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Rice plant- and leafhopper incidence in Malaysia and Indonesia—Report of a research tour January to March 1976

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CONTENTS

RICE PLANT- AND LEAFHOPPER INCIDENCE IN MALAYSIA AND INDONESIA --- REPORT OF A RESEARCH TOUR JANUARY TO MARCH 1976

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I. INTRODUCTION

Some plant- and leafhopper species (Hemiptera: Delphacidae and Cicadellidae) are well known as harmful rice pests with their intensive plant-juice sucking and transmission of virus and mycoplasma-like diseases. Particularly, in tropical Asia, damage caused by the brown planthopper, *Nilaparvata lugens* Stål, has recently become quite heavy. We have lots of reports and discussion about this pest in Nos. 1-4 of *the Rice Entomology Newsletter.*

In some localities of the Philippines, severe hopperburn[1] occurred in 1972 and 1973 (Dyck, 1974); in the Mekong Delta, Vietnam, *N. lugens* is regarded as the most serious insect pest of rice since 1970 (Huynh, 1975); in the Amparai district of Sri Lanka, the pest has become destructive since 1972 (Fernando, 1975); and in Kerala and some other localities of India, epidemic occurrences of *N. lugens* have recently become prevalent, grassy stunt disease, too, being epidemic in some of them (Kulshreshtha, 1974; Abraham and Nair, 1975; Bhalla and Pawar, 1975; Velusamy et al., 1975).

In Indonesia, *Nilaparvata* problem is particularly serious. During the 1968/1969 wet season, heavy occurrences of the pest were noticed in Central and West Java, and then infestation spread all over Java Island and also to North Sumatra, South Sulawesi and Bali (Dyck, 1975; Mochida and Tatang, 1976). Recently, the Indonesian Government has started a strong policy of replacing susceptible rice varieties such as Pelita with IR 26 and some other resistant ones in the heaviest *Nilaparvata*-infested areas.

The outbreaks of *N. lugens* in the above-mentioned countries and also in the Solomon Islands (Stapley, 1975) are likely to be related to the recent modernization in rice growing practices in the tropics such as introduction of high-tillering, high-yielding varieties with increased application of nitrogenous fertilizers and widespread rice cultivation of more than one crop a year due to improved irrigation systems. Even in many of the countries which are still recognized as low in incidence of the pest, there must exist some occasional sporadic mass-occurrences of it as observed, for instance, at Nakonpatom, about 100 km west of Bangkok, in 1974 (Hamamura, personal communication) and at Bumbong Lima, West Malaysia, in 1975 (Heong, 1975).

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1) Heavy damage due to plant-juice sucking by delphacids, mainly *N. lugens.* The rice plants become yellow, sometimes brown according to varieties, and then die. Heavy hopperburn over a paddy field is demonstrated in the color plate of this report (p. 29).

The authors made a tour of studying rice plant- and leafhopper problems in the tropics from January to March, 1976. We first visited the northern half of Province Wellesley and the Kedah-Perlis Coastal Plain, West Malaysia, and then Java, Bali and Lampung, Sumatra, Indonesia. Reflecting the above-mentioned state of affairs around rice plant- and leafhoppers, our deepest concern was to study *N. lugens* incidence and we were keenly impressed with the seriousness in this problem and interested in the fact that the pest there was largely different in some population features from that in our country.

II. METHODS

Places chosen for investigation are respectively given code numbers as shown in Fig. 1. The place names corresponding to the code numbers in the figure are given in Table 1. In the table, a paddy field, rice nursery or weedy ground investigated at each coded place is expressed by combining the code number with symbol f, n or w, respectively, as, for instance, mK6-fA, iC4-n, etc.

In many parts of the Kedah-Perlis Coastal Plain, a large rice-growing area of about 100,000 ha, crop had already been under the harvesting stage. In Province Wellesley, rice was a little younger in general. In both regions, however, there were also some fields with much less mature rice. The rice plants we chose there for investigation ranged from the maximum tiller-number stage to the dough ripe one.

In West Malaysia, however, there has been considerable confusion in rice varietal names and we could not help giving up the idea of identifying the variety exactly in every field we investigated. On the contrary, in Indonesia, it was usually possible for us to know the varietal names at the time of investigation. The main varieties chosen to study in that country were Pelita and IR 26; the former had been produced by crossing Syntha and IR 5 and then rapidly spread over the country since the early 1970's but it is susceptible to *N. lugens*, while the latter is resistant to the pest and has recently replaced the former in many places of Java and Bali. Other than these varieties, we occasionally observed local varieties because they were exclusively grown in some localities and neither Pelita nor IR 26 could be found there.

In many parts of Indonesia, rice cultivation was highly asynchronous and there existed almost all stages of rice growth. Even under such circumstances, however, most of the paddy fields we investigated were ones with plants under the growth stage between maximum tiller-number and booting (St. c and d in Table 1). In a few places, we also observed much younger rice (St. a and b in the table). Whenever a hopperburned area was studied, the heaviest part of hopperburn was avoided and relatively lightly burned paddy was only investigated.

In both Malaysia and Indonesia, application of insecticides on rice seemed not to be intensive.

The methods adopted for the paddy field investigation were "counting", "sweeping" and "sucking".

Counting ---- Female adults and 5th-instar nymphs of plant- and leafhoppers were counted with the naked eyes on 20 hills randomly sampled in a field. The number of male adults was not recorded because they were so highly movable that exact counting was not expectable. Spiders on the hills were also counted. Concerning them, however, no discrimination was made between matuare and immature individuals but too young and small ones were omitted. Observation on grassy stunt disease was made at the same time, and out of the 20 sampled hills, ones with distinct symptoms of the disease were counted. Other than these, there were some hills which were suspicious of being infected but not counted.

Sweeping ---- In each field, 40 strokes with a butterfly net, 36 cm in diameter, were conducted. Adult insects thus collected were preserved as dry specimens, and spiders as ones soaked in alcohol.

Sucking --- In Java, more than 50 female *N. lugens* were collected with a glass aspirator in each of some fields with high densities of the pest. They were preserved in alcohol and then examined for parasitism in accordance with Ôtake et al. (1976). In the 2 fields chosen at Hargomuryo, Sekampung, Lampung, spiders were collected by sucking for the purpose of comparing species composition with collection by sweeping.

Sweeping was conducted also on rice nurseries and weeds. In Malaysia, only one nursery was found in the course of our tour, but in Indonesia, we often had chances of investigating nurseries which were surrounded by mature or pre-mature paddy. As a rule, each nursery was swept with the same intensity as in the paddy field. Weeds chosen for sweeping were gramineous ones which were growing near but not very close to paddy. Every weedy ground chosen was swept 30 times with the butterfly net.

With a few exceptions, the localities selected for study belonged to the double rice cropping area.

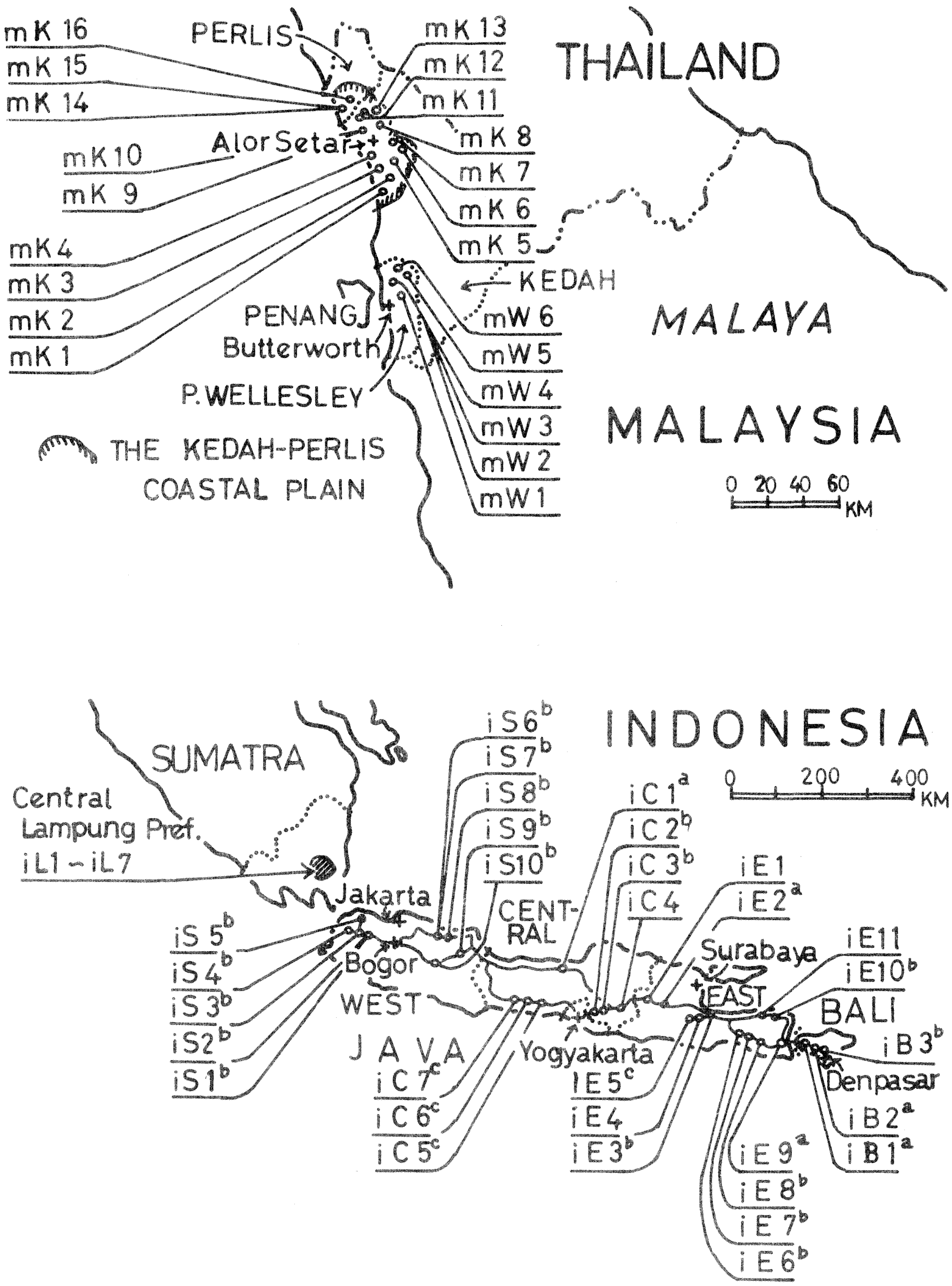

Fig. 1. Places of investigation with code numbers. Symbols a, b and c attached to some code numbers indicate Localities I, II and III, respectively, defined in the text (p. 10). Lines drawn in Java and Bali Islands indicate the route of the tour.

Table 1. Investigation sites and methods of investigation adopted

Investigation site[1]	Place name	Date in 1976	Method: Counting	Method: Sweeping	Method: Sucking	Remarks[2,3]
P. Wellesley, West Malaysia						
mW1-n	Sungai Dua	Jan.29		○		
mW2-f	Pak Elong	29		○		St. c
mW3-fA	Permatang Manggis 1	29		○		St. d
mW3-fB	Permatang Manggis 2	29		○		St. e
mW4-fA	Permatang Manggie 2	29		○		St. d
mW4-fB	Permatang Manggis 2	29		○		St. f
mW4-wA	Permatang Manggis 2	29		○		
mW4-wB	Permatang Manggis 2	29		○		
mW5-f	Pinang Tunggal	29		○		St. f
mW5-wA	Pinang Tunggal	29		○		
mW5-wB	Pinang Tunggal	29		○		
mW6-w	Bumbong Lima	29		○		
The Kedah-Perlis Coastal Plain, West Malaysia						
mK1-f	Sedaka, Kedah	Feb. 5		○		St. d
mK1-w	Sedaka, Kedah	5		○		
mK2-f	A little south of Kota Serang Semut, Kedah	5		○		St. c
mK2-w	A little south of Kota Serang Semut, Kedah	5		○		
mK3-f	Sala Kecil, Kedah	5		○		St. c
mK3-w	Sala Kecil, Kedah	5		○		
mK4-f	Between Alor Setar and Sala Kecil, Kedah	5		○		St. e
mK4-w	Between Alor Setar and Sala Kecil, Kedah	5		○		
mK5-f	Tana Merah, Kedah	4		○		St. f
mK5-w	Tana Merah, Kedah	4		○		
mK6-fA	Kuala Lanjut, Kedah[4]	4		○		St. f
mK6-fB	Kuala Lanjut, Kedah	4		○		St. f
mK6-w	Kuala Lanjut, Kedah	4		○		
mK7-f	Langgar, Kedah	4		○		St. d
mK7-w	Langgar, Kedah	4		○		
mK8-f	South of Jitra, Kedah	4		○		St. e
mK8-w	South of Jitra, Kedah	4		○		
mK9-f	A little south of Padang Lalang, Kedah	1		○		St. d
mK9-w	A little south of Padang Lalang, Kedah	1		○		
mK10-fA	Pandang Lalang, Kedah	1		○		St. f
mK10-fB	Pandang Lalang, Kedah	1		○		St. f
mK10-fC	Pandang Lalang, Kedah	1		○		St. f
mK10-wA	Pandang Lalang, Kedah	1		○		
mK10-wB	Pandang Latang, Kedah	1		○		
mK11-f	Between Aier Hitam and Junjang 1, Kedah	3		○		St. d
mK11-w	Between Aier Hitam and Junjang 1, Kedah	3		○		

(Continued –– Table 1)

Investiga-tion site	Place name	Date in 1976	Method Counting	Sweeping	Sucking	Remarks
mK12-f	Between Aier Hitam and Junjang 2, Kedah	Feb. 3		○		St. f
mK12-w	Between Aier Hitam and Junjang 2, Kedah	3		○		
mK13-f	Between Junjang and Jitra, Kedah	3	○	○		St. c
mK13-w	Between Junjang and Jitra, Kedah	3		○		
mK14-f	West of Sanglang 1, Perlis	3	○	○		St. e
mK14-w	West of Sanglang 1, Perlis	3		○		
mK15-f	West of Sanglang 2, Perlis	3		○		St. c
mK15-w	West of Sanglang 2, Perlis	3		○		
mK16-f	Bohor Mentalon, Perlis	1		○		St. c
mK16-w	Bohor Mentalon, Perlis	1		○		
West Java, Indonesia						
iS1-fA	Sukarendah 1, Pandeglang	Feb. 13	○			IR 26, St. c
iS1-fB	Sukarendah 1, Pandeglang	13	○	○	*N. lugens*	IR 20, St. c
iS2-fA	Sukarendah 2, Pandeglang	14	○			Pe, St. c
iS2-fB	Sukarendah 2, Pandeglang	14	○		*N. lugens*	IR 26, St. c
iS2-fC	Sukarendah 2, Pandeglang	14	○			St. a
iS2-n	Sukarendah 2, Pandeglang	14		○		
iS3-w	Pandeglang, Pandeglang	13		○		
iS4-f	Chandur, Pandeglang	13	○			Pe, St. c
iS5-fA	Serang, Serang	14	○			Pe, St. c
iS5-fB	Serang, Serang	14	○			Var. ?, St. c
iS5-n	Serang, Serang	14		○		
iS5-w	Serang, Serang	14		○		
iS6-fA	Ciberes 1, Subang	17	○			Pe, St. c
is6-fB	Ciberes 1, Subang	17	○		*N. lugens*	Pe, St. c
iS7-fA	Ciberes 2, Subang	17	○	○		Pe, St. c
iS7-fB	Ciberes 2, Subang	17	○			Pe, St. c
iS7-w	Ciberes 2, Subang	17		○		
iS8-n	Sukamandi, Subang	16		○		
iS8-w	Sukamandi, Subang	16		○		
iS9-n	Tomo, Majalengka	26		○		
iS10-fA	Ujungberung, Bandung	26	○			Pe, St. c
iS10-fB	Ujungberung, Bandung	26	○	○		Pe, St. c
Central Java, Indonesia						
iC1-fA	Kendal, Kendal	18	○			IR 26+28, St. c
iC1-fB	Kendal, Kendal	18	○	○		IR 26, St. d
iC2-f	Kanang Anom, Klaten	18	○	○		Pe, St. c
iC3-fA	Madusari, Klaten	18	○			IR 26, St. c

(Continued -- Table 1)

Investigation	Place name	Date in 1976	Method: Counting	Method: Sweeping	Method: Sucking	Remarks
iC3-fB	Madusari, Klaten	Feb. 18	○	○		IR 26, St. c
iC3-fC	Madusari, Klaten	18	○			Pe, St. c
iC3-n	Madusari, Klaten	18		○		
iC4-n	Karanganyar, Karanganyar	19		○		
iC5-fA	Kutoarjo, Purworejo	25	○			Local var., St. d
iC5-fB	Kutoarjo, Purworejo	25	○	○		Local var., St. c
iC5-w	Kutoarjo, Purworejo	25		○		
iC6-n	Karanganyar, Kebumen	25		○		
iC7-fA	Gombong, Kebumen	25	○			Local var., St. c
iC7-fB	Gombong, Kebumen	25	○	○		Local var., St. c
East Java, Indonesia						
iE1-n	Ngawi, Ngawi	Feb. 24		○		
iE1-w	Ngawi, Ngawi	24		○		
iE2-f	Nganjuk, Nganjuk	19	○	○		Pe, St. c
iE3-f	Bangil, Pasuruan	19	○	○		Pe, St. c
iE3-w	Bangil, Pasuruan	19		○		
iE4-n	Pandaan, Malang	24		○		
iE5-fA	Prigen, Malang	24	○			Local var., St. c
iE5-fB	Prigen, Malang	24	○	○		Local var., St. c
iE5-w	Prigen, Malang	24		○		
iE6-fA	Jatiroto, Lumajang	20	○	○		Pe, St. c
iE6-fB	Jatiroto, Lumajang	20	○			IR 26, St. e
iE6-w	Jatiroto, Lumajang	20		○		
iE7-fA	Rambipuji, Jember	20	○			Pe, St. c
iE7-fB	Rambipuji, Jember	20	○			Pe, St. c
iE7-w	Rambipuji, Jember	20		○		
iE8-fA	Silo, Jember	20	○			Pe, St. b
iE8-fB	Silo, Jember	20	○		*N. lugens*	Pe, St. b
iE8-fC	Silo, Jember	20	○	○		IR 26, St. c
iE9-fA	Rogojampi, Banyuwangi	21	○	○		IR 26, St. c
iE9-fB	Rogojampi, Banyuwangi	21	○			IR 26, St. c
iE9-w	Rogojampi, Banyuwangi	21		○		
iE10-fA	Asembagus, Situbondo[4]	23	○			Pe, St. c
iE10-fB	Asembagus, Situbondo	23	○	○		St. a
iE10-w	Asembagus, Situbondo	23		○		
iE11-n	Arjasa, Situbondo	23		○		

(Continued — Table 1)

Investigation	Place name	Date in 1976	Method: Counting	Sweeping	Sucking	Remarks
Bali, Indonesia						
iB1-fA	Penyaringan, Negara	Feb. 21	○	○		IR 26, St. c
iB1-fB	Penyaringan, Negara	21	○			IR 26, St. c
iB1-w	Penyaringan, Negara	21		○		
iB2-fA	Antosari, Tabanan	23	○	○		IR 26, St. c
iB2-fB	Antosari, Tabanan	23	○			IR 26, St. c
iB3-fA	Badung, Denpasar	21	○			Pe, St. c
iB3-fB	Badung, Denpasar	21	○			St. a
iB3-n	Badung, Denpasar	21		○		
iB3-w	Badung, Denpasar	21		○		
Lampung Tengah, Lampung, Indonesia						
iL1-w	Purwodadi, Trimurjo	Mar. 2		○		
iL2-n	Ganjaragung 1, Metro	2		○		
iL3-n	Ganjaragung 2, Metro	2		○		
iL3-w	Ganjaragung 2, Metro	2		○		
iL4-n	Ganjaragung 3, Metro	3		○		
iL4-w	Ganjaragung 3, Metro	3		○		
iL5-fA	Purjokerto, Trimurjo	4	○			Pe, St. d
iL5-fB	Purjokerto, Trimurjo	4	○	○		Pe, St. c
iL5-w	Purjokerto, Trimurjo	4		○		
iL6-fA	Banarjoyo, Batanghari	3	○	○		Pe, St. c
iL6-fB	Banarjoyo, Batanghari	3	○			Pe, St. c
iL6-w	Banarjoyo, Batanghari	3		○		
iL7-fA	Hargomuryo, Sekampung	3 and 5	○	○	Spiders	Pe, St. c
iL7-fB	Hargomuryo, Sekampung	3 and 5	○	○	Spiders	Pe, St. c
iL7-w	Hargomuryo, Sekampung	3		○		

1) Three-letter code before the hyphen indicates the locality (cf. Fig. 1), and f, n and w after the hyphen mean a paddy field, nursery and weeds, respectively.

2) St. means a growth stage of paddy. a: 1-2 weeks after transplanting; b: 3-4 weeks after transplanting; c: around the maximum tiller-number stage or further aged, but prior to the booting stage; d: the booting stage; e: the heading stage; and f: the dough ripe stage.

3) In Indonesia, varietal names were recorded concerning paddy under St. b and older. Pe means Pelita.

4) Single rice cropping area.

III. PLANT- AND LEAFHOPPERS IN WEST MALAYSIA

On paddy, delphacid density was very low as guessed from the result of sweeping (Appendix I). In the 2 fields where counting was conducted, neither *N. lugens* nor *Sogatella furcifera* Horváth was recorded (Appendix III). It is noteworthy that even under such circumstances, 7 *N. lugens* were collected from the nursery which was swept (Appendix I). Importance of nursery beds as a place for the maintenance of *N. lugens* and probably also *S. furcifera* populations should be recognized (cf. Section IV-1).

On weeds, only 3 individuals belonging to 2 delphacid genera were collected by sweeping. Neither *N. lugens* nor *S. furcifera* was included in them (Appendix I).

The reason why *N. lugens* has usually been kept under a very low population level in spite of intensive growing of high-yielding rice varieties in West Malaysia is still unknown. It is speculated, however, that the present practice of rice cultivation with about one-month interruption of rice growing between 2 successive cultivation seasons would more or less seriously influence the population growth of this actually monophagous rice pest.

The number of cicadellids collected from a paddy field was much larger in general than that of delphacids (Appendices I and II). Most of them were *Nephotettix* spp. They, however, were not so abundant as *N. cincticeps* Uhler on age-advanced paddy in Japan. Both *N. nigropictus* Stål and *N. virescens* Distant are vectors of the tungro group virus disease (Hino et al., 1974), and vector/disease relationship in Malaysia has been studied by Lim et al. (1974). But we did not find any occurrence of the disease in the area we inspected.

At mW6-w, lots of *N. nigropictus* were collected (Appendix II). The site was located in the experimental farm of the Rice Research Centre, Bumbong Lima, and considerably moist. It is supposed to have been influenced by fertilizer application in nearby experimental paddy fields. So, the weeds there might be more attractive to the leafhoppers than usual as nutritious food source and also as a good habitat with moderate moisture. Except this site, however, *Nephotettix* density on weeds seemed not to be significantly higher than that on paddy. Difference in *Nephotettix* species composition between paddy and weeds is another interesting subject (cf. Appendix II). This, however, will be dealt with in a separate paper (Hokyo et al., 1976).

Recilia dorsalis Motschulsky has been demonstrated in the Philippines (Revera et al., 1969) and in Thailand (Wathanakul, 1969) to be another vector of tungro group virus disease. During our study in Malaysia, they were collected in small number from both rice and weeds, the highest density of them being recorded from the nursery investigated (Appendix II).

We knew that in Malaysia, BHC is still being manufactured. Previously in Japan, this insecticide was applied against *N. lugens* and some other harmful rice pests, but its use was then banned because of its persistent environmental pollution, destruction of natural enemies and other harmful side effects.

It has experimentally been demonstrated by Kiritani and Kawahara (1973) that spiders can be seriously affected by soil-applied γ-BHC (granular formulation) through its biological concentration in the course of its movement from soil to the body of the spiders via rice plant and the prey, *Nephotettix cincticeps*. The application of such a harmful insecticide must be undesirable even in Malaysia.

IV. *NILAPARVATA LUGENS* AND OTHER LEAFHOPPERS IN INDONESIA

1. Nilaparvata *incidence and grassy stunt disease infection in Java and Bali*

The results of counting on paddy under the growth stage between maximum tiller-number and booting are most informative (Appendix III). Since there existed some fairly distinct differences in varietal composition of rice among the toured localities of Java and Bali, the concerned data were rearranged in accordance with the varietal situation as classified below:

Locality I ---- Overwheling growing of IR 26. This was the locality where *Nilaparvata* infestation had previously been very serious and therefore the replacement of susceptible rice varieties with the resistant one, IR 26, had rapidly taken place (cf. the introductory section, p. 1).[1]

Locality II ---- Growing of Pelita was dominant. Localities of this category were often situated around Locality I, thus indicating that they were not yet affected so seriously by the pest as Locality I had previously been. In some of the localities, IR 26 was also seen in high frequency.

Locality III ---- Overwhelming growing of local varieties.

The result of rearrangement and some statistics calculated from it are shown in Table 2. As seen in Table 2B, density of *N. lugens* on IR 26 was much lower in average than that on Pelita, this indicating that the policy of replacement of the latter with the former has been successful at least in the existing circumstances.

The number of sampled paddy fields in Locality I (Table 2A) was much smaller than that in Locality II but this never means the smallness in the area with the local character I. Paddy grown there was in general so clean that a heavy accumulation of quantitative data did not seem to be essential. Thus, the intensity of sampling for *Nilaparvata* was much reduced there as compared to Locality II. This is the reason why the number of fields in Locality I was small and this would be another evidence to show how effectively *Nilaparvata* population was being restrained by overwhelming growing of IR 26 in Locality I.

Generally speaking, rice cultivation in Locality II appeared to be further asynchronous than that in Locality I. This suggests that the probability *N. lugens* can find rice at any time of the year would be higher in Locality II than in Locality I. Thus, the former locality may have provided better conditions for the pest's multiplication than the latter one even in the aspect of cultivation practices.

There were 4 paddy fields in which hopperburn was in progress when investigated (Table 2A). Densities of adult female *Nilaparvata* were very high in all of them. It is particularly note-

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1) Some other resistant varieties of IR series were also being grown but the area occupied by them was very small as compared to IR 26.

Table 2. Rearrangement of counting data (A) and some statistics calculated from them (B)

(A)[1]

Paddy field	Date in 1976		Variety and St.	Adult female *Nilaparvata lugens*			GS	Remarks
				M	B	Total		
Locality I[2]								
iC1-fA	Feb.	18	IR26+28, c	22	1	23	0	
iC1-fB		18	IR26, d			0	0	
iE9-fA		21	IR26, c	54	0	54	1	
iE9-fB		21	IR26, c	69	0	69	0	
iB1-fA		21	IR26, c	19	1	20	0	
iB1-fB		21	IR26, c	3	0	3	0	
iB2-fA		23	IR26, c	9	0	9	1	
iB2-fB		23	IR26, c	13	0	13	2	
Total				189	2	191	4	
Locality II								
iS1-fA	Feb.	13	IR26, c	5	0	5	0	
iS2-fB		14	IR26, c	133	3	136	0	Hopperburn in progress
iC3-fA		18	IR26, c			0	2	
iC3-fB		18	IR26, c	2	0	2	1	
iE8-fC		20	IR26, c	28	0	28	3	
Total				168	3	171	6	
iS2-fA	Feb.	14	Pe, c	149	31	180	0	Hopperburn in progress
iS4-f		13	Pe, c	37	56	93	2	
iS5-fA		14	Pe, c	0	1	1	0	
iS6-fA		17	Pe, c	51	41	92	0	Hopperburn in progress
iS6-fB		17	Pe, c	429	226	655	0	Hopperburn in progress
iS7-fA		17	Pe, c	20	1	21	0	
iS7-fB		17	Pe, c	24	9	33	0	
iS10-fA		26	Pe, c			0	0	
iS10-fB		26	Pe, c			0	0	
iC2-f		18	Pe, c			0	9	Medium hopperburn
iC3-fC		18	Pe, c	3	0	3	16	
iE2-f		19	Pe, c	2	1	3	0	
iE3-f		19	Pe, c	19	0	19	0	
iE6-fA		20	Pe, c	14	8	22	15	
iE7-fA		20	Pe, c	61	3	64	6	Medium hopperburn
iE7-fB		20	Pe, c	19	1	20	1	Medium hopperburn
iE10-fA		23	Pe, c	7	0	7	10	
iB3-fA		21	Pe, c			0	13	
Total				835	378	1213	72	

(Continued —— Table 2)

Paddy field	Date in 1976		Variety and St.	Adult female *Nilaparvata lugens*			GS	Remarks
				M	B	Total		
Locality III								
iC5-fA	Feb.	25	Local, d	1	1	2	0	
iC5-fB		25	Local, c	4		4	0	
iC7-fA		25	Local, c			0	0	
iC7-fB		25		1	0	1	0	
iE5-fA		24	Local, c	3	0	3	0	
iE5-fB		24	Local, c	2	2	4	0	
Total				11	3	14	0	

1) Derived from Appendix III.
2) See Text.

(B)

		Locality	I	II		III
		Variety	IR 26	IR 26	Pelita	Local
		No. of fields	8	5	18	6
Adult female *Nilaparvata lugens*	M	Mean [1]	23.63	33.60	46.39	1.83
		Standard error [2]	8.779	25.355	24.061	0.601
	B	Mean	0.25	0.60	21.00	0.50
		Standard error	0.164	0.600	12.664	0.342
	Total	Mean	23.88	34.20	67.39	2.33
		Standard error	8.768	25.943	36.324	0.667
		Percentage of macropterous forms (%) [3]	98.95	98.25	68.84	78.57
GS		Mean	0.50	1.20	4.00	0
		Infectious rate (%) [4]	2.50	6.00	20.00	0

1) Total number of insects or GS hills / No. of fields.
2) $\sqrt{\text{Variance / No. of fields.}}$
3) $\frac{M}{M+B} \times 100\%$
4) $\frac{\text{Mean GS}}{20} \times 100\%$ (20 = No. of hills observed in a field).

worthy that in one of them, IR 26 was grown.[1] That field, iS2-fB, was situated adjacent to iS2-fA with hopperburned Pelita, and it is clear that the pest was attacking the former field without any fundamental discrimination from the latter one.

Thus, in an area infested so heavily with the pest as to be widely hopperburned, varietal resistance can never be perfect, and this should be recognized as a warning against too much and easygoing reliance on varietal resistance in the practice of *Nilaparvata* control.

Once the pest adapts itself to a resistant variety of rice by stemming out a new strain, the policy of pest control by means of wide-ranged exclusive growing of that variety would be nullified at once. We hope such a tragedy will not happen in the course of the present *Nilaparvata* control campaign in Indonesia. As for pest control by means of host resistance, simultaneous growing of a number of resistant varieties of different genetical sources would strategically be recommendable.

In Locality II, there were also 3 fields with medium hopperburn (Table 2A). Densities of adult females there were not so high as in the above-mentioned fields where hopperburn was in progress. Particularly, in iC2-f, no adult was counted. In each of them, however, young nymphs were observed abundantly (Appendix III).

It is believed, therefore, that the adults, probably the immigrants, had already disappeared through death and migration after leaving a vast number of their progeny, when the fields were investigated. The progeny would then take either of the 2 ways; first, continuance of their feeding on to the complete devastation of rice crop, and, second, extinction due to rapid deterioration of the survival conditions for them prior to the complete death of host plants.

In Locality III, *Nilaparvata* infestation was very low (Table 2). This locality was characterized by a synchronized cultivation practice of rice, and application of fertilizers was believed to be infrequent because of the low fertilizer requirement of the local varieties grown there. Probably, these would be the main reasons why the local varieties bore only a small population of *N. lugens*.

It should be noticed in Table 2B that the proportion of macropterous females to the whole female adults was very high in all of the varieties. Particularly, in IR 26, almost all of the counted females were macropterous, this suggesting a high extent of imperfection of the variety as food of *N. lugens*.

In Table 2, the result of investigation on grassy stunt disease infection is also shown (column GS). This subject will be discussed later.

Frequency distributions of adult female *N. lugens* counted on the respective 20 rice hills and values of some indices for aggregation pattern are tabulated in Appendix IV. The index, $\hat{\sigma}^2/\hat{x}$, can be tested by F-values with the degrees of freedom, n - 1 and ∞. If it is significantly larger than unity (=1), the spacial distribution is judged to be not random but aggregative (Torii,

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1) This field was responsible for the higher mean density of *N. lugens* on IR 26 of Locality II than that on the same variety of Locality I, as shown in Table 2B.

1956).[1] In the tables of Appendox IV, 14 of the 20 distributions with means more than 2.00 are aggregative in this sense. Even in the other distributions with smaller means, some are also aggregative.

Kuno (1968) presented the index $\hat{C}_A$ and applied it to his data on *Nilaparvata* population. This is similar to $\overset{*}{x}$ presented by Iwao (1968, 1970), but the latter seems to be more informative because of its linear relation to sample mean, $\hat{x}$. As drawn in Fig. 2, the regression lines, $\overset{*}{x} = g + h\hat{x}$, were calculated. (Brachypterous forms on IR 26 and mactopterous and brachypterous forms on local varieties were not treated because of their scarcity.)

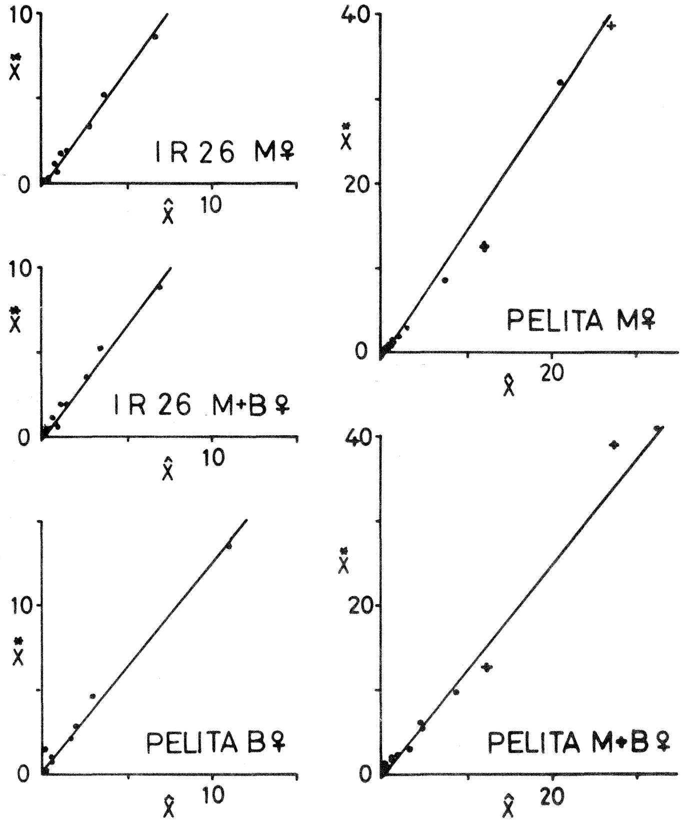

Fig. 2. Relationship between $\hat{x}$ and $\overset{*}{x}$, and regression lines, $\overset{*}{x} = g + h\hat{x}$. Symbol • represents a paddy field with rice under St. c or d, and +, iE8-fA and B with Pelita under St. b, which are not included in calculation of the regression.

1) When $\hat{x} > \hat{\sigma}^2$, $\hat{x}/\hat{\sigma}^2$ is calculated for F-test. In this case, statistical significance indicates the tendency in distribution towards evenness. In Appendix IV, there are 2 distributions of this sort, *i.e.* M and M+B in iB1-fA.

The values of the intercepts of the regressions on $\overset{*}{x}$-axis, g, and the regression coefficients, h, are given in Table 3. As seen in the table, g values are distributed around zero, and all of the h values are significantly higher than unity. Thus, according to Iwao's classification (1970), the spacial distribution in adult femal *Nilaparvata* can be regarded as an aggregative one correspondent to a mathematical model of negative binomial series with a common k.

In Java and Bali, there were 17 paddy fields in which both counting and sweeping were conducted. As shown in Fig 3, however, the total number of macropterous females counted in a field did not correlate to that collected with a net in the same field. It is believed that in some fields, insects may have been caught easily in the net because of their gathering at the upper part of the plants for dispersal, while in some fields, a large proportion of the insects may still have settled down at the base of the plants where it was so deep that the net would only seldom reach

At any rate, it can be said that the sweeping method was not always adequate for the purpose of exact estimation of *Nilaparvata* densities in the respective fields, although it would often be useful for getting information about the general trend of the pest's incidence over a stretch of rice crop.

On the 20th of February, we had a lucky chance of observing 2 paddy fields, iE8-fA and B, in which plants were about 3-4 weeks after transplanting and infested with macropterous *Nilaparvata* of surprisingly high densities (cf. Appendices III and IV). In field B, there were 3 rice hills on which indeed more than 60 insects were counted respectively. Farmers told us that they had just applied some granular insecticides, but the treatment seemed to be incomplete and probably too late because the insects were still alive and sucking plant juice so intensively as to make leaves yellow when we observed the fields.

In Java and Bali, we also investigated 3 fields with much younger rice, one of which was located near hopperburned fields, but they were nearly free from *Nilaparvata* infestation (cf. Appendix III).

Since Dr. Mochida had observed hopperburned rice nurseries in the preceding year when *Nilaparvata* incidence was much heavier than at the time of our visit to Indonesia, it can be said that even young plants are never immune against a convergent attack of *Nilaparvata* when a very high population impact of the pest exists. However, under less severe conditions as so in case of our present study, it may be allowed to assume that young paddy soon after transplanting (under St. a as defined in Table 1) is usually avoided but one under the available tillering stage or so (St. b) is highly preferred, by migrating macropterous *Nilaparvata*.

When a field with rice under St. b is situated under the course of mass movement of the pest, it would probably happen that a large number of insects convergently alight on it and devastate it sooner or later. The situation realized in iE8-fA and B may thus be recognized as examples of such a convergent attack of migrating *Nilaparvata*.

Yellowing of the plants in the above-mentioned fields must have been a symptom of acute deterioration of rice due to intensive juice sucking of a vast number of the immigrants. If the density of the invaders had been a little lower, it would have taken a longer time until the appear-

Table 3. Values of the intercepts of the regression, $\overset{*}{x} = g + h\hat{x}$, on $\overset{*}{x}$-axis, and the regression coefficients, calculated from $\hat{x}$ and $\overset{*}{x}$ in Appendix IV

Variety	Growth stage of rice[1]	Wing form[2]	Sample size[3]	g	h
IR 26	St. c and d	M	11	− 0.1314	1.3521**[4]
		M + B	11	− 0.1431	1.3591**
Pelita[5]	St. c and d	M	17	− 0.3434	1.4900**
		B	14	0.2817	1.2171**
		M + B	19	0.0858	1.2304**

1) Refer to Table 1.
2) M, B and M + B mean macropterous, brachypterous and the whole adult female *N. lugens*, respectively.
3) No. of paddy fields with $\hat{x} > 0$.
4) The null hypothesis, the universe regression coefficient $\beta = 1$, is rejected at 1% level of significance.
5) Including the data from Lampung, Sumatra.

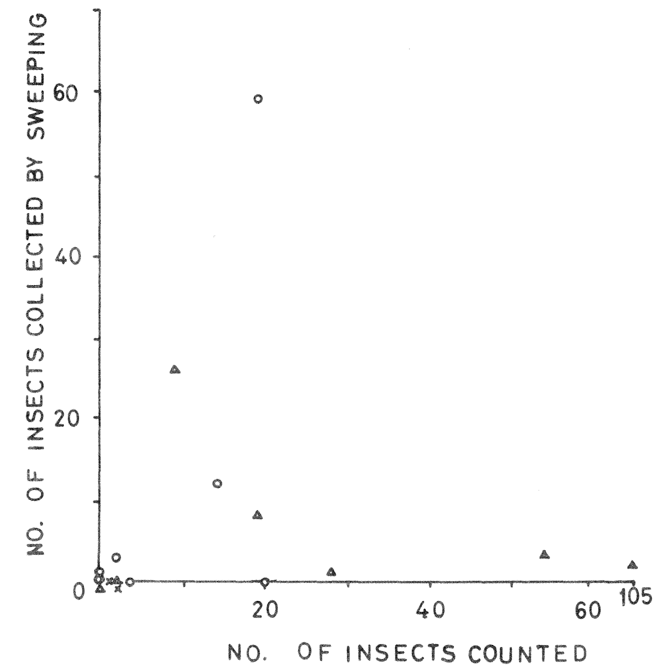

Fig.3. Relationship in the number of macropterous female *Nilaparvata lugens* between counting and sweeping, in Java and Bali. ●, ▲ and × represent paddy fields with varieties Pelita, IR series and local, respectively.

ance of hopperburn. Probably, the symptom of hopperburn observed on paddy under St. c (Table 2A) would result from such a protracted process of deterioration. Thus, the behaviour in population level of *N. lugens* which was taken in Indonesia at the time of our visit can be speculated as follows:

(1) Migrating macropterous adults preferred paddy of susceptible varieties under St. b. Thus, more or less concentrated attacks of them upon paddy took place.

(2) When the attack was very severe, paddy sufferred from an acute process of hopperburn, but in case the density of alighted insects was not so high (this would happen more frequently than the acute case), the process of hopperburn was somewhat slower; thus, the damage of rice becomes conspicuous at St. c, when the pest would be in the second or partially third generation from the founders.

(3) Within the area of double rice cropping with asynchronous cultivation practices, occurrences of hopperburn, though usually small in scale, on susceptible varieties were not rare, probably because of frequent local migrations of the pest.

The process of hopperburn as speculated above differs largely from that in Japan. In most parts of Japan, paddy is cropped once a year, and migrations of *Nilaparvata* from the south (kisimoto, 1971, 1976) take place during the rainy season (mid June - mid July). The initial density of *Nilaparvata* invaded paddy fields is extremely low as compared with that in Indonesia. According to Kuno (1968), in Kyushu, it is less than 0.02 per rice hill in average. However, when it exceeds the average to some extent, the pest finally attains a population level so high as to bring about thorough destruction of rice crop in autumn.

Through his elaborate field observations, Kisimoto (1965) clarified the process of building up of *Nilaparvata* population on paddy in Shikoku: In his fields for observation, the average densities of macropterous immigrants on 50 hills were less than 5 in July. The succeeding 2 generations were mainly composed of brachypterous forms, and their reproductive rate was so high that the average density of adults on 50 hills exceeded the 100 level at the beginning of September. An explosive increase in number of adults took place in the next month when they were in the fourth generation and mainly composed of macropterous forms. Their density per 50 hills was in the 1,000 level and fourth- and fifth-instar nymphs had increased further in number. The plants in the fields were soon destroyed by them.[1] Thus, in Japan, the final phase of the heavy damage by *N. lugens* usually appears in autumn when the crop has already been under maturing.

Even in Indonesia, the authors once observed a hopperburned field with dead ears although no quantitative data were obtained from it. However, that case seemed to be an exceptional one. The ordinary process of hopperburn would be completed on much younger paddy in that country.

In Fig. 2, iE8-fA and B are also plotted. It is interesting that they are located near the regression lines which were calculated from the result of counting on paddy distinctly different in growth stage from that in iE8-fA and B.

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1) The insects are believed to have then perished because of lack of host plant and rapid descent of the air temperature which is fatal to them. It is thought that the *Nilaparvata* population next year will have to be rebuilt up again by the immigrants from the south.

The numbers of adult *Nilaparvata* collected from nurseries with a net were very variable (Appendix I). In some nurseries, a large number of both males and females, which were all macropterous, were collected. They are supposed to have moved into there from nearby paddy fields probably due to harvesting or hopperburning. *N. lugens* were occasionally collected even from weeds (Appendix I). It can be said, however, that weeds were not a fundamental habitat of the pest.

The numbers of rice hills with distinct symptoms of grassy stunt disease are tabulated in Table 2A. In Indonesia, the disease is said to have been first noticed in 1967 and then become epidemic (Tantera et al., 1973). At the time of our visit there, however, infection did not seem to be still critical. In fact, Table 2A indicates that paddy fields with severe infection of the disease were not very common, though we must be cautious of giving excessive reliance upon the figures in the table, which have a tendency of underestimating the real state of infection because doubtful infectious cases were omitted from counting.

In Table 2B, there exist remarkable differences in infectious rate among the rice varieties. It is said that neither IR 26 nor local varieties are resistant to grassy stunt disease, so that the above-mentioned sharp varietal differences would be mainly due to the differences in vector's density among the varieties. As for Pelita, heavily infected fields were seen in Central Java and further east (Table 2A).

Other than the varietal difference in the pest's density, the following 2 features of *Nilaparvata* population would be important in their relation to grassy stunt disease dissemination. First, the existence of macropterous forms in very high proportion (Table 2) suggests the possibility of rapid and frequent field-to-field dissemination of the disease. Judging from the fact that almost all of the counted females were macropterous on IR 26, this variety would particularly be responsible in this regard. Secondly, the evidence that nurseries were sometimes populated densely by *N. lugens* (Appendix I) suggests that there would exist fairly high frequent infections of the disease in the very nursery. The infected seedlings were to be scattered over the surroundings through transplanting, thus becoming new sources of further dissemination of the disease.

2. Nilaparvata *in Lampung*

Differing from the situation in Java and Bali, Lampung, Sumatra, did not suffer very much from *N. lugens* infestation (Appendix III). Even in that area, however, the provincial bureau of agriculture had already received some reports on sporadic occurrences of hopperburn within the territory. Out of the 6 paddy fields where we made the counting investigation, the following 2 were particularly noticeable in this connection.

In iL5-fB, a fairly large number of fifth-instar nymphs were recorded. Some leaves had already been in the course of changing yellow, the situation strongly suggesting the possibility of development of hopperburn.

On the contrary, iL7-fA may have had no problem in appearance. However, the evidences that in there, 4 adult females existed in total on the observed 20 hills and 3 of them were brachypterous should not be overlooked. The situation can be thought to have had dangerous possibilities of a future explosion of the pest population provided that they could display their high potential of reproduction there.

3. *Plant- and leafhoppers other than* Nilaparvata lugens

As for the counting data, there was no paddy field where the total number of female *Sogatella furcifera* exceeded 20 (Appendix III). When paddy fields and nurseries were swept with a net, however, catches of this species were occasionally large in number (Appendix I). Nevertheless, the following general rule seemed to be applicable to the situation in Indonesia: *S. furcifera* cannot be as serious as a rice pest as *N. lugens,* because the former is usually much less intensive in juice sucking activity than the latter and it is not a vector of any virus or virus-like disease. As was so in West Malaysia, the number of collected delphacids other than *N. lugens* and *S. furcifera* was very small in Indonesia (Appendix I).

The average number of female *Nephotettix* counted in a paddy field was further smaller than that of *S. furcifera.* However, the result of sweeping shows that *N. nigropictus* and *N. virescens* were fairly common on paddy (Appendix II). They were also collected in a large number from some of the nurseries swept. Particularly, catches of more than 1,800 *N. nigropictus* from iC6-n is conspicuous. The nursery was located amongst paddy fields after harvesting, the situation suggesting a heavy concentration of *Nephotettix* from the surroundings to the nursery.

During our tour of Java, Bali and Lampung, we did not observe any occurrence of tungro disease and it is generally thought that other than disease transmission, *Nephotettix* usually have no serious influence upon rice cultivation[1].

In Indonesia, more *Recilia dorsalis* were collected from paddy fields and nurseries than in West Malaysia (Appendix II).

Thaia spp., a group of small reddish planthoppers, were fairly abundant in some paddy fields and nurseries (Appendix II). Hasegawa (1971) observed in Malaysia that one of them, *T. subrufa,* were abundant in paddy fields just after transplanting, occasionally causing damage of leaves by their feeding on. In our study, we had no such serious case, but it is thought that *Thaia* spp. should be viewed with some importance as latent pests of rice.

Differing from the result from Malaysia, neither *Nephotettix malayanus* nor *N. parvus* was obtained from weeds in Indonesia (Appendix II). As already mentioned, this topic will be discussed in a separate article (Hokyo et al., 1976).

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1) It has been reported by Rao et al. (1976) that in South Sulawesi, Indonesia, *Nephotettix* caused stunting and yellowing of rice plants by their intensive juice sucking. As pointed out by the authors, however, the damage of this sort would not have been so much conspicuous if the fields had been well managed.

V. ENTOMOPHAGOUS ORGANISMS INHABITING PADDY AND WEEDS

The data concerned are summarized as Appendices V-VIII.

Through microscopic examination of *Nilaparvata lugens* specimens collected from paddy fields with high densities of the pest, the following external symptoms of parasitism were recognized: degeneration of ovipositor, which was always combined with parasitism by Strepsiptera in our specimens; an extrusion of the male puparium in Strepsiptera; the opening of an adult female in Strepsiptera; and a sac containing a premature larva of Dryinidae. Nematodes were detectable by dissecting the specimens. As shown in Appendix V, parasitism was low as a whole, and this suggests that the parasites concerned had no significant influence upon the host population when it had attained the epidemic level.

By sweeping, more than 30 species of spiders were collected. In each of the habitats, paddy field, nursery and weeds, there was no fundamental difference in fauna of spiders among the districts given in Appendix II. So, Table 4, a list of species with indication of abundance, was made by getting together the data in each habitat. The table indicates that difference in species composition was slight among the habitats but the average number of the whole spiders collected from a rice field was considerably higher than any of those from a nursery and weeds though the difference in the intensity of sweeping between paddy and weeds should be taken into consideration.

In 2 paddy fields in Lampung, comparison of species composition in spiders was made between the different 2 methods of collection, sweeping with a net and sucking with an aspirator (Appendix VII). The result suggests the superiority of the latter method over the former one because the species spectrum of spiders caught by sucking was richer than that by sweeping. Particularly, *Enoplognatha, Mysmena, Erigone* and *Dolomedes* were genera which were not recorded from any of the places where sweeping was conducted during our tour. In the table of Appendix VII, however, we can point out no clear-cut tendency that the 2 different behavioural habits of spiders, snaring and hunting, were related to the above-mentioned difference of the result of collection by sweeping and that by sucking.

All the coccinellid species but *Illeis bistigmosa* Mulsant shown in Appendix VIII are predacious, and it is confirmed that plant- and leafhoppers are included in diets of *Coccinella transversalis* Fabricius and *Harmonia octomaculata* Fabricius (Miyatake, personal communication). *I. bistigmosa* usually feeds on mildew or fungi on plants, but Dr. Miyatake suggests some possibility of its preying on aphids. It is noteworthy to point out that in spite of its dominance in Malaysia, *Micraspis discolor* Fabricius was not collected in Indonesia at all (Appendix VIII). Instead, *M. lineata* Thunberg seems to have been dominant in paddy fields of Indonesia.

The average numbers of the mirid, *Cyrtorrhinus lividipennis* Reuter, were very variable among the districts as shown in Appendix VIII. High averages in some districts, however, were brought about by the existence of paddy fields or nurseries with extremely dense population of the mirid (Table 5). It is important in Table 5 that *C. lividipennis* were collected abundantly from paddy fields and nurseries with high densities of plant- and leafhoppers, but the reverse was not always true as there were some cases in which the number of collected *Cyrtorrhinus* was small in spite of abundant existence of hoppers. Thus, it can be said that the response of *C. lividipennis* to

Table 4. **Comparison of species compositions in spiders among the 3 different habitats, paddy field, nursery and weeds**[1)]

Species	Family	Habitat Paddy field[2)]	Nursery	Weeds
Theridion sp.	Theridiidae		+	
Coleosoma blandum	Theridiidae	+[3)]		
Araneus inustus	Argiopidae	++[4)]	+	++
Singa sp.	Argiopidae	+		+
Argiope catenulata	Argiopidae	+	+	+
Larinia sp.	Argiopidae		+	+
Dyschiriognatha sp.	Tetragnathidae	+	+	+
Tetragnatha japonica	Tetragnathidae	+		+
T. javana	Tetragnathidae	++	+	+
T. mandibulata	Tetragnathidae	++		+
T. sp. A	Tetragnathidae	++	++	+
T. sp. B	Tetragnathidae	+	+	+
Other *Tetragnatha*	Tetragnathidae	+	+	+
Leucauge sp.	Tetragnathidae	+		+
Callitrichia sp.	Micryphantidae	+	+	
Lycosa pseudoannulata	Lycosidae	+	+	+
L. spp.	Lycosidae	+	+	+
Hippasa agelenoides	Lycosidae			+
Oxyopes assamensis	Oxyopidae	+	+	+
O. lineatipes	Oxyopidae	+		+
O. spp.	Oxyopidae	+	+	++
Oxytate sp.	Thomisidae	+		
Runcinia acuminata	Thomisidae			+
R. spp.	Thomisidae	+	+	
Gen. ? spp.	Salticidae	+	+	+
Chiracanthium sp.	Clubionidae	+		
Clubiona japonicola	Clubionidae	+		+
C. lena	Clubionidae	+		
C. spp.	Chubionidae	++	+	+
Heteropoda sp.	Heteropodidae	+		
Gen. ? sp. ?	Fam. ?	+		
Total no. of catches (adults and nymphs), T		965	112	236
Sample size, n		47	14	42
Mean, T / n		20.53	8.00	5.62

1) Summary of Appendix VI.
2) The nursery, mW1-n, investigated in Malaysia is included.
3) Indicating the existence.
4) Abundant in a relative sense.

Table 5. **Results of collection of insects and spiders in the respective paddy fields (A) and nurseries (B), in Indonesia** [1)]

(A) Paddy field

District	Paddy field[2)]	Date in 1976	Variety and St.[3)]	Plant- and leafhoppers[4)]: Delphacidae	Cicadellidae	Total	Predacious insects[5)]: Coccinellidae	Carabidae	Staphylinidae	Miridae	Nabidae and Reduviidae	Total	Spiders[6)]: Agriopidae	Tetragnathidae	Micryphantidae	Lycosidae	Oxyopidae	Thomisidae	Salticidae	Clubionidae	Family ?	Total
West Java	iS1-fB	Feb. 13	IR 20, c	2'	1	3	2					2	7	13								20
	iS7-fA	17	Pe, c	1		1						0	1									1
	iS10-fB	26	Pe, c	5	48	53	7					7	3	10					1			14
Central Java	iC1-fB	18	IR 26, d	11	1	12				1		1										0
	iC2-f	18	Pe, c	207	507	714	26	4	5	325	10	370	7	17			6			3	2	35
	iC3-fB	18	IR 26, c	13	9	22	2	5		4		11	11	15			5					31
	iC5-fB	25	Local, c	3	88	91	5	4	2			11	34	53			3		2	8		100
	iC7-fB	25	Local, c		40	40	12					12	3	15	1		6		1	1		27
East Java	iE2-f	19	Pe, c	12	135	147	4	1	1	7		13					1	1				2
	iE3-f	19	Pe, c	132	23	155				7		7		16			4		3	1		24
	iE5-fB	24	Local, c	16	16	32			1	6		7	1	12								13
	iE6-fA	20	Pe, c	33	126	159	4	2		11		17	4	3			1		4			12
	iE8-fC	20	IR 26, c	3		3	3					3	5	35		1			1			42
	iE9-fA	21	IR 26, c	16	8	24				12		12	7	77					2	5		91
	iE10-fB	23	a	7	3	10				3		3		34			4			5		43
Bali	iB1-fA	21	IR 26, c	23	4	27			1	61		62	3	30								33
	iB2-fA	23	IR 26, c	91	132	223	3	6		87		96	8	14		1						23
Lampung	iL5-fB	Mar. 4	Pe, c	25	12	37	2			1		3	1	1		2			1			5
	iL6fA	3	Pe, c	4	29	33	6			5		11	3	55		1				3		62
	iL7-fA	3	Pe, c	18	18	36	1	1		2		4	2	26						1		29
	iL7-fB	5	Pe, c	2	56	58	1	1	1	5		8	1	3								4

(B) Rice nursery

District	Paddy field[2]	Date in 1976	Plant- and leafhoppers[4]			Predacious insects[5]						Spiders[6]									
			Delphacidae	Cicadellidae	Total	Coccinellidae	Carabidae	Staphylinidae	Miridae	Reduviidae	Total	Theridiidae	Agriopidae	Tetragnathidae	Micryphantidae	Lycosidae	Oxyopidae	Thomisidae	Salticidae	Clubionidae	Total
West Java	iS2-n	Feb. 14	37	4	41	1			6	1	8										0
	iS5-n	14	7	54	61	1			1		2			3							3
	iS8-n	16	7	3	10						0										0
	iS9-n	26	67	72	139	2	1				3						1				1
Central Java	iC3-n	18	74	156	230		1		53		54			1			2				3
	iC4-n	19	264	188	452	1	2	1	91	1	96	1		5	1		6	1			14
	iC6-n	25	29	1898	1927	3	9		61		73		1				6				7
East Java	iE1-n	24	56	52	108	5	2		2		9		4	5			1				10
	iE4-n	24	48	180	228				1		1			3		1	4		3	1	12
	iE11-n	23	162	98	260	2	1		109	3	115		1	6			6		1		14
Bali	iB3-n	21	5	46	51				3		3								1		0
Lampung	iL2-n	Mar. 2	4	20	24	2			1	1	4		2	19							22
	iL3-n	2	4	9	13	1			14		15		1	2							3
	iL4-n	3	4	10	14						0			20		2					22

1) Collection by means of sweeping. Insects were adults only, and spiders were adults and age-advanced nymphs.
2) Refer to Table 1.
3) Refer to Table 1.
4) Species names are given in Appendices I and II.
5) Species names are given in Appendix VIII.
6) Species names are given in Appendix VI.

prey density was neither very sensitive nor very strong to bring about effective density-dependent control of the pests by the very predator.

Since Hinckley (1963), this mirid has been emphasized by some authors as an excellent predator of the eggs and nymphs of *N. lugnes,* but the result of our investigation in Indonesia suggests that further study would still be necessary before any conclusion is drawn about the effectiveness of the mirid upon the pest population.

Two individuals of another predacious mirid, *Tytthus chinensis* Stal, were collected in Central Java. Kisimoto (1975) caught a fairly large number of it by a net trap equipped on a ship sailing the East China Sea. This species would be a predator worthy of further study.

In spite of their nature of being polyphagous, predators can never be said that they feed on all the phytophagous species living in the surroundings indiscriminately. As a matter of fact, some of the predators mentioned above have been reported to prefer rice plant- and leafhoppers, but it is believed, on the other hand, that some predators would hardly be dependent on the hoppers.

Even if it is allowed to assume that the carnivorous species collected in the course of our study choose hoppers as one of their daily diets, it can be concluded from Table 5 that all of them but *C. lividipennis* had almost no relation of density with the preys inhabiting the same habitat. (As for spiders, Appendix III can also be referred.)

We never deny the possibility of their contribution to the rice pest control when the pests are under endemic phase, and we think an accumulation of minute studies on the ecology of the respective predators with special reference to their relation with prey species would be necessary for discussing their effect upon the pest multiplication further.

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VII. SUMMARY

1. Investigation was conducted in the northern half of Province Wellesley and the Kedah-Perlis Coastal Plain, West Malaysia, and Java, Bali and Lampung, Sumatra, Indonesia, from January to March, 1976. In paddy fields, plant- and leafhoppers and spiders were counted by the naked eyes. Counting was also conducted for rice hills with distinct symptoms of grassy stunt disease. Insects and spiders were collected by sweeping paddy fields, rice nurseries and gramineous weeds with a butterfly net. In some paddy fields of Indonesia, adult female *Nilaparvata lugens* were collected with an aspirator in order to study their parasitism. Sucking was also tried for spiders in 2 paddy fields in Lampung.
2. In West Malaysia, delphacid density was very low both on paddy and on weeds. Cicadellids including *Nephotettix* spp. were generally more abundant than delphacids, but tungro disease infection was not observed.
3. In Java and Bali, incidence of *N. lugens* was still scrious. In the area where the pest had particularly been destructive in the past, a policy of replacement of susceptible rice varieties such as Pelita with IR 26 and other resistant ones was strongly being undertaken by the Indonesian Government. When *Nilaparvata* density on IR 26 was compared with that on Pelita, the growing of the former variety was proved to have desirable effects upon restraint of the pest population. At the same time, however, some fear was undeniable that the policy of wide-ranged exclusive growing of the single resistant variety may become nullified if the pest once stems out a strain adaptive to the variety in the future. Instead, simultaneous growing of a number of resistant varieties of different genetical sources would strategically be recommendable.
4. In the area with prevalent growing of Pelita, asynchronous rice cultivation was general, all

the stages of growth of rice from nursery to ripening being seen in some parts of the area. *Nilaparvata* multiplication seemed to be encouraged by such cultivation practice as well as hereditary susceptibility of the variety. The area with local varieties, on the contrary, was characterized by synchronous cultivation and hardly suffered from the pest's infestation in spite of susceptibility of the varieties.

5. Surprisingly high densities of macropterous *N. lugens* were recorded from 2 paddy fields about 3-4 weeks after transplanting. It is believed that migrating *Nilaparvata* had convergently alighted on them due to the pest's preference to rice plants under that stage of development. Based on the results of investigation in these fields and also some other ones with hopperburned rice under more advanced growth stages, speculation was made about the process of hopper-burning in connection with some population features of *N. lugens* in Indonesia. It was pointed out that the process of *Nilaparvata* population construction in that country differs to a large extent from that in Japan.
6. Aggregation pattern in *N. lugens* was discussed by using some statistical procedures.
7. In Java and Bali, there were some paddy fields with heavy infection of grassy stunt disease. They were all grown with Pelita. The varietal difference in intensity of the disease was considered to be closely related to the difference in density of the vector, *N. lugens,* among the varieties. Existence of macropterous forms of *Nilaparvata* in high rates and occasional concentration of the pest to rice nurseries seemed to be important with regard to dissemination of the disease.
8. In Lampung, *N. lugens* problem was not very serious. It was pointed out, however, that there were some paddy fields with fairly high densities of the pest, this suggesting some possibility of epidemic occurrence of the pest in the near future even in that region.
9. In Indonesia, *Sogatella furcifera* were abundantly collected from some of the paddy fields and nurseries swept. This delphacid, however, did not seem to be serious against rice cultivation there. In that country, *Nephotettix* spp. were fairly common and more *Recilia dorsalis* were collected than in Malaysia, but no occurrence of tungro disease was observed during the course of the tour. *Thaia* spp. were sometimes collected abundantly from paddy.
10. In Indonesia, strepsipterans, dryinids and nematodes were recorded as parasites of *N. lugens* but parasitism by them was not very high to exert any significant influence upon the pest population at the epidemic level. The predacious mirid, *Cyrtorrhinus lividipennis,* were abundant in some paddy fields and nurseries with high densities of plant- and leafhoppers. Abundance in spiders and carnivorous insects other than *C. lividipennis* was hardly related to the density of plant- and leafhoppers inhabiting the same habitat. Species spectrum in spiders collected by sucking was richer than that by sweeping.

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P L A T E

Overall heavy hopperburn in a paddy field (A), and affected rice plants in the same field (B). Photographed by A. Ôtake at Kentandan, Klaten, Central Java, on 18th February, 1976.

X 和文摘要

1　1976年1～3月に，イネのウンカ・ヨコバイ類の発生と被害に関する調査を，西マレイシアのプロビンス・ウェレスレー北部およびケダ平野，ならびにインドネシアのジャワ，バリ，ランポン（スマトラ）でおこなった。主として二期作地帯の水田で，20株上のウンカ・ヨコバイ類の雌成虫数およびクモ類の〝よみとり〃をおこない，さらに，それら20株のうちでグラッシー・スタント病の明らかな病徴を示す株の数を記録した。また，水田，苗代および水田近くの雑草地で，〝すくいとり〃によってウンカ・ヨコバイ類，クモ類，捕食性こん虫類を調査した。ジャワ島では，トビイロウンカ（*Nilaparvata lugens*）の密度の高い数枚の田から，このウンカの雌成虫を吸虫管によって採集し，寄生虫の寄生率を調べた。ランポンでは，2枚の田から吸虫管によってクモ類を採集し，この方法とすくいとり法とで採集されたクモの種類相を比較した。

2　西マレーシアでは，イネ，雑草ともにウンカ類（Delphacidae）の密度は非常に低かった。ヨコバイ類（Cicadellidae）は，ウンカよりは密度が高かったが，ツマグロヨコバイ（*Nephotettix* spp.）などによって媒介されるツングロ病は見られなかった。

3　ジャワとバリでのトビイロウンカの発生は，今なお相当に激しかった。インドネシア政府は，以前とくに被害のひどかった区域で，プリタ（Pelita）のような感受性品種をＩR26 などの抵抗性品種におきかえる政策を強力に進めている。ＩR26 とプリタとで，トビイロウカ雌成虫のよみとり数を比較すると（第2表），たしかにＩR26 の栽培は，このウンカの発生を抑えるうえで役立っていることがわかる。ただし，広い水田地帯が単独の抵抗性品種によって占められることは，もし将来，その品種に適応した系統がウンカの側に生じた場合，稲作が再び壊滅的打撃を受ける危険性をはらむという点で問題がある。抵抗性に関して遺伝的組成を異にする複数の品種を同時に使うゆき方が望ましいのではなかろうか。

4　プリタの栽培の盛んな区域では，イネの作期の乱れが一般に大きかった。ところによっては，苗代から収穫期まであらゆる発育段階のイネが見られた。このような環境は，プリタの遺伝的感受性とともにトビイロウンカの増殖にとって好ましい条件であると考えられる。他方，在来品種の栽培されている区域では，作期がよくそろい，これらの品種はトビイロウンカ抵抗性ではないにもかかわらず，このウンカの発生は非常に少なかった（第2表）。

5　東ジャワの田植え後3～4週間の水田で，トビイロウンカ有翅型成虫の著しく高い密度が記録された（付表Ⅲ，Ⅳの iE8-fA およびB）。恐らく，移動中のウンカが，その発育段階のイネに選択的に集中して降り立ったのであろう。それらの田のイネの葉は，ウンカの激しい吸汁活動で黄色くなりはじめていた。これは，いわゆる hopperburn の初期段階とみなされるが，本格的な hopperburn（図版参照）は，発育段階のより進んだイネに認められる場

合が多かった（第2表）。一般に，ある田で hopperburn が現われる場合，その時期は，そこへはじめに侵入したウンカの密度が大きく影響すると考えられる。これに関連して，本文では，インドネシアでの hopperburn の形成過程と日本でのトビイロウンカによる坪枯れの形成過程との違いが考察された。

6　トビイロウンカの空間分布にみられる集中性が，いくつかの集中度指数によって示された（付表Ⅳおよび第2図，第3表）。

7　トビイロウンカによって媒介されるグラッシー・スタント病は，ジャワとバリの一部の水田で目立った被害を及ぼしていたが，これらはすべてプリタの栽培された水田であった（第2表）。プリタでの高い罹病株率は，この品種でのウンカの高い平均密度が関係したものと思われる。この病気の伝播に関連して，水田でトビイロウンカの有翅型率が高かったことと，一部の苗代でこのウンカの密度が高かったこととは重要である。なぜなら，移動力の大きい有翅型成虫の病気伝播に果す役割りは大きく，また苗代でウンカを通じてこの病気の感染が起こることは，田植えによる罹病苗の本田へのもちこみを意味するからである。

8　ランポンでのトビイロウンカの発生は一般に少なかったが，このウンカの密度が比較的高い田も数枚あった。この状況から，ランポンといえども，将来トビイロウンカが大発生する可能性は否定できない。

9　インドネシアには，セジロウンカ（*Sogatella furcifera*）がかなり大量に採集された水田や苗代がいくつかあったが，このウンカの稲作への影響は認められなかった。ツマグロヨコバイ類は水田や苗代にふつうに見られ，イナズマヨコバイ(*Recilia dorsalis*)はマレイシアより多く採集されたが，これらのヨコバイによって伝播されるツングロ病の発生は見られなかった。ヒメヨコバイ亜科に属する *Thaia* spp.が時どきイネからかなり多く採集された。

10　インドネシアで採集したトビイロウンカ雌成虫には，ネジレバネ（Strepsiptera），カマバチ,(Dryinidae)，線虫の寄生が認められたが，それら天敵の寄生率は高くなかった。捕食性こん虫のなかで，カタグロミドリメクラカメムシ（*Cyrtorrhinus lividipennis*）は，ウンカ・ヨコバイの密度の高い水田および苗代の一部で豊富に採集された。しかし，他の捕食性こん虫類やクモ類の密度は，ウンカ・ヨコバイ類の密度とほとんど関連性を示さなかった（第5表）。捕食性天敵類の効果については，今後さらに研究が必要であるが，少なくともウンカ・ヨコバイ類が多発生したときのこれら天敵の抑圧効果は期待できないと思われる。吸虫管で集めたクモ類の種類相は，すくいとりによるものより豊富であった。

ORDERS, FAMILIES AND OTHER TAXA IN INSECTS (INSECTA) AND SPIDERS (ARANEAE) LISTED IN APPENDICES I-VIII

Taxa	Appendices concerned
Class: Insecta (こん虫綱) Order: Hemiptera (半翅目) Family: Delphacidae (ウンカ科) Species: *Nilaparvata lugens* (brown planthopper, トビイロウンカ), *Sogatella furcifera* (white-backed planthopper, セジロウンカ), etc.	I, III, IV, V
Family: Cicadellidae (ヨコバイ科) Subfamily: Deltocephalinae (マダラヨコバイ亜科) Species: *Nephotettix nigropictus* (green rice leafhopper, クロスジツマグロヨコバイ), *Recilia dorsalis* (zigzag-striped leaf-hopper, イナズマヨコバイ), etc. Subfamily: Hecalinae (フクロヨコバイ亜科) Iassinae (アオズキンヨコバイ亜科) Tettigellinae (オオヨコバイ亜科) Typhlocybinae (ヒメヨコバイ亜科)	II
Family: Miridae (メクラカメムシ科) Species: *Cyrtorrhinus lividipennis* (カタグロミドリメクラカメムシ), etc. Family: Nabidae (マキバサシガメ科) Reduviidae (サシガメ科)	VIII
Order: Strepsiptera (でん翅目；ネジレバネと総称される)	V
Order: Hymenoptera (膜翅目) Family: Dryinidae (カマバチ科)	V
Order: Coleoptera (鞘翅目) Family: Coccinellidae (テントウムシ科) Species: *Coccinella transversalis* (メンガタテントウムシ), etc. Family: Carabidae (ゴミムシ科) Species: *Ophionea indica* (クビナガゴミムシ), etc. Family: Staphylinidae (ハネカクシ科) Species: *Paederus fuscipes* (アオバアリガタハネカクシ), etc.	VIII
Class: Arachnida (くも形綱) Order: Araneae (真正くも目) Family: Theridiidae (ヒメグモ科) Symphytognathidae (ヨリメグモ科) Argiopidae (コガネグモ科) Tetragnathidae (アシナガグモ科) Pisauridae (キシダグモ科) Lycosidae (ドクグモ科) Oxyopidae (ササグモ科) Thomisidae (カニグモ科) Salticidae (ハエトリグモ科) Clubionidae (フクログモ科) Heteropodidae (アシダカグモ科)	VI, VII

Results of collection of adult delphacids, cixiids and meenoplids by means of sweeping

District	Code No.[1)]	Date in 1976	Variety and growth stage of rice[2)]	Delphacidae											Cixiidae	Meenoplidae
				Nilaparvata lugens Stål					*Sogatella furcifera* Horváth					Others		
				♂		♀			♂		♀					
				M[3)]	B	M	B	Total	M	B	M	B	Total			
∘*Paddy field*																
P. Wellesley, West Malaysia	mW2-f	Jan. 29	-c	2	0			2					0	Gen ? sp. A 1		
	mW3-fA	"	-d					0			1	0	1			
	" B	"	-e	1	0			1					0			
	mW4-fA	"	-d					0	1	0			1			
	" B	"	-f			1	0	1	3	0	3	1	7			
	mW5-f	"	-f					0	1	0			1			
The Kedah-Perlis Coastal Plain, West Malaysia	mK1-f	Feb. 5	-d					0					0			
	mK2-f	"	-c			1	0	1					0			
	mK3-f	"	-c					0	1	0	1	0	2			
	mK4-f	"	-e					0					0		*Oliarus* sp. ♀1	
	mK5-f	Feb. 4	-f					0					0			
	mK6-fA	"	-f					0					0			
	" B	"	-f					0			1	0	1			
	mK7-f	"	-d					0	1	0			1			
	mK8-f	"	-e					0					0			
	mK9-f	Feb. 1	-d					0					0			
	mK10-fA	"	-f					0					0			
	" B	"	-f					0			1	0	1			
	" C	"	-f					0					0			
	mK11-f	Feb. 3	-d			0	1	1					0			
	mK12-f	"	-f					0	1	0			1			
	mK13-f	"	-c					0	1	0			1			
	mK14-f	"	-e					0					0			
	mK15-f	"	-c					0					0			
	mK16-f	Feb. 1	-c					0	1	0			1			

District	Code No.[1]	Date in 1976	Variety and growth stage of rice[2]	Delphacidae: *Nilaparvata lugens* Stål ♂ M[3]	♂ B	♀ M	♀ B	Total	Delphacidae: *Sogatella furcifera* Horváth ♂ M	♂ B	♀ M	♀ B	Total	Delphacidae: Others	Cixiidae	Meenoplidae
West Java, Indonesia	iS1-fB	Feb. 13	IR20 -c			2	0	2					0			
	iS7-fA	Feb. 17	Pe -c	1	0			1					0			
	iS10-fB	Feb. 26	Pe -c					0	3	0	0	2	5			
Central Java, Indonesia	iC1-fB	Feb. 18	IR26 -d					0	3	0	6	2	11			
	iC2-f	"	Pe -c			1	0	1	109	0	96	1	206			
	iC3-fB	"	IR26 -c	1	0			1	8	0	4	0	12			
	iC5-fB	Feb. 25	Local-c	2	0			2	1	0			1			
	iC7-fB	"	Local-c					0					0			
East Java, Indonesia	iE2-f	Feb. 19	Pe -c	8	0	3	0	11					0	*Sogatella pusana* Distant ♂1		
	iE3-f	"	Pe -c	69	0	59	0	128	2	0	2	0	4			
	iE5-fB	Feb. 24	Local-c	3	0			3	5	0	7	0	12	*S. pusana* Distant ♀1		
	iE6-fA	Feb. 20	Pe -c	5	0	12	12	29	2	0	2	0	4			
	iE8-fC	"	IR26 -c			1	0	1			1	1	2			
	iE9-fA	Feb. 21	IR26 -c	8	0	3	0	11	4	0	1	0	5			
	iE10-fB	Feb. 23	-a	6	0			6	1	0			1			
Bali, Indonesia	iB1-fA	Feb. 21	IR26 -c	4	0	8	0	12	4	0	7	0	11			*Nisia* sp. ♂1
	iB2-fA	Feb. 23	IR26 -c	25	0	26	8	59	13	0	17	2	32			
Lampung, Indonesia	iL5-fB	Mar. 4	Pe -c	4	0	4	0	8	11	0	4	1	16	Gen ? sp. F ♂1		
	iL6-fA	Mar. 3	Pe -c					0	3	0	1	0	4			
	iL7-fA	"	Pe -c	1	0	1	0	2	6	0	1	9	16			
	" B	Mar. 5	Pe -c					0	1	0	1	0	2			*Nisia* sp. ♀1
∘ *Rice nursery*																
Malaysia	mW1-n	Jan. 29		6	0	1	0	7	1	0	1	0	2			
West Java, Indonesia	iS2-n	Feb. 14		14	0	21	0	35	1	0			1	Gen ? sp. C ♀1		
	iS5-n	"		0	1			1	4	2			6			
	iS8-n	Feb. 16				1	0	1	4	0	2	0	6			
	iS9-n	Feb. 26		45	0	11	0	56	8	0	2	0	10	*Toya propinqua* Fieber ♀1		*Nisia* spp. ♂1, ♀1

District	Code No.[1]	Date in 1976	Delphacidae: *Nilaparvata lugens* Stål ♂ M[3]	♂ B	♀ M	♀ B	Total	Delphacidae: *Sogatella furcifera* Horváth ♂ M	♂ B	♀ M	♀ B	Total	Delphacidae: Others	Cixiidae	Meenoplidae
Central Java, Indonesia	iC3-n	Feb. 18	10	0	3	0	13	39	0	21	1	61			*Nisia* sp. ♀1
	iC4-n	Feb. 19	147	0	115	0	262	2	0			2			*Nisia* sp. ♂1
	iC6-n	Feb. 25	8	0	13	0	21	8	0			8			
East Java, Indonesia	iE1-n	Feb. 24	25	0	19	3	47	6	0			6	*S. pusana* Distant ♂1, ♀2		
	iE4-n	"	21	0	14	0	35	10	0	2	0	12	*S. sirokata* Matsumura et Ishihara ♂1		
	iE11-n	Feb. 23	40	0	63	0	103	51	0	8	0	59			*Nisia* spp. ♂3, ♀1
Bali	iB3-n	Feb. 21			1	0	1	1	0	3	0	4			
Lampung, Indonesia	iL2-n	Mar. 2	3	0	1	0	4					0			
	iL3-n	"	2	0			2	2	0			2			
	iL4-n	Mar. 3					0	3	0	1	0	4			
∘ *Weeds*															
P. Wellesley, West Malaysia	mW4-wA	Jan. 29					0					0			
	" B	"					0					0			
	mW5-wA	"					0					0			
	" B	"					0					0			
	mW6-w	"					0					0	Gen ? sp. B ♂1, ♀1		
The Kedah-Perlis Coastal Plain, West Malaysia	mK1-w	Feb. 5					0					0			
	mK2-w	"					0					0			
	mK3-w	"					0					0			
	mK4-w	"					0					0		*Oliarus* sp. ♀1	
	mK5-w	Feb. 4					0					0		*Oliarus* sp. ♂4, ♀1	
	mK6-w	"					0					0	*S. terryi* Muir ♂1		
	mK7-w	"					0					0			
	mK8-w	"					0					0			*Nisia* sp. ♀1
	mK9-w	Feb. 1					0					0			*Nisia* sp. ♀1
	mK10-wA	"					0					0			
	mK10-wB	"					0					0			
	mK11-w	Feb. 3					0					0			

District	Code No.[1]	Date in 1976	Delphacidae												Cixiidae	Meenoplidae
			Nilaparvata lugens Stål					*Sogatella furcifera* Horváth					Others		
			♂		♀			♂		♀					
			M[3]	B	M	B	Total	M	B	M	B	Total			
The Kedah-Perlis Coastal Plain, West Malaysia	mK12-w	Feb. 3					0					0			
	mK13-w	"					0					0			
	mK14-w	"					0					0			
	mK15-w	"					0					0		*Oliarus* sp. ♂2	
	mK16-w	Feb. 1					0					0			
West Java, Indonesia	iS3-w	Feb. 13	1	0	3	0	4					0	*S. pusana* Distant ♂1		*Nisia* sp. ♀2
	iS5-w	Feb. 14					0					0			
	iS7-w	Feb. 17					0					0			
	iS8-w	Feb. 16					0					0			
Central Java	iC5-w	Feb. 25			1	0	1					0	Gen ? sp. D ♂1		
East Java, Indonesia	iE1-w	Feb. 24	5	0			5					0			*Nisia* sp. ♂2
	iE3-w	Feb. 19			1	0	1					0	*Tropidocephala brunnipennis* Signoret ♂1		
	iE5-w	Feb. 24	1	0			1					0			
	iE6-w	Feb. 20					0					0			
	iE7-w	"					0					0			
	iE9-w	Feb. 21	1	0			1	1	0			1			
	iE10-w	Feb. 23					0					0			
Bali, Indonesia	iB1-w	Feb. 21					0					0			*Nisia* sp. ♀1
	iB3-w	"					0					0			
Lampung, Indonesia	iL1-w	Mar. 2	1	0			1					0	Gen ? sp. E ♂1		
	iL3-w	"					0					0	*Toya propinqua* Fieber ♂1		
	iL4-w	Mar. 3					0					0			
	iL5-w	Mar. 4					0					0	Gen ? sp. E ♂1		
	iL6-w	Mar. 3					0					0	Gen ? sp. E ♂1		
	iL7-w	"			0	1	1					0			

1) Refer to Table 1, Fig. 1 and text on p. 2.

2) Refer to Table 1.

3) M and B mean macropterous and brachypterous, respectively. Other than *N. lugens* and *S. furcifera*, no brachypterous form was collected.

APPENDIX II

Results of collection of adult cicadellids by means of sweeping

(1) List of species

Subfamily	Tribe	Species	Symbol[1)]
Deltocephalinae	Stirellini	*Nephotettix nigropictus* Stål	N1
		Nephotettix virescens Distant	N2
		Nephotettix malayanus Ishihara et Kawase	N3
		Nephotettix parvus Ishihara et Kawase	N4
		Exitianus indicus Distant	Ex
	Deltocephalini	*Recilia dorsalis* Motschulsky	R1
		Recilia okinawanus Matsumura (?)	R2
	Athysanini	*Scaphoideus morosus* Melichar	Sc
	Macrostelini	*Macrosteles* sp. or spp.	Ma
		Cicadulina bipunctella Matsumura	Cn
		Balclutha incisa Matsumura	Bl
		Balclutha spp.	B2
	Euscelini	*Aconura* sp.	Ac
		Cicadula spp.	Ci
		Gen? spp?	X
Hecalinae		*Hecalus* sp.	He
Iassinae		*Batrachomorphus* sp.	Bt
Tettigellinae		*Tettigella spectra* Distant	Te
		Yasumatsuus mimicus Distant	Ya
Typhlocybinae	Typhlocybini	*Thaia* spp.	Th
		Empoascanara sp. or spp.	Er
	Empoascini	*Empoasca* sp.	Em
		Sundapteryx biguttula Ishida	Su
		Austroasca sp.	Au

1) Corresponding to the same symbol in the next table.

APPENDIX II (Cont'd)

(2) Numbers of catches

Habitat: Paddy Field

District: P. Wellesley, West Malaysia (mW2-f – mW5-f); The Kedah-Perlis Coastal Plain, West Malaysia (mK1-f – mK16-f); West Java, Indonesia (iS1-fB – iS10-fB)

Code no.[1]		mW2-f	mW3-fA	mW3-fB	mW4-fA	mW4-fB	mW5-f	mK1-f	mK2-f	mK3-f	mK4-f	mK5-f	mK6-fA	mK6-fB	mK7-f	mK8-f	mK9-f	mK10-fA	mK10-fB	mK10-fC	mK11-f	mK12-f	mK13-f	mK14-f	mK15-f	mK16-f	iS1-fB	iS7-fA	iS10-fB
Date in 1976		Jan 29	29	29	29	29	29	Feb 5	5	5	5	4	4	4	4	4	1	1	1	1	3	3	3	3	3	1	Feb 13	17	26
N1[2]	♂	1	1		27	5	19	0	6	3		16	0	0	1	2		0	4		42	4	0		1	1			20
	♀	1	0		12	19	18	2	3	1		11	1	1	0	5		3	16		23	3	1		0	1			7
N2	♂	1	5	10	6	9	3	9		0			2	8	2	0		2		3	2	1	4	11	3	1			1
	♀	1	0	5	2	7	1	7		2			2	10	0	1		1		3	4	1	1	8	0	0			0
N3	♂																								1				
	♀																								0				
N4	♂																												
	♀																												
Ex																													
R1	♂									0														1					1
	♀									1														0					1
R2																													
Sc																													
Ma																													♀2
Cn	♂																												
	♀																												
Bl	♂																												
	♀																												
B2																													
Ac	♂																									1			
	♀																									1			
Ci	♂																												
	♀																												
X				♀1		♀1																		♀1					
He	♂																												
	♀																												
Bt																													
Te	♂																							1			1		
	♀																							0			0		
Ya	♂																												
	♀																												
Th	♂	1																					0	1		0			3
	♀	0																					1	0		5			13
Er	♂																												
	♀																												
Em																													
Su																													
Au																													

1) Refer to Table 1, Fig. 1 and text on p. 2.

2) Corresponding to the same symbol in the preceding table.

APPENDIX II (Cont'd)

Habitat		Paddy field																		Rice nursery							
District		Central Java, Indonesia					East Java, Indonesia							Bali, Indonesia		Lampung, Indonesia				Malaysia	West Java, Indonesia				Central Java, Indonesia		
Code no.		iC1-fB	iC2-f	iC3-fB	iC5-fB	iC7-fB	iE2-f	iE3-f	iE5-fB	iE6-fA	iE8-fC	iE9-fA	iE10-fB	iB1-fA	iB2-fA	iL5-fB	iL6-fA	iL7-fA	iL7-fB	mW1-n	iS2-n	iS5-n	iS8-n	iS9-n	iC3-n	iC4-n	iC6-n
Date in 1976		Feb 18	18	18	25	25	Feb 19	19	24	20	20	21	23	Feb 21	23	Mar 4	3	3	5	Jan 29	Feb 14	14	16	26	Feb 18	19	25
N1	♂		266	0	17	2	22	4	6	83		2		0	15	1	22	1	35	4	2	19	1	2	41	15	1381
	♀		199	1	12	1	14	1	2	36		0		1	7	3	4	2	19	2	1	24	1	6	64	17	440
N2	♂				7	13	2	4	1				1				0	5	2	1		3		1	1	3	12
	♀				5	15	0	3	1				0				1	5	0	3		3		0	1	1	8
N3	♂																										
	♀																										
N4	♂																										
	♀																										
Ex			♂1																								
R1	♂		12			0	2		0			1	1		0	2				2				0	3	2	1
	♀		12			2	3		1			0	0		2	1				5				1	1	4	3
R2																											
Sc																											
Ma																											
Cn	♂														1												
	♀														0												
B1	♂																										
	♀																										
B2																											
Ac	♂						0																		0	1	
	♀						3																		1	0	
Ci	♂																										
	♀																										
X																											
He	♂		1					0		0													1				
	♀		0					1		1													0				
Bt																											
Te	♂						38			2				1	15					1				7		0	
	♀						25			1				0	6					0				1		2	
Ya	♂						3			0						2						1		0	1		0
	♀						5			1						2						0		1	0		2
Th	♂	0	0	0	10	2	7	1	0	1		0	0	0	5	1	2	2		0	0	0		8	4	5	10
	♀	1	16	8	36	5	10	9	5	1		5	1	2	52	0	0	3		1	1	4		42	39	138	20
Er	♂						0								23									1			4
	♀						1								6									2			17
Em					♀1																						
Su																											
Au																											

APPENDIX II (Cont'd)

Code no.		iE1-n	iE4-n	iE11-n	iB3-n	iL2-n	iL3-n	iL4-n	mW4-wA	mW4-wB	mW5-wA	mW5-wB	mW6-w	mK1-w	mK2-w	mK3-w	mK4-w	mK5-w	mK6-w	mK7-w	mK8-w	mK9-w	mK10-wA	mK10-wB
Habitat		Rice nursery							Weeds															
District		East Java, Indonesia			Bali, Indonesia	Lampung, Indonesia			P. Wellesley, West Malaysia					The Kedah-Perlis Coastal Plain, West Malaysia										
Date in 1976		Feb 24	24	23	Feb 21	Mar 2	2	3	Jan 29	29	29	29	29	Feb 5	5	5	5	4	4	4	4	1	1	1
N1	♂	14	16	1	13	4	0		7			16	63	6	6	8	18	5	1		26		7	8
	♀	6	32	3	29	2	2		3			23	24	6	7	5	10	4	0		9		4	7
N2	♂	4	18	2				0	1				1	0			1			0	0			
	♀	2	45	1				2	0				0	2			2			1	1			
N3	♂											4	5				1					2	1	0
	♀											1	1				0					1	1	1
N4	♂															2								
	♀															1								
Ex			♂1																					
R1	♂	1	3	4		3	2	1					0					0						
	♀	0	3	8		1	1	2					1					1						
R2																								
Sc																								
Ma																								
Cn	♂	1																						
	♀	0																						
Bl	♂												6											
	♀												1											
B2						♀1							1											
Ac	♂	3	33	1								1	1											
	♀	0	15	14								1	4											
Ci	♂																							
	♀																							
X																			♂2,♀2					
He	♂																					0		
	♀																					1		
Bt																								
Te	♂	3		0		1	0	1	1			2		0	12	0				2	0			
	♀	2		2		0	1	0	0			1		1	8	2				1	1			
Ya	♂		0			1						1				1								
	♀		1			1						0				0								
Th	♂	1	6	3	1	0	1	2									2			0				
	♀	2	7	14	3	6	2	2									1			1				
Er	♂	10		31																				
	♀	3		14																				
Em																								
Su												♂1												
Au																								

APPENDIX II (Cont'd)

Habitat		Weeds																									
District		The Kedah-Perlis Coastal Plain, West Malaysia						West Java, Indonesia				Central Java, Indon.	East Java, Indonesia							Bali, Indo-nesia		Lampung, Indonesia					
Code no.		mK11-w	mK12-w	mK13-w	mK14-w	mK15-w	mK16-w	iS3-w	iS5-w	iS7-w	iS8-w	iC5-w	iE1-w	iE3-w	iE5-w	iE6-w	iE7-w	iE9-w	iE10-w	iB1-w	iB3-w	iL1-w	iL3-w	iL4-w	iL5-w	iL6-w	iL7-w
Date in 1976		Feb 3	3	3	3	3	1	Feb 13	14	17	16	Feb 25	Feb 24	19	24	20	20	21	23	Feb 21	21	Mar 2	2	3	4	3	3
N1	♂	5	8	7	0	3		0	0	1	0	5	2			2	0				2		3			0	10
	♀	1	1	1	2	2		1	1	0	1	1	1			5	1				2		4			1	7
N2	♂	1	0				1																				
	♀	3	1				0																				
N3	♂					2																					
	♀					1																					
N4	♂																										
	♀																										
Ex						♀1		♂1	♀1				♂2,♀1		♀1												
R1	♂							2		1																	
	♀							3		0																	
R2															♂1												
Sc																♂1											
Ma																											
Cn	♂															1											
	♀															0											
B1	♂								0	0																	
	♀								1	2																	
B2					♂1																						
Ac	♂																										
	♀																										
Ci	♂										0	1			2								0				
	♀										3	0			4								1				
X								♀1							♂1,♀2	♀1									♂1		
He	♂		0			5			4	6	1		0		3			0		1	2			2			
	♀		1			2			1	3	0		1		0			1		1	0			0			
Bt											♀1																
Te	♂		5			3			1			0				0	0					1				0	4
	♀		8			2			0			1				1	1					1				1	5
Ya	♂		4			1										0	1							0		1	
	♀		0			0										2	0							1		0	
Th	♂												1			0						0					
	♀												0			1						1					
Er	♂																						12			0	
	♀																						6			2	
Em																											
Su																											
Au									♂1																		

Total numbers of plant- and leafhoppers and spiders counted on 20 rice hills, and numbers of hills with distinct symptoms of grassy stunt disease (GS)

District	Investi-gation site[1]	Date in 1976	Variety/ St.[2]	*Nilaparvata lugens* Adult female M[3]	B	Total	Nymph 5th-instar	Younger	GS	*Sogatella furcifera* Adult female M	B	Total	Nymph 5th-instar	*Nephotettix* spp. Adult female	*Recilia dorsalis* Adult	Spider	Remarks
West Malaysia	mK13-f	Feb. 3	-c			0	0		0			0	0	0	0	7	
	mK14-f	"	-e			0	0		0			0	0	1	0	17	
West Java	iS1-fA	Feb. 13	IR26 -c	5	0	5	0		0			0	0	0	0	15	There was a hopperburned field on the opposite side of the road
	" B	"	IR20 "	105	1	106	0		0			0	0	0	0	17	
	iS2-fA	14	Pe "	149	31	180	0		0	1	0	1	0	0	0	9	Yellowing of leaves due to *Nilaparvata* infestation
	" B	"	IR26 "	133	3	136	0		0			0	0	0	0	15	
	" C	"	-a			0	0		0			0	0	0	0	1	Located near fields A and B
	iS4-f	13	Pe -c	37	56	93	0		2			0	0	0	0	6	
	iS5-fA	14	" "	0	1	1	4		0			0	0	0	1	21	
	" B	"	? "	2	1	3	3		0			0	0	0	0	12	
	iS6-fA	17	Pe "	51	41	92	0		0			0	0	0	0	11	Yellowing of leaves due to *Nilaparvata* infestation
	" B	"	" "	429	226	655	0		0	13	0	13	0	0	0	17	
	iS7-fA	"	" "	20	1	21	0		0	1	0	1	0	0	0	8	
	" B	"	" "	24	9	33	4		0			0	0	0	0	10	
	iS10-fA	26	" "			0	0		0			0	0	1	0	9	
	" B	"	" "			0	0		0			0	0	1	0	22	
Central Java	iC1-fA	Feb. 18	IR26 -c +28	22	1	23	0		0	7	7	14	0	0	0	7	
	" B	"	IR26 -d			0	0		0	2	1	3	0	0	0	18	
	iC2-f	"	Pe -c			0	4	Abundant	9	3	0	3	2	11	0	12	Medium hopperburn
	iC3-fA	"	IR26 "			0	0		2	0	1	1	0	0	1	27	
	" B	"	" "	2	0	2	0		1	2	0	2	0	0	0	35	
	" C	"	Pe "	3	0	3	0	Abundant	16	0	1	1	0	0	0	42	
	iC5-fA	25	Local-d	1	1	2	0		0			0	0	12	0	17	
	" B	"	" c	4	0	4	0		0			0	0	15	0	20	
	iC7-fA	"	" "			0	0		0			0	0	0	0	24	
	" B	"	" "	1	0	1	0		0			0	0	0	0	24	

APPENDIX III (Cont'd)

District	Investigation site[1)]	Date in 1976	Variety/ St.[2)]	*Nilaparvata lugens* Adult female M[3)]	B	Total	Nymph 5th-instar	Younger	GS	*Sogatella furcifera* Adult female M	B	Total	Nymph 5th-instar	*Nephotettix* spp. Adult female	*Recilia dorsalis* Adult	Spider	Remarks
East Java	iE2-f	Feb. 19	Pe -c	2	1	3	1		0			0	0	0	0	26	
	iE3-f	"	" "	19	0	19	1		0	1	0	1	0	1	0	24	
	iE5-fA	24	Local "	3	0	3	2		0			0	0	0	1	4	
	" B	"	" "	2	2	4	5		0			0	1	1	0	5	
	iE6-fA	20	Pe "	14	8	22	1		15			0	0	6	0	13	
	" B	"	IR26 -e	1	0	1	0		1	3	1	4	3	1	0	23	
	iE7-fA	"	Pe -c	61	3	64	9	Numerous	6			0	0	0	0	19	Medium hopperburn
	" B	"	" "	19	1	20	1	"	1			0	0	0	0	4	
	iE8-fA	"	" b	238	0	238	0		0	6	0	6	0	1	0	3	Yellowing of leaves due to *Nilaparvata* infestation
	" B	"	" "	546	0	546	0		0	10	0	10	0	2	0	2	
	" C	"	IR26 -c	28	0	28	0		3	5	4	9	0	2	0	23	
	iE9-fA	21	" "	54	0	54	0		1	9	0	9	0	0	0	16	
	" B	"	" "	69	0	69	0		0	5	0	5	0	2	0	13	
	iE10-fA	23	Pe "	7	0	7	0		10	1	0	1	0	0	0	18	Single rice cropping area
	" B	"	-a	3	0	3	0		0	1	0	1	0	0	0	12	
Bali	iB1-fA	Feb. 21	IR26 -c	19	1	20	0		0	18	0	18	1	0	0	33	
	" B	"	" "	3	0	3	0		0	7	0	7	0	0	0	25	
	iB2-fA	23	" "	9	0	9	0		1			0	0	0	0	30	
	" B	"	" "	13	0	13	0		2	1	0	1	0	0	0	17	
	iB3-fA	21	Pe "			0	0		13			0	0	0	0	30	
	" B	"	-a			0	0		0	1	0	1	0	0	0	5	
Lampung	iL5-fA	Mar. 4	Pe -d	0	1	1	0		0			0	0	0	0	3	
	" B	"	" c	1	4	5	72		0	1	0	1	0	0	0	18	
	iL6-fA	3	" "	2	0	2	0		0	3	2	5	0	0	0	28	
	" B	"	" "	2	0	2	0		0			0	3	0	0	15	
	iL7-fA	"	" "	1	3	4	1		0			0	0	0	0	12	
	" B	"	" "			0	1		0			0	0	1	0	16	

1) Refer to Table 1, Fig. 1 and text on p. 2.

2) Refer to Table 1.

3) M and B mean macropterous and brachypterous, respectively.

APPENDIX IV

Frequency distribution of adult female *Nilaparvata lugens* on rice hills[1], and values of some indices for aggregation pattern

District	Investigation site[2]	Date in 1976	Variety/ St.[3]	Wing form[4]	Frequency distribution (The numerator indicates the number of insects on a hill (=x), and the denominator, the number of hills bearing x indivudls of insects (=q))	Total of insects (T)	Mean $(\hat{x})$[5]	Variance $(\hat{\sigma}^2)$[6]	$\hat{\sigma}^2/\hat{x}$[7]	$\hat{C}_A$[8]	$\overset{*}{x}$[9]
West Java	iS1-fA	Feb.13	IR26 - c	M	0/15 1/5	5	0.25	0.197	0.790	-1	0.040
	" B	"	IR20 - "	M	2/3 3/4 4/3 5/1 6/3 7/1 8/2 9/1 10/2	105	5.25	7.145	1.361	0.070	5.611
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	2/3 3/4 4/3 5/1 6/2 7/2 8/2 9/1 10/2	106	5.30	7.274	1.372	0.071	5.672
	iS2-fA	14	Pe "	M	1/2 2/1 3/2 6/1 7/4 8/2 9/2 10/2 12/2 13/1 14/1	149	7.45	15.208	2.041**	0.142	8.491
				B	0/5 1/8 2/2 3/3 4/1 6/1	31	1.55	2.471	1.594	0.404	2.144
				M + B	1/1 2/1 3/1 4/1 8/2 9/3 10/5 11/2 13/2 14/1 15/1	180	9.00	14.842	1.649*	0.073	9.649
	" B	"	IR26 "	M	1/1 2/2 3/3 4/1 5/3 6/2 7/2 9/1 10/1 12/2 14/1 17/1	133	6.65	19.292	2.901**	0.292	8.551
				B	0/18 1/1 2/1	3	0.15	0.240	1.597	8.500	0.747
				M + B	1/1 2/2 3/3 4/1 5/2 6/3 7/2 9/1 10/1 12/1 14/2 17/1	136	6.80	20.484	3.012**	0.303	8.812
	iS4-f	13	Pe "	M	0/5 1/2 2/6 3/5 4/2	37	1.85	1.818	0.983	-0.010	1.833
				B	0/7 2/2 3/6 5/1 6/2 7/1 10/1	56	2.80	7.958	2.842**	0.693	4.642
				M + B	0/3 2/1 3/5 4/2 5/1 6/3 7/1 8/2 9/1 13/1	93	4.65	10.976	2.361**	0.300	6.011
	iS5-fA	14	" "	B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
	" B	"	? "	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
	iS6-fA	17	Pe "	M	0/2 1/5 2/3 3/6 4/2 6/1 8/1	51	2.55	3.840	1.506	0.204	3.056
				B	0/3 1/5 2/8 3/2 6/1 8/1	41	2.05	3.734	1.822*	0.419	2.872
				M + B	1/4 2/2 3/2 4/3 5/3 6/1 7/1 8/1 9/1 10/1 11/1	92	4.60	9.516	2.069**	0.238	5.669

District	Investigation site[2]	Date in 1976	Variety/ St.[3]	Wing form[4]	Frequency distribution	Total of insects (T)	Mean ($\hat{x}$)[5]	Variance ($\hat{\sigma}^2$)[6]	$\hat{\sigma}^2/\hat{x}$[7]	$\hat{C}_A$[8]	x^*[9]
West Java	iS6-fB	Feb. 17	Pe - c	M	4/2 5/1 7/1 11/2 12/2 13/1 14/1 16/1 18/1 21/1 25/1 28/1 37/1 40/1 41/1 51/1 59/1	429	21.45	261.103	12.173**	0.536	32.623
				B	2/2 3/1 4/1 6/1 7/1 8/1 9/1 10/1 11/1 12/2 13/1 15/3 20/2 21/2	226	11.30	39.168	3.466**	0.222	13.766
				M + B	7/1 13/1 14/2 16/1 23/2 25/1 26/1 31/1 34/2 36/2 43/1 48/2 52/1 58/1 74/1	655	32.75	296.829	9.064**	0.250	40.814
	iS7-fA	Feb. 17	Pe - c	M	0/10 1/4 2/2 3/4	20	1.00	1.474	1.474	0.511	1.474
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/10 1/4 2/2 3/3 4/1	21	1.05	1.734	1.652*	0.674	1.702
	" B	"	"	"	M	0/6 1/8 2/4 4/2	24	1.20	1.432	1.193	0.169	1.393
				B	0/14 1/4 2/1 3/1	9	0.45	0.682	1.515	1.375	0.965
				M + B	0/5 1/7 2/3 3/2 4/1 5/2	33	1.65	2.555	1.549	0.349	2.199
Central Java	iC1-fA	Feb. 18	IR26 +28 - c	M	0/8 1/7 2/2 3/2 5/1	22	1.10	1.779	1.617*	0.606	1.717
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/8 1/7 2/1 3/3 5/1	23	1.15	1.924	1.673*	0.631	1.823
	iC3-fB	"	IR26 "	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
	" C	"	Pe "	M	0/18 1/1 2/1	3	0.15	0.240	1.597	8.500	0.747
	iC5-fA	25	Local-d	M	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
	" B	"	" c	M	0/17 1/2 2/1	4	0.20	0.274	1.368	2.800	0.568
	iC7-fB	"	" "	M	0/19 1/1	1	0.05	0.050	1.000	-	0.050
East Java	iE2-f	Feb. 19	Pe - c	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
	iE3-f	"	" "	M	0/7 1/9 2/2 3/2	19	0.95	0.892	0.939	-0.067	0.889
	iE5-fA	24	Local-c	M	0/17 1/3	3	0.15	0.134	0.895	-1	0.045

APPENDIX IV (Cont'd)

District	Investigation site[2]	Date in 1976	Variety/ St.[3]	Wing form[4]	Frequency distribution	Total of insects (T)	Mean $(\hat{x})$[5]	Variance $(\hat{\sigma}^2)$[6]	$\hat{\sigma}^2/\hat{x}$[7]	$\hat{C}_A$[8]	$\overset{*}{x}$[9]
East Java	iE5-fB	Feb. 24	Local-c	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
				B	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
				M + B	0/16 1/4	4	0.20	0.168	0.842	-1	0.042
	iE6-fA	20	Pe "	M	0/12 1/4 2/2 3/2	14	0.70	1.063	1.519	0.831	1.219
				B	0/15 1/3 2/1 3/1	8	0.40	0.674	1.684*	2.167	1.084
				M + B	0/10 1/5 2/1 3/1 4/3	22	1.10	2.200	2.000**	1.000	2.100
	" B	"	IR26 - e	M	0/19 1/1	1	0.05	0.050	1.000	-	0.050
	iE7-fA	Feb. 20	Pe - c	M	0/1 1/3 2/3 3/6 4/3 5/2 6/2	61	3.05	2.787	0.914	-0.029	2.964
				B	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
				M + B	0/1 1/3 2/3 3/5 4/3 5/2 6/3	64	3.20	3.221	1.007	0.002	3.207
	" B	"	" "	M	0/9 1/6 2/4 5/1	19	0.95	1.524	1.604*	0.694	1.554
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/9 1/6 2/3 3/1 5/1	20	1.00	1.684	1.684*	0.747	1.684
	iE8-fA	"	" b	M	5/1 6/1 7/1 9/3 10/4 11/1 12/1 13/1 14/1 15/2 17/2 18/1 21/1	238	11.90	18.095	1.521	0.044	12.421
	" B	"	" "	M	10/1 11/1 12/1 15/2 16/2 17/1 21/1 23/2 24/1 25/1 26/1 27/1 31/2 62/1 68/1 73/1	546	27.30	343.905	12.597**	0.435	38.897
	" C	"	IR26 - c	M	0/6 1/7 2/3 3/2 4/1 5/1	28	1.40	2.042	1.459	0.346	1.859
	iE9-fA	21	" "	M	0/3 1/4 2/3 3/3 4/4 5/1 6/1 8/1	54	2.70	4.537	1.680*	0.260	3.380
	" B	"	" "	M	0/1 1/4 2/5 3/5 6/1 7/3 13/1	69	3.45	9.629	2.791**	0.541	5.241
	iE10-fA	23	Pe "	M	0/14 1/5 2/1	7	0.35	0.345	0.985	-0.050	0.335
	" B	"	a	M	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
Bali	iB1-fA	21	IR26 - c	M	0/5 1/12 2/2 3/1	19	0.95	0.576	0.607*	-0.428	0.557
				B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				M + B	0/4 1/13 2/2 3/1	20	1.00	0.526	0.526*	-0.487	0.526
	" B	"	" "	M	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
	iB2-fA	23	" "	M	0/12 1/7 2/1	9	0.45	0.366	0.813	-0.457	0.263

APPENDIX IV (Cont'd)

District	Investigation site[2]	Date in 1976	Variety/ St.[3]	Wing form[4]	Frequency distribution	Total of insects (T)	Mean $(\hat{x})$[5]	Variance $(\hat{\sigma}^2)$[6]	$\hat{\sigma}^2 / \hat{x}$[7]	$\hat{C}_A$[8]	$\overset{*}{x}$[9]
Bali	iB2-fB	Feb. 23	IR26 - c	M	0/12 1/4 2/3 3/1	13	0.65	0.871	1.340	0.583	0.990
Lampung	iL5-fA	Mar. 4	Pe -d	B	0/19 1/1	1	0.05	0.050	1.000	-	0.050
	" B	"	Pe -c	M	0/19 1/1	1	0.05	0.050	1.000	-	0.050
				B	0/18 1/1 3/1	4	0.20	0.484	2.421**	18.001	1.621
				M + B	0/17 1/2 3/1	5	0.25	0.513	2.053**	7.143	1.303
	iL6-fA	3	" "	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
	" B	"	" "	M	0/18 1/2	2	0.10	0.095	0.947	-1	0.047
	iL7-fA	"	" "	M	0/19 1/1	1	0.05	0.050	1.000	-	0.500
				B	0/17 1/3	3	0.15	0.134	0.895	-1	0.045
				M + B	0/17 1/2 2/1	4	0.20	0.274	1.368	2.800	0.568

1) Counting data. Fields without adult female *N. lugens* were omitted.

2) Refer to Table 1, Fig. 1 and text on p. 2.

3) Refer to Table 1.

4) M and B mean macropterous and brachypterous forms, respectively. M + B indicates the whole females. When either M or B was zero, the lines on it and M + B do not exist in the Table.

5) T/20.

6) $\frac{1}{n-1}(\Sigma q x^2 - \frac{(T^2)}{n})$.

7) * and ** indicate that the null hypothesis, $\frac{\hat{\sigma}^2}{\hat{x}} = 1$, is rejected at 5% and 1% level of significance.

8) $(\hat{\sigma}^2 - \hat{x})/(\hat{x}^2 - \frac{\hat{\sigma}^2}{n})$ (Kuno, 1968).

9) $\hat{x} + (\frac{\hat{\sigma}^2}{\hat{x}} - 1)$ (Iwao, 1968).

APPENDIX V

Parasitism of adult female *Nilaparvata lugens* collected by sucking

Investigation site	Date in 1976	Wing form[1)]	Total no. of insects collected	No. of insects: Without any symptom of parasitism	With symptoms of parasitism[2)]		Percentage parasitism
iS1-fA	Feb. 13	M	55	53	DgO and OFS:	1	
					SD:	1	
					Total:	2	3.77
iS2-fB	Feb. 14	M	55	48	DgO and OFS:	1	
					OFS:	6	
		B	2	1	DgO, EMS and OFS:	1	
		M + B	57	49	Total:	8	14.04
iS6-fB	Feb. 17	M	55	49	Ne:	6	
		B	12	5	SD and Ne:	1	
					Ne:	6	
		M + B	67	54	Total	13	19.40
iE8-fB	Feb. 20	M	94	81	DgO and OFS:	6	
					DgO and ENS:	1	
					OFS:	2	
					SD:	4	
					Total	13	13.83

1) M and B mean macropterous and brachypterous forms, respectively.

2) DgO: degeneration of ovipositor; OFS: the opening of an adult female strepsipteran; EMS: extrusion of the male puparium in strepsipteran; SD: sac containing a dryinid larva; and Ne: nematode.

APPENDIX VI

Results of collection of spiders by means of sweeping

Habitat	District	No. of investigation sites	Snarer															
			Theridiidae				Argiopidae								Tetragnathidae			
			Theridion sp.		*Coleosoma blandum* O.P.Cambridge		*Araneus inustus* L. Koch		*Singa* sp.		*Argiope catenulata* Doleschall		*Larinia* sp.		*Dyschiriognatha* sp.		*Tetragnatha japonica* Boes. et Str.	
			Ny	Ad[1]	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad
Paddy field and nursery	West Malaysia	26			1[2] 0.04		22 0.85	22 0.85		2 0.08	2 0.08				2 0.08			1 0.04
Paddy field	West Java	3					2 0.67	4 1.33	2 0.67	3 1.00								
	Central Java	5					38 7.60	12 2.40		1 0.20	3 0.60	1 0.20			2 0.40	3 0.60		
	East Java	7					8 1.14	7 1.00			1 0.14	1 0.14					1 0.14	1 0.14
	Bali	2					11 5.50									1 0.50		
	Lampung	4					4 1.00	2 0.50		1 0.25								1 0.25
Rice nursery	West Java	4																
	Central Java	3	1 0.33				1 0.33								1 0.33	1 0.33		
	East Java	3					2 0.67	1 0.33			1 0.33		1 0.33			4 1.33		
	Bali	1																
	Lampung	3					3 1.00											
Weeds	West Malaysia	22					9 0.41	2 0.09	1 0.05	2 0.09								
	West Java	4					2 0.50	2 0.50										
	Central Java	1					20 -	5 -			1 -							
	East Java	7					2 0.29								1 0.14			1 0.14
	Bali	2					6 3.00	1 0.50					1 0.50					
	Lampung	6					8 1.33	1 0.17							1 0.17			

1) Ny and Ad mean age-advanced nymph and adult, respectively.

2) Total no. (upper) and mean no. (lower), of spiders collected.

APPENDIX VI (Cont'd)

Habitat	District	No. of investigation sites	Snarer												Snarer[1]		Hunter	
			Tetragnathidae												Micryphantidae		Lycosidae	
			Tetragnatha javana Thorell		*Tetragnatha mandibulata* Walckenaer		*Tetragnatha* sp. A		*Tetragnatha* sp. B		*Tetragnatha* spp.		*Leucauge* sp.		*Callitrichia* sp.		*Lycosa pseudoannulata* Boes. et Str.	
			Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad
Paddy field and nursery	West Malaysia	26	10 0.39	1 0.04	12 0.46	41 1.58	99 3.81	79 3.04			1 0.04					1 0.04		
Paddy field	West Java	3	4 1.33			1 0.33	4 1.33	6 2.00		2 0.67	1 0.33		5 1.67					
	Central Java	5	16 3.20	8 1.60			43 8.60	22 4.40			1 0.20		5 1.00			1 0.20		
	East Java	7	16 2.29	2 0.29			113 16.14	42 6.00	2 0.29									1 0.14
	Bali	2	5 2.50			1 0.50	24 12.00	10 5.00			3 1.50						1 0.50	
	Lampung	4	15 3.75	1 0.25	4 1.00	1 0.25	29 7.25	18 4.50	6 1.50	2 0.50	5 1.25		3 0.75				2 0.50	
Rice nursery	West Java	4	1 0.25					1 0.25			1 0.25							
	Central Java	3					4 1.33									1 0.33		
	East Java	3	8 2.67				1 0.33	1 0.33									1 0.33	
	Bali	1																
	Lampung	3	3 1.00				31 10.33	6 2.00		1 0.33								
Weeds	West Malaysia	22	2 0.09		6 0.27	3 0.14	11 0.50	7 0.32									4 0.18	
	West Java	4																
	Central Java	1					1 -											
	East Java	7									2 0.29							
	Bali	2		1 0.50				1 0.50						2 1.00				
	Lampung	6			1 0.17		5 0.83		2 0.33		1 0.17						3 0.50	1 0.17

1) Snarer with a habit of hunting.

Habitat	District	No. of investigation sites	Hunter																	
			Lycosidae				Oxyopidae						Thomisidae						Salticidae	
			Lycosa spp.		*Hippasa agelenoides* Simon		*Oxyopes assamensis* Tikader		*Oxyopes lineatipes* C. L. Koch		*Oxyopes* spp.		*Oxytate* sp.		*Runcinia acuminata* Thorell		*Runcinia* spp.		Gen? spp?	
			Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad
Paddy field and nursery	West Malaysia	26								2 0.08	1 0.04		1 0.04				2 0.08	3 0.12	2 0.88	
Paddy field	West Java	3																	1 0.33	
	Central Java	5						1 0.20		2 0.40	17 3.40								3 0.60	
	East Java	7								1 0.14	9 1.29							1 0.14	6 0.86	4 0.57
	Bali	2																		
	Lampung	4	1 0.25																	1 0.25
Rice nursery	West Java	4									2 0.50									
	Central Java	3						2 0.67			12 4.00						1 0.33			
	East Java	3									11 3.67								1 0.33	3 1.00
	Bali	1																		
	Lampung	3	2 0.67																1 0.33	
Weeds	West Malaysia	22	3 0.14	2 0.09							3 0.14				1 0.05				2 0.09	
	West Java	4		1 0.25							3 0.75								2 0.50	1 0.25
	Central Java	1						4 -			4 -									1 -
	East Java	7		1 0.14							2 0.29								2 0.29	1 0.14
	Bali	2		1 0.50						1 0.50	58 29.00	1 0.50							2 1.00	
	Lampung	6	6 1.00	2 0.33	1 0.17					1 0.17	4 0.67								1 0.17	2 0.33

APPENDIX VI (Cont'd)

Habitat	District	No. of investigation sites	Hunter										?	
			Clubionidae								Heteropodidae		Fam.?	
			Chiracanthium sp.		*Clubiona japonicola* Boes. et Str.		*Clubiona lena* Boes. et Str.		*Clubiona* spp.		*Heteropoda* sp.		Gen? spp?	
			Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad	Ny	Ad
Paddy field and nursery	West Malaysia	26				21 0.81			24 0.92		1 0.04			1 0.04
Paddy field	West Java	3												
	Central Java	5		1 0.20				1 0.20	10 2.00				1 0.20	1 0.20
	East Java	7							11 1.57					
	Bali	2												
	Lampung	4						1 0.25	3 0.75					
Rice nursery	West Java	4												
	Central Java	3												
	East Java	3							1 0.33					
	Bali	1												
	Lampung	3												
Weeds	West Malaysia	22				1 0.05			3 0.14					
	West Java	4												
	Central Java	1												
	East Java	7												
	Bali	2												
	Lampung	6												

Comparison of spiders collected by sweeping and those by sucking

Paddy field			iL7-fA								iL7-fB								Total							
Method			Sweeping				Sucking				Sweeping				Sucking				Sweeping				Sucking			
Date in 1976			Mar. 3				Mar. 5				Mar. 5				Mar. 5				-				-			
Developmental stage[1] and sex			Ny	Ad ♂	Ad ♀	Ad Total	Ny	Ad ♂	Ad ♀	Ad Total	Ny	Ad ♂	Ad ♀	Ad Total	Ny	Ad ♂	Ad ♀	Ad Total	Ny	Ad ♂	Ad ♀	Ad Total	Ny	Ad ♂	Ad ♀	Ad Total
Snarer	Theridiidae	*Enoplognatha* sp.					2												0			0	2			0
		Coleosoma blandum O.P. Cambridge														1	0	1	0			0	0	1	0	1
	Symphytognathidae	*Mysmena* sp.					1	2	1	3					1	2	1	3	0			0	2	4	2	6
	Argiopidae	*Araneus inustus* L. Koch		1	1	2	1												0	1	1	2	1			0
		Singa sp.					2					0	1	1					0	0	1	1	2			0
		Argiope catenulata Doleschall													1				0			0	1			0
	Tetragnathidae	*Dyschiriognatha* sp.						1	1	2					1	0	2	2	0			0	1	1	3	4
		Tetragnatha javana Thorell	9	0	1	1					3								12	0	1	1	0			0
		T. mandibulata Walckenaer	1																1			0	0			0
		T. sp. A	3	0	2	2													3	0	2	2	0			0
		T. sp. B	4												3				4			0	3			0
		T. spp.	4																4			0	0			0
		Leucauge sp.	2												1				2			0	1			0
Snarer with a habit of hunting	Micryphantidae	*Callitrichia* sp.					5	4	4	8						4	4	8	0			0	5	8	8	16
		Erigone sp.						2	0	2									0			0	0	2	0	2
Hunter	Pisauridae	*Dolomedes* sp.					1								5				0			0	6			0
	Lycosidae	*Lycosa pseudoannulata* Boes.et Str.													2				0			0	2			0
		L. spp.					6								1				0			0	7			0
	Thomisidae	*Runcinia* spp.					1												0			0	1			0
	Salticidae	Gen ? spp?						1	0	1					1				0			0	1	1	0	1
	Clubionidae	*Clubiona* spp.	1												2				1			0	2			0
Total			24	1	4	5	19	10	6	16	3	0	1	1	18	7	7	14	27	1	5	6	37	17	13	30

1) Ny and Ad mean age-advanced nymph and adult, respectively.

APPENDIX VIII

Results of collection of adult insect carnivores by means of sweeping

Habitat	District	No. of investigation sites	Coccinellidae: *Coccinella transversalis* Fabricius	*Harmonia octomaculata* Fabricius	*Micraspis discolor* Fabricius	*Micraspis afflicta* Mulsant	*Micraspis lineata* Thunberg	*Scymnus (Neopullus)* sp. A	*Scymnus (Neopullus)* sp. B	*Scymnus (Pullus)* sp.	*Burmoides lineatus* Weise	*Illeis bistigmosa* Mulsant[2)]
Paddy field and nursery	West Malay-sia	26		6[1)] 0.23	231 8.89	3 0.12		3 0.12			1 0.04	
Paddy field	West Java	3		2 0.67		7 2.33						
	Central Java	5	1 0.20	13 2.60		1 0.20	27 5.40		1 0.20	2 0.40		
	East Java	7		2 0.29		5 0.71	3 0.43		1 0.14			
	Bali	2					3 1.50					
	Lam-pung	4					3 0.75		7 1.75			
Rice nursery	West Java	4	1 0.25				1 0.25		2 0.50			
	Central Java	3		1 0.33			3 1.00					
	East Java	3		1 0.33			4 1.33		1 0.33			1 0.33
	Bali	1										
	Lam-pung	3					1 0.33		2 0.67			
Weeds	West Malay-sia	22	1 0.05	3 0.14	23 1.05	3 0.14		1 0.05	1 0.05			
	West Java	4										
	Central Java	1										
	East Java	7		1 0.14								
	Bali	2										
	Lam-pung	6										

1) Total no. (upper) and mean no. (lower), of insects collected.

2) Fungivorous, and probably an occasional aphid feeder.

APPENDIX VIII (Cont'd)

Habitat	District	No. of investigation sites	Carabidae: *Ophionea indica* Thunberg	Carabidae: *Clivina* sp.	Carabidae: *Bembidion (Notaphocampa)* sp.	Staphylinidae: *Paederus fuscipes* Curtis	Staphylinidae: *Paederus tamulus* Erichson	Staphylinidae: Gen? sp?	Miridae: *Cyrtorrhinus lividipennis* Reuter	Miridae: *Tytthus chinensis* Stål	Nabidae	Reduviidae
Paddy field and nursery	West Malaysia	26	25 0.96			2 0.08			55 2.12			
Paddy field	West Java	3										
	Central Java	5	12 2.40		1 0.20	5 1.00	1 0.20	1 0.20	328 65.60	2 0.40		10 2.00
	East Java	7	3 0.43			2 0.29			46 6.57			
	Bali	2	6 3.00			1 0.50			148 74.00			
	Lampung	4	2 0.50						13 3.25			
Rice nursery	West Java	4	1 0.25						7 1.75			1 0.25
	Central Java	3	12 4.00			1 0.33			205 68.33			1 0.33
	East Java	3	2 0.67	1 0.33					112 37.33			3 1.00
	Bali	1							3 -			
	Lampung	3							15 5.00			1 0.33
Weeds	West Malaysia	22				12 0.55			2 0.09			
	West Java	4									2 0.50	
	Central Java	1										
	East Java	7										
	Bali	2							1 0.50			
	Lampung	6										1 0.17

APPENDIX IX

Tentative Reports Presented during the Time of Tour

Dr. A. Ōtake/Dr. N. Hokyo

Tropical Agriculture Research
Center, Yatabe, Ibaraki, Japan/
Kyushu Agricultural Experiment
Station, Chikugo, Fukuoka, Japan

9th February, 1976

Tan Sri Mohamad bin Jamil

Director, MARDI,
Selangor, Malaysia

Report on Rice Leafhopper Incidence in West Malaysia

1. Because of their direct plant-juice sucking and/or of their transmission of some virus diseases, rice leafhoppers are causing more and more serious troubles in many Asian countries. So it is highly significant for us to have an opportunity of studying the incidence of these pest insects in Malaysia by getting good understanding and kind help on the part of Malaysian scientists and other officials concerned.

2. Our investigations were first conducted in the northern half of Province Wellesley on the 29th January, and then all over the Kedah-Perlis Coastal Plain (so-called Muda area) from the 1st to 5th February.

3. Throughout our inspection trip, we found neither hopperburn nor tungro (penyakit merah) virus infection in the field.

4. Leafhoppers were collected from paddy fields, mostly of double cropping, under various growth stages of rice plant ranging from maximum tillering to dough ripening. The numbers of fields sampled were 6 and 19 in Wellesley and Muda, respectively, and in each of them, 20 double-sweeping was carried out. The result of the investigation shows that the density of leafhoppers is generally very low on paddy in this season: the total numbers of collected adult *Nilaparvata lugens* (the brown planthopper), *Sogatella furcifera* (the white-backed planthopper) and *Nephotettix* spp. (the green rice leafhopper) were 2, 13 and 155 in Wellesley, and 7, 4 and 239 in Muda, respectively.

(Cont'd - APPENDIX IX)

5. Samples were also taken from nearby gramineous weeds. In this case, 15 double-sweeping was done in each of the 4[1)] and 17 samples taken in Wellesley and Muda, respectively. Through the weed sweeping, neither *N. lugens* nor *S. furcifera* was recorded, but *Nephotettix* spp. were surely inhabiting; the total numbers of collected *Nephotettix* adults were 55 and 160 in Wellesley and Muda, respectively. It should be noticed that gramineous weeds play an important role in the maintenance of the *Nephotettix* population in these areas.

6. As a by-product of the sweeping-net sampling, predators such as spiders, ladybirds and mirid bugs and some kinds of stink bugs were also collected. The data on them and the ones on *Nephotettix* species composition will be analyzed in our final report after we return to Japan.

7. In conclusion, we can say that at least in this main rice crop season, there is no trouble about rice leafhoppers in the northern Wellesley/Muda region. However, it would be recommended to conduct a continuous and systematical study on leafhopper field populations in order to provide for the future possibility of any outbreaks of tungro disease and hopperburn.

Dr. Akio Ōtake
Tropical Agriculture Research Center, Japan
and
Dr. Nobuhiko Hokyo
Kyushu Agricultural Experiment Station, Japan

6th March, 1976

Governor of Propinsi Lampung
Sumatra, Indonesia

<u>Report on the Incidence of Rice Leafhoppers in Lampung Tengah</u>

1. Among rice leafhoppers, widely distributed important species are the brown planthopper, *Nilaparvata lugens*, the white-backed planthopper, *Sogatella*

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1) Except a smaple plot with abundant *Nephotettix*.

furcifera, and the green leafhopper, *Nephotettix* spp. Their damage, sucking the plant juice and/or transmitting some virus diseases, are serious in most of the Asian countries.

2. We, two Japanese entomologists, are interested in this group of pest insects, and came to Indonesia to study the real state of its occurrence and damage in this country. We have already finished inspecting some brown planthopper-infesting and grassy stunt-infected areas in Java and Bali. Now we have had a chance of studying rice leafhoppers even in Lampung.

3. Our 4-day investigation in the rice growing area of Lampung Tengah was conducted as follows:

Date in March	Places investigated
2nd	Ganjaragung, Metro; and Purwodadi, Trimurdjo.
3rd	Hargomuryo, Sekampung; Banarjoyo, Batanghari; and Ganjaragung, Metro.
4th	Pujokerto, Trimurdjo.
5th	Hargomuryo, Sekampung.

At Hargomuryo, Banarjoyo and Pujokerto, we chose some fields with variety Pelita at the rice-growing stage between maximum tillering and booting, and counted adult female leafhoppers and spiders on 20 hills sampled in each. After counting, in some of the fields, insects and spiders were collected by means of 20 double-sweeping with a butterfly net. At Ganjaragung, some nurseries were also swept with the same intensity as in the paddy fields. At some places in the area, gramineous weeds were swept (15 double-sweeping) in order to make a comparison in leafhopper fauna between weed and paddy.

4. The density of the brown planthopper on paddy crop was generally very low but we must not overlook a few exceptions. At Hargomuryo, there was a field from which 3 brachypterous and 1 macropterous females were counted on the total 20 hills sampled. This means 0.2 adult female per hill. Seemingly the figure is very small but actually it cannot be ignored because in this pest the potential power of multiplication is so high that hopperburn can finally be led even from a low density level as mentioned above.

A high nymphal density of brown planthoppers which was observed in a field chosen at Pujokerto is mentioned as another exception. On the total 20 hills sampled, 72 fifth-instar nymphs were counted, and also there existed a much larger number of younger nymphs there.

Those evidences indicate that even in Lampung, where the brown plant-hopper problem has not been serious, the pest partially attains a warning density level, warning because it suggests the possibility of hopperburn occurrence afterwards before the booting stage of rice growth. So continuous and careful monitoring would be necessary for detecting any change in the incidence of brown planthoppers on paddy.

5. In some fields, the number of white-backed planthoppers collected by sweeping was larger than that of brown planthoppers. Nevertheless, the white-backed planthopper seems not to be dangerous in this area. Green leafhoppers were not very abundant in either of the paddy field, nursery or weed plot.

6. In many of the paddy fields investigated, spiders were fairly abundant. They are recognized as an effective check of the leafhopper population. So precaution should be taken of an excessive application of insecticides which may significantly decrease the number of those effective natural enemies.

7. We want to express our deepest appreciation to His Excellency Sutiyoso, Governor of Propinsi Lampung, kindly permitting us to study the rice leafhoppers in Lampung. We also want to thank Mr. Nusyirwan Zen, Director of Dinas Pertanian Propinsi Lampung, and his staff, particularly Mr. Soehendi, Deputy Director, Mr. Senggono, Mr. H. Sugito and Mr. Sarimin, Lampung Tani Makmur Proyek, and Mr. Yusfian Yusuf, Subject Matter Specialist on Plant Protection, for giving us precious information and suggestions about the leafhopper incidence in Propinsi Lampung.

Dr. Akio Ōtake

Tropical Agriculture Research Center, Japan

and

Dr. Nobuhiko Hokyo

Kyushu Agricultural Experiment Station, Japan

7th March, 1976

(Cont'd - APPENDIX IX)

Professor Ir. A. M. Satari

Director, CRIA,
Bogor, Indonesia

Report on Rice Leafhopper Incidence in Indonesia

1. Among rice leafhoppers, widely distributed important species are the brown planthopper, *Nilaparvata lugens*, the white-backed planthopper, *Sogatella furcifera*, and the green leafhoppers, *Nephotettix* spp. In Indonesia, the damage caused by *N. lugens* has been particularly serious. So it is highly significant for us to have the opportunity of studying rice leafhopper problem in the very country.

2. We made field inspections in the double rice cropping areas of Java and Bali from the 11th to the end of February. The central rice growing area in Lampung, Sumatra, was also inspected from the 2nd to 5th March. The numbers of paddy fields, nurseries and gramineous weed plots thus inspected are as follows:

	West Java	Central Java	East Java	Bali	Lampung	Total
Paddy field	14	10	15	6	6	51
Nursery	4	3	3	1	3	14
Weed plot	4	1	7	2	4	18

Most of the above-mentioned paddy fields were inspected during the rice growing stages between maximum tillering and booting. On 20 hills sampled in each of the fields, female hoppers and spiders were counted and the number of hills with distinct symptoms of the grassy stunt disease was also recorded. Collections of insects and spiders were obtained by means of butterfly-net sweeping from some of the paddy fields and all of the nurseries and weed plots mentioned above.

3. In Java and Bali, there were fairly distinct differences in rice varietal composition among the rice growing areas we visited. So the areas are classified into the following 3 categories for the convenience of discussion:

Area A: Overwhelming growing of IR 26. This would be an area where brown planthoppers burst previously.

Area B: The growing of Pelita is more or less conspicuous.

Area C: Overwhelming growing of local varieties.

Concerning *N. lugens*, data obtained from the fields at the stage between maximum tillering and booting are arranged as follows:

Area	Variety	No. of fields	No. of *N. lugens* adult females on 20 hills per field			No. of hills with distinct symptoms of g.s. per field
			Macroptr.	Brachyptr.	Total	
A	IR 26	8	23.63	0.25	23.88	0.50
B	IR 26	5	33.60	0.60	34.20	1.20
	Pelita	18	46.39	21.00	67.39	4.00
C	Local	6	1.83	0.50	2.33	0.00

Examining the above table, we can point out some interesting tendencies in the present situation of *N. lugens* problem. First, IR 26 is quite effective to keep *Nilaparvata* population below its destructive density level at the moment (although it is a question whether exclusive growing of a single rice variety over a wide area is a wise step as a control measure against *Nilaparvata* because in this pest the selection of a strain destructive to a given resistant rice variety is not so difficult at least under experimental conditions). Secondly, in Area C with local varieties, the population density is very low as compared to Areas A and B. The practice of simultaneous rice cropping in Area C would be one of the main causes of the present small *Nilaparvata* population because through the practice, some interruption in rice growing would take place every year and this must make *Nilaparvata*, a monophagous pest, difficult to maintain a large population all the year round. Third, difference in the proportion of macropterous females to the whole ones is remarkable between IR 26 and Pelita. On IR 26, the proportion was much higher than on Pelita. Perhaps this means that the former is less suitable as a host of *Nilaparvata* than the latter. Anyway, the vigorous production of macropterous adults on IR 26 seems to be important from the viewpoint of grassy stunt disease dissemination because the macropterous form has a strong tendency of dispersion and is therefore considered to play the leading part as a disseminator of the disease. As easily estimated from the table, grassy stunt rate is much lower in IR 26 than in Pelita. Perhaps this is a reflection of the difference in *Nilaparvata* density between the 2 varieties. However, it should be noticed that the evidence of a low grassy stunt rate in IR 26 is a matter quite different from the possibility of active dissemination of the disease by macropterous adults originated from IR 26.

4. At a certain place in East Java, we found many *N. lugens* macropterous adults on Pelita which was much younger than the maximum tillering stage (on some hills, the number of macropterous females exceeded 60). It is believed that the paddy had been at a stage attractive to migrating macropterous adults just when they had come upon the place.

5. In each of 2 of the 11 nurseries chosen in Java and Bali, more than 100 adult *N. lugens* were collected by sweeping. We can say, therefore, that sometimes the planthoppers concentrate to a nursery and probably this heightens the rate of infection of rice seedlings with grassy stunt at the very nursery.

6. In Lampung, the density of *N. lugens* was generally very low. However, it should be noticed that even in that area, there existed a few paddy fields in which the pest had attained a density level significantly higher than the average. This evidence seems to suggest that rice cultivation there, too, is never immune from the brown planthopper infestation.

7. In order to establish an efficient monitoring or forecasting system against *N. lugens*, it would be necessary, first of all, to analyze step by step the complicated situation of the pest in this country. There would exist such important basic subjects to be solved as local migration and population establishment of the pest, transmission and dissemination of the grassy stunt disease by the pest, etc.

8. In some of the paddy fields and nurseries inspected, *S. furcifera* was higher in density than *N. lugens*. Nevertheless, the former is regarded much less important than the latter.

9. In some of the nurseries, *Nephotettix* were abundant. Particularly, when a nursery surrounded by fields after harvesting was investigated, a vast number of *Nephotettix* were collected. It is positive that the nursery bed is important as a habitat for the insect after the rice crop is harvested in a double cropping area. A comparison in *Nephotettix* species composition between paddy and weed will be made after the taxonomical identification is finished concerning our collection.

10. Generally speaking, the fauna of natural enemies around the rice leaf-hoppers was poorer in West Java than in the other provinces studied. At some places, spiders were fairly abundant on paddy. Precaution should be taken of an excessive application of insecticides which may seriously decrease the

number of these effective natural enemies.

11. We should like to make special mention of how successfully our research work in Indonesia has been accomplished by receiving full cooperation and kind assistance from you and your staff including Dr. I. N. Oka and Mr. Dandi Soekarna. The final report of our research trip will be published after we return to Japan. We hope the materials therein would be helpful for your scientists in intensifying their study on the rice leafhopper problem.