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A comparative analysis of rearing performance of Eri Silkworm (*Samia ricini*) across diverse micro-climates in Garo Hills, Meghalaya

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Abstract
Ericulture, a vital "Ahimsa" silk industry in India, faces productivity challenges in the Garo Hills of Meghalaya due to fluctuating environmental conditions and a lack of region-specific scientific standards. This study investigates the rearing performance of *Samia ricini* across five sites—Gajingpara, Horinkata, Dobu, Agalgre, and Gondenggre—to determine the impact of temperature and humidity on larval and cocoon parameters. Results indicate that average temperature is a primary driver for cocoon weight (r = +0.79), with the highest weight (3.55g) recorded at 30˚C. Conversely, relative humidity exerts a profound non-linear influence on the shell ratio (r = +0.74), which spiked to 30.8% at 95% humidity in Dobu. While higher temperatures favor biomass, they show a weak negative correlation with hatching rates (r = -0.29). The study concludes that maintaining a high-humidity micro-climate (85–95%) is essential for maximizing silk shell yield, providing a framework for sustainable ericulture in the subtropical monsoon climate of the Garo Hills.

Keywords: Ericulture, garo hills, rearing performances, cocoon parameters, micro-climate management

Introduction

Eri silkworm, *Samia ricini* (Lepidoptera: Saturniidae) is a polyphagous, multivoltine insect domesticated for centuries across Asia (Peigler and Nauman, 2003) [6]. Tropical Asian region host 19 Samia species, while the North East India, a biodiversity hotspot reported two Samia species among 28 total Saturnids in the region (Keisa and Devi, 2022; Boro and Borah, 2020) [2, 5].

Ericulture, a vital Indian Vanya silk in sericulture industry is known as Ahimsa due to its non-violent harvest. It is also known for its thermal regulation and its pupae is consume among tribal communities for its protein source.

Eri silkworm is highly sensitive temperature and fluctuation relative humidity (Gohain and Borua, 1983) [4]. Its multivoltine nature and the availability of host plant allow 5-6 cycles annually but its performances vary greatly with seasons. The primary host plant of eri silkworm is Castor and kesseru while tapioca, borpat, borkesseru and papaya are secondary host plants. Extreme temperature and relative humidity affect Effective rate of rearing (ERR), fecundity (Vaidya *et al*., 2014) [7].

Garo Hills region of Meghalaya is characterized by subtropical monsoon climate and an abundance of primary host plants like Castor (*Ricinus communis*). However, Garo hills farmers often struggle with sudden crop failures and inconsistent yields due to the lack of region-specific scientific standardization.

This present study provides a cross seasonal comparative analysis of *S. ricini* in the Garo Hills. Larval parameters like weight, length, breadth and other cocoon parameters are evaluated to identify optimal rearing and to enhance productivity and sustainable livelihood.

Materials and Methods

The present study was conducted across the two distinct seasons and across three districts of Garo Hills Meghalaya. The Garo Hills district of Meghalaya occurs between 89°49’- 91°2’ E longitude and 25°9’-26°1’ N latitude. The sampling sites include 2 from North Garo Hills, 1 from East Garo Hills and 2 from West Garo Hills district of Meghalaya. Meteorological data, specifically temperature and humidity were recorded daily within the rearing house using a digital thermo hydrometer.

The five instar larvae of silkworm were collected from local rearers with help of Sericulture Department from North, East and West Garo Hills district of Meghalaya. They were preserved in formalin and evaluated for morphological measurements. Parameters like larval weight, length, breadth, cocoon weight were recorded. Larval weight, length, breadth was recorded on the 5th day of 5th instar larva. The length and breadth of the larva measured using vernier caliper and the weight was taken using weighting machine.

Rearing performance like fecundity, hatching, ERR (Effective rate of rearing) and moth emergence was also observed.

Fecundity is the number of eggs produced by each female moth and is calculated by

$$Fecundity = \frac{Total\ number\ of\ eggs\ laid\ by\ female\ moths}{\text{Number of females observed}}$$

Hatching is one of the most important characters for rearing performance and is calculated as

$$\text{Hatching} = \frac{Number\ of\ eggs\ hatched}{\text{Number of eggs kept for brushing}} X100$$

ERR determines the amount of silk to be spanned and is calculated as

$$\text{ERR} = \frac{Number\ of\ cocoon\ yield}{\text{Number of cocoons brushed}} X100$$

The emergence of moth from maximum cocoons indicates healthy rearing process. The moth emergence percentage is calculated as

$$\text{Moth emergence} = \frac{\textit{Number of moth emerged}}{\text{Number of cocoons kept for moth emergence}} X100$$

Cocoon character like whole cocoon weight and cocoon shell weight were taken using weighing machine. Shell ratio is the measure of ratio between shell weight and whole cocoon and is calculated as

$$\text{Shell ratio} = \frac{\textit{Weight of cocoon shell}}{\text{Weight of whole cocoon}} X100$$

Results

Temperature and humidity parameters are essential in the growth and development of the Eri silkworm as it directly affects the physiological activities of silkworm. According to Vaidya *et al.,* 2014 [7] as the temperature raises the larval growth accelerates, but extreme low temperature slows physiological activities. At low humidity, larva loses a significant amount of water from their bodies resulting in inefficient metabolism and reduced energy for pupa and adult stage affecting the capacity to lay eggs. During the study period, both temperature and humidity was recorded using hydro thermometer and presented in table below.

Table 1: Temperature and humidity recorded during the study period from the study sites

Study Site	Temp °C (Avg)	Humidity % (Avg)	Fecundity (nos)	Hatching (%)	ERR (%)	Moth Emergence (%)	Cocoon Weight (g)	Shell Weight (g)	Shell Ratio (%)
Horinkata	25	65	250	95	80	95	1.55	0.72	13.29
Agalgre	27	75	300	83	90	80	2.50	0.39	15.86
Dobu	27	95	250	92	80	95	2.35	0.73	30.80
Gajingpara	30	84	250	95	80	95	3.55	0.54	15.12
Gondenggre	30	83	300	83	90	80	2.62	0.42	15.79

This study also assessed rearing performances of Eri silkworm such as fecundity, hatching, ERR and moth emergence. In the current study, the average fecundity was found to be 270 eggs per female moth across the study sites and the highest was observed in Agalgre and Gondenggre followed by Gajingpara, Horinkata and Dobu. ERR (effective rate of rearing) has a direct impact on efficiency and success rate of rearing (Bora *et al*., 2024) [1]. In this study the average ERR percentage was found to be 84 where the highest percentage was observed to be in Agalgre and Gondenggre. The hatching was recorded highest in Gajingpara and Horinkata followed by Dobu and lowest was observed to be in Agalgre and Dondenggre. The moth emergence rate was also recorded highest in Gajingpara, Horinkata and Dobu.

Environmental Conditions and Rearing Performance

The average temperature across sites ranged from 25°C to 30°C, while average relative humidity varied significantly from 65% to 95%.

Table 2: Rearing Performance for different Study Sites

Village Name	Fecundity (nos)	Hatching (%)	ERR (%)	Moth Emergence (%)
Gajingpara	250	95	80	95
Horinkata	250	95	80	95
Dobu	250	92	80	95
Agalgre	300	83	90	80
Gondenggre	300	83	90	80

Cocoon Parameters

Cocoon weight was highest in Gajingpara (3.55g) at an average temperature of 30°C. Notably, Dobu exhibited a significantly higher Shell Ratio (30.8%) compared to other sites (13.29%–15.86%).

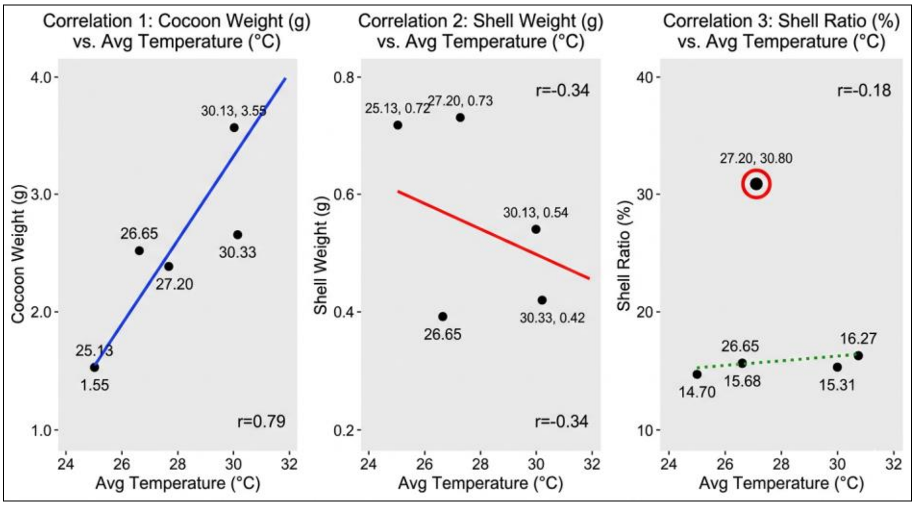

Fig 1: Correlation between Average Temperature and Cocoon Quality parameters

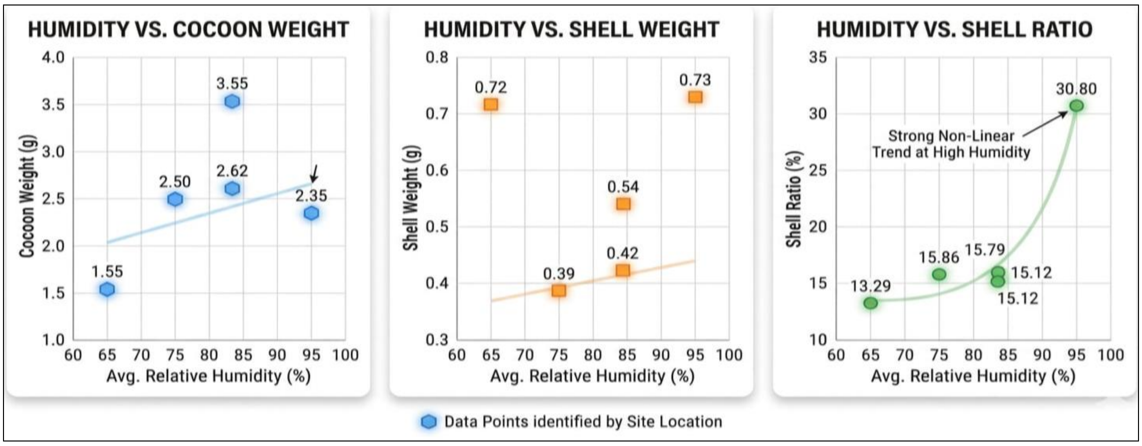

Fig 2: Correlation analysis between environmental humidity and physical characteristics of silkworm cocoons

Table 3: Statistical correlation (r) and qualitative interpretation between environmental factors and silkworm performance matrices

Environmental Factor	Performance Metric	Correlation (*r*)	Relationship Strength & Interpretation
Temperature	Cocoon weight	+0.79	Strong Positive: Cocoon weight increases steadily as temperature rises from 25°C to 30°C.
Humidity	Shell ratio	+0.74	Strong Positive: High humidity is the primary driver for a higher shell-to-cocoon percentage.
Temperature	Fecundity	+0.52	Moderate Positive: Warmer environments (30°C) generally favor higher egg production.
Temperature	Hatching %	-0.29	Weak Negative: As temperatures reach 30°C, hatching rates may begin a minor decline.

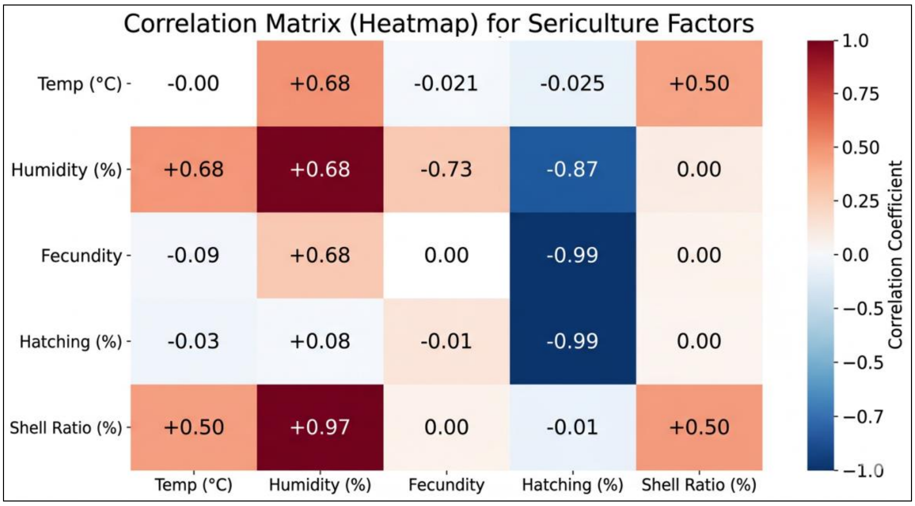

Fig 3: Correlation matrix heatmap illustrating the relationships between environmental factors (Temperature and Humidity) and sericulture performance metrics (Fecundity, Hatching, and Shell Ratio)

Discussion

The physiological activities of *S. ricini* are directly influenced by environmental drivers. Our data reveals a strong positive correlation ($r = +0.79$) between temperature and cocoon weight, suggesting that warmer study sites (up to 30°C) accelerate larval growth and silk secretion.
However, humidity emerged as the more critical factor for silk quality. The "non-linear spike" in shell ratio observed at Dobu (95% humidity) indicates that high moisture levels disproportionately favor shell weight over pupal weight. While fecundity showed a moderate link to temperature ($r = +0.52$, hatching rates showed a slight decline at higher temperatures ($r = -0.29$, suggesting a trade-off between growth and reproductive success. The data suggests an "optimal humidity zone" of 80–85% for balanced weight, but higher humidity is essential if the primary goal is maximizing shell ratio.

Conclusion

This study confirms that micro-climatic variations in the Garo Hills significantly impact *S. ricini* productivity. While temperature drives the physical weight of the cocoon, humidity is the essential factor for maximizing silk shell yield. Implementing these standardized environmental controls will help local farmers achieve more consistent yields and improve sustainable livelihoods in the region.

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