Research article

Diversity of Aquatic Insects in the Organic and Conventional Rice Fields in Khon Kaen Thailand

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Abstract Water quality has significant effects toward the diversity and distribution of aquatic insect. The application of fertilizer and pesticides may degrade water quality and affect to diversity of aquatic insects. Aquatic insect in rice fields was surveyed to compare the diversity between organic and conventional rice fields in Khon Kaen province during June to October 2015. Three replication of sampling by aquatic sweep net were conducted at sampling sites. The result showed that aquatic insect was represented by 17 species belongs to 16 families of 6 orders. The order Hemiptera was the highest in abundance groups in the fields (5 families) followed by Odonata (3 families), Diptera (3 families), Coleoptera (2 families), Ephemeroptera was the lowest in abundance (2 families) and Collembola (unidentified family). The richness of aquatic insects in the organic rice field was found slightly higher than the conventional one. The species diversity index (H') was 0.427 in organic site and conventional site was 0.401. This study is considered to have no significant in diversity or abundance of aquatic insects between organic and conventional rice field. Order Hemiptera was found abundant and dominant among other orders.

Keywords aquatic insect, organic rice field, conventional rice field

INTRODUCTION

Rice production is one of the main agricultural activities in Thailand. Mostly, there are two types of rice cultivation include organic and conventional methods (Kenji et al., 2005). For the convention rice cultivation, synthetic chemicals such as fertilizer and pesticides are generally applied while these chemicals are not used in the organic rice cultivation. Aquatic insects play an important role in aquatic ecosystem functioning (Dunbar et al., 2010). They are an important component of invertebrate assemblages in aquatic ecosystem where they are a controlling group in food webs. At the larval stage, they constitute the principal nutritive fauna for fish. Diversity of aquatic insects in rice field can be divided into two groups: beneficial and insect pests (Bambaradeniya, 2000; DOA, 2010). The beneficial insects are usually known as natural enemies Natural enemies are also known as biological agents in biological control for minimizing the population of insect pests. In paddy field, some of the predators in rice fields are associated with water. Improper agronomic practices in rice field such as the extensive used of fertilizers and pesticides may degrade the disturbance of water quality. The diversity and distribution of aquatic insect communities, considering that some species of insects are very sensitive to pollution and prefer to live in good environment with good quality water (Mohd Rasdi et al., 2012). Thus, the objective of this study is to compared diversity of aquatic insects between organic and conventional rice cultivation in Khon Kaen province northeastern Thailand.

METHODOLOGY

The study was carried out in irrigation rice fields at the Khon Kaen province, north-eastern Thailand during June to October 2015. Study site was divided into two plots; organic cultivation (no chemical pesticides and chemical fertilizers applied) and conventional cultivation (applied chemical pesticides and chemical fertilizers). The samples were taken two2 periods including early period (30 days after transplanting, DAT) and mid period (60 days after transplanting, DAT). Aquatic insects were collected in three replications at each sampling areas. The insects were randomly collected using sweeping net dragged about one meter. The samples were preserved in 70% ethyl alcohol and were identified at least up to taxonomic order using the identification guides of Dudgeon (1999), McCafferty (1983), Yule and Sen (2004). The specimens were also compared with the reference collections at the Insect Museum, Faculty of Agriculture, Khon Kaen University. The Shannon-Wiener's diversity index (Krebs, 1999), was used to calculate the diversity of aquatic insects. The formula of the Shannon-Wiener's diversity index (*H´)* used is presented as follow

$$H' = \sum_{i=1}^{s} (pi)(\ln pi)$$

Where *H*' is species diversity index, *s* is number of species and *pi* is proportion of the total sample belonging to *i* th species. The evenness index (J´) (Krebs, 1999) was calculated to determine the equal abundance of aquatic insects in each study site as follows:

$$J' = \frac{H'}{H'\mathrm{MAX}}$$

Where *H´* is observed index of species diversity and *H´*MAX is maximum possible index of diversity. Shannaon-Wiener Index (H') which accounts for both abundance and evenness was used to characterize species diversity. Diversity values may very directly with water quality and low diversity may indicate an unstable community (Chiangthong and Phalaraksh, 2007).

RESULTS AND DISCUSSION

A total of 951 individual of aquatic insects from six orders (Hemiptera, Diptera, Coleoptera, Odonata, Ephemeroptera and Collembola) and twenty-three different families were recorded in this study. The order Hemiptera was the highest in abundance groups (8 families included Hydrometridae Mesoveliidae Micronectidae Notonectidae Veliidae Nepidae Gerridae and Pleidae) followed by Coleoptera (5 families included Dytiscidae Norteridae Hydraenidae Hydrophilidae and Scirtidae), Diptera (4 families included Ceratopogonidae Chironomidae Culicidae and Stratiomyidae), Odonata (3 families included Coenagrionidae Libellulidae and Protoneuridae) Ephemeroptera (2 families of Baetidae and Caenidae) and Collembola was the lowest in abundance (1 unidentified family). Table 1 shows the insect composition for two sampling periods of two studied sites. The most abundance of aquatic insect was found in mid period than the early period. The richness of aquatic insects in the organic site was found slightly higher than the conventional site. The dominant aquatic insects found in this study were from the Micronectidae with 21 percentage of abundance followed by Baetidae (18.30%) and Coenagrionidae (6.73%). In organic rice field, the Order Hemiptera was found highest in number of taxa followed by Odonata and Diptera in early period (30 DAT). Order Hemiptera was also the highest of number taxa in the mid period (60 DAT) followed by Ephemeroptera and Diptera respectively. Meanwhile, order Collembola was found only in mid period (Fig. 1). In conventional rice field, order Odonata was found highest of number taxa in early period followed by order Hemiptera and Diptera respectively while order Ephemeroptera was found highest of number taxa in mid period followed by order Coleoptera and Hemiptera respectively. In this study, order Collembola was found only in mid period similar to the organic rice field. The Collembola is dominant group of scavenger in the rice field. They are known as an important source prey for predator insect (Alvarez et al., 1997) The collembolan are more abundant in moist rice soil rich in organic matter and may decrease abundant in rice field after pesticide application. Moreover, the different species react differently to the changing conditions as the plant grows and canopy close (Takagi et al., 1996).

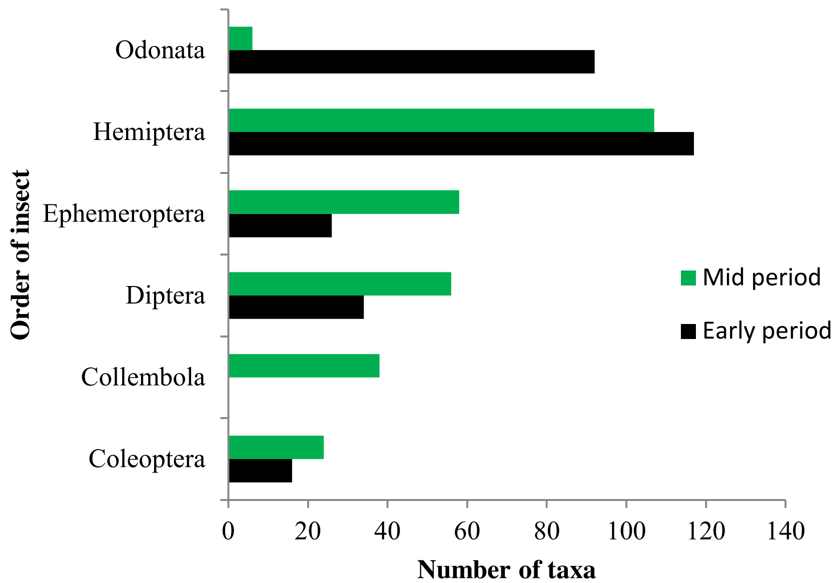

Fig. 1 Taxonomic of aquatic insects in conventional rice field

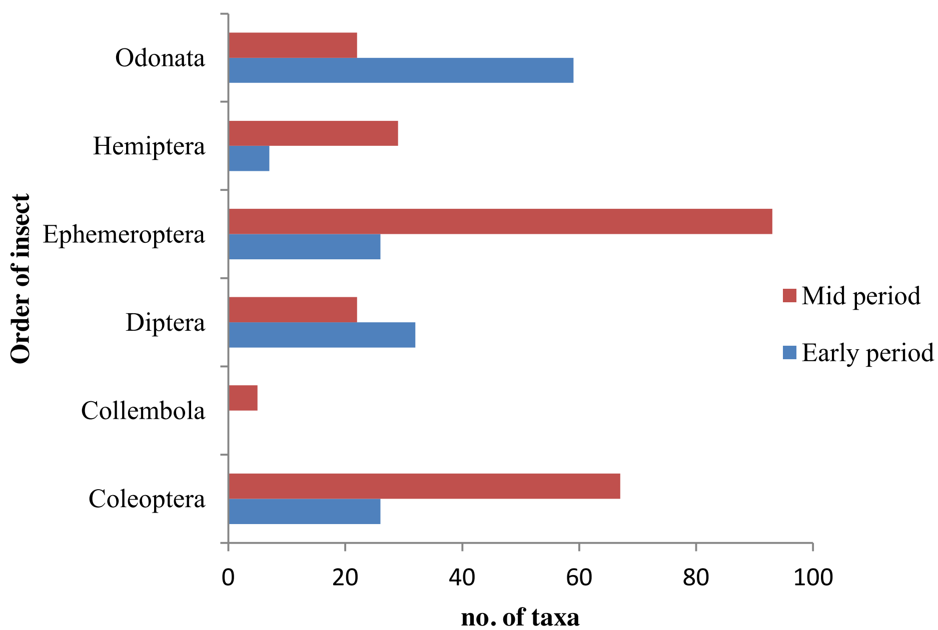

Fig. 2 Taxonomic of aquatic insects in the conventional rice field

Table 1 Relative proportion of aquatic insects in the organic rice field (ORG) and the conventional rice field (CON) at Khon Kaen province Thailand

			Early Period		Mid Period		total	%abundance
Order	Family	Genus	ORG	CON	ORG	CON		
Coleoptera	Dytiscidae	unknown	2	0	5	6	13	1.37
Coleoptera	Dytiscidae	*Hydaticus sp.*	0	23	0	1	24	2.52
Coleoptera	Dytiscidae	*Hydrovatus sp.*	1	0	1	8	10	1.05
Coleoptera	Dytiscidae	*Hydroporus sp.*	0	0	1	0	1	0.11
Coleoptera	Dytiscidae	*Hyphydrus sp.*	9	0	7	0	16	1.68
Coleoptera	Dytiscidae	*Eretes sp.*	1	0	0	0	1	0.11
Coleoptera	Norteridae	unknown	0	0	2	2	4	0.42
Coleoptera	Norteridae	*Hydrocanthus sp.*	0	0	0	1	1	0.11
Coleoptera	Hydraenidae	*Hydraena sp.*	2	0	0	1	3	0.32
Coleoptera	Hydrophilidae	unknown	1	2	0	31	34	3.58
Coleoptera	Hydrophilidae	*Hydrobiomorpha sp.*	0	1	0	4	5	0.53
Coleoptera	Scirtidae	unknown	0	0	8	12	20	2.10
Collembola			0	0	38	5	43	4.52
Diptera	unknown		0	0	1	0	1	0.11
Diptera	Ceratopogonidae	*Bezzia sp.*	1	0	23	1	25	2.63
Diptera	Chironomidae	*Chironominae*	12	0	22	4	38	4.00
Diptera	Chironomidae	*Tanypodinae*	8	21	6	0	35	3.68
Diptera	Culicidae	unknown	12	8	0	17	37	3.89
Diptera	Stratiomyidae	*Odontomyia sp.*	1	3	4	0	8	0.84
Ephemeroptera	Baetidae	*Cloeon sp.*	26	0	57	91	174	18.30
Ephemeroptera	Caenidae	*Caenodes sp.*	0	26	1	2	29	3.05
Hemiptera	Hydrometridae	*Hydrometra sp.*	0	0	2	1	3	0.32
Hemiptera	Mesoveliidae	*Mesovelia sp.*	0	0	1	7	8	0.84
Hemiptera	Micronectidae	*Micronecta sp.*	105	1	90	10	206	21.66
Hemiptera	Notonectidae	*Notonecta sp.*	0	3	5	0	8	0.84
Hemiptera	Notonectidae	*Aphelonecta sp.*	7	0	0	0	7	0.74
Hemiptera	Notonectidae	*Nychia sp.*	0	0	9	0	9	0.95
Hemiptera	Veliidae	*Pseudovelia sp.*	0	0	0	1	1	0.11
Hemiptera	Nepidae	*Ranatra sp.*	3	0	0	0	3	0.32
Hemiptera	Nepidae	*Laccotrepes sp.*	1	1	0	0	2	0.21
Hemiptera	Gerridae	*Amemboa sp.*	0	2	0	0	2	0.21
Hemiptera	pleidae	*Paraplea sp.*	1	0	0	0	1	0.11
Odonata	Coenagrionidae	unknown	0	0	5	22	27	2.84
Odonata	Coenagrionidae	*Agrionemis sp.*	63	0	1	0	64	6.73
Odonata	Libellulidae	*Brachythemis sp.*	1	33	0	0	34	3.58
Odonata	Libellulidae	*Crocothemis sp.*	24	0	0	0	24	2.52
Odonata	Libellulidae	*Orthemis sp.*	0	24	0	0	24	2.52
Odonata	Libellulidae	*sympetum sp.*	0	1	0	0	1	0.11
Odonata	Protoneuridae	*Prodasineura sp.*	4	1	0	0	5	0.53
		total	285	150	289	227	951	100

The highest Shannon-Weiner Index in organic rice fields which was 2.02 in mid period. The lowest indexes were found in conventional rice fields and organic rice which was 1.92 in early period (Fig. 3). In this study the diversity index of aquatic insects is no different between organic and conventional rice field were similar to those recorded by Rozilah and Ali (1998), where no significant in diversity or abundance of aquatic insects when insecticide treated and untreated rice fields were compare. This study showed that the number of families in aquatic insects from organic cultivation (15 families) was less than conventional cultivation (16 families) in mid period, but found that Shannon-Weiner Index average score was higher in organic site than conventional site and found the populations of aquatic insects were higher in the fields. Roger (1996), maintain that the dominance of faunal assemblages by one or two taxa and lowered species richness is likely to indicate community disturbance by agrochemicals in rice field environments. In this study, the insect samples taken from the organic rice field in mid period assemblages with greater richness and slightly higher Shannon diversity indices than those collected from the conventional rice field. The major distinction between these management regimes was the application of agrochemicals exclusively to the conventional rice fields. According to Settle et al., (1996) demonstrated that the loss of species richness and decreased faunal assemblage evenness after pesticide applications.

(A) (B)

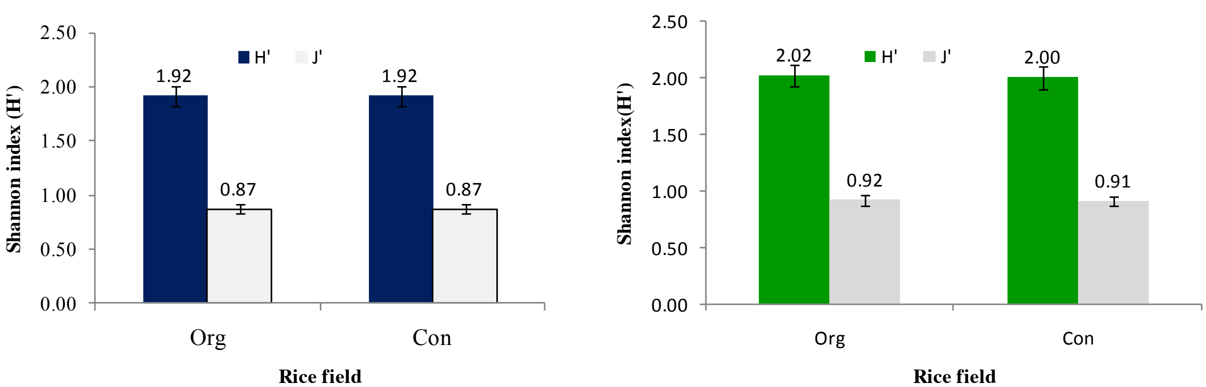

Fig. 3 Comparison between Shannon index and Evenness of aquatic insects in organic rice field (org) and conventional rice field (Con): (A) early period, (B) mid period

CONCLUSION

This study concluded that the organic cultivation method was recommended to apply in rice fields. Although, Shannon-Wiener diversity index showed no significantly difference between two rice cultivation practices. The interesting point arising from this study is that the aquatic insects representative of the Coleoptera, Hemiptera and Odonata were all beneficial insects as predator of rice pest. The result from this study indicates that the aquatic insect communities are important factors for check and balance in rice fields thereby controlling increase in insect pest populations. This condition is important in understanding ecological rice pest management. For the further work, the water parameters should be included.

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