Temporal Changes in Zooplankton Community Composition and Abundance in Chemical and Organic Rice Fields in Buri Ram Province, Thailand

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ABSTRACT

Rice fields present a unique ecosystem characterized by seasonal fluctuations in soil, water conditions, rice growth, and associated organisms including algae and invertebrates. This study analyzed zooplankton diversity and abundance patterns between organic and conventional chemical rice fields over a growing season in a paddy field site in Buri Ram Province, Thailand. The aim of this study is to compare differences in zooplankton community structure based on cultivation method and temporal changes along a growing season. Environmental parameters and zooplankton samples were collected from adjacent 3 organic and 3 chemical rice fields between September and November 2019. A total of 67 zooplankton taxa encompassing 3 major groups were identified (55 rotifers, 8 cladocerans, and 4 copepod larval stages). Overall, zooplankton abundance showed no significant differences between organic and chemical rice fields. However, organic fields exhibited higher Shannon-Weiner diversity and supported more zooplankton taxa compared to chemical fields. Margalef species richness and Pielou evenness were similar between rice field types. In terms of temporal variability, zooplankton did not show statistically difference in overall mean abundance, but Shannon-Weiner diversity and evenness showed a slight drop in October when compared to September. Although total abundance was comparable, differences in zooplankton community composition and diversity metrics highlight distinctions between organic and conventional cultivation that may arise from contrasting agricultural practices.

Keywords: Fertilizers, Organic, Rice field, Zooplankton

INTRODUCTION

Zooplankton serve as crucial consumers, facilitating energy and nutrient transfer between phytoplankton producers and higher trophic levels such as fish and invertebrates in aquatic ecosystems (Alcaraz and Calbet, 2003). Sensitivity to environmental changes, including water quality, nutrient levels, temperature fluctuations, and toxins, underscores the importance of studying zooplankton for preserving water resource equilibrium and understanding their response to environmental factors (Chen, 2020).

The abundance and diversity of zooplankton are influenced by various environmental factors, such as nutrient levels, phytoplankton abundance, hydrological conditions, and predation pressure from fish species, shaping zooplankton community structure (Badsi *et al*., 2010). Temperature variations positively influence zooplankton distribution (Sellami *et al*., 2011), while increased nutrient levels correlate with higher zooplankton abundance (Yang *et al*., 2023). Seasonal and habitat variability further contribute to differences in zooplankton distribution. Climate change and anthropogenic impacts significantly affect community abundance and structure (Hassan *et al*., 2022; Yang *et al*., 2023).

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Rice, a staple food for over half of the global population, particularly in Asia, undergoes cultivation influenced by both chemical and organic fertilizers, which impact rice production and environmental conditions (Tongta and Yongsawatdigul, 2011; Innok, 2015). While chemical fertilizer use enhances agricultural productivity, it poses risks of water pollution and environmental harm through leaching into surface and groundwater (Khrueakham, 2015). Increasingly, organic rice consumption gains popularity due to its perceived health safety and minimal environmental impact (Innok, 2015).

Rice fields provide seasonal aquatic habitats that support diverse organisms, including zooplankton (Plangklang and Athibai, 2021a; Maiphae *et al*., 2023). As they are lower trophic levels, zooplankton are impacted by water level fluctuations and agricultural management (Nishio *et al*., 2017). Chemical usage affects not only zooplankton but also organisms in higher trophic levels (Hanazato, 2001; Soum *et al*., 2022).

This study investigates differences in zooplankton community structure and abundance between organic rice fields (ORF) and chemical rice fields (CRF) in Buri Ram Province, Thailand, throughout various stages of the rice growing season. We hypothesized that zooplankton abundance and diversity vary between ORF and CRF or across months of the rice growing season.

MATERIALS AND METHODS

Study site

This study was conducted in six rice fields located in Muang Buri Ram District, Buri Ram Province, Thailand (Table 1). These fields belong to the Sakae Prong local community cooperation. The sites comprised of 3 ORFs and 3 CRFs (Figure 1). ORF cultivation followed the European EG-7280 guidelines, while CRFs received three applications of different fertilizers during distinct growth periods: 46–0–0 urea, 16–16–8, and 15–15–15 N–P–K formulations. The rice fields occupied the same geographic area with similar rainfall patterns and soil characteristics.

Water sampling

The 2019 rice growing season in Buri Ram typically extends from late May to late October. However, drought conditions and rainfall deficits delayed cultivation, restricting the season to September through November with only one crop cycle. Monthly water samples were collected, except in November when the chemical rice fields were drained, preventing further collection.

In each field, 36 Liters of water were pooled from four corners and measured for pH, electrical conductivity (EC), total dissolved solids

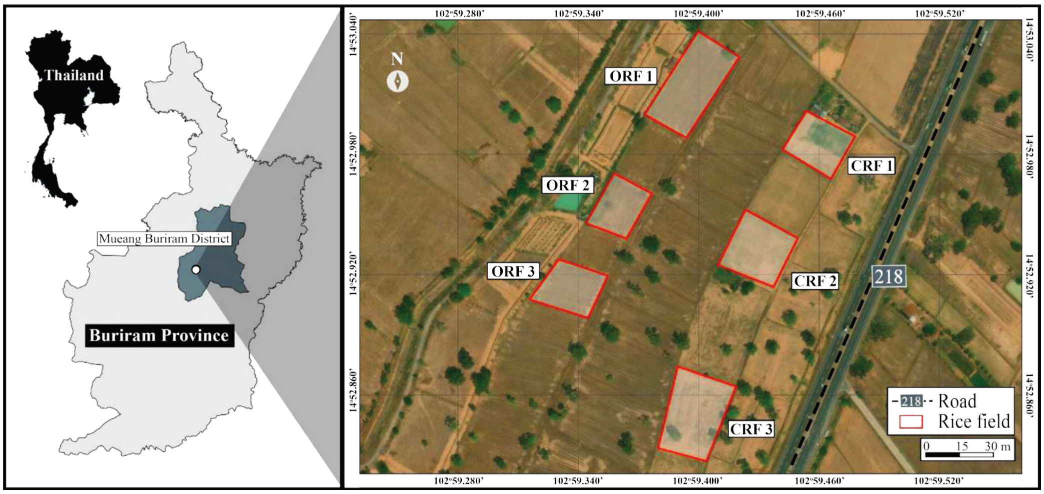

Figure 1. Study sites and sampling fields (ORF: Organic rice field, CRF: Chemical rice fields).

Table 1. Geographic coordinates of water sampling stations.

Areas	Stations	Latitude (N)	Longitude (E)
ORF 1	organic rice fields	14.883568	102.989908
ORF 2	organic rice fields	14.882569	102.989322
ORF 3	organic rice fields	14.881950	102.988935
CRF 1	chemical rice fields	14.883107	102.990956
CRF 2	chemical rice fields	14.882200	102.990441
CRF 3	chemical rice fields	14.880868	102.989947

(TDS) and temperature using a Yieryi EZ-9908 portable multimeter. Concurrently, zooplankton were collected by filtering the 36 L composite through 22 µm nylon mesh and preserving with 3% Lugol's iodine solution.

Zooplankton enumeration

Zooplankton were identified and counted using a compound light microscope at 100x total magnification. A Sedgwick-Rafter chamber was loaded with at least three 1 mL replicate samples and counted to a minimum of 100 individuals of the most abundant taxa to achieve 80% precision. Identification followed practical taxonomic keys (Wongrat, 1998; Dang *et al*., 2015). Using abundance data, community indices were calculated as:

Shannon-Weiner Diversity Index (H')

$$H' = -\sum_{i}^{k} pi \ln (pi)$$

Where: H' = Shannon-Weiner index
k = Number of individuals of each species
pi = The relative abundance of i^{th} species in community

Pielou's Evenness Index (J')

$$J' = H' / \ln(S)$$

Where: J' = Evenness index
H' = Shannon-Weiner index
S = Number of taxa

Margalef's Species Richness (R)

$$R = S-1/\ln (N)$$

Where: R = Richness index
S = Number of taxa
N = Total population of all taxa

Statistical analysis

Data normality was assessed using the Shapiro-Wilk test. For comparisons between organic and chemical rice fields, Welch's t-test was used for normally distributed abundance and environmental data. Non-normal data were analyzed by the nonparametric Kruskal-Wallis test. One-way analysis of variance (ANOVA) evaluated differences in normal datasets among monthly stages of the growing season. All statistical tests were interpreted at a significance level of $p<0.05$.

RESULTS AND DISCUSSION

Physical and chemical characteristics

The water temperature in the studied rice fields varied between 30.2 °C and 35.7 °C, with the lowest temperature recorded in organic rice fields during November and the highest in organic rice fields during September. Water depth ranged from 1.5 cm to 24.3 cm, with the deepest waters observed in chemical rice fields in September and the shallowest in organic rice fields. Electrical Conductivity (EC) ranged from 9 to 162 $\mu S \cdot cm^{-1}$, with the highest values found in organic rice fields during November and the lowest in chemical rice fields during October. Total Dissolved Solids (TDS) in water ranged between 4 and 89 ppm, with the highest concentration observed in organic rice fields during November and the lowest in organic rice fields during October. The pH levels ranged between 3.85 and 6.07, with the highest values measured in organic rice fields in November and the lowest in organic rice fields in September (Table 2).

The results revealed that most environmental factors were within typical range for tropical rice fields, with no mean differences between types of rice fields ($p \geq 0.05$). However, water depth (H = 9.167, p = 0.010, Sep>Nov) and TDS (H = 7.269, p = 0.026, Nov>Oct) varied among sampling months. These results reflected the nature of rice fields: rainfall in early months could increase water depths in the field before decreasing and subsequently, the fields dried-out in the following months. TDS concentrations increased in later months due to decreased water levels in the fields.

In details, pH varied between 3.85 and 6.07, which was close to the natural pH (4.9–9.0). Moreover, electrical conductivity (EC) ranged from 9 to 162 $\mu S \cdot cm^{-1}$ while total dissolved solid (TDS) were between 4 and 81 ppm, which falls within suitable ranges for living organisms (Kalayot and Chaichana, 2015). The water temperature ranged from 30 to 32 °C, which aligns with the optimum temperature for tropical aquaculture (Sriyasak *et al*., 2014).

Zooplankton species list

A total of 67 taxa of zooplankton were identified during a crop cycle in the rice fields. They comprised of 55 rotifers, 8 cladocerans, and 4 larval stages of copepods (Table 3).

When comparing the two types of rice fields (Table 4) and the three months throughout the growing season (Table 5), different sets of zooplankton dominated the rice fields. Briefly, ORF

Table 2. Physical and chemical characteristics of water measured in the rice fields.

Months	Sites	pH	EC ($\mu S \cdot cm^{-1}$)	TDS (ppm)	Water depth (cm)	Temperature (°C)
September	ORF1	4.51	42	21	7.0	35.7
	ORF2	3.85	44	22	15.0	32.8
	ORF3	4.29	41	19	13.7	33.2
	CRF1	4.83	110	55	24.3	30.3
	CRF2	4.34	127	58	15.5	30.5
	CRF3	4.75	79	40	14.8	30.3
October	ORF1	4.57	77	38	11.8	33.3
	ORF2	5.35	73	36	13.3	33.2
	ORF3	4.24	112	56	13.6	33.9
	CRF1	4.14	24	11	12.0	32.3
	CRF2	4.32	28	14	8.8	33.9
	CRF3	4.33	9	4	12.0	32.9
November	ORF1	6.07	122	61	5.0	30.2
	ORF2	5.31	162	89	1.5	30.5
	ORF3	4.86	103	58	4.5	30.5
	CRF1	NA	NA	NA	NA	NA
	CRF2	NA	NA	NA	NA	NA
	CRF3	NA	NA	NA	NA	NA

Note: NA = Not available due to naturally dried field

Table 3. List of zooplankton species in organic rice fields (ORF) and chemical rice fields (CRF).

Taxa	**Organic rice fields**			**Chemical rice fields**		
	ORF1	**ORF2**	**ORF3**	**CRF1**	**CRF2**	**CRF3**
Phylum Rotifera						
Anuraeopsis sp.	✓	✓	✓	✓	✓	
Ascomorpha sp.						✓
Asplanchna sp. 2	✓	✓	✓	✓	✓	✓
Asplanchna sp.		✓			✓	✓
Brachionus sp.		✓	✓			
Colurella sp.	✓	✓	✓	✓	✓	✓
Dipleuchlanis propatula		✓				✓
Dipleuchlanis sp.	✓	✓	✓	✓		
Filinia sp.		✓				
Hexarthra sp.					✓	
Lecane aegania		✓				
Lecane arcuata						✓
Lecane bulla	✓	✓	✓	✓	✓	✓
Lecane closterocerca		✓				
Lecane curvicornis		✓		✓	✓	✓
Lecane decipiens		✓	✓	✓	✓	✓
Lecane elegans						✓
Lecane furcata						✓
Lecane hamata			✓		✓	
Lecane hastata			✓			
Lecane imbricata			✓			
Lecane leontina	✓	✓	✓	✓	✓	✓
Lecane ludwigi			✓	✓		✓
Lecane ludwigi f.ercodes			✓		✓	
Lecane luna	✓	✓	✓	✓	✓	✓
Lecane lunaris		✓			✓	✓
Lecane monostyla		✓		✓	✓	
Lecane nana		✓				
Lecane papuana	✓	✓				
Lecane ploenensis		✓				
Lecane quadridentata		✓	✓	✓	✓	✓
Lecane signifera	✓	✓	✓	✓	✓	✓
Lecane sp.		✓	✓	✓	✓	✓
Lecane sp. 2				✓		
Lecane stichaea	✓	✓	✓	✓	✓	✓
Lecane unguitata		✓				
Lecane ungulata					✓	
Lepadella acuminata		✓				

Table 3. (Continued)

Taxa	Organic rice fields			Chemical rice fields		
	ORF1	ORF2	ORF3	CRF1	CRF2	CRF3
Phylum Rotifera						
Lepadella ovalis					✓	
Lepadella patella					✓	
Lepadella sp.	✓	✓	✓	✓	✓	✓
Macrochaetus sp.		✓	✓		✓	✓
Monommata sp.	✓	✓	✓	✓	✓	✓
Mytilina sp.				✓		
Platyias patulus	✓	✓	✓	✓	✓	✓
Platyias quadricornis				✓	✓	✓
Polyarthra sp.	✓	✓	✓	✓	✓	✓
Ptygura pectinifera				✓	✓	
Scaridium longicaudum		✓		✓	✓	✓
Sinantherina sp.	✓	✓	✓	✓	✓	✓
Testudinella sp.	✓	✓	✓		✓	✓
Tricrocerca bicristata					✓	
Tricrocerca sp.	✓	✓	✓	✓	✓	✓
Tripleuchlanis plicata		✓				
Tripleuchlanis sp.	✓					
Phylum: Arthropoda						
Subphylum: Crustacea						
Class: Hexanauplia						
Subclass: Copepoda						
Copepod nauplius	✓	✓	✓	✓	✓	✓
Juvenile copepodite (calanoid)	✓	✓	✓			✓
Juvenile copepodite (cyclopoid)	✓	✓	✓	✓	✓	✓
Juvenile copepodite (harpacticoid)	✓					
Phylum: Arthropoda						
Subphylum: Crustacea						
Class: Branchiopoda						
Subclass: Phyllopoda						
Superorder: Cladocera						
Alona sp.	✓	✓	✓	✓	✓	✓
Bosminopsis sp.				✓	✓	
Ceriodaphnia sp.	✓	✓	✓	✓		✓
Chydorus sp.	✓	✓		✓	✓	✓
Cladocera sp.	✓			✓		
Diaphanosoma sp.	✓	✓	✓	✓	✓	✓
Ephemerporus sp.	✓	✓	✓	✓		✓
Macrothrix sp.	✓	✓	✓	✓	✓	✓

Table 4. List of top 5 zooplankton taxa by mean Relative Abundance (RA) (%) in organic rice fields (ORF) and chemical rice fields (CRF).

Taxa in CRF	**Mean RA (%)**	**Taxa in ORF**	**Mean RA (%)**
Sinantherina sp.	35.60	*Lecane curvicornis*	42.54
Polyarthra sp.	19.76	Copepod nauplius	16.41
Lecane furcate	14.96	*Sinantherina* sp.	14.64
Lecane sp.4	6.30	*Asplanchna* cf.	13.23
Ptygura sp.	5.91	*Polyarthra* sp.	11.89

Table 5. List of top 5 zooplankton taxa by mean Relative Abundance (RA) (%) comparing among months (September to November).

Taxa	**Mean RA (%)**	**Taxa**	**Mean RA (%)**	**Taxa**	**Mean RA (%)**
September		October		November	
Sinantherina sp.	40.09	*Polyarthra* sp.	26.72	*Lecane curvicornis*	42.54
Copepod nauplius	17.29	*Lecane furcata*	14.96	*Sinantherina* sp.	31.30
Ptygura sp.	16.18	*Asplanchna* cf.	11.09	*Anuraeopsis* sp.	20.38
Polyarthra sp.	8.38	Copepod nauplius	9.72	*Lecane stichaea*	15.55
Asplanchna cf.	6.14	*Monommata* sp.	7.08	*Lecane luna*	10.92

was dominated by *Lecane curvicornis*, Copepod nauplius, *Sinantherina* sp., *Asplanchna* cf., and *Polyarthra* sp., while CRF had *Sinantherina* sp., *Polyarthra* sp., *Lecane furcate*, *Lecane* sp.4, and *Ptygura* sp. as dominant zooplankton. Regarding temporal progress, fields in September were dominated by *Sinantherina* sp., Copepod nauplius, *Ptygura* sp., *Polyarthra* sp., and *Asplanchna* cf., while those in October had *Polyarthra* sp., *Lecane furcate*, *Asplanchna* cf., Copepod nauplius, and *Monommata* sp.. In November, ORF fields were dominated by *Lecane curvicornis*, *Sinantherina* sp., *Anuraeopsis* sp., *Lecane stichaea*, and *Lecane luna*.

Zooplankton abundance

Overall, across both types of rice fields and all three sampling months, the average abundance of total zooplankton in rice fields was 4,889±4,866 individuals·L^{-1} (mean±standard deviation). When using t-test to compare between types of rice fields, the mean abundance of CRF (8,515±6,105 individuals·L^{-1}) was not statistically different from that of ORF (2,471±1,303 individuals·L^{-1}) ($t = 0.002$, $p = 0.226$) (Figure 2a). Mean zooplankton abundance did not show statistically significant temporal differences when comparing among the three months of the growing season by one-way ANOVA ($F = 2.397$, $p = 0.133$). The monthly mean abundances from high to low were as followed: September (8,022±6,433 individuals·L^{-1}), October (2,826±2,218 individuals·L^{-1}), and November (2,748±929 individuals·L^{-1}) (Figure 2b).

When analyzing the data separated by types of rice fields and months, CRF and ORF did not exhibit statistical differences in zooplankton abundance in both September ($t = 1.218$, $p = 0.299$) and October ($t = -3.396$, $p = 0.070$) (Figure 3).

When considering particular groups of zooplankton, rotifers (64.01%–96.21%) dominated the community in relative abundance in both ORF and CRF throughout all three months of the growing seasons. They were followed by copepods (3.14%–34.04%) and cladocerans (0.65%–7.19%) (Figure 4).

Our results in this study highlight the similarity in the abundance of zooplankton between field types (Figure 2 and Figure 3), and the dominance of rotifers in zooplankton community, either by abundance (Figure 4) or by the number of taxa (Table 3). Rotifers stand as the primary component of freshwater resources (Chittapun, 2009), and variations in environmental factors, including temperature, season, and light, can influence rotifer migration (Maiphae and Jantawong, 2020). The abundance and dominance of rotifers may be in consistent or in contrast with other studies due to differences in methods, study periods, and study locations. For example, our findings that rotifers were the dominant zooplankton group were consistent with the findings in Pathum Thani Province of Thailand (Chittapun *et al*., 2009), where rotifers dominated rice fields in a crop cycle. In addition,

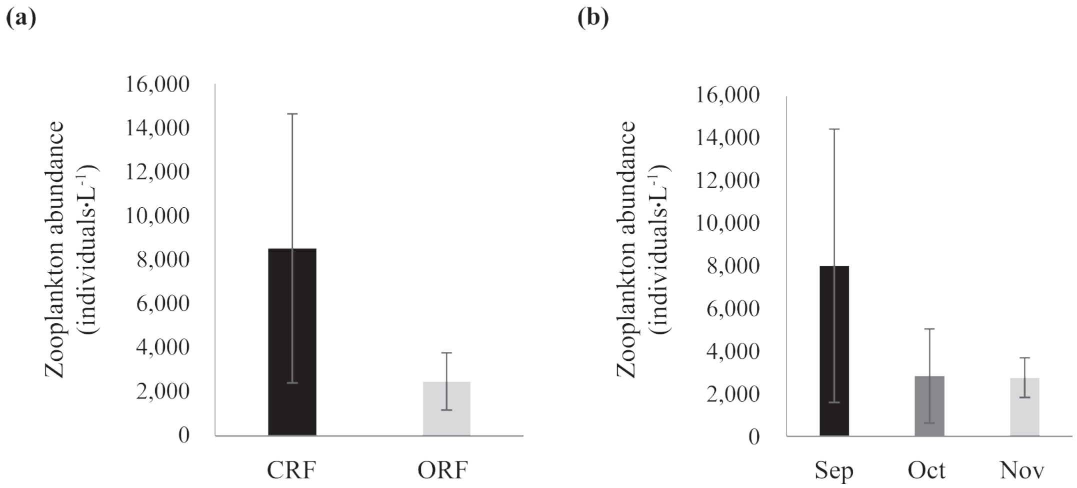

Figure 2. Abundance of zooplankton: (a) in two types of rice fields ($p = 0.226$); (b) in each month during the growing season ($p = 0.133$); CRF and ORF = chemical- and organic rice field, respectively; Bars represent mean values and error bars represent standard deviation.

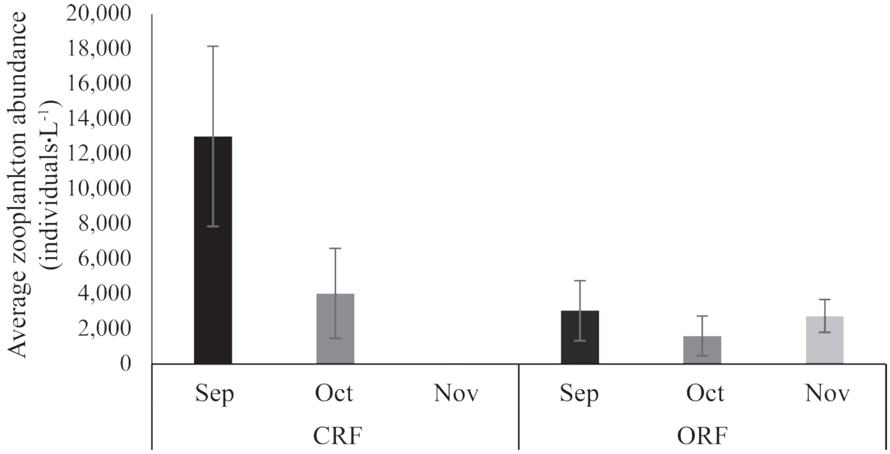

Figure 3. Total monthly abundance of zooplankton in chemical – and organic rice fields; Bars represent mean values and error bars represent standard deviation; CRF and ORF = chemical- and organic rice field, respectively; Nov CRF data was not available due to dried fields.

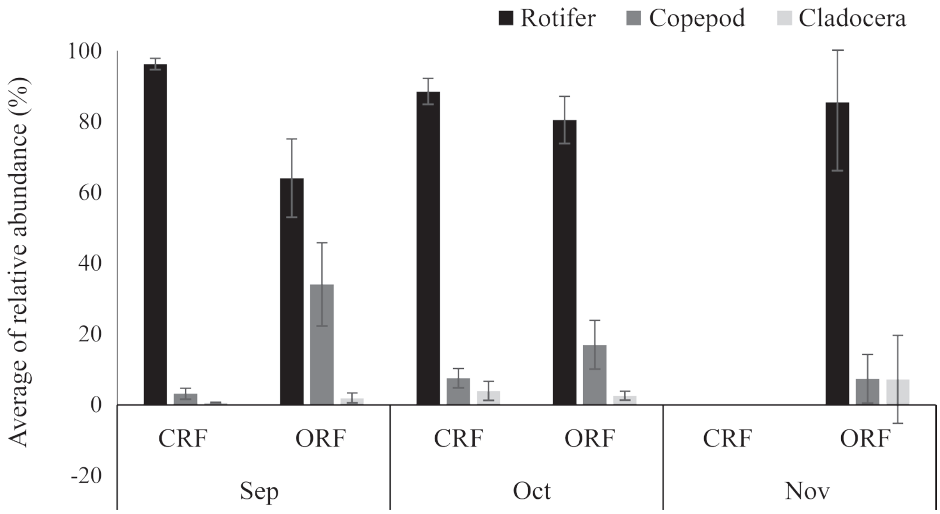

Figure 4. Mean Relative Abundance of each zooplankton group in rice fields; CRF and ORF = chemical- and organic rice field, respectively; Bars represent mean values and error bars represent standard deviation.

Plangklang and Athibai (2021b) revealed the same domination of rotifers with the presence of up to 61 and 79 rotifer species in rice fields with and without pesticidal use, respectively. In contrast, Rajashree *et al*. (2017) identified 33 taxa of cladocerans as the dominant group in two consecutive growing seasons in an Indian rice field. This was in contrast with our results, probably due to the longer period of sampling.

When considering the predominant taxa in each group of zooplankton found in rice fields, the most common zooplankton taxa in CRF were *Sinantherina* sp., *Polyarthra* sp., and *Lecane furcate*, respectively, while those in ORF were *Lecane curvicornis*, Copepod nauplius, and *Sinantherina* sp.. Obviously, there were different sets of zooplankton taxa that dominates both types of fields, although they were mainly contributed to by rotifers. Many rotifers found in this study could attach to plant roots and stems as their habitats, and rice fields provide excellent habitats from rice stems and leaf sheaths. This may be the main factor for this type of rotifers being highly dispersed in the studied rice fields. For example, *Sinantherina* sp. attached to the roots and stems of aquatic plants (Malee *et al*., 2018). Similarly, *Lecane bulla* was the most abundant rotifer species in a Brazilian paddy field (Rodrigues *et al*., 2011). Both zooplankton genera can attach themselves to the roots and stems of aquatic plants. In contrast, in the canals of rice fields, the most abundant rotifers were *Brachionus*, followed by *Lecane* and *Filinia*, respectively (Chittapun, 2009), probably because of pelagic habitats.

Relatively high TDS (4 and 89 ppm) and EC (9 to 162 $\mu S \cdot cm^{-1}$) in September CRF could play a role in the initial high abundance of *Lecane* and *Polyarthra*, as both genera, along with *Euchlanis*, were positively related to high TDS and EC (Ramarn *et al*., 2019).

Although not examined within the scope of this study, nutrients could play a major role in rotifer dominance in the zooplankton community. CRFs in our study were applied with three types of fertilizers that could be sources for allochthonous nutrients. For example, *Philodina* sp., *Filinia* sp., and *Brachionus* sp. were showed to be positively related to high ammonia, nitrite, and phosphate content in water (Ramarn *et al*., 2019).

Our study revealed that CRF did not show significant difference in total zooplankton abundance when compared to ORF, either overall (Figure 2a) or when separated by months (Figure 3). This is interesting and quite departed from our hypotheses.

It was thought that increased nutrients would have an impact on plankton community, but perhaps due to high variations of zooplankton abundance in the analyses.

Interestingly, from a non-organic aspect, there have been a few studies that focus on the effect of herbicides and pesticides as stimuli on the zooplankton community in rice field ecosystem (Romero *et al*., 2022). For example, rice fields with pesticide applications (chlorpyrifos and glyphosate) had less abundant zooplankton than those without them (Plangklang and Athibai, 2023). Additionally, Kalayot and Chaichana (2015) found that rice fields with herbicidal applications (2,4-D and paraquat) along with artificial fertilizers had slightly higher zooplankton abundance than organic fields.

Although changes in the growth cycle of rice fields may alter habitats and potentially influence zooplankton population dynamics (Maiphae *et al*., 2023), temporally, zooplankton abundance in this study did not appear to be statistically different among the months of the growing season (Figure 2b). Nevertheless, September, especially in CRF, generally had high zooplankton abundance. It is possible that September was the first period of rice cultivation when the amount of water is abundant and supported the growth of zooplankton. Water depth may influence zooplankton abundance later in season. This is consistent with Plangklang and Athibai (2019), who found a relationship between water level and the diversity of zooplankton in rice fields in Nakhon Ratchasima Province, Thailand. Similarly, the results of Maiphae and Jantawong (2020) show that in October, the rainy season likely contributes to increased zooplankton diversity, as rainwater washes essential nutrients into the water. Abundant nutrients likely lead to an increase in phytoplankton, the primary food source for zooplankton. Therefore, the increase in phytoplankton could be related to an increase in zooplankton abundance. However, as the water levels decrease entering the dry season, the abundance of zooplankton has decreased.

Community diversity indices

When considering the general trend in ecological community indices, ORF had higher diversity (as indicated by the Shannon-Weiner diversity index), higher evenness, and a greater number of zooplankton taxa than CRF (Figure 5). Overall temporal changes of these indices throughout the growing season showed that the Shannon-Weiner diversity index and evenness decreased in October before increasing in November, reaching levels similar to those in September (Figure 6). Richness and the number of taxa exhibited high variability within months, and general trends were obscured.

Our results demonstrated variability in ecological community indices. The differences in these indices may be attributed to variation in study sites, environmental factors, rice growth, and fluctuations in water levels, which subsequently and collectively influence habitat conditions for zooplankton, leading to changes in zooplankton community structure. Consequently, the composition of zooplankton is expected to undergo changes throughout the cultivation period (Maiphae *et al*., 2023). In the later stage of the crop cycle, rice fields are mostly covered with vegetation, which may serve as a refuge for some zooplankton species (Montiel-Martínez *et al*., 2015).

When comparing CRF and ORF, the results imply that the zooplankton community in ORF was generally more diverse, more even, and with a higher number of zooplankton taxa. This is in accordance with our hypotheses that CRF would have elevated nutrients and therefore supports a narrower range of zooplankton, preferably those that grow fast and rely on foods that benefit from increased nutrients. This idea is consistent with Romero *et al*. (2022), which showed that Argentinean rice fields without herbicides were more diversified and of better environmental quality than chemical rice fields.

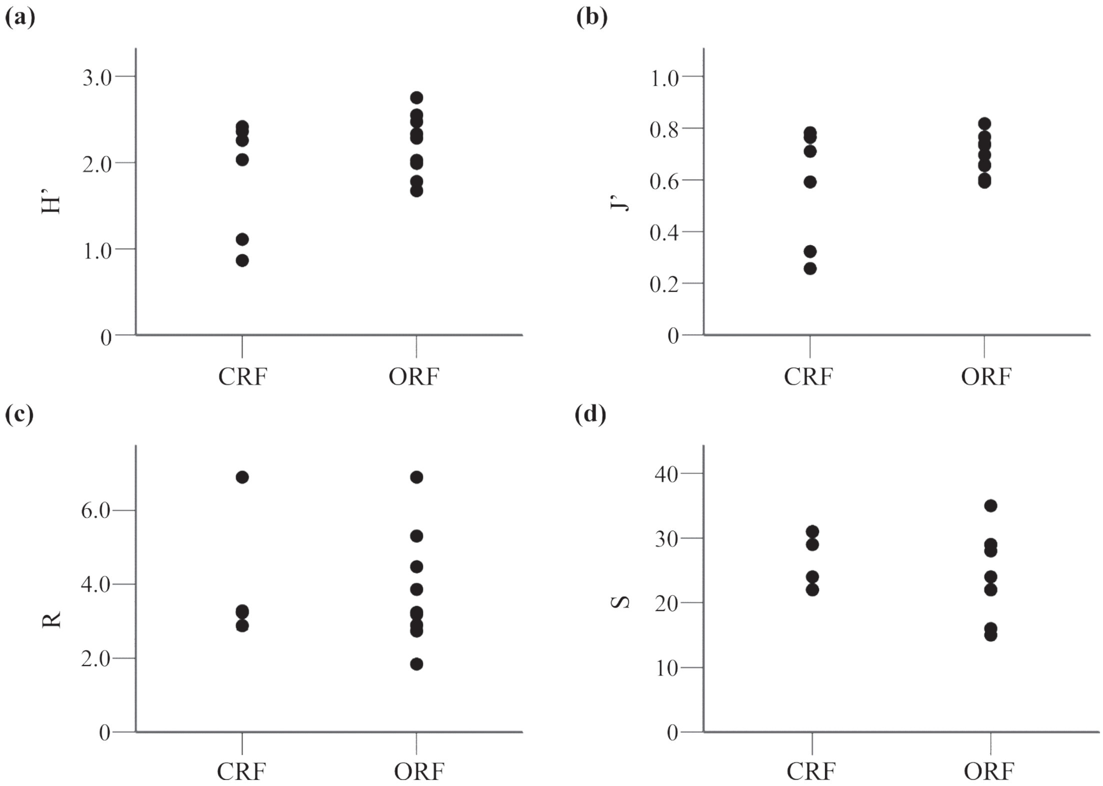

Figure 5. Index values of zooplankton in chemical rice fields (CRF) and organic rice fields (ORF): (a) the Shannon-Weiner diversity index; (b) evenness index; (c) species richness index; (d) number of species.

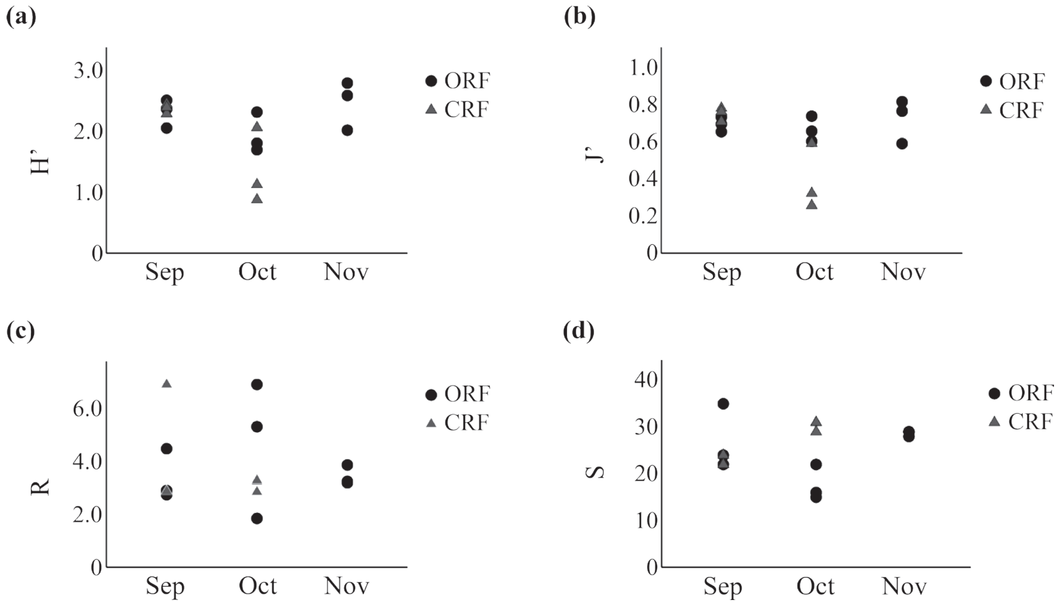

Figure 6. Monthly index values of zooplankton in the studied rice fields: (a) the Shannon-Weiner diversity index; (b) evenness index; (c) species richness index; (d) number of species; CRF = chemical rice fields; ORF = organic rice fields.

CONCLUSION

A total of 67 zooplankton taxa were identified over the single crop cycle, primarily comprising rotifers along with cladocerans and copepods. While water depth and total dissolved solids significantly varied monthly, total zooplankton abundance showed no statistical differences either temporally or between organic and chemical rice fields. However, community structure analysis revealed greater diversity, evenness, and species richness in organic systems. Specifically, organic rice fields exhibited higher Shannon-Wiener diversity, greater numbers of unique taxa, and more stable Pielou evenness proportions. These community composition distinctions, despite similarities in abundance, provide insight into how alternative cultivation practices can influence seasonal rice paddy ecosystem dynamics.

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LITERATURE CITED

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