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Rearing and Grainage Performances of *A. Frithi* under *In Situ* and *Ex Situ* Conditions in Manipur (North East India)

[1*]S. Subharani., [2]L. Bidyapati Devi & [3]Alok Sahay
[1&2]Regional Tasar Research Station, Mantripukhri, Imphal, Manipur
[3]Central Tasar Research and Training Institute, Ranchi
*Corresponding Author

Abstract

Antheraea frithi Moore (Lepidoptera: Saturniidae) is an endemic species in Manipur and its commercial characters of cocoons are at par with that of *A. proylei.* It is naturally bivoltine and is subject to certain constraints like prolonged grainage span, unsynchronization of adult moth emergence leading to low coupling incidence and low survivability . Hence, attempt was made to study the rearing and grainage performances of *A. frithi* to establish a standardized method of rearing and grainage practices for better crop production and sustainability. Grainage performances viz. emergence %, coupling %, fecundity etc were higher under *in situ* conditions than ex *situ.* The development and adoption of appropriate grainage models and techniques will surely increase the coupling tendency and enhance the dfl production of *A. frithi*. Further, studies on the rearing performances of *A. frithi* also *indicated* that hatching %, ERR, cocoon weight, shell weight, silk ratio in *in situ* were better than *ex situ* conditions.

Key words: *comparative, rearing, grainage, in situ ex situ, A. frithi, endemic.*

Introduction

Oak tasar culture in Manipur is predominated by *Antheraea proylei* but its productivity is quite low fluctuating between 4 to 5 MT only. *A. proylei* is bivoltine and two crops can be reared in a year, the first crop during May –June and second crop during September -October. However, the second crop is unstable and due to its outdoor mode of rearing, the silkworm is exposed to many vagaries of nature. For faster production of oak tasar cocoons in large quantity in the state introduction of bi-voltine silkworm rearing in oak tasar industry is the need of the hour. Jolly *et al.* (1974) reported that *A. frithi* is one such oak feeding wild silk moth found in the oak forest of North –Eastern India which can be exploited for production of oak tasar silk .Therefore, the exploitation of *A. frithi*, a bivoltine silkworm (two broods can be reared in a year: April-June & Aug.-Oct) by nature as a new source of oak tasar will certainly help in boosting the productivity. Earlier studies carried out by Singh *et al.*, 2005 in RTRS, Imphal on conservation, characterisation, utilization of *A. frithi* had reported its productive and commercial characters at par with that of *A. proylei and A. pernyi*. Thus by stabilizing the rearing and grainage techniques and further, mass multiplication of *A. frithi* among the farmers will be able to sustain the production of commercial raw silk in the state. *A. frithi* is endemic to the natural oak forest of North east India, feeding mainly on the oak food plant, *Lithocarpus dealbata* which is grown in plenty in the foot hills of Manipur as mixed plantation with that of *Q. accutissima*. Arora and Gupta (1979) reported the area of distribution of *A. frithi* including Himachal Pradesh, Bihar, West Bengal, Sikkim, Meghalaya and Andaman in India; Bhutan; Saigon in Vietnam; and Java in Indonesia.In Manipur, it is estimated that the oak flora occurs in about 40,000 hectare, out of which 20,000 hectare can be exploited for raising oak tasar cocoons. *A. frithi* also feeds on other oak food plants viz. *Quercus accutissima, Quercus griffihtii* etc. Singh , N.I, 2005 revealed that *A. frithi* is distributed in the oak growing undisturbed forest of N.E India particularly more abundant in Phaibung khullen, Senapati district of Manipur and sparsely at other districts of Manipur.

Materials and Methods

Studies on the rearing and grainage performances of *A. frithi* under *ex situ* and *in situ* conditions were carried out during the month of July to September 2015. The *in situ* rearing and grainage was conducted in Luwangsangol, Senapati district situated about 50 km from Imphal and the *ex situ* experiments was carried out in the RTRS, Imphal.

1. Rearing performances of *A. frithi* under *in situ* and *ex situ* conditions.

Rearing performances under *ex situ* and *in situ* conditions were studied by rearing 5 dfls each in three replications in two different locations. Proper care were taken to avoid pest and predators during rearing by removing dry leaves & twigs of the oak plants and ant nests, cleaning of plots, and erection of nylon nets before rearing. Prophylactic measures were also taken to avoid disease incidence by dusting lime & bleaching powder in the field before initiation of rearings. 100 eggs each in three replications were kept to record the hatching percentage. The eggs were spread in a thin layer when the hatching started and few twigs of *L. dealbata* leaves were placed on the hatched larvae. Worms crawled over the leaves within half an subsequently to hour and the twigs were collected and directly shifted on *L. dealbata* foliages growing outdoors. The worms were further transferred to fresh bush with good foliage by cutting along with the branches with the help of secateurs. Worms were not touched by hand as far as practicable. Transfer of worms was always carried out in the morning and evening hours. Harvesting of cocoons was done after 6-7 days of spinning. The rearing performances were then assessed on the following parameters viz., hatching (%,), ERR %, cocoon yield, larval weight (g) cocoon weight (g), shell weight (g) and silk ratio in both the locations.

2. Grainage performances of *A. frithi under in situ* and *ex situ* conditions.

Grainage performance of *A. frithi* under *in situ* conditions were conducted at Luwansangol, Senapati District, while *ex situ* experiments were conducted at RTRS, Imphal. In both the cases 100 seed cocoons of *A. frithi* were garlanded and kept inside insect cages with 3 replications. The nature of moth emergence and behaviour of mating and fecundity were recorded. The moths were allowed to couplate for 10-15 hours inside spacious wire mesh cages (6'x6'x6.5'). Decoupled moths were later kept individually for egg laying inside nylon netted cloth bags for 72 hours. The disease free layings (dfls) were collected and incubated at 22±2^{0}c and R.H. 70-80 % (Jiang *et al*., 1992).

Result

1. Rearing performances of *A. frithi* under *in situ* and *ex situ* conditions.

Considerable variations in the rearing performances of *A. frithi* (Table 2 & 3s) were observed under *in situ* and *ex situ* conditions. There were five larval instars and the larval period of 32 days under *in situ* was extended upto 38 days under *ex situ* conditions. Chaoba and Singh, 1998 reported that the optimum environmental conditions required for *A. frithi* development is similar to that of *A. proylei.* The first instar larva was yellowish in colour with black stripes and head capsule was black in colour. The second instar to fifth instar larvae was green in colour, with black tubercles present in the prothorax and caudal region. (Table. No.1). from third instar onwards, the shining spot appears on the fourth and fifth segment during second crop. Crotch (1956) had also described the moth characters and a few fragmentary remarks on the species.

Table no. 1. Morphological characters of *A. frithi* larvae

Instars	Colour	Length (mm)	Breadth(mm)	Weight(mg)	Larval duration
I	Yellowish	6.35 ± 0.39	1.20 ± 0.17	0.046 ± 0.20	6-7
II	Greenish	10.62 ± 1.08	2.40 ± 0.18	0.167 ± 0.39	5-6
III	Greenish	27.74 ± 0.35	3.0 0 ± 0.34	1.06 ± 0.42	6-7
IV	Greenish	42.98 ± 0.56	8.5 0 ± 0.44	3.26 ± 0.58	8-9
V	Greenish	54.9 ± 0.38	12.36 ± 0.48	7.43 ± 0.64	11-12

Hatching of the eggs took place after 9-10 days and continued for 3-4 days. Just after hatching the larvae crawled in search of food and were in the habit of eating bits of egg shell. The larvae preferred tender leaves to mature leaves irrespective of the instars. The larvae crawled to up to the tip of the branches and fed on the tender leaves, consuming the entire leaves including the midrib. It stopped feeding with slight disturbance. It was observed that under *in situ* conditions the mean hatching percentage recorded was 60. The cocoon yield per dfl observed was 18.33 cocoons with an ERR of 16.27 %. The mean cocoon weight recorded was 4.35gm, shell weight 0.51 gm and silk ratio 11.72 % whereas under *ex situ* conditions the mean hatching percentage was 58 %. The mean cocoon yield observed was 11.26 cocoons /dfl with an ERR of 10.79. The mean cocoon weight observed was 3.99 gm, shell weight 0.40 gm and silk ratio 10.02 %. (Table No. 2 &3). Similar observations on hatching %, ERR and cocoon yield were also made by Singh, N.I *et al.*, 2005 during the study on *ex situ* conservation of *A. frithi*.

Table no 2. Rearing performance of *A.frithi* under in *situ* condition

Replication	No. of Dfls	Average Feccundity	Hatching %	No. of Worms brushed	Larval Period	Cocoon Yield	ERR %	Dfl: Cocoon
1	5	185	58	536	32	87	16.23	1: 17.4
2	5	190	62	589	33	98	16.63	1: 19.6
3	5	188	60	564	32	90	15.95	1: 18.0
Mean	5	187.6	60	588.3	32.3	88.3	16.27	1: 18.33

Table no 3. Rearing performance of *A.frithi* under *ex situ* condition

Replication	No. of Dfls	Average Fecundity	Hatching %	No. of Worms brushed	Larval Period	Cocoon Yield	ERR %	Dfl: Cocoon
1	5	178	56	498.4	36	52	10.4	1: 10.4
2	5	182	60	546	38	61	11.17	1: 12.2
3	5	175	58	507.5	38	56	10.82	1: 11.2
Mean	5	178.3	58	517.3	37.3	56.3	10.79	1:11.26

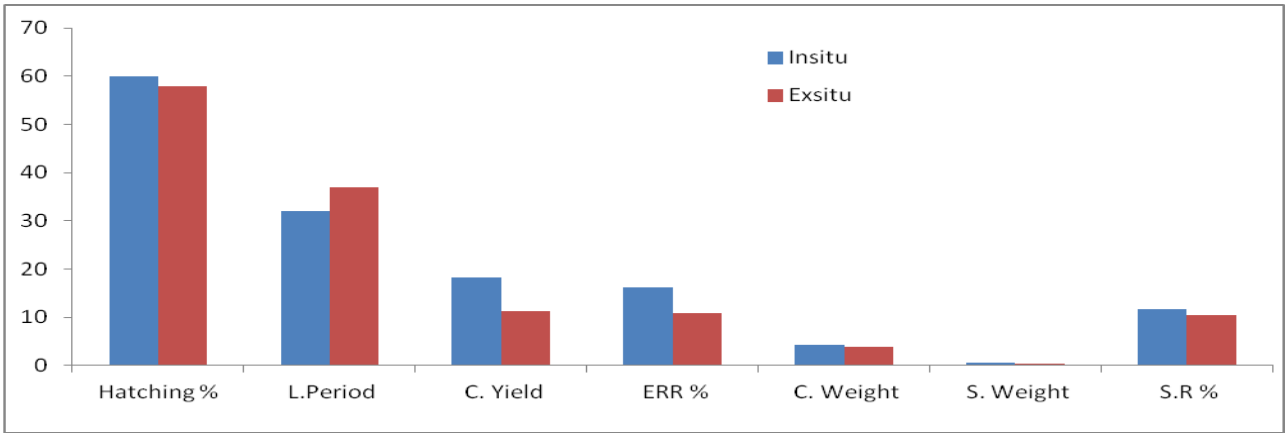

Fig.1. Comparative rearing performances of *A.frithi* under *in situ* and *ex situ*

The comparative rearing performances (Fig. 1) indicated that under *in situ* conditions the hatching percentage, shell weight, silk ratio % are higher than *ex situ.* This indicated that commercial characters of cocoons deteriorate by human handling. The *in situ* rearing of *A. frithi* performed better than *ex situ* in terms of ERR also. It was observed that during *A. frithi rearing* under *ex situ* conditions the larvae stopped feeding with human interference and due to less feeding the larvae were exposed to diseases which eventually lead to heavy mortality of the larvae. Ponnuvel *et al*., 1996 reported low survivability during summer and autumn crops than spring crop which may be due to the seasonal variations in the quality of leaves in *A.proylei*.

2. Grainage performances of *A. frithi* under *in situ* and *ex situ* conditions.

To observe the male and female emergence pattern, coupling behaviour and fecundity under *in situ* and *ex situ* conditions, grainage was conducted at RTRS, Imphal (*ex situ*) and Luwansangol, Senapati district (*in situ*). The emergence of moths started from 7 P.M in *ex situ* conditions whereas in *in situ* conditions the moth emergence started from 8 P.M onwards. Mating continued till 10-11 am of next day if not disturbed. However, the coupling moths detached with slight mechanical disturbance. *A. frithi* exhibited great polymorphism in wing colouration. It ranged from dark brown to reddish (i.e., reddish-brown, orange, or violet, etc.) or to dark red with yellow highlights, or to orange or yellow in males. The most common colouration was reddish with yellow highlights. In females, the variation usually ranged from brown to (rarely) completely yellow, most often in combinations of red and a little yellow. (Table no. 4).The eyespot in both forewing and hindwings of both the sexes are very distinct and are round to oval with large transparent round to elliptical fenestra. The eyespot of the hindwing is smaller than that of the forewing. Similar observations were also made by Singh, N.I *et al.*, 2005.

Table 4. Morphological characters of *A. frithi* moth.

Moth	Colour	Wing span (mm)	Body length(mm)	Life span (days)
Male	Greenish yellow, Brick red, Brown	135.2 ± 4.82	29.15 ± 1.22	7.2 ± 0.91
Female	Yellow, Brown Pinkish,& Grey	148 ± 0.38	34.0 ± 2.87	6.4 ± 0.17

The oviposition period last for 3-4 days in both the conditions. The eggs were white and slightly oval and flattened with two broad brown rings and were cemented to the substrate with a dark brown adhesive. Incubation period ranged from 6-7 days. There was marked difference in the regular emergence at both *in situ* and *ex situ* conditions. The total emergence of moths was 68.3 % in *in situ* conditions. Whereas, in the *ex situ* conditions it was comparatively less with 54 % only (Table 5 & 6). The fecundity was 197 eggs/ moth in *in situ* grainage whereas fecundity was lesser in *ex situ* grainage with 170 eggs/moth. However, considerable difference was observed in respect of the couplings obtained in both the conditions. Under *ex situ* conditions only 39% couplings were obtained in comparison with 60 % couplings in *in situ* conditions. Overall one dfl was prepared by utilising 6 seed cocoons under *in situ* conditions whereas in case of *ex situ* conditions one dfl could be prepared by utilising 12 seed cocoons.

Table no. 5. Grainage performances of *A. frithi* under *ex situ* conditions

Replication	No. of S/cocoons utilized	No. of moths emerged		Emergence %	Coupling obtained	Coupling %	Dfls obtained	Av. fecundity	Cocoon : dfl
		Male	Female						
1	100	25	20	45	6	30.0	6	178	16.66:1
2	100	31	24	55	11	45.83	11	165	9.09:1
3	100	36	22	63	9	40.90	9	165	11.11:1
Mean	100	30.6	22	54	8.6	38.91	8.66	170.3	12.28:1

Table no. 6. Grainage performance of *A. frithi* under *in situ* conditions

Replication	No. of S/cocoons utilised	No. of moths emerged		Emergence %	Coupling obtained	Coupling %	Dfls obtained	Av. fecundity	Cocoon : dfl
		Male	Female						
1	100	45	27	72	17	62.96	17	190	5.88:1
2	100	41	25	66	14	56.00	14	208	7.14:1
3	100	36	31	67	19	61.29	18	195	5.55:1
Mean	100	40.6	27.6	68.3	13.6	60.08	16.3	197.6	6.19:1

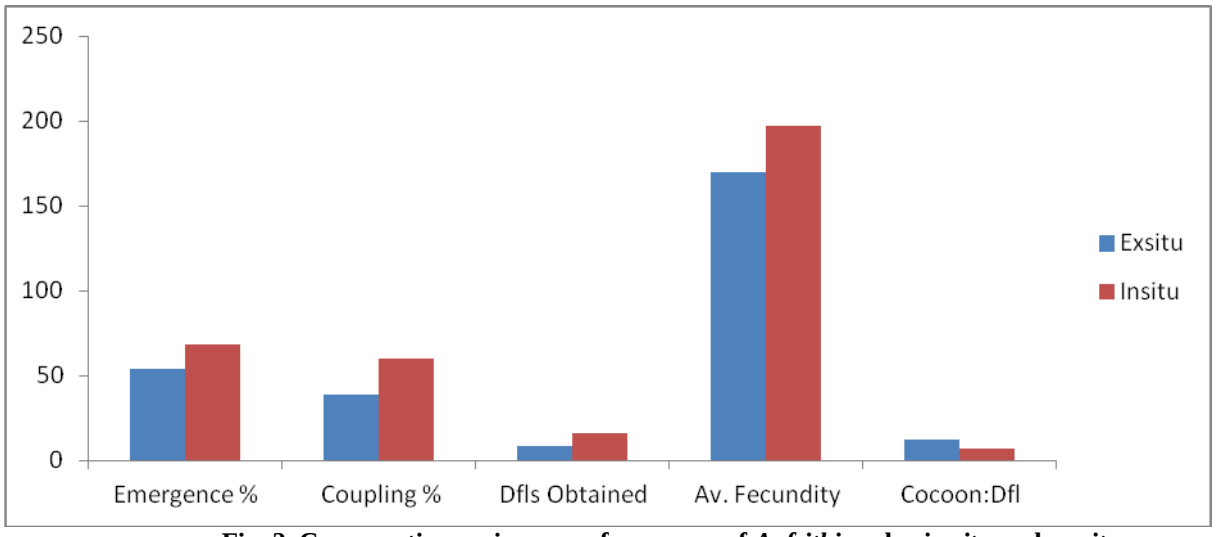

Fig. 2. Comparative grainage performances of *A. frithi* under *in situ* and *ex situ.*

The comparative grainage performances (Fig. 2) indicated that under *in situ* conditions the emergence %, coupling %, fecundity were higher than *ex situ* conditions. Thus, by designing *in situ* conditions for grainage operation, *A. frithi* dfl production could be enhanced.

Conclusion

At present, the wild oak tasar biodiversity in India are facing a threat of extinction from their natural abode due to deforestation and climatic change. So such wild insects need conservation both under *in situ* and *ex situ* condition. Standardization of the rearing and grainage techniques of *A. frithi* is the need of the hour for conserving its population. If the rearing and grainage technology of *A. frithi* is standardized, the technology can be transferred to the State Department of Sericulture for multiplication programme of *A. frithi* and thereby it can be popularize amongst the stakeholders as an alternative to *A. proylei*.

Reference

1. Arora, G. S. and Gupta, I. J. 1979. Taxonomic studies of some of the Indian non-mulberry silk moths (Lepidoptera: Saturniidae). *Memoirs of the Zoological Survey of India.* **16**(part 1): 1-63 + xi plates.
2. Chaoba Singh, k & Ibohal Singh, N. 1998. Biology and ecology of temperate tasar silk moth, *Antheraea proylei*. Indian J.seric.37 (2): 89-100.
3. Crotch, W. J. B. 1956. A silkmoth rearer's handbook. *Amat. Entomol. Soc.* **12**: 165 pp. (1969 reprint).
4. Jiang, Z., Changle, C., Yongquing, C; Yuqing, Z. and Yujin, D. 1992. Identification and purification of vitellin from the Chinese oak silkworm *Antheraea pernyi*, and its changes during oogenesis and embryogenesis. *Wildsilkmoths*, 126-133.
5. Jolly, M. S., Narasimhahanna, M. N. and Sen., S. K. 1974. Morphology of *Antheraea frithi* Moore (Lepi: Saturniidae). *Indian Journal of Sericulture.* **XIII**: 23-35.
6. Ponnuvel, K.M; Naomani, M.K.R.; Luikham, R. and Singh, K.C. 1996. Seasonal variation in the biochemical constituents of Oak (*Quercus serrata*) leaf. *Proc. Nat. Acad. Sci. India*, 66 (B): 283-287.
7. Singh, N. I., Singh, N. I and Singh, L. S. and Sinha, B. R. R. Pd. 2004. Rearing performance of *Antheraea frithi* – an indigenous vanya silkmoth. *Proceedins of the National Workshop on Potential and Strategies for Sustainable Development of Vanya Silks in the Himalayan States.* : 141-143.
8. Singh, N.I., Singh, N. I., Singh, L.S., Suryanaryana, N. 2005. *An Overview of the Salient features of Antheraea frithi* Moore: A promising wild silk moths of India. 74-77.