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ORIGINAL ARTICLE

Zooplankton Genera from Sematan River, Sarawak: A Preliminary Inventory

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ABSTRACT - The present study provides a baseline inventory of zooplankton genera and their abundance, based on data collected during the dry (August 2010) and wet (January 2011) seasons from six stations in the Sematan River, Sarawak, Malaysia. Despite the age of the data, this study represented the only known record of zooplankton diversity in the river, offering a valuable reference for monitoring ecological changes over time. A total of 14 genera belonging to four taxa were identified, with Copepoda dominating the assemblages, contributing 68.44% of the total abundance. Among the genera, *Limnocalanus* was the most abundant, comprising 29.56% of the total count, followed by *Diaptomus* and *Macrothrix*. However, zooplankton abundance was significantly higher during the dry season, particularly at Stations 3 and 4, likely due to influenced by environmental conditions such as light availability and water flow. The finding of this inventory would serve as a critical reference for future biodiversity assessments and comparative studies in the region, particularly in light of potential environmental changes over the past decades. Although the data were collected in 2010 and 2011, they serve as a valuable baseline for future ecological comparisons and assessments in this relatively understudied tropical river.

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INTRODUCTION

Zooplankton are integral to aquatic ecosystems, serving as primary consumers that transfer energy from phytoplankton to higher trophic levels, including fish and other aquatic organisms. Their sensitivity to environmental changes makes them valuable bioindicators for assessing water quality and ecosystem health [1; 2]. Factors such as water temperature, dissolved oxygen, turbidity, and habitat conditions significantly influence their diversity and abundance [3; 4]. Understanding zooplankton communities is essential for comprehending ecological patterns and dynamics in freshwater and estuarine ecosystems.

The Sematan River, located in western Sarawak, Malaysia, is influenced by tidal flows and bordered by mangrove vegetation. It supports diverse aquatic habitats and human activities, including aquaculture and small-scale fisheries. Despite its ecological importance, studies on the biodiversity of zooplankton in this river are limited. Previous research in Sarawak has focused on areas such as Kuching Bay [5], Batang Lupar [6], and Lawas River [7], leaving a knowledge gap regarding the zooplankton assemblages of the Sematan River. Baseline data from this river are crucial for understanding its ecological characteristics and for evaluating the impact of anthropogenic activities and environmental changes over time.

Recent studies have highlighted the significance of zooplankton assemblages as indicators of aquatic ecosystem health in tropical rivers. For instance, zooplankton have been used effectively to assess trophic status and environmental quality in tropical freshwater and estuarine systems due to their sensitivity to ecological changes and pollutant levels [8-10]. Zooplankton functional diversity has also been proposed as a strong indicator of freshwater ecosystem health across different land-use gradients [11]. However, there remains a scarcity of region-specific data in many parts of Borneo, including the Sematan River, which

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limits the ability to assess ecological shifts over time. This challenge is echoed in similar tropical systems where spatial and seasonal data gaps hinder comprehensive ecological assessments [12; 13].

This study provides an inventory of zooplankton genera and their abundance in the Sematan River during the dry (August 2010) and wet (January 2011) seasons. Although more recent data collection was not feasible, the historical dataset from 2010–2011 provides a rare insight into the earlier zooplankton assemblages in Sematan River. This makes the data useful for long-term monitoring efforts and detecting ecosystem shifts over time. By focusing on zooplankton composition and seasonal variations, the present research aims to address the lack of data on this understudied river ecosystem. The findings serve as a critical reference for future biodiversity assessments and ecological monitoring in tropical river systems. Such baseline studies are particularly relevant for assessing long-term environmental changes and for informing conservation and management strategies in the region [14; 15]. Despite the ecological importance of the Sematan River, there is limited information on its zooplankton community structure. This knowledge gap hampers effective monitoring and conservation planning. Therefore, establishing a baseline inventory is crucial.

MATERIALS AND METHODOLOGY

Sampling Sites

The study was conducted in the Sematan River, located in western Sarawak, Malaysia (Figure 1). The river is influenced by tidal flows and is surrounded by mangrove vegetation, with aquaculture activities and human settlements along its banks. Six sampling stations were selected along the river, covering various environmental conditions, such as shaded forested areas, open sunlit zones, aquaculture-affected locations, and river mouth zones. The geographical coordinates of each station were recorded using a Global Positioning System (GPS). (Table 1, Figure 1). Zooplankton were collected during two distinct seasons: the dry season (7–8 August 2010) and the wet season (15–16 January 2011). These seasons were chosen to capture potential seasonal variations in zooplankton assemblages.

With a light source of 1,000 *lumens*. If all these 1,000 *lumens* are spread over an area of 1 square meter, there will be an illumination of 1,000 *lux*. If the lumens spread over 10 square meters the illumination or lux would diminish to a less intense and grader 100 *lux*. Equation (1) shows the computation of the illumination. Table 1 presents examples of light levels common to the natural light source released by the Illuminating photovoltaic energy harvest of the solar-powered IoT device.

Table 1. Descriptions and geographical coordinates of sampling stations in the Sematan River

Stations	Location (coordinate)	Location description
Station 1	N 01° 47’ 43.9 E 109° 45’ 23.6	Shaded area and enclosed by forest canopy. Slow water current flow.
Station 2	N 01° 46’ 28.9 E 109° 47’ 15.2	Serayan River. The station is situated closely to the mangrove vegetation.
Station 3	N 01° 47’ 00.1 E 109° 47’ 02.6	Sematan River. Junction of Simpang Tembaga River and Serayan River. The station is open area and exposed directly to sunlight.
Station 4	N 01° 47’ 18.8 E 109° 47’ 02.6	The existing of aquaculture pond area found at the station.
Station 5	N 01° 47’ 38.7 E 109° 47’ 19.6	Human settlements and residential area.
Station 6	N 01° 48’ 08.4 E 109° 47’ 01.9	‘Kuala Sematan’ Station was close to river mouth area. Station was influenced by saltwater.

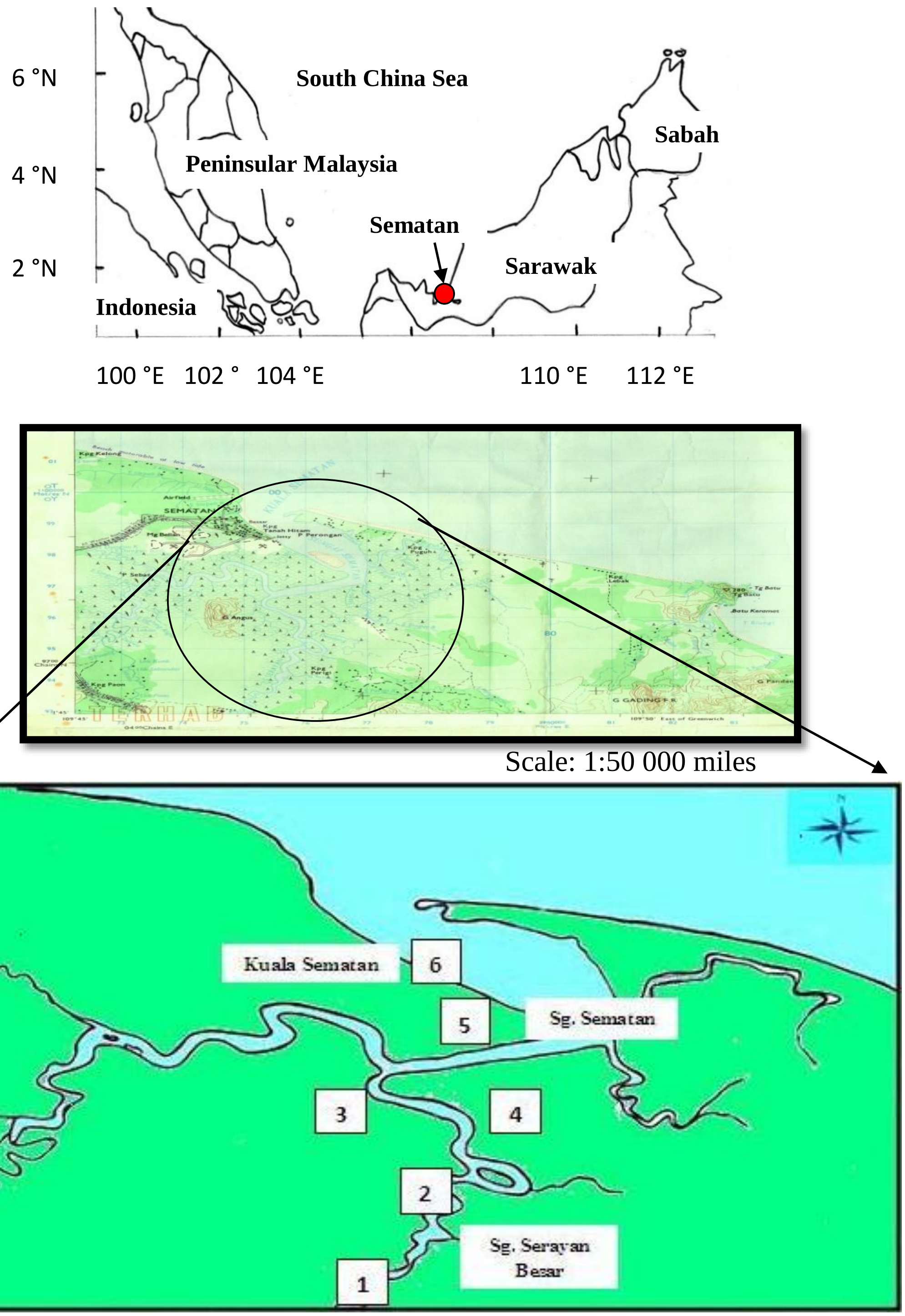

Figure 1. Location of six sampling sites along the Sematan River

Zooplankton Sampling

Zooplankton samples were collected using a 100 μm mesh size plankton net, which was towed horizontally at each station for a fixed duration to standardize sample collection. The collected samples were transferred into sterile Nasco Whirl-Pak™ plastic bags and preserved with a few drops of Lugol's iodine solution for further analysis.

Identification and Enumeration

In the laboratory, zooplankton samples were analyzed under a compound microscope (Magnus Microscope). Zooplankton were identified to the genus level using the established identification keys [16 - 20]. Enumeration was performed using a Sedgwick-Rafter counting chamber. A 1 mL aliquot of the preserved sample was transferred to the chamber, and the total number of individuals was counted. The presence of each genus was recorded, and a checklist was compiled.

RESULTS AND DISCUSSION

Zooplankton Genera Composition and Abundance

In total, 14 genera of zooplankton were identified in the Sematan River, distributed among four taxa: Copepoda, Cladocera, Rotifera, and Protozoa (Table 2). Copepoda dominated the zooplankton assemblages, accounting for 68.44% of the total abundance, with *Limnocalanus* being the most abundant genus (29.56%), followed by *Diaptomus* (20.89%) and *Macrothrix* (6.56%) as shown in Figure 2. Other genera, such as *Cyclops*, *Daphnia*, and *Acroperus*, were less abundant but consistently recorded across multiple stations. Rarely observed taxa including *Testudinella* and unidentified gastropod larvae, suggested their occurrence might be influenced by localized or sporadic environmental factors. Figure 2 shows that copepods and rotifers dominate the zooplankton community, suggesting a freshwater-influenced environment with sufficient organic matter input.

These results are consistent with the findings from other tropical aquatic ecosystems, where copepods were often dominated due to their high adaptability and feeding versatility [1; 4]. The significant presence of genera such as *Limnocalanus* and *Diaptomus* underscored their ecological importance in nutrient cycling and their role as a primary food source for higher trophic levels [3].

Spatial Distribution of Zooplankton

Zooplankton abundance varied significantly across the six sampling stations (Table 3). Stations 3 and 4 recorded the highest abundances, with 232 and 228 individuals, respectively, during the dry season. These stations are characterized by open sunlight exposure and aquaculture activities, which probably contributed to higher phytoplankton productivity, providing an abundant food source for zooplankton. Conversely, Station 1 exhibited the lowest abundance (6 individuals), possibly due to its shaded location under forest canopy, limiting light availability and primary productivity.

The spatial distribution of zooplankton has been linked to microhabitat variability and localized environmental conditions, such as water flow, light penetration, and anthropogenic influences [14]. Similar patterns have been observed in tropical rivers, where zooplankton abundance peaks in nutrient-rich and well-lit zones [2].

Table 2. Occurrence of zooplankton genera across sampling stations in the Sematan River

No.	Group	Taxa	Genera	Stations					
				1	**2**	**3**	**4**	**5**	**6**
1.	**Crustacea: Copepoda**	Maxillopoda	*Canthocamptus*	+	++	++	+	+	-
2.		Maxillopoda	*Diaptomus*	-	++	++	+++	+	++
3.		Maxillopoda	*Cyclops*	-	+	-	+	+	+
4.		Maxillopoda	*Limnocalanus*	-	++	+++	++	++	+++
5.		Immature stage (*Nauplius*)		-	-	+	++	+	+
6.	**Crustacea: Cladocera**	Branchiopoda	*Diaphanosoma*	-	+	+	++	-	-
7.		Branchiopoda	*Camptocercus*	-	+	+	+	-	-
8.		Branchiopoda	*Macrothrix*	-	++	-	++	+	+
9.		Branchiopoda	*Acroperus*	+	+	+	+	+	+
10.		Branchiopoda	*Daphnia*	-	-	+	++	+	+
11.	**Crustacea: Anostraca**	Branchiopoda	Unidentified 1	-	-	-	+	-	+
12.	**Crustacea: Ostracoda**	Ostracoda	*Cypridopsis*	-	-	-	-	+	+
13.	**Rotifera**	Monogononta	*Testudinella*	-	+	-	-	-	-
14.		Monogononta	*Hexarthra*	-	+	-	-	-	-
15.		Monogononta	*Platyias*	-	+	-	-	-	-
16.		Unidentified	Unidentified 2	-	-	-	+	-	-
17.	**Protozoa**	Unidentified (i)	Unidentified 3	-	-	-	-	-	+
18.		Unidentified (ii)	Unidentified 4	-	+	-	-	-	-
19.		Unidentified (iii)	Unidentified 5	+	+	-	-	-	-
20.	**Mollusca**	Bivalvia larvae	Unidentified 6	-	-	-	-	++	-
21.		Gastropod larvae	Unidentified 7	-	-	-	+	-	+
		Total of occurrences		**3**	**13**	**8**	**13**	**10**	**11**

Note: +++ = common/abundance (>50 individuals); ++ = moderate (10 ≤ 50 individuals); + = rare (≤ 10 individuals); - = absent

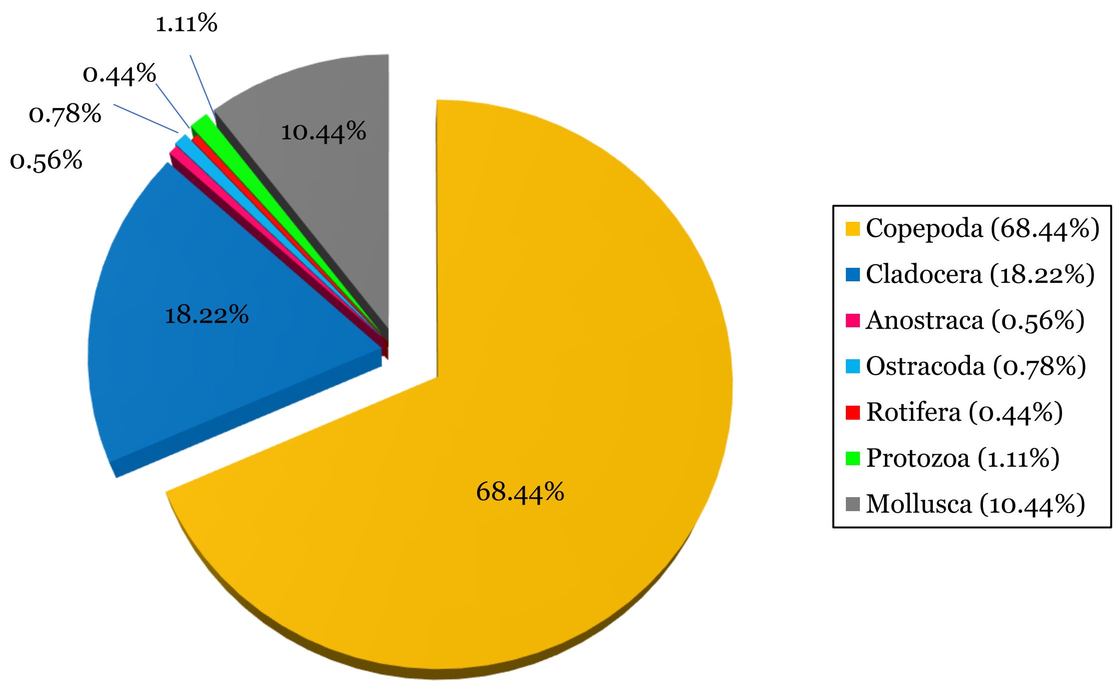

Figure 2. Proportion of zooplankton groups identified in the Sematan River during the study

Seasonal Variations

Zooplankton abundance was markedly high during the dry season compared to the wet season across all stations (Figure 3). During the dry season, stable hydrological conditions and reduced turbidity likely enhanced light penetration, promoting phytoplankton growth, which in turn supported higher zooplankton densities. In contrast, the wet season was characterized by lower zooplankton abundance, with the most significant reductions observed at Stations 3 and 4. The decline in zooplankton abundance during the wet season is attributed to increased turbidity caused by sediment runoff from surrounding catchments. High turbidity reduces light penetration and negatively impacts primary producers, leading to a cascading effect on zooplankton populations [15; 21]. Additionally, increased organic loads during the wet season may lead to hypoxic conditions, further limiting zooplankton growth and survival [4].

The zooplankton assemblage exhibited marked seasonal variation (Figure 2 and Figure 3). Copepods were the most dominant group in both seasons, but their abundance was notably higher in the dry season. This may be attributed to favourable water conditions such as lower turbidity and greater salinity intrusion, which supports copepod reproduction. In contrast, during the wet season, the abundance of rotifers and cladocerans increased slightly, potentially due to nutrient input from surface runoff. The overall decrease in zooplankton abundance in the wet season suggests the influence of hydrological changes and water quality dynamics.

Table 3. Abundance and distribution of zooplankton genera across six sampling stations in the Sematan River

No.	Group	Taxa	Genera	Stations						Total
				1	2	3	4	5	6	
1.	**Crustacea: Copepoda**	Maxillopoda	*Canthocamptus*	4	45	39	3	4	-	**95**
2.		Maxillopoda	*Diaptomus*	-	27	50	71	7	33	**188**
3.		Maxillopoda	*Cyclops*	-	8	-	2	1	2	**13**
4.		Maxillopoda	*Limnocalanus*	-	15	117	23	24	87	**266**
5.		Immature stage (*Nauplius*)		-	-	9	32	3	10	**54**
6.	**Crustacea: Cladocera**	Branchiopoda	*Diaphanosoma*	-	2	6	16	-	-	**24**
7.		Branchiopoda	*Camptocercus*	-	6	1	3	-	-	**10**
8.		Branchiopoda	*Macrothrix*	-	20	-	28	5	6	**59**
9.		Branchiopoda	*Acroperus*	1	2	6	7	2	9	**27**
10.		Branchiopoda	*Daphnia*	-	1	4	28	5	6	**44**
11.	**Crustacea: Anostraca**	Branchiopoda	Unidentified 1	-	-	-	3	-	2	**5**
12.	**Crustacea: Ostracoda**	Ostracoda	*Cypridopsis*	-	-	-	-	1	6	**7**
13.	**Rotifera**	Monogononta	*Testudinella*	-	1	-	-	-	-	**1**
14.		Monogononta	*Hexarthra*	-	1	-	-	-	-	**1**
15.		Monogononta	*Platyias*	-	1	-	-	-	-	**1**
16.		Unidentified	Unidentified 2	-	-	-	1	-	-	**1**
17.	**Protozoa**	Unidentified (i)	Unidentified 3	-	-	-	3	-	2	**5**
18.		Unidentified (ii)	Unidentified 4	-	2	-	-	-	-	**2**
19.		Unidentified (iii)	Unidentified 5	1	2	-	-	-	-	**3**
20.	**Mollusca**	Bivalvia larvae	Unidentified 6	-	-	-	-	37	-	**37**
21.		Gastropod larvae	Unidentified 7	-	-	-	11	-	46	**57**
			No. of genera	**6**	**133**	**232**	**228**	**89**	**209**	**900**

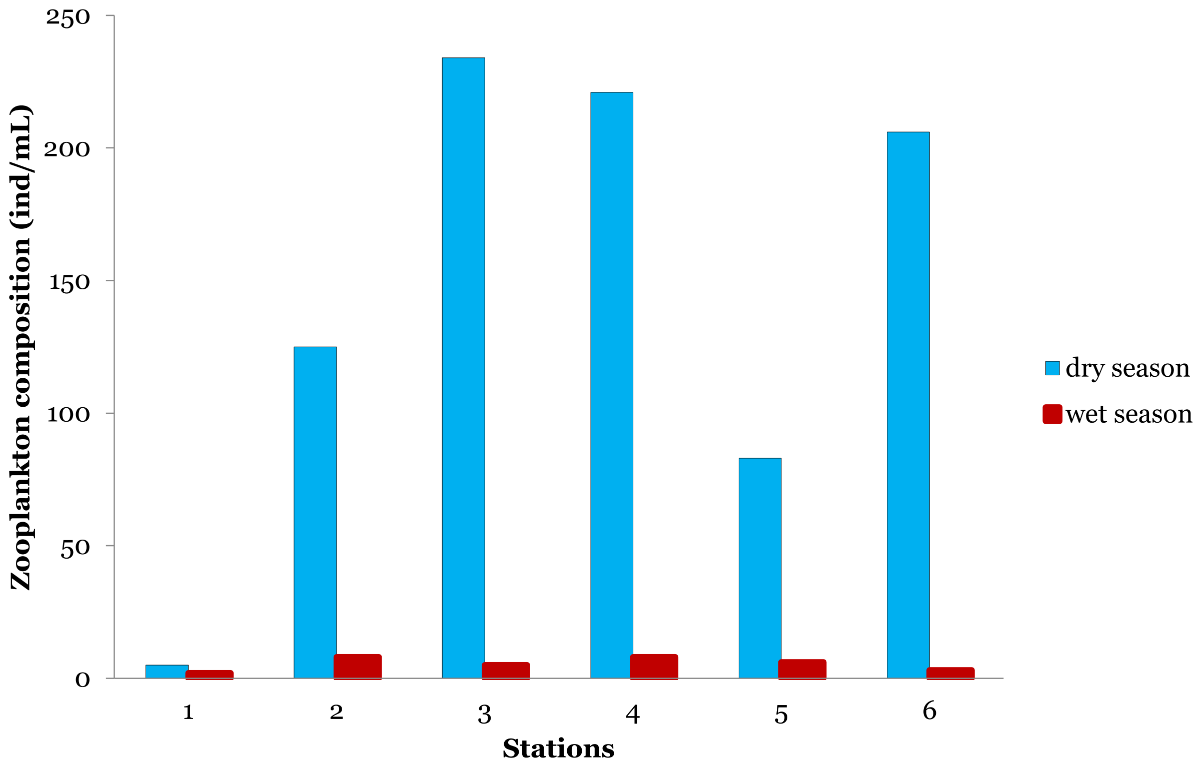

Figure 3. Comparison of zooplankton abundance between the dry and wet seasons in the Sematan River. The dry season showed significantly higher total abundance, possibly due to reduced freshwater inflow and greater water stability. The wet season abundance decreased, potentially influenced by increased turbidity and dilution effects from monsoonal rainfall.

Ecological Insights

The dominance of Copepoda, particularly *Limnocalanus*, highlighted their ecological importance in tropical river systems. Copepods are known for their adaptability to environmental fluctuations, including variations in salinity, temperature, and dissolved oxygen [1]. The significantly higher abundance during the dry season emphasized the importance of stable hydrological conditions for supporting zooplankton communities.

The composition of zooplankton in the Sematan River also reflected the influence of environmental parameters, such as light availability and water flow. These findings align with studies in similar ecosystems, where environmental factors shape zooplankton community structure [2; 14]. The presence of rare taxa such as *Testudinella* suggests localized ecological niches within the river system, which may warrant further investigation.

Implication for Biodiversity Monitoring

This study provided the first comprehensive inventory of zooplankton genera in the Sematan River, offering valuable baseline data for future biodiversity assessments and monitoring. The findings highlighted the sensitivity of zooplankton communities to seasonal and spatial environmental changes, reinforcing their role as bioindicators of ecosystem health. Given the increasing anthropogenic pressures on tropical river systems, such as aquaculture and land-use changes, this baseline data would not only be essential for tracking ecological shifts over time but also be helpful for implementing the conservation strategies in the Sematan River ecosystem to a greater extent [15; 22].

CONCLUSION

This study provided a baseline inventory of zooplankton genera in the Sematan River, highlighting the dominance of Copepoda and the significant abundance of genera such as *Limnocalanus* and *Diaptomus*. The findings revealed the spatial and seasonal variations in zooplankton abundance, with the higher numbers observed during the dry season, particularly at stations exposed to higher light penetration and aquaculture activities. The wet season, characterized by increased turbidity and reduced dissolved oxygen, showed a marked decline in zooplankton abundance across all stations. These results underscored the ecological importance of zooplankton as primary consumers and bioindicators of aquatic health. By documenting the diversity and abundance of zooplankton in the Sematan River, this study established a critical reference for future research and biodiversity monitoring in the region. The data can be instrumental in understanding long-term ecological changes, assessing the impact of anthropogenic activities, and guiding conservation efforts in tropical river ecosystems. Further research is recommended to investigate the functional roles of zooplankton and their responses to the evolving environmental conditions.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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