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Life cycle of gundhi bug *Leptocorisa oratorious* F on alternate host *Echinochloa colonum* L under laboratory condition

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Abstract
Studies on biology and morphometry of paddy earhead bug, *Leptocorisa oratorius* F (Hemiptera: Alydidae) were carried out on its alternate host *Echinochloa colonum* L in the laboratory of Bihar Agricultural University, Sabour, Bhagalpur, Bihar in the year 2016. The study revealed that the eggs had an incubation period of 7.81±0.87 days which ranges from 7-9 days. The nymphs were observed to pass through five instars where the insects moulted between each stages and the duration of each instars was 3.4±0.84, 3.9±0.87, 3.9±0.87, 3.9±1.10 and 4.2±1.03 days for I, II, III, IV and V instars respectively. The total nymphal period was observed to be ranged between 14-26 days whereas the total developmental period from egg to adult was ranged between 21-35 days. Eggs were laid singly, in clusters or in a linear fashion with an average fecundity of 75-135, and the linear pattern found most common, under laboratory condition on the *E. colonum* L. The longevity of adult male and female was observed to be considerably different and it was ranged from 17-30 days and 45-62 days for male and female respectively. The length and width of the eggs were ranged from 0.76 to 1.2 mm (0.94±0.09) and 0.45 to 0.83 mm (0.64 to±0.10) respectively. The adult females were measured to be 15.8 to 17.5 mm (16.58±0.57) in length and 2.00 to 3.00 mm (2.69±0.34) in width whereas the length and width of males were observed to be slightly smaller and were varied from 14.00 to 15.50 mm (15.06±0.49) and 1.6-1.8 mm (2.36±0.27) respectively. The demonstration of all the stages of *L. oratorius* development on alternate host should make this notorious pest easy to be identified and this knowledge can allow for timely and effective management, thus a reduction in the qualitative and quantitative losses on the yield of rice.

Keywords: Biology, *Echinochloa colonum*, *Leptocorisa oratorius*, Morphometry, rice earhead bug

Introduction
Rice ear head bug *Leptocorisa oratorius* F formerly known as *L. maculiventris* Dallas and sometimes confused with *L. acuta* Thunberg but can easily be separated by a series of ventrolateral black dots on the abdomen (Ahmad, 1965) [1]. It is a major pest of rice, widely distributed in southern and south-eastern Asia and Australia (Pathak, 1968) [10]. It appears to be a minor pest of rice in northern India, where it is known as gundhi bug. This bug has a wide range of host plants includes mostly Graminae (cultivated or wild), such as sorghum, grasses (*viz. Ccnchrus, Digitaria, Echinochloa and Panicum*) and legumes (Li, 1985) [7].
As we know that wild rice (*Echinochloa spp.*) is a major weed in rice crop which causes substantial yield reductions because of its severe infestations, rapid growth and great competitive ability. The yield losses ranged from 27 to 60% under saturating *E. colonum* (Fischer *et al.*, 1997) [5]. Not only that the crop is also attacked by more than 100 species of insects; 20 of them can cause economic damage. Among them, rice gundhi bug is most destructive insect pest of rice. The pest appears on rice just before flowering stage and continues until panicles ripen. Both nymphs and adults suck juice from grains in milky stage, also from peduncle, leaves and stem causing shrivelled and chaffy grains and the feeding site favour the development of sooty mould which cause considerable loss in the yield which sometimes rich up to 30% (Tiwari *et al.*, 2014) [13]. Heavy infestation can result in 80% (Maharashtra) or total (Malaysia) loss of the crop (Schaefer and Panizzi, 2000) [12]. It is estimated that *L. oratorious* may damage 6.4 to 7.7 rice grains/day/adult, when released in caged rice plants with the panicle at flowering stage (Schaefer and Panizzi, 2000) [12]. Interestingly wild rice is served as alternate host for gundhi bug. This bug continues to feed on the panicle of jungle rice until the crop reaches milking stage. As *E. colonum* is predominantly autogamous, which reproduces primarily through seeds but is able to reproduce through nodes

also (Peerzada *et al.*, 2016) [11] so it can be easily grow in harsh condition where other can't.

This particular tendency of *E. colonum* makes suitable hosts for gundhi bug as they provide easy and prolonged food sources to the bug. So it is very important to understand the biology of gundhi bug in relation to Jungle rice. The information available on these aspects of the pest under Indian conditions is very scanty. So keeping in view the need of information the biological study of gundhi bug (*Leptocorisa oratorius*) on alternate host Jungle rice (*E. colonum*) were undertaken under laboratory condition.

Material and methods

Studies on biology and morphometry of paddy earhead bug, *Leptocorisa oratorius* F (Hemiptera: Alydidae) were carried out on the alternate host *Echinochloa colonum* L in the laboratory of Bihar Agricultural University (B.A.U.), Sabour, Bhagalpur, Bihar in the year 2016. For studying the biology, bunch of *E. colonum* were extirpated form the bund of rice field and were raised in ten earthen pots under transparent acrylic insect rearing cage. Cages were provided with sleeves to enable easy release of bugs. The weeds of the cages were changed twice in a week till the study. Ten pairs of gundhi bug were collected from field while in copulation and each pair was released on *E. colonum* L in each cage. A pair of newly emerged male and female bugs were kept in each cages and rest all were removed to study the biological characters like mating behavior, pre-oviposition period, ovipositon period, fecundity and adult longevity. The nymphs were observed daily through the developmental stages, from first instar to adult and dates for each moult recorded. Observations on morphometry of egg to adult emergence in term of length and width were recorded by using ocular micrometre under stereomicroscope.

Results and Discussions

The reproductive biology of *L. oratorious* was studied in the laboratory condition and the observations are presented in Table 1. The bugs were observed to be mated during morning hours and late evening hours. The mating period ranged from 2-7 hrs with an average of 4.1±1.79 hrs. The male and female were faced in opposite directions during mating and often shifted during copulation and with the slight disturbance, they separated. The female stored the male sperm after mating to fertilize the eggs. Once fusion is over it takes 3-8 days as preoviposition period with a mean of 5.3±1.56 for laying the first egg. The mated female laid an average of 98.9±27.02 eggs which ranges from 75-135. It was reported that the lapse between the oviposition of the first egg of one clutch and the oviposition of the terminal egg of the last clutch ranged between 5-28 days with a mean of 14.8 ± 6.87. Eggs were laid singly, in clusters or in linear fashion on the tip of the upper leaf surface and sometime on petiole and as many as 17 eggs were found in a batch. The linear pattern of egg laying was found most common, under laboratory condition on the *E. colonum* L. Li (1985) [7] reported that eggs are laid in rows on the leaf blade of rice near the tip, and occasionally on the stem or the panicle which corroborates the present findings. The newly laid eggs were pinkish black, oval in shape and glossy in appearance, which latter turned into deep black in colour. Each egg was placed on the surface in contact with the previous egg and cemented. In spite of the fact that operculum was missing, there was line of weakness before hatching and the egg's dorsal surface was precisely broken off from the micropyler and left a portion which was shaped like a cup. It was observed that the incubation period, time of egg laying to hatching varied from 7-9 days with an average of 7.81±0.87 days. The present findings are in support of Li (1985) [7] who found that the incubation period of gundhi bug (*L. oratorious*) on rice is 5-8 days, a small variation in the incubation period may be due to different host.

There were five nymphal stages where the insects moulted between each stage. The number of days for each moult was recorded by observing cumulative increase in number of exo-skeleton/exuviae in each rearing cage (Table 2). Freshly hatched nymphs (first instar) were pale greenish in colour and had long reddish antennae with whitish bands. They were found to feed on the inflorescence of *E. colonum.* Some other workers (Torres *et al*, 2010 [14] and Dale, 1995 [4]) reported that the *L. oratorious* hangout and reproduce on certain grasses near or around rice cultivation. The antennae were longer than the body. Eyes were reddish and legs were reddish brown in colour. The duration of the first instar nymph lasted for 2-4 days with an average of 3.4±0.84 days. The present findings are in support of Hosmani, *et al.,* (2009) [6] who reported that the duration of first instar nymph of *L. oratorious* on rice ranged from 3-5, a small variation in moulting period may be due to different host. Morrill, *et al.,* (1990) [8] reported that *L. oratorious* preferred grasses for oviposition over rice and have shorter developmental time. Second instar nymph was similar to that of first instar in appearance except for the size. The duration of second and third both instars were lasted for 3-5 days with an average of 3.9±0.87 days but the third instar nymph was dark greenish in colour. In this stage, the antennae were not much longer than the body and the pale green wing pads start to appear. The duration of fourth instar nymph ranged between 3-6 days with an average of 3.9±1.10, having greyish green in colour with reddish to reddish brown eyes. As the days progressed, the dark greenish stripe on the lateral side of the head becomes reddish brown, lateral margins of the pronotum became cream-coloured and femora became reddish brown. The fifth instar nymph was larger and pale brown in colour with well-developed wings. The duration of this instar ranged from 3-6 days with an average of 4.2±1.03. The shortest period was observed for the first instar (2 to 4 days), while the longest mean period was recorded for the fifth instar 4.2±1.03. The present findings are in conformity with Baharally and Simon (2014) [2] who found that the duration of fifth instar was longest as compared to the previous instars. As such, the total nymphal development period ranged from 14 to 26 days with an average of 19.70 ± 3.33 days. After egg laying, it takes 21-35 days to develop from egg to adult with a mean of 27.6±3.86. Adult bugs were slender, robust with variation in colour ranging from green to brownish-orange and they can be distinguished from other species of this genus by the presence of brownish to black coloured ventro-lateral spots on the abdomen. The average life span of adult males were recorded to be 24.33±4.58 and was ranged from 17 to 30 days where as the females lived for 45 to 62 days (mean 53.56±7.07 days). Hosmani, *et al.,* (2009) [6] reported that the average life span of male and female of *L. oratorious* under greenhouse condition were 20-37 days (30.30±5.21) and 50-83 days (71.00±11.48) respectively. The variation in these findings can be as a result of several factors beyond human control *viz.* temperature, relative humidity and different habitats. Schaefer and Panizzi, (2000) [12] reported that *L. oratorious* having black coloured spot on the ventro-lateral side of the abdomen where as it was absent in case of *L. acuta.*

Various stages of rice ear head bug (*leptocorisa oratorious*) were measured morphometrically during the present investigations and presented in Table 3. During the study the length of egg was observed to be ranged from 0.76-1.2 mm with a mean of 0.94±0.09 mm whereas the average width of egg was 0.64±0.10 mm which varies from 0.45-0.83 mm. The length and width of 1st instar nymph were 1.5-2.1 mm (1.79±0.20) and 0.35-0.6 mm (0.49±0.08 mm) respectively. The average length and width of second instar nymph of *L. oratorious* were recorded as 5.94±0.24 mm and 0.75±0.09 mm respectively which ranged from 5.6-6.3 mm in length and 0.62-0.9 mm in width. The length and width of gundhi bug (*L. oratorious*) increased in their successive growth stages and reached up to 7.8-10.1 mm and 0.9-1.99 mm respectively with an average of 8.90±0.76 mm in length and 1.25±0.23 mm in width in 3rd instar. The length and width of 4th instar nymph were varied from 11-13.2 mm (12.32±0.69) and 1.31-1.62 mm (1.47±0.09) respectively whereas it was 13.15-16.5 mm (14.83±2.14) and 1.6-1.8 mm (1.71±0.07) in length and width respectively in 5th instar. During study length and width of adult female were observed greater than adult male and it was ranged from 15.8-17.5 mm (16.58±0.57) in length and 2-3 mm (2.69±0.34) in width whereas the length and width of adult male varied from 14-15.5 mm (15.06±0.49) and 1.6-1.8 mm (2.36±0.27) respactively. The present findings are in line with Cobblah and denhollander, (1992) [3] and Nayak, (1984) [9] with slight variations that may be due different host and agroclimatic conditons.

Table 1: Reproductive Biology

Sl. No.	Parameter	Range	Mean ± S.D
1	Mating period (hrs.)	2-7	4.1 ± 1.79
2	Preoviposition period (days)	3-8	5.3 ± 1.56
3	Fecundity (no.)	75-135	98.9 ± 27.02
4	Oviposition period (days)	5-28	14.8 ± 6.87
5	Incubation period (days)	7-9	7.81 ± 0.87

Table 2: Developmental period of gundhi bug

Sl. No.	Developmental stages	Range (Days)	Mean ± S.D
1	**Nymph**		
	1 Instar	2-4	3.4 ± 0.84
	2 Instar	3-5	3.9 ± 0.87
	3 Instar	3-5	3.9 ± 0.87
	4 Instar	3-6	3.9 ± 1.10
	5 Instar	3-6	4.2 ± 1.03
2	Total nymphal period	14-26	19.70 ± 3.33
3	Total developmental period (egg to adult)	21-35	27.6 ± 3.86
4	**Adult longevity**		
	Male	17-30	24.33 ± 4.58
	Female	45-62	53.56 ± 7.07

N =10

Table 3: Morphometric of different stages of gundhi bug (Leptocorisa oratorius)

Sl. No.	Stages	Length (mm)		Width (mm)	
		Range	Mean ± S.D	Range	Mean ± S.D
1	**Egg**	0.76-1.2	0.94 ± 0.09	0.45-0.83	0.64 ± 0.10
2	**Nymph**				
	1 Instar	1.5-2.1	1.79 ± 0.20	0.35-0.6	0.49 ± 0.08
	2 Instar	5.6-6.3	5.94 ± 0.24	0.62-0.9	0.75 ± 0.09
	3 Instar	7.8-10.1	8.90 ± 0.76	0.9-1.99	1.25 ± 0.23
	4 Instar	11-13.2	12.32 ± 0.69	1.31-1.62	1.47 ± 0.09
	5 Instar	13.15-16.5	14.83 ± 2.14	1.6-1.8	1.71 ± 0.07
3	**Adult**				
	Male	14-15.5	15.06 ± 0.49	1.6-1.8	2.36 ± 0.27
	Female	15.8-17.5	16.58 ± 0.57	2-3	2.69 ± 0.34

N = 20

Conclusion

The studies revealed that paddy earhead bug, *Leptocorisa oratorius* passes through five nymphal stages which ranged, 14-26 days whereas the total developmental period ranged between 21-35 days on alternate host, *Echinochloa colonum* and linear pattern of egg laying found most common under laboratory condition. Both the size (mm) and longevity (days) of adult female is more than adult male. Considering the importance of this pest, it is necessary to understand the biology of this notorious pest. The data generated here on the alternate host *E. colonum* helps in the integrated management of paddy earhead bug.

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