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IDENTIFICATION OF PHYTOPLANKTON AT EPHEMERAL POND WITH ACIDIC pH IN BANGKA REGENCY

IDENTIFIKASI FITOPLANKTON DI PERAIRAN EPHEMERAL DENGAN pH ASAM DI KABUPATEN BANGKA

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Abstract

Ephemeral waters, the temporary aquatic environment become an interesting habitat to explore extremophile organism, include phytoplankton. Furthermore, the waters have an acidic condition or low pH that impact to metabolisms, community structure, and diversity of phytoplankton. This study was conducted on June until August 2022 in Bangka Regency, Bangka Belitung Archipelago Province, Indonesia. We analyzed the phytoplankton presence at acidic ephemeral waters to indicated their potential as primary producer in food web, bioindicator, and ecological succession agent. This study was conducted by exploration method of phytoplankton diversity. The research observed and found five class and twelve genera that consist of class *Chlorophyceae* (genera *Enteromorpha*, *Ankistrodesmus*, *Prasiola*, *Pleurococcus*, and *Coleochaete*), class *Rhodophyceae* (genera *Lemanea*), class *Diatoms* (genera *Diatoma*, *Synedra*, and *Navicula*), class *Xanthophyceae* (genera *Ophiocytium*), and class *Cyanobacteria* (genera *Oscillatoria* and *Anabaena*). The class *Chlorophyceae*, genera *Enteromorpha* were the highest community at the both of acidic waters and they could survive at pH 3.52 $\pm$ 0.5 to 3.71 $\pm$ 0.8.

***Keywords*:** Acidic water; Bioindicator; Ephemeral; Phytoplankton

Abstrak

Perairan ephemeral, lingkungan perairan musiman menjadi suatu habitat yang menarik untuk mengeksplorasi organisme ekstremofil, termasuk fitoplankton. Lebih jauh lagi, perairan tersebut memiliki kondisi asam atau pH rendah yang berdampak pada metabolisme, struktur komunitas, dan diversitas fitoplankton. Penelitian ini dilaksanakan pada Juni hingga Agustus 2022 di Kabupaten Bangka, Provinsi Kepulauan Bangka Belitung, Indonesia. Kami menganalisis keberadaan fitoplankton di perairan ephemeral asam untuk mengindikasikan potensi fitoplankton sebagai produsen utama, bioindikator dan agen suksesi lingkungan. Penelitian ini dilaksanakan dengan metode eksplorasi diversitas fitoplankton. Penelitian ini mengobservasi dan menemukan lima kelas dan dua belas genus yang terdiri atas kelas Chlorophyceae (genus Enteromorpha, Ankistrodesmus, Prasiola, Pleurococcus, dan Coleochaete), kelas Rhodophyceae (genus Lemanea), kelas Diatoms (genus Diatoma, Synedra, dan Navicula), kelas Xanthophyceae (genus Ophiocytium), dan kelas Cyanobacteria (genus Oscillatoria dan Anabaena). Kelas Chlorophyceae, genus Enteromorpha adalah komunitas tertinggi pada kedua perairan asam dan mampu bertahan pada pH 3.52 $\pm$ *0.5 to 3.71* $\pm$ *0.8.*

Kata Kunci*: Perairan asam; Bioindikator; Ephemeral; Fitoplankton*

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INTRODUCTION

Aquatic ecosystems are a subset of ecosystems or ecological system in which water is a key component. There, interactions are happened between all living organisms and non-living components, of a water-based environment. Some of the water available on Earth have high level of biodiversity, one of the waters is freshwater ecosystems, such as water flow, river, stagnant water in lakes, and areas with temporary water availability in seasonal wetlands called ephemeral (Reddy & Campus, 2018).

Temporary aquatic environments, are generally shallow and small water are common in almost all terrestrial ecosystems, with seasonally changing patterns of precipitation and/or evaporation. These habitats include floodplains that may be closely associated with semi-permanent and permanent bodies of water, dry riverbeds that periodically become raging rivers, or completely isolated from permanent bodies of water and includes small rainwater pools that may exist for only a few weeks out of the year (Polačik & Podrabsky, 2015). Nevertheless, temporary wetlands play important role to enhance biodiversity and provide aesthetic, biogeochemical, and hydrologic functions (Calhoun et al., 2016). In fact, some fish species have evolved to stay in seasonal habitats, even require the periodic drying of their seasonal habitat and there is a relationship between the species composition with seasonal changes (Wolter & Bischoff, 2001; Okogwu, 2010; Tang et al., 2018).

In aquatic ecosystems, planktons form the base of the food web. Planktons are microscopic organisms that flow with streamlined water which non-motile and water-current-resistant organisms in both freshwater and marine environments. Planktons are one of species inhabiting extreme environments called extremophiles. Their physiological adaptation to extreme conditions supposes relevant biochemical mechanisms so they can survive in this environment (Padisák & Naselli-Flores, 2021). Analysis of plankton communities across pollution gradient is an essential tool to assess the effects of anthropogenic activities on river systems, including ephemeral rivers. They are excellent bioindicators of ecological changes as they have short life cycles, and can respond quickly to shifts in physicochemical variables (Edegbene et al., 2022).

The ecological role of phytoplankton as primary producers is a major source of food webs. They perform important functions in aquatic ecosystems that can have cascading effects on food webs. Phytoplankton is the primary producer in ecosystems, producing oxygen, and organic matter through photosynthesis. Phytoplankton were affected by water type, seasonal's variation, and nutrient supply. Phytoplankton are the dominant primary producers and the decisive biological factor when assessing ecological status. Therefore, changes in phytoplankton communities can affect zooplankton growth and system-wide ecological conditions. These changes are mainly influenced by physical-chemical (bottom-up effects) and predation (top-down effects) through the aquatic food web (Li et al., 2020; Florescu et al., 2022).

We have found one of extreme ephemeral environment in Bangka Regency, Bangka Belitung Archipelago Province with acidic condition. Understanding plankton presence of ephemeral aquatic ecosystems and condition of water quality are fundamental goals of this research.

MATERIALS AND METHODS

The research was conducted on June-August 2022, dry season, in Bangka Regency, Bangka Belitung Archipelago Province, Indonesia (Figure 1). Physical-chemistry of water quality were measured two times for once sampling at each research location. We composited 50 L water and filtered it with plankton net to collect plankton. Plankton was collected using plankton net (*mesh size* 330 µm) at 3 sampling points at each research station. A water sample of 100 mL was preserved using 15 mL of lugol and then observed using a microscope to observe the plankton contained in the water sample. Plankton identification is adjusted to the identification manual and refers to Kurniawan et al. (2023). Data analysis was carried out using the Excel 2010 Program to determine the number of plankton, Shannon-Wiener Diversity Index (H'), Evenness Index (E'), and Simpson Dominance Index (D) (Sirait et al., 2018). The formula of Shannon-Wiener Diversity

Index (H’), Evenness Index (E’), and Simpson Dominance Index (D) refers to Sulawesty and Aisyah (2020).

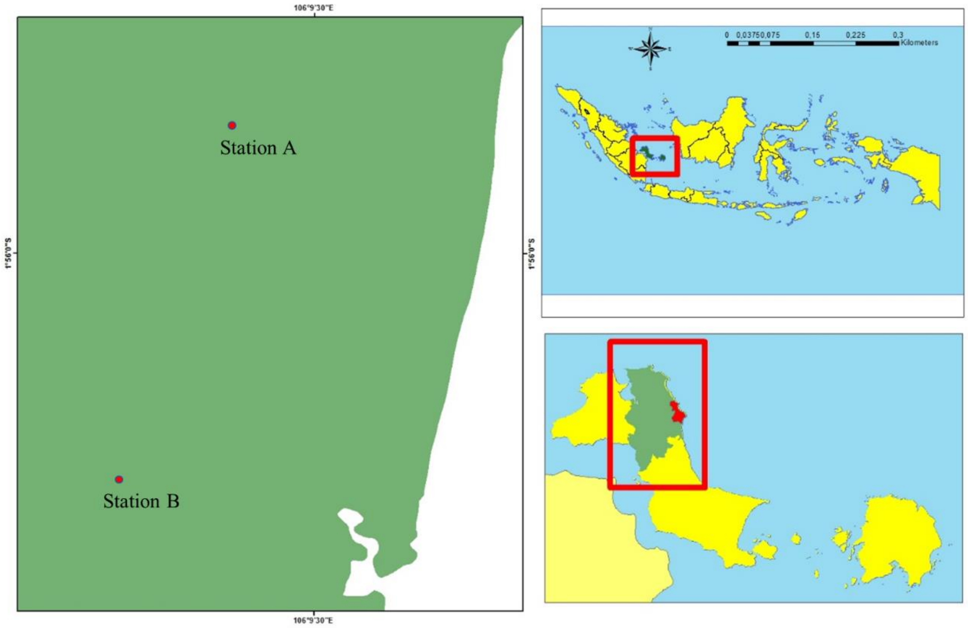

Figure 1. Research station, acidic ephemeral water in Bangka Regency

RESULTS

The ephemeral waters, based on pH value, both of research stations were acidic water with pH range 3.52 ± 0.5 to 3.71 ± 0.8 (Table 1). The Station A was a small ephemeral water like a pond which inlet of water source and outlet. This Station A had many water plants around the water body with mud sediment. The color of water was light green and there were some species of fishes such as *Rasbora* sp., *Brevibora* sp., *Striuntius* sp., *Hemiramphus* sp. with high abundance. While, Station B was a small ephemeral water like small river which inlet of water source and outlet. There were bigger water plants around the water body that covered water from sunlight and it had a sand sediment.

Station A had many phytoplankton than Station B. The ephemeral waters had phytoplankton community structure that consist of genera *Enteromorpha*, *Ankistrodesmus*, *Prasiola*, *Pleurococcus*, *Coleochaete*, *Lemanea*, *Diatoma*, *Synedra*, *Navicula*, *Ophiocytium*, *Oscillatoria*, and *Anabaena*. The class *Chlorophyceae*, genera *Enteromorpha* dominated the both of acidic ephemeral waters at research station that 143–465 individual/L or about 69.20–70.79% (Table 2; Figure 2).

Table 1. Parameters of water quality at acidic ephemeral waters

Research station	Parameters					
	pH	Temperature (°C)	DO (ppm)	TDS (ppm)	Water velocity (m/s)	Water depth (cm)
A	3.71 ± 0.8	31.36 ± 1.2	6.10 ± 1.3	13.18 ± 1,8	0.4 ± 0.1	135
B	3.52 ± 0.5	31.70 ± 0.8	6.20 ± 1.1	12.4 ± 1.5	0.9 ± 0.2	32

Note: Potential hydrogen (pH), Dissolved Oxygen (DO), and Total Dissolved Solid (TDS)

Table 2. Distribution of phytoplankton at acidic ephemeral waters

Class	Genera	Station 1				Station 2			
		Abundance (individual/L)	H’	E’	D	Abundance (individual/L)	H’	E’	D
Chlorophyceae	*Enteromorpha*	465				143			
	Ankistrodesmus	105				33			
	Prasiola	10				2			
	Pleurococcus	5				1			
	Coleochaete	1				1			

Class	Genera	Station 1				Station 2			
		Abundance (individual/L)	H’	E’	D	Abundance (individual/L)	H’	E’	D
Rhodophyceae	*Lemanea*	45				11			
Diatoms	*Diatoma*	5				1			
	Synedra	10				2			
	Navicula	5				1			
Xanthophyceae	*Ophiocytium*	15				3			
Cyanobacteria	*Oscillatoria*	5				3			
	Anabaena	1				1			
Total of phytoplankton		672	1,09	0,47	0,51	202	1,02	0,44	0,53

Note: Shannon-Wiener Diversity Index (H’), Evenness Index (E’), and Simpson Dominance Index (D)

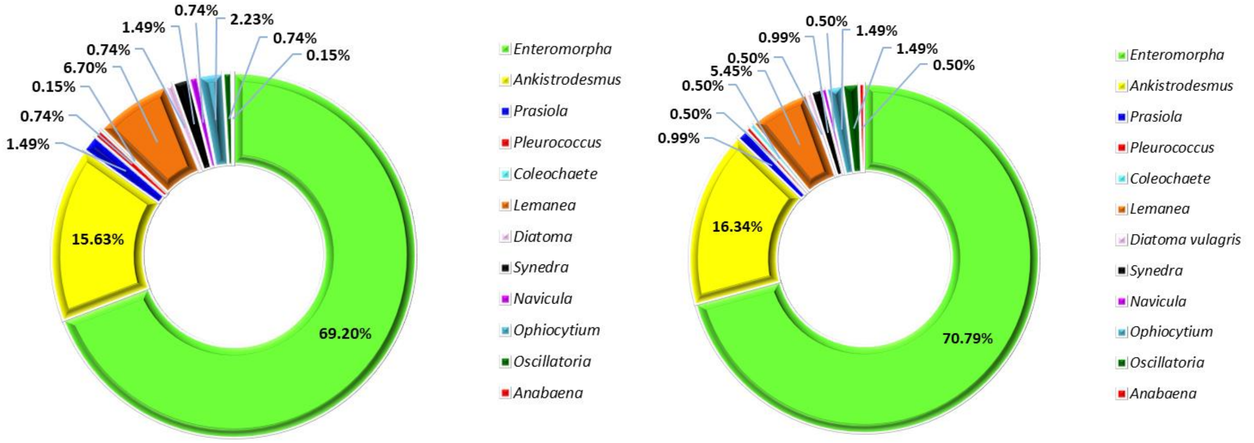

Figure 2. Dominance percentage of phytoplankton genera at acid ephemeral water; Station A (left) and Station B (right)

DISCUSSION

The presence and higher abundance of phytoplankton at Station A than Station B may be impacted by waters condition such as there was no water plants covered the water that disturb intensity of sunlight to water body. The presence of water plants also contributed to diversity phytoplankton as long as photosynthesis process.

Temporary aquatic ecosystems are of great evolutionary and ecological importance, having communities that are physiologically adapted and that have developed effective and diversified mechanisms for their colonization, permanence, and reproduction. These are highly endemic sites of rare species and endangered. Often ignored, these ecosystems are hot spots of biodiversity in regions and landscapes (Céréghino et al., 2008; Paina & Melão, 2019). We have discovered that the phytoplankton have different community composition at both of the research stations. However, in fact phytoplankton from class *Chlorophyceae*, especially genera *Enteromorpha* dominated the waters.

Phytoplankton are the plant-like organisms that are found in aquatic habitats, as a producer which serves as food for zooplankton in a food chain. As photosynthetic organisms, these groups play a key role in productivity of the water (Shalaby, 2011). They are also a major source of organic carbon and may represent an important source of oxygen in aquatic ecosystem (Adadu et al., 2018).

Enteromorpha are uncommon phytoplankton in freshwater, while it also has species are found in a wide range of habitats and able to grow in estuarine to sea environment (Messyasz, 2009; Sinha et al., 2016; Zhao et al., 2016). *Enteromorpha* prefers sunny locations and oxygen-rich water. Dense populations of *Enteromorpha* are closely associated with eutrophication and also can be used as indicators to explain changes in habitat trophic status (increased nutrient availability) (Messyasz, 2009) and heavy metals contamination (Żbikowski et al., 2007). Station A had higher sunlight intensity than Station B due to there were no any shade plants that inhibit sunlight reach the water body. The presence of dissolved oxygen at Station A might be influenced some water grass around the water, also movement and activity of some fishes found there, despite of water velocity was weak. Visually, we indicated that Station A had higher nutrient availability than Station B with indications of more fishes and water plants found there. The substrate of water at Station A was mud and sand, while sand at Station B may impacted to diversity of *Enteromorpha* at both of locations.

The dynamics of phytoplankton are a function of some environmental processes that affect species abundance and diversity. In this research, *Chlorophyceae* (*Chlorophyta*) grew and dominated acidic waters at both of stations with pH 3.52 ± 0.5 to 3.71 ± 0.8. While, *Rhodophyceae* (e.g. *Lamella*) grow at pH optimum 7.1–7.8 (Simić, 2007), *Diatom* (e.g. *Synedra*) at pH 8.0 (Li et al., 2017), *Xanthophyceae* (e.g. *Ophiocytium*) at pH 4–5 (Sari et al., 2013), *Cyanophyceae* (*Oscillatoria*) at pH 7.5–9.0 (Wangwibulkit et al., 2008). pH value is an important factor for phytoplankton growth. The pH can affect the enzymatic activities and the metabolism of phytoplankton (Filali et al., 2021), decrease in total accumulated carbon and oxygen evolution (pH decreased from 7.0 to 5.0) and inefficient accumulation of carbon high supply of carbonates required to maintain photosynthetic activity at pH >9.0, (Juneja et al., 2013). Effect of an acid water effluent can decrease phytoplankton biomass, chlorophyll level, and primary production productivity (Levings et al., 2005). We are shown that an environment variations parameters affect the physic-chemical variables thus causing variation in abundance and diversity of phytoplankton. However, class *Chlorophyceae* can survive at acidic pH, furthermore, this phytoplankton community can be a bioindicator for water quality based on pH value and can be utilized for primary producer as extremophile and pioneer agent in primary succession at acidic water.

CONCLUSION AND SUGGESTIONS

We observed that phytoplankton play important role at acidic temporary waters as primary biomass. Class *Chlorophyceae* and genera *Enteromorpha* were dominant at the ephemeral waters. We are also studying about interaction between microorganism at acidic waters, include lentic and lotic waters to support the understanding of food chain at acidic waters.

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