BIOECOLOGY OF PYRROCHORID PLANT BUG *IPHITA LIMBATA* (STAL).

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[Gomathy, Christudhas, A. & Mathai, M. T. 2014. Bioecology of pyrrochorid plant bug *Iphita limbata* (Stal). Munis Entomology & Zoology, 9 (2): 795-803**]**

ABSTRACT: *Iphita limbata* is a macropterous but flightless, phytophagous bug feeding on the seeds of *Sterculia foetida*. The studies on bio-ecology, activity pattern and sexual dimorphism in *Iphita limbata* from specified areas of Madras Christian College, Tambaram reveals that the occurrences of males were more than the females. Predominant mating behavior was found during the months of late December, January and February during which females were in mated condition. *Iphita limbata* prefers a relatively high humidity and an optimum temperature of 36.1°C for the population to flourish. The activity of *Iphita limbata* was found to be closely correlated to environment parameters especially temperature. The males are smaller than females. The reproductive organs of males consist of a pair of testis connected with paired seminal vesicle and a median ejaculatory duct; females consist of 7 pairs of teleotrohic ovarioles on either side of the alimentary canal with a spermatheca.

KEY WORDS: Bioecology, Hemiptera, Pyrrohoridae, *Iphita limbata*, Tambaram.

The reproduction in insects pronounces a remarkable adaptive radiation in the ecology of habitat, including host plant or host materials to maintain their population. It plays an important role in making them as successful group of organism in this world. All kinds of ecological resources and habitats in this universe are well exploited for their survival.

The pyrrochorid plant bug *Iphita limbata* is a bicolor, terrestrial, harmless, elegant bug, belongs to the suborder Heteroptera of the order Hemiptera. The bug is abundant and seasonal.

Here an attempt has been made to study the bioecology of *I. limbata* with reference to their habitat, host selection, distribution, reproduction and life cycle. The detailed study include identifying the host plant and their distribution, the daily activity pattern, sexual dimorphism, biology and the morphology of male and female internal reproductive organs of *I. limbata*.

MATERIAL AND METHODS

Population study was conducted for a period of one year from June 2008-May 2009. Survey of the vegetations in MCC present in the specific area was done to know about the habitat, which provided suitable environment and diet *ad libitum* to work out the entire life cycle. Live mating individuals of *I. limbata* where collected *en mass* using an insect net from the scrub jungle of Madras Christian College (MCC) campus, situated 40 kilometers away from Chennai. Studies on ecology and activity pattern were carried out primarily in specific area where *Iphita limbata* were predominantly present. The live samples collected were transferred to laboratory for further studies.

Female collected after mating where reared *en mass* in a glass trough filled with soil and dry litters. The seeds of *Sterculia foetida* were provided as food along with water in soaked cotton. The trough was covered with fine muslin cloth

as to prevent the escape of insects and provide air. Pairs of *I. limbata* where maintained separately to understand the mating behavior and longevity.

The ovaries and testis of *I. limbata* were dissected along with copulatory organ and preserved in 70% alcohol; later mounted by counter staining technique. The reproductive organs were allowed to be in 95% alcohol for 10 minutes and then stained with 2-3 drops of hematoxine for 3-5 minutes. Add 95% alcohol to remove excess stain and after resting for 2-5 minutes 2-3 drops of eosin was added. The excess stain was washed by xylene. The samples were mounted on a slide with a drop of DPX and viewed under microscope. Microphotographs were taken using Nikon D200 camera fixed to Nikon Alphaphot YS2 microscope.

RESULTS

Habitat

The scrub Jungle of MCC campus extends about 365 acres and *I. limbata* is found to be present only on the north western side of the campus. *I. limbata* was found wandering and aggregated on plants including teak tree (*Tectona grandis*), Indian ash tree (*Linnea coromandelica*) and yellow lidnder (*Thevitia neirifolia*). They feed extensively on the fruits of wild almond (*Sterculia foetida*). During warmer days the insect were found on *Hemidesmus indicus* and *Jasminum sessilibforum.*

Life-Cycle

The survey of the campus reveals that *S. foetida* are localized only in one pocket of the scrub jungle and *I. limbata* being flightless and feeds on fruits particularly on the seeds of *S. foetida,* are often seen aggregating exclusively in this area. Aggregated feeding during nymphal stages is well noticed in *I. limbata* and the adult as well as the nymphs are voracious feeders. The nymphs were noticed during the months of December and February in the crevices. They don't seem to feed during the first instar.

Sexual Dimorphism

The adults of both sexes are macropterous, but flightless. The gravid females have remarkably enlarged abdomen than males. Morphometrics of nine different regions of the body is shown in table 1. It is evident that the body length, the length and width of the abdomen, wing length show significant size variation between the adult male and female apart from external genetalia like an aedeagus and the ovipositor. Other characters however, do not show any significant size variation.

Male Internal Reproductive Organ

The testis of *I. limbata* are paired, white, more or less spherical structures lying ventrally in the region of the fifth abdominal segment, beneath the digestive system and are held in position by surrounding tracheae and fat bodies (Figure 3). Each testis is a compact structure consisting of typically seven follicles, bounded externally by a thin membranous peritoneum. Each follicle has a length of 0.32 ± 0.4mm and a width of 0.3 ± 0.5mm. The total length of testis is 0.8 ± 1.2mm (Table 2).

Each vas efference from the follicle are not externally visible and opens independently into vas deferens, which is a minute construction externally between the testis and seminal vesicle. These very small ducts are differentiated from seminal vesicle by their smaller size measuring 0.08 ± 0.03mm in length

and 0.16 ± 0.25mm in width. The vesicular seminis are transparent in the day 0 male and later are filled with the seminal fluid and appear gorged. The vesicular seminis measures 0.4 ± 0.5mm in length and 0.32 ± 0.45mm in width (Table 2). The walls of seminal vesicle are lined with single layered epithelium and their terminal region run along the upper margin of the multi-lobed mesadene or mesodermal accessory reproductive gland. The median unpaired ectadene has two lobes and is laterally question mark shaped. The lower lobe is continued as the ejaculatory duct that ends in gonopore.

Female Internal Reproductive Organ

I. limbata consists of 7 pairs of teleotrophic ovarioles on either side of the alimentary canal along with a paired lateral oviduct and a median oviduct with a definite highly chitinised "horse-shoe shaped bulbous spermatheca (Figure 4). The length of the ovariole calyx is comparatively shorter than the lateral and median oviduct.

Each ovariole distally produces an independent terminal filament that later unite to form a suspensory ligaments attached to the body wall of the first abdominal segment. Each filament consists of a syncytial core bounded by the tunical propria and measures 0.25 ± 0.35mm in length and 0.2 ± 0.32mm in width (Table 2). The germarium occupies more than two third the length of the ovariole and their trophic cells are randomly distributed in groups and a definite trophic core is absent. The nutritive cord was not evident. The ovariole has a length of 0.45 ± 0.5mm and width of 0.35 ± 0.42mm. The lateral oviduct measures 0.3 ± 0.4mm in length and 0.25 ± 0.3mm in width. The median oviduct in *I. limbata* exhibits a thin inner lining of cuticle, which extends upto a genital opening.

In *I. limbata*, the well matured oocyte occupies the proximal end of the ovariole. Inter-follicular epithelial cells are well noticed between the developing and developed oocytes and also, as the oocytes increases in size the follicular epithelial cells which are cuboidal or columnar shape on the developing oocyte are stretched over the mature oocyte as a single layer of flattened, rectangular squamous epithelium. The oocyte nucleus is very predominant and is situated near the periphery of the oocyte.

Activity Pattern

Activity of the insect was found to be closely correlated to environmental parameters especially temperature (Table 3; Figure 1). These bugs are primarily diurnal and have a range of optimum activity between 27 to 29°C. The inactive adult starts emerging out for foraging during early 800hrs. As temperature rises after 900hrs the insects enter the crevices or hide under dry leaves there by a reduction in the activity of feeding. At 1500hrs temperature falls and the insects emerges back from the niches. The peak activity was noticed at about 0100 hrs when the temperature was 28°C. Again when the light intensity drops towards the end of the day, they settle back into their niches. Thus *I. limbata* show two peaks in their activity during the day.

Population

The population study was conducted for a period of one year. The meteorological data during the period of study is given in Figure 2. The temperature ranged from 19.5-42°C and the relative humidity of the atmosphere was between 77 and 98%. The maximum rainfall was 724.6mm. The number of *I. limbata* was maximum when the temperature was between 31 to 42°C and

relative humidity between 77 and 98%. These suggest that *I. limbata* prefers a optimum temperature of 36.1°C and a relatively high humidity for the population to flourish.

The number of *I. limbata* was found to be at maximum during December to February, with a decline of population during January. The occurrences of males were more than the females throughout the period. The mating behavior was found predominantly during the mating period (Late January and early February) during which females were in mated condition.

The bugs were found in large numbers on the leaves of *T. grandis* and were gregarious on the leaves of *L. coromandelica* where a maximum of 22 insects were found on a single leaf. But towards the beginning of January the insects decent to the ground and were abundant in the gutters and fallen dry leaves feeding on the fruits and seeds of *S. foetida*.

DISCUSSION

In the present investigation on *I. limbata*, it was observed that during the months of December and early January insects were seen in large numbers even on the peripheral areas of the site and beyond the experimental areas too. But later there was a general movement of the insects towards more denser, shady interiors indicating the preference of *I. limbata* for lower temperature and high humidity, moist soil and shows maximum reproductive activity as in *Dysdercus cingulatus* (Srivastava & Bahadur, 1958). The first nymphal instars could not be located and even when noticed they were always in the crevices, mainly because they do not feed during this stage (Nayar, 1968).

I. limbata exhibits marked differences in the male reproductive tract compared to other groups of insects in the cellular organization of each testis follicle, the structure of vas deferens, seminal vesicle and in the organization of the mesadenia and ectadenia. The milky-white testis are richly supplied with trachea and covered by well pronounced outer envelope of fat tissue as reported in other heteropterans (Livingstone, 1967). Sperm tubules or testicular follicles measure 7 in number and are visible externally. The number varies from 4-7 in other heteropterans (Woodward, 1950; Bhatnagar & Singh, 1968). There are 6 follicles in *D. cingulatus* (Ambika & Prabhu, 1978) and *Phyrrhocoris apterus* (Aysev & Sisli, 1979). An exception is *Tingis buddleia* having only 2 follicles in each testis (Livingstone, 1967). In sections, *I. limbata* however has 7 pairs of vas efferentia opening individually into the vas deferens on each side similar to *Odontopus nigricornis* (Sharma & Livingstone, 1978). In *I. limbata* vas efferens are the extensions of each follicle at its posterior end. The vas deferens lacks the muscular coat hence the observation that the sperms are inactive in the vas deferens and are carried along by peristaltic movements of the walls of the tubes (Payne, 1934) remains not applicable in *I. limbata*. The external appearance of the ejaculatory bulb which undergoes modification as an unpaired glandular ectadane shows close resemblance to the condition in *O. nigricornis* (Sharma & Livingstone, 1978).

The ovaries of *I. limbata* are provided with 7 pairs of ovarioles. The ovarioles vary greatly in numbers: 2 ovarioles in each ovary (*Ipstypographus, Hylobius abietus* and *Sitona lineatus*), 6-7 (*Ocypus olens*), 4 (*Dorcus*), 12 (*Saperda charcharias*), 13 (*Cicindela campestris*) (Jaglarz, 1989), 20 (*Bhyrrus pilula*), extremely short and numerous in Meloidea (Richards & Davies, 1977). In some hymenopterans and dipterans the number may be increased to 100 or even 200 (Snodgrass, 1935) and 3000 or more in Isopterans (Truckenbrodt, 1973).

Generally accessory glands are associated with the female reproductive system but in *I. limbata*, no external accessory glands are present. It appears as though the glandular walls of the ovarian ducts are secretory in function. The secretions perform various functions as in Mallophaga the cement secretion is used for attaching the eggs (Richards & Davies, 1977), in Acridoidea, secretions makeup the pod in which eggs are laid (Lauverjat, 1965; Baccetti, 1972), in *Glossina* it secretes a milky fluid which serves to nourish the intra uterine larva (Richards & Davies, 1977).

ACKNOWLEDGEMENTS

The authors are thankful to the Department of Zoology, Madras Christian College, Tambaram for the facilities provided during the course of study.

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Table 1. Morphometry of Live male and female *I. limbata* in cm.

Sr no	Part of the body	Male		Female	
		Range	Average	Range	Avereage
1	Body length	1.86-2.12	1.97	2.17-2.52	2.34
2	Head length	0.24-0.35	0.29	0.32-0.37	0.35
3	Head width	0.22-0.29	0.27	0.30-0.33	0.32
4	Thorax length	0.56-0.66	0.62	0.79-0.78	0.74
5	Thorax width	0.41-0.47	0.44	0.49-0.53	0.51
6	Abdomen length	1.30-1.44	1.39	1.58-1.74	1.66
7	Abdomen width	0.67-0.82	0.94	0.88-1.12	0.94
8	Wing length	1.15-1.33	1.48	1.38-1.57	1.48
9	Antennal length	1.02-1.20	1.31	1.27-1.35	1.31

Table 2. Measurements of reproductive organs of *I. limbata* using micrometer.

Reproductive Organ		Length (mm)	Width (mm)
Male	Testis	0.32±0.4	0.3±.05
	Vas deference	0.08±0.03	0.16±0.25
	Seminal Vesicle	0.4±0.5	0.32±0.45
	Total length	0.8±1.2	-
Female	Terminal Filament	0.25±0.35	0.2±0.32
	Ovarioles	0.45±0.5	0.35±0.45
	Calyx	0.25±0.32	0.1±0.25
	Lateral Oviduct	0.3±0.4	0.25±0.3
	Total length	1.25±1.57	-

Table 3. Activity pattern of *I. limbata*.

Time	Temperature	Adult %	Nymph %
6:00	22.5	14.5	27
7:00	25	43	50.5
8:00	27.5	71.5	75
9:00	28	96.5	99
10:00	28.5	78.5	89.5
11:00	29	75	72
12:00	30	68	61.5
13:00	30.5	64	54
14:00	31.5	61	55
15:00	30.5	68	63.5
16:00	29.5	89	69
17:00	29	86	68
18:00	28	75	65.5

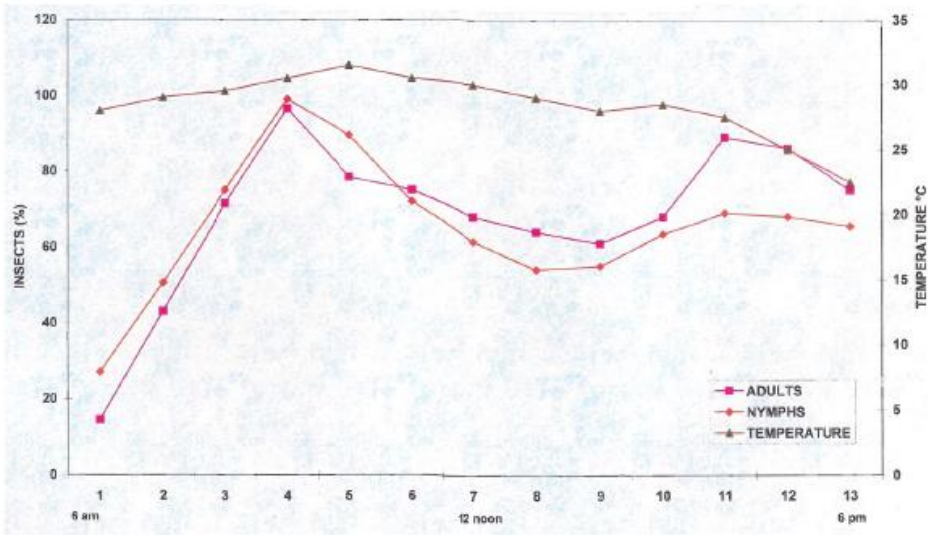

Figure 1. Daily Activity pattern of *I. limbata*.

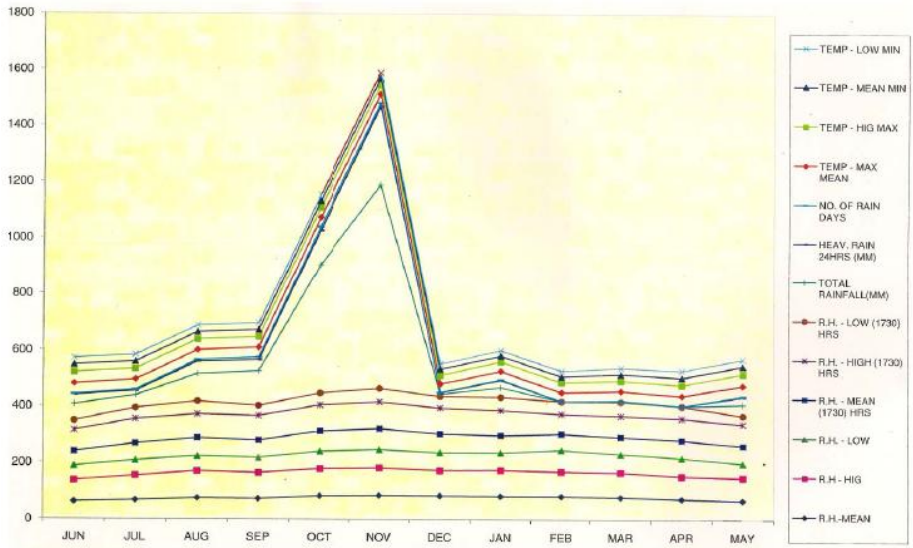

Figure 2. Meterological data during the study.

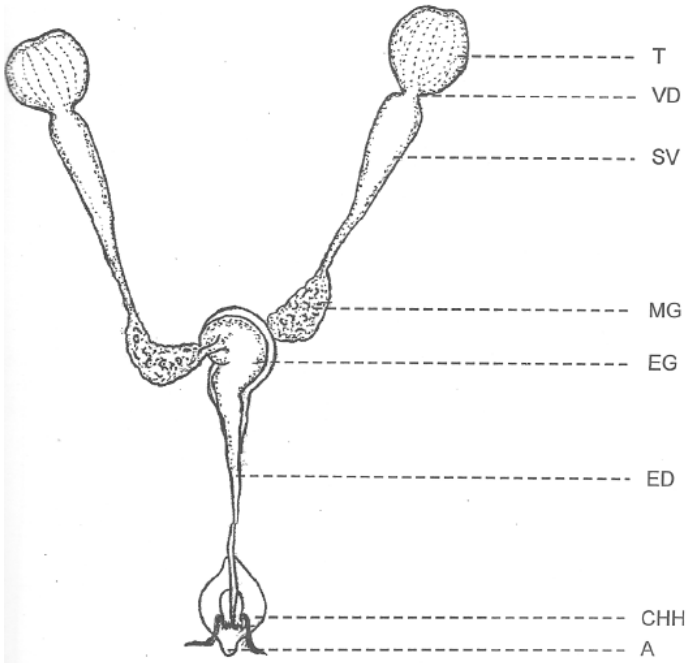

Figure 3. Structure of male reproductive organ. (T-Testis; VD- Vas Deferens; SV- Seminal Vesicle; MG- Mesodermal Gland; EG- Ectodermal Gland; ED- Ejaculatory Duct; CHH Chitinous Hooks; A- Aedeagus).

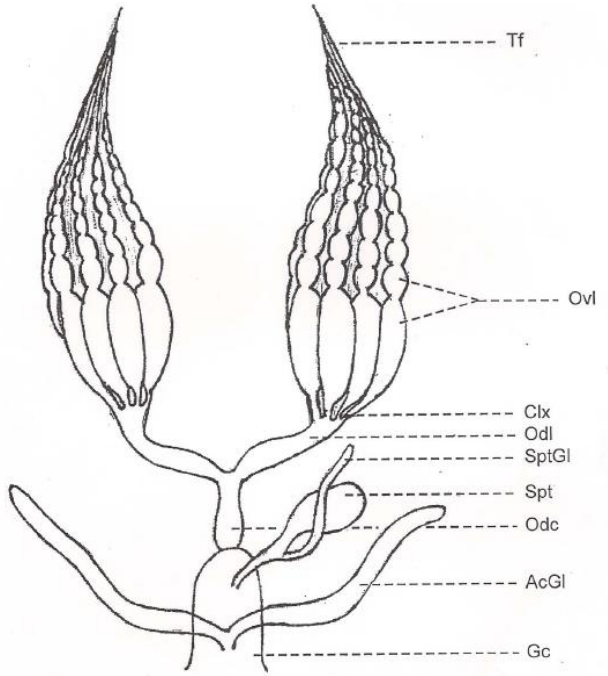

Figure 4. Structure of female reproductive organ. (TF- Terminal Filament; Ovl- Ovariole; Clx- Calyx; Odl- Oviducts lateralis; SptGl- Spermatheca Gland; Spt- Spermatheca; Odc- Oviducts Communis; AcGl- Accessory Gland; Gc- Genital Chamber).