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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

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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 (≥ 5% individual); A=Accessory (2.5% ≤ D ≤ 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 (χ^2=1274.840, P=0.000), rice growing seasons ($\chi^{2=}$16.393, P=0.001) and rice cultivation phases (χ^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 dihaslkan 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 (≥ 5% individu); A=Sering (2.5% ≤ D ≤ 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 (χ^2=1274.840, P=0.000), musim pertanaman padi ($\chi^{2=}$16.393, P=0.001) dan fase pertanaman padi (χ^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). 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.

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 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 it's 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 humadity varies from 78 % to 89%. Mean ± SE of water depth were 24.39 ± 0.069, pH score were 7.45 ± 0.235, and water temperature showed 26.77 ± 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 particulary diverse insect fauna which serve as an important food source for fishes (Fernando 1993). Fish culture in rice fields had a checkered histrory 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 µm mesh) (Lawton, 1971; Che Salmah, 1996 and Wilson *et al.*, 2008). The core sampler was pressed into the sediment and the bottom area strirred 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 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).

Table 1. List of aquatic organisms were identified from four rice growing seasons (2008-2010)

DI=Dominance Index; D=Dominant(≥5%); A=Accessory (2.5%≤D≤ 5%); O=Occasional (<2.5%)

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

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Potamarcha congener (Rambur)	6	0.01	
Trithemis aurora (Burmeister)	28	0.06	
Tholymis tillarga (Fabricius)	30	0.06	
Hemiptera			
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
Coleoptera			
Dysticidae	162	0.33	O
Laccophilus sp	90	0.19	
Cybister sp	72	0.15	
Hydrophilidae		0.53	O
Berosus sp	255	0.53	
Noteridae		0.54	O
Noterus sp	259	0.54	
Diptera			
Chironomidae	13188	27.4	D
Ceratopogonidae	4332	9	D
Culicidae	471	0.98	O
Culex sp	253	0.53	
Anopheles 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 (≥ 5% individual); A=Accessory (2.5% ≤ D ≤ 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
Oligochaeta					
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)
Ephemeroptera	(13.04)	(22.68)	(25.91)		

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Baetidae				70 (5.48)	36 (4.63)
Caenidae	0 (0)	9722	3636	32 (2.50)	19 (2.44)
Odonata	1(0.24)	(30.95)	(25.50)		
Zygoptera		115 (0.37)	68 (0.48)		
Coenagrionidae					
Agriocnemis femina				116 (9.08)	16 (2.06)
A. pygmaea	28 (6.76)			59 (4.62)	20 (2.57)
Ischnura senegalensis	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)		
Ictinogomphus decorates		64 (0.20)	23 (0.16)	1 (0.08)	0 (0)
Anisoptera	0 (0)				
Libellulidae		3 (0.0019)	1 (0.0017)		
Orthetrum sabina				97 (7.59)	89
Pantala flavescens	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)
Hemiptera	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)
Coleoptera	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)
Diptera	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)
Culex sinensis		(29.99)	(25.81)	30 (2.35)	56 (7.21)
Anopheles vagus	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)		
Total	**414**	**31401**	**14258**	**1277**	**777**

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 (χ^2=1274.840, P=0.000), rice growing seasons ($\chi^{2=}$16.393, P=0.001) and rice cultivation phases (χ^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.

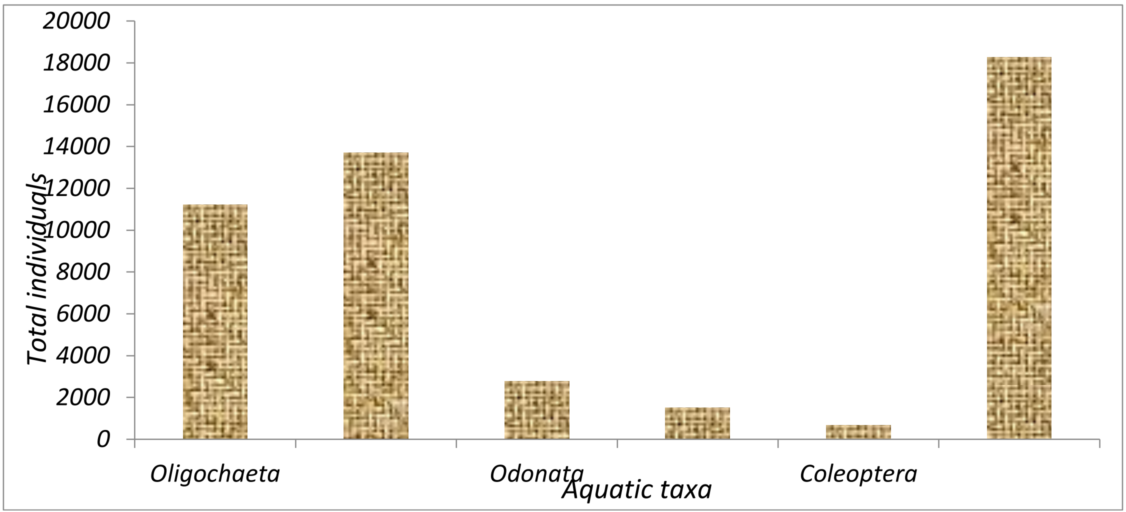
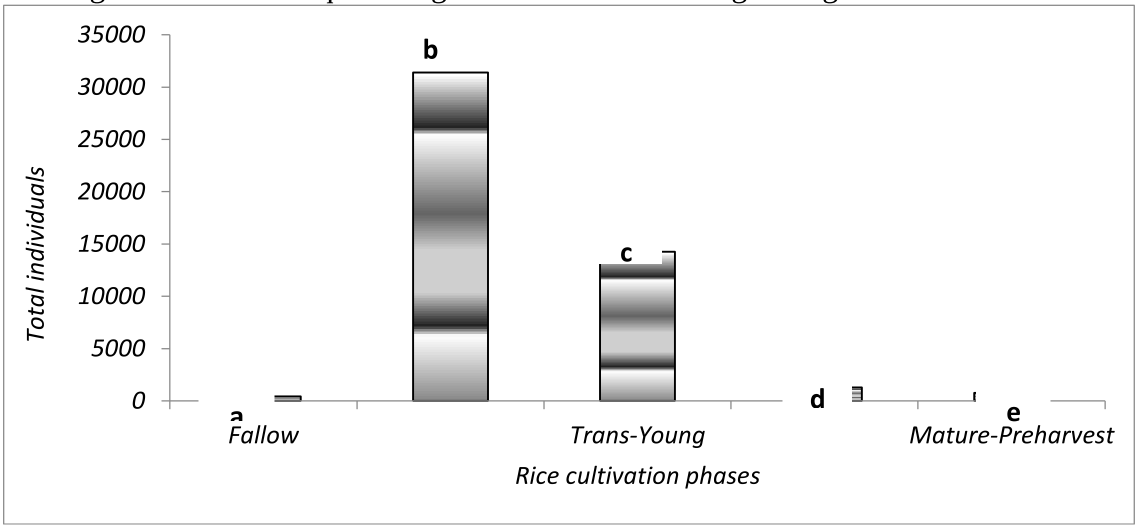


Figure 1. Order of aquatic organisms from four rice growing seasons in MRRF



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 conventionaly 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 was statistically significant among rice growing seasons but aquatic organisms was 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 similary 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 an the rich detritus from soft muddy substrate especially during the plough phase while other insects such as Araneae, coleopterans, hemipterans, odonate are preys/predators (Merrit 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* (McPeek 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 (Wissinger, 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 affected the abundance and diversity of aquatic organisms in their habitats.

In MRRF, the application of chemicals such as fertilizers (urea, nitrate, phosphate, pottasium), herbicides (H Ally-XP) and insecticide (imidacloprid, rhodiamine) (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 (≥ 5% individual); A=Accessory (2.5% ≤ D ≤ 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 (χ^2=1274.840, P=0.000), rice growing seasons ($\chi^{2=}$16.393, P=0.001) and rice cultivation phases (χ^2=8.618, df=4, *P*=0.004). The study about fish farming given benefit for food security and measure environmental impact quality.

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