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Studies on the biology of cigarette beetle, *Lasioderma serricorne* (F.) (Coleoptera: Anobiidae) in turmeric powder

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Abstract
The cigarette beetle, *Lasioderma serricorne* (F.) is a serious pest of stored turmeric, therefore, an experiment was conducted to study their life history in turmeric powder. The female insect laid their eggs singly on the surface of turmeric powder. Eggs were pearl white, oval shaped with spines on the single end of an egg. The larvae were scarabaeiform, creamy white in colour and uniformly covered with fine hairs. They have completed four larval instars and pupated inside the cocoon made from food materials. The mean incubation, larval, pre-pupal, pupal and the developmental period were 9.40 ± 0.40, 28.20 ± 1.45, 4.50 ± 0.34, 9.50 ± 0.65 and 51.60 ± 2.06 days, respectively. The percentage of egg hatching, pupation, adult emergence, fecundity and sex ratio were 76.75 ± 3.00, 89.79 ± 1.42 and 89.73 ± 1.27, 26.70 eggs and 1:1.1, respectively. The adults were reddish brown beetles with a head deflexed down which is at right angle to the body giving humpback appearance. The adult longevity and total life cycle of male, female were 11.20 ± 0.55, 12.40 ± 0.60 and 62.80 ± 2.06, 64.00 ± 2.26 days, respectively.

Keywords: Biology, *Curcuma longa*, *Lasioderma serricorne*

Introduction
Turmeric, *Curcuma longa* (L.) is an ancient sacred spice in India which is also known as 'Indian saffron' belongs to the family Zingiberaceae. It is the native of Indian subcontinent and Southeast Asia. In India, it is grown in Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat and Kerala covering a total area of 193,570 ha with an annual production of 969,500 MT. India is the largest producer, consumer and exporter of turmeric in the world (Tamang, 2015) [13]. Indian turmeric occupies a major share in world market and is considered as the best because of its high curcumin content (Velayudhan *et al.*, 2012) [14]. In Tamil Nadu, it is mainly cultivated in the districts of Erode, Salem, Coimbatore, Tiruppur, Dharmapuri, Krishnagiri, Karur and Villupuram (Dsouza *et al.*, 2015) [7].

The cigarette beetle, *L. serricorne* is one of the severe storage pests that commonly infest during storage, manufacturing and at the retail level (Arbogast *et al.*, 2003) [1]. It is known to successfully breed and develop on a variety of grain-based products, spices, tobacco, flour, dried yeast and animal matters (Dimetry *et al*, 2004) [6]. Larval feeding causes bore hole damage on the stored commodities (Minor, 1979) [11] while adults are known to cause damage by cutting holes to escape from packaged commodities (Highland, 1991) [8]. In addition to feeding damage, the presence of dead insects, residues from different life stages such as cast skins or pupal cases and frass become contaminants in commodities and render them undesirable for human consumption.

Material and Methods
Study entitled "Biology of Cigarette beetle, *L. serricorne* (F.) (Coleoptera: Anobiidae) in turmeric powder" was carried out in the Post Graduate Laboratory, Department of Plant Protection, Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Tiruchirappalli during the year 2017 to 2018.

Mass culturing of test insect
The test insect, cigarette beetle was collected from infested rhizomes stored in the godowns of M/S Ulavan Producers Company Ltd., Erode and Indian Institute of Food Processing Technology (IIFPT), Thanjavur.

The stock culture was maintained in sterilized wheat flour + 5% dried yeast. Adults were released into the plastic container (14 cm × 11.5 cm) of 1.5 litre capacity containing 250 gm of wheat flour + 5% dried yeast. The containers were covered with muslin cloth and kept for oviposition at 30 ± 2 °C room temperature and 60 ± 5 per cent relative humidity. The plastic container was fully covered with a black sheet to create darkness. A paper strip was provided for the purpose of movement of adults and to facilitate hiding themselves. Adults started emerging from the culture, after 40 to 45 days of initial introduction.

Experimental setup

The ten numbers of test tubes (14.5 cm × 2.3 cm) and petri plates (100 mm × 15 mm) was used for the study. The experimental set up is demonstrated in Plate 1. Observations were recorded on the fecundity (no.), incubation period (days), egg hatching (%), total larval period (days), pre-pupal period (days), pupation (%), pupal period (days), total developmental period (days), adult emergence (%), sex ratio, adult longevity (days) and total life cycle (days).

To study the fecundity of the cigarette beetle, a pair of newly emerged adults was released into a test tube (14.5 cm × 2.3 cm) of 70 ml capacity containing turmeric powder (10g) for mating and oviposition. Number of eggs were counted using a trinocular microscope after the pre-oviposition period of three days. The adults were removed carefully and eggs along with turmeric powder were transferred to petri plates (100 mm × 15 mm) daily until the death of adults. The period between egg laying and hatching was calculated as incubation period. The hatching percentage of the eggs was calculated by

$$\text{Egg hatching (\%)} = \frac{\text{Number of eggs hatched}}{\text{Total number of eggs laid}} \times 100$$

From hatching to pupation, the period spent by the larvae was taken as larval period. The presence of exuviae was noted as the proof of completion of larval instars. The pre-pupal period was calculated from the day of cocoon formation to the day, the cocoon was fully formed. The percentage of pupation was calculated by

$$\text{Pupation (\%)} = \frac{\text{Number of pupa formed}}{\text{Number of eggs hatched}} \times 100$$

The pupal period was calculated as the period between the formation of pupa to the adult emergence. After the completion of cocoon formation, turmeric powder was removed and the pupa adhering to the surface of petri plates were carefully observed for adult emergence. The emerged adults were again transferred to test tubes for studying adult parameters of beetles. The developmental period was calculated as the total of incubation period, larval period, pre-pupal period and pupal period. The percentage adult emergence was calculated by

$$\text{Adult emergence (\%)} = \frac{\text{Number of adults emerged}}{\text{Number of pupa formed}} \times 100$$

Adult male and female insects were differentiated on the basis of size *viz.*, females are larger than the males. The emerged adults were separated and counted to get the sex ratio. The male and female longevity was recorded as the period between the date of emergence to the date of death of the adult. The period between the date of egg laying to the death of an adult was considered as a total life cycle.

Table 1: Biology of *L. serricorne* in turmeric powder

Biological Parameters	Period (days)		Mean ± S.E.
	Min.	Max.	
Fecundity (no.)	9.00	42.00	26.70 ± 3.23
Incubation period	7.00	11.00	9.40 ± 0.40
Egg hatching (%)	58.62	85.18	76.75 ± 3.00
Larval period	22.00	35.00	28.20 ± 1.45
Pre-pupal period	3.00	6.00	4.50 ± 0.34
Pupation (%)	83.33	96.77	89.79 ± 1.42
Pupal period	7.00	13.00	9.50 ± 0.65
Total developmental period	42.00	63.00	51.60 ± 2.06

Mean ± SE of ten observations; SE - Standard Error

Table 2: Adult parameters of *L. serricorne* in turmeric powder

Adult parameters		Min.	Max.	Mean ± S.E.
Adults emerged (%)		83.33	96.96	89.73 ± 1.27
Adults emerged (no.)	Male	3.00	15.00	8.00 ± 1.31
	Female	2.00	17.00	8.60 ± 1.36
Sex ratio		1: 0.5	1: 1.6	1: 1.1
Adult longevity (days)	Male	9.00	14.00	11.20 ± 0.55
	Female	10.00	15.00	12.40 ± 0.60
Total lifecycle (days)	Male	55.00	74.00	62.80 ± 2.06
	Female	56.00	77.00	64.00 ± 2.26

Mean ± SE of ten observations; SE - Standard Error

Results and Discussion

The results showed that the eggs were oval shaped, white in colour, translucent with spines at their single end. The fecundity of the female insect varied from 9.00 to 42.00 eggs with an average of 26.70 ± 3.23 eggs. The incubation period of eggs laid by the cigarette beetle ranged from 7.00 to 11.00 days with an average of 9.40 ± 0.40 days and the hatching percentage of the eggs ranged from 58.62 to 85.18 per cent with an average of 76.75 ± 3.00 per cent. The first instar larvae were active and started to make bore holes through feeding while the last instar larvae were sluggish. The larval period ranged from 22 to 35 days with an average of 28.20 ± 1.45 days. The final instar larvae constructed cocoons which were attached to the bottom surface of petri plate. The pre-pupal period ranged from 3.00 to 6.00 with an average of 4.50 ± 0.34 days. Pupation took place inside the cocoon. The percentage of pupation ranged from 83.33 to 96.77 with an average of 89.79 ± 1.42. The pupal period ranged from 7.00 to 13.00 days with an average of 9.50 ± 0.65 days. The total developmental period varied from 42.00 to 63.00 days with an average of 51.60 ± 2.06 days (Plate 2, Table 1).

The observed fecundity was different from the findings of Tamang (2015) [13], who recorded 50.20 eggs in turmeric powder. The difference in oviposition might be due to the nutritional status of the host. Chun (2008) [5] and Tamang (2015) [13] reported that the egg period was 8 days and 9 days, respectively which was in agreement with the present findings. Sivik *et al.* (1957) [12] and (Tamang (2015) [13] reported that the hatching percentage was 68.00 per cent in tobacco and 67.20 ± 8.44 in turmeric powder which was in accordance with the present findings. Even though various authors have reported different larval period in different hosts, the present study coincides with the findingsof Tamang, 2015 [13] (27.1 days) and Chaitanya *et al.*, 2016 [4] (30.0 days) in turmeric. Regarding pre-pupal period, the present finding is supported by the reports of Tamang, 2015 [13] (4 to 6 days), Ashworth, 1993 [2] (2 to 4 days) and found controversy with

the findings of Basheer *et al.* 2013 [3] (8 days) who reared it in tobacco leaves.

The present findings of pupal period were collaborate with the findings of Ashworth, 1993 [2] (4 - 12 days) and Tamang, 2015 [13] (7 - 10 days). The total developmental period varied between 46.00 - 109.20 days (Mahroof and Phillips, 2007) [10] on different food sources (Ground chilli, paprika, cayenne pepper, chewing leaf tobacco, cigar tobacco, wheat flour and NOW bait) which coincides with our present findings. However, the variations might be due to the changes in the quality, quantity of the food and also changes in the environment.

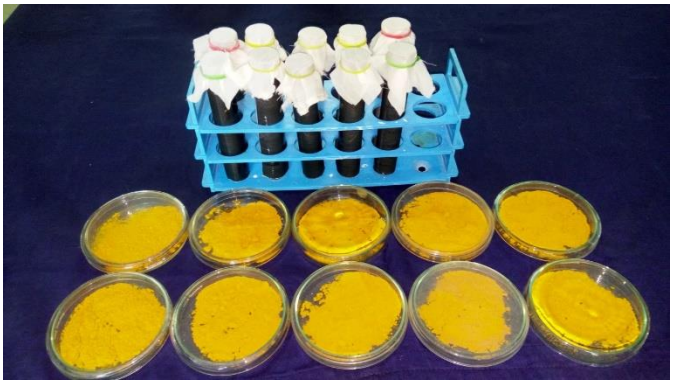

Plate 1: Experimental set up for the studies on the biology of *L. serricorne* in turmeric powder

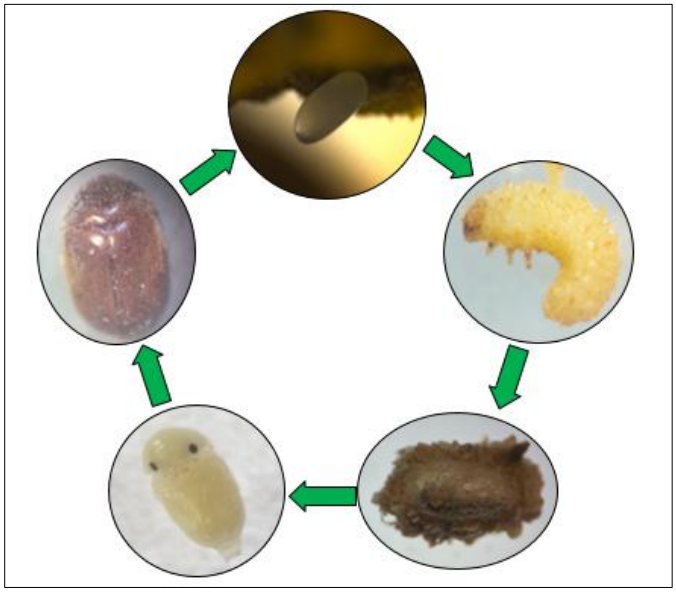

Plate 2: Life cycle of *L. serricorne* in turmeric powder

The adult beetles were reddish brown in colour with smooth elytra. The percentage of adult emergence ranged from 83.33 to 96.96 per cent with an average of 89.73 ± 1.27 per cent. The male and female ratio ranged from 1:0.5 to 1:1.6 with an average of 1:1.1. The adult male survived for 9.00 to 14.00 days with an average of 11.20 ± 0.55 days, whereas in case of female, the survival rate was 10.00 to 15.00 days with an average of 12.40 ± 0.60 days. The average total life cycle of male was 62.80 ± 2.06 days which varied from 55.00 to 74.00 days, for the female, it was 64.00 ± 2.26 days, as an average and ranged from 56.00 to 77.00 days (Table 2).

The present findings of sex ratio (1:1.1) are in accordance with Howe (1957) [9], Ashworth (1993) [2] and Chun (2008) [5] who reported the sex ratio as 1:1. Tamang (2015) [13] recorded the similar adult male longevity of 10 to 18 days and adult female longevity of 13 to 19 days. It was observed that the females lived for longer duration than males. The observations pertaining to longevity of adults was also in agreement with Basheer *et al.* (2013) [3] who reported that females lived longer than male insects.

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