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A NOTE ON ZOOPLANKTON DISTRIBUTIONS AT TWO DIFFERENT TYPES OF WATER MANAGEMENT SYSTEMS IN THE MUDA RICE AGROECOSYSTEM

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Abstrak: Komposisi dan kelimpahan komuniti zooplankton di dalam dua sistem pengurusan air (kitar semula dan mengalir) di agroekosistem Muda telah dikaji selama dua musim penanaman padi pada tahun 2002–2003. Sejumlah 25 spesies rotifer, 19 spesies kladosera dan 2 spesies kopepoda telah berjaya dikenal pasti dalam kajian ini. Tidak ada perbezaan yang ketara bagi bilangan taksa zooplankton di antara dua sistem pengurusan air (kitar semula dan mengalir). Kelimpahan kumpulan kopepoda adalah dominan diikuti oleh kumpulan rotifera dan akhir sekali kladosera untuk kedua-dua plot yang dikaji. Spesies kladosera yang kerap direkodkan di kedua-dua sistem pengairan ini adalah *Simocephalus latirostris* dan *Diaphanosoma sarsi* manakala untuk rotifera ialah *Asplanchna pridonta* dan *Platyias patulus.*

Abstract: The species composition and abundance of the zooplankton community from two types of irrigation water management system (recycled and uncontrolled flow) in the Muda agro-ecosystem, were studied over two during rice planting seasons during the period of 2002–2003. A total of 25 species of rotifers, 19 species of cladocerans and 2 species of copepods were identified during the study period. There was not much difference in the number of taxa between the two areas (recycled and uncontrolled flow). Copepods were the most dominant group followed by the rotifers and cladocerans for both plots systems studied, respectively. The most common species recorded from both areas were *Simocephalus latirostris* and *Diaphanosoma sarsi* (cladocerans), and followed by *Asplanchna pridonta* and *Platyias patulus* (rotifers).

Keywords: Rice fields, Water Management, Zooplankton

INTRODUCTION

The study of agro-biodiversity has become more important during the last two decades (Bambaradeniya *et al*. 2004). One of the main agro-ecosystems is rice fields, as rice constitutes the largest cereal crop in the world after wheat (Weeraratna & Fernando 1984). Rice is the staple food in Malaysia.

The main rice cultivation area in Malaysia is located in northern part of the Peninsular and under the Muda irrigation scheme. This area, which consists of 97,000 ha of rice fields, is managed by the Muda Agricultural Development Authority (MADA) and contains intensive irrigation canals and drainage systems

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that allow double cropping. The scheme depends on rainfall as the main source of water supply (56%), followed by dam released water (30%), uncontrolled flow (rivers below the dam) (13%) and recycled water (5%) (Lau & Yeow 1995). The recycling system was initiated in 1982 to overcome water deficient in the Muda irrigation scheme (Lau & Yeow 1995). Normally, the operation of recycling system was based on the water that been pumped from nearby river into selected irrigation canals and keep for some time before distribute to selected rice area plots when needed. The introduction of the recycling system was of great concern to the public, and especially with regards the safety of the reused water and its impact on agro-biodiversity (Sani *et al.* 1992; Maimon *et al.* 1998).

According to Fernando (1996), rice fields, together with their contiguous aquatic habitats and dry land, comprise a rich mosaic of rapidly changing ecotones harboring rich biological diversity which is maintained by rapid colonization as well as rapid reproduction and growth of organisms. Zooplankton are an important component of rice field fauna. Since zooplankton occupy lower trophic levels, they play an important role in fish production, especially at early life history stages of the fishes (Heckman 1979; Boonsom 1984; Ali 1995).

Most studies on rice-field zooplankton in Malaysia deal with taxonomy, distribution and effects of pesticides (Lai & Fernando 1978; 1979; 1980; Fernando *et al.* 1979; Karunakaran & Johnson 1978; Idris 1983; Lim *et al.* 1984). The importance of microcrustacea (copepods and cladocerans) and rotifer communities for rice-fish farming was studied by Ali (1990) at the North Krian rice agro-ecosystem. Ali (1990) has recorded a total of 38 and 33 taxa of microcrustaceans and rotifers were collected where there are no significant difference in the number of taxa between the two habitats (rice fields and sump ponds) ($P > 0.05$).

Zooplankton information in the Muda irrigation area is still incomplete. Shah and Ali (2002) studied the seasonal dynamics of zooplankton at a selected irrigation canal in Muda whereas Zarul Hazrin *et al.* (2003) studied the effects of aquaculture activity to zooplankton diversity and distribution at Terusan Tengah.

Therefore, this paper surveys zooplankton population between the recycled and uncontrolled flow rice plots during dry and wet seasons. The results later were incorporated with the impact of pesticide usage in the rice agro-ecosystem.

MATERIALS AND METHODS

Zooplankton sampling was conducted at Kampung Alur Sekawan, Mukim Tajar, Pendang, Kedah, Malaysia (Fig. 1). The study area was divided into two treatment plots based on the different irrigation management systems i.e. recycled and uncontrolled (non-recycled) flow. Four subplots were selected at each treatment plot to provide representative samples of the zooplankton assemblage structure in the habitats pest zooplankton communities (Fig. 1). Sampling was conducted twice each month at each station during wet season started from November 2002 to January 2003 and dry season from April to July 2003.

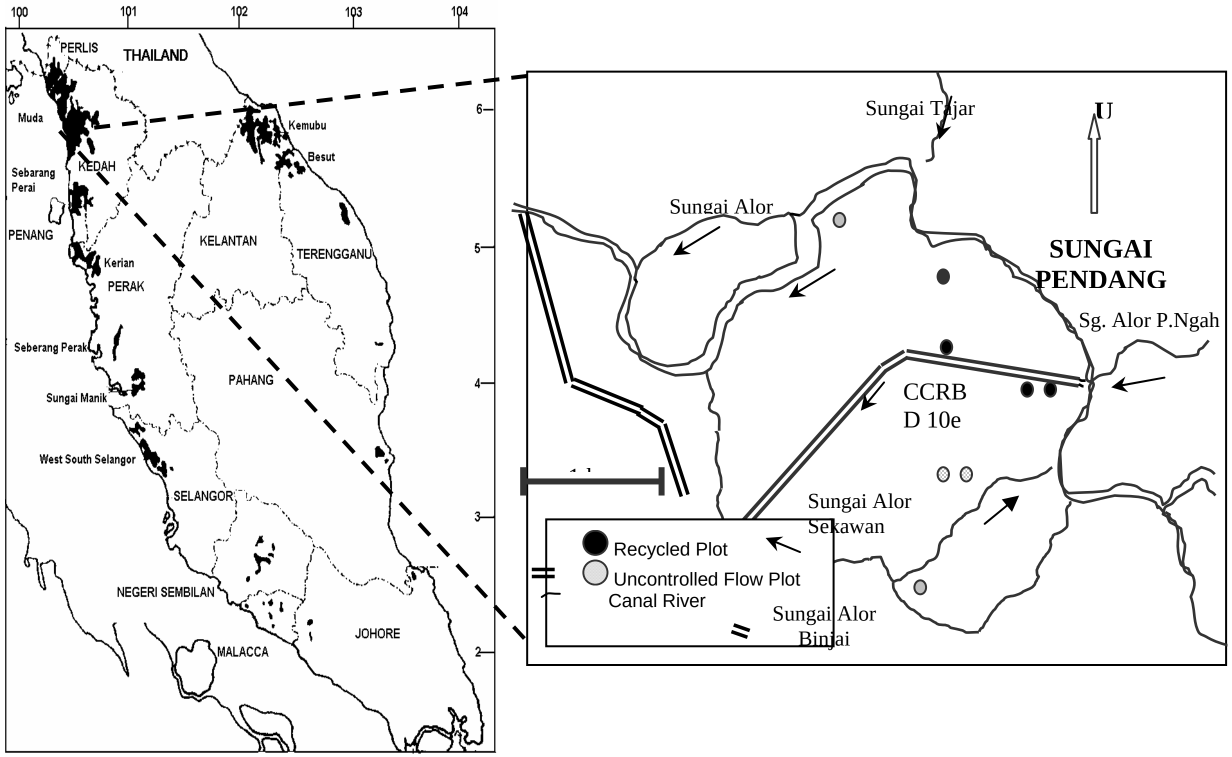

Figure 1: Location of the main rice granary area in Peninsular Malaysia namely, the Muda Irrigation Scheme (modified from Azmi (1994). On the right is the location of the sampling station in this study.

Prior to zooplankton sampling, *in situ* physico-chemical readings were taken at each site. Dissolved oxygen (DO) (mg/l) and temperature (°C) were measured using the YSI meter (Model 57), conductivity (µS/cm) and total dissolved solids (TDS) (mg/l) were measured using the Hach meter (Model 4460) and pH was measured using the Orion pH meter (Model 230A).

Zooplankton samples were collected by filtering 40 l of water through a conical plankton net (80 µm mesh) and later the samples were preserved by using 5% buffered formalin (Murphy & Willis 1996). For each samples, two subsample replicates were examined under a microscope (400X magnification) using a Sedgwick-Rafter counting chamber. Zooplankton identification and counting were done according to the standard taxonomic references (Pennak 1979; Idris 1983; Edmondson 1992). The data (individual/l) were averaged and converted to percentage prior to the transformation to arc-sine before one-way ANOVA was conducted (Snedecor & Cochran 1967).

RESULTS AND DISCUSSION

Table 1 summarized the water physico-chemical characteristics for each treatment plot. Results indicate that D.O., temperature, conductivity and TDS are slightly higher at uncontrolled flow plots when compared to recycled plots. There was no significant difference of two-way ANOVA analysis ($P > 0.05$) on water physico-chemical properties between the two different irrigation systems and the seasons. Sani *et al*. (1992) also demonstrated similar results pattern in their study with the exception of the *Escherichia coli* count which was significantly higher ($P < 0.05$) at recycled area as compared to the non-recycled area.

46 species of zooplankton were identified from both irrigation systems. Rotifers were the dominant taxonomic group (25 species) followed by the cladocerans (19 species) and copepods (2 species) (Table 2). The number of cladocerans recorded in this study is lower than that reported by Idris (1983), Ali (1990), and Shah and Ali (2002) which noted 33 species, 26 species and 20 species, respectively. Meanwhile, only 10 species of cladocerans were recorded in the Sri Lanka rice agro-ecosystem (Bambaradeniya *et al.* 2004). The rotifers taxon number in this study is lower when compared to Ali (1990) which noted recorded 33 species. While only 18 rotifers species been recorded at Sri Lanka (Bambaradeniya *et al.* 2004). There were only 2 species of copepods recorded in the present study whereas in Sri Lanka 7 species were recorded by Bambaradeniya *et al.* (2004).

Among the cladocerans, the Chydoridae was the most dominant family (31%) followed by Sididae (21%), Daphnidae and Macrothricidae (16%), Moinidae (11%) and Bosminidae (5%). On the other hand, Brachionidae was dominant family (56%) among the rotifers followed by Lecanidae (20%), Testudinellidae (12%), Asplachidae (8%) and Synchaetidae (4%).

The frequency of zooplankton occurrence pattern between recycled and uncontrolled flow plots is shown in Table 2. No significant difference ($P > 0.05$) was observed in the number of taxon between the two different systems. Study by Ali (1990) also noted that there are no significant differences in number of taxa between the two habitats studied (rice fields and sump ponds) ($P > 0.05$). The total number of zooplankton species recorded at the uncontrolled flow and recycled plots in wet season and dry season were 45, 46 and 45, 35 species, respectively (Table 3). The uncontrolled flow plots had the highest Shannon-Wiener Diversity Index and Evenness Index as compared to the recycled plots for both seasons. However, the different between two systems and season is smalls (Table 3). Ali (1990) also points out that the zooplankton diversity index from the two habitats that been studied (rice fields and sump ponds) not much different along his study period. Shah and Ali (2002) also reported that there are not much different of the Shannon-Wiener Diversity Index and Evenness Index of zooplankton between a recycled and non-recycled irrigation canals although their sampling location are located faraway to each others (ranging 20–35 km).

Table 1: Summary of physico-chemical properties and water quality (± standard error**)** of the two different irrigation management study areas of the Muda Scheme started from November 2002 to January 2003 (Wet Season) and from April to July 2003 (Dry Season).

Water parameters	**Treatment stations**			
	Recycled			
	average	**± s.e.**	**min**	**max**
Water level (cm)	6.2	0.6	1.0	11.0
DO (mg/l)	4.1	0.5	0.5	10.6
Temperature (°C)	29.0	0.9	23.0	38.0
pH	5.7	0.2	3.6	8.4
Conductivity (µS/cm)	71.5	10.5	3.4	279.0
TDS (mg/l)	36.1	4.9	2.0	221.0
	Uncontrolled Flow			
	average	**± s.e.**	**min**	**max**
Water level (cm)	5.8	1.0	1.0	14.0
DO (mg/l)	5.1	0.6	1.4	10.6
Temperature (°C)	30.0	1.1	23.0	38.0
pH	5.5	0.3	3.8	8.4
Conductivity (µS/cm)	79.3	20.6	22.0	279.0
TDS (mg/l)	42.6	10.9	10.0	221.0

Note: s.e. = standard error

However, the results are different from those reported by Maimon *et al*. (1998) whereby a high diversity of insects and arachnids was recorded at recycled plots compared to the non-recycled plots. The different may due to the different reaction of different aquatic organism based on the different life-cycled.

Generally, aquatic insect has the long life cycle (around 7–20 days) when compared to zooplankton (4 days). As a result, the aquatic insects become more resistant to pesticides due to the exposure of pesticides residues in long term at recycled plots when compared to non-recycled plots.

The dominant and frequently encountered species were as follows, copepods: *Mesocyclops thermocylcopoides*, nauplii; cladocerans: *Simocephalus latirostris*, *Diaphanosoma sarsi*; rotifers: *Asplanchna pridonta* and *Platyias patulus* (Table 2). In contrast, Ali (1990) reported that the two top dominant species of cladocerans were *Moina micrura* and *Simocephalus latirostris* while for rofiters were *Platyias patulus* and *Asplanchna pridonta*. In terms of density, the average percentage composition of copepods was dominant over rotifers and cladocerans for both systems plots and seasons (Fig. 2). These findings are in line with other studies done in Malaysia (Lim *et al.* 1984; Ali 1990; Shah & Ali 2002). Figure 2 also showed that the percentage composition of copepods at un-controlled flow plots in wet season was less when compared to in dry season. On the other hand, the percentage composition of rotifers during wet season was higher when compared to during dry season whereas not much different of cladocerans composition for both seasons (Fig. 2). Meanwhile, the percentage compositions of cladocerans and rotifers at recycled plots during dry season were high when compared to during wet season (Fig. 2). Conversely, the percentage composition of copepods was high during wet season when compared to during dry season (Fig. 2). The exactly reason for this finding is still unknown and further study need to be carried out before concluded.

There are several factors that influence zooplankton community in the study areas and time of sampling. Among the factors are the application pesticides, predator-prey relationships, hydrophyte abundance and interactions among zooplankton on themselves. These factors been reported and discussed by Ali (1990), and Shah and Ali (2002). Ali (1990) also noted that densities of several zooplankton species declined after fertilizer-pesticide applications, but recovered quickly indicating the absence of long acute toxicity. The low rotifer density in the rice fields studied was probably due to both predation by copepods and inhibitory effects caused by chemical compounds secreted by the hydrophytes. Previous studies showed that cladocerans population was kept low by the copepods (Ali 1990). Vertebrate predators such as fish are also size-selective, but prefer larger zooplankton like copepods as prey (Kerfoot 1977; Lane 1979).

As conclusion, there is not much difference in the species taxa number recorded in recycled and uncontrolled flow plots. This finding been supported by Ali (1990), and Shah and Ali (2002) where there are not much different of zooplankton taxa that been identified between sump ponds-rice fields and irrigation canals, respectively. Further studies which cover a large area need to be done in order to obtain a clearer picture on all the species found in the MADA area since the low number of zooplankton taxa had been identified in this study when compared to previous study in Peninsular Malaysia. Overall, the percentage composition of copepods and cladocerans in recycled plots are higher when compared to uncontrolled flow plots whereas the composition of rotifers is higher at uncontrolled flow plots.

Table 2: Species checklist and the frequency of occurrence of zooplankton collected from the two different rice plots water management during the study period. (November 2002 to July 2003)

Cladocera	**R**	**UCF**	**Rotifera**	**R**	**UCF**
Bosminopsis dietersi	+	++	*Asplanchna priodonta*	++++	++++
Alona affinis	+	++	*Asplanchna* spp.	++	+
A. davidi	+	+	*Brachionus bidentata*	+	+
Alona spp.	+	+	*B. forficula cf. mina*	+	+
Alonella hamulatus	+	+	*B. havanaensis*	+	+
A. nana	+	++	*B. quadridentata*	+++	++
Chydorus spp.	+	+	*B. calyciflorus*	+	+
Ceriodaphnia cornuta	+	+	*B. caudatus*	+	+
Simocephalus latirostris	+++	+++	*Epiphanes* spp.	+	+
S. serralatus	+	+	*Kellicottia* sp.	+	++
Ilyocryptus spinifer	+	+	*Keratella quadrata*	++	++
Macrothrix triseralis	+	+	*K. cochlearis*	+	+
M. spinosa	+++	++	*K. earline*	+	+
Moina micrura	++	++	*Platyias patulus*	+++	+++
Moinodaphnia macleayi	+	+	*P. polyanthus*	+	++
Diaphanosoma modigliani	+	+	*P. quadricornis*	+	+
D. aspinosum	++	+	*Lecane depressa*	+	+
D. excisum	+	++	*L. luna*	++	++
D. sarsi	+++	+++	*L. elasma*	+	+
			Monostyla bulla	+	++
Copepoda			*M. lunaris*	+	+
Tropodiatomus vicinus	+	++	*Polyarthra* spp.	+	+
Nauplii	+++	+++	*Filinia longiseta*	+++	++
Mesocyclops thermocyclopoides	++++	++++	*F. opoliensis*	+	++
			F. branchiata	+	+

Notes: R = recycled plots; UCF = uncontrolled flow plots; + = present 25% or less; ++ = present 26%–50%; +++ = present 51%–75%; ++++ = 75%–100%

Table 3: The Shannon-Wiener Diversity Index and Evenness Index by two different rice plots water management and season during the study period (Wet season - November 2002 to January 2003; Dry season - April to July 2003).

Water Treatment System	Season	Shannon-Wiener Index	Evenness Index	Number of species
Uncontrolled flow	Wet	1.559	0.937	45
	Dry	1.549	0.926	46
Recycled	Wet	1.510	0.913	45
	Dry	1.424	0.922	35

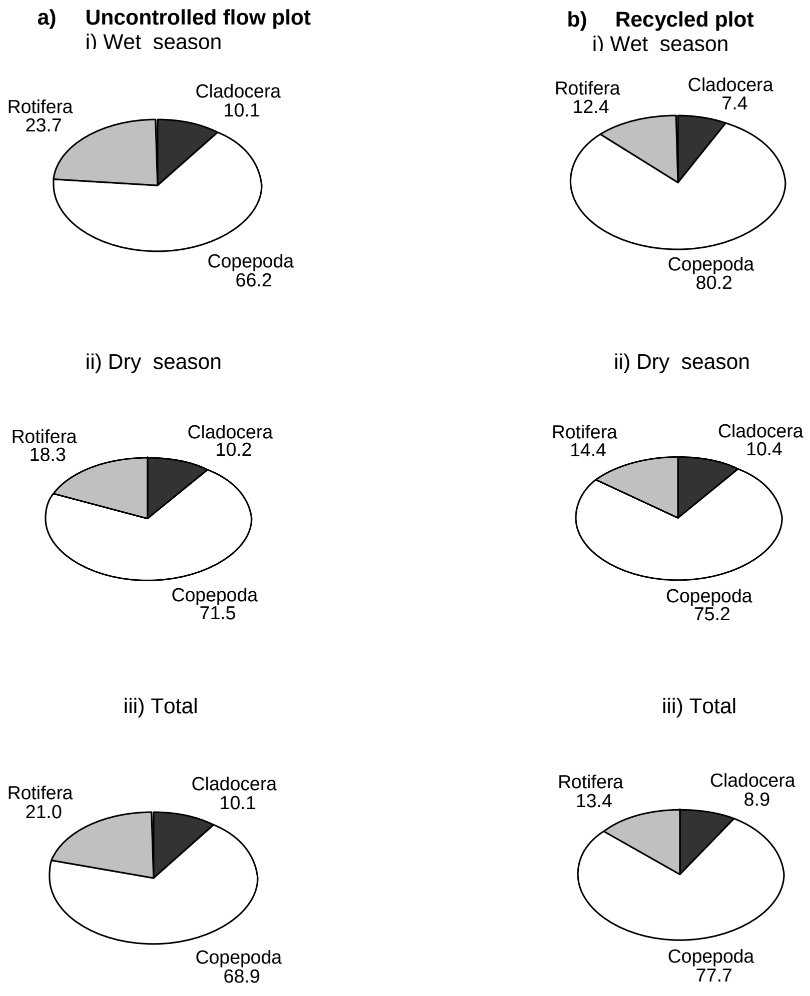

Figure 2: The average of percentage composition by water plot management, zooplankton groups and seasons during the study period (Wet season - November 2002 to January 2003; Dry season - April to July 2003).

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