

BIOLOGY AND MORPHOMETRICS OF *PHALERA RAYA* MOORE (LEPIDOPTERA: NOTODONTIDAE) INFESTING *QUERCUS SERRATA* THUNB.

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[Subharani, S., Debaraj, Y., Chaudhuri, R. S. & Ibotombi Singh, N. 2019. Biology and morphometrics of *Phalera raya* Moore (Lepidoptera: Notodontidae) infesting *Quercus serrata* Thunb.. Munis Entomology & Zoology, 14 (2): 643-647]

ABSTRACT: The hairy caterpillar, *Phalera raya* Moore is a major defoliator infesting *Quercus serrata*, the primary food plant of oak tasar silkworm, *Antheraea proylei*. Studies on biological parameters of *P. raya* revealed that females laid light brown colour eggs and fecundity was 610 ± 24.80 eggs per female. Incubation period of the eggs was 8.4 ± 0.24 days and measured 0.91 ± 0.03 mm in diameter. The larvae passed through 6 larval instars. The duration of the 1st, 2nd, 3rd, 4th, 5th and 6th instar was 5.8 ± 0.37 , 8.0 ± 0.45 , 6.2 ± 0.37 , 6.6 ± 0.24 , 6.8 ± 0.20 and 11.0 ± 0.32 days respectively. Larval and pupal period was 43.4 ± 1.81 and 13.4 ± 0.67 days. The mean adult longevity was 4.5 ± 0.43 days and the average length and breadth of the adult was 30.50 ± 0.10 mm and 7.55 ± 0.24 mm respectively. The total developmental period was completed in 65 - 72 days.

KEY WORDS: *Phalera raya*, biology, morphometric, developmental stages, *Quercus serrata*

The saw tooth oak, *Quercus serrata* Thunberg is the primary food plant of the sericigenous insect, *Antheraea proylei*. This food plant is prone to attack of various insect pests, the severity of which is related to season and other environmental and management factors. Among the insect pest infesting *Q. serrata*, *Phalera raya* Moore, commonly known as hairy caterpillar is the most voracious and abundant (Devi & Singh, 2011) causing considerable loss to the silk industry. Yi-Ren et al. (2013) reported *Phalera* species as a major defoliating pest of Oak. There are also reports that *Phalera* species is also known to feed gregariously on Oak leaves as young larvae (Turacani et al., 2010). It has been recorded to affect various species of Oak throughout the world (Kalapanida & Petrakis, 2017). The damage due to this caterpillar is enormous as they skeletonise the leaves consuming the cell walls and its watery cell contents. The highest infestation of 12.1 population density per plant was reported by Goel & Rao (2004). The loss of the leaf tissues reduces the food making capability resulting in weakening and stunting growth of the oak plant. The adult of *P. raya* is characterized by having a pale brown apical moon spot and less conspicuous blackish tornal spot in the broad forewings (Schintlmeister, 2008). He further reported that the adult of *P. raya* appears from March to November upto 2000 m.

Since, production of better quality oak tasar silk depends on the leaf quality of food plant, the slightest loss from the insect pest are a great concern to the oak tasar rearers. In spite of the importance of oak tasar farming which supports livelihood of a number of people of this region, the work on the insect pests damaging the food plants are more or less neglected (Singh & Tikoo, 1990). Rao, et al. (1996) had reported that fairly large numbers of insect pests of diversified groups have been found to be attacking and damaging *Quercus* spp. during their different developmental stages. Singh & Kulshrestha, (1990) also reported that

inspite of having abundant oak, the main constraints being faced in oak tasar culture is the attack of the food plants by a large number of insect pests causing potential threat to the tasar silk industry.

From the available literatures, it appears that attempts have been made by few workers to study the seasonal incidence of major insect pests infesting oak but the study on biology of this insect have not been carried out so far. Hence, the present study was undertaken to know the total developmental statistics of *P. raya* which can be used as a predictive basis for its control.

MATERIAL AND METHODS

Phalera raya was reared in wired mesh cages of size (2.5' x 2' x 7") under laboratory conditions at Regional Sericultural Research Station, Mantripukhri, Imphal, Manipur, India. To maintain the culture newly hatched larvae were randomly selected and individually transferred with the help of moist camel hair brush to the rearing trays with *Q. serrata* leaves and reared till completion of their life stages in ten replications. Fresh leaves were changed whenever required and the rearing cages were cleaned regularly. Adult moths were kept in specially prepared cages provided with fine wire grills from the sides. The top of the cage was provided with movable glass to study the reproductive and ovipositional behaviour of the adults. The adults were fed with 10 % sucrose solution and honey mixture (3:1). The number of eggs laid by the individual females was recorded as fecundity. The duration of larva and pupa were recorded. Incubation period of the eggs were also recorded. The hatchability of the eggs were then determined. The length and breadth of the different instars of the larvae and pupae of *P. raya* was determined using Vernier Calliper Gauge micrometer just after moulting. Observations were made from ten randomly selected samples and the average was calculated. In case of adults the body length, wing span by spreading the insect in horizontal position in a standard setting board and the sex ratio was determined.

RESULTS AND DISCUSSION

The biology of *Phalera raya* was studied under laboratory conditions and the results were presented in Table 1 & 2.

Egg: Freshly laid eggs were light brown in colour. The eggs were laid in single layer glued the dorsal surface of the oak-leaf. The shape of the eggs was round and the size varied from 0.80 mm to 1.0 mm in diameter. The incubation period varied from 8-9 days with a mean of 8.4 ± 0.24 days, the average diameter of the eggs was 0.91 ± 0.03 mm. The colour of the egg changed from brown to blue on the 8th day of oviposition before hatching. *P. raya* eggs hatched in about 9 days under the normal room temperature and relative humidity and the hatching percentage recorded was in the range of 95-98 %.

Larval period: In the present study, six larval instars were recorded. The newly hatched larvae were black in colour and the duration of 1st instar lasted for 5-7 days with a mean of 5.8 ± 0.37 days depending on the natural environmental condition. The length of the first instar larvae varied from 6.95 -7.20 mm and 0.38 - 0.45 mm in wide. Tiny soft hairs were present all over the segmental region. The second instar larvae were very active in movement. The body colour changed into brick red with brown body hairs. The larval duration of second instar ranged from 7 to 9 days with a mean of 8.0 ± 0.45 days. The larval body ranged from 11.90 mm to 12.45 mm in length and 1.10 mm to 1.25 mm in width

respectively. The third instar larvae were brick red to chocolate colour in the third instar and lasted for 5 to 7 days with a mean of 6.2 ± 0.37 days. It measured 18.45 mm to 19.67 mm in length and 2.62 mm to 2.86 mm in breadth with a mean of 19.04 ± 0.193 and 2.42 ± 0.102 mm respectively. Body colour of fourth instar larvae was the same as the one in the third instar larvae and the larval duration varied from 6 to 7 days with an average of 6.6 ± 0.24 days. The body hairs became longer and more conspicuous and changed from white to brown. The body size ranged from 26.12 mm to 27.15 mm in length and 3.34 mm to 3.94 mm in width with an average of 26.72 ± 0.223 and 3.66 ± 0.104 mm respectively. The fifth instar larva was darker in colour than that of the fourth instar. The segmental hair turned white or yellow. The duration of the fifth stage larva also lasted for 6 to 7 days with an average of 6.8 ± 0.20 days. The larvae remained in cluster hanging downwards with the help of fine threads released from the mouth. Length of the fifth instar larva measured 34.61 mm to 36.13 mm and 5.04 mm to 5.95 mm in width respectively. The final and sixth instar larvae were dark red in colour with white segmental hairs. The larval duration of the sixth instar lasted for a period of 10 to 12 days with a mean of 11.0 ± 0.32 days. The total larval period ranged from 39-49 days with an average of 43.4 ± 1.81 days.

Prepupal and pupal period: The mature larvae became shorter and sluggish in movement. The prepupal varied from 2-3 days with a mean of 2.4 ± 0.24 days. The larva started crawling down the stem towards the soil and burrowed in the soil upto a depth of 2 to 2½" deep. Within a period of 3 to 4 days the last instar larva underwent pupation leaving its exuviae and assumed the obtect adecticous pupa. The pupal period lasted for 12-15 days with an average of 13.4 ± 0.67 days. The male pupa is slender than female pupa. The length and width of the pupa were 24.45 to 26.74 mm in length and 8.10 to 8.61 mm in width with a mean of 25.64 ± 0.40 and 8.30 ± 0.08 respectively.

Adult Moth: The adult moth was dirty white or light brown in colour having one or two blackish strips on the wing. Adult longevity was recorded 4 – 5 days. The fore wing expanse of female moth measured 73.2 to 75.6 mm and hind wing 18.3 to 20.9 mm. The abdominal length of female adult ranged from 30.2 to 37.5 mm and width ranged from 7.5 to 8.0 mm. The antenna was bipectinate type with a length of 13.7 to 14.3 mm. The fore wing of male moth was 57.1 to 59.6 mm and hind wing with a length of 12.2 to 13.4 mm. The abdominal length of adult male measured 22.6 to 24.7 mm bearing bushy antenna measuring 12.4 to 13.3 mm in length. The total developmental period from egg to adult was 65-72 days.

Oviposition period and fecundity: The sex ratio observed was 1 : 1.5 (male to female). Pairing took place after half an hour to one hour of emergence and continued for 12 to 18 hours, if not disturbed. The moths detached themselves after copulation. The male moths died 2-3 days after emergence while female moth continued surviving for 4-5 days. Sometimes, it was also observed that female moth died during oviposition. The fecundity ranged from 543 to 680 eggs/female (average of 610 ± 24.80 eggs/ female).

CONCLUSION

The present study on the biology of *Phalera raya* will surely lead to development of a feasible pest management programme and further help in the development of the oak tasar silk industry and boost the oak tasar cocoon productivity.

ACKNOWLEDGEMENTS

The authors are thankful to Central Silk Board, Ministry of Textiles, Govt. of India, Bangalore for providing financial support for carrying out this work.

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Table 1. Biological attributes of *Phalera raya*.

Sl. No.	Parameters	Range	Mean \pm SD
1.	Incubation Period (days)	8 - 9	8.4 \pm 0.24
2.	Fecundity (no.)	543 - 680	610.8 \pm 24.80
3.	Hatching %	95 - 98	97.05 \pm 0.58
4.	Larval Instars (days)	-	-
	1 st instar	5 - 7	5.8 \pm 0.37
	2 nd instar	7 - 9	8.0 \pm 0.45
	3 rd Instar	5 - 7	6.2 \pm 0.37
	4 th instar	6 - 7	6.6 \pm 0.24
	5 th instar	6 - 7	6.8 \pm 0.20
	6 th instar	10 - 12	11.0 \pm 0.32
5.	Total Larval period (days)	39 - 49	43.4 \pm 1.81
6.	Pre-pupal period (days)	2 - 3	2.4 \pm 0.24
7.	Pupal Period (days)	12 - 15	13.4 \pm 0.67
8.	Adult longevity (days)	4 - 5	4.5 \pm 0.43
9.	Sex ratio	1 : 1.5	--
10.	Total Life cycle (days)	65 - 72	--

*Mean of 10 replications

Table 2. Morphometric dimension of life stages of *Phalera raya*.

Life Stages	Body length (mm)	Body width (mm)
Egg		0.91 \pm 0.03 (diameter)
1 st instar	7.06 \pm 0.046	0.41 \pm 0.012
2 nd instar	12.12 \pm 0.092	1.17 \pm 0.025
3 rd instar	19.04 \pm 0.193	2.42 \pm 0.102
4 th instar	26.72 \pm 0.223	3.66 \pm 0.104
5 th instar	35.11 \pm 0.268	5.43 \pm 0.19
6 th instar	59.45 \pm 0.642	7.44 \pm 0.088
Pupa	25.64 \pm 0.401	8.30 \pm 0.08
Adult	30.50 \pm 0.103	7.55 \pm 0.242

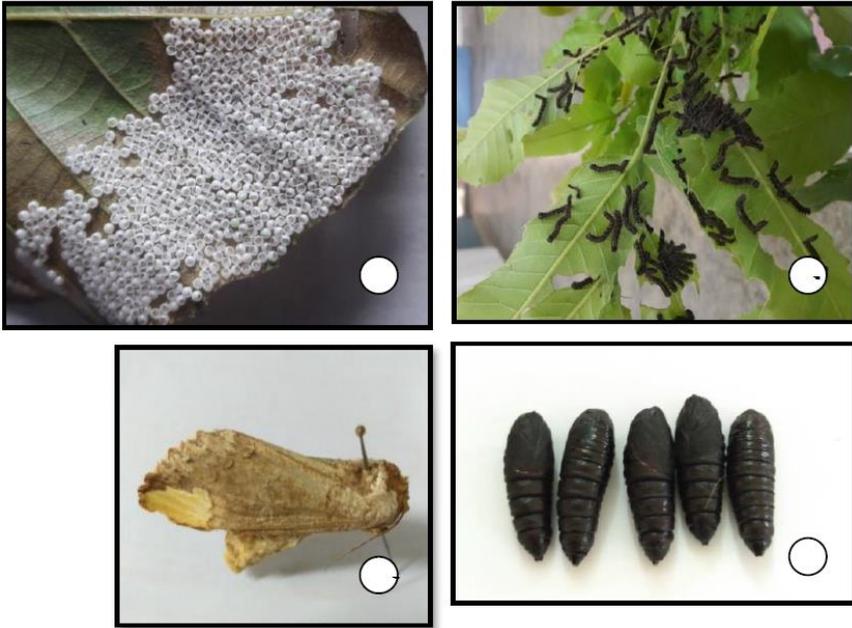


Figure 1. Life stages of *Phalera raya*, a-egg, b-larva, c-pupa, d-adult.



Figures 2-3. A. Leaf damage caused by *P. raya* colony, B. Gregarious nature of *P. raya* larva.