflicts of interest to disclose. All authors declare that they have no conflicts of interest.

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