

## SISTEM MINA PADI DI DESA MANIK RAMBUNG MENDUKUNG KETAHANAN PANGAN SUMATERA UTARA

### FISH-RICE FARMING AREA AT MANIK RAMBUNG RICE FIELD SUPPORTED FOOD SECURITY IN NORTHERN SUMATRA

Ameilia Zuliyanti Siregar

Program Studi Agroekoteknologi, Fakultas Pertanian USU, Medan- 20155

Corresponding author : [zuliyanti@yahoo.com](mailto:zuliyanti@yahoo.com), [azsyanti@gmail.com](mailto:azsyanti@gmail.com)

#### ABSTRACT

*Rice and fish have been an essential part of the life of Indonesian people which produce from rice field. The research was conducted during two years (Dec.2008 to Sept.2010) using a purposive random sampling using three plots in lowland and terrace from Manik Rambung Rice Field (MRRF). Two types of rice crops (Ciherang and IR 64) are cultivated showed 6 orders, 21 families, 34 taxa and 25 species. Oligochaeta, Ephemeroptera, Hemiptera and Diptera were identified respective families, while families of Odonata and Coleoptera were further identified to species. There are three categories of Dominance Index (DI) in rice field, these are: D=Dominant ( $\geq 5\%$  individual); A=Accessory ( $2.5\% \leq D \leq 5\%$  individual) and O=Occasional ( $<2.5\%$  individual) with four families (Baetidae, Chironomidae, Tubificidae and Ceratopogonidae) as ranked high on the DI list. The Kruskal-Wallis test showed significant differences between abundance of aquatic organisms during the time of sampling ( $\chi^2=1274.840$ ,  $P=0.000$ ), rice growing seasons ( $\chi^2=16.393$ ,  $P=0.001$ ) and rice cultivation phases ( $\chi^2=8.618$ ,  $df=4$ ,  $P=0.004$ ). The study about fish farming produce plant and animal proteins and sustainable for food security in Northern Sumatra.*

*Keywords: Fish farming, Manik Rambung, food, security and Northern Sumatra*

#### ABSTRAK

*Beras dan ikan merupakan komponen penting bagi masyarakat Indonesia yang dihasilkan dari sawah padi. Penelitian ini dilakukan selama dua tahun, dimulai sejak Desember 2008 hingga September 2010 menggunakan metode rancangan acak kelompok pada tiga plot pada dataran rendah dan dataran tinggi pada pertanaman padi di Desa Manik Rambung (SPMR). Dua jenis tipe padi (Ciherang dan IR 64) di tanam menunjukkan 6 ordo, 21 famili, 34 taksa dan 25 spesies. Oligochaeta, Ephemeroptera, Hemiptera and Diptera diidentifikasi sampai tingkat famili, manakala Odonata dan Coleoptera diidentifikasi sampai tingkat spesies. Dikategorikan dari Indeks Dominan (ID) di sawah padi terdiri dari: D=Dominan ( $\geq 5\%$  individu); A=Sering ( $2.5\% \leq D \leq 5\%$  individu) and O=Jarang ( $<2.5\%$  individu) dengan empat famili (Baetidae, Chironomidae, Tubificidae dan Ceratopogonidae) sebagai urutan tertinggi dari daftar Indeks Dominan. Uji Kruskal-Wallis menunjukkan perbedaan signifikan antara kelimpahan serangga akuatik selama masa penyampelan ( $\chi^2=1274.840$ ,  $P=0.000$ ), musim pertanaman padi ( $\chi^2=16.393$ ,  $P=0.001$ ) dan fase pertanaman padi ( $\chi^2=8.618$ ,  $df=4$ ,  $P=0.004$ ). Kajian yang dilakukan pada mina padi memberikan keuntungan menghasilkan protein nabati dan hewani dan menjaga ketahanan pangan di Sumatera Utara.*

*Kata Kunci: Mina padi, Manik Rambung, ketahanan, pangan dan Sumatera Utara.*

## INTRODUCTION

Rice-based fish farming is the main source of earning in many parts of the world. There is 11 million ha of flood prone land under rice cultivation covered from 81 million ha of irrigated rice lands in the worldwide. Presently, common carp *Cyprinus carpio* is the main target species of freshwater aquaculture production in South, Southeast, West Africa and East Asia (Saikia and Das, 2008).

The common carp (*Cyprinus carpio* L.) is probably the first fish species whose distribution was widely extended by human introduction in Indonesia (Halwart, 1998), since its introduction by the Romans from the River Danube throughout Europe (Hartvich *et al.*, 2003).

Table 1. Production, harvesting area, and productivity of rice in Sumatera Utara

Year	Production (Ton)	Wide of Harvest (Ha)	Productivity (Kw/Ha)
1998	3.321.049	823.749	40.32
1999	3.451.430	838.626	41.16
2000	3.514.253	847.61	41.46
2001	3.291.515	801.948	41.04
2002	3.153.305	765.161	41.21
2003	3.401.004	825.264	41.21
2004	3.418.782	826.091	41.39
2005	3.447.394	822.073	41.94
2006	3.423.762	813.415	42.09

(Source: BPS Sumatera Utara, 2007)

Indonesian rice fields in Manik Rambung, Sumatera are intensively managed starting from land preparation, transplanting of seedlings to harvesting for about six months. During inundated phases of these cultivation processes, aquatic organisms survived in the areas in varying abundance (Che Salmah and Abu Hassan, 2002). Pereira *et al.* (2000) reported on the aquatic community responses to water supply and soil permeability; fertilizers and pesticide application (Hayasaka *et al.*, 2012); seasonal climatic changes (Lupi *et al.*, 2013) in the rice field. Meanwhile Wissinger (1989) found water level (Mogi, 2007) and cultivation phases (Che Salmah

The systems of rice fish is being practiced in Thailand (3 million ha), Bangladesh, India (Saikia and Das, 2009), Cambodia, China (1.2 million ha), Egypt (173000 ha), Indonesian (138000 ha), Republic of Korea, Vietnam (40.000 ha), and Madagascar (13000 ha) (Halwart, 1998) and Central Europe (Hartvich *et al.*, 2003).

Indonesian people are popularly referred "fish-rice farming." Rice and fish have been an essential part of the life of Indonesian people from time immemorial. Rice farming is the single most important livelihood for a vast majority of the rural poor. Otherwise, Sumatera Utara has four central production of rice, such as Deli Serdang, Simalungun, Karo, and Madina. Data of rice production and harvesting area in Sumatera can look at table 1.

and Abu Hassan, 2002) of paddy affected the aquatic communities.

Rice cultivation activities regulate the abundance of various aquatic organisms in rice fields. For instance, abundances of *Culex* and *Anopheles* mosquitoes are high during ploughing of the field, while Dysticidae, Anisoptera and Zygoptera are more abundant in tiller or mature fields (Mogi and Miyagi, 1990; Che Salmah and Abu Hassan 2002). Other aquatic organisms such as hydrophilid, ostracods, gastropods and corixids succinate when the water surface is completely exposed to sunlight on ratoons of *O.sativa* during the fallow

period (Schoenly *et al.*, 1998). Rice cultivation phases are separated following specific characteristics of the rice field during the cultivation process. The depth of water and the amount of shading of water surface by progressive growth of rice plants determine the groups or species of aquatic organisms that prefer such microhabitats or environments.

In the plough phase when the water level is approximately 40 cm, some of the aquatic organism, such as oligochaete worms, dipterans chironomids and mosquitoes, ephemeropteran Baetidae, hemipterans Belostomatidae and *Micronecta*, coleopterans *Berosus* (Hydrophilidae), *Laccophilus*, *Hydrovatus* (Dysticidae), Elmidae and Odonata are abundant in rice fields (Hidaka, 1998; Che Salmah, 1996; Suhling *et al.*, 2000; Molozze *et al.*, 2007; Amir Shah Ruddin *et al.*, 2008).

Despite the common carps ubiquity and economic importance, little is known of its feeding ecology in natural systems (Jiri & Zdnek, 2008). The functional morphology of its feeding apparatus (Sibbing, 1988) and the impact of this cyprinid species on macrophytes and water quality have been well documented. Yet most of the studies on diet have been done on fish culture ponds (Mitchel and Oberdoff, 1995) with a very preliminary report from rice fields.

## MATERIALS AND METHODS

A fish farming is located were N2°53'52.4" and E97°02'26.3" at 612 feet above sea level. Manik Rambung is the only agrarian tribe practicing settlement agriculture in this part of Simalungun district, North of Sumatera. Average rainfall is 173.97 cm and temperature covers a range from maximum 28.2°C in dry and to minimum 20.4°C in wet season. The relative humidity varies from 78 % to 89%. Mean  $\pm$  SE of water depth were  $24.39 \pm 0.069$ , pH score were  $7.45 \pm$

$0.235$ , and water temperature showed  $26.77 \pm 0.294$ .

A fish culture is a wet field when water level could reach up to 15-50 cm. Twenty golden fishes (*Cyprinus carpio*) were livestock in each ponds, consist of 2 ponds with fishes and 1 pond without fish. Fishes were given pellet, plankton and periphyton in the ponds every two days until eight weeks. Tropical rice field usually have a particular diverse insect fauna which serve as an important food source for fishes (Fernando 1993). Fish culture in rice fields had a checkered history during 4 seasons of fish farming (start from January 2009 to February 2009, July to August 2009; January to February 2010; and July to August 2010), the total are 240 days when records are available.

Thirty samples of aquatic organisms were collected from three plots each with an approximate area of 40 x 60 meter (2400 square meter). Aquatic organisms were sampled biweekly using combine samplers, a core sampler (85 cm high and 46 cm in diameter) and an aquatic net (40 cm x 40cm, 400  $\mu$ m mesh) (Lawton, 1971; Che Salmah, 1996 and Wilson *et al.*, 2008). The core sampler was pressed into the sediment and the bottom area stirred by hands for three to five minutes. The content was collected and passed through a fish net (0.5 mm mesh) using a plastic dipper. The aquatic organisms were transferred into a plastic bag, fastened with a rubber band. The collected samples were placed in a chilled ice to maintain samples in a good condition and brought to the laboratory.

In the laboratory, each sample was washed in a tray and screened through successive sieves of 1 mm, followed by 0.5 mm mesh size. Larvae of aquatic insects were sorted visually using a pair of fine forceps. They were placed in universal bottles containing 75% ethanol (ETOH) and identified to respective taxa or species under a dissecting microscope (Olympus CX41, Japan) following key by Usinger (1956); Edmonson (1992); Ward

(1992); Morse *et al.* (1994); Triplehorn *et al.* (2006) and Merritt and Cummins (2006). Then the mean difference of aquatic organisms were analyzed with Kruskal-Wallis test (at  $P < 0.05$ ) using the SPSS version 20.0 to determine differences among sampling times, rice growing seasons and rice cultivation phases.

## RESULTS AND DISCUSSIONS

### Abundance of Aquatic Insects in MRRF

A total of 48,127 individuals were collected during August 2008 to Table 1. List of aquatic organisms were identified from four rice growing seasons (2008-2010)

August 2010 from in MRRF comprising of 6 orders, 21 families, 34 taxa and 25 species (Table 1). Oligochaeta, Ephemeroptera, Hemiptera and Diptera were identified respective families, while families of Odonata and Coleoptera were further identified to species. The percentage dominance index of aquatic organisms varied from 0.01% to 27.97%. Higher percentages of aquatic organisms were represented by Baetidae (27.97%), Chironomidae (27.40%) and Tubificidae (22.91%), while *I. decorates* and *P. congener* (0.01%) were the lowest (Table 1).

DI=Dominance Index; D=Dominant( $\geq 5\%$ ); A=Accessory ( $2.5\% \leq D \leq 5\%$ ); O=Occasional ( $< 2.5\%$ )

Class/Order/Family/Species	Total organisms	DI (%)	Categories of DI
<b>Oligochaeta</b>			
Lumbricidae	186	0.39	O
Tubificidae	11028	22.91	D
<b>Ephemeroptera</b>			
Baetidae	13464	27.97	D
Caenidae	235	0.49	O
<b>Odonata</b>			
<b>Zygoptera</b>			
Coenagrionidae	1373	2.86	A
<i>Agriocnemis femina</i> (Rambur)	776	1.61	
<i>Agriocnemis pygmaea</i> (Rambur)	339	0.7	
<i>Agriocnemis rubescens</i> (Selys)	39	0.08	
<i>Ischnura senegalensis</i> (Rambur)	147	0.31	
<i>Pseudagrion microcephalum</i> (Rambur)	35	0.07	
<i>Pseudagrion pruniosum</i> (Burmeister)	17	0.04	
<i>Pseudagrion rubriceps</i> (Selys)	20	0.04	
<b>Anisoptera</b>			
Gomphidae	5	0.01	O
<i>Ictinogomphus decorates</i> (Selys)	5	0.01	
Libellulidae		2.49	O
<i>Acisoma panorpoides</i> (Rambur)	16	0.03	
<i>Crocothemis servilia</i> (Drury)	89	0.18	
<i>Diplacodes trivialis</i> (Rambur)	10	0.02	
<i>Neurothemis ramburii</i> (Kaup in Brauer)	20	0.04	
<i>Neurothemis terminata</i> (Ris)	34	0.07	
<i>Orthetrum sabina</i> (Drury)	578	1.2	
<i>Orthetrum testaceum</i> (Burmeister)	26	0.05	
<i>Pantala flavescens</i> (Fabricius)	357	0.74	

<i>Potamarcha congener</i> (Rambur)	6	0.01	
<i>Trithemis aurora</i> (Burmeister)	28	0.06	
<i>Tholymis tillarga</i> (Fabricius)	30	0.06	
<b>Hemiptera</b>			
Belostomatidae	36	0.49	O
Corixidae	248	0.52	O
Mesovellidae	299	0.62	O
Nepidae	161	0.33	O
Notonectidae	226	0.47	O
Veliidae	285	0.59	O
Pleidae	241	0.5	O
<b>Coleoptera</b>			
Dysticidae	162	0.33	O
<i>Laccophilus</i> sp	90	0.19	
<i>Cybister</i> sp	72	0.15	
Hydrophilidae		0.53	O
<i>Berosus</i> sp	255	0.53	
Noteridae		0.54	O
<i>Noterus</i> sp	259	0.54	
<b>Diptera</b>			
Chironomidae	13188	27.4	D
Ceratopogonidae	4332	9	D
Culicidae	471	0.98	O
<i>Culex</i> sp	253	0.53	
<i>Anopheles</i> sp	218	0.45	
Tipulidae	279	0.58	O

According to Kandibane *et al.* (2005) and Oliveira and Vasconcelos (2010), there are 3 categories of Dominance Index (DI) in rice field, these are: D=Dominant ( $\geq 5\%$  individual); A=Accessory ( $2.5\% \leq D \leq 5\%$  individual) and O=Occasional ( $< 2.5\%$  individual). Four families of aquatic organisms, such as Baetidae, Chironomidae, Tubificidae and Ceratopogonidae ranked high on the DI list. Among the Odonata, three species *A. femina*, *A. pygmaea* (Coenagrionidae)

and *O. sabina* (Libellulidae) were dominant in MRRF.

Separating the collection according to rice growth phenology, the highest number of aquatic organisms was collected during the plough phase, then the transplanting to the young phase and followed by the tiller phase. Lower number of aquatic organisms were collected during the fallow and the mature phases (Table 2).

Table 2. Total of aquatic organisms from four rice growing seasons based on rice cultivation phases in MRRF

Notes: FA=Fallow field phase, PF=Plough phase, TF=Transplanting and young phase; TR=Tiller phase; MF=Mature to preharvest phase,( )=Dominance index (%).

Class/Order/Family/Species	FA	PF	TF	TR	MF
<b>Oligochaeta</b>					
Lumbricidae	0 (0)	76 (0.24)	46 (0.32)	34 (2.66)	30 (3.86)
Tubificidae	54	7123	3695	84 (6.58)	72 (9.27)
<b>Ephemeroptera</b>	(13.04)	(22.68)	(25.91)		

Baetidae				70 (5.48)	36 (4.63)
Caenidae	0 (0)	9722	3636	32 (2.50)	19 (2.44)
<b>Odonata</b>	1(0.24)	(30.95)	(25.50)		
<b>Zygoptera</b>		115 (0.37)	68 (0.48)		
Coenagrionidae					
<i>Agriocnemis femina</i>				116 (9.08)	16 (2.06)
<i>A. pygmaea</i>	28 (6.76)			59 (4.62)	20 (2.57)
<i>Ischnura senegalensis</i>	20 (4.83)	422 (1.34)	194 (1.36)	30 (2.35)	20 (2.57)
Other Zygoptera	10 (2.41)	158 (0.50)	82 (0.57)	17 (1.33)	7 (0.90)
Gomphidae	0 (0)	51 (0.16)	36 (0.25)		
<i>Ictinogomphus decorates</i>		64 (0.20)	23 (0.16)	1 (0.08)	0 (0)
<b>Anisoptera</b>	0 (0)				
Libellulidae		3 (0.0019)	1 (0.0017)		
<i>Orthetrum sabina</i>				97 (7.59)	89
<i>Pantala flavescens</i>	25 (6.04)			80 (6.26)	(11.45)
Other Anisoptera	15 (3.62)	201(0.64)	166 (1.16)	48 (3.76)	53 (6.82)
<b>Hemiptera</b>	20 (4.83)	134 (0.43)	75 (0.53)		36 (4.63)
Corixidae		94 (0.30)	60 (0.42)	33 (2.58)	
Mesovellidae	15 (3.62)			43 (3.37)	22 (2.83)
Notonectidae	28 (6.76)	112 (0.36)	73 (0.51)	46 (3.60)	25 (3.22)
Other Hemiptera	22 (5.31)	119 (0.38)	91 (0.64)	134(10.49)	26 (3.35)
<b>Coleoptera</b>	62 (4.98)	123 (0.39)	71 (0.50)		82
Dysticidae		358 (1.14)	233 (1.63)	26 (2.04)	(10.55)
Hydrophilidae	10 (2.41)			51 (3.99)	
Noteridae	18 (4.35)	68 (0.22)	40 (0.28)	61 (4.78)	18 (2.32)
<b>Diptera</b>	11 (2.66)	87 (0.28)	76 (0.53)		30 (3.86)
Chironomidae		87 (0.28)	80 (0.56)	48 (3.76)	20 (2.57)
Ceratopogonidae	26 (6.28)			82 (6.42)	
Culicidae	16 (3.86)	9419	3680		31 (3.99)
<i>Culex sinensis</i>		(29.99)	(25.81)	30 (2.35)	56 (7.21)
<i>Anopheles vagus</i>	11(2.66)	2526 (8.04)	1642	27 (2.11)	
Tipulidae	8 (1.93)		(11.52)	28 (2.19)	23 (2.96)
	14 (3.38)	111 (0.35)			22 (2.83)
		97 (0.31)	78 (0.55)		24 (3.09)
		131 (0.42)	30 (0.21)		
			82 (0.58)		
<b>Total</b>	<b>414</b>	<b>31401</b>	<b>14258</b>	<b>1277</b>	<b>777</b>

Three orders (Oligochaeta, Ephemeroptera and Diptera) were widely distributed in the study sites, while some Coleoptera and Hemiptera were found in lower abundance in MRRF (Figure 1). The Kruskal-Wallis test showed significant differences between abundance of aquatic organisms during the time of sampling ( $\chi^2=1274.840$ ,  $P=0.000$ ), rice growing seasons ( $\chi^2=16.393$ ,  $P=0.001$ ) and rice cultivation phases ( $\chi^2=8.618$ ,  $df=4$ ,  $P=0.004$ ) (Figure 2).

Usually in the fallow and the mature phases, limited water supply was released into rice fields which likely affected composition and abundance of aquatic organisms in MRRF. Furthermore, in the plough phase, there was maximum light penetration and high availability of food sources from decomposed organic matter from previous growing season that provided conducive environmental conditions to support high abundance of aquatic organisms.

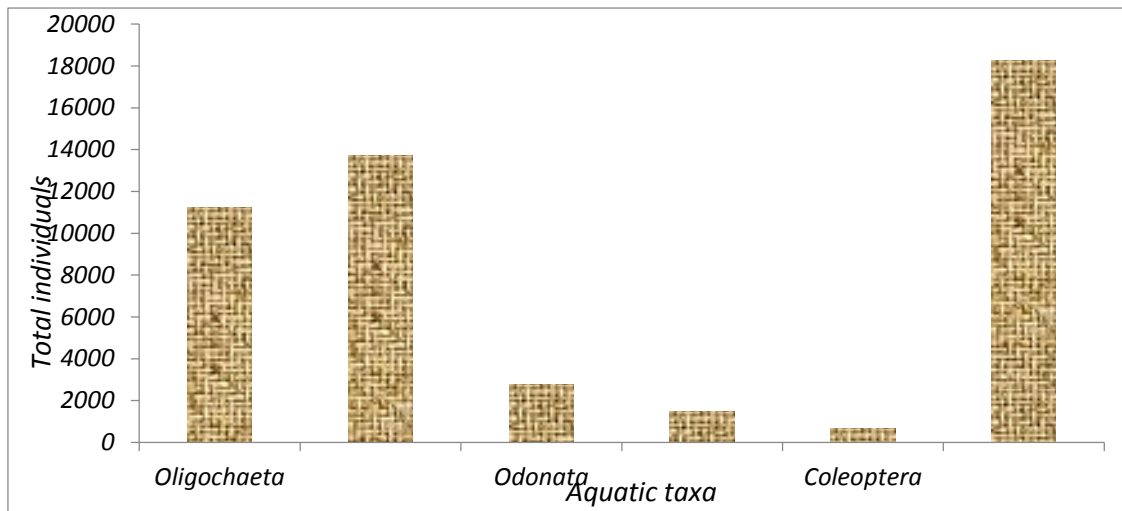
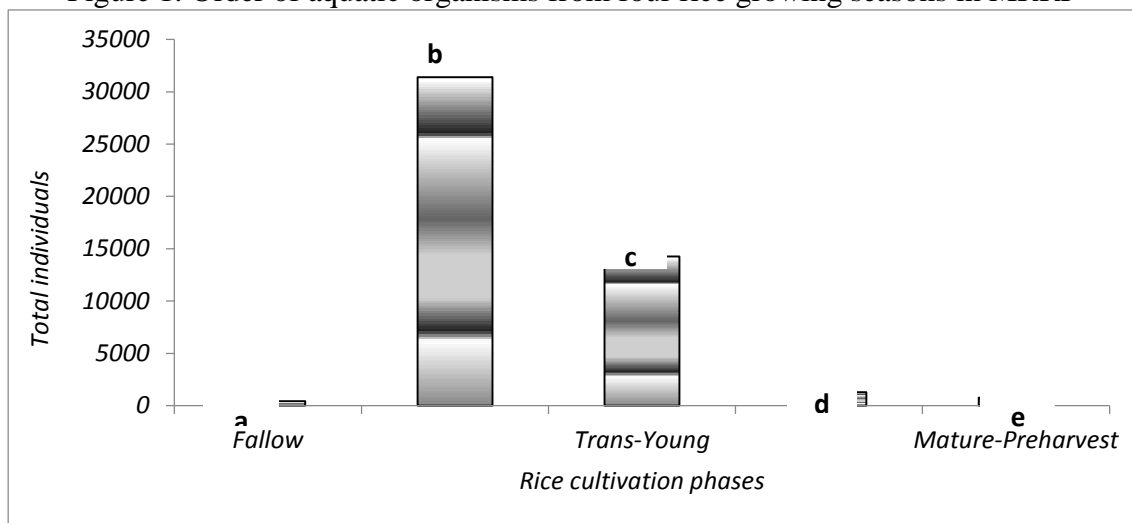


Figure 1. Order of aquatic organisms from four rice growing seasons in MRRF



Notes: Different letters indicate significant difference in mean abundance (Mann-Whitney U test,  $P < 0.05$ ).

Figure 2. Composition of aquatic organisms from four rice growing seasons with rice cultivation phases

In MRRF, 25 species, 34 taxa from 21 families and 6 orders of aquatic organisms were recorded. Out of 21 families listed, 14 families of aquatic organisms were not identified beyond the family level, due to limitation of identification keys and unsuitable condition of the specimens. This macroinvertebrate assemblage was much lower than what were observed in Japanese (44 taxa, Yamazaki *et al.*, 2003); Portugal (71 taxa, Leitao *et al.*, 2007) and Italian (173 taxa, Lupi *et al.*, 2013) rice fields but comparable to those found in Malaysia (39 taxa, Lim 1990; 21 families, Maimon

*et al.*, 1994). On the other hand it was higher than the assemblages recorded from rice fields in the Phillipines (9 taxa, Banwa, 2013), France (23 species, Suhling *et al.*, 2000), India (26 taxa, Roger *et al.*, 1988) and Brazil (28 taxa, Mollozze *et al.*, 2007).

Three orders; Oligochaeta, Ephemeroptera and Diptera occurred in significantly high numbers in the study site. Chironomids (Diptera) were the highest collected organisms while a few Odonata species (*I. decoratus* P. congener, *O. sabina*, *P. flavescens*, *D. trivialis*, *A. femina* and *A. pygmaea*) were considered

the lower assemblage. Chironomidae were also dominant in conventionally managed rice fields in France (Mesleard *et al.*, 2005). *Orthetrum sabina*, *P. flavescens* and zygopterans *A. femina* and *A. pygmaea* had relatively high abundances compared to other organisms in this group.

Dominance of Oligochaeta, Ephemeroptera and Diptera was similarly observed by Stenert *et al.* (2009) in the wetlands of southern Brazil. Oligochaeta and ephemeropteran families Baetidae, Caenidae and dipteran Chironomidae were found to be preys of Odonata larvae (Baker *et al.*, 1999; Yamazaki *et al.*, 2003; Leitao *et al.*, 2007; Katayama, 2013). Together with mosquito larvae, chironomids are readily consumed by some aquatic insects when available, but frequently mosquito larvae and its odonate predators do not co-exist in the same niche in rice field (McDonald and Buchanan, 1981; Mogi and Miyagi, 1990). Mosquito larvae are commonly found floating at the water surface while Odonata larvae are crawling on the sediments or resting on stems or twigs of aquatic plants.

The richness pattern of aquatic organisms in MRRF rice fields followed a similar pattern in all four seasons with high abundance in the plough phase but lower during the fallow phase and mature to preharvest phases. These variations were statistically significant among rice growing seasons but aquatic organisms were the most abundant in season one, followed by season two, but decreased markedly in season three and season four. Differences in macroinvertebrate abundance among rice cultivation phases were similarly reported by Stenert *et al.* (2009) and Asghar (2010) also recorded higher density and richness of macroinvertebrates during the flooded phase (the plough, tiller) and lower during fallow and after harvest.

The worms, dipterans and ephemeropterans are feeding on the rich detritus from soft muddy substrate especially during the plough phase while

other insects such as Araneae, coleopterans, hemipterans, odonate are preys/predators (Merritt and Cummins, 1984; Asghar, 2010; Hayasaka *et al.*, 2012) in the rice field. Then species of *I. elegans* (Heads, 1985); *N. tullia* (Che Salmah, 1996); *E. boreale* (McPeck and Peckarsky, 1998); *Agriocnemis* spp (Rapusas *et al.*, 2005); *S. frequens* (Mogi, 2007) and *C. servilea* (Varela and Gaput, 2013) live on insects such as baetids, corixids, notonectids, hyrophilids, *C. tarsalis* (Mogi, 2007; Lupi *et al.*, 2000), *A. aegyptii* (Al-Shami *et al.*, 2010) which occur in high abundances in at least a couple of rice cultivation phases.

High abundances of Oligochaeta, Baetidae, *A. femina*, *A. Pygmaea*, *O. sabina*, *P. flavescens*, Chironomidae and Ceratopogonidae during the plough to the tiller phases were attributed to ample water supply through proper irrigation (Mogi, 1993). Irregular water supply can affect abundance and diversity of aquatic organism communities (Chovanec and Waringer, 2001). The loss of water is a potential catastrophe on aquatic organisms because many species have no adaptations to tolerate or escape the dry phase (Wissingger, 1999). Usually ditches or ponds in the vicinity of rice fields provided water for growth of aquatic organisms population during dry period. Very low water level during the mature phase (less than 5 cm) and completely shaded water surface influence the abundance of aquatic organisms, such as Tubificidae, Baetidae, Hydrophilidae, Chironomidae, Ceratopogonidae, *O. sabina* and *P. flavescens* (Table 2). Variation in habitat suitability, availability of food sources (Wissingger, 1989; Bambaradeniya, 2000; Leitao *et al.*, 2007), soil drainage, machinery use and herbicide application (Roger *et al.*, 1992; Roxas *et al.*, 2005; Asghar, 2010) have been found to positively or negatively affect the abundance and diversity of aquatic organisms in their habitats.



In MRRF, the application of chemicals such as fertilizers (urea, nitrate, phosphate, potassium), herbicides (H Ally-XP) and insecticide (imidacloprid, rhodamine) (Staring, 1984; Arce *et al.*, 1998; Baumart and Santos, 2010) often leads to nutrient enrichment of surface waters (Dudgeon, 2000; Jergentz *et al.*, 2005), especially after the applications during the end of the young phase and beginning of the tiller phase. The abundance of aquatic organisms, such as ephemeropterans, odonate, coleopterans and dipterans were affected by this application in MRRF. Negative effects of pesticides on aquatic organisms in rice fields were previously reported by various authors (Schoenly *et al.*, 1998; Suhling *et al.*, 2000; Wilson *et al.*, 2008).

### CONCLUSIONS

Two types of rice crops (Ciherang and IR 64) are cultivated in Manik Rambung Rice Field (MRRF) were showed 6 orders, 21 families, 34 taxa and 25 species. There are three categories of Dominance Index (DI) in rice field, these are: D=Dominant ( $\geq 5\%$  individual); A=Accessory ( $2.5\% \leq D \leq 5\%$  individual) and O=Occasional ( $<2.5\%$  individual) with four families (Baetidae, Chironomidae, Tubificidae and Ceratopogonidae) as ranked high on the DI list. Oligochaeta, Ephemeroptera, Hemiptera and Diptera were identified respective families, while families of Odonata and Coleoptera were further identified to species. The Kruskal-Wallis test showed significant differences between abundance of aquatic organisms during the time of sampling ( $\chi^2=1274.840$ ,  $P=0.000$ ), rice growing seasons ( $\chi^2=16.393$ ,  $P=0.001$ ) and rice cultivation phases ( $\chi^2=8.618$ ,  $df=4$ ,  $P=0.004$ ). The study about fish farming given benefit for food security and measure environmental impact quality.

### REFERENCES

- Al-Shami, S.A., Che Salmah M.R., Siti Azizah, M.N. and Abu Hassan, A. 2010. The influence of routine agricultural activities on the quality of water in a tropical rice field ecosystem. *Applied Ecology and Environmental Research* **8(1)**: 11-18.
- Arce, R.G and A.G. Cagauan. 1988. Overview of pesticide used in rice-fish farming in Southeast Asia. Paper presented at International Rice Fish-Farming System Workshop. 21-25 March 1988. Ubon, Thailand.
- Amir Shah Ruddin Md. Shah, M. Mansor, S.A. Mohd.Shah, C.S. Md Rawi, A.H. Ahmad and I. Jaafar. 2008. Agrobiodiversity of Muda Rice agroecosystem: a case study in largest granary area of Malaysia. *Wetland Science* **6 (1)**: 34-44.
- Asahnia, S. 1979. An illustrated key to the dragonflies found in the paddy field of Thailand. *IABCR-NEWS* **4**: 3-10.
- Asghar, M. 2010. Biodiversity of insects associated with rice (*Oryza sativa* L.) crop agroecosystem in Punjab, Pakistan. Ph.D thesis. 235p.
- Baker, R.L., M.E. Che and A.B. Heather. 1999. Aggressive interactions and risk of fish predation for larval damselflies. *Journal of Insect Behavior* **12 (2)**: 213-223.
- Bambaradeniya, C.N.B. 2000. *Ecology and Biodiversity in an Irrigated Rice Field Ecosystem in Sri Lanka*. Ph.D. thesis. University of Peradeniya, Sri Lanka. pp.1-525.
- Banwa, T.P., B.M. Cyrila., E. Henrylin and M. Zorayda. 2013. Rice terrace macroinvertebrates as indicator of water quality in indigenous community of the cordillera region, North Luzon, Philippines. *European Scientific Journal* **4**: 458-464.

- Baumart, J.S. and S.Santos. 2010. The impact of herbicide on benthic organism in flooded rice field in Southern Brazil in herbicides and environment. *In technology Publication: 369-382.*
- BPS –Statistical Bureau of North Sumatra. 2010. *Statistical Year Books*. Biro Pusat Statistik Indonesia.
- Che Salmah, M.R. 1996. *Some Aspect of Biology and Ecology of Neurothemis tullia (Drury) (Odonata: Libellulidae) in Laboratory and Rainfed Rice Field in Peninsular Malaysia*. Ph.D thesis, Universiti Pertanian Malaysia, Serdang, Selangor.
- Che Salmah, M.R. and Abu Hassan A. 2002. Distribution of aquatic insects in relation to rice cultivation phases in a rain fed rice field. *Jurnal Biosains* **13 (1): 87-107.**
- Chovanec, A. and J. Waringer. 2001. Ecological integrity of river: Floodplain systems-assessment by dragonfly surveys (Insecta: Odonata). *Regulated Rivers: Research and Management* **17: 493-507.**
- Dudgeon, D. 2000. Riverine biodiversity in Asia: a challenge for conservation biology. *Hydrobiologia* **418: 1-13.**
- Edmunson, W.T. 1992. *Freshwater Biology (M)*. 2nd ed, New York. John Willey and Sons, Inc. pp.1-248.
- Hidaka, K. 1998. Biodiversity conservation and environmentally regenerated farming system in rice paddy fields, Japan. *J. Ecol.* **48: 167-178** (in Japanese).
- Halwart, M. 1998. Trends in rice–fish farming. *FAO Agriculture Newsletter* **18: 3–11.**
- Hartvich, M. F., Nydl, V., Vondra, T. and Pavlicek, T. 2008. Growth testing of two breeds of common carp, *Cyprinus carpio* L (Hungarian mirror and Trebon scaly carp) in ponds with low and high stocking density. *Aquaculture Research* **34: 1015-1021.**
- Hayasaka, D., T. Korenaga, F.Sanchez Bayo and K. Goka. 2012. Differences of ecological impact of systemic insecticide with difference physicochemical properties on biocenosis of experimental paddy fields. *Ecotoxicology* **21: 191-201.**
- Jiri, K. and Zdnok A. 2008. Behaviour response of carp (*Cyprinus carpio* L) pond stock upon occurrence of hunting great cormorant (*Phalacrocorax carbo sinensis*) flocks. *Aquacul.Int.* **10:86-92**
- Jergentz, S., P. Pessacq, H. Mugni, C. Bonetto and R.Schulz. 2005. Linking in situ bioassays and population dynamics of macroinvertebrates to assess agricultural contamination in streams of the Argentine pampa. *Ecotoxicology and Environmental Society* **59: 133-141.**
- Kandibane, M, S. Raguraman and N. Ganapathy. 2005. Relative abundance and diversity of Odonata in an irrigated rice field of Madurai, Tamil Nadu. *Zoo's Print Journal* **20 (11): 2051-2052.**
- Katayama, M. 2013. Differential survival rates of damselfly larvae in the presence of newt and dragonfly predators. *International Journal of Odonatology* **16(2): 177-182.**
- Lawton, J.H. 1971. Maximum and actual field feeding-rates in larvae of the Damselfly *Pyrrhosoma nymphula* (Sulzer) (Odonata: Zygoptera). *Freshwat. Biol.* **1: 99-111.**
- Leitao, S., P. Pinto, T. Pereira and M.F. Brito. 2007. Spatial and temporal variability of macroinvertebrate communities in two farmed Mediterranean rice fields. *Aquatic Ecology* **41: 373-386.**

- Lim, R.P. 1990. Effects of pesticides on the aquatic invertebrate community in rice fields. In *Proceedings of the International Conference on Tropical Biodiversity "in Harmony With Nature"*. 2-16 June 1990. Kuala Lumpur, Malaysia.
- Lupi, D, A. Rocco and B. Rossaro. 2013. Benthic macroinvertebrates in Italian rice fields. *Journal Limnology* **72(1)**: 184-200.
- Maimon A., Z.R. Azura, A.D. Nor, M.Nashriyah, N.K.Ho and S. Ismail. 2013. *Pests in Malaysia rice field. Malaysia Institute for Nuclear Technology Research (MNT) and Muda Agriculture Development Authority (MADA)*. Pp.87-96.
- McDonald, I. and G.Buchanan. 1981. The mosquito and predatory insect fauna inhabiting freshwater ponds, with particular reference to *Culex annulirostris* Skutse (Diptera: Culicidae). *Australian Journal Ecology* **6**: 21-27.
- McPeck M.A and B.L. Peckarsky. 1998. Life histories and the strengtgs of species interactions: combining mortality, growth and fecundity effects. *Ecology* **79**: 867-879.
- Merrit, J.W and Cummins, K. 2006. *Aquatic Insect in North America*. Kendal Publ., America.145p.
- Mesleard, F., S. Garnero, N. Beck, E. Rosecchi. 2005. Uselessness and indirect negative effects of an insecticide on rice field invertebrates. *Comptes Rendus Biologies* **328 (10-11)**: 955.962.
- Mitchel, R and Oberdoff. 1995. Storm-induced dispersal in the damselfly *Ishinura verticallis* (Say). *Am. Midl. Nat.* **82**: 359-366.
- Mogi, M. and I.Miyagi. 1990. Colonization of rice fields mosquitoes (Diptera: Culicidae) and larvivorous predators in asynchronous rice cultivation areas in the Phillipines *Journal of Medicine Entomology* **27 (4)**: 530-536.
- Mogi, M. 1993. Effect of intermittent irrigation on mosquitoes (Diptera: Culicidae) and larvivorous predator in rice fields. *Journal of Medicine Entomology* **30 (2)**: 309-319.
- Mogi, M. 2007. Insect and other invertebrate predators. *Journal of the American Mosquito Control Association* **23(2)**:93-109.
- Morse, J.C., Yang, L. and Tian L. 1994. *Aquatic Insects of China Useful for Monitoring Water Quality*. Hejhai University Press. Nanjing, China. 570pp.
- Oliveira, T.C and S.D. Vasconcelos. 2010. Insects (diptera) associated with cadavers at the Institute of Legal Medicine in Pernambuco, Brazil: Implications for forensic entomology. *Forensic Science International* **198**: 97-102.
- Orr, A.G. 2005. *Dragonflies of Peninsular Malaysia and Singapore*. Natural History Publications (Borneo), Malaysia.1-125p
- Pereira, T., M.J. Cerejeira, M.F. Brito and M.A. Morbey. 2000. Laboratory studies with microbiotests to evaluate the acute toxicity to aquatic biota of herbicides used in Portuguese paddy fields. In: Perssone *et al.* (ed) *New micobiotests for routne toxicity and biomonitoring*. Kluwer Academic/Plenum, New York, pp. 495-500.
- Rapusas, H.R., J.M.Schiller, K.L.Heong, A.T.Barrion, V. Sensoulivong, S.Inthavong, and K. Inthavong. 2005. Arthropod communities of the lowland rice ecosytems in the Lao PDR in Montane paddy rice: opurtunity for increasing food security inthe highlands of Laos. Lao IRRI Project,P.O.Box. 4195, Vientiane-Laos. pp.235-429.
- Roger, P.A and 1986. *Biology and Management of the Floodwater*

- Ecosystem in rice fields.* International Rice research Institute, Los Banos, Phillipines
- Roger, P.A., I. Simpson, B. Official, S.Ardales and R. Jimenez. 1992. *Bibliographic and experimental assessment of the impacts of pesticides on soil and water microflora and fauna in wetland rice field.* In: *Proceeding International Rice research Conference.* IRRI. Los Banos, Phillipines. pp. 255-276.
- Roxas, P.G., R.D. Boniao, E.M.Burton, A.G. Villarino and S.S. Nacua. 2005. Community Based Inventory and Assessment of Riverine and Riparian ecosystems in the Northeastern Part of Mt. Malindang, Micamis Occidental: *Biodiversity Resaerch Programme (BRP) for Development in Mindanao: Focus in Mt. Malindang and Environs.* SEAMEO SEARCA College, Laguna-Phillipines.
- Saikia, S.K. and Das, D. 2008. Rice fish culture and it's potential in rural development; A lesson from Apatni farmers, Arunachal Pradesh, India. *J. Agri Rural Dev* **6 (1&2)**: 125-131.
- Saikia, S.K. and Das, D.N. 2009. Feeding ecology of common carp (*Cyprinus carpio* L) in a rice fish culture system of the Apatani plateau (Arunachal Pradesh, India). *Aquatic ecol* **43**: 559-568.
- Schoenly, K.G., Justo, M., A.T, Barrion, M.K. Harris and D.G. Botrell. 1998. Analysis of invertebrate biodiversity in a Phillipine farmer's irrigated field. *Environmental Entomology* **27**: 1125-1136.
- Suhling, F., S. Befeld, M. Hausler, K. Katur, S. Lepkojus and F. Mesleard. 2000. Effects of pesticide applications on macroinvertebrate density and biomass in ricefields in Rhone-delta, France. *Hydrobiologia* **431**: 69-79.
- Staring, W.D.E. 1984. *Pesticide: Data Collection Systems and Supply, Distribution and Use in Selected Countries of the Asia-Pacific Region.* CABI Publisher, USA. pp.223
- Stenert, C., R. C. Bacca, L. Maltchik and O. Rocha. 2009. Can hydrologic management practices of rice fields contribute to macroinvertebrate conservation in southern Brazil wetlands? *Hydrobiologia* **635**:339–350.
- Triplehorn, C.A and F.E. Johnson. 2006. *Introduction Study of Insects.*7<sup>th</sup> Edition, Hunt Kendal Publisher, USA. pp.1-345.
- Usinger, R.L. 1956. *Aquatic Insects of California with Keys to North American Genera and California Species.* California: University California Press.
- Varela, R.P. and V.P. Gaput 2013. Interdependence between natural habitats and environments. *Hydrobiologia* **435**:226–232
- Ward, J.V. 1992. *Aquatic Insect Ecology. I. Biology and Habitat .* John Wiley and Sons. Inc, USA.
- Wilson, A.L., Watts, R.J., and Stevens, M.M. 2008. Effects of different management regimes on aquatic macroinvertebrate diversity in Australian rice fields. *Ecol Res* **23**: 565-572.
- Wissinger, S.A. 1989. Seasonal variation in the intensity of competition and predation among dragonfly Larvae. *Ecology* **70 (4)**: 1047-1027.
- Wissinger, S.A. 1999. *Ecology of Wetland Invertebrates: Synthesis and Application for Conservation and Management .*In: Batzer D.P, R.B. Rader and S.A. Wissinger. *Invertebraes in Freshwater Wetland of North America.* Ecology and Management, John

Wiley and Son, New York.pp.1043-1086.  
Yamazaki, M., Y. Aiba, Y. Hamada, N. Yasuda, N.Kamimoto, S.Mizuno, T. Momii, S. Yoshidaand M.Kimura. 2003. Changes in the community structure of aquatic organisms after midseason drainage in the floodwater of

Japanese paddy fields. *Soil Science Plant Nutrient* **49 (1)**: 125 – 135.