Original Research Article

Rearing Of Eri Silkworm (*Samia cynthia ricini* Boisd.) (Lepidoptera: Saturniidae) In Arunachal Pradesh: A Study In Papumpare District

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Abstract: Eri silkworm, *Samia cynthia ricini* Boisd. (Lepidoptera: Saturniidae) is known to be reared in different parts of the world with diverse expectations for its silk fibre, food and biomaterials. In India, eri silkworms are reared in many parts particularly in northeast region. In Arunachal Pradesh Nyishi, Apatani, Aka, Sherdukpen, Bugun and certain other communities wear the eri silk clothes during religious community festivals and ritual events with traditional fervour. However, proper documentation on rearing practice of eri silkworm followed in the region is found to be missing. Therefore, realising the importance of eri silk in the region, a questionnaire based and self monitored survey was conducted in Papumpare district, Arunachal Pradesh to understand the rearing technique, innovations and beliefs associated with eri silkworm in the region. Indigenous rearing technique was mostly found to be similar with that of Assam in certain aspects like selection of food plants, larvae rearing and spunning technique. However, outdoor mountages constructed from banana leaves, use of traditional degumming ingredients prepared from ash of banana leaves, rice husk etc. called "chola" or "pila", social beliefs and taboos are unique to this region. Most of the farmers were found to lack the scientific knowledge regarding disease of the silkworm and modern eri silk spunning techniques. Microscopic observation of the hemolymph of diseased larvae sample collected from farmers showed the infection from bacteria and fungus. Similarly, most of the farmers were also found not to be aware of government schemes provided to support the farmers. This indicates the need of training regarding the effective rearing technique and silkworm diseases.

Key words: mountages, pathogens, *S. c. ricini*, seed cocoon, status, taboo

Introduction

Among the commercially exploited non-mulberry silkworms, the eri silkworm, *Samia cynthia ricini* Boisduval, 1854 (Lepidoptera: Saturniidae) is the only domesticated silkworm adopted for indoor rearing round the year (Reddy, 2000; Debaraj *et al.*, 2002). Different larval colourmrphs of *S. c. ricini* are known and are reared in many parts of the world expecting to produce silk for making up cloths and medically important biomaterials (Nakawaza *et al.*, 2003; Kim *et al.*, 2012). Arunachal Pradesh, India's easternmost state is the home to about 28 major tribes and 110 sub-tribal communities which follow a number of fascinating and unique socio-cultural traditions (Govt. of A.P., 2015). Ericulture, the rearing of eri silkworm is also one of such socio-culturally valued practices. Nyishi, Aka, Sherdukpen, Monpa, Apatani, Bugun and certain other communities in this region wear the eri clothes during religious community festivals and ritual events with traditional fervour. In Arunachal Pradesh and Assam, India, the eri silk has its utility especially in making traditional winter cloth and

fashionable modern dresses such as 'Gale' and 'Shawl'. Apart from silk production, eri caterpillar and pupa are used as delicious food item in Arunachal Pradesh like many other parts of the world. Thus, the eri silkworm rearing is a means of employment and income source for a wider section of rural population in ericulture concentrated regions as it provides engagement through food and eri silk production and weaving activities.

Therefore, realizing the importance of eri silk in the region, present investigation was conducted to highlight the rearing technique, innovations and beliefs linked with the rearing of eri silkworms and to identify the problems and prospects of eri silkworm rearing in the region so that it can help in uplifting the eri culture practice.

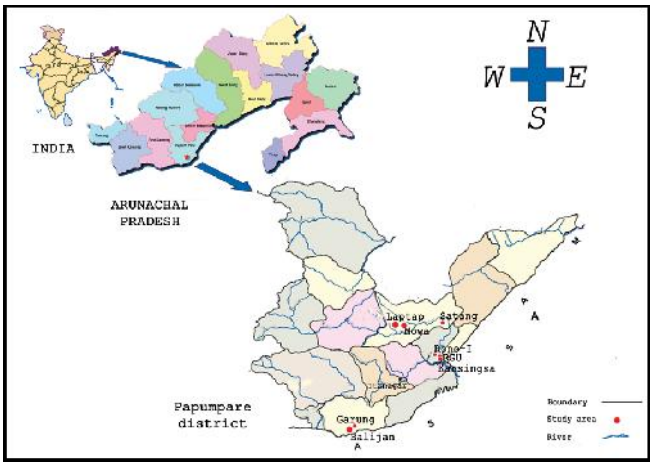

Fig. 1. Study area in Papumpare district, Arunachal Pradesh.

Methods

Ericulture practice

Information relating to the ericulture practice in Arunachal Pradesh were collected through survey in eight ericulture concentrated villages (locally known as 'basti') namely Karsingsa, Rono-I, Rono-Hills, Laptap, Mowa, Satang, Balijan and Garung in Papumpare district (Fig. 1). A questionnaire was prepared and self observation of rearing was done during the year 2015 to collect data on the current system and status of ericulture from 50 rearers. Secondary data on the status of ericulture in Arunachal Pradesh were sourced by the sericulture offices, govt. of Arunachal Pradesh, India.

Pathogens of the eri silkworm diseases

The diseased larvae were collected before death. Hemolymph was collected by cutting off an abdominal pro-leg and the hemolymph smears were spread on clean dry glass slides. The smears were air dried and then fixed using heat fixing method. The heat fixed slides were stained with safranin and cotton blue stain separately to detect the presence of bacteria and fungus respectively (Chelsters, 1934; Lecker, 1999; Beveridge, 2001; Schoenlein- crusius *et al*., 2006; Vasic and Dubak, 2012) and photographed using Leica DM 5000B microscope.

Results

Food plants

Castor (*Ricinus communis* Linn.) and kesseru (*Heteropanax fragrans* Seem.) were found to be used by the farmers as food plant for raising eri silkworm. However, farmers preferred *R. communis* over *H. fragrans* as it was believed that feeding on castor yields large sized larvae and cocoons. Besides, *H. fragrans* being the perennial plant, they were used during scarcity of *R. communis*. *R. communis* and *H. fragrans* were not found to be cultivated by the small scale rearers. Instead, the food plants grown in the wild were collected using specially constructed bamboo basket to feed the silk worms.

Rearing house

Sixty percent of the farmers used their residential hut for rearing the eri silkworm. However, other 40% farmers constructed farm house outside the residential house. Some of the rearing houses were of open type, structured without any wall while others were usually constructed with bamboo wall. The general layout of the farm houses included open areas and rearing beds. Open areas were designed for working area and storage area. Storage area were used for keeping leaves and rearing materials such as bamboo tray, bamboo mountage etc. Rearing beds were made of bamboo poles, bamboo railings and bamboo mats.

Fig. 2. A-Seed cocoon of *S. c. ricini;* B- White colourmorph (degummed); C- Brown colourmorph (degummed); D- Orange colourmorph (degummed); E- outdoor mountage constructed with semi dried banana leaves.

Seed cocoon

In the present study, three different coloured cocoons were found to be used by the farmers. Five percent farmers used both orange coloured cocoon breeds and white cocoon breeds, ninety percent farmers used white cocoon breeds and rest of five percent of the farmers randomly selected cocoon breeds as seed irrespective of colour. About 20-30 cocoons were kept hanging using a thread or rope in the rearing room until emergence of the moths (Fig. 2 A-D). Moths were then freely allowed to mate randomly. The female moths oviposited on the wall of the rearing house or on a white cloth kept as background against a wall of the rearing house. The eggs laid were collected and wrapped in a paper till the emergence of larvae.

Larvae rearing technique

Farmers used two techniques for larvae rearing - (a) surface (tray) rearing technique and (b) bunch hanging technique. The 1st, 2nd and 3rd stadia were reared using surface rearing technique. The 4th and 5th stadia were mostly reared using bunch hanging method in which bunches of the host plant leaves were hanged pointing downward on a bamboo pole hanged parallel to ground surface using rope fixed to the roof of the rearing house.

Mountage

Three types of mountages were used by the farmers. One type is made up of semi dried of banana leaves, second type is made up of dried banana and jackfruit leaves with twig kept in a jute or plastic sack ("basta") or traditional basket ("igin") and the third type called 'chandrike' is made up of bamboo (Fig. 2 E). Ripened larvae were picked up and transferred to mountages. The bamboo 'chandrike' ensures uniform distribution of larvae which reduced the chances of forming double cocoons. Five percent farmers constructed the mountages outside the rearing house believing that outdoor temperature is more suitable for silk production.

Spunning

Pre-pupa, the 5th instar larvae before being metamorphosed into pupa were taken out from the cocoon ("Giirw") through opening the loose end of the cocoon manually. The pupa free cocoons were then degummed in boiling water without adding soda or other surfactant or using traditional degumming ingredients prepared from ash of banana leaves, ash of husk etc. locally known as "chola" or "pila". The degummed cocoons were then washed in normal water and dried in sunshine. Dried empty cocoons were used for manufacturing silk yarns using ''takuri" or "tapo", a traditional device used by the farmers interacted.

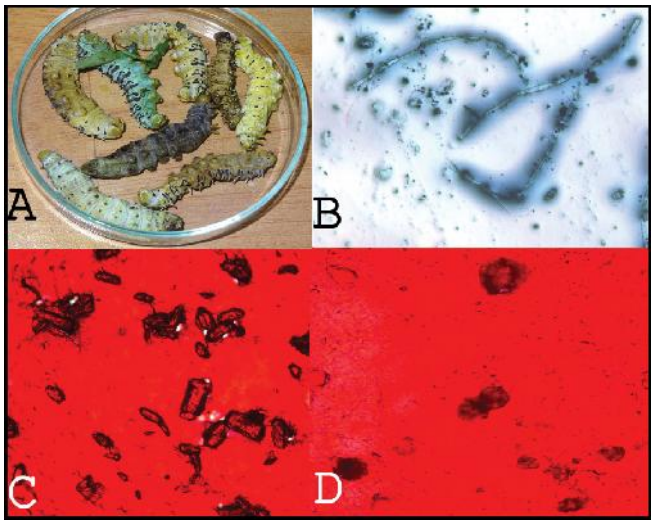

Fig. 3. A- Diseased larvae of *S. c. ricini*; B- Fungal hyphae in diseased larvae; C- Bacillus bacteria in infected larvae; D- Coccus bacteria in infected larvae.

Diseases

As reported by the farmers, they did not observed any severe disease in eri silkworm which encounter economic loss. However, negligible number of larval death was found to appear due to irregular cleaning and feeding indicating the occurrence of flacherie disease. No disinfectants were found to be used by the farmers to control the larval death. Microscopic observation of the hemolymph of diseased larvae was found to be infected from Coccus and Bacillus bacteria and fungus (Fig. 3).

Social taboos and beliefs

Some social taboos were practiced by the farmers during eri silkworm rearing. During menstruation period women did not enter into the rearing room as it was believed that it causes death of silkworms. Some farmers also believed that minor earthquake also causes the severe death of larvae. Another belief was the "najar loga", which means that if some people praise the good heath of the silkworms, the silkworm become sick and dies thereafter.

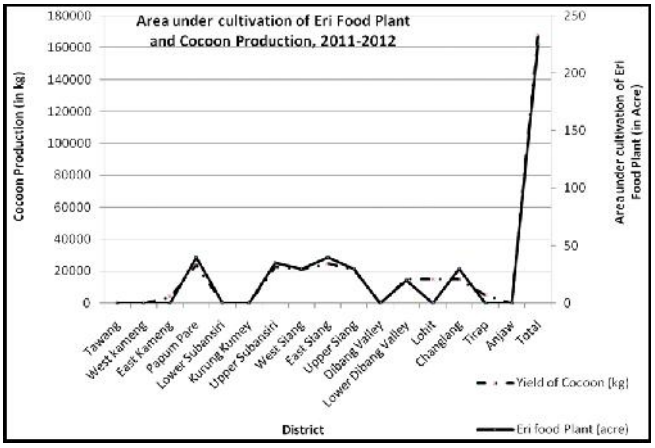

Fig. 4. Area under cultivation of eri food plant and cocoon production, 2011-2012 in Arunachal Pradesh. (Data Source: Statistical abstract of Arunachal Pradesh 2013).

Status of ericulture in Arunachal Pradesh

Currently, cultivation of food plant of *S. c. ricini* (*R. communis* and *H. fragrans*) covers an area of approximately 225 acres of land yielding 1,68,000.00 kg of cocoon. It can fetch an amount of rupees around ten crore per annum by selling cocoon at a rate of Rs. 600.00 per kg and an amount of rupees around twenty lakh per annum by selling caterpillar at a rate of Rs. 200.00 - 400.00 per kg (Fig. 4).

At present, the Department of Textile and Handicraft, Govt. of Arunachal Pradesh is assisting the eri silkworm rearers by providing high yielding breeds of eri silkworm, rearing equipments, disinfectants, seeds of food plants and by imparting training under the schemes like, Integrated Sericulture Development Project under North Eastern Regional Textile Promotion Scheme, Ministry of Textile, Govt. of India besides the normal State Plans.

Department of Textile and Handicraft is also providing loans for construction of rearing house and food plant cultivation for ericulture under Catalytic Development Programme (CDP) under Central Silk Board, India and Integrated Sericulture Development Project under North Eastern Region Textile Promotion Scheme, Ministry of Textile, Govt. of India and Normal State Plan. One hundred persons (70 male and 30 female) were covered under CDP in the year 2014-15. The department has been conducting training programmes to motivate the villagers for ericulture and 510 persons are covered in the year 2014-15. But, the sericulture demonstration centre under the Department of Textile and Handicraft itself lacks necessary articles and instruments for rearing of eri silkworm.

Problems faced by eri farmers

The villagers are rearing eri silkworm in small scale to improve their economic status. Ericulture is considered by the farmers as subsidiary work as most of the eri farmers in the villages are housewives or agricultural farmers and are not registered under CDP and other schemes under Department of Textile and Handicraft. Many of them are not aware of the training programmes. They rear eri silkworms for consumption of caterpillar/pupae as food. The caterpillar/pupae and cocoons are sold at a rate of Rs. 200-300 and Rs. 500-600 per kg respectively making a total earning of 3000-6000 per life cycle. Eri farmers are mostly not indulged in reeling and weaving as it needs proper technology which they lack.

Discussion

During the present investigation, only *R. communis* and *H. fragrans* were found to be used by the farmers as food plants for eri silkworms. Tapioca (*Manihot utilissima* Phol.) was also recorded as another important food plant for eri silkworm in scientific literature (Patil *et al*., 2009; Kumar and Gangwar, 2010). Despite the fact that *M. utilissima* is cultivated in the region for the edible starchy tuberous roots, farmers did not use tapioca as food plant.

R. communis is an ideal candidate for bio-fuel production with environment friendly bio products (cake, seed coats and biomass) and unique fatty acid constituents. *R. communis* bean oil contains low concentration of cadmium, lead, zinc, nickel, manganese and is copper free. Cake and seed coats can be useful for soil fertilization applications since the metal concentrations are below safety regulations. The biomass carbon was around 43%, which suggests its potentiality to be used for bio gas production (González-Chávez *et al*., 2014).

Thus, the cultivation of *R. communis* for dual purposes viz. for ericulture and castor oil production will deliver economic benefit to the eri farmers of Arunachal Pradesh.

Moreover, the caterpillars and pupa can be used as feed ingredients in fishery, poultry and piggery sectors which has proven to be more beneficial and cost effective (Ijaiya and Eko, 2009).

The silkworm's cocoon is composed of two kinds of silk proteins, the silk sericin, which makes up the membrane and the silk fibroin, which makes up the inner portion. The silk sericin is a glue-like mixture of glycoproteins with varying molecular mass. The latter is removed by the process of degumming and rinsing steps. The aesthetic and physical properties such as dull appearance, surface fibrilization and strength loss are known to be dependent on the process of degumming. Biodegradable natural surfactants can reduce damage to silk fabric, besides being cheap, abundant, eco-friendly and economical (Sarmah *et al*., 2012). The eri rearers in Papumpare district degummed the silk cocoon by extracting sericin in boiling water without adding soda or other surfactant or using traditional degumming ingredients. However, these methods need standardization for gaining better quality silk.

The eri silk in cocoons are discontinuous and hence cannot be reeled, but be spun. Spunning of eri silk filament to make silk yarn using "takuri" or "tapo" is time consuming. Though, little improvement was done in the technology through motorised-cum-pedal operated ring as well as flyer spinning machine, amber charka and mill spinning, these were not found to be used by the farmers.

The farmers were not aware about the bacterial, viral and fungal diseases of the silkworms. Instead, they believe in some social taboos and superstitions. During the present study, diseased larvae of *S. c. ricini* showed the presence of Bacillus and Coccus bacteria in infected larvae indicating the occurrence of Flacherie disease. Flacherie disease is known to be caused by consortium of various pathogenic bacteria and virus individually or in combination (Selvakumar and Datta, 2013). Thus, these findings necessitate the improvement of the scientific knowledge of the farmers in the region regarding the diseases of silkworms.

The farmers did not discriminate between the larval colourmorphs while selecting their seed cocoons. The farmers were recorded to rear any of the colourmorphs which ever is available as seed from the sericulture department, relatives or friends. C2 breed of eri silkworm developed by the central Muga and Eri Research Training Institute, Lahdoigarh, Jorhat, Assam is recommended by the sericulture department, govt. of Arunachal Pradesh for its high productivity with higher shell weight and fecundity but it was not found to be reared by the local eri farmers of the Papumpare district of Arunachal Pradesh.

The aspects in rearing of *S. c. ricini* that differ from neighbouring state Assam are the use of separate rearing house, outdoor construction of mountage from banana leaves, use of bamboo mountage. The type of mountage and the plant material used in construction of the mountage are known to influence the silk yield. Probably, the volatiles or other chemicals or the surface structure of the banana leaves used in the region may also have some influence on the quality

and quantity of the silk. Moreover, the outdoor mountage may have some advantages from the sunlight which may influence silk protein secretion from the silk gland of the worm as mountages are known to affect the silk quality of cocoons (Singh *et al.,* 2011; Debaraj *et al.,* 2012).

Rearing of *S. c. ricini* was mostly done by the local farmers during May to September. Farmers preferred these rearing months due to availability of food plants and shorter life cycle of *S. c. ricini*. Singh *et al*. (2006) observed maximum cocoon weight, shell weight, shell ratio and hatching percentage during September-October rearing season. Virk *et al*. (2009) found larval duration to be shorter during July-August (Monsoon) rearing compared to winter season. Hata *et al*. (2005) and Mahobia *et al*. (2005) recorded highest hatching percentage, larval weight, cocoon weight, shell weight, silk ratio and minimum larval period during August-September.

Thus, from the present study it can be stated that though the ericulture practice followed by the farmers of Arunachal Pradesh is a traditionally established indoor rearing method of eri silkworm through time tested techniques, farmers need awareness on the scientific knowledge on rearing technique, silkworm disease and the use of disinfectants to prevent the occurrence of diseases.

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