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Studies on growth and cocoon parameters of *Bombyx mori*L. exposed to various temperature

Dr. E. M. Jeena[1] & Dr. M. Thilsath Fatima Quraiza[*]

[1]Ph.D. Research Scholar, Reg. No. 19123092192018, Department of Zoology, Muslim Arts College, Thiruvithancode, Affiliated to Manonmaniam Sundaranar University,Tirunelveli.

[*]Corresponding Author,Assistant Professor, Department of Zoology, Muslim Arts College, Thiruvithancode, Affiliated to Manonmaniam Sundaranar University, Tirunelveli.

Abstract: The mulberry silkworm, or Bombyx mori L., is exceedingly delicate, extremely sensitive to changes in its surroundings, and incapable of surviving in harsh environments. The silkworm's morphological and biochemical characteristics, including the diameter and weight of the cocoon, the length and weight of the larvae, and the protein content of the silk gland and cocoon, are impacted by seasonal variations. Daily and seasonal variations in the environment emphasise the need for physical characteristics like temperature, light, and humidity for sustained cocoon production.The two key factors that affect an insect's physiology are humidity and temperature. Insects exhibit an amazing spectrum of environmental adaptations, allowing them to maintain an acceptable internal temperature and water content despite significant variations in their surrounding environment.The purpose of this work was to examine B.mori's growth and economic parameters in response to varying temperatures. The many growth and economic metrics of the silkworm, B. mori, were observed. The effects of temperature on the larval duration, weight, weight index, adult weight, pupal weight, pupal and adult weight index, cocoon weight, shell weight, shell ratio, and silk index of the fifth instar B. mori were studied. Larvae were exposed to varying temperatures from the first to the fourth instar. This study assessed how various temperatures affected the growth and development of silkworm larvae in their fifth instar. T2 temperature was found to be associated with the maximum pupal weight (950±65.09) and adult weight (0.69±0.020).

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Key words: *B. mori*, Temperature, Growth index, Shell ratio, Silk index.

1. Introduction

The process of adaptation is dynamic and complex, and it varies greatly amongst species. Insects must disperse, choose their habitats, alter them, have a relationship with water, be resistant to cold, go through diapauses, and synthesise a range of cryoprotectant chemicals in order to survive in a changing environment.Temperature and humidity are the primary factors influencing the physiology of insects (Couret et al., 2014). The majority of insects are able to adjust to daily changes in the surrounding temperature (Chen et al., 2015). Maintaining the internal temperature and water content helps to regulate environmental fluctuation, but there is a limit to how much tolerance can be used (Singh et al., 2009).

A key factor in the silkworms' growth is temperature. Due to their chilly blood, silkworms' numerous physiological functions will be directly impacted by temperature. The silkworm's physiology, including its ability to absorb nutrients, digest food, circulate blood, and breathe, is directly impacted by its rearing temperature. Larvae die due to temperature variations during raising. According to Sinha and Sanyal (2013), silkworms can withstand heat exposure at temperatures between 17°C and 33°C, but 43°C has a fatal effect. The reason for this is that the larvae are unable to adjust to the heat shock.

The ideal temperature range for silkworm larvae to grow normally is between 20 and 28°C, while the range that produces the most productivity is between 23 and 28°C. Larvae health is directly impacted by temperatures exceeding 30°C (Rahmathulla, 2012 and Sinha and Sanyal, 2013). Raising the temperature during maintenance will hasten the growth of the larvae and shorten their life cycle, particularly during the late instar phase. Conversely, the growth and larval phase slow down at low temperatures. Seasonal variations in environmental factors have a significant impact on the genotypic expression manifested in phenotypic output, including cocoon weight, shell weight, and cocoon shell ratio. The changes in the climate over the past ten years highlight the necessity of controlling the relative humidity and temperature for the formation of cocoons in a sustainable manner. Good quality cocoons are generated between 22 to 27°C, according to Ramchandra et al. (2001). A temperature above these indicates a worse quality cocoon (Penzaman and Jegdeeshkumar, 2010).

The care done during the cocoon spinning process plays a significant role in determining the qualities, dependability, and features of the spun silk, in addition to the type of silkworm used (Tazima, 1984). It is recognised that temperature, humidity, light, and physical disturbances all affect spinning. There is a degree of temperature variance in the growth of seeds and raw silk produced commercially.Wide temperature swings should therefore be avoided. Because of their reduced metabolic activity, larvae survive longer in colder temperatures. In order to assess the impact of varying temperatures on the growth and cocoon properties of the silkworm, B. mori, the current study was conducted.

2. Materials and Methods

The State Government Sericulture Centre in Thenkasi provided the Disease FreeLayings (DFLs) of B. mori (L×CSR2), which were raised using conventional procedures. (1978, Krishnaswamy).

The freshly hatched larvae in this study were divided into two batches (T1 and T2) for the experiment after being randomly selected. Additionally, control was set up. Every group is duplicated three times. Every group has twenty-five larvae in it. T2 was the second group to get treatment, whereas T1 was the first experimental group. The first instar (230C), second instar (240C), third instar (250C), fourth instar (260C), and fifth instar (270C) were the temperatures to which the T1 larvae were exposed. First instar (300C), second instar (290C), third instar (280C), fourth instar (270C), and fifth instar (260C) were the temperatures at which the T2 larvae were exposed. Both experimental groups maintained a temperature between 26 and 280C during the spinning time.

The silkworm's growth and economic metrics were noted. Therefore, the purpose of this study was to ascertain how temperature change affects B. mori larvae.Using the proper techniques, larval weight, larval time, and larval weight index were determined. According to Prasad and Bhattacharya (2009), growth indices including pupal weight, adult weight, and pupal and adult weight indices were computed. Calculations were also made for the cocoon parameters, which included cocoon weight, pupal weight, shell weight, shell ratio, and silk index. Statistics were used to analyse every data set (Zar, 1984).

Table 1

Effect of temperature on the larval weight index of *B. mori*larvae (5th instar)

Treatments	Larval duration (Days)	Larval weight (mg)	Larval Weight Index
Control	24± 1.27	1831±130.90	
T_1	22±1.02	2248±163.06 (20.85)	1.22

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T_2	27±1.49	2016±158.29 (9.25)*	1.10

Per cent deviation over control values in parentheses

N=25

* not significant

All other deviations significant at P≤ 0.05 (t-test)

Table 2

Effect of temperature on the pupal and adult weight index of *B. mori*

Treatments	Pupal Weight (mg)	Pupal Weight Index	Adult Weight (mg)	Adult Weight Index
Control	860±49.55		0.40±.011	
T_1	950±65.09 (10.8)	1.10	0.69±0.020 (72.5)	1.72
T_2	750±50.38 (-13.2)*	0.87	0.47±0.025 (17.5)	1.17

N=25

Per cent deviation over control values in parentheses

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* not significant

All other deviations significant at P≤ 0.05 (t-test)

Table 3

Effect of the temperature on the cocoon characteristics of *B.mori*

Treatments	Cocoon Weight (mg)	Pupal Weight (mg)	Shell Weight (mg)	Shell Ratio (%)	Silk Index
Control	1090± 80.33	860±49.55	230±18.48	21.10±1.95	
T_1	1240±68.16 (13.5)	950±65.09 (10.8)	290±17.95 (25.8)	23.38±2.08 (10.81)	1.26
T_2	970±61.89 (-10.8)*	750±50.38 (-13.2)*	220±19.06 (-4.3)*	22.68±1.94 (7.49)*	0.95

Per cent deviation over control values in parentheses

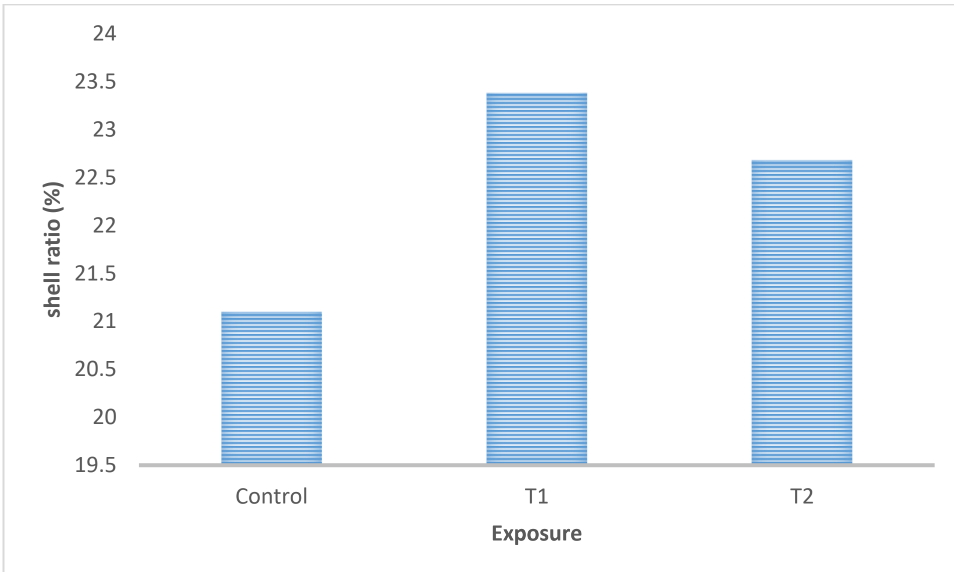
N=25

* not significant

All other deviations significant at P≤ 0.05 (t-test)

Figure 1

Effect of temperature on the shell ration of *B.mori*



3. Results and Discussion

The mulberry silkworm is extremely delicate, extremely susceptible to changes in its surroundings, and unable to withstand drastic temperature variations that occur naturally. The length of the larvae, weight, pupal weight index, adult weight index, silk index, silk gland ratio, and cocoon features of the silkworm, B. mori, were all observed in the current study.

Raising silkworms at a higher temperature speeds up larvae development and shortens the larval period, especially in late instars. In the current study, the T1-treated larvae showed the greatest improvement in larval weight (2248±163.06 mg), and the same group also showed the

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lowest larval duration (22±1.02). Tanjung et al. (2017) claim that under low temperatures, development is sluggish and the larval stage is lengthened. Silkworms develop best at temperatures between 200 and 280 degrees Celsius, and between 230 and 280 degrees Celsius is ideal for maximum productivity. The health of the worms is directly impacted by temperatures above 300C.

Larval deaths are caused by variations in temperature during raising. According to Sinha and Sanyal's (2013) report. They die when exposed to heat between 17 and 33 degrees Celsius. Nearly every biological process, including physiological and biochemical activities, is impacted by high temperatures (Regniere et al., 2012). In this investigation, the larvae treated with T2 treated groups showed the lowest larval weight index (1.10). This study supported the findings of Scriber and Slansky (1981), who hypothesised that temperature can influence larvae's physiological processes and that variations in temperature above the optimal range can lead to growth problems and the failure of physiological processes.The impact of several environmental parameters, such as temperature, on silkworm development, survival, production, and disease incidence has been covered by Sureshkumar et al. (2001).

According to Sekarappa and Gururaj (2009), worms require a high temperature during their early instars in order to feed actively, grow rapidly, and achieve a high growth rate. According to this discovery, treating the larvae with T1 temperature considerably enhanced the weight of the pupae and adults. This group exhibited the highest pupal weight (950±65.09) and adult weight (0.69±0.020). Simultaneously, the maximal pupal weight index (1.10) and adult weight index (1.72) were reported for the same group. Shirota (1992) showed that during the fourth and fifth stages, silkworms were more susceptible to high temperatures. Over 300 degrees Celsius causes irregular metabolic activities that are detrimental to health. In addition, when temperatures drop below 200 degrees Celsius, metabolic processes revert to being dormant, resulting in abnormal growth and poor health (Murugan and George, 1992).

The characteristics pertaining to cocoon quality have a significant impact on the raw silk reel's quality. According to research on how temperature affects leaf-to-silk conversion in silkworms, bivoltine silkworms that are exposed to lower temperatures (260C) had higher silk conversion and improved survival rates (Narayana Prakash et al. 1985). The current study found that the T1 temperature was associated with the largest cocoon weight (1240±68.16), pupal weight (950±65.09), shell weight (290±17.95), and shell ratio (23.38±2.08). In the same group, the highest silk index (1.26) was noted.

Various temperature regimes have a significant impact on the weight of the cocoon (Singh and Samson, 1999). The cocoon shell becomes weak and very loose during the production of the cocoon if the temperature goes above 22–250C. Moreover, it alters the nature of sericin, produces filament silk, and hinders the production of cocoons (Gowda and Reddy, 2007). The maximum silk index (0.95) was seen in the larvae treated with T2 temperature, while the minimum cocoon weight (970±61.89), pupal weight (750±50.38), shell weight (220±19.06), and shell ratio (22.68±1.94) were also reported in this study (Table 3 and Figure 1). According to Datta et al. (2001), low temperatures are always preferable to high ones for silkworm productivity and larval longevity across several instars. It has been shown that the temperature range between 22 and 270C is optimal for producing high-quality cocoons, with lower quality cocoons formed beyond this range. According to Khan (2014), greater cocoon yield can be achieved by cultivating larvae at temperatures between 25 and 260 degrees Celsius. According to Kremky and Michalska (2004), silkworm larvae spun their best cocoons at 250°C and 75%

relative humidity. Good quality cocoons are created between 25 and 300 degrees Celsius, according to many other researchers, and temperatures greater than this deteriorate the quality.

4. Final Thoughts

The temperature at which silkworm larvae are raised has a significant impact on their development and growth. The goal of this study is to gather up-to-date data in order to get a sense of how to conduct multiple experiment trials on different silkworm B. mori larval stages at different temperatures. This study found that temperature had a substantial impact on the mulberry silkworm's growth parameters, silk gland ratio, cocoon features, and ovipositional activity. According to the current study, B. mori growth (2248±163.06) and silk gland ratio (41.37±2.57) considerably increased at temperatures between 21 and 250C (T1), which helped to raise sericulture productivity.

The study found that the T1 temperature was associated with the largest cocoon weight (1240±68.16), pupal weight (950±65.09), shell weight (290±17.95), and shell ratio (23.38±2.08). In the same group, the highest silk index (1.26) was noted. The weight of the cocoon and the silk index were significantly impacted by varying temperature regimes.

Larval weight generally decreases as temperature rises. Elevated temperatures were detrimental to the silkworms' productivity as they caused the mulberry leaves they were given to wither, which decreased the amount of food they received. However, high temperatures quicken the rate of growth, which results in low-quality cocoons.

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