

**RESEARCH ARTICLE :**

Biology and behaviour of lesser grain borer, *Rhizopertha dominica* (Fabricious) (Coleoptera: Bostrichidae) on stored wheat in laboratory conditions

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SUMMARY : The study on biology and behavior of *R. dominica* was made on the wheat variety GW-496 under laboratory conditions in at an average temperature of $30 \pm 1^{\circ}$ C. and 70 ± 5 % relative humidity. Eggs were laid loosely on the surface of the grain and are oblong with rounded ends. An average length and breadth of freshly laid eggs is 0.56 ± 0.06 mm and 0.23 ± 0.04 mm with an average incubation period of 4.05 ± 1.89 days. The grub was white in colour and as it matures, it becomes C-shaped and immobile. The mean duration of grub period was 16.24 ± 4.24 days and pupal period was 3.75 ± 2.82 days. The total developmental period was varied from 38 to 67 days in male and 78 to 107 days in female with an average of 52.20 ± 5.66 days in male, whereas it was 95.85 ± 9.19 days for the female. Adults were dark reddish brown and the body has a slender cylindrical form. Males occurred slightly higher in number than females and male to female sex ratio was 1.09: 1.0. The average life span of female and male was 32.75 ± 2.82 , 25.85 ± 2.12 days, respectively. The average pre-oviposition, oviposition, post-oviposition periods were 1.75 ± 0.72 , 22.05 ± 2.12 and 7.95 ± 1.41 days, respectively. The average of 159.1 ± 16.81 eggs was laid by a single female.

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BACKGROUND AND OBJECTIVES

Wheat is attacked in field as well as in storage by several pests. About 39 species of insect pests attack the stored grains and grain produce. Among them lesser grain borer, *R. dominica* (Coleoptera: Bostrichidae) is the major pest in the storage causing heavy losses

to the tune of 15 to 66% (Saxena and Singh, 1995). It not only causes quantitative loss but also qualitative losses like nutritive loss, germination losses and make the wheat unfit for marketing as well as for human consumption. Lesser grain borer, *R. dominica* is a field to store pest and this may cause economic damage in the store (Adedire, 2001).

The adults are powerful fliers and migrate from one godown to another, causing fresh infestation. When the infestation is severe, the adults produce a considerable amount of frass, spoiling more than what they eat. The flour, so produced, serves as nourishment for the young grubs until they are ready to bore into the grain. It not only reduces the quantity but also deteriorate the quality of grain and its products (Atwal, 1994). Lesser grain borer is one of the smallest beetles, infesting wheat grain. Unlike most primary stored-grain pests, *R. dominica* is not known to attack cereals in the field, but it is a strong flier and has been found in festing grain, in supposedly clean stores within weeks or months after storage. This rapid colonization behaviour, strong flight ability and broad polyphagy, coupled with the fact that *R. dominica* has been trapped in diverse environments, including woodlands substantial distances from grain stores led us to suspect movement of this pest between potentially natural habitats and grain storage facilities. It is originally native to the tropics and it has spread through commerce to all parts of the world. It is most prominent in the United States, Southern Canada, Argentina, India and Australia.

Lesser grain borer is the primary pest and therefore it attacks undamaged grain and renders it susceptibility to secondary pests. Both the adults and grub feed on the grain creating floury dust and potentially leaving little but empty husks. The adults are active and may infest a large number of kernels while the larvae penetrate kernels and develop within the grain in infested wheat. So, the present work is undertaken to study the morphological measurement of the different developmental stages of this pest to suggest suitable management option.

RESOURCES AND METHODS

Ten pairs of one to two days old adults of *R. dominica* were released for egg laying in glass jars (21 cm × 15 cm) containing 200 g wheat grains. The grains containing the eggs were collected on next day morning. In order to facilitate the observations, one egg was kept on each grain, while other was removed with the help of needle. Such one hundreds grains were kept individually in plastic vials (6.5 × 2.5 cm) under laboratory conditions. The eggs laid on wheat grains were observed under microscope for studying their colour, shape and size. To determine number and duration of different larval instars, 900 grains bearing eggs will be kept in group of 30 grains in plastic vials (6.5 × 2.5 cm) and will be closed with

perforated plastic lids. 30 wheat grains will be softened and dissected daily with the help of fine needles and was observed with binocular microscope. The measurements such as length and breadth of larvae were recorded daily. The adults emerged on the day were paired and released in plastic vials (6.5 × 2.5 cm) containing fifty grains of wheat. The grains with eggs were replaced daily by healthy grains and the numbers of eggs laid by an individual female were recorded till all the female died.

Length and breadth:

The length and breadth of different stages of the insect were observed under a stereo- microscope and measured with the help of slide calipers.

Observations to be recorded :

- Egg
- Larval period
- Pupal period
- Adult
- Total developmental period
- Sex ratio
- Longevity of male and female
- Oviposition period
- Fecundity
- Behaviour

OBSERVATIONS AND ANALYSIS

Biology and behavior of *R. dominica* was studied on wheat variety GW-496 at an average temperature of $30 \pm 1^{\circ}\text{C}$ and $75 \pm 5\%$ R.H under laboratory conditions. The study was carried out during the month of November 2014. The results of present studies are summarized in Table 1 and 2.

Egg :

Eggs were laid loosely on the surface of the grain and were oblong with rounded ends. One of the ends was usually slightly narrower than the other. The tip of the anterior end was sometimes elongated into a short projection, but the egg shape was considerably variable. Fresh eggs were opaque, alabaster white in colour and with a waxy appearance and the colour of the oldest eggs tends towards pink. The tip of the anterior end was light brown in colour. The results presented Table 1 indicated that the length of freshly laid eggs varied from 0.50 to 0.60 mm with an average of 0.56 ± 0.06 mm and

breadth varied from 0.18 to 0.26 mm with an average of 0.23 ± 0.04 mm. More or less similar observations on measurement of eggs were also reported by LeCato and Flaherty (1974).

The data presented in Table 1 revealed that the incubation period was ranged from 5 to 6 days with an average of 4.05 ± 1.89 days. The viability of eggs was 90 %. Potter (1935) studied that eggs are oval-shaped, 0.5 - 0.6 mm in length and 0.2 in diameter. The eggs were hatch out in about 7-18 days depending upon temperature (Anonymous, 2012). Bharati (2009) noted that eggs hatch in about 5-11 days into fleshy grubs, which appear swollen at the extremities and bore into grains and feed inside. Mason and McDonough (2012) reported that egg development takes 32 days at 18.1°C (64.6°F) but only five days at 36°C (96.8°F). According to Mason (2003) eggs lay in stored commodities at moisture level as low as 8% can still hatch and develop. Thus, the present findings are more or less similar to the results obtained by the earlier workers.

Larvae :

Most of the newly-hatched larvae feed on the grains and complete their entire development in the grains. The creamy white larva is a C-shaped grub with a small dark head that is partly retracted into the thorax. The thorax has three pairs of small legs. The larva is white and as it matures, it becomes C-shaped and immobile. First instar larvae was campodeiform and usually bore into the grain where it remains and continues to feed on the endosperm until it becomes an adult. The second larval stage was scarabaeiform but is capable of active locomotion. The third and subsequent larval stages were also scarabaeiform and are largely immobile. The number of moults was ranged from four to five. The larval period was varied from 12 - 19 days. The mean duration of

larval period is 16.24 ± 4.24 days.

First instar:

The length of first instar larva varied from 0.70 to 0.85 mm with an average of 0.78 ± 0.04 mm, whereas the breadth varied from 0.15 to 0.23 mm with an average of 0.20 ± 0.04 mm.

Second instar :

The length of second instar larva varied from 1.04 to 1.16 mm with an average of 1.09 ± 0.06 mm, whereas the breadth varied from 0.28 to 0.32 mm with an average of 0.30 ± 0.03 mm.

Third instar :

The length of third instar larva varied from 2.04 to 2.15 mm with an average of 2.08 ± 0.08 mm, whereas the breadth varied from 0.38 to 0.43 mm with an average of 0.40 ± 0.04 mm.

Fourth instar :

The length of fourth instar varied from 3.04 to 3.16 mm with an average of 3.10 ± 0.05 mm, whereas the breadth varied from 0.54 to 0.68 mm with an average of 0.61 ± 0.08 mm. These observations were also tallied with those reported by Potter (1935) and Howe (1950).

The larva bore into the grains where they feed and develop into fleshy forms with a typical C-shape. There are upto five moults leading to pupation in the grain, Anonymous (2012). Bharati (2009) revealed that the larval period lasts from 25 to 50 days depending on the season. Mason and McDonough (2012) revealed that a 3-degree increase in temperature (25 to 28°C) (77 to 82.4°F) results in to 17-days increase in larval development. Larvae are white and c-shaped. They have four to five larval instars if on whole grain, or two to

Table 1 : Measurement of different life stages of *R. dominica* recorded on wheat grain

Sr. No.	Stage	Length (mm)			Breadth (mm)		
		Min.	Max.	Average \pm S.D.	Min.	Max.	Average \pm S.D.
1.	Egg	0.50	0.60	0.56 ± 0.06	0.18	0.26	0.23 ± 0.04
2.	Larva						
	First instar	0.70	0.85	0.78 ± 0.04	0.15	0.23	0.20 ± 0.04
3.	Second instar	1.04	1.16	1.09 ± 0.06	0.28	0.32	0.30 ± 0.03
4.	Third instar	2.04	2.15	2.08 ± 0.08	0.38	0.43	0.40 ± 0.04
5.	Fourth instar	3.04	3.16	3.10 ± 0.05	0.54	0.68	0.61 ± 0.08
6.	Pupa	3.48	3.58	3.53 ± 0.07	1.04	1.18	1.11 ± 0.06
7.	Adult						
	Male	2.2	2.7	2.44 ± 0.28	0.85	0.98	0.91 ± 0.06
8.	Female	2.7	3.2	2.97 ± 0.21	1.10	1.22	1.16 ± 0.06

seven (usually three to four) if feeding on whole meal. The limiting temperatures for larval development are 18.2°C (64.8°F) and 38.6°C (101.5°F). Linda (2010) reported that the larval development is more rapid on whole grain than on meal made from the same grain. Young larvae cannot penetrate undamaged kernels. If inside whole kernels, larvae moult four to five times, where as if in whole meal, they will moult two to seven times. Larval development usually takes 27-31 days at 28°C (82.5 °F) and 46 days at 25°C (77°F). The larvae may complete their development in the grain residue. Larval hatch takes place between 5 - 14 days depending on environmental conditions (Chittenden, 1911 and Crombie, 1941). Larval development is more rapid on whole grain than on meal made from the same grain and usually takes 27 - 31 days at 28 °C and 46 days at 25°C. Young larvae cannot penetrate undamaged grains (Mason, 2003 and Hodges, 1986). Larvae develop more rapidly in whole grains than flour, especially grains with damaged pericarp. Larvae takes 17–19 days to complete 3–5 moults at 30–34°C and 70–80 % R.H, and pupate in whole grains (Howe, 1950 and Osuji, 1982). Thus the present findings are in accordance with earlier workers.

Pupa :

Pupation takes place inside the hollow shell of the seed or in the flour that accumulates with infested grain. The length and breadth of pupa summarized in Table 1 revealed that length of pupa ranged from 3.48 to 3.58 mm, with an average of 3.53 ± 0.07 mm, whereas breadth varied from 1.04 to 1.18 mm with an average of 1.11 ± 0.06 mm.

The pupal period was varied from 3 - 5 days. The mean duration of pupal period is 3.75 ± 2.82 days. The pupal stage lasts for about one week Anonymous (2012). The mature fourth instar larva pupates within the feeding cavity inside the grain and gradually assumes the form of an adult. According to Mason (2003) the duration of the pupal stage is approximately 5 - 6 days at 28°C and 8 days at 25°C. Linda (2010) revealed that pupation takes place in an enlarged cell where the larval feeding tube ends. The duration of the pupal stage was approximately 5-6 days at 28 °C (82.5°F) and 8 days at 25°C (77°F). Thus, the results obtained during present investigations are more or less supported the results reported by earlier workers.

Adult :

Adults were dark reddish brown and 3 mm long with distinctly shaped, loose 3-segmented club. The body has a slender cylindrical form. The head was hidden under the slightly knobby, pitted prothorax. The elytra (hard, shell-like forewings) have distinct rows of pits running their length. The males were usually more active and better flier than the females. Measurement of male adult revealed that the length in Table 1 varied from 2.2 to 2.7 mm with an average of 2.44 ± 0.28 mm, while breadth varied from 0.85 to 0.98 mm with an average of 0.91 ± 0.06 mm. In case of female the length varied from 2.7 to 3.2 mm with an average of 2.97 ± 0.21 mm, while breadth varied from 1.10 to 1.22 mm with an average of 1.16 ± 0.06 mm. Thus, the female were slightly bigger in size than the male.

At 26°C and 70 % RH the life cycle last for 45 days and adults can live for 10 months Anonymous (2012). Bharati (2009) reported that the beetle was small (about 4 mm long), slender, cylindrical, polished dark brown or black, with a roughened wing surface. The head was turned down and covered by a hood-shaped thorax which bears small patches around the edge. Doug (2009) revealed that the adults are 0.1 inch long, brown to black beetles with cylindrical bodies and numerous small pits on the wing covers. The head was directed downward and covered by the prothorax so that it is not visible when the insect was viewed from above. Thus, the above findings support the present investigation.

Total developmental period :

The total developmental period was calculated from the day of oviposition to adult emergence. It was varied from 38 - 67 days in male and 78 - 107 days in female with an average of 52.20 ± 5.66 days in male, whereas it was 95.85 ± 9.19 days for the female at 30 ± 1 °C under laboratory conditions (Table 2).

The total life cycle lasts from 24-133 days depending upon the temperature Anonymous (2012). The life cycle lasts 45 days at 26 °C and 70 % RH (14% moisture content in commodities. Anonymous (2014) reported the normal development time for the lesser grain borer to develop from egg to adult is 58 days, but it can develop to an adult in 25 days under optimal conditions around 30° C. *R. dominica* requires about 27-30 days at 30°C and 60% RH to develop from egg to adult when reared on wheat, Anonymous (2012). Doug (2009) reported that

development from egg to adult requires about 25 days under ideal conditions of 93°F and 12 % moisture. Thus, the results obtained in present investigations are substantiated with the studies conducted by earlier workers.

Sex ratio :

The males and females were separated from 90 adults emerged. Among the 90 adults emerged during the study of biology of *R. dominica* on GW-496 variety of wheat, 47 were males and 43 were females. Thus, males occurred slightly higher in number than females and male to female sex ratio was 1.09: 1.0. According to Malgorzataklys (2006) studied on the sex ratio of *Rhizopertha dominica* in different habitat and diet conditions and found that at the initial and final stages of the population development in wheat, the proportion of males was higher ($\frac{\text{♂}}{\text{♀}} > 2$), whereas a higher number of females was observed in the period between the 100th and 160th day of the experiment.

Longevity :

The results presented in (Table 2) indicated that the female lived longer than male. The average life span of female was 32.75 ± 2.82 days, while that of male was

25.85 ± 2.12 days. Longevity of males was varied from 23 – 28 days and that of females 30 – 35 days. Detailed study on longevity of adult *R. dominica* (Edde unpublished data) showed that the beetle can survive upto 54 weeks at 29-30°C and 65 % RH when fed on wheat. The adult beetle was dark reddish-brown with a cylindrical body about 3 mm long and may live upto 240 days and is a strong flier Anonymous (2014). According to Hagstrum and Throne (1989) the adults are long lived and can fly to disperse and initiate new grain infestations.

Pre-oviposition period :

Adults were found to mate within one hour of their emergence from the grain. For mating the adults preferred to come on the surface layer of grain. The studies on pre-oviposition period showed the average period of 1.75 ± 0.72 days with a range of 1 - 3 days. Linda (2010) mentioned that the oviposition starts approximately 15 days later and last upto 4 months.

Oviposition period :

The results obtained on oviposition period are presented in Table 2. It is evident from the data that mean oviposition period was 22.05 ± 2.12 days with a range of 20 - 25 days.

Table 2 : Biology of *R. dominica* at $30 \pm 1^{\circ}$ C and 75 ± 5 % R.H. in stored wheat under laboratory conditions

Stage	Number of individuals observed	Duration in days	
		Range	Average \pm S.D.
Egg	100	5 - 6	4.05 ± 1.89
Total larval period	90		
First instar		3 – 5	3.70 ± 1.04
Second instar		2 – 4	3.05 ± 0.70
Third instar		3 – 7	4.65 ± 2.12
Fourth instar		4 - 8	6.10 ± 1.41
Pupal period	90	3 – 5	3.75 ± 2.82
Total developmental period (Egg to adult emergence)			
Male	25	38 – 67	52.20 ± 5.66
Female	25	78 - 107	95.85 ± 9.19
Adult			
Sex ratio (male: female)	90	1.09 : 1	-
Adult longevity			
Male	25	23 – 28	25.85 ± 2.12
Female	25	30 – 35	32.75 ± 2.82
Pre- oviposition period	25	1 – 3	1.75 ± 0.72
Oviposition period	25	20 – 25	22.05 ± 2.12
Post- oviposition period	25	6 – 11	7.95 ± 1.41
Fecundity (eggs/ female)	25	127 – 182	159.1 ± 16.81

Bharati (2009) indicated that the oviposition period was upto 3-6 weeks. Linda (2010) indicated that the moisture content of the grain can influence oviposition and developmental rates. Oviposition starts approximately 15 days later and can last upto 4 months. Females survive for several days after oviposition ceases.

Post- oviposition period :

A close perusal of data presented in Table 2 indicated that the post oviposition period was 6 - 11 days with an average of 7.95 ± 1.41 days. Linda (2010) stated that females survive for several days after oviposition ceases.

Fecundity :

The experimental results summarized in Table 2 reveals that the average number of eggs laid by a single female was 159.1 ± 16.81 which varied from 127 – 182 eggs per female.

The female lesser grain borer lays eggs 300-500 over a period of three weeks and are laid singly or in clusters from 2-30 and are often attached to the grain, Anonymous (2012). The female lay eggs one at a time or in batches of upto 30 and can lay upto 500 eggs over 3 or more months and optimal conditions for egg laying are 20°C to 34°C and 14 % grain moisture content, Anonymous (2014). Bharati (2009) mentioned that adults lay from 300 to 500 eggs singly or in clusters on grains or in powdery material over a period of 3-6 weeks. One female can deposit between 200-500 eggs during her lifetime. Eggs may be deposited either in clusters on grain, or singly among the frass produced by the insect. The beetle lays an average of one to seven eggs per day over several months (Hagstrum and Flinn, 1994), and the number of eggs laid may be affected by photoperiods, such that more eggs were laid during long photoperiod (Aslam *et al.*, 1994). Doug Johnson (2009) observed that the female deposits eggs in clusters of about 2 to 30 on grains.

Behaviour :

Adults were found active in the morning and evening time. The beetle showed feigns death, when disturbed them. They resumed their normal activity after short time. Freshly emerged adults were sexually matured and mating took place within a day of emergence. Mating generally occurred during 6.30 to 9. 30 am, and 6.00 to 10.00 pm.

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