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SPECIES DISTRIBUTION OF *TRICHOGRAMMA* AND *TRICHOGRAMMATOIDEA* GENUS (TRICHOGRAMMATOIDEA:HYMENOPTERA) IN JAVA.

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ABSTRACT

Trichogramma and *Trichogrammatoidea* are the most studied egg parasitoids in biological control programs. Information on geographical distribution and status of those genus are limited in Indonesia. The research sought to study community and species distribution of these genus across the island of Java. Egg parasitoids were surveyed by collecting host eggs from various agricultural crops across the island. Approximatelly five species of Trichogrammatidae were recorded, *Trichogrammatoidea armigera, Trichogramma flandersi, Trichogramma cojuangcoi, Trichogramma japonicum* and *Trichogramma minutum*. *T. japonicum* was the only egg parasitoid species recorded to be associated with yellow stem borer, *Scirpophaga incertulas*. *T. 'oidea armigera, T flandersi*, and *T cojuangcoi* were found to attack *P. xyllostella* and *T. minutum* was recorded to parasitize eggs of Pieridae. Results showed that *T. flandersi* and *T. minutum* are habitat specific, while the rest have a much more wider distribution, and can be found across the Java Island. *T'oidea armigera* was the most cosmopolite species that occurs across the island by parasitizing various host species including Dipteran eggs.

Key words: Egg parasitoid, community, host, parasitization, biological control

INTRODUCTION

Trichogrammatids are the common group of egg parasitoid used for biological control and parasitoid modelling across the world. The genus *Trichogramma* are the most studied and successful taxa used in biological control programs (Li, 1994). They have been used in more than 30 million ha worldwide to control lepidopteran pests in agriculture and forestry (Hassan, 1988; Li, 1994). Many species of Trichogrammatidae (Hymenoptera) are known to attack various lepidopteran host species on various agricultural crops (Alba, 1988). The Trichogrammatids also attack eggs of Hymenoptera, Neuroptera, Diptera and Hemiptera (Nagarkatti and Nagaraja, 1977), Coleoptera and Megaloptera (Clausen, 1940). Today, those parasitoids are reared usually under laboratory conditions using alternative Lepidopteran hosts (Hassan, 1993; Housewear *et al*., 1983; Herlinda, 1995; Van Bergeijk *et al.*,1989).

In Indonesia, the evaluation of *Trichogramma* and *Trichogrammatoidea* as biological control agents have been conducted through many studies (Nurindah *et al*., 1993; Herlinda, 1995; Marwoto and Supriyatin, 1999, Marwoto and Saleh 2003). Most of these studies focused on the fitness of the parasitoids, mass rearing, and mass release (Nurindah *et al*., 1993; Marwoto and Supriyatin, 1999; Marwoto and Saleh, 2003), while very limited information are available on the

taxonomic distribution and occurrence of those genus in the field. As a tropical country, Indonesia is expected to harbour large numbers of insect species, including trichogrammatids. Unfortunately, the large extent of land use change and pesticide applications may lead to species extinction, including those which have not yet been discovered. Since information on species list, distribution, niche breadth (generalist versus specialist) is very important to support biological control program, studies on the taxonomic distribution and population status of trichogrammatids are crucial.

Java is the most populated island in Indonesia and suffers the highest rate of habitat destructions, hence investigation on the population density of Trichogrammatid's species is necessary. This research was conducted to investigate the status of trichogrammatids across different regions in Java which also include the species list and egg distribution of *Trichogramma* and *Trichogrammatoidea* collected from various host species and host plants in Java.

METHODOLOGY

Study Area and Sites

Ecological samplings were conducted in different locations in East and West Java from July 1998 to June 1999 (Table 1). Egg parasitoids were collected from various agricultural crops including vegetables, paddy, and sugar cane. All collected specimens were identified in the Department of Crop Protection, Bogor Agricultural University.

Table 1. Study site of egg parasitoid survey across Java Island.

Geographical Region	District	Sites
West Java	Karawang	Jatisari, Amansari, Rengas Dengklok,
	Cianjur	Sindang Asih, Ciloto, Cipeyeum, Ciranjang
	Bogor	Darmaga, Jalan Baru, Cisarua, Cibogo, Ciampea, Leuwiliang, Sindangbarang
	Tangerang	Cengkareng
	Cirebon	Sumber , Losari, Ciledug, Kemantren
	Lembang	Cikole
	Palimanan	Beberan
	Phumbon	Kenanga
Central Java	Yogyakarta	Umbul Harjo
	Bantul	Ringroad Selatan
	Kulon Progo	Sentolo, Wates,
	Sleman	Moyundan, Godean
	Tawangmangu	Blumbangan,
	Karanganyar	Jaten
	Brebes	Wonosari,
East Java	Situbondo	Asembagus
	Malang	Pujon

Egg Parasitoid Surveys

Egg parasitoids were surveyed by collecting plants from 20% of the crop areas. Eggs from the collected plants were then temporarily stored in glass tubes containing honey solution for emerging parasitoids. These were incubated under room temperature until the parasitoids emerged and subsequently reared in *Corcya cephalonica* eggs to produce enough progeny for identification purposes. The parasitization level was estimated by using the following formula:

Parasitization (%) = (total parasitized eggs / total collected eggs) X 100%

Mass rearing of *C. cephalonica* and Trichogrammatidae

C. cephalonica eggs used for rearing were collected from livestock feed storages located in Ciawi and Karawang, West Java. Adult moths were kept in a cylinder container made of cardboard paper (8x20cm) and covered by a 25 mesh nylon for oviposition . Eggs attached on the nylon were then harvested daily to serve as hosts of trichogrammatids. Some of the *C. cephalonica* eggs were left to hatch and the larvae were reared in plastic boxes (35x25x7 cm) for maintenance of *C. cephalonica* cultures. For parasitoid rearing, host eggs were attached on a 1x10 cm paper using gum arabic and exposed to female parasitoids in 3x15 cm diameter glass tubes containing 20% honey solution**.** Females were exposed to the host eggs for 24 hours and the eggs were replaced with new ones while parasitized eggs were incubated under room temperature until emergence.

Identification

A dry collection, embedded in object glass, was prepared for identification using morphological characters. The genus level was distinguished based on wing pairs and the species level was identified from differences found in the male genitalia (Alba, 1988; Pinto, 1995; Nagarkatti and Nagaraja,1977).

RESULTS

Collection of Herbivorous Insect Eggs

The survey was conducted for seven months by collecting eggs of herbivorous insects attacking various agricultural crops across regions in Java. There were many eggs collected, among others *Scirpophaga incertulas* on paddy, *Plutella xyllostella* and *Crocidolomia pavonana* on cabbage and cauliflower, *Spodoptera litura* on shallot and red onion, *Etiella zinckenella* on soybean, and *Helicoverpa armigera* on various agricultural crops (Table 2).

Table 2. Eggs of herbivorous insects collected from various host plants and location.*

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster// Species
1	29-07-98	Jatisari, Karawang, West Java	Paddy	RBPH, YSB	28	Paddy	>100 YSB
2	18-08-98	Sindang Asih, Cianjur, West Java	Paddy	Golden snail, rat	–	Paddy, corn + pepper	–
3	22-08-98	Amansari, Rengas dengklok, Karawang, West Java	Paddy	RBPH, golden snail, YSB	–	Paddy	7 YSB

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster/ Species
4	22-08-98	Pabrik es, Karawang, West Java	Paddy	RBPH , YSB	-	Paddy	13 YSB
5	25-08-98	Darmaga, Bogor, West Java	Paddy	RBPH, GLH	-	Paddy	-
6	29-08-98	Cengkareng, Tangerang, West Java	Paddy	RBPH, GLH	-	Paddy	-
7	04-09-98	Ciloto, Cianjur, West Java	Shallot	*Spodoptera exigua*	1315	Mixed Crop, cabbage	>100 *S. exigua*
8	04-09-98	Ciloto, Cianjur, West Java	Cabbage	*Plutella xylostella*	1325	Cabbage, tomato, shallot	26 *P. xylostella*
9	05-09-98	Jalan Baru, Bogor, West Java	Corn	*Mithymna sp, Heliothis sp*	220	Corn	-
10	05-09-98	Jalan baru, Bogor, West Java	Taro	*S. litura, Spingidae*	220	Mixed crop, cassava	-
11	09-09-98	Tugu, Cisarua, Bogor, West Java	Cabbage, mustard greens	*P. xylostella*	1120	Cabbage, small red bean + lettuce	74 *P. xylostella*
12	09-09-98	Tugu, Cisarua, Bogor, West Java	Cabbage, mustard greens	*Crocidolomia pavonana*	1120	cabbage + small red bean+ lettuce	3 *C. pavonana*
13	10-09-98	Cipeyeum, Cianjur, West Java	Soybean	*S. litura, Lamprosema, Chrysodeixis*	-	Soybean	1 *S. litura,* 1 *Piezodoros*
14	14-09-98	Cibogo, Bogor, West Java	Paddy	RBPH, WSB, YSB, X1	-	Paddy, banana	3 YSB, 5 eggs X1
15	14-09-98	Batulayang, Cisarua,Bogor, West Java	Paddy	RBPH	-	Paddy, banana	-
16	16-09-98	Cubungbulan, Ciampea, Bogor, West Java	Paddy	RBPH, YSB	210	Paddy	3 YSB
17	16-09-98	Leuwiliang, Bogor, West Java	Paddy	Stink bug, YSB	230	Paddy	4 YSB
18	16-09-98	Karehkel, Leuwiliang, Bogor	Paddy	RBPH + YSB	145	Paddy	1 YSB

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster/ Species
19	07-10-98	Umbul harjo. Central Java	Paddy	RBPH + golden snail +YSB	110	Paddy	2 YSB
20	07-10-98	Bantul, Central Java	Paddy	YSB +golden snail	80	Paddy	5 YSB
21	07-10-98	Ringroad Selatan, Bantul,Central Java	Soybean	*Piezodorus sp*	40	Soybean, corn, peanut.	2 *Piezodorus*
22	08-10-98	Sentolo, Kulon Progo, Central Java	Corn	*Mithymna sp*	80	Corn, + Caper bush (*Capparis* sp)	-
23	08-10-98	Sentolo, Kulon Progo, Central Java	Paddy	YSB + rat	65	Paddy	2 YSB
24	08-10-98	Wates, Kulon Progo, Central Java	Paddy	YSB + rat	35	Paddy	2 YSB
25	08-10-98	Wates, Kulon Progo, Central Java	Red Onion and Shallot	*S. exigua*	35	Paddy, cabbage, Shallot	-
26	08-10-98	Wates, Kulon Progo, Central Java	Cabbage	*P. xylostella + C. binotalis*	35	Paddy +cabbage +Shallot	-
27	09-10-98	Moyundan, Sleman, Central Java	Paddy	YSB + rat	150	Paddy	1 YSB
28	09-10-98	Godean, Sleman, Central Java	Paddy	YSB + rat	160	Paddy	3 YSB
29	10-10-98	Blumbangan, Tawang Mangu, Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1465	Mixed crop: carrot +cabbage +shallot	157 *P. xylostella*
30	10-10-98	Blumbangan, Tawang Mangu, Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1420	Mixed crop: carrot +cabbage +shallot	108 *P. xylostella*
31	10-10-98	Blumbangan, Tawang Mangu, Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1465	Mixed crop: carrote +cabbage +shallot	12 C. pavonana
32	10-10-98	Blumbangan, Tawangmangu , Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1420	Mixed crop carrot +cabbage +shallot	16 C. pavonana

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster/ Species
33	10-10-98	Blumbangan, Tawangmangu, Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1465	Mixed crop: carrot +cabbage +shallot	9 *S. exigua*
34	10-10-98	Blumbangan, Tawang Mangu, Central Java	Cabbage	*P. xylostella, C. binotalis, S. exigua, S. litura*	1420	Mixed crop: carrot +cabbage +shallot	12 *S. exigua*
35	10-10-98	Jaten, Karang anyar, Central Java	Paddy	YSB + rat	170	Paddy	3 YSB
36	11-10-98	Tegal Catak, Umbul Harjo, Central Java	Paddy	YSB + Snail + RBPH	110	Paddy	1 YSB
37	16-10-98	Raja Baluh, Sumber, Cirebon	Paddy	Golden snail + rat	160	Paddy	-
38	16-10-98	Kramat Jati, Sumber, Cirebon	Paddy	Golden snail + rat + RBPH	110	Paddy	1 *S. litura*
39	16-10-98	Dukupuntang, Sumber, Cirebon	Paddy	X2	95	Paddy	1 cluster X2
40	17-10-98	Wonosari, Brebes, Central Java	Red Onion	larvae of *S. exigua*	10	-	-
41		Losari, Cirebon	Paddy	*Lepidopteran larvae*	75	Paddy, sugar cane	-
42		Pabuaran Lor, Ciledug, Cirebon	Red Onion	*Larvae of S. exigua*	90	Red onion	-
43	18-10-98	Kemantren, Cirebon Selatan	Paddy	-	85	Paddy	-
44	18-10-98	Kenanga, Phumbon	Paddy	YSB, eggs (X2), *S. Litura*	105	Paddy	1 *S. litura*, 3 YSB,4 X2
45		Palad, Sumber, Cirebon	Paddy	*Golden snail + rat*	150	Paddy	2 *Nezara*, 1 Egg X2
46		Beberan, Palimanan	Paddy	YSB, WSB	40	Paddy	1 YSB
47	02-11-98	Sindang Barang Bogor	Paddy	YSB + RBPH		Paddy	1 YSB
48	11-11-98	Cikole, 1 Lembang	Cauliflower	*P. xylostella*	1305	Cauliflower	26 Eggs *P. xylostella*
		Cikole, 1 Lembang	Caulflower	*C. pavonana*	1305	Cauliflower	3 clusters *C. pavonana*
		Cikole, 1 Lembang	Cauliflower	*S. litura*	1305	Cauliflower	3 clusters *S. litura*

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster/ Species
49	11-11-98	Cikole, 2 Lembang	Cabbage Caulflower	*P. xylostella*	1305	Cauliflower +cabbage +shallot +lettuce	49 eggs *P. xylostella*
		Cikole, 2 Lembang	Cauliflower	*C. binotalis*	1305	Cauliflower + cabbage +shallot +lettuce	28 clusters *C. binotalis*
		Cikole, 2 Lembang	Cauliflower	*S. litura*	1305	Cauliflower +cabbage +shallot +lettuce	1 cluster *S. litura*
		Cikole, 2 Lembang	Cauliflower	Diptera	1305	Cauliflower +cabbage +shallot +lettuce	31 Dipteran eggs
50	17-11-98	Ciranjang, Cianjur	Paddy	Stinkbug + grasshopper	390	Paddy	-
		Ciloto 1, Cianjur	Cauliflower	*C. binotalis*	1410	Mixed crop: cabbage +carrot +corn	49 clusters *C. binotalis*
		Ciloto 2, Cianjur	Cabbage	*C. binotalis*	1390	Mixed crop: cabbage +shallot	1 cluster *C. binotalis*
		Ciloto 2, Cianjur	Cabbage	Diptera	1390	Mixed crop: cabbage +shallot	13 Dipteran eggs
		Ciloto 2, Cianjur	Shallot	*S. exigua*	1390	Shallot	5 clusters *S. exigua*
51	27-02-99	Ciloto, Cianjur	Cabbage	*P. xylostella*	1350	Cabbage	96 eggs *P. xylostella*
52	-	Cianjur	Soybean	*Etiella zinckenella*	-	Soybean	-
53	-	Cianjur	Kassod tree (Cassia)	*Pieridae*	-	-	-
54	24-3-99	Asembagus, Situbondo, Jatim	Sugar cane	*S. incertulas*	0	Sugar cane	-
55	24-3-99	Asembagus, Situbondo, Jatim	Cotton	*Helicoverpa armigera*	0	Cotton	-
56	24-3-99	Malang, Jatim	Cotton	*Helicoverpa armigera*		-	-
57	25-03-99	Mantung, Pujon, Malang	Cabbage	*P.xylostella*	1090	Cabbage	85 eggs *P. xylostella*

No	Date	Location	Host Plant	Pests/hosts	Altitude (masl)	Plantations	Egg cluster/ Species
57	25-03-99	Mantung, Pujon, Malang	Cabbage	*P. xylostella*	1090	Mixed crop: cabbage	168 eggs *P. xylostella*
58	26-3-99	Malang	Soybean	*Etiella zinckenella*	370	-	-

(YSB=Yellow stemborer; RBPH=rice brown planthopper; GLH=green leafhopper, WSB=white stemborer.)

Egg parasitoid community

In total, there were approximately five species of egg parasitoids recorded from various hosts by surveying 20% of observed agricultural crops. All of the recorded egg parasitoids belong to the family Trichogrammatidae and have been identified to belong to the genus *Trichogramma* and *Trichogrammatoidea* (*T'oidea*). *T'toidea armigera*, recorded to be the most generalist species, adapts to various host species and attacks various host plants. In contrast, *T. flandersi* and *T. minutum* were only found in certain host species in a certain location (Table 3).

Table 3. Species list of Trichogramma and Trichogrammatoidea recorded from the survey.

No	Species	Hosts	Host Plant	Distribution
1	*T. flandersi*	*P. xylostella*	Cabbage	Tawangmangu
2	*T. japonicum*	*S. incertulas*	Paddy	Karawang, Bantul, Kulonprogo, Sleman, Umbul harjo
3	*T. minutum*	Pieridae	Kassod tree (Cassia)	Cianjur
4	*T'toidea cojuangcoi*	-*Plutella xylostella* -Diptera -unknown	Cabbage, Cauliflower - Plumbon-Cirebon	Lembang, Ciloto-Cianjur, Cisarua-Bogor, Tawangmangu, Pujon-Malang
5	*T'toidea armigera*	-*P. Xylostella* *Crocidolomia binotalis* -*Helicoverpa armigera* -*S. incertulas* -*Etiella zinckenella*	Cabbage Cabbage, Cauliflower Cotton Sugar cane Soybean	Cisarua-Bogor Lembang,Cianjur, Malang, Situbondo

Geographic distribution and parasitism.

Not all collected eggs were parasitized (Table 4). *Spodoptera* eggs were occasionally free of parasitism and parasitism varied from low to medium (1% to 60%). There was also host specific parasitoid species recorded from the survey. *T. japonicum* was the only species recorded to be associated with eggs of *S. incertulas* with low-medium parasitization level, between 13.60 and 33.82%, across selected locations and altitude. *T. flandersi* and *T. cojuangcoi* were two species found to parasitize eggs of *P. xyllostella* on highland brassicaceae. *T. cojuangcoi* was found to occur in the highlands, attacking Brassicaceae across Java. In contrast, *T. flandersi* was only recorded in highland area in Tawangmangu-Central Java. *T. minutum* was recorded from Pieridae eggs in cabbage plantations. A single female *T'oidea cojunagcoi* was collected from rice paddy in West Java.

T'oidea. armigera was found to be a cosmopolitan species, attacking various host species across Java. It attacks not only Lepidopteran eggs but also Dipteran eggs.

Table 4. Distribution and parasitism by egg parasitoids attacking various hosts from various plant hosts across Java.

Region	Sites	Host plant	Hosts	Altitude	% Parasiti	Species
West	Jatisari, Karawang	Paddy	*Scirpophaga incertulas*	28	-	*Trichogramma japonicum*
West Java	Tugu, Cisarua, Bogor,	Cabbage, lettuce	*P. xylostella*	1120	9.50	*T'toidea cojuangcoi* *T'toidea armigera*
West Java	Cikole, 1 Lembang	Cauliflower	*P. xylostella*	1305	11.50	*T'toidea cojuangcoi*
West Java	Cikole, 2 Lembang	Cabbage + Cauliflower	*P. xylostella*	1305	42.90	*T'toidea cojuangcoi* *T'toidea armigera*
West Java	Cikole, 2 Lembang	Cauliflower	Diptera	1305	22.60	*T'toidea cojuangcoi* *T'toidea armigera*
West Java	Ciloto 1, Cianjur	Cauliflower	*C. binotalis*	1410	1.29	*T'toidea armigera*
West Java	Ciloto, Cianjur	Cabbage	*P. xylostella*	1350	55.20	*T'toidea cojuangcoi*
West Java	Cianjur	Soybean	*Etiella zinckenella*	1200	-	*T'toidea armigera*
West Java	Cianjur	Kassod tree (Cassia)	Pieridae	1250	-	*T. minutum*
West Java	Kenanga,	Paddy	*Scirpophaga incertulas*	105	Single female	*T'toidea cojuangcoi*
Central Java	Umbul harjo.	Paddy	*Scirpophaga incertulas*	110	33.82	*T. japonicum*
Central Java	Bantul,	Paddy	*Scirpophaga incertulas*	80	25.30	*T. japonicum*
Central Java	Sentolo, Kulon Progo,	Paddy	*Scirpophaga incertulas*	65	21.15	*T. japonicum*
Central Java	Wates, Kulon Progo,	Paddy	*Scirpophaga incertulas*	35	26.49	*T. japonicum*
Central Java	Moyundan, Sleman,	Paddy	*Scirpophaga incertulas*	150	13.60	*T. japonicum*

Region	Sites	Host plant	Hosts	Altitude (M asl)	% Parasitism	Species
Central Java	Blumbangan, Tawang Mangu,	Cabbage	*P. xylostella*	1465	4.50	*T. flandersi*
Central Java	Blumbangan, Tawang Mangu,	Cabbage	*P. xylostella,*	1420	2.80	*T'toidea cojuangcoi*
Central Java	Tegal Catak, Umbul Harjo,	Paddy	*Scirpophaga incertulas*	110	25.86	*T. japonicum*
East Java	Asembagus, Situbondo,	Sugar cane	*S. incertulas*	0	-	*T'toidea armigera*
East Java	Asembagus, Situbondo,	Cotton	*Helicoverpa armigera*	0	-	*T'toidea armigera*
East Java	Malang,	Cotton	*Helicoverpa armigera*		-	*T'toidea armigera*
East Java	Mantung, Pujon, Malang	Cabbage	*P.xylostella*	1090	49.41	*T'toidea cojuangcoi*
East Java	Mantung, Pujon, Malang	Cabbage	*P. xylostella*	1090	62.50	*T'toidea cojuangcoi*
East Java	Malang	Soybean	*Etiella zinckenella*	370	-	*T'toidea armigera*

Table 5 shows the diversity of trichogrammatids found in Java. This table was compiled to assess the overall trichogrammatids that has been recorded thus far. There is one species of trichogrammatids (*T'oidea cojuangcoi*) found in this study that is a new record for Java.

Table 5. Trichogrammatid species recorded from various host plants in Indonesia.

No.	Species	Hosts	Host plant	Reference
1	*Trichogramma japonicum*	*Scirpophaga incertulas*	Paddy	Mahrub (1993), Soejitno
		Tryporyza nivella	Sugar cane	(1989), Meilin et al. (2000)
		Chillo auricilius	Sugar cane	Samoedi, *et al*., (1988)
		S. innotata	Paddy	Samoedi, *et al*., (1988)
				Kalshoven (1981)
2	*T. chilonis*	*Helicoverpa armigera*	Soybean	Herlinda, Pudjianto and Winasa (1996)
			Shallot	Shepard dan Barrion (1998)
3	*T. australicum*	*Nivella*	Sugar cane	Samoedi *et al*., (1988)
		Auricilius	Sugar cane	Samoedi *et al*., (1988)
		Chillo spp.	Sugar cane/ Paddy	Kalshoven (1981)

No.	Species	Hosts	Host plant	Reference
4	*T. chilotraeae*	*H. armigera*	Corn	Nurindah and Bindra (1989)
		Suppresalis	Corn	Uintah and Bindra (1989)
		Ostrinia furnacalis	Corn	Nurindah and Bindra (1989)
		C. infuscatellus	Sugar cane	Nagarkatti and Nagaraja (1977)
		C. sacchariphagus	Sugar cane	Nagarkatti and Nagaraja (1977)
		Etiella zinckenella	-	Nurindah and Bindra (1989)
5	*T. minutum*	*Heliothis* spp.	Tobacco	Kalshoven (1981)
		Agrius convolvuli	Sweet potato	Shepard and Barrion (1998)
		Pieridae	Soybean	Meilin *et al.* (2000)
			Cabbage	
6	*Trichogramma* sp.	*Cricula trifenestrata*	Cashew	Djuarso dan Wikardi (1977)
7	*Trichogramma* sp.	*Milionia basalis*	Pinus	Nagarkatti and Nagaraja (1977)
8	*Trichogrammatoidea*	*Etiella* sp.	Soybean	Marwoto, Supriyatin dan Djuarso (1997)
	Bactrae bactrae			Shepard and Barrion (1998)
9	*T'toidea bactrae*	*C. sacchariphagus Straminellus*	Sugar cane	Nagarkatti and Nagaraja (1977)
10	*T'toidea thoseae*	*Setora nitens*	Oil Palm	Sipayung, Chenon dan Sudharto (1989)
		Setothoseae asigna	Oil Palm	Sipayung, *et al*., (1989)
		Darna trima	Oil Palm	Sipayung, *et al*., (1989)
11	*T'toidea armigera*	*H. armigera*	Cotton	Nurindah and Bindra (1989), Meilin et al. (2000)
		D. zinckenella	Sugar cane	Nagarkatti and Nagaraja (1977)
		P. xyllostella	Cabbage	Meilin et al 2000
12	*T'toidea guamensis*	*H. armigera*	Corn	Nurindah and Bindra (1989)
13	*T'toidea nana*	*C . sacchariphagus Straminellus*	Sugar cane	Nagarkatti and Nagaraja (1977)
		C. infuscatellus	Sugar cane	Kalshoven (1981)
		Tetramoera schistaceana	Sugar cane	Kalshoven (1981)

DISCUSSION

In this survey, five species of trichogrammatids from seven hosts were collected across geographic regions in Java. The parasitization rate varies, from no parasitism at all to medium parasitism. Interestingly, all eggs of *Spodoptera* spp. were not parasitized by Trichogrammatid even though these occured in the same habitat of parasitized eggs of other species. This indicates that *Spodoptera* may not serve as a promising host for Trichogrammatid. This was supported by Djuwarso *et al.,* (1997) who identified that under laboratory conditions, *S. litura* eggs can be

parasitized by *T'toidea bactrae bactrae (*with parasitization level up to 80.3%) however the survival of the parasitoid reared on *Spodoptera* was very low, i.e. only reached 0.80%. The most common herbivorous insects attacked by trichogrammatids were *P. xylostella* and *S. incertulas,* common pests of cabbage and rice paddy. The differences in parasitism rate may reflect various factors, i.e the use of pesticides (which resulted in low parasitism rate), differences in population size of the parasitoids, differences in ability of parasitoids to find and parasitize their hosts, and differences in landscape structure. Complex landscape, whereby various vegetation can be found within a landscape has been found to be correlated with high incidence of parasitism (Buchori *et al.*, 2008, Hunter, 2002, Marino *et al*., 2006). This finding suggests that for parasitoid conservation, landscape structure that harbors high diversity of vegetation is crucial in maintaining parasitoid presence.

From five trichogrammatid species, three species were recorded to attack eggs of *P. xylostella*. Meilin *et al*., (2000) reported that *Trichogramma flandersi, T'toidea cojuangcoi, T'toidea armigera* were three species found to be associated with *P. xyllostella* in Indonesia. This finding was different with several studies on Trichogrammatid attacking *P. xylostella* in other countries. In Thailand, species that were found to be associated with this pest are *T'toidea bactrae* Nagaraja and *T. confusum* Viggiani, in Japan were *T. chilonis* Ishii (Keinmessuke *et al*., 1992; Klemm *et al*., 1992) and in Philipine were *T. evanescens* and *T'toidea armigera* (Alba 1988). In this study, *T'toidea cojuangcoi* was recorded to parasitize eggs *P. xyllostella*, however in the Philippines, this species was reported to attack *Acrocercops cramerella*, a cocoa pod borer and rambutan pest (Alba, 1988).

T'toidea armigera was the only species found to attack several host species including *P. xylostella, C. binotalis, H. armigera, S. incertulas* and *E. zinckenella*. This species was also found across geographic regions and host plants. Previous studies reported that *T'toidea armigera* attacks *H. a*rmigera on cotton plantations (Nurindah and Bindra, 1989) and tomato (La Daha, 1997), *Etiella zinckenella* in sugar cane plantations (Nagarkatti and Nagaraja, 1977). An interesting result was that *T'toidea armigera* survived in eggs of *C. pavonana* with low level parasitism. This was the first finding reported the association of *T'toidea armigera* and *C. pavonana* in Indonesia. These findings suggested that *C. pavonana* may serve as potential alternative hosts in the field. Further research is needed to evaluate the ability of the species to control *C. pavonana* in the field. Since *C. pavonana* has not been controlled using biocontrol agents, it is very important for biocontrol measures against *C. pavonana* be developed.

T. japonicum Ashmead is the only species found to be associated in paddy fields by parasitizing yellow stem borer (*S. incertulas*). This was confirmed by Nagarkatti and Nagaraja (1977) who reported that *T. japonicum* was associated with paddy field. Further research supports the results that the species was found to attack *S. incertulas* in paddy field (Soejitno, 1989; Mahrub, 1993).

In the research, *T. minutum* was reported to parasitize eggs of Pieridae on Kassod tree (*Cassia seamea)*, however some research reported different results, this species attacks *Heliothis* spp. on tobbaco (Kalshoven, 1981) and *Agrius convolvuli* on sweet potato and soybean (Shepard and Barrion, 1998). Our results are new findings for Indonesia, i.e *T. minutum* can be found in perennial trees.

CONCLUSIONS

Three species of *Trichogramma* and two species of *Trichogrammatoidea* were recorded in this survey. *T. flandersi* and *T. japonicum* were found to be more host species specific, compared to other trichogrammatids. A new record of Trichogramma was found in *Croccidolomia pavonana*, a very important pest of cabbage. *T'oidea. armigera* and *T. cojuangcoi* are found to be able to survive in alternative species. These findings are valuable information for biological control programs. Further field investigation and laboratory tests are needed to verify the effectiveness of those

identified species for biological control agents.

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