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Parasitic Activities of Egg Parasitoids on the Rice Planthoppers,
Nilaparvata lugens (STÅL) and *Sogatella furcifera* (HORVÁTH)
(Homoptera: Delphacidae), in the Muda Area, Peninsular Malaysia

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Natural enemies of the eggs of the rice planthoppers *Nilaparvata lugens* and *Sogatella furcifera* were investigated in two direct-sowing paddy fields of the Muda area during the main cropping season in 1989. Egg mortality was estimated with a "trap method" in which "trap plants" with planthopper eggs were exposed in the fields, and field sampling of eggs. Mortality in egg stage varied from 23% to 92% in *N. lugens*, and from 11% to 90% in *S. furcifera*. Parasitism by wasps was the major mortality factor in the egg stage. The parasitoids *Anagrus* and *Oligosita* emerged from both planthopper eggs. In *N. lugens* eggs, *Anagrus* spp. were predominant when the rice plants were young. The parasitism by *Oligosita* spp. increased with growth of the rice plants. In *S. furcifera* eggs, *Anagrus* spp. were predominant throughout the crop season. The maximum parasitism rates were 68% in *N. lugens* eggs and 69% in *S. furcifera* eggs. Significant differences between the two methods were detected in only two cases. Parasitism indicated by the trap method reflected the actual state of parasitism in the field fairly well.

Key words: *Nilaparvata lugens*, *Sogatella furcifera*, egg parasitoid, *Anagrus*, *Oligosita*

INTRODUCTION

The Muda irrigation site is a large rice-growing area, ca. 100,000 ha, located in the northwest of Peninsular Malaysia. A double cropping system of rice has been adopted in this area since 1970: the 1st crop (off-season) from late March to August, and the 2nd crop (main season) from September to January. After intensification of paddy farming, including the introduction of high-yielding varieties and increased fertilization, the brown planthopper (BPH) *Nilaparvata lugens* and the white-backed planthopper (WBPH) *Sogatella furcifera* have become potential threats to rice production (CHANG, 1980). In recent years, however, planthoppers seldom have outbreaks, disregarding non-resistant varieties (mainly MR84) being planted in more than two thirds of rice cropping areas. Natural enemies play an important role in controlling rice planthopper populations in this area, as pointed out for other tropical rice areas

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(COOK and PERFECT, 1989; DYCK and ORLIDO, 1977; KENMORE et al., 1984). CHANG (1980) has emphasized the importance of predation by spiders and egg parasitism by *Anagrus* sp. in Muda. Our study was conducted to examine mortality factors of planthopper eggs during the main cropping season in 1989.

METHODS

Two directly sowed paddy fields (variety MR84) were selected in the Muda area. Field "A" (0.27 ha) was at Kg. Kandai, Alor Setar, Kedah, and field "B" (0.68 ha) at Kg. Gelam, Bk. Besar, Kedah. The dates of sowing in fields A and B were October 14 and September 12 (1989) respectively. Herbicides (molinate+2,4 D) were applied in both fields about 30 days after sowing (30 DAS). No insecticides or fungicides were used.

Egg mortalities were estimated using two methods. One was the "trap method" similar to the method of ÔTAKE (1967) and KUNO (1968). The procedures differed depending on the rice stage in the field. When the paddy was young (before 60 DAS), young rice plants (variety: TN1 or MR84) planted in a pot (7 cm dia. × 8 cm ht.) were used as "Trap plants". The potted plants were put in plastic cases (25 cm ht.). Gravid females were released into cases at a rate of one BPH and one WBPH per case for oviposition for 24 h. The eggs in the potted plants were then exposed to parasitoids and predators in the paddy.

Four days later, the trap plants were taken back to the laboratory and dissected to check the eggs. Eggs detected were placed on a wet filter paper in a petri dish and incubated at 25°C and 14L-10D. The eggs were checked daily for color change due to parasitism. Predation was checked by the presence of collapsed planthopper egg shells remaining in dissected plants. From the paddy observation, we believed the major predator to be *Cyrtorrhinus lividipennis* REUTER. The eggs that died after the eye pigmentation stage without any sign of color change were regarded as hatched eggs.

When the paddy became older (after 60 DAS), rice plants standing in the field were used as "Trap plants". The rice stem was covered with nylon cloth (3.5 cm dia. × 20 cm length) and gravid females were introduced into cages at a rate of one BPH and one WBPH per cage. Cages were removed 24 h later. The subsequent procedures were the same as those for the potted plants mentioned above.

Ten trap plants (replicates) were prepared for each trial. Trapping was carried out every week from 23 to 103 DAS.

Another method used was field sampling of planthopper eggs. Rice plants were sampled from the fields, and planthopper eggs in the plants were checked for parasitism and predation. Density of eggs and egg masses per stem varied with rice stage and planthopper density. We therefore tried to sample more than 10 egg masses at each sampling. This method was conducted occasionally to check the reliability of the data obtained by the Trap method.

RESULTS

Parasitoids

Parasitoid wasps belonging to two genera, *Anagrus* (Mymaridae) and *Oligosita* (Trichogrammatidae), emerged from eggs of both planthopper species. *A. optabilis*,

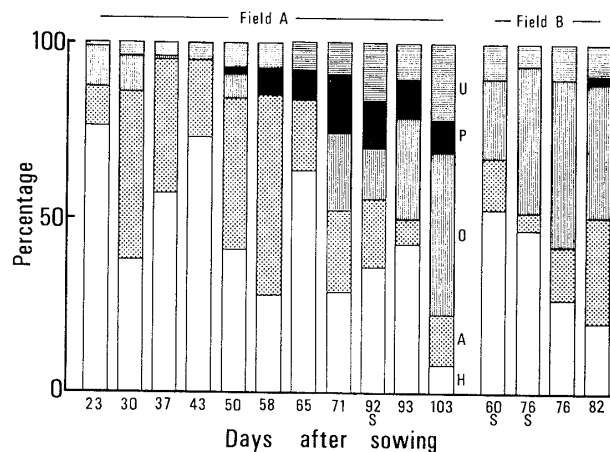


Fig. 1. Changes in *Nilaparvata lugens* egg mortality, in relation to the growing stage of rice. H: normal hatch of eggs; A: parasitism by *Anagrus* spp.; O: parasitism by *Oligosita* spp.; P: predation; U: death due to unknown mortality factors; S: data by sampling of field eggs. Other data was from the trap method.

O. naias and *O. aesopi* emerged from BPH eggs. *A. flaveolus*, *A. perforator*, *A. frequens* and *O. aesopi* emerged from WBPH eggs.

Parasitoid genera can be identified by the color characteristics of parasitized eggs. When a planthopper egg is parasitized by *Anagrus*, egg color turns orange or yellow orange. Parasitoid pupae can then be observed through the transparent chorion of the host with a binocular microscope. The egg parasitized by *Oligosita* turns to dark yellow. The parasitoid pupa cannot be seen through the dark gray of the host egg chorion.

Parasitism of BPH eggs

Parasitism varied from 20–60% in field A (Fig. 1). *Anagrus* spp. were predominant before 71 DAS. The parasitism by *Oligosita* spp. rapidly increased after 71 DAS, and reached 46% at 103 DAS. In field B, parasitism varied from 34–68%. *Oligosita* spp. were predominant throughout the study period. The maximum percentage of parasitism by this genus was 47% at 76 DAS.

Interspecific association between *Anagrus* spp. and *Oligosita* spp. on BPH egg masses was analyzed by COLE's (1949) index (Table 1). When the parasitism of egg masses increased, COLE's index tended to decrease. The negative index value at 82 DAS in field B was significant, suggesting a negative association between *Anagrus* spp. and *Oligosita* spp.

Parasitism of WBPH eggs

In field A, the parasitoid activity gradually increased until 58 DAS and declined thereafter (Fig. 2). The maximum percentage of parasitism was 47% at 58 DAS. *Anagrus* spp. always dominant. The activity of *Oligosita* spp. was low; less than 5% of eggs were parasitized by this genus. Parasitism was generally higher in field B than field A. The maximum parasitism in field B was 69% at 82 DAS.

Predators and unknown mortality factors

Percentage mortality by predators and failure to hatch (due to unknown factors)

Table 1. Interspecific association between the two groups of egg parasitoids, *Anagrus* spp. and *Oligosita* spp. on *N. lugens* egg masses

Field name	DAS ^a	No. of egg masses	No. of egg masses parasitized by			C ^c	S.E. ^c
			<i>Anagrus</i>	<i>Oligosita</i>	<i>Anagrus</i> and <i>Oligosita</i>		
A	23	170	27	45	12	51.2	0.198
A	71	13	3	5	2	76.9	0.325
A ^e	92	38	9	8	6	60.5	0.106
B	82	52	13	17	19	94.2	0.218
							n.s. ^d
							n.s.
							n.s.
							$p < 0.05$

^a Days after sowing.

^b Total percentages of egg masses parasitized by one or both of the parasitoid genera.

^c COLE's coefficient of interspecific association (C) and its standard error (S.E.).

^d C value is not significantly different from 0 by χ^2 -test ($p > 0.05$).

^e Data was obtained by field sampling of naturally deposited planthopper eggs.

Data on the other lines were obtained by the trap method.

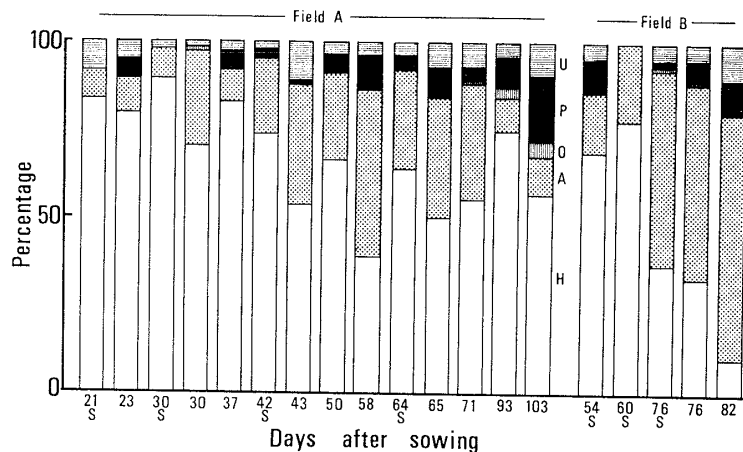


Fig. 2. Changes in *Sogatella furcifera* egg mortality, in relation to the growing stage of rice. H: normal hatch of eggs; A: parasitism by *Anagrus* spp.; O: parasitism by *Oligosita* spp.; P: predation; U: death due to unknown mortality factors; S: data by sampling of field eggs. Other data was from the trap method.

increased with the age of paddy plants. Mortality from predation ranged from 0 to 18%, being distinctly lower than that from parasitism. Mortality from unknown factors ranged from 1 to 22% in BPH, and from 0 to 12% in WBPH.

DISCUSSION

In our study, the egg mortality ranged from 23 to 92% in BPH, and from 11 to 90% in WBPH. Such a high level of egg mortality of BPH has been reported in the Philippines by COOK and PERFECT (1989) and KENMORE et al. (1984).

COOK and PERFECT (1989) reported that predation by *C. lividipennis* was the major mortality factor in the egg stage of BPH. The mortality from predation, however, did not exceed 18% in our study. FOWLER et al. (1991) recorded egg feeding of BPH by larvae belonging to *Panstenon* (Hymenoptera: Pteromalidae) in Sri Lanka. We also observed that hymenopterous larvae of unknown species fed on planthopper eggs, but numerical estimates of this predation was impossible because consumption was complete. Therefore, predation may have been underestimated if the hymenopterous larvae were active in our study area.

TAN (1981) reported 14 species of parasitoids from eggs of rice-infesting plant-hoppers and leafhoppers in Peninsular Malaysia. In our study, the activity of egg parasitoids was generally so high that parasitism was regarded as the major mortality factor at the egg stage of rice planthoppers. Concerning local variation in the intensity of parasitism of rice planthopper eggs, there are several reports of activity throughout Asia: 3–63% in BPH of Muda, Malaysia (CHANG, 1980), 16–58% in WBPH and 12–25% in BPH in Japan (KUNO, 1968), and 0–32% or 20–42% in BPH of the Philippines (COOK and PERFECT, 1989; KENMORE et al., 1984). Some researchers occasionally noted parasitism rates higher than 80% for WBPH and BPH in Shikoku, Japan (ÔTAKE, 1967), Thailand (NISHIDA et al., 1976; MIURA et al., 1979), Taiwan (MIURA et al., 1981), and Kelantan, the east coast of Peninsular Malaysia (Anon., 1984).

ÔTAKE (1967) estimated parasitism with the trap method using only two variables:

numbers of hatched nymphs of planthoppers and numbers of emerged parasitoids. The maximum values of parasitism that we obtained by his method were as high as 88% in BPH and 87% in WBPH. His calculation may overestimate parasitism if there are many eggs that have been preyed on or did not hatch from unknown causes.

Parasitism by "trap method" tended to be higher than that from field samplings, however, a significant difference was detected only in two out of seven cases between the two methods (χ^2 test, $p < 0.01$). A lower parasitism in the field sampling may be caused by a shorter exposure period of host eggs in the field than that in the trap method. ÔTAKE (1970) has suggested that *Anagrus* nr. *flaveolus* does not attack the planthopper eggs that have entered the later half of embryonic development under normal outdoor conditions. The results of the trap method seem to reflect the actual state of parasitism in the field fairly well.

As mentioned above, egg parasitism of planthoppers seems to be one of the important mortality factors in the Muda area. Further study is needed to investigate the influence of egg parasitoids on population growth of the planthoppers.

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