OPEN ACCESS Freely available online

Entomology, Ornithology & Herpetology: Current Research

Research Article

Flight and Aggregation of the Rice Black Bug (RBB), *Scotinophara coarctata* Indicate an Ovipositional Preference for the Booting Stage of Rice

Dennis C. Ramo[1*], Celia Medina[2], Luis Rey I. Velasco[2], Barbara L. Caoili[2], Rowena Dt. Baconguis[3]

[1]Department of Municipal Agriculture, Institute of Municipal Agriculturist Office-Local Government of Monkayo, Monkayo, Philippines; [2]Department of Weeds, Entomology and Plant Pathology, University of The Philippines Los Banos, Los Banos, Laguna, Philippine; [3]Department of College of Public Affairs and Development, University of the Philippines Los Banos, Los Banos, Laguna, Philippines

ABSTRACT

Mass flight and aggregation behavior of the Rice Black Bug (RBB), *Scotinophara coarctata* are poorly understood. This paper was designed to investigate a possible explanation of the flight and aggregation of RBB by linking these behaviors to the reproduction of the bug and rice phenology. A greenhouse experiment was conducted to determine if the oviposition of RBB is confined to a certain phenological stage of rice. Behavioral experiments showed that RBB discriminated against the seedling stage as an oviposition site. The significantly higher number of egg masses laid on the booting and soft dough stages of rice, as well as the number of visits and the length of time RBB, stayed on these stages indicate a preference over other phenological stages. Results of the study signify that RBB oviposition is restricted to certain phenology of rice. Because of this specific requirement in oviposition, a wide-scale absence of appropriate growth stage of rice and other possible host plants in an area for an extended period could be a driving factor that leads to flight and aggregate to seek favorable habitat involving a large number of individuals. It is recommended that a landscape-scale of analysis should be done to further test the above hypothesis.

Keywords: Oviposition preference; Rice phenology; Flight; Aggregation behavior; Booting stage

INTRODUCTION

The Rice Black Bug (RBB), *Scotinophara coarctata* (Fabricius), is a serious rice pest in the Philippines owing to its unpredictable bouts of attack. Adult RBBs are alleged to be migratory or undergo mass flight [1] reported that the developing adults are destined to fly coinciding with the occurrence of the full moon where thousands of adults dominated by males are attracted to lights. The catch size fluctuated synchronously with the lunar phase of which large catches occurred around the full moon period and higher catches in certain months within a year. However, the migratory or dispersal behavior is poorly understood whether a mass flight is related to host finding or mate finding. The postulated that the flight behavior could be related to host findings because of the seasonality in the trap catch and stages of rice growth [2].

Analyzed from his review of the various studies on the life history of RBB that the dispersal behavior of RBB by flight may occur to seek aestivation sites, to return to rice fields from aestivation sites, to seek another rice crop after harvest, or males seeking mates. In this context, rice is required or critical in the reproduction and development of RBB [3]. On a landscape scale, the presence of an appropriate stage of rice to the RBB is a stochastic event. Rice is usually planted in two cropping seasons per year where irrigation is available. A two-month fallow period is observed because it takes a month to prepare the rice paddy for planting. Depending on the scale of analysis, rice could be viewed as synchronously or asynchronously planted. The flight and aggregation behavior of RBB could have evolved as an adaptation to this fragmented availability of a suitable host. The oviposition of RBB in rice is probably time-limited. The reproduction of RBB is constrained by the time needed to find a suitable host for egg-laying.

Correspondence to: Dennis C. Ramo, Department of Municipal Agriculture, Institute of Municipal Agriculturist Office-Local Government of Monkayo, Monkayo, Philippines, E-mail: dcramo@up.edu.ph

Received: July 06, 2021; **Accepted:** July 20, 2021; **Published:** July 27, 2021

Citation: Ramo CD, Medina C, Velasco LRI, Caoili BL, Baconguis RDt (2021) Flight and Aggregation of the Rice Black Bug (RBB), *Scotinophara Coarctata* Indicate an Ovipositional Preference for the Booting Stage of Rice. Entomol Ornithol Herpetol. 10: 246.

This observation and inference constitute the biological question that serves as the core problem. Is the oviposition of the RBB restricted to certain phenology of rice? What are the preferred rice stages for egg-laying? Insects are the most diverse group of living organisms and exhibit great diversity in their modes of reproduction, yet the reproductive patterns of insects have seldom been studied in terms of life-history theory in general [4]. Insect reproduction is a highly organized process with a time-space dimension shaped by the selection pressures present in the environment where the insect population evolved. It is internally controlled by a hormonal system closely linked to environmental cues so that insects would likely produce and deposit eggs only when ecological conditions are favorable for the survival of their progeny [5].

In this paper, the influence of host plant phenology on the reproductive pattern of RBB was explored. Ovipositional preference of the bug to various stages of rice was conducted under greenhouse conditions. This will provide biological information relative to the bug reproduction strategies concerning the host phenology. And its implication to flight and aggregation behavior of the adult rice black bug.

- Rice black bugs discriminated against the seedling stage of rice as an oviposition site.
- A significant number of egg masses laid on the booting stage of rice.
- A significant number of adult Rice Black Bug (RBB) often visits and stayed longer on booting stage of rice.
- Results indicate preference of Rice Black Bug to booting stage over other phenological stages.
- The wide-scale absence of appropriate growth stages is a driving factor for RBB to fly and seek favorable habitat.

MATERIALS AND METHODS

Test insects

Adult insects were collected from the different study sites and reared in potted rice plants under greenhouse conditions. Fully-grown nymphs were transferred and reared in individual cages made of muslin cloth (0.30 m x 0.30 m x 0.75 m) to ensure that only newly eclosed adults were used in the experiment. These newly-eclosed adults were paired and kept in individual cages for mating which usually lasted for 1-2 days Figure 1.

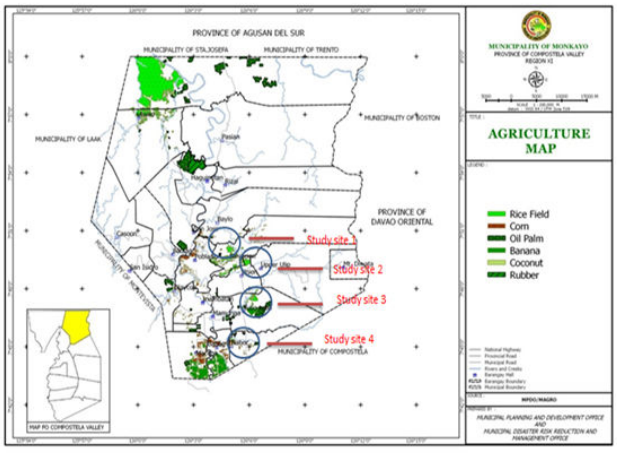

Figure 1: The agriculture map of the Municipality of Monkayo, Province of Davao de Oro showing the study sites.

Test plants

Seeds of PSB RC 160 rice variety were soaked for 24-36 hours with water being replaced every five to six hours. After soaking, seeds were incubated at 30°C for 24-36 hrs. Incubated seeds were sown when roots were emerging. They were planted in pots (21 cm in diameter x 18 cm in height) with soil from irrigated rice paddy during the onset of land preparation. Plants were fertilized based on the recommended rates. Planting was done in a staggered schedule to produce five different phenological growth stages (seedling, tillering, booting, soft dough, and hard dough) at the same time.

Choice experiment

The choice experiment was conducted in a cage made of muslin cloth measuring 0.75 m wide x 0.75 m long and 1.0 m high that served as the test arena. One potted rice plant representing each of the following growth stages was arranged at random inside the test arena: Seedling, tillering, booting, soft dough, and hard dough. Five pairs of adult bugs were introduced and held in the cage for 10 days. Similar to the procedure in determining the attractiveness of the host plant, each individual was marked uniquely to track the number of days an insect spent on a plant and the number of times the plant was visited by the insect. The observation was done at the same time every day and the number of egg masses found on the plant was recorded. Two trials of this experiment were conducted with three replications per trial.

No-choice experiment

A parallel no-choice experiment was conducted where a pair of RBB was provided with one potted plant representing the seedling, tillering, booting, soft dough, or hard dough stage. It was done in a cage made of muslin cloth measuring 0.30 m wide x 0.30 m long x 0.75 m high. The insects were held in this cage for 10 days and the number of egg masses laid was counted and recorded every day. After 10 days, the female RBB was dissected to determine the remaining eggs in the ovary.

Statistical analysis

Data were subjected to analysis of variance using Statistical Analysis Software (SAS), version 9.4. Means were compared using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

The variation in the number of egg masses laid on the rice plants of the different phenological stages was statistically significant in either choice and no-choice tests. In the choice test, the highest number of egg masses (2.44 ± .244 egg masses) was observed on the plants at the booting stage. This was followed by the soft dough stage (1.33 ± .244 egg masses) which was not significantly different from the hard dough stage (0.55 ± .244 egg mass). The least number of eggs laid was observed on the tillering stage but this number was so low to be significantly different from seedling stage where no egg was laid at all. In the no-choice test where RBB was confined to one rice growth stage, the females laid at least one egg mass in a period of 10 days on all plant stages tested except on the seedling stage. However, the variation in the number of egg mass was not significantly different among the tillering, booting, soft dough, and hard

dough growth stages where eggs were laid Table 1.

Phenological stage of rice	Mean no. of egg mass	
	Choice1	No-Choice2
Seedling	0.00c	0.00b
Tillering	0.22 ± 0.11c	0.67 ± 0.33 ab
Booting	2.44 ± 0.22a	1.00 ± 0.00 a
Soft dough	1.33 ± 0.19b	1.00 ± 0.00 a
Hard dough	0.55 ± 0.22bc	1.00 ± 0.00 a

1Based on 5 pairs of RBB per cage, means with the same letter are not significantly different, alpha= .05.
2Based on 1 pair RBB per cage, means with the same letter are not significantly different, alpha= .05.

Table 1: Mean egg masses laid by RBB in the phenological stages of rice during 10 days of a choice and no-choice experiment under greenhouse conditions.

Over 10 days of observation on the attractiveness of RRB to phenological stages of rice, the mean number of adult RBB was significantly highest on plants at the booting stage (4.00 ± .516 females) followed by 2.00 ± .516 at tillering and 1.67 ± .516 at soft dough and hard dough stages. The lowest mean number of adult RBB was taken during the seedling stage. For the number of days spent in the rice plant, a similar pattern was observed. This means that adult RBB stayed longest in the rice plant during the booting stage (10.00 ± 1.174) and shortest during the seedling stage (1.67 ± 1.174) **Table 2.**

Phenological stage of rice	Mean/10 day	
	Adult Found	Days Spent
Seedling	0.67 ± 0.33 b	1.67 ± 1.20c
Tillering	2.00 ± 0.00 b	5.33 ± 1.33bc
Booting	4.00 ± 0.58 a	10.00 ± 0.00a
Soft dough	1.67 ±0.33 b	8.67 ± 0.33ab
Hard dough	1.67 ± 0.33 b	7.67 ± 0.33ab

Means with the same letter are not significantly different, alpha= .05.

Table 2: Mean adult rice black bugs found and days spent in the phenological stages of rice during 10 days of a choice experiment under greenhouse conditions.

The experimental results seem to indicate that Rice Black Bug (RBB), *Scotinophara coarctata* discriminates against the seedling stage as an oviposition site. Although RBB lays eggs on any growth stages older than the seedling stage, there is an indication that it prefers the booting stage of rice growth. This finding was supported by a field survey conducted in which a significant number of mated and matured ovary adult female RBB found and laid eggs in the booting stage of rice [6,7]. revealed that phenological stages of both plants had a significant effect on the relative oviposition preference of C. pavonana. Results of C. bimaculata's ovipositional preference was dictated more by leaf phenology than by the three species [8-9]. Oviposition preference may be determined by either physical or chemical cues, or a combination of both [10]. Physical cues involve color, leaf toughness as well as leaf shape [11]. However, the cues used by RBBs are not known and were not investigated in this present study. Rice, nonetheless, is considered an ovipositional and developmental host of RBB.

The result of the other test confirmed that the booting and dough stages were more attractive for RBB than other stages of rice. This implies the abundance and reproduction of RBB most likely happen in this stage. Concluded insects' abundance may be attributed to the presence of suitable host plant species and plant growth stage. Rice as an important resource of RBB has evolved through time [12]. Before the rice is planted once in a year with a long maturity period. But with the advent of modern technology and the intensification of rice production, rice nowadays is often planted synchronously or asynchronously in two croppings seasons in a year with a two or four-month fallow period depending on the climatic conditions of the area. This indicates that there are certain months of the year with no rice or having overlapping growth stages of rice which would eventually influence the Spatio-temporal abundance and reproduction of RBB.

In the absence of a preferred stage, RBBs most likely will disperse by flight and aggregate or just crawl to the nearest areas having suitable rice stages. Most flight in insects is in pre-reproductive (i.e., reproductively immature), occurring at a particular time in adult life [13]. It was generally observed that RBB undergoes dispersal through flight. RBB flight is regarded as an adaptation triggered by unfavorable resources (i.e., absence or fragmented availability of appropriate growth stages of rice) of which insects have no access to food and sites for oviposition.

CONCLUSION

The oviposition preference of Rice Black Bug (RBB), *Scotinophara coarctata*, concerning the rice phenology was examined to offer a possible link between flight and aggregation of RBB to its reproduction. Where the RBB had a choice, booting and dough stages were significantly more attractive to RBB for oviposition than other rice growth stages. Without a choice, however, the RBB will lay eggs only once on whatever plant stage is available. Rice phenology obviously influenced the oviposition preference of RBB as observed during the behavioral experiments. This also implies that the reproduction behavior of the RBB is most likely the driving factor that leads a large number of individuals to flight to seek favorable oviposition sites.

ACKNOWLEDGEMENT

We are grateful to the rice growers of the Municipality of Monkayo, Province of Davao de Oro who freely allowed access to their farms, to the DOST-SEI ASTHRPD, DOST-PCAARRD and DA-BAR provided funds for this research.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this article.

REFERENCES

1. Shepard BM, Arida GS, Heong KL. Sex ratio and productive status of Scotinophara coarctata collected from light traps and rice fields. Int. Rice Res. Notes. 1986; 11(3):23-24
2. Ito K, Sugiyama H, Min CP. Effects of lunar phase on light trap catches of the Malayan black rice bug, *Scotinophara coarctata (Heteroptera: Pentatomidae). Bull. Entomol. Res. 1993 Mar; 83(1):59-65.*
3. Litsinger JA. Cultural, Mechanical, and Physical Control of Rice Black Bugs. Rice Black Bugs.2007; 387.
4. Fritz RS, Stamp NE, Halverson TG. Iteroparity and semelparity in insects. Am. Nat.1982;120(2):264-8.
5. Medina DC. The reproductive biology of the Mango Pulp Weevil. Ph.D. Dissertation. University of the Philippines Los Baños.2002.
6. Velasco LR, Walter GH. Availability of different host plant species and changing abundance of the polyphagous bug Nezara viridula (Hemiptera: Pentatomidae). Environ. Entomol. 1992; 21(4):751-9.
7. Ramo DC. Reproductive cycles and behavior of rice black bug (*Scotinophara coarctata* (Fab.)) (Hemiptera: *Pentatomidae*), as influenced by rice phenology: Implications to its flight and aggregation behavior. 2003.
8. Smyth RR, Hoffmann MP, Shelton AM. Effects of host plant phenology on oviposition preference of Crocidolomia pavonana (Lepidoptera: Pyralidae). Environ. Entomol. 2003; 32(4):756-64.
9. Steinbauer MJ, Clarke AR, Madden JL. Oviposition preference of a Eucalyptus herbivore and the importance of leaf age on interspecific host choice. Ecol. Entomol. 1998; 23(2):201-6.
10. Renwick JA, Chew FS. Oviposition behavior in Lepidoptera. Annu. Rev. Entomol. 1994; 39(1):377-400.
11. Leuthardt FL, Baur B. Oviposition preference and larval development of the invasive moth C ydalima perspectalis on five E European box-tree varieties. J APPL ENTOMOL. 2013; 137(6):437-44.
12. Litsinger JA. The role of alternate plant hosts in rice black bug ecology. Rice black bugs: taxonomy, ecology, and management of invasive species. 2007.
13. Johnson CG. Physiological factors in insect migration by flight. Nature. 1983;198(4879):423-7.