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Biology of eri silkworm, *Samia ricini* (Donovan) on castor, *Ricinus communis* L.

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ABSTRACT: Studies on biology of eri silkworm, *Samia ricini* (Donovan) on castor, *Ricinus communis* L. under laboratory condition revealed that the eggs were laid in clusters on *kharika*. A female laid average 360.10±23.88 eggs with 97.17±2.09 per cent hatching and 8.83±0.91 days of incubation period. The duration of first, second, third, fourth and fifth instar larva were 3.77±0.43, 3.23±0.43, 3.70±0.47, 4.60±0.50 and 7.67±0.55 days, respectively with total larval duration of 22.97±0.85 days. The pre-pupal and pupal periods were2.63±0.49 and 15.73±0.74 days, respectively. The pre-oviposition, oviposition and post-oviposition period were 11.61±0.37, 70.47±1.78 and 122.73±4.81hrs, respectively. The female and male longevity were 204.82±5.24and155.99±7.99hrs, respectively with sex ratio of 1:2.01 (Male: Female).

KEYWORDS: Bionomics, morphometrics, silkworm**,** *Samia ricini*

Sericulture is broadly classified into two distinct sectors *viz.,* mulberry and non-mulberry. Mulberry sericulture is concerned with mulberry silk production. Whereas, non-mulberry sericulture includes eri, tasar, and muga culture. India holds a unique distinction in producing all three kinds of non-mulberry silks. Among the non-mulberry silkworm species only eri silkworm is completely domesticated and reared indoors. It is a multivoltine insect completing at least six to seven generations in a year. The word "Eri" is derived from the Sanskrit term "Erranda", which refers to the Castor plant. *Ricinus communis* L., which is the primary host plant.

Ericulture is relatively a less remunerative occupation as compared to the production of other silks, but has its own advantages. Eri silkworms require comparatively minimum care as they are neither as wild as muga or tasar worms nor so much domesticated as mulberry silkworms. Eri silk has always been identified as 'Ahimsa silk' because there is no need to kill the pupae for getting silk. The rearer can easily preserve the cocoons till a reasonable price is offered. It is advantageous to producers. Eri silk is widely used for preparing warm clothing like chadars, quilts and scarves, which are used by the poor rural folk and the silk is referred as poor man's silk. The present investigation has been designed with the objective of measuring the potential of sustainable utilization of the non-mulberry silk moth for rearing through understanding basic biology and various stages of eri silkworm.

The rearing of eri silkworm was carried with the use of castor (GCH-7) leaves from well grown

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castor plot near Sericulture laboratory, Department of Entomology, N. M. College of Agriculture, N.A.U., Navsari during 2018-19. The studies on biology of eri silkworm on castor conducted under laboratory conditions. In order to study the biology of various stages of eri silkworm 20 freshly emerged male and female adult moths were kept in tray for mating and paired moths were covered with cloth. After six hours, unpaired female moths were allowed to lay eggs on cloth (*kharika*). The *kharika* with eggs were collected on next day morning. The eggs were detached from *kharika* and used for further studies. The study on biology started with at least 30 neonate larvae of the same age and reared individually. The size of eggs and initial instar larvae measured with stereo trinocular microscope (Make: Olympus-SZ 61) fitted with Brand Catcam-130 camera having software power Scopephoto (Version 3.1) while, later instar larvae were measured with scale.

The freshly laid eggs by female were sticky, oblong in shape and yellowish in colour, after few second it turned milky-white in colour. Eggs were usually laid on the *kharika* (to which the moth kept) sticking in cluster one above the other in an orderly manner due to their secretion of gummy substances. The eggs were initially creamy white and later became darker to violet in colour at the time of hatching (Plate 1). At the time of hatching, the chorion cracked at one end of egg and larva wriggled out from the eggs. Renuka and Shamitha (2014) and Brahma *et al.* (2015) described same results on eggs of eri silkworm.

The data on morphometrics of the eggs are presented in Table 1 indicated that the length and breadth of eggs were 1.29±0.05 and 1.19±0.05mm, respectively. The results are more or less similar with Brahma *et al.* (2015) who reported the length and breadth of eggs were 1.7±0.02 and 1.1±0.06mm, respectively on castor. The data (Table 2) revealed that the incubation period of *S. ricini* was 8.83±0.91days with 97.17±2.09 per cent hatching. The results are more or less agreement with Patil (2004) who recorded 8.00 days of incubation period of *S. cynthia ricini* on castor leaves. Moreover, Naik and Murthy (2014) found 95.18 per cent hatching in *S. ricini.*

Table 1. Morphometrics of various stages of eri silkworm, *S. ricini* (n = 25)

Sr. No.	Stage	Length			Breadth		
		Min.	Max.	Av.±SD	Min.	Max.	Av.±SD
1.	Eggs (mm)	1.18	1.40	1.29±0.05	1.06	1.26	1.19±0.05
2.	Larva						
	1st instar (mm)	2.28	2.62	2.49±0.07	0.55	0.67	0.59±0.04
	2nd instar (mm)	8.23	9.70	8.75±0.35	1.83	2.23	2.07±0.11
	3rd instar (mm)	22.50	30.10	26.00±1.57	3.40	7.10	4.54±0.81
	4th instar (mm)	35.40	39.10	37.10±1.18	8.10	9.42	8.71±0.42
	5th instar (mm)	55.23	60.20	58.45±1.19	11.10	12.40	11.93±0.36
3.	Pupa (mm)	21.35	25.20	24.08±1.06	10.23	12.57	11.51±0.73
4.	Cocoon (mm)	40.12	52.32	49.43±2.46	20.10	22.36	21.27±0.71
5.	Adult wing span						
	Female (cm)	12.10	13.00	12.52±0.27	-	-	-
	Male (cm)	10.30	11.70	10.90±0.42	-	-	-
6.	Adult size						
	Female (cm)	3.40	4.00	3.70±0.21	0.70	0.90	0.79±0.08
	Male (cm)	2.80	3.10	2.94±0.11	0.70	1.00	0.81±0.09

Plate 1. Different stages of eri silkworm, *S. ricini*

During present investigation, it was observed that the larva of eri silkworm moulted four times thus, there were five larval instars. The present findings are similar to findings of Kavane (2014) and Yaligar (2014). The newly hatched neonate larvae were dark yellow in colour with black linings and hairs. The head capsule was dark brown in colour with black hairs. Small black spots observed in between two rows of larger black spots. The larva had black thoracic prolegs. On the second day, it changed its colour to creamy yellowish colour with two dorsal black spots on prothorax. However, the other thoracic and abdominal segments had two parallel brownish round spots with a row of small brown spot till the last abdominal segment, which has a darker brown spot. The head covered with black hairs while the body had hairs on the lateral sides of larva on each segment. Second instar larva has

Table 2. Biology of eri silkworm, *S. ricini* on castor, *R. communis*

Sr. No.	Particulars	No. Observed	Periods		
			Min.	Max.	Av.±SD
1	Incubation period (Days)	30	8.00	11.00	8.83±0.91
2	Hatching (%)	3212	93.13	99.39	97.17±2.09
3	Larval period (Days)				
	1st instar	30	3.00	4.00	3.77±0.43
	2nd instar	30	3.00	4.00	3.23±0.43
	3rd instar	30	3.00	4.00	3.70±0.47
	4th instar	30	4.00	5.00	4.60±0.50
	5th instar	30	7.00	9.00	7.67±0.85
	Total larval period (Days)	30	22.00	25.00	22.97±0.85
4	Pre-pupal (Days)	30	2.00	3.00	2.63±0.49
5	Pupal- period (Days)	30	15.00	17.00	15.73±0.74
6	Pre-oviposition period (hrs)	25	11.00	12.10	11.61±0.37
7	Oviposition period (hrs)	25	68.00	72.50	70.47±1.78
8	Post-oviposition period (hrs)	25	118.00	135.00	122.73±4.81
9	Adult emergence (%)	159	86.67	100.00	92.30±5.16
10	Sex ratio (Male: Female)	147	1:1.25	1:3.33	1:2.01
11	Adult longevity (hrs)				
	Female (F)	25	198.50	218.10	204.82±5.24
	Male (M)	25	144.00	168.10	155.99±7.99
12	Total life cycle (Days)				
	Male	30	52	55	52.85±0.93
	Female	30	55	58	56.50±0.95
13	Fecundity (No. of eggs per female)	10	322.00	409.00	360.10±23.88
14	Temperature (°C)	-	22.30	25.40	23.71±0.64
15	Relative humidity (%)	-	43.00	63.10	51.63±6.06

a dark brown head with yellowish white fleshy body. A pair of black colour spots presented on the thoracic region. The larvae had black tubercles with whitish hair and pairs of black spots observed longitudinally on the body. Third instar larva did not exhibit any variation except size however, the small black coloured spots observed on body with short white tubercles. Longitudinal black spots observed on the body, pairs on dorsally and uneven manner on dorso-ventrally with yellow colour legs, anal flap and claspers. Fourth instar larva has a yellow colour head, creamy white body colour with short white tubercles and whole body covered with white powder like substance. The fifth instar larva was similar in general appearance to fourth instar larva, excluding large in size and the larva was white in colour (Plate 1). Kavane (2014) reported the same descriptions of larvae of eri silkworm. The length and breadth of first, second, third, fourth and fifth instar larva was 2.49±0.07 and 0.59±0.04mm, 8.75±0.35 and 2.07±0.11mm, 26.00±1.57 and 4.54±0.81mm, 37.10±1.18 and 8.71±0.42mm, 58.45±1.19 and 11.93±0.36mm, respectively (Table 1).The average larval period of first, second,

third, fourth and fifth instar larva were3.77±0.43, 3.23±0.43, 3.70±0.47, 4.60±0.50 and 7.67±0.55 days, respectively with the total larval period of 22.97±0.85 days (Table 2). The results are more or less in agreement with Yaligar (2014).

The full grown larvae were voracious feeder, consuming a large quantity of food and finally stopped the feeding once they accomplished their larval stage and enter maturity. At the beginning of this stage, the larva retracted its body and remained still until emptying the last excreta both in solid and semi-solid form. The mature larva dropped in their weight, became soft and yellowish transparent in colour. Matured larva avoided feeding, started to move away in search of a proper place for cocooning in the early morning to till noon and by spinning the silk around formed cocoons on both leaves and rearing tray if it was not properly placed on mountage. A sound of hollowness is produced while, picking up the matured worms and rubbing in between fingers. Such worms were then collected and kept for cocooning on plastic mountage. Pupa was obtect type, the pro-legs were shrivelled up and secretly curved, the thoracic legs, as well as wing pads, were developed. Newly formed pupa became soft and yellow to initiate the final moult inside the cocoon. The pupa became robust and changed its appearance into dark brown to reddish brown colour. The cocoons were shining white in colour elongated, spindle shape with an opening at one end and could be easily distinguished from those of other silkworm cocoons. The cocoons were compact and hard without peduncle (Plate 1). The description of pupa and cocoon are similar to Renuka and Shamitha (2014). The duration of the pre-pupal and pupal period were 2.63±0.49 and 15.73±0.74 days, respectively (Table 2). The results are similar with Naik *et al.* (2010), Yaligar (2014) and Deori and Khanikor (2015). The data on morphometrics of pupa and cocoon presented in Table 1. The results revealed that the length and breadth of pupa were 24.08±1.06 and 11.51±0.73mm, respectively. Whereas, the length and breadth of cocoon were 49.43±2.46 and 21.27±0.71mm, respectively. The results are more or less similar to Brahma *et al.* (2015).

The adult moths were stout, brownish or blackish in colour and covered with white scales (Plate 1). The male moth was smaller and had a larger and longer bipectinate antenna while, the female moth was having a larger abdomen with a thinner and smaller bipectinate antenna. The wings were broad, buff coloured with white coloured strips in the marginal portion. Wings covered with scales of different colour and shape. The prominent veins visible from both sides. Forewings observed longer and narrower than hind wings. The forewings of both sexes were more or less similar in structure and colour pattern. The characteristics anti median line observed bright chocolate in colour with a white border on each sides and almost run through the centre. The post median line was black in colour with a single dull grey border on each sides. A conspicuous black spot and pterostigma with a whitish tinge was present at the top of the wing apex. Furthermore, the wing had a few white oblique lines. The ocellus in both the sexes was crescent shaped. The hyaline area almost unseen and located in the anterior region of the ocellus. The space between the ocellus and post median line was darker. The remaining colouration of both fore and hind wings identical apart from the yellow strips of ocellus which was broader and prominent in hind wings. The data presented in Table 1 revealed that the average wing span of female and male were 12.52±0.27 and10.90±0.42cm, respectively. The results are more or less similar with Naik *et al.* (2010) and Subramanian *et al.* (2012) and Brahma *et al.* (2015). The observation on measurements of body length and breadth of female and male moths are presented in Table 1. The data revealed that the body length and breadth of female were 3.70±0.21and 0.79±0.08cm, respectively. Whereas in male, the length and breadth 2.94±0.11 and0.81±0.09cm, respectively. More or less similar measurements of adults had been recorded by Subramanian *et al.* (2012). The average adult emergence was 92.30±5.16 per cent. Naik *et al.* (2010), Naik and Murthy (2014) and Yaligar (2014) observed more or less similar results in eri silkworm. The sex ratio of eri silkworm (male to female) varied from 1:1.5 to 1:3.3 with an average of 1:2.01. The pre-oviposition, oviposition

and post-oviposition period were 11.61±0.37, 70.47±1.78 and 122.73±4.81hrs, respectively (Table 2).

The longevity of male and female was 155.99±7.99 and 204.82±5.24hrs, respectively (Table 2). The results are more or less similar with Gomma (1973) and Reddy *et al.* (1989). The egg laying capacity of female moth varied from 322 to 405 eggs per female with an average of 360.10±23.88 eggs per female. The present findings are more or less in agreement with Naik *et al.* (2010) who reported that the fecundity was 339.50 eggs per female. The total life cycle of female and male were 56.50±0.95 and 52.85±0.93 days, respectively (Table 2). The results are more or less similar with Naik and Murthy (2014) who reported the total life cycle of eri silkworm completed in 47.50 days.

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