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Bio-ecology of rice moth *Corcyra cephalonica* (Stainton) on groundnut seeds

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Abstract
Biology of rice moth, *Corcyra cephalonica* (Stainton) was studied under controlled conditions at a temperature of 27 ± 1.8 ^{0}C and 70 ± 4.5% relative humidity in laboratory on groundnut variety GG-20, respectively. The mean length of eggs, full grown larva, pupa and adult wing span were 0.39 ± 0.03, 9.37 ± 0.71, 8.56 ± 0.55, 17.45 ± 1.37 (male) and 18.37 ± 1.66 (female) mm, respectively. Duration of egg, larva, pupa and adult ranged from 4.16 ± 0.80, 43.65 ± 4.52, 9.1 ± 0.96, 7.85 ± 0.87 (male) and 8.55 ± 0.94 (female) days, respectively. The average fecundity of rice moth was 202.2 ± 44.57 eggs with a 94% hatching. The survival percentage (S), mean development period (D) and growth index were 90 percent, 58.36 days and 1.54, respectively. The sex ratio of rice moth was 1:1.05.

Keywords: Bio-ecology, rice moth, survival percentage, growth index

Introduction
Groundnut, *Arachis hypogea* Linnaeus is an important oil seed crop which is native to South America. It is the third largest source of vegetable protein (Anonymous 2018) [1]. Also called as 'king of oilseeds', wonder nut and poor men's cashew nut. While being a valuable source of all the nutrients, it is a low-priced commodity (Thamaraikannan *et al.*, 2009) [15]. More than 100 species of insects that infest stored groundnuts are reported in documents (Delinger & Davis, 1982) [4]. Among the major pests of stored groundnut, rice moth, *Corcyra cephalonica* (Stainton) is considered to be an important pest. It is universally known as the "Rice meal moth" or the "Flour moth" (Pyralidae: Lepidoptera). The previous reference of this insect was made by Stainton (1866) [14], who conditionally named it *Melissoblaptes cephalonica* Stainton by giving a concise explanation. Afterwards a new genus, *Corcyra* was erected by Rogonot (1885) [12] to put up this insect, the name being imitative from the ancient name of "Corfu", where it was supposed to have been imported into England. According to Durant and Beveridge (1913) [6], *Corcyra* is apparently of eastern origin which has been introduced into Europe and elsewhere by the rice trade. Though, it is pest on various stored grains which also used as a factitious host for rearing of bio-control agents like lepidopteran egg parasitoids *Trichograma chilonis* Ishii and entomopathonic nematodes. The findings of the Nathan *et al.* (2006) [10] showed that the rearing of *C. cephalonica* from a high-quality source of nutrients contributed to high quality eggs for the development of high-quality *T. chilonis*. Hence, the present work was aimed at studying aspects of the bionomics of *C. cephalonica* on groundnut seeds variety GG-20 so that in future further study can be made for rearing of *T. chilonis*.

2. Materials and Methods
Morphometric study and biology of rice moth on groundnut has been studied under laboratory conditions. Adult moths collected from the stock culture maintained at Biocontrol Research Laboratory, A.A.U, Anand were used for mass culturing of *C. cephalonica* at a temperature of 27 ± 1.8 ^{0}C and 70 ± 4.5% relative humidity in laboratory on groundnut variety GG-20, respectively. The broken seeds of groundnut were sterilized by heating at 55 ºC temperature for four hours in an oven and the moisture content of the seeds was adjusted between 14 to 16 per cent. The broken seeds of groundnut were taken separately in wide mouth cylindrical jars up to three fourth level. A few pairs of male and female moths were released in each jar for oviposition. The top of the jar was covered with two muslin cloth tied with the help of rubber band. The jars were kept at an optimum temperature for the development of pest.
Twenty freshly laid eggs were kept in Petriplates and examined for studying their colour, shape and size. Eggs were observed daily till hatching for the evaluation of incubation

period and hatchability of the eggs. Hatching percentage was calculated from the number of eggs hatched out of total number of eggs (n=50) kept under observation. With the help of stereomicroscope, the length and breadth of eggs, larva, pupae, and adults were measured.

The freshly emerged male and female adults were collected from host commodity and were released in plastic jars (diameter 6 cm; height 12 cm) containing groundnut seeds. The jars were covered with muslin cloth tied with rubber band. Five per cent honey solution was provided as food every day. The eggs laid by each female on grain and jar surface as well as on outer surface of muslin cloth were counted daily with the help of moist camel hair brush and total number of eggs laid by each female (fecundity) were recorded. Pre-oviposition, oviposition and post-oviposition were also recorded. In order to study the sex ratio, laboratory reared adults were critically examined and the ratio determined by distinguishing male and female on the basis of labial palps, which are smooth and forward in females, however, blunt and unnoticeable in males. Growth index of *C. cephalonica* was calculated using the following formula (Singh and Pant, 1955) [13].

$$\text{Growth index} = \frac{\text{Percentage of adult emergence}}{\text{Average developmental period (days)}}$$

The percentage of adult emergence was calculated from the total number of eggs kept under observation and the total number of adults emerged from them. The period from the emergence of eggs to adults was known as developmental period.

3. Results and Discussion

The freshly laid eggs when observed under microscope, appeared pearly white, oval which was sculptured and at one end there was a short nipple-like process. At the time of hatching, the eggs turned yellowish in colour. On hatching, the young larva was creamy white in colour with reddish brown head. The larva had three pairs of true legs on thoracic segments and five pairs of pro legs on abdominal segments with a short hair on a body (Plate 1 & 2). There was characteristic seta above each spiracle arising from a small clear patch of cuticle surrounded by a dark ring of cuticle. Similar observations were also reported by Menge *et al.* (2018), Patil (2009) and Patel (2010) [9].

Table 1: Morphometric parameters of *C. cephalonica* reared on groundnut (GG 20, n=20)

Stages	Length(mm)			Width (mm)		
Egg	**Min**	**Max**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**
	0.35	0.43	0.39 ± 0.03	0.26	0.33	0.30 ± 0.02
Larva	Length (mm)			Width of head cap (mm)		
1st instar	0.56	1.06	0.86 ± 0.17	0.186	0.205	0.19 ± 0.01
2nd instar	0.95	1.33	1.09 ± 0.15	0.211	0.248	0.23 ± 0.02
3rd instar	2.36	2.85	2.64 ± 0.16	0.288	0.316	0.31 ± 0.01
4th instar	3.94	4.58	4.17 ± 0.18	0.392	0.432	0.41 ± 0.01
5th instar	5.01	5.92	5.53 ± 0.26	0.531	0.566	0.55 ± 0.01
6th instar	5.84	8.32	7.26 ± 0.92	0.615	0.645	0.63 ± 0.01
7th instar	8.45	10.56	9.37 ± 0.71	0.692	0.815	0.76 ± 0.04
Pupa	Length(mm)			Width (mm)		
Pre-Pupa	7.66	9.48	8.49 ± 0.59	1.04	1.89	1.61 ± 0.22
Pupa	7.69	9.41	8.56 ± 0.55	1.18	1.95	1.59 ± 0.23
Adult	Length (mm)			Wing span (mm)		
Male	6.5	9.1	8.22 ± 0.74	14.35	19.01	17.45 ± 1.37
Female	8.1	10.41	9.3 ± 0.71	15.9	21.5	18.37 ± 1.66

The average length and breadth of freshly laid eggs were 0.39 ± 0.03 mm and 0.30 ± 0.02 mm (Table 1). According to Devi *et al.* (2013) [5], average length of *Corcyra* eggs ranged from 0.42 ± 0.02 mm and width ranged from 0.31 ± 0.01 mm. The average incubation period of *Corcyra* eggs was 4.16 ± 0.80days. Haritha *et al.* (2000) [7] reported that average duration of eggs was about 4.5 days. The hatching percentage (Table 2) recorded was about 94.00% which confined the result of Menge *et al.* (2018) [9] that hatchability percentage was 94.33%.

Table 2: Duration of different life stages of *C. cephalonica* in stored groundnut seeds (GG-20, n=20)

Stages	Particulars	Duration (Days)		Mean ± SD
		Min	**Max**	
Egg	Egg	3	5	4.16 ± 0.80
Larva	1st instar	3	5	3.85 ± 0.74
	2nd instar	4	6	5.05 ± 0.68
	3rd instar	5	7	6.05 ± 0.68
	4th instar	5	7	6.10 ± 0.71
	5th instar	6	8	6.90 ± 0.71
	6th instar	7	8	7.30 ± 0.47
	7th instar	8	9	8.40 ± 0.51
Total		38	50	43.65 ± 4.52
Pupa	Pre-Pupa	1	2	1.45 ± 0.51
	Pupa	8	11	9.1 ± 0.96
Adult	Pre oviposition	1	2	1.45 ± 0.51
	Oviposition	4	6	5 ± 0.72
	Post oviposition	1	2	1.45 ± 0.51
	Longevity (M)	6	9	7.85 ±0.87
	Longevity (F)	7	14	8.55 ± 0.94
	Fecundity	128	296	202.2 ± 44.57
Total life span	Male	56	77	67.30 ± 6.33
	Female	57	82	70.05 ± 8.55
Sex-ratio	Male: Female			1: 1.05
Egg Hatching%	94			

The average length and width of 1st instar larva were 0.86 ± 0.17 mm and 0.19 ± 0.01 mm (Table 1). The average duration of first instar larva ranged from 3.85 ± 0.74 days. Following larval instars resembled the first instar larvae except in size. The average length of 2nd, 3rd, 4th, 5th and 6th instar larvae recorded were 1.09 ± 0.15 mm, 2.64 ± 0.16 mm, 4.17 ± 0.18 mm, 5.53 ± 0.26 mm, and 7.26 ± 0.92 mm, respectively and width of 0.23 ± 0.02 mm, 0.31 ± 0.01 mm, 0.41 ± 0.01 mm, 0.55 ± 0.01 mm and 0.63 ± 0.01 mm, respectively. The duration of 2nd, 3rd, 4th, 5th and 6th instar larvae recorded were 5.05 ± 0.68, 6.05 ± 0.68, 6.10 ± 0.71, 6.90 ± 0.71 and 7.30 ± 0.47 days, respectively. Full-grown larva was uniform in shape, dirty white in colour with reddish brown head and bigger than the sixth instar larva. The average length and breadth of seventh instar larvae were 9.37 ± 0.71 mm and 0.76 ± 0.04 mm, while the mean duration period was 8.40 ± 0.51 days (Table 1). Similar observations were also reported by Menge *et al.* (2018), Patil (2009) and Patel (2010) [9].

Before transforming into pupa, the last instar larvae stopped feeding and became less active. Pupation took place in a silken cocoon. The cocoon was thinner but stronger and more closely woven. The pupa was leathery brown coloured, obtect form with a robust body and a gradually tapering abdomen (Plate 2). The average length of pupa was 8.56 ± 0.55 mm, while average width of pupa ranged from 1.59 ± 0.23 mm. The average duration of pupal period was 9.1 ± 0.96 days. Similar observations were also reported by Devi *et al.* (2013) [5] duration of pupal period was 9 to 16 days. Menge *et al.*

(2018) [9] reported an average duration of pupal period was 10.70 days.

The adults were small and nocturnal. The hind wings were pale buff and the fore wings were mid brown or greyish brown with vague lines of dark brown colour along the wing veins. The male was smaller than the female. Morphologically, both male and female moths adults were closely resembled to each other except the labial palp which was blunt and inconspicuous in male, while long, pointed and straight forward in female (Plate 2). Similar characters of adult moth were also described by Devi *et al.* (2013), Patil (2009) and Patel (2010) [5].

The average length of male and female was 8.22 ± 0.74 mm and 9.3 ± 0.71 mm, while average wing span of adult male and female moth ranged from 17.45 ± 1.37 mm and 18.37 ± 1.66 mm (Table 1). Devi *et al.* (2013) [5] reported that average length of male moth was 10.75 ± 0.15 mm and average length of female moth was 12.24 ± 0.38 mm. The pre-oviposition, oviposition and post-oviposition periods (Table 2) varied from 1 to 2, 4 to 6 and 1 to 2 days with an average of 1.45 ± 0.51, 5.00 ± 0.72 and 1.45 ± 0.51 days, respectively. The average longevity of male and female moth ranged from 7.85 ± 0.87 and 8.55 ± 0.94 days, respectively.

The average fecundity of rice moth ranged from 202.2 ± 44.57 eggs in its entire life span (Table 2). The fecundity of rice moth was recorded as 277 eggs per female on groundnut kernels (Haritha *et al.*, 2000) [7]; Rajkumari *et al.* (2014) [11] reported that the average fecundity of rice moth was 151.70 ± 2.44 eggs per female. The data revealed that the sex ratio was recorded as 1: 1.05 (Table 2). Menge *et al.* (2018) [9] revealed that sex ratio of *C. cephalonica* ranged from 1: 0.71 to 1: 1.54 with a mean 1: 1.11 respectively on different groundnut varieties. The survival percentage of *C. cephalonica* was 90% when reared on groundnut kernels. The mean developmental period of rice moth was 58.36 days and growth index of 1.54 on groundnut kernels (Table 3). Similarly, Patel (2010) also revealed that the survival percentage of *Corcyra* was 80%, mean development period of 60.20 days and growth index of 1.33.

Table 3: Survival percentage, mean development period and growth index of *C. cephalonica* on groundnut kernel (GG 20, n=50)

No. of individuals observed	No. of adults survived	Survival% (S)	Mean Developmental Period (D)	Growth Index
50	45	90	58.36	1.54

Wadaskar *et al*., 2015 observed similar finding that the fecundity of rice moth was found maximum (135.66 eggs) with most favourable combination of temperature and relative humidity at 30ºC and 75% relative humidity, respectively. However, according to Bhardwaj *et al*. (2017) [3] The shortest life cycle was found in the combinations of bajra + jowar + maize up to 35 and 40 days, respectively and longest life cycle was found in rice extending of 60 to 70 days. Patil (2009) reported that survival percentage of rice moth was 82% and growth index was 1.59 when reared on grain purpose sorghum. Arun kumar *et al*. (2018) [2] observed that the combination of sorghum 1000 g + groundnut 50 g was found to superior to rest of other dietary formulations and resulted in lowest larval period (30.33 days), lowest pupation period (7 days), lowest total development period (47.33 days), highest adult emergence (82%), highest adult female emergence (52.11 days), highest male longevity (8.33 days), highest female longevity (9.67 days) and highest fecundity (312.33).

Plate 1: Biology of rice moth, *Corcyra cephalonia*

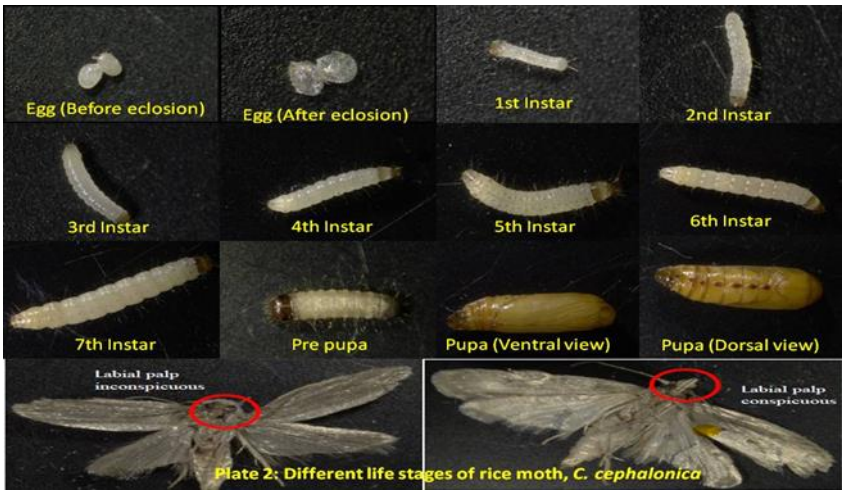

Plate 2: Different life stages of rice moth, *C. cephalonica*

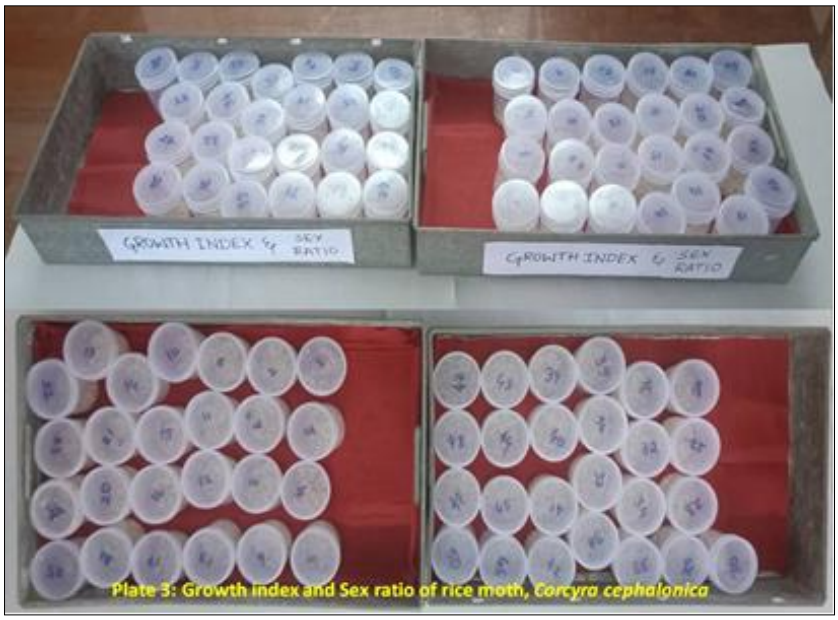

Plate 3: Growth index and Sex ratio of rice moth, *Corcyra cepholonica a*

4. Conclusion

From the present study, it can be concluded that the average fecundity of rice moth was 202.2 ± 44.57 eggs with a 94% hatching on groundnut seeds (GG-20). The average length of eggs, full grown larva, pupa and adult wing span were 0.39 ± 0.03 mm, 9.37 ± 0.71 mm, 8.56 ± 0.55 mm, 17.45 ± 1.37 mm (male) and 18.37 ± 1.66 mm (female), respectively. Duration of egg, larva, pupa and adult ranged from 4.16 ± 0.80, 43.65 ± 4.52, 9.1 ± 0.96, 7.85 ± 0.87 (male) and 8.55 ± 0.94 (female) days, respectively. The survival percentage (S), mean development period (D) and growth index were 90 per cent, 58.36 days and 1.54, respectively, while the sex ratio of rice moth was 1:1.05. So, the GG-20 variety can be utilized for the mass rearing of rice moth in the laboratory condition.

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