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**EGG AND NYMPHAL PARASITES OF RICE LEAFHOPPERS AND
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IN THAILAND IN 1977^{1) 2) 3)}**

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Abstract

Results of field studies of egg and nymphal parasites of *Sogatella furcifera*, *Nilaparvata lugens* and *Nephotettix nigropictus* made in Thailand in 1977 are presented. Two species of egg parasites, *Oligosita* sp. and *Anagrus optabilis*, were reared from *Sogatella furcifera*, 1 species of egg parasite, *Anagrus optabilis*, was reared from *Nilaparvata lugens*, and 2 species of egg parasites, *Paracentrobia* sp. and *Gonatocerus* sp. were reared from *Nephotettix nigropictus*. *Paracentrobia* sp. and *Gonatocerus* sp. were found to be ecologically similar species inhabiting the same rice paddy and parasitize even the same egg-mass of *Nephotettix nigropictus*. Larvae of dryinid wasps were detected from *Sogatella furcifera*, *Nilaparvata lugens* and *Nephotettix nigropictus*. Stylopids were also detected from the 3 rice hoppers mentioned above. *Nephotettix nigropictus* is recorded as a new host of Strepsiptera in Thailand.

This paper reports one of the results of our field studies on the natural enemies of rice leafhoppers and planthoppers made in Thailand from October to December, 1977. Only the insect parasites attacking eggs, nymphs and adults of three important rice hoppers, *Sogatella furcifera*, *Nilaparvata lugens* and *Nephotettix nigropictus*, are dealt with in this paper.

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MATERIAL AND METHODS

Three sampling methods were adopted as follows:

1. **Method I** (sweeping)

Collecting of insects and spiders was made by sweeping using a 42x 80 cm insect net with a handle of 90 cm in length. Fourty sweeps were made for one unit. For a rice paddy of about 1, 250 m², 2 units of sweepings at the periphery and 1 unit at the center were made for one grand unit.

All the animals thus collected were anesthetized by ether in a plastic bag and then killed by cyanid or alcohol. They were sorted out to species later and individual numbers were recorded.

2. **Method II** (covering-and-cutting of the rice hill)

Ten hills of rice were chosen at random in one rice paddy of about 1,250 m². Each hill was covered straight by a 42x80 cm insect net all of a sudden and then the hill was cut from just above the root. All the animals thus collected in the net were treated as in the method I.

All the rice hills which were cut and brought back to the laboratory were carefully examined one by one for the eggs of rice leafhoppers and planthoppers.

When the eggs of them were found, the stem of rice which contains the eggs was cut for 5 cm in length, and it was put into a small glass tube for rearing (Fig. 1). Nymphs of the hoppers as well as the adults of parasites emerged from the eggs were carefully identified and the individual numbers of them were recorded.

3. Method III (sucking of hoppers by an aspirator)

An aspirator was used to suck up the hoppers, both nymphs and adults, from the rice hills. Ten hills were examined for one unit in one rice paddy. All the hoppers thus collected were kept alive and carefully examined for the parasites under the binocular microscope. When the parasitized hoppers were found, they were reared separately in a small glass tube for further examination.

LOCALITIES

Table 1 lists 25 localities where 29 unit samplings were made from October 3 to December 6, 1977. These localities are belonged to 3 areas, which are named here for the sake of convenience, Chiang Mai area (northern Thailand), Chai Nat area (middle Thailand), and Khon Kaen area (north-eastern Thailand).

The growth stage of rice is generally divided into 3, i. e., vegetative, reproductive and ripening stages. As a whole, rices were in the ripening stage at the time of our investigation; those in Chiang Mai area were in the early stage, those in Chai Nat area in the middle stage, and those in Khon Kaen area in the late stage of ripening. Rices in Lampang, Thoen, Kamphaeng Phet, Chai Nat (IV), In Buri, and Chai Yo were observed to be in the stage of reproduction, however.

Very unfortunately, some parts of Thailand were suffered with heavy drought in 1977. We observed severe damages to the rice in Thoen, Ban Mae Chung Rai, Kamphaeng Phet, Khanu Worakabsaburi (middle Thailand), Udon Thani, Hin Kong, Nam Phong, Kalasin and Khon Kaen (north-eastern Thailand).

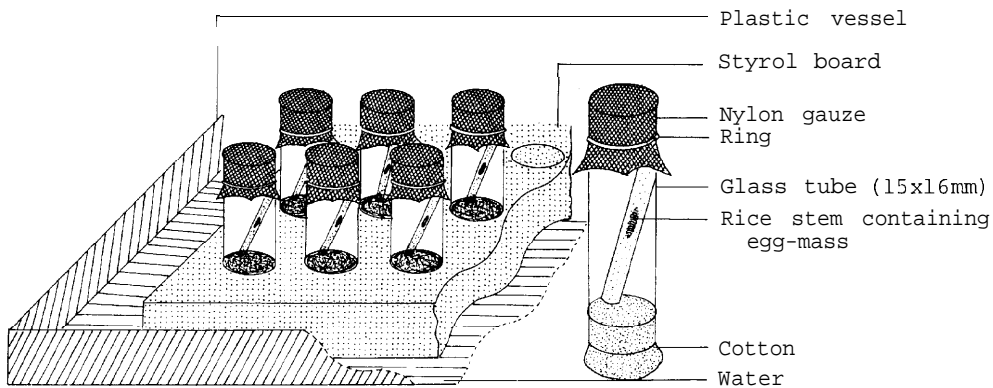


Fig. 1. Rearing apparatus for the hopper's eggs and their parasites.

Table 1. Field study areas, dates and sampling methods employed.

Locality	Date	Growth stage of rice	Sampling method		
			I	II	III
Mae Ai	Oct. 25	Ri ¹⁾	0	0	0
Fang	Oct. 25	Ri	0	0	0
Chiang Dao	Oct. 17	Ri	0	0	0
Mae Theng	Oct. 17	Ri	0	○	0
Doi Saket	Oct. 6	Ri	0	0	0
Lamphun	Oct. 6	Ri	0	0	0
San Pa Tong	Oct. 3	Ri	0	0	0
San Pa Tong	Oct. 14	Ri		0	0
San Pa Tong	Oct. 18	Ri	0	—	
Chom Thong	Oct. 11	Ri	0	0	0
Hot	Oct. 11	Ri	0	0	0
Lampang	Oct. 13	Re ²⁾	0	0	0
Thoen	Nov. 15	Re	0	0	0
Ban Mae Chung Rai	Nov. 15	Ri	0	0	0
Tak	Nov. 16	Ri	0	0	○
Kamphaeng Phet	Nov. 14	Re	0	0	0
Khanu Woralaksaburi	Nov. 9	Ri	0	0	○
Phayuhakhiri	Nov. 9	Ri	0	0	0
Chai Nat (I)	Nov. 4	Ri	0	0	0
Chai Nat (II)	Nov. 4	Ri	0	0	0
Chai Nat. (III)	Nov. 11	Ri	0	0	0
Chai Nat (IV)	Nov. 18	Re	0	0	0
In Buri	Nov. 7	Re	0	0	0
Chai Yo	Nov. 7	Re	0	0	0
Khon Kaen	Nov. 29	Ri	0	0	0
Kalasin	Nov. 29	Ri	0	0	0
Chum Phae	Nov. 28	Ri	0	0	0
Nam Phong	Dec. 6	Ri	0	0	0
Hin Kong	Dec. 2	Ri	0	0	0
Udon Thani	Dec. 1	Ri	0	0	0

1) Ripening stage. 2) Reproductive stage.

RESULTS

I. EGG PARASITES OF RICE LEAFHOPPERS AND PLANTHOPPERS

1. Egg density of the hoppers

Fig. 2 shows the number of eggs of the 3 species of hoppers per one hill of rice collected at the 24 localities. The figure was calculated from the results of samplings by the method II.

(a) *Sogatella furcifera*, the white-backed planthopper

As can be seen from Fig. 2, the eggs of *Sogatella furcifera* were collected

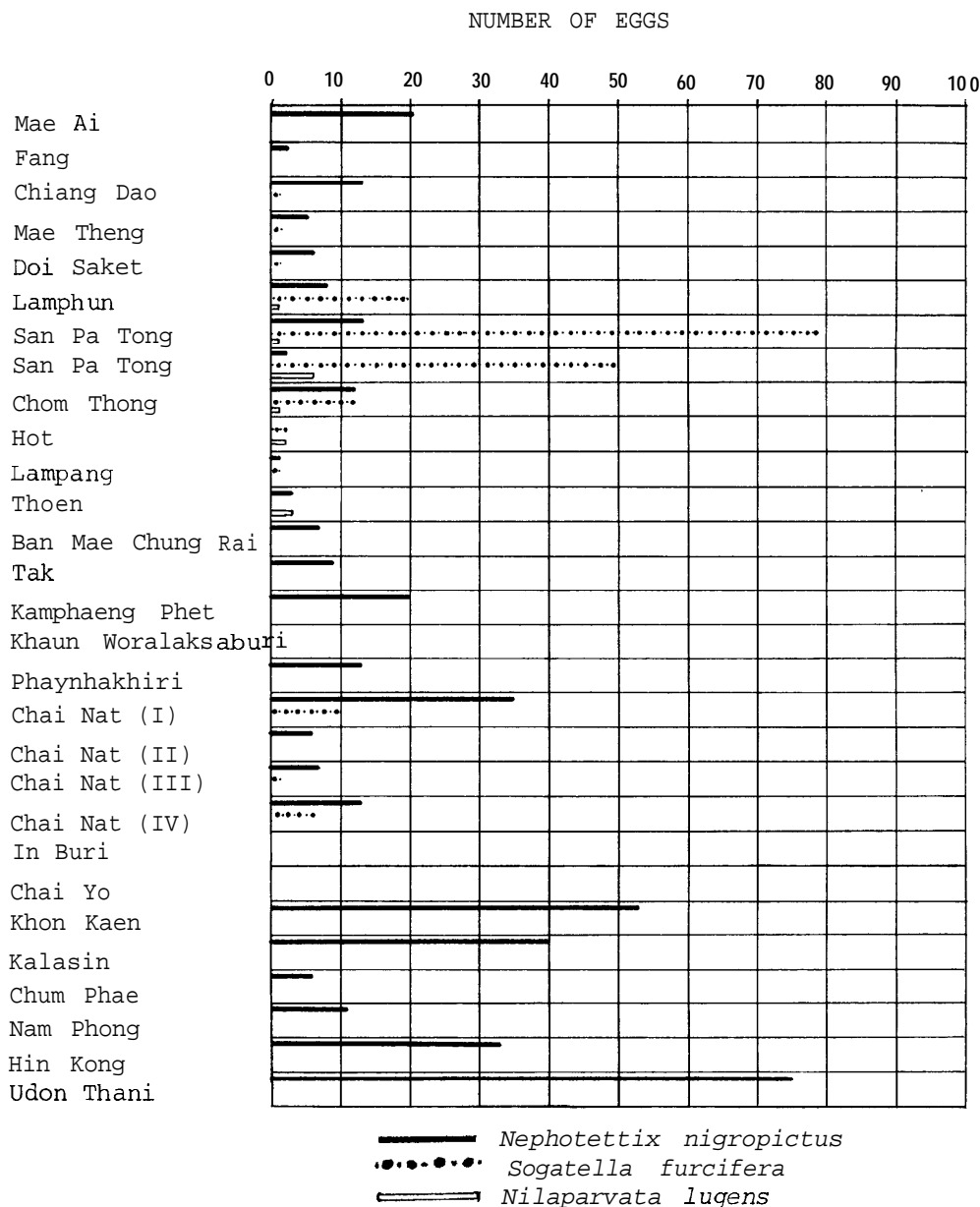


Fig. 2. Number of eggs of 3 species of rice hoppers per one hill of rice.

from 9 localities only. In total, the average number of egg-masses per one hill of rice was 2.39, and that of the individual eggs in one egg-mass was 15.78 in these areas. However, in San Pa Tong, the average number of egg-masses was 11.6 (October 3) and 8.4 (October 14), and that of the individual eggs per one egg-mass was 77.7 (October 3) and 58.9 (October 14). Compara-

tively high value of the average numbers of egg-masses as well as individual eggs of *Sogatella furcifera* were also observed in Lamphun. On the contrary, the densities of egg-masses as well as individual eggs of this species per one hill of the rice were low in Chiang Dao, Mae Theng, Doi Saket, Chom Thong, Hot, Lampang, and Chai Nat (I), (II) and (III).

No egg of *Sogatella furcifera* was found in the rice paddies of Mae Ai and Fang in northern Thailand, Thoen, Ban Mae Chung Rai, Tak, Kamphaeng Phet, Khanu Worolaksaburi, and Phayuhakhiri of middle Thailand, and Khon Kaen, Kalasin, Chum Phae, Nam Phong, Hin Kong, and Udon Thani in north-eastern Thailand.

(b) *Nilaparvata lugens*, the brown planthopper

Eggs of *Nilaparvata lugens* were discovered from only 5 localities as can be seen from Fig. 2. They were few in numbers: the average number of egg-masses and that of individual eggs in 5 rice paddies in 5 localities were 0. 22 and 2. 1, respectively.

(c) *Nephotettix nigropictus**, the green rice leafhopper

Eggs of *Nephotettix nigropictus* were collected from 24 rice paddies in 21 localities, as can be seen from Fig. 2. The average number of the egg-masses and that of individual eggs of this species per one hill of rice, from 25 unit samplings in 24 different rice paddies, was 1. 1 and 16. 36, respectively.

Table 2. Summary of samplings of eggs of *Sogatella furcifera* by the method II.

Locality	Date	No. of egg masses found	No. of eggs found	Parasite species	No. of parasitized egg masses	Per-centage parasitism	No. of parasitized eggs	Per-centage parasitism
Chiang Dao	Oct. 17	2	10	O ¹⁾	1	50.00	1	10.00
Mae Theng	Oct. 17	2		O	1	50.00	3	33.33
Doi Saket	Oct. 6		12	A ²⁾	4	100	10	83.33
Lamphun	Oct. 6	39	198	A	34	87.18	131	66.16
San Pa Tong	Oct. 3	116	777	A	72	62.07	276	35.52
San Pa Tong	Oct. 14	84	589	A	52	61.90	279	47.37
Chom Thong	Oct. 11	17	115	A	12	70.59	43	37.39
Hot	Oct. 11	2	17	A	1	50.00	5	29.41
Lampang	Oct. 13							
Ban Mae Chung Rai	Nov. 15	2	12					
Chai Nat (I)	Nov. 4	12	95	A	5	41.67	34	35.79
Chai Nat (III)	Nov. 11	1	12		—			
Chai Nat (IV)	Nov. 18	7	56	A	1	14.29	5	8.93

1) *Oligosita* sp. 2) *Anagrus optabilis*.

* Apparently *Nephotettix virescens* was mixed up with this species. *Nephotettix nigropictus* in this paper should be understood as the *Nephotettix nigropictus-virescens* complex.

Values of egg densities of this species were moderate in the rice paddies in Mae Ai, Chiang Dao (northern Thailand) and Kamphaeng Phet (middle

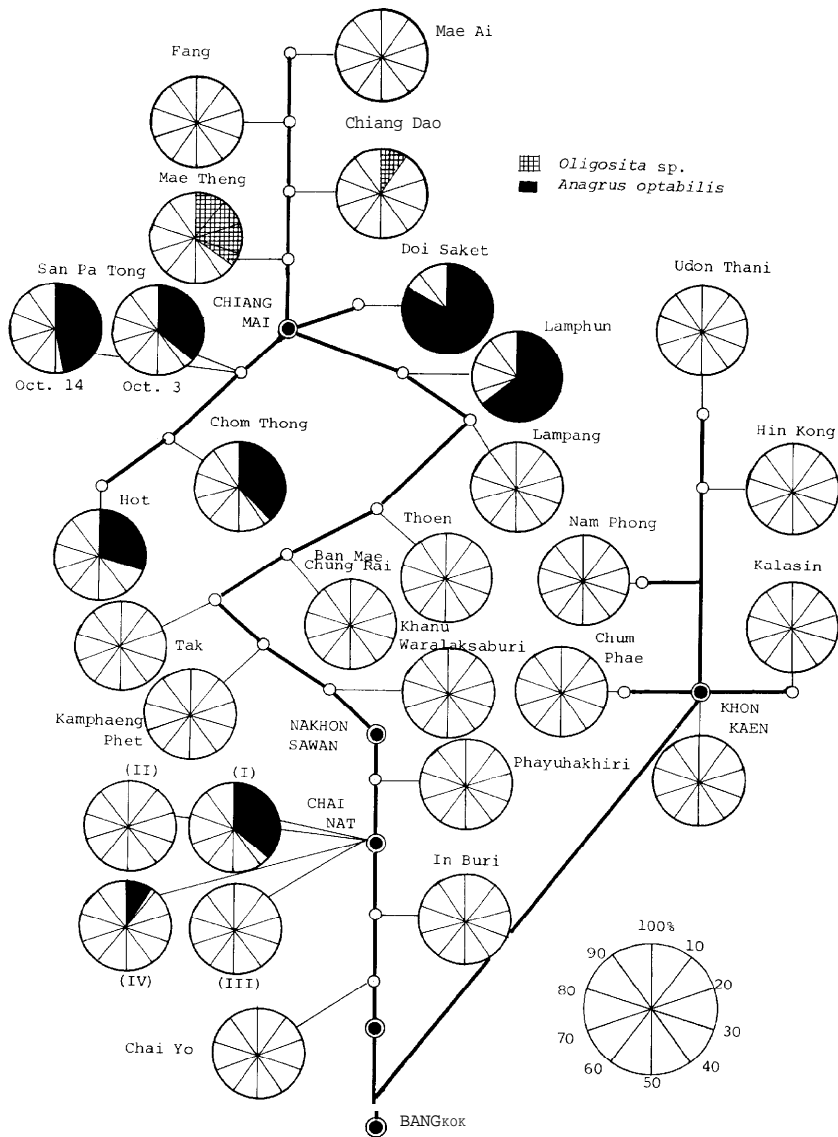


Fig. 3. Percentage parasitism of *Oligosita* sp. and *Anagrus optabilis* to the *Sogatella furcifera* eggs in Thailand (October to December, 1977).

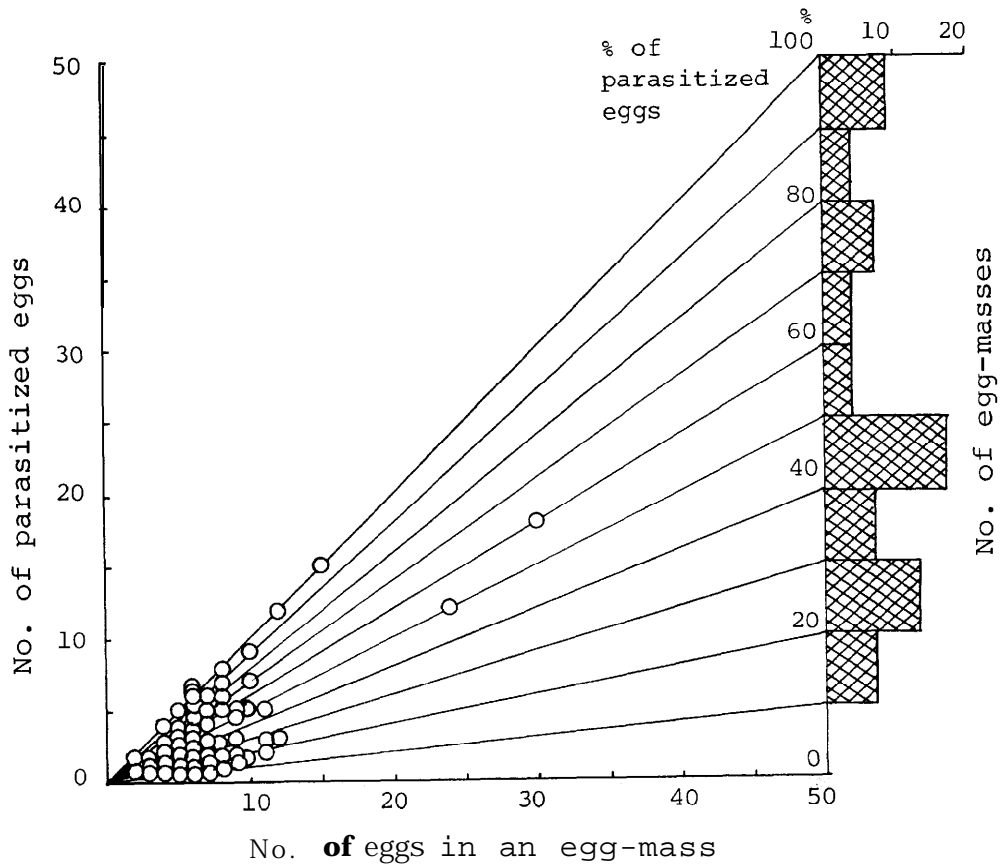


Fig. 4. The relation between the parasitized eggs and the number of eggs in an egg-mass. Host: *Sogatella furcifera*, Parasite: *Anagrus optabilis*. Date: Oct. 13, 1977. Locality: San Pa Tong.

Thailand), and low for other areas.

2. Egg parasites collected

Yasumatsu et al. (1975) reported that the following wasps are important as egg parasites of rice leafhoppers and planthoppers in Thailand:

Trichogrammatidae

Paracentrobia yasumatsui Subba Rao

Paracentrobia garuda Subba Rao

Oligosita sp.

Mymaridae

Anagrus optabilis (Perkins)

Mymar taprobanicum Ward

Polynema sp.

Gonatocerus sp.

We were able to find 4 hymenopterous egg parasites in total, i. e., *Paracentrobia* sp., *Oligosita* sp., *Anagrus optabilis* and *Gonatocerus* sp.

3. Egg parasites of *Sogatella furcifera*

Two species of parasites, *Oligosita* sp. and *Anagrus optabilis*, were reared from the eggs of *Sogatella furcifera* (Table 2, Fig. 3).

Oligosita sp. was only collected from northern Thailand such as Chiang Dao and Mae Theng. *Anagrus optabilis* was found from Doi Saket, Lamphun, San Pa Tong, Chom Thong, Hot, and Chai Nat (I), (III) and (IV).

The percentage parasitism of *Anagrus optabilis* was highest in a rice paddy in Doi Saket ; 100 % for egg-masses and 83.33 % for individual eggs per one egg-mass. On the contrary, the lowest value of the percentage parasitism was observed in a rice paddy at Chai Nat (IV) ; 14.2 % for egg-masses and 8.93 % for individual eggs per one egg-mass.

Our investigation shows that *Anagrus optabilis* attacks the individual eggs in one egg-mass of *Sogatella furcifera* at random (Fig. 4). The percentage parasitism of *Anagrus optabilis* for the individual eggs per one egg-mass of *Sogatella furcifera* was 20–100 %, but it was often less than 50 %.

We observed that although *Nephotettix nigropictus* deposits its eggs in thin and soft parts of the leaf-sheath of the rice but *Sogatella furcifera* does in more thicker parts close to the main vein. Therefore it seems probable that the eggs of *Sogatella furcifera* which were deposited shallowly into the tissue are easily parasitized by *Anagrus optabilis*. Thus, we often observed that all the individual eggs in one egg-mass of *Sogatella furcifera* were parasitized by *Anagrus optabilis* when they were put onto the surface of the leaf tissue. In this case, the percentage parasitism of *Anagrus optabilis* to the individual eggs of the host hopper, not that to the egg-masses, is reliable to evaluate the effectiveness of *Anagrus optabilis*.

4. Egg parasites of *Nilaparvata lugens*

Anagrus optabilis was reared from the egg of *Nilaparvata lugens*, although the percentage parasitism was low (Table 3).

Table 3. Summary of samplings of eggs of *Nilaparvata lugens* by the method II.

Locality	Date	No. of egg masses found	No. of eggs found	Parasite species	No. of parasitized egg masses	Percentage parasitism	No. of parasitized eggs	Percentage parasitism
Lamphun	Oct. 6	1	3					
San Pa Tong	Oct. 3	2	12	A ¹⁾	1	50.00	3	25.00
San Pa Tong	Oct. 14	5	62	A	2	30.00	6	9.68
Chom Thong	Oct. 11	1	4					
Hot	Oct. 11	2	19					

1) *Anagrus optabilis*.

Table 4. Summary of samplings of eggs of *Nephotettix nigropictus* by the method II.

Locality	Date	No. of egg masses found	No. of eggs found	Parasite species	No. of parasitized egg masses	Percentage parasitism	No. of parasitized eggs	Percentage parasitism
Mae Ai	Oct. 25	10	175	P ¹⁾	9	90.00	102	58.29
				G ²⁾	1	10.00	6	3.43
Fang	Oct. 25	2	23	G	2	100	20	86.96
Chiang Dao	Oct. 17	7	133	P	6	85.71	54	40.60
				G	1	14.29	14	10.53
Mae Theng	Oct. 17	3	50	P	3	100	41	82.00
Doi Saket	Oct. 6	3	56	P	3	100	38	85.71
Lamphun	Oct. 6	7	77	P	2	28.57	5	6.49
				G	3	42.86	28	36.36
				P + G	1	14.29	10	12.99
San Pa Tong	Oct. 3	7	125	G	1	14.29	2	1.60
San Pa Tong	Oct. 14	1	21	G	1	100	21	100
Chom Thong	Oct. 11	11	124	P	8	72.73	79	63.71
				G	1	9.09	16	12.90
				P + G	1	9.09	11	8.87
Lampang	Oct. 13	1	5					
Thoen	Oct. 15	2	26	P	1	50.00	16	61.54
				G	1	50.00	10	38.46
Ban Mae	Nov. 15	5	71	P	1	20.00	4	5.63
Chun Rai				G	2	40.00	11	15.49
Tak	Nov. 16	6	93	P	4	66.67	33	35.48
				G	1	16.67	9	9.68
Kamphaeng Phet	Nov. 14	11	200	P	8	57.14	83	42.00
				G	2	14.29	38	19.00
Phayuhakhiri	Nov. 9	8	130	G	8	100	95	73.08
Chai Nat (I)	Nov. 4	25	352	P	14	56.00	147	41.76
				G	5	20.00	56	15.91
				P + G	2	8.00	38	10.80
Chai Nat (II)	Nov. 4	4	59	G	3	100	44	74.58
Chai Nat (III)	Nov. 11	5	74	G	5	100	72	97.30
Chai Nat (IV)	Nov. 18	11	130	P	3	27.27	27	20.77
				G	8	72.73	92	70.77
Khon kaen	Nov. 27	38	534	P	38	100	432	80.90
Kalasin	Nov. 29	30	395	P	20	66.67	189	47.85
				G	5	16.67	60	15.19
				P + G	1	3.33	15	3.80
Chum Phae	Nov. 28	4	55	P	4	100	50	90.90
Nam Phong	Dec. 6	9	105	P	9	100	96	91.43
Hin Kong	Dec. 2	23	330	P	19	82.61	234	70.91
				G	3	17.39	41	12.42
Udon Thani	Dec. 1	39	748	P	31	79.49	313	55.21
				G	3	7.69	42	5.61
				P + G	1	2.56	15	2.01

1) *Paracentrobia* sp. 2) *Gonatocerus* sp.

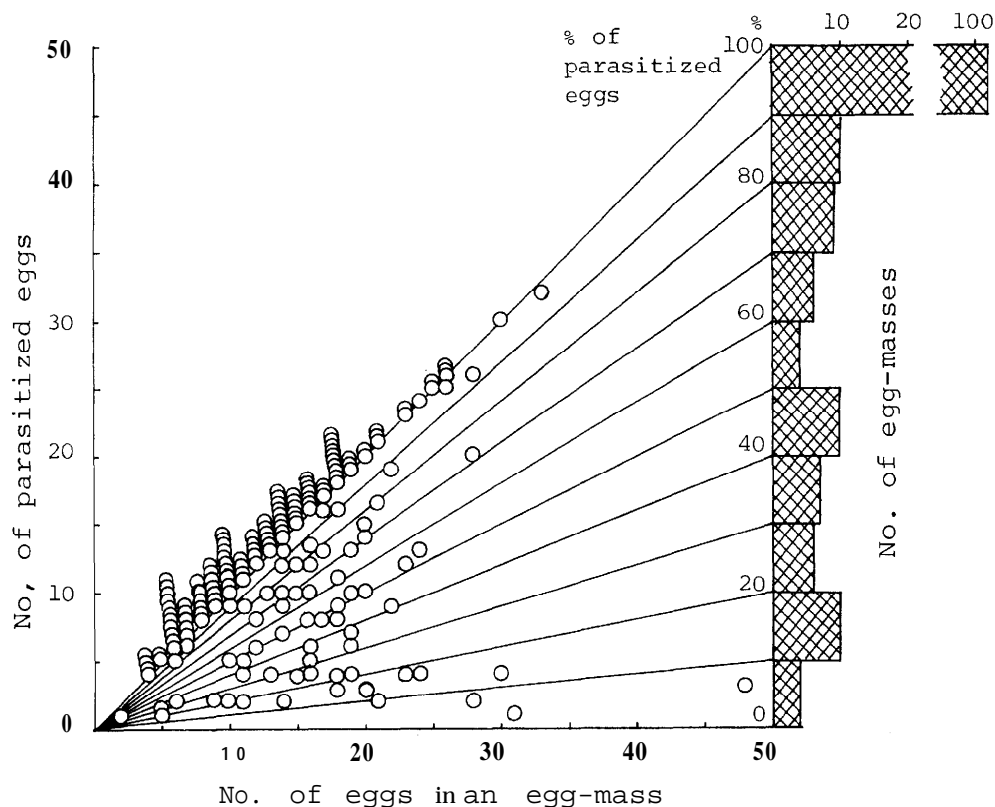


Fig. 5. The relation between the parasitized eggs and the number of eggs in an egg-mass.
Host : *Nephotettix nigropictus*. Parasite : *Paracentrobia* sp.

5. Egg parasites of *Nephotettix nigropictus*

Two species of egg parasites, *Paracentrobia* sp. and *Gonatocerus* sp., were reared from the egg of *Nephotettix nigropictus* (Table 4).

As can be seen from Table 4, *Paracentrobia* sp. was known only from 5 localities, i. e., Mae Theng, Doi Saket, Khon Kaen, Chum Phae, and Nam Phong out of 21 localities where investigations were made. In these areas, however, the percentage parasitism of *Paracentrobia* sp. was very high; 100 % to the egg-masses, and 81–90 % to the individual eggs.

Gonatocerus sp. was found from Fang, San Pa Tong, Phayuhakhiri, Chai Nat (II) and Chai Nat (III). High rate of parasitism by this egg parasite was observed in these areas; 100 % to the egg-masses, and 73–97 % to the individual eggs.

Very interestingly, both *Paracentrobia* sp. and *Gonatocerus* sp. were emerged at the same time from eggs of *Nephotettix nigropictus* collected from the same rice paddies in 13 localities such as Mae Ai, Chian Dao, Lamphun, Chom Thong, Thoen, Ban Mae Chung Rai, Tak, Kamphaeng Phet, Chai Nat (I) and

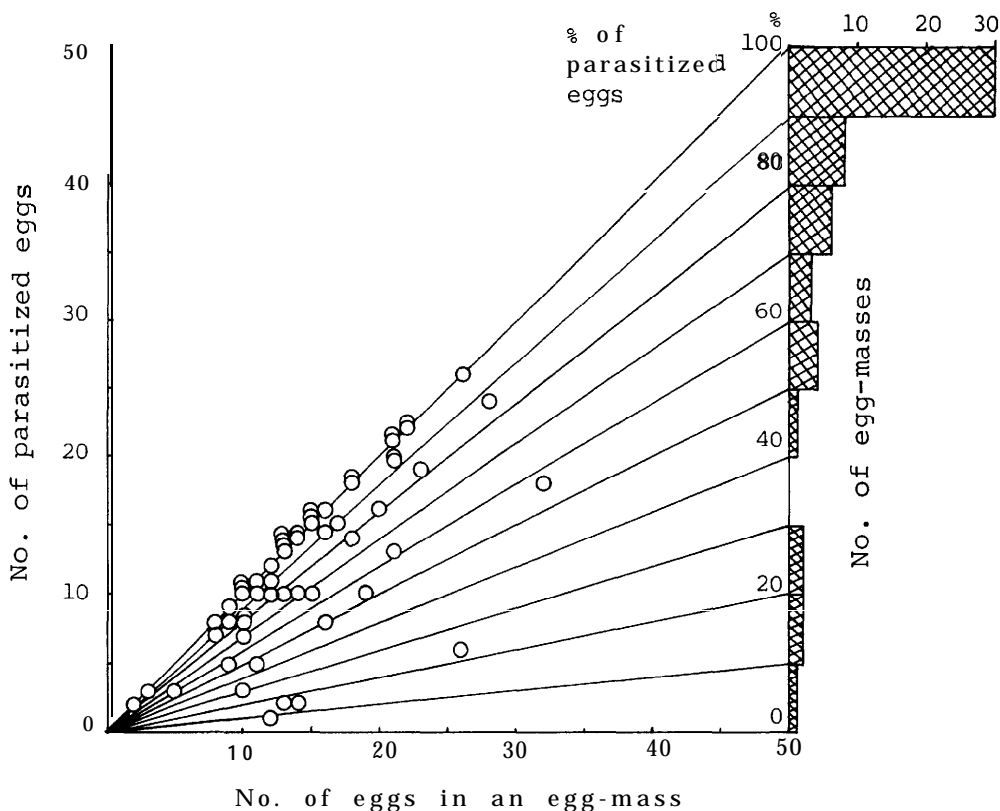


Fig. 6. The relation between the parasitized eggs and the number of eggs in an egg-mass.
Host : *Nephotettix nigropictus*. Parasite : *Gonatocerus* sp.

(IV), Kalasin, Hin Kong and Udon Thani.

Miura (1976) observed in Japan that *Paracentrobia andoi* and *Gonatocerus* sp. occur simultaneously in the same rice paddies, both are the egg parasites of *Nephotettix cincticeps* there. In this instance either *Paracentrobia andoi* or *Gonatocerus* sp. is dominant according to different localities.

Our field studies in Thailand show that *Gonatocerus* sp. was dominant in Mae Ai, Chiang Dao, Lamphun, Chom Thong, Thoen, Tak, Kamphaeng Phet, Chai Nat (I), Kalasin, Hin Kong and Udon Thani. On the contrary, *Paracentrobia* sp. was dominant in Lamphun, Ban Mae Chun Rai and Chai Nat (IV).

Thus, it is apparent that *Gonatocerus* sp. and *Paracentrobia* sp. parasitic to *Nephotettix nigropictus* are ecologically similar species. Otake (1956) reported the coexistence of two egg parasites of the rice stem borer in the same rice paddy in Japan: *Trichogramma japonicum* and *Phanurus beneficiens* (now known as *Telenomus dignus*), which are also ecologically similar species. Hokyō (1970) also discussed the coexistence of *Trissolcus mitsukurii* and *Telenomus nakagawai*,

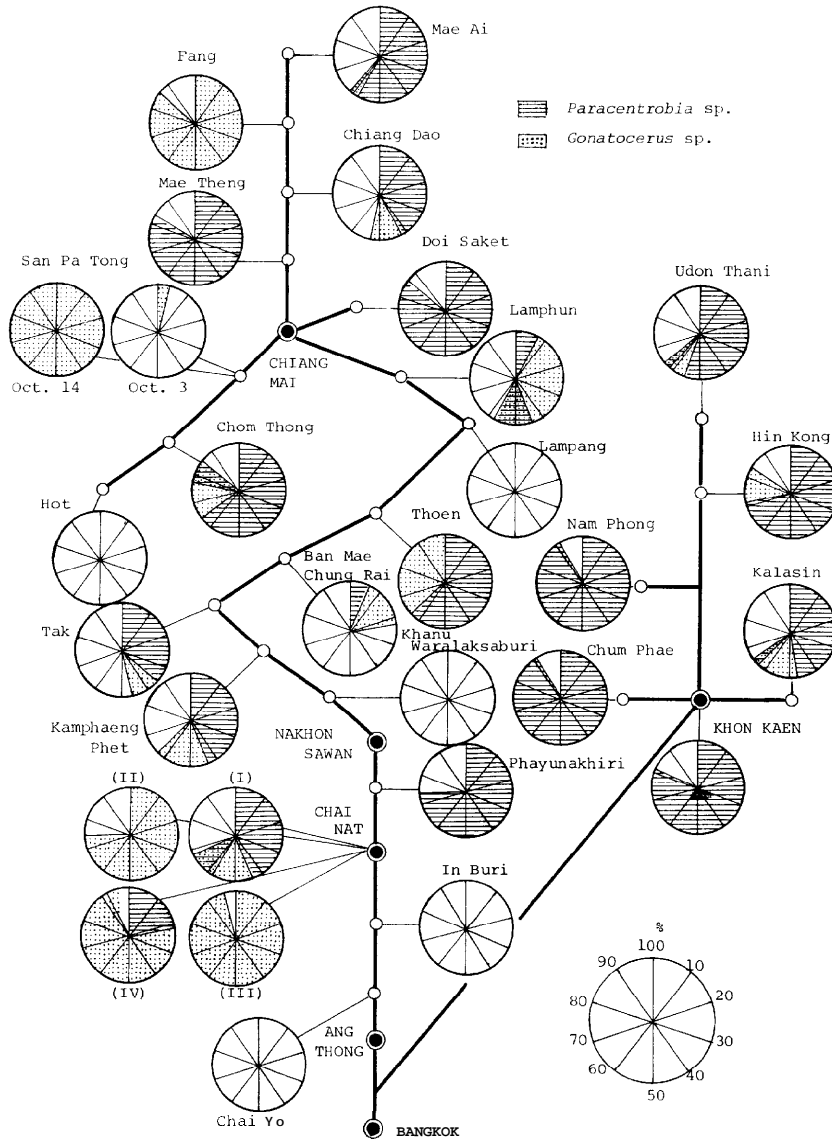


Fig. 7. Percentage parasitism of *Paracentrobia* sp. and *Gonatocerus* sp. to the *Nephotettix nigropictus* eggs in Thailand (October to December, 1977).

both are parasitic to the egg of *Nezara viridula*, a stink bug.

Empirical study of Gause (1934) showed that ecologically similar species were seldom able to coexist in simple laboratory systems. Therefore, it has been emphasized that species living together must have their own unique niche. This niche theory became accepted as ecological dogma. However, Otake (1959) discussed the niche theory in detail and emphasized the exist-

cally similar species in the same niche as in the case of *Trichogramma japon-*

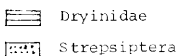


Fig. 8. Percentage parasitism of Dryinidae and Strepsiptera to *Sogatella furcifera* in Thailand (October to December, 1977).

Table 5. Summary of samplings of *Sogatella furcifera* by the method I.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Per-centage para-sitism	No. of spms parasitized by Strepsiptera	Per-centage para-sitism
Mae Ai	Oct. 25	Adult	282	52	18.44	10	3.55
		Nymph	89	14	15.73	1	1.12
		Total	371	66	17.79	11	2.96
Fang	Oct. 25	Adult	6	2	33.33		
		Nymph					
		Total	6	2	33.33		
Chiang Dao	Oct. 17	Adult	547	139	25.41	6	1.10
		Nymph	396	33	8.33	3	0.76
		Total	943	172	18.24	9	0.95
Mae Theng	Oct. 17	Adult	230	54	22.50	3	1.25
		Nymph	78	2	2.56	3	3.85
		Total	318	56	17.41	6	1.89
Doi Saket	Oct. 6	Adult	71	11	15.45	2	2.82
		Nymph	1090	1	0.09	2	0.18
		Total	1161	12	1.03	4	0.31
Lamphun	Oct. 6	Adult	416	40	9.62	22	5.29
		Nymph	2791	74	2.65	25	0.90
		Total	3207	114	3.55	47	1.47
San Pa Tong	Oct. 3	Adult	462	18	3.90	26	5.63
		Nymph	1307	23	1.76	16	1.22
		Total	1769	41	3.32	42	2.37
San Pa Tong	Oct. 18	Adult	2059	142	6.89	142	6.89
		Nymph	2539	224	8.82	55	2.17
		Total	4598	366	7.96	197	4.28
Chom Thong	Oct. 11	Adult	539	48	8.91	23	4.27
		Nymph	1394	47	3.37	7	0.50
		Total	1933	95	4.91	30	1.55
Hot	Oct. 11	Adult	112	19	16.96	2	1.79
		Nymph	248	21	8.47	2	0.81
		Total	360	40	11.11	1	1.11
Lampang	Oct. 13	Adult	16	4	25.00	1	6.25
		Nymph	54	3	5.56		
		Total	70	7	10.00	1	1.13
Thoen	Oct. 15	Adult	60	19	31.67	2	3.33
		Nymph	105	25	23.81		
		Total	165	44	26.67	2	1.21
Ban Mae Chung Rai	Nov. 15	Adult	46	6	13.04		
		Nymph	75	3	4.00		
		Total	121	9	7.44		
Tak	Nov. 16	Adult	2				
		Nymph	9			-	
		Total	11				
Kamphaeng Phet	Nov. 14	Adult	22	1	4.55	-	
		Nymph	9	-			
		Total	31	1	3.23		
Khanu Woralaksaburi	Nov. 9	Adult	25	2	8.00		
		Nymph	59	1	1.69		
		Total	84	3	3.57	-	
Phayuhakhiri	Nov. 9	Adult	26	2	7.70	1	3.85
		Nymph	20	4	20.00		
		Total	16	6	13.04	1	2.17

Table 5. Continued.

Chai Nat (I)	Nov. 4	Adult	15	2	13.33	
		Nymph	10			
		Total	25	2	8.00	
Chai Nat (II)	Nov. 4	Adult	30	4	13.33	
		Nymph	45	5	11.11	
		Total	75	9	12.00	
Chai Nat (III)	Nov. 11	Adult	35	8	22.86	
		Nymph	35	4	11.43	
		Total	70	12	17.14	
Chai Nat (IV)	Nov. 18	Adult	25			
		Nymph	21	4	19.05	
		Total	46	4	8.70	
In Buri	Nov. 7	Adult	19	2	10.53	
		Nymph	61	1	1.64	—
		Total	80	3	3.75	
Chai Yo	Nov. 7	Adult	18	4	22.22	
		Nymph	15			
		Total	33	4	12.12	
Khon Kaen	Nov. 29	Adult	3			
		Nymph				
		Total	3			
Kalasin	Nov. 29	Adult	2		—	
		Nymph	—			
		Total	2			
Chum Phae	Nov. 28	Adult	11	1	9.09	
		Nymph	8	1	12.50	
		Total	19	2	10.53	
Nam Phong	Dec. 6	Adult	3			—
		Nymph	3			
		Total	6			—
Hin Kong	Dec. 2	Adult	5	—		
		Nymph	2			
		Total	7			
Udon Thani	Dec. 1	Adult	2	—		—
		Nymph	3	1	33.33	
		Total	5	1	20.00	

Table 6. Summary of samplings of *Sogatella furcifera* by the method II.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Percentage parasitism	No. of spms parasitized by Strepsiptera	Percentage parasitism
Mae Ai	Oct. 25	Adult	1				
		Nymph	—				
		Total	1				—
Fang	Oct. 25	Adult	1				
		Nymph	—				
		Total	1				
Chiang Dao	Oct. 17	Adult	5	1	20.00		20.00
		Nymph	—				
		Total	5	1	20.00	1	20.00
Doi Saket	Oct. 6	Adult	10				
		Nymph	5				
		Total	15				

Table 6. Continued.

San Pa Tong	Oct. 3	Adult	43		—	3	6.98
		Nymph	61		—	1	1.64
		Total	104	—	—	4	3.85
San Pa Tong	Oct. 14	Adult	6	—	—	2	12.50
		Nymph	22	—	—		
		Total				2	9.09
Chom Thong	Oct. 11	Adult	11	1	14.29	1	7.14
		Nymph	25	3	12.00 9.09		
		Total				1	4.00
Hot	Oct. 11	Adult	3	—	—		
		Nymph	1	—	—		
		Total	4	—	—		
Kamphaeng Phet	Nov. 14	Adult	1	—		—	
		Nymph		—			
		Total	1	—	—		
Chai Nat (I)	Nov. 4	Adult	1	—	—	—	
		Nymph	—	—	—	—	
		Total	1	—	—	—	
Chai Nat (II)	Nov. 4	Adult	1	—	—	—	
		Nymph		—	—	—	
		Total	1	—	—	—	
Khon Kaen	Nov. 29	Adult	—	—	—	—	
		Nymph	2	—	—	—	
		Total		—	—	—	
Chum Phae	Nov. 28	Adult	—	—	—	—	
		Nymph	1	—	—	—	
		Total		—	—	—	

Table 7. Summary of samplings of *Sogatella furcifera* by the method III.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Per-centage parasitism	No. of spms parasitized by Strepsiptera	Per-centage parasitism
Mae Ai	Oct. 25	Adult	1	—	—	—	—
		Nymph	—	—	—		—
		Total	1	—	—		—
Mae Theng	Oct. 17	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	2	—	—	—	—
Doi Saket	Oct. 6	Adult	1	—	—	—	—
		Nymph	15	—	—	—	—
		Total	16	—	—	—	—
Lamphun	Oct. 6	Adult		2	50.00	1	25.00
		Nymph	28	—	—	4	14.29
		Total	32	2	6.25	5	15.63
San Pa Tong	Oct. 3	Adult	27	—	—	—	—
		Nymph	18	—	—	—	—
		Total	45	—	—	—	—
San Pa Tong	Oct. 14	Adult	37	4			8.11
		Nymph	96	6	10.81 6.25	32	2.08
		Total	133	10	7.52	5	3.76
Chom Thong	Oct. 11	Adult	2	1	50.00	1	50.00
		Nymph	15	2		—	—
		Total	17	3	13.33 17.65	1	5.88

Table 7. Continued.

Hot	Oct. 11	Adult	—	—			
		Nymph	3	—			
		Total	3	—		—	—
Lampang	Oct. 13	Adult	—	—	—		
		Nymph	3	—	—		
		Total	3	—	—	—	—
Chai Nat (II)	Nov. 4	Adult	—	—	—		
		Nymph	2	—	—		
		Total	2	—	—	—	

Table 8. Summary of sampling of *Nilaparvata lugens* by the method I.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Per-centage parasitism	No. of spms parasitized by Strepsiptera	Per-centage parasitism
Mae Ai	Oct. 25	Adult	3	—	—	—	—
		Nymph	3	—	—	—	—
		Total	—	—	—	—	—
Fang	Oct. 25	Adult	4	—	—	—	—
		Nymph	—	—	—	—	—
		Total	4	—	—	—	—
Chiang Dao	Oct. 17	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	2	—	—	—	—
Mae Theng	Oct. 17	Adult	7	—	—	—	—
		Nymph	—	—	—	—	—
		Total	7	—	—	—	—
Doi Saket	Oct. 6	Adult	1	—	—	—	—
		Nymph	—	—	—	—	—
		Total	1	—	—	—	—
San Pa Tong	Oct. 3	Adult	3	—	—	—	—
		Nymph	138	2	1.45	1	0.72
		Total	141	2	1.42	1	0.71
Chom Thong	Oct. 11	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	a	—	—	—	—
Hot	Oct. 11	Adult	1	—	—	—	—
		Nymph	—	—	—	—	—
		Total	1	—	—	—	—
Kamphaeng Phet	Nov. 14	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	2	—	—	—	—
Khanu Woralaksaburi	Nov. 9	Adult	1	—	—	—	—
		Nymph	—	—	—	—	—
		Total	1	—	—	—	—
Phayuhakhiri	Nov. 9	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	2	—	—	—	—
Chai Nat (I)	Nov. 4	Adult	—	—	—	—	—
		Nymph	1	—	—	—	—
		Total	1	—	—	—	—
Chai Nat (II)	Nov. 11	Adult	2	—	—	—	—
		Nymph	—	—	—	—	—
		Total	2	—	—	—	—

Table 8. Continued.

Chun Phae	Nov. 28	Adult	1		—		—
		Nymph	—	—	—	—	—
		Total	1	—		—	—
Nam Phong	Dec. 6	Adult	1	—			—
		Nymph					—
		Total	1	—	—	—	—
Udon Thani	Dec. 1	Adult	7		—		—
		Nymph	2	1	50.00	—	—
		Total	9	1	11.11	—	—

Table 9. Summary of samplings of *Nephotettix nigropictus* by the method I.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Per-centage parasitism	No. of spms parasitized by Strepsiptera	Per-centage parasitism
Mae Ai	Oct. 25	Adult	380	—			
		Nymph	259	1	0.39	—	
		Total	639	1	0.16	—	
Fang	Oct. 25	Adult	18	—			
		Nymph	3		—	—	
		Total	21	—	—	—	
Chiang Dao	Oct. 17	Adult	112	—	—	—	
		Nymph	102	—		—	
		Total	214		—	—	
Mae Theng	Oct. 17	Adult	90	1	1.11	—	
		Nymph	197	4	2.03	—	
		Total	287	5	1.74		
Doi Saket	Oct. 6	Adult	22				
		Nymph	199	—		—	
		Total	221	—	—		
Lamphun	Oct. 6	Adult	53		—	—	
		Nymph	141	—	—		
		Total	194	—	—		
San Pa Tong	Oct. 3	Adult	9		—	—	
		Nymph	8		—	—	
		Total	17		—	—	
San Pa Tong	Oct. 14	Adult	14	—		—	
		Nymph	9	—			
		Total	23		—	—	
Chom Thong	Oct. 11	Adult	116	1	0.86	—	
		Nymph	154		—	—	
		Total	270	1	0.37	—	
Hot	Oct. 11	Adult	34	—		—	
		Nymph	25		—		
		Total	59		—		
Lampang	Oct. 13	Adult	12		—	—	
		Nymph	33	—	—		
		Total	45	—	—		
Thoen	Oct. 15	Adult	17	—		—	
		Nymph	66		—	—	
		Total	83		—		
Ban Mae Chung Rai	Nov. 15	Adult	12	—		—	
		Nymph	45	—	—		
		Total	57			—	

Table 9. Continued,

Tak	Nov. 16	Adult	56	—	—	—	—
		Nymph	105			—	—
		Total	161			—	—
Kamphaeng Phet	Nov. 14	Adult	41		—	—	—
		Nymph	109	1	0.92	1	0.92
		Total	150	1	0.67	1	0.67
Khanu Woralaksaburi	Nov. 9	Adult	56				—
		Nymph	94				—
		Total	150				—
Phayuhakhiri	Nov. 9	Adult	28	—		—	—
		Nymph	58			—	—
		Total	86		—	—	—
Chai Nat (I)	Nov. 4	Adult	72				—
		Nymph	173				—
		Total	245	—			—
Chai Nat (II)	Nov. 4	Adult	35	—		—	—
		Nymph	47				—
		Total	82				—
Chai Nat (III)	Nov. 11	Adult	72		—	—	—
		Nymph	181			—	—
		Total	253				—
Chai Nat (IV)	Nov. 18	Adult	24	—	—	—	—
		Nymph	43		—	—	—
		Total	67				—
In Buri	Nov. 7	Adult	35		—	—	—
		Nymph	323	—	—	—	—
		Total	358	—		—	—
Chai Yo	Nov. 7	Adult	28			—	—
		Nymph	28	—	—	—	—
		Total	28				—
Khon Kaen	Nov. 29	Adult	24				—
		Nymph	37				—
		Total	61				—
Kalasin	Nov. 29	Adult	46				—
		Nymph	152	1	0.66	—	—
		Total	198	1	0.51	—	—
Chum Phae	Nov. 28	Adult	60	2	3.33	—	—
		Nymph	60	2	1.67	—	—
		Total	120				—
Nam Phong	Dec. 6	Adult	22	1	4.55	—	—
		Nymph	58				—
		Total	80	1	1.25		—
Hin Kong	Dec. 2	Adult	41		—	1	2.44
		Nymph	80	1	1.25	—	—
		Total	121	1	0.83	1	0.83
Udon Thani	Dec. 1	Adult	14	1	7.14		—
		Nymph	16		—		—
		Total	30	-1	3.33	—	—

icum and *Telenomus dignus* or *Paracentrobia* sp. and *Gonatocerus* sp.

We often observed in Thailand, as stated above, that the two species of egg parasites were emerged even from the same egg-mass of *Nephotettix nigropictus*. The same phenomenon was also often observed by Miura (1976) in Japan.

Table 10. Summary of samplings of *Nephotettix nigropictus* by the method II.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Percentage parasitism	No. of spms parasitized by Strepsiptera	Percentage parasitism
Mae Ai	Oct. 25	Adult	2				—
		Nymph	2			—	—
		Total	4			—	—
Chiang Dao	Oct. 17	Adult	2			—	—
		Nymph	2			—	—
		Total	4			—	—
Mae Theng	Oct. 17	Adult	1			—	—
		Nymph	7			—	—
		Total	8			—	—
Doi Saket	Oct. 6	Adult				—	—
		Nymph	3	—		—	—
		Total	3		—	—	—
Lamphun	Oct. 6	Adult				—	—
		Nymph	10			—	—
		Total	10			—	—
San Pa Tong	Oct. 3	Adult	1		—	—	—
		Nymph	3			—	—
		Total	4		—	—	—
Chom Thong	Oct. 11	Adult	4			—	—
		Nymph	16	—		—	—
		Total	20		—	—	—
Hot	Oct. 11	Adult			—	—	—
		Nymph	1	—		—	—
		Total	1		—	—	—
Thoen	Oct. 15	Adult	1	—		—	—
		Nymph				—	—
		Total	1			—	—
Ban Mae Chung Rai	Nov. 15	Adult	1			—	—
		Nymph				—	—
		Total	1		—	—	—
Tak	Nov. 16	Adult	2				—
		Nymph				—	—
		Total	2			—	—
Kamphaeng Phet	Nov. 14	Adult	1	—		—	—
		Nymph	3			—	—
		Total	4		—	—	—
Khanu Woralaksaburi	Nov. 9	Adult					—
		Nymph	3				—
		Total	3	—	—		—
Phayuhakhiri	Nov. 9	Adult		—		—	—
		Nymph	5	—		—	—
		Total	5	—		—	—
Chai Nat (II)	Nov. 4	Adult	2	—		—	—
		Nymph	3	—	—	—	—
		Total	5		—	—	—
Khon Kaen	Nov. 29	Adult				—	—
		Nymph	1	—	—	—	—
		Total	1		—	—	—
Chun Phae	Nov. 28	Adult	—	—		—	—
		Nymph	8	2	25.00	—	—
		Total	8	2	25.00	—	—

Table 10. Continued.

Hin Kong	Dec. 2	Adult				—
		Nymph	7		—	
		Total	7			
Udon Thani	Dec. 1	Adult				
		Nymph	4			
		Total	4			

Table 11. Summary of samplings of *Nephotettix nigropictus* by the method III.

Locality	Date	Stage	No. of specimens collected	No. of spms parasitized by Dryinidae	Percentage parasitism	No. of spms parasitized by Strepsiptera	Percentage parasitism
Mae Ai	Oct. 25	Adult					
		Nymph	1				
		Total	2				—
Chiang Dao	Oct. 17	Adult	19	5	26.32		
		Nymph	1	—			
		Total	20	5	25.00		
Doi Saket	Oct. 6	Adult	2				
		Nymph	2		—		
		Total				—	—
San Pa Tong	Oct. 14	Adult	1				
		Nymph	1				
		Total	2				
Lampang	Oct. 13	Adult					
		Nymph	1				
		Total	3			—	—
Tak	Nov. 16	Adult	2	—			
		Nymph					
		Total	5				
Kamphaeng Phet	Nov. 14	Adult	11	2	18.18		
		Nymph					
		Total	11	2	18.18	—	—
Chai Nat (I)	Nov. 4	Adult	2	—	—		
		Nymph	4				
		Total	6	—		—	—
Chai Nat (II)	Nov. 4	Adult	1				
		Nymph					
		Total	1	—	—		
Chai Nat (III)	Nov. 11	Adult	5				
		Nymph	1	1	100		
		Total	6	1	16.67		

The percentage parasitism of the two egg parasites together at various localities was observed as follows :

Mae Ai (100 % to the egg-masses, and 61.72 % to the individual eggs), Chiang Dao (100 % and 51.13 %), Lamphun (85.72 % and 55.84 %), Chom Thong (90.91 % and 85.48 %), Thoen (100 % and 100 %), Ban Mae Chung Rai (60.00 % and 21.12 %), Tak (83.34 % and 45.16 %), Kamphaeng Phet (71.43 % and 61.00 %), Chai Nat (I) (84.00 % and 68.47 %), Chai Nat (IV) (100 % and 91.54 %),

Kalasin (86.67 % and 66.84 %), Hin Kong (100 % and 83.33 %), and Udon Thani (89.74 % and 62.83 %).

Figs. 5 and 6 show that how many per cents of the individual eggs in one egg-mass of *Nephotettix nigropictus* were attacked by *Paracentrobia* sp. and *Gonatocerus* sp., respectively. Fig. 7 shows these figures by the circular graphs. As can be seen from these figures, the percentage parasitism of the two egg parasites is rather high. The same is true of *Paracentrobia andoi* and *Gonatocerus* sp. in Japan. Yasumatsu (personal communication) thinks that *Gonatocerus* sp. of Japan is the same species with *Gonatocerus* sp. of Thailand.

II. NYMPHAL PARASITES OF RICE LEAFHOPPERS AND PLANTHOPPERS

Dryinid wasps (Hymenoptera : Dryinidae), stylopids (Strepsiptera : Elenchiidae) and pipunculid flies (Diptera: Pipunculidae) are known to be parasitic to both nymphal and adult stages of rice leafhoppers and planthoppers. They are treated here under this heading except for the pipunculid flies. Because the classification of the larval stage of these parasites is not available, they are treated here collectively. It is very certain that at least several species of dryinid wasps and three species of stylopids are found in the rice paddies of Thailand. Yano (1979) records 10 species of the pipunculid flies from Thai rice paddies and presents an illustrated key for them based on the collection made by us (including him) during the last 10 years or so.

1. Dryinid wasps and stylopids parasitic to *Sogatella furcifera*

Tables 5, 6 and 7 show the results of samplings of *Sogatella furcifera*, both nymphs and adults, by the three sampling methods, respectively, as well as the percentage parasitism of dryinid wasps and stylopids to them. Although the total number of catch of *Sogatella furcifera* varies distinctly from place to place, it is estimated that the percentage parasitism of dryinid wasps is about 20 % at the time of our investigation (October to December). Stylopids are found to be parasitic on *Sogatella furcifera* in northern Thailand only. Its percentage parasitism was 1 - 4 %. Yasumatsu et al. (1975) reported that *Elenchus yasumatsui* Kifune et Hirashima plays an important role in controlling *Sogatella furcifera* and *Nilaparvata lugens* in northern Thailand. We see the percentage parasitism of the stylopid fluctuates according to seasons of the year.

2. Dryinid wasps and stylopids parasitic to *Nilaparvata lugens*

Table 8 shows the results of collectings of *Nilaparvata lugens* by the method I as well as the percentage parasitism of dryinid wasps and stylopids to this hopper. In San Pa Tong only both dryinid wasps and stylopids were detected, but they were very few in number. Also, only one nymph of this hopper was found to be parasitized by a dryinid in Udon Thani, although the total catch of the hopper was 9 in number.

3. Dryinid wasps and stylopids parasitic to *Nephotettix nigropictus*

Tables 9, 10 and 11 show the results of collectings of *Nephotettix nigropictus* by the three sampling methods, respectively.

Larvae of dryinid wasps were collected by the method I (sweeping) in the rice paddies at Mae Ai, Mae Theng, Chom Thong, Kamphaeng Phet, Kalasin, Chum Phae, Nam Phong, Hin Kong, and Udon Thani, but they were few in number. The percentage parasitism was less than 3 %. By the method II, the percentage parasitism of dryinid wasps was 25.0 % in Chum Phae, and by the method III, it was 25.0 % at Chiang Dao, 18.18 % at Kamphaeng Phet, and 16.67 % at Chai Nat (III).

Stylopids which are parasitic to *Nephotettix nigropictus* were also few in number. They were found in Kamphaeng Phet (the percentage parasitism, 0.67 %) and Hin Kong (0.83 %) only.

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