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Damages in Rice Plants Caused by Ear-Sucking Bugs in the Muda Area, West Malaysia

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Abstract

Outbreaks, damages in rice plants and ecology of ear-sucking bugs in the Muda area were investigated. *Leptocorisa oratorius* was the most common species in paddy fields and its density was the highest among the bugs. The high density of this bug was observed at the milkripe stage of rice plants in weedy fields, especially where the *Echinochloa crus-galli* complex predominated. The harvested rice samples collected from 8 rice mills showed that the total ratio of pecky and empty grains was 8.4-29.7%. Although all of the empty grains were not necessarily attributed to rice bugs, their attacks seemed to cause a serious yield-loss. Caging experiments showed that *L. oratorius* adults damaged 6.40-7.66 grains/day/adult at maximum, when the adults were released on the panicle at the flowering stage. The relationship between the density of L. oratorius in paddy fields and the number of damaged grains was not clear as indicated by a low regression of the latter to the former (r=0.405). It was therefore difficult to estimate the control threshold from this relationship, The control of weeds, especially *E. crus-galli* complex, seemed to be the most effective and practical means to reduce rice damages caused by ear-sucking bugs.

Discipline: insect pest
Additional key words: control threshold, Echinochloa crus-galli, Leptocorisa oratorius, occurrence, weed

Introduction

Rice bugs had been considered in the past to be minor pests compared to plant- and leafhoppers or stem borers in the Muda irrigation area, which is located on the west coast of Peninsular Malaysia. However, outbreaks of rice bugs have often taken place after the early 1980s, when the farmers introduced direct-seeding rice cultivation. Nik Mohd. Noor and Hirao[2] speculated on the causes of the outbreaks, suggesting possible connections to the increase of weeds in paddy fields, which was associated with the spread of that type of cultivation practices. No investigations have so far been made, however, to verify those connections. Hirao and Ho[1] reported that the rice bug (*Leptocorisa oratorius*) and the southern green stink bug (*Nezara viridula*) were important species among ear-sucking bugs, and Malayan black rice bug (*Scotinophara coarctata*) was also important among stem-sucking bugs. As far as the ecology of these bugs in the

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Muda area is concerned, available information is very limited.

The present paper accounts for some results of the surveys on rice bug fauna in the paddy fields of the Muda area, and rice grain damages caused by rice bugs, mainly *L. oratorius*. The attacking ability of *L. oratorius* on a rice ear was also studied under an experimental condition.

Materials and methods

1) Rice bug fauna in paddy fields

Collection with net-sweeping and direct investigations of rice bugs were carried out in paddy fields in and around the Muda area. The major part of this study was conducted in 1986 and 1987.

2) Population density of ear-sucking bugs and crop conditions

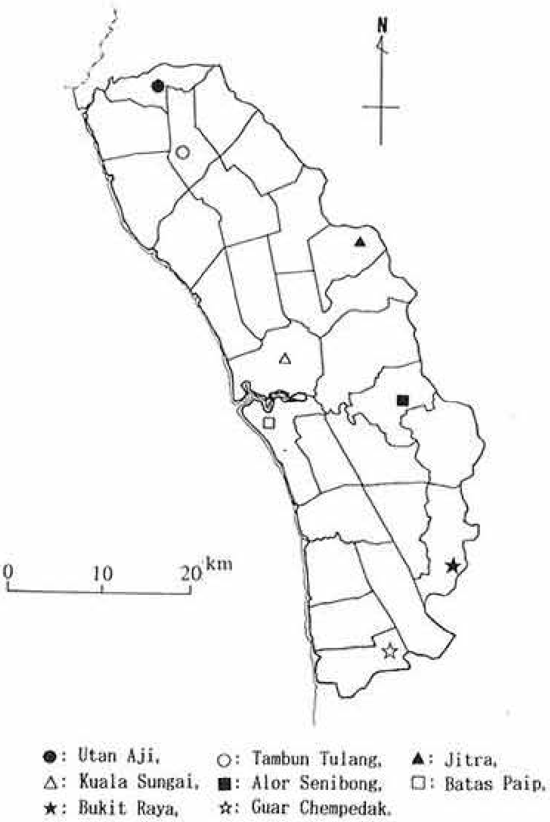

Fig. 1. Location of rice mills where samples were collected

Bugs were collected for counting with 20-stroke net-sweepings after the heading stage of rice plants, which were grown in the first crop season, 1986. The crop factors recorded were rice cultivation type, rice growth stage and weed species grown in the paddy fields.

3) Post-harvest evaluation of damages by ear-sucking bugs

Samples of rice grains harvested in the first season of 1988 were collected from 8 rice mills, as shown in Fig. 1. About 30 m*l* of unhulled grains per sack were sampled from three sacks selected at random in each rice mill. The samples were dried in an incubator at 50°C for one day and then 500 grains were randomly chosen from each sample and weighed. These grains were hulled by hand and classified into five groups: empty, immature, pecky, colored and perfect grains.

4) Attacking ability of L. oratorius adult to rice ear

Rice ears of the cultivar: TN1 in the flowering stage was enveloped separately in a screened cage, with a size of 6 cm in diameter and 30 cm in length, on December 7 and 8, 1987. One, two or four adults of field-collected *L. oratorius* were released in each cage for 5 days at 0 day (corresponding to flowering stage), 10 days (milk-ripe stage) and 15 days (dough-ripe stage) after enveloping. After a given feeding period, the adult and eggs laid were removed, but the cages were left until harvest. The ears were harvested on January 9, 1988 and dried. All the grains were hulled by hand and the number of damaged grains was counted. The experiment was replicated 3 times.

5) Relationship between L. oratorius density and grain rice damages in paddy fields

Bugs were collected for counting with 20-stroke net-sweepings at 11 different sites in the Muda area, where rice plants were from flowering to milk-ripe stages, in the first season of 1989. At the yellow-ripe stage, 30 ears were collected at random in each site. They were dried in an incubator at 50°C for 1 day and threshed, and then 500 grains were sampled at random for each site. The grains were hulled by hand and the numbers of empty, pecky and perfect grains were counted.

Results

1) Rice bug fauna in paddy fields

The results obtained are summarized in Table 1.

Table 1. List of bugs collected or observed in paddy fields

Species	Abundance[a)]
Pentatomidae	
Scotinophara coarctata	++++
Scotinophara sp.	+
Storthecoris sp.	++
Nezara viridula	+
Pigomenida bengalensis	+++
Eysarcoris ventralis	+++
Alydidae	
Leptocorisa oratorius	++++
Leptocorisa chinensis	+
Leptocorisa luzonica	+
Riptortus linearis	+
Coreidae	
Cletus punctiger	+++
Cletus trigonus	+
Homoeocerus unipunctatus	+
Lygaeidae	
Paromius gracilis	+++
Lygaeidae sp.	+

a): ++++ : Major species, +++ : Common species, ++ : Not so many, + : Few or rare.

A total of 4 families with 15 species, including 3 unidentified species, of rice attacking bugs and some bugs which are likely to attack rice plants was collected from paddy fields. Ear-sucking *L. oratorius* and stem-sucking *S. coarctata* predominated among the bugs collected. Following these 2 species, *Pigomenida bengalensis*, *Eysarcoris ventralis*, *Cletus punctiger* and *Paromius gracilis* were predominant. These 4 species are of an ear-sucking type. Although Hirao and Ho[1)] reported that *N. viridula* was an important species, the population density of this bug was low and its distribution seemed to be limited in this study area.

2) Population density of ear-sucking bugs and crop conditions

The results are presented in Table 2. *L. oratorius* was the most dominant species throughout this survey. Other rice bugs collected were *P. gracilis*, *E. ventralis*, *C. punctiger* and *N. viridula*. The largest number of *L. oratorius* collected was 41 adults and 133 nymphs per 20-stroke sweeping, followed by 58 adults and 31 nymphs. Both were recorded at the milk-ripe rice stage in direct-seeded fields overgrown with barnyard grass (*Echinochloa crus-galli* complex).

The population density of rice bugs was higher in direct-seeded fields than in transplanted ones. Among the rice growing stages, the density was highest at the milk-ripe stage. In direct-seeded fields,

Table 2. Population density of ear-sucking bugs in paddy fields after heading in relation to field or plant conditions

Field and plant conditions	No. of fields surveyed	Average no. of bugs/20-stroke sweeping		
		L. oratorius		Others
		Adult	Nymph	Adult
Planting (milk-ripe stage)				
Transplanting	11	2.9 (0–9)[a)]	3.4 (0–13)	1.9
Direct seeding	12	16.7 (0–58)	16.7 (0–133)	4.5
Growth stage (transplanted field)				
Flowering	6	1.3 (0–5)	0.8 (0–3)	3.7
Milk-ripe	9	3.4 (0–9)	4.0 (0–13)	2.2
Dough-ripe	3	1.7 (0–3)	0.7 (0–2)	0.7
Weed condition (direct-seeded field)				
E. crus-galli complex	9	21.8 (0–58)	20.9 (0–133)	6.0
S. grossus	2	0.5 (0–1)	0	1.0
No weeds	3	1.3 (0–3)	4.0	0

a): Figures in parentheses indicate a range of number of bugs collected.

Table 3. Degree of contamination of imperfect rice grains in the samples collected from 8 rice mills

Location of rice mills[a)]	Date of collection (in Aug. 1988)	Weight/500 grains[b)] (g)	No. of grains/500 grains[b)]				
			Empty	Immature	Pecky	Colored	Perfect
○ Tambun Tulang	21	10.74	22.3	37.0	19.7	3.3	417.7
● Utan Aji	21	9.87	22.0	22.7	57.7	7.3	390.0
△ Kuala Sungai	21	9.02	34.0	10.3	114.7	7.7	333.3
▲ Jitra	21	9.55	20.7	6.3	76.3	5.3	391.3
■ Alor Senibong	20	9.74	27.3	39.0	41.3	11.3	381.0
★ Bukit Raya	20	9.88	55.3	11.3	79.3	6.3	347.7
□ Batas Paip	20	9.09	55.0	25.3	47.3	15.0	357.3
☆ Guar Chempedak	20	8.96	44.0	16.3	76.7	6.0	357.0

a): Each symbol corresponds to that in Fig. 1.
b): Average of 3 replications.

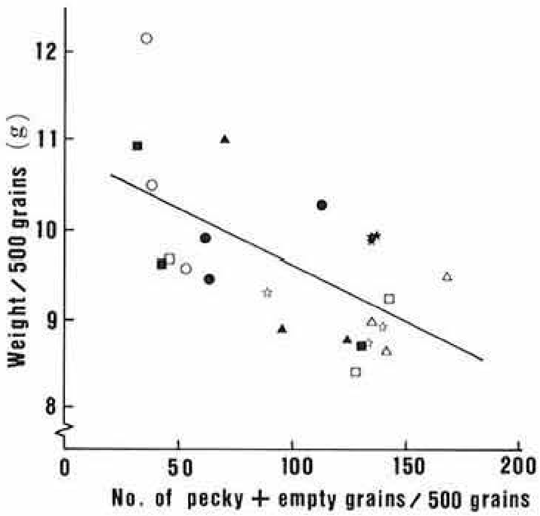

Fig. 2. Relationship between the total pecky and empty grains and the 500-grain weight
Each symbol refers to that in Table 3.
The regression line shows:
$Y = -0.01282X + 10.88$ ($r = -0.618$).

a great number of rice bugs were observed in the fields rampant with *E. crus-galli* complex; the mean population density of *L. oratorius* was 21.8 adults and 20.9 nymphs, while the bug density was low in the fields predominated by sedge plants (*Scirpus grossus*) as well as the fields without weeds.

It was confirmed that the population density of rice bugs, especially *L. oratorius*, was high in the weedy fields, especially those covered by overgrown *E. crus-galli* complex as pointed out by Nik Mohd. Noor and Hirao[2)].

Table 4. Estimated yield-loss based on the regression line in Fig. 2

Pecky + empty	0%	10%	20%	30%
Weight/ 500 grains (g)	10.88	10.24	9.60	8.96
Ratio	100	94.1	88.2	82.4
Yield-loss	0	5.9	11.8	17.6

3) *Post-harvest evaluation of damages by ear-sucking bugs*

The degree of contamination by imperfect rice grains in the samples collected from the 8 rice mills is summarized in Table 3. The largest mean weight of 500 grains was 10.74 g for the sample from Tambun Tulang. On the other hand, the mean grain weights of the samples from Guar Chempedak (8.96 g), Kuala Sungai (9.02 g) and Batas Paip (9.09 g) were rather small. The number of perfect grains was also relatively small in these samples. The number of pecky grains which were caused by ear-sucking bugs was large in those samples from Kuala Sungai (the average was 114.7 grains out of 500 grains, which was equivalent to 22.9%), Guar Chempedak (76.7 grains, 15.3%), Jitra (76.3 grains, 15.3%), while it was very small in Tambun Tulang (19.7 grains, 3.9%).

In addition to the pecky grains, empty grains are often produced by rice bugs, when the rice ear is attacked during the period of early endosperm formation[5)]. Therefore, it is necessary to take empty grains into account in addition to pecky grains to estimate the damages by ear-sucking bugs. But

Table 5. Damages of rice grains by *L. oratorius* adults at flowering, milk-ripe and dough-ripe stages[a)]

No. of adults caged/ear	No. of total grains	No. of undamaged grains	No. of grains damaged		
			Pecky	Empty	Total
(At flowering stage)					
♀ 1	107.0	39.0	11.7	56.3	68.0
♀ 2	115.7	22.3	8.7	84.7	93.4
♀ 4	112.7	2.0	4.3	106.3	110.6
♂ 1	108.7	47.0	20.3	41.3	61.6
♂ 2	129.0	47.3	13.7	68.0	81.7
♂ 4	103.7	24.0	7.0	72.7	79.7
(At milk-ripe stage)					
♀ 1	117.3	63.7	23.7	30.0	53.7
♀ 2	105.3	44.3	38.0	23.0	61.0
♀ 4	111.3	17.3	39.7	54.3	94.0
♂ 1	117.3	64.0	20.3	33.0	53.3
♂ 2	104.7	39.0	26.0	39.7	65.7
♂ 4	116.3	42.3	29.3	44.7	74.0
(At dough-ripe stage)					
♀ 1	113.7	64.3	22.3	27.0	49.3
♀ 2	108.0	60.0	27.6	20.3	47.9
♀ 4	119.3	52.0	35.0	32.3	67.3
♂ 1	116.0	67.0	20.3	28.7	49.0
♂ 2	122.0	72.3	23.3	26.3	49.6
♂ 4*	135.0	54.5	46.5	34.0	80.5
0	99.7	70.0	7.0	22.7	29.7

a): Each figure shows an average of 3 replications, but * indicates an average of 2 replications.

it is difficult to distinguish the empty grains caused by ear-sucking bugs from those caused by other factors such as pathogens or physiological disorders. Assuming that all the empty grains are caused by ear-sucking bugs, the relationship between the total pecky and empty grains and the 500-grain weight is shown in Fig. 2. There was a negative correlation between these two factors:

$$Y = -0.01282X + 10.88 \quad (r = -0.618).$$

The yield-loss due to ear-sucking bugs was tentatively estimated from Fig. 2. Providing that the harvests contain 10% (50 grains out of 500 grains), 20% (100/500) and 30% (150/500) of pecky and empty grains, the yield-loss is estimated at 5.9, 11.8 and 17.6%, respectively (Table 4).

No difference in damages was observed between the coastal (Tambun Tulang, Kuala Sungai, Batas Paip and Guar Chempedak; white symbols) sites and the inland (Utan Aji, Jitra, Alor Senibong and Bukit Raya; black symbols) sites (Fig. 2). The study showed that rice bug infestation caused a considerable yield-loss in general.

4) Attacking ability of L. oratorius adult to rice ear

Average numbers of the damaged grains caused by the attack of *L. oratorius* at flowering, milk-ripe and dough-ripe stages of rice plants are summarized in Table 5. The largest number of empty grains was observed when the bugs attacked at the flowering stage, with a decreasing number at the later stage, while the incidence of pecky grains was in a reverse order. Consequently, a larger number of damaged grains were caused by the attacks at earlier developmental stages of the ears. The number of empty grains in the control plot without bugs was fairly large, i.e. 22.7% of the total grains on an average.

The number of grains damaged by one adult per

Table 6. Number of damaged grains produced by one adult per day at 3 different developmental stages of rice ear

Developmental stage	♀ No. of adults caged	♀ Damaged grains /day/adult	♂ No. of adults caged	♂ Damaged grains /day/adult
Flowering	1	7.66	1	6.40
	2	6.36	2	5.20
	4	4.05	4	2.50
Milk-ripe	1	4.80	1	4.72
	2	3.13	2	3.60
	4	3.22	4	2.22
Dough-ripe	1	3.93	1	3.86
	2	1.83	2	2.00
	4	1.88	4	2.54

Table 7. Number of rice bugs caught by 20-stroke net-sweeping

Field	Date of collection	Rice growing stage	*L. oratorius* Adult	*L. oratorius* L-nymph[a)]	*L. oratorius* S-nymph[b)]	Other rice bugs[c)]
A	Jul. 23	Flowering	19	2	1	Ev: n=2, Ly: a=1
B	Jul. 23	Flowering	13	1	0	Ev: a=3, n=3, Ly: a=6, n=6
C	Jul. 30	Flowering	6	2	2	Ev: a=2, n=1
D	Aug. 7	Flowering	24	0	1	Ev: a=1, Cp: a=8, n=5, Ly: a=1
E	Aug. 7	Flowering	15	0	3	Ev: a=4, n=1, Cp: a=3, n=2
F	Aug. 7	Flowering	43	1	16	Ev: a=2, n=1, Cp: a= 4, n=5, Ly: n=1
G	Aug. 7	Milk-ripe	63	3	83	Ev: a=2, Cp: a=1, Ly: a=17, n=1
H	Aug. 7	Milk-ripe	76	2	70	Ev: a=2, Cp: n=1, Ly: a=13, n=2
I	Aug. 7	Milk-ripe	105	2	39	Ev: a=1, Cp: a=1, n=2, Ly: a=9, n=1
J	Aug. 7	Milk-ripe	9	2	6	Ev: a=2, Cp: a=2, n=1
K	Aug. 7	Milk-ripe	8	0	6	Ev: a=3, Cp: a=2

a): L-nymph; 4th–5th instar nymph.
b): S-nymph; 1st–3rd instar nymph.
c): Ev; *Eysarcoris ventralis*, Cp; *Cletus punctiger*, Ly; Lygaeidae bugs, a; adult, n; nymph.

day is presented in Table 6. One-adult-caging plots at the flowering stage show the largest numbers in both sexes. The average numbers of the damaged grains were 7.66 and 6.40 per adult per day in the female and male, respectively. The earlier the attack took place, the more damaged grains were produced in general. In each treatment, one-adult-caging plot was faced by the heaviest damage. This may be attributed to size of the cage used. Adults might have competed with each other in a cage when more than two bugs were placed in.

5) Relationship between L. oratorius density and grain rice damages in paddy fields

The results of the sweeping survey at the 11 sites are summarized in Table 7. The majority of the collected bugs were *L. oratorius* at all sites studied. The minimum and maximum number of *L. oratorius* adults was 6 at field C and 105 at field I. The number of large nymphs, i.e. 4th–5th instar, was generally small. The first instar nymphs were highly predominant among the small nymphs, or 1st–3rd instar. In addition to *L. oratorius*, *E. ventralis*, *C. punctiger* and Lygaeidae bugs were collected, but their population density was much lower than *L. oratorius*.

The relationship between the density of bugs and the damage of grains expressed by the total number of empty and pecky grains in the sampled 500 grains, is presented in Fig. 3, on the basis of following

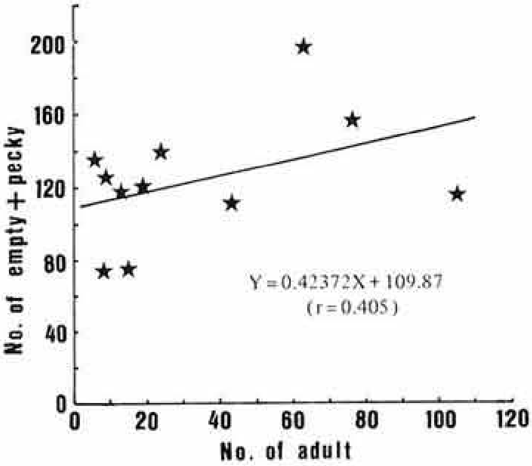

Fig. 3. Relationship between the number of *L. oratorius* adults (per 20-stroke sweeping) and damaged grains

assumptions; (1) rice bugs caused all the empty grains, and (2) the number of *L. oratorius* adults was regarded as an index of the density of bugs at that place. The second assumption may be justified by the fact that *L. oratorius* highly predominated over the other bugs (Table 7) and most of the *L. oratorius* nymphs were in the first instar (Table 7) that may have a very low ability to damage the grains. From this figure, it is estimated that when the bug density is 0, the number of damaged grains is about 110 out of 500 grains, or 22%, which ratio corresponds to the result obtained in the control plot of the caging experiment, i.e. 22.7% which value is presented in the previous section of this paper. But the relationship between the density of bugs and the number of damaged grains was not clear as indicated by a low regression of the latter to the former (r = 0.405). Therefore, it is difficult to estimate the reliable control threshold of rice bugs from this figure. Sugimoto and Nugaliyadda[4] reported similar results obtained from the same type of study that was earlier conducted in Sri Lanka. It seems that the causes of the empty grains are highly complicated.

Discussion

This study confirmed that *L. oratorius* was the most important ear-sucking rice bug in the Muda area. This study also showed that population density of *L. oratorius* was high in weedy fields, especially where the *E. crus-galli* complex predominated. Since 1980, direct-seeding rice cultivation has been spreading in the Muda area, where more than 80% of the rice fields are under that type of practice in recent years. The direct-seeding in the Muda area was introduced and expanded not through the government recommendations in the form of a complete technical package, but through the farmers' own initiatives[3]. It is well known that the direct-seeded fields are much more susceptible to a rank growth of weeds than the transplanted ones are. The cultivation techniques employed by farmers are still not well established; especially their weed control is inadequate. This may lead to a scenario: expansion of direct-seeded area → increase of weedy (especially *E. crus-galli* complex) fields → outbreak of ear-sucking rice bugs (especially *L. oratorius*).

In the case of Japan, rice damages caused by ear-sucking bugs generally take place not in flat areas but in mountainous fields. In Sri Lanka, the fields attacked severely by *L. oratorius* are also located in the mountains or hillside (Sugimoto, personal communication). The outbreak of or the damage increase by ear-sucking bugs in the Muda area, which is a vast flat plain of about 96,000 ha, is very likely a result of the expansion of weedy direct-seeded fields. Alternative host plants, consisting mainly of *E. crus-galli* complex, may provide continuous food availability for ear-sucking bugs.

Weed management may be the most effective and practical measure to reduce rice damages caused by ear-sucking bugs. If farmers control *E. crus-galli* complex effectively, the population density of *L. oratorius* could considerably be decreased in the flat Muda area.

References

1) Hirao, J. & Ho, N. K. (1987): Status of rice plants and measures of control in the double cropping area of the Muda irrigation scheme, Malaysia. *Trop. Agr. Res. Ser.*, **20**, 107–115.
2) Nik Mohd. Noor, N.S. & Hirao J. (1987): Status of rice insect pests in the direct-seeded field in the Muda area. *Teknol. Padi Jil.*, 3, 39–44.
3) Nozaki, M. (1989): Present status and problems relating to rice double cropping in the Muda irrigation area —Cultural techniques—. *Res. Rep. Trop. Agr.*, **63**, 13–22 [In Japanese].

4) Sugimoto, A. & Nugaliyadda, L. (1990): Rice grain sterility caused by *Leptocorisa oratorius* in Sri lanka. *Jpn. J. Trop. Agr.*, **34** (Extra issue 1), 10–11 [In Japanese].
5) Swanson, M. C. & Newsom, L. D. (1962): Effect of infestation by the rice stink bug, *Oebalus pugnax*, on yeild and quality in rice. *J. Econ. Entomol.*, **55**, 877–879.

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