Plankton Abundance in Senggarang Waters as Blue Swimming Crab Catchment Area, Tanjungpinang City, Riau Islands

Wahyu Muzammil*, Nurhidayah Rahmah, Tri Apriadi, Winny Retna Melani, Andi Zulfikar

ABSTRACT

Senggarang waters are a traditional fishing spot for small-scale blue swimming crab (BSC) fishermen in Tanjungpinang City. The fishermen have their own BSC catchment areas to capture this product, which is the primary aim. Plankton, an aquatic microbe that lives floating in the water column and can't move or only move slightly to follow the current, has a high ecological significance as a source of food for fisheries biota. The purpose of this study was to monitor the existence of plankton by determining plankton abundance, diversity index, uniformity index, and plankton dominance index in crab fishermen's traditional fishing grounds in Senggarang seas. This is a quantitative study; planktons were sampled at 10.00−13.00 using the horizontal static method with a plankton net, placed in a sample bottle, and given 10% Lugol, before being identified at the Marine Biology Laboratory, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University. Samples were collected for five weeks at five locations designated by purposive sampling in the same location as the BSC fishermen who set their traps (*bubu*). The results revealed 41 genera of planktons classified as Cyanophyceae, Bacillariophyceae, Branchiopoda, Chlorophyceae, Dinophyceae, Sarcodina, Copepods, and Tintinnidae. The largest plankton abundance occurs in the fourth week of Station 5, with 15961 ind.L^{-1}. The plankton diversity index was low, and the uniformity index was inversely proportional to dominance.

Keywords: blue swimming crab catchment areas, plankton abundance, Senggarang Waters, Tanjungpinang City

INTRODUCTION

Plankton is the primary component of aquatic ecosystems, consisting of a diverse group of animals that drift in aquatic environments, unable to swim against currents, and serve as the foundation of marine and freshwater food webs. The term, originating from the Greek word for "wandering," refers to both tiny plants (phytoplankton) and animals (zooplankton) that play important roles in aquatic ecosystems (Manickam *et al*. 2019, Santhanam *et al*. 2019). Plankton plays critical roles in food webs and biogeochemical cycles, acting as both primary producers and consumers. Plankton richness in blue swimming crab (BSC) catchment areas has a significant impact on coastal ecosystems, particularly in Tanjungpinang, Riau Islands. It is particularly relevant to food web dynamics and the health of coastal ecosystems. According to some studies, phytoplankton and zooplankton play important roles in coastal ecosystems as primary producers and herbivores, respectively (Pillay & Nair 1973, Khasanah *et al*. 2013). Plankton abundance can vary greatly depending on seasonal changes, nutrient availability, and environmental circumstances, all of which are critical for the survival of crab populations and other marine species (Zingone *et al*. 2023). The abundance of plankton is directly proportional to the availability of food for crab larvae, determining survival and growth rates. Areas with high plankton concentrations are likely to have higher crab and decapod populations. Monitoring plankton dynamics is critical for evaluating the health of crab populations and the whole marine ecosystem, particularly in areas impacted by anthropogenic changes (Zingone *et al*. 2023).

Based on food chain relationships, zooplankton are preyed upon by a variety of fish, crabs, shrimp, benthos, and marine mammals (Apriadi *et al*. 2020, Fikri *et al*. 2018, Mulyadi 2013, Muzammil *et al*. 2020, Muzammil *et al*. 2021a, 2021b). Plankton is the largest group of organisms that play a very important role in various lives. Phytoplankton production is very important because it describes the supply of resources to the ecosystem, such as primary productivity (phytoplankton) and assessment of the ecological status of a body of water (Effendi *et al*. 2016, Juranek *et al*. 2020). Plankton can be used to assess whether water is clean or contaminated (Effendi *et al*. 2016). Unfavorable circumstances, such as foggy waters, can prevent sunlight from entering the water body (Yolanda *et al*. 2020), limiting phytoplankton's ability to photosynthesise. Unfavorable environmental variables also reduce

Department of Aquatic Resources Management, Faculty of Marine Science and Fisheries, Raja Ali Haji Maritime University, Kepulauan Riau 29115, Indonesia
* Corresponding Author:
  Email: wahyu.muzammil@umrah.ac.id

plankton quantity and diversity. The abundance of the plankton abundance is determined by the nutritional availability of a body of water and the presence of varied marine biota, one of which is the BSC (*Portunus pelagicus*). The BSC is an extremely promising fishing product. Aside from its delicious meat, its high nutritional value has resulted in increased demand for this commodity in both domestic and export markets. Swimming crabs are commonly caught utilizing traps on a small, medium, and large scale, according to BBPPI (2014). Traps have several advantages over other fishing gears: they are selective and environmentally friendly, provide a high level of freshness, provide reliable catchability, and may be used in regions where traditional fishing gear is impractical.

Knowing the abundance plankton in Senggarang seas leads to the conclusion that these waters are beneficial to biota, particularly BSC, which is a major catch for fishermen in Senggarang coastal towns. Senggarang Waters is in Tanjungpinang City and serves as a source of income for the locals, particularly fishermen. Using its natural resources, the community can engage in a variety of activities such as netting, fishing, shrimp farming, and sea transit routes. The diversity of plankton, particularly zooplankton, is important for assessing the ecological conditions of the waters, including water balance (Graff *et al*. 2015). Given the importance of plankton, both phytoplankton and zooplankton, as food chain components and indicators of the tropic level in terms of water quality in an aquatic ecosystem, it is necessary to study plankton and its relationship to environmental parameters in Senggarang waters, which is one of the BSC capture locations in Tanjungpinang City, Riau Islands Province.

METHODS

Research Site
The sampling period for this study lasted five weeks, from September 10th to October 15th, 2020. Water samples and physicochemical characteristics were taken every seven days for five weeks. The sampling location was Tanjungpinang City's Senggarang Waters (Figure 1). *In situ* parameter measurements were taken in the field, while plankton samples were identified at the Marine Biology Laboratory, Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University.

Materials
We collected plankton samples using a 2-liter bucket, sample bottles, a 30 cm diameter plankton net, and 10% Lugol solution as a color and preservative sample. The Faculty of Marine and Fisheries Biology Laboratory of Raja Ali Haji Maritime University analyzed plankton samples. All samples were examined with a sedgewick rafter counting chamber (SRC) and an optical microscope. Plankton abundance was determined using the census method (APHA 2017). Then, identification was performed using the identification books Illustrations of the Marine Plankton of Japan (Yamaji 1979) and The Marine and Freshwater Plankton (Davis 1955).

Procedures
Water sampling was performed using a horizontal static approach, with a total volume of 100 L filtered through sequential collection using a 10 L bucket (repeated ten times). The collected water was filtered through a plankton net with a mesh size of 30−50 μm to retain microplankton. The filtrate was then concentrated to a final volume of around 320 mL. This concentrate was placed in a sterile sampling bottle and preserved in situ with Lugol's iodine solution at a final concentration of 10% (v/v) until a distinctive brick-red hue appeared, indicating sufficient fixation. Sampling occurred in the morning (8 a.m. to 11 a.m.), and data was collected quantitatively by recording parameters measured directly in the field. The sample approach utilized in this study was purposive sampling, which involves examining the existence of marine life, notably BSC, which are the principal catch
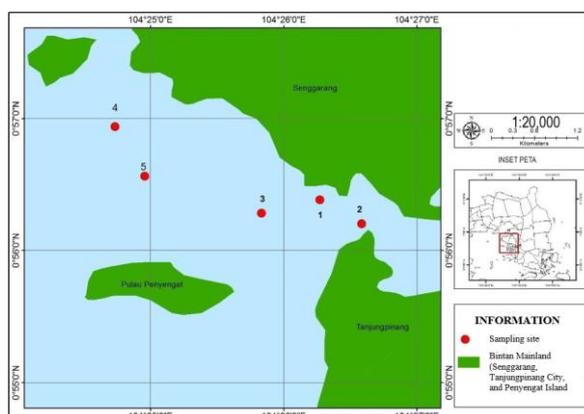

Figure 1 Sampling sites in the coastal waters of Senggarang, Tanjungpinang City, Riau Islands Province.

of fish trap fishermen in Senggarang waters. Sampling sites were divided into five stations in Tanjungpinang City's Senggarang seas, where fishermen set traps (bubu) to catch BSC.

Data Analysis
Plankton Abundance
The census method for plankton enumeration was utilized. Plankton abundance using SRC is shown below (APHA 2017).

$$N = n \ x \ \frac{A}{a} \ x \ \frac{v}{vc} \ x \ \frac{1}{V}$$

where
N = Phytoplankton abundance (cells/L)
n = Number of phytoplankton counted (cells)
A = Area of the cover glass (1,000 mm^2)
a = Area of the visual field (1,000 mm^2)
v = Volume of concentrated water (mL)
vc = Volume of water under the cover glass (1 mL)
V = Volume of filtered water (L)

Diversity Index (H')
Phytoplankton diversity was calculated using the Shannon-Wiener index equation as follows (Fachrul 2007).

$$H' = -\sum_{i=1}^{s} (p_i \ ln \ p_i)$$

where
H' = Diversity index
p_i = n_i/N
n_i = Total individuals of the ith species
N = Total number of individuals in the community
The diversity index criteria were classified into three groups:
$H'<2.306$ = Low diversity
$2.306<H'<6.9076$ = Medium diversity
$H'>6.0976$ = High diversity

Evenness Index (E)
The evenness index was calculated using the Shannon-Wiener formula (Fachrul 2007) as follows:

$$E = \frac{H'}{H_{maks}}$$

where
E = Evenness index
H' = Diversity index
H_{max} = ln S (number of species)
S = Number of genera found

The range of evenness index was classified as follows:
0.00 < E 0.50 = The community is in a low (stressed) condition

0.50 < E 0.75 = The community is in a moderate (unstable) condition
0.75 < E 1.00 = The community is in a high (stable) condition

Dominance Index (C)
The dominance index was calculated using the Simpson Dominance Index (Krebs 1999) by the following formula:

$$C = \sum_{i=1}^{s} (Pi)^2$$

where
C : Dominance index
P_i : Proportion of the ith species (n_i/N)

The C value ranges from 0 to 1. A value close to 0 indicates no dominant individual, while a value close to 1 indicates a dominant individual in the population.

RESULTS AND DISCUSSION

Plankton Abundance
Plankton abundance is an important measure of aquatic ecosystem health and productivity, with fluctuations caused by environmental factors such as nutrient availability and water quality. During the five-week sample period in Senggarang waters, ten plankton groups totaling 42 species were discovered (Table 1).

During the first week, 32 plankton species were identified from eight classes: Cyanophyceae, Bacillariophyceae, Branchiopoda, Chlorophyceae, Dinophyceae, Sarcodina, Copepods, and Tintinnidae. Station 5 had the maximum abundance of *Oscillatoria* sp., with 5,137 ind/L. *Thalassiosira* sp. and *Triceratium* sp. had the lowest abundances, each at 6 ind/L. In the second week, new species were discovered in the Bacillariophyceae and Chlorophyceae classes, whereas the Branchiopoda class was no longer present in the samples. A total of 33 species from seven classes were documented. *Chaetoceros* sp. was the most abundant at Station 1, with 5,638 ind/L, while *Ditylum* sp. and *Synedra* sp. had the lowest abundances (6 ind/L each). According to Wulandari *et al.* (2014), Chaetoceros' supremacy is due to its morphology—chain-forming cells with chaeta—which reduces sinking rate and makes it less sensitive to herbivorous predation.

In the third week, the species count grew again with the addition of new Bacillariophyceae class members, bringing the total to 37 species across seven classes. The fourth week showed a decrease in species from the Cyanophyceae and Bacillariophyceae classes, leaving 33 species throughout six classes. *Chaetoceros* sp. once again

had the maximum abundance at Station 1 (3,014 ind/L). The lowest abundances (6 ind/L) were seen for *Triceratium* sp., *Globigerina* sp., *Limacina* sp., and *Luderia* sp. Notably, *Chaetoceros* sp. peaked at 15,961 ind/L at Stations 1, 2, and 3, while *Peridinium* sp., *Nauplius* sp., *Calanus* sp., *Synedra* sp., and *Hemiaulus* sp. had the lowest levels (6 ind/L). In the fifth week, both increases and decreases in species diversity were seen. Species were added to the Cyanophyceae, Copepods, and Chlorophyceae classes, whereas Sarcodina and Chlorophyceae were reduced. A total of 31 species from six classes were recorded. At Station 5, *Oscillatoria* sp. had the maximum abundance (3,113 ind/L), whereas *Navicula* sp. and *Nauplius* sp. had the lowest abundance (6

ind/L each).

The Bacillariophyceae class, which was consistently abundant over the study period, is known for its widespread distribution in a variety of aquatic habitats, including open ocean, coastal, and estuary environments (Gonçalves *et al.* 2021, Sunesen *et al.* 2015). Members of this group are often phototactic and are more abundant during the day (Liwutang *et al.* 2013, Ramesh *et al.* 2015). *Nitzschia* sp., a Bacillariophyta species found in the samples, is known to feed swimming crabs (Portunidae). These crabs eat slow-moving prey like plankton and mollusks. Bacillariophyta, the main phytoplankton species in marine ecosystems, serve as primary producers and represent an important foundation of

Table 1 Weekly plankton types in Senggarang coastal waters, Tanjungpinang City on September 10th to October 15th, 2020

Class	Species	week				
		First	Second	Third	Fourth	Fifth
Cyanophyceae	*Oscillatoria* sp.	√	√	√	X	√
Bacillariophyceae	*Coscinodiscus* sp.	√	√	√	√	√
	Thalassiosira sp.	√	√	√	√	√
	Cerataulina sp.	√	√	√	√	√
	Biddulphia sp.	√	√	√	√	√
	Chaetoceros sp.	√	√	√	√	√
	Bacteriastrum sp.	√	√	√	√	√
	Rhizosolenia sp.	√	√	√	√	√
	Lauderia sp.	√	√	√	√	√
	Hemiaulus sp.	√	√	√	√	√
	Melosira sp.	√	√	√	√	√
	Thalassionema sp.	√	√	√	√	√
	Thalassiothrix sp.	√	√	√	√	√
	Synedra sp.	√	√	√	√	√
	Pleurosigma sp.	√	√	√	√	√
	Navicula sp.	√	√	√	√	√
	Nitzschia sp.	√	√	√	√	√
	Surirella sp.	√	√	√	√	√
	Triceratium sp.	√	√	√	√	√
	Amphora sp.	√	√	√	√	√
	Ditylum sp.	√	√	√	√	X
	Diatoma sp.	X	√	√	√	X
	Stephanopyxis sp.	X	X	√	X	X
	Tabellaria sp.	X	X	√	X	X
	Skeletonema sp.	√	√	√	√	X
	Plagiotropsis sp.	√	√	√	√	X
Branchiopoda	*Daphnia* sp.	√	X	X	X	X
	Bosmina sp.	X	X	X	X	√
Chlorophyceae	*Netrium* sp.	√	√	√	√	√
	Scenedesmus sp.	X	√	√	√	X
	Spirogyra sp.	X	X	X	X	√
Dinophyceae	*Ceratium* sp.	√	√	√	√	√
	Peridinium sp.	√	√	√	√	√
	Nauplius sp.	√	√	√	√	√
Sarcodina	*Globigerina* sp.	√	√	X	√	X
Copepods	*Calanus* sp.	√	√	√	√	√
	Centropages sp.	√	√	√	√	√
	Copepoda sp.	X	X	X	X	√
	Oncaea sp.	√	X	X	X	X
Tintinnidae	*Tintinnopsis* sp.	√	√	√	√	√
	Favella sp.	X	X	√	√	√

the food web (Romimohtarto & Juwana 2007). *Nitzschia* sp., a primary producer, is consumed by a wide range of species, including heterotrophic dinoflagellates and planktivorous fish such as the BSC.

Diversity Index (H'), Evenness Index (E), and Dominance Index (C)

The diversity (H'), evenness (E), and dominance (C) indices of plankton communities are essential for understanding ecosystem health and function. These indices shed light on species diversity, distribution patterns, and the ecological roles of dominant species (Ignatiades 2020, Fontana *et al*. 2018). The parts that follow go into greater detail about these important factors. Table 2 shows the H', E, and C indices of plankton communities in Senggarang waters. The species H', which measures both species' richness and abundance within a community (Kadir *et al*. 2015), fluctuated across the five-week observation period. The average H' during the first, second, third, fourth, and fifth weeks was 2.17, 2.09, 2.32, 1.61, and 1.99, respectively. Based on these parameters, the overall plankton diversity in the research region is classed as low. According to Satrioajie *et al*. (2012), the E categorizes community stability as follows: values between $0.00 < E \leq 0.50$ indicate a stressed condition, $0.50 < E \leq 0.75$ indicate an unstable condition, and $0.75 < E \leq 1.00$ indicate a stable condition. The E was highest in the third week (0.73) and lowest in the fourth week (0.43). E for the first, second, and fifth weeks were 0.68, 0.66, and 0.68, respectively. These findings indicate that the plankton population was stressed during the fourth week, yet unstable during the following weeks. The C exhibited an inverse relationship with E. The average C from the first to the fifth week were 0.20, 0.24, 0.16, 0.52, and 0.23, respectively. The maximum C was reported in the fourth week, corresponding with the lowest E and indicating a pressured environment. In contrast, the third week had the lowest C and the highest E. These results indicate an inverse link between D and E in the plankton community structure.

Changes in H', E, and C indices have a substantial impact on the resilience of plankton populations under changing environmental conditions. Research suggests that while biodiversity can improve functional and compositional resistance, it may also reduce resilience, confounding the relationship between these indices and community stability. Higher species variety frequently correlates to increased functional resistance, allowing communities to keep ecosystem services running despite environmental shocks. However, this diversity might lead to reduced resilience, as more diverse groups may recover at a slower rate after shocks (Baert *et al.* 2016). Evenness, or the distribution of individuals across species, can help to stabilize community dynamics. In changing habitats, increasing evenness can lessen the dominance of a few species, promoting overall community stability (Gonzalez & Descamps-Julien 2004). In contrast, dominance by a few species can enhance susceptibility, as demonstrated in studies in which dominant species were more affected by environmental changes (Steiner *et al*. 2006).

Table 2 Types of weekly diversity, evenness, and dominance indices in Senggarang coastal waters, Tanjungpinang City on September 10th to October 15th, 2020

Community structure	First week				
	St 1	St 2	St 3	St 4	St 5
Diversity (H')	2.34	1.88	2.51	2.03	1.87
Evenness (E)	0.75	0.63	0.81	0.65	0.60
Dominance (C)	0.14	0.28	0.10	0.22	0.26
	Second week				
Diversity (H')	1.48	2.15	2.04	2.51	2.26
Evenness (E)	0.46	0.71	0.64	0.75	0.74
Dominance (C)	0.48	0.19	0.25	0.12	0.17
	Third week				
Diversity (H')	2.54	2.29	2.18	2.39	2.20
Evenness (E)	0.77	0.70	0.66	0.78	0.72
Dominance (C)	0.11	0.17	0.21	0.13	0.18
	Fourth week				
Diversity (H')	1.92	0.84	1.01	1.89	0.59
Evenness (E)	0.61	0.29	0.34	0.72	0.19
Dominance (C)	0.27	0.68	0.64	0.22	0.80
	Fifth week				
Diversity (H')	2.24	2.34	2.01	2.24	1.13
Evenness (E)	0.73	0.70	0.74	0.85	0.39
Dominance (C)	0.18	0.16	0.20	0.14	0.50

Environmental Factors and Their Relationship to Plankton Abundance

Table 3 shows the environmental factors for Senggarang waterways. An assessment of physicochemical characteristics in Tanjungpinang City's Senggarang waters, as measured against marine water quality requirements established by Government Regulation of the Republic of Indonesia No. 22 of 2021, finds generally favorable environmental conditions for aquatic life. While most indicators stayed below acceptable ecological thresholds, a few did not meet the required requirements, potentially affecting plankton quantity and community structure. Temperature, a key regulator of metabolic and physiological processes in plankton, varied between stations but remained mostly within the optimal growth range of 20 to 35 °C (Faturohman *et al*. 2016). These changes are in line with diurnal variations in solar radiation and atmospheric conditions. Temperature affects not just enzyme activity, but also water stratification, nutrient availability, and species competition, all of which influence plankton productivity. Current velocity remained low (0.04 m/s) in weeks 1–4, indicating rather gentle water conditions. Low flow regimes are often linked with restricted horizontal mixing and longer residence durations, which promote localized plankton blooms due to nutrient retention and poor dispersal. According to Darmawan *et al*. (2018), velocity less than 0.1 m/s are "very slow," which promotes vertical phytoplankton buildup. However, by week 5, current velocity increased to 0.15 m/s, most likely due to increasing wind action or tidal influences. The relationship between increased turbulence and plankton abundance is complicated because turbulence can disturb plankton aggregation and boost advective losses. Increased turbulence can reduce zooplankton abundance, especially in the upper water layers, because organisms may avoid turbulent conditions (Tanaka 2019).

Table 3 Environmental parameters in Senggarang coastal waters, Tanjungpinang City on September 10th to October 15th, 2020

Parameter	Unit	Station					Quality standard
		I	II	III	IV	V	
				First week			
Temperature	°C	29.7	31.3	33.7	31.9	29.7	Natural
Current	m/s	0.06	0.03	0.03	0.05	0.05	
Transparency	meter	1.42	1.27	1	1.05	1.48	>5, >3
pH		7.76	7.46	7.25	7.83	8.18	7–8.5
Salinity	‰	29.3	25	25.3	28.3	29.3	33–34 ‰
Dissolved oxygen	mg/L	5	6.6	4.5	6	5.03	> 5
				Second week			
Temperature	°C	31.4	30.5	32.4	31	30.8	Natural
Current	m/s	0.1	0.03	0.04	0.03	0.02	
Transparency	meter	1.54	1.2	1.17	1.23	1.6	>5, >3
pH		8.14	7.85	7.54	7.26	8.86	7–8.5
Salinity	‰	28	31.3	28.3	29.3	30	33–34 ‰
Dissolved oxygen	mg/L	7.3	5.5	7.4	6.9	6.5	> 5
				Third week			
Temperature	°C	31.9	31.4	31.6	31.6	31.9	Natural
Current	m/s	0.03	0.05	0.04	0.04	0.04	
Transparency	meter	2.7	2.53	2.71	2.6	2.69	>5, >3
pH		7.32	7.34	7.26	7.31	7.12	7–8.5
Salinity	‰	26.7	28	26.3	27.3	28	33–34 ‰
Dissolved oxygen	mg/L	6.2	5.6	6.2	5.5	6.3	> 5
				Fourth week			
Temperature	°C	28.1	30.3	30.3	30.1	30	Natural
Current	m/s	0.06	0.07	0.04	0.02	0.02	
Transparency	meter	2.7	2.53	2.71	2.6	2.8	>5, >3
pH		7.01	7.87	7.02	7.14	7.28	7–8.5
Salinity	‰	30	30	29.7	31.3	30	33–34 ‰
Dissolved oxygen	mg/L	4.6	7.7	5.5	5.8	5.6	> 5
				Fifth week			
Temperature	°C	30.3	30.4	26.3	28.3	29.7	Natural
Current	m/s	0.08	0.02	0.03	0.02	0.02	
Transparency	meter	1.3	1.19	1.05	1.54	1.26	>5, >3
pH		8.25	8.25	8.21	8.33	8.06	7–8.5
Salinity	‰	28.7	29.3	27.7	31	30	33–34 ‰
Dissolved oxygen	mg/L	5.5	7.6	6.9	6.3	8.6	> 5

Water transparency was assessed using Secchi depth, which ranged from 1.24 m (week 1) to 2.67 m (week 4). These values fall short of the optimal standards set by Government Regulation No. 22 of 2021, notably in primary production zones. The reduced transparency is most likely caused by suspended particle matter in Senggarang's shallow coastal waters. Nonetheless, adequate light penetration was attained to support photosynthetic activity, as transparency levels above the compensatory depth for phytoplankton photosynthesis. Even with restricted light availability, chlorophyll-bearing organisms have evolved to fix carbon using only a small portion of incident solar radiation. This phenomenon is especially visible in aquatic habitats, where diverse animals have evolved unique adaptations to enhance photosynthesis under varying light circumstances (Gao & Xu 2010, Poulton et al. 2006). pH levels ranged from 7.26 to 8.22, which is consistent with the optimum tolerance range for marine biota (7.0–8.5). This slightly alkaline environment is ideal for planktonic organisms and supports essential physiological processes like enzyme function, food uptake, and calcification in some species. The pH profile remained steady over a five-week period, indicating no anthropogenic acidification or eutrophication. Salinity levels ranged from 27.44 to 30.2‰, somewhat lower than the marine biota criterion of 33−34‰ but still within a sustainable range for most estuarine and coastal phytoplankton. Despite this deviation, salinity levels are unlikely to cause significant physiological stress to local species. Yuliana et al. (2012) found that salinities above 20 ppt are generally acceptable for phytoplankton reproduction and photosynthesis. Salinity influences cellular osmoregulation, and sudden changes may affect plankton survival; nevertheless, the gradual trend of observed fluctuations suggests adaptive responses rather than acute consequences.

Dissolved oxygen (DO) concentrations ranged from 5.43 to 6.98 mg/L, constantly exceeding the biological minimum requirement of 5 mg/L (Government Regulation No. 22 of 2021), with all values maintaining far above hypoxic limits. These values support robust aerobic respiration and indicate moderate to high photosynthetic activity. DO levels in week 5 were the highest observed (6.98 mg/L), which could be attributed to enhanced wind-driven aeration or a surge in daytime photosynthetic production. According to Wijayanti (2011), DO concentrations more than 3 mg/L are sufficient to support planktonic life; thus, the reported levels indicate a favorable environment for microbial and planktonic productivity. Overall, the physicochemical data show a very healthy aquatic system with generally favorable conditions for plankton growth, despite localized variations in salinity and transparency. These criteria, taken together, most likely determine the temporal changes observed in species composition, abundance, and dominance during the research period. Environmental changes can destabilize populations while stabilizing aggregate community features, implying a complex interaction of diversity, evenness, and resilience (Gonzalez & Descamps-Julien 2004). Plankton communities reorganize dramatically in nutrient-limited or warmer environments, affecting their resilience and functional connections. Environmental conditions may cause variations in community composition and trophic dynamics, altering ecosystem stability and biodiversity (Anderson et al. 2022; Verbeek et al. 2018).

CONCLUSION

The dominant plankton species identified in this study are from the Bacillariophyceae family, particularly *Nitzschia* sp., which is a key primary producer and food source for a variety of aquatic animals, including heterotrophic dinoflagellates, plankton-eating fish, and swimming crabs. The presence of *Nitzschia* sp. shows that it plays an important role in the trophic dynamics of the Senggarang waters ecosystem, perhaps sustaining the growth and population stability of blue swimming crab (BSC) species. To fully understand crab feeding ecology and confirm the dietary importance of major plankton taxa, more research focusing on stomach content analysis is necessary.

ACKNOWLEDGMENTS

REFERENCES

Anderson SI, Franzè G, Kling JD, Wilburn P, Kremer CT, Menden-Deuer S, Litchman E, Hutchins DA, Rynearson TA. 2022. The interactive effects of temperature and nutrients on a spring phytoplankton community. *Limnology and Oceanography.* 67(3): 634–645. https://doi.org/10.1002/lno.12023

[APHA] America Public Health Association. 2017. *Standard Methods for The Examination of Water and Wastewater. 23rd Edition*. Washington DC (US): America Public Health Association.

Apriadi T, Muzammil W, Melani WR, Safitri A. 2020. Community structure of macrozoobenthic organism in Senggarang creek, Bintan Island, Riau Islands. *DEPIK Jurnal Ilmu–Ilmu Perairan, Pesisir, dan Perikanan*. 9(1): 119–130. https://doi.org/10.13170/depik.9.1.14641

Baert JM, De Laender F, Sabbe K, Janssen CR. 2016. Biodiversity increases functional and compositional resistance but decreases resilience in phytoplankton communities. *Ecology*. 97(12): 3433–3440. https://doi.org/10.1002/ecy.1601

[BBPPI] Balai Besar Pengembangan Penangkapan Ikan. 2014. *Bubu Kubah: Bubu Rajungan Yang Selektif dan Ramah Lingkungan.* Semarang (ID): Kementerian Kelautan dan Perikanan.

Darmawan A, Sulardiono B, Haeruddin H. 2018. The analysis of fertilizer supply based on phytoplankton, nitrate and phosphate in the river Bengawan Solo City of Surakarta. *Journal of Maquares.* 7(1): 1–8. https://doi.org/10.14710/marj.v7i1.22519

Davis CC. 1955. *The Marine and Freshwater Plankton*. East Lansing (US): Michigan State University Pr.

Effendi H, Kawaroe M, Lestari DF, Mursalin, Permadi T. 2016. Distribution of phytoplankton diversity and abundance in Mahakam Delta, East Kalimantan. *Procedia Environmental Sciences.* 33: 496–504. https://doi.org/10.1016/j.proenv.2016.03.102

Fachrul MF. 2007. *Metode Sampling Bioekologi*. Jakarta (ID): Bumi Aksara.

Faturohman I, Sunarto, Nurruhwati I. 2016. The correlation of plankton abundance with sea water temperature at Cirebon steam electricity power station. *Jurnal Perikanan dan Kelautan.* 7(1): 115–122.

Fikri IA, Darmono OP, Tetelepta JMS, Damora A, Muzammil W. 2018. Risk potency analysis and sustainability status of mud crab *Scylla* sp. of Sorbay Bay, Southeast Maluku District, Indonesia. *IOP Conference Series: Earth and Environmental Science.* 216(1): 012038. https://doi.org/10.1088/1755-1315/216/1/012038

Fontana S, Thomas MK, Moldoveanu M, Spaak P, Spaak P, Pomati F, Pomati F. 2018. Individual-level trait diversity predicts phytoplankton community properties better than species richness or evenness. *The ISME Journal.* 12(2): 356–366. https://doi.org/10.1038/ismej.2017.160

Gao K, Xu J. 2010. Ecological and physiological responses of Macroalgae to solar and UV radiation. In: Seckbach J, Einav R, Israel A. (eds) *Seaweeds and their Role in Globally Changing Environments 1st Edition. Cellular Origin, Life in Extreme Habitats and Astrobiology*, vol 15. Dordrecht (GE): Springer. https://doi.org/10.1007/978-90-481-8569-6_11

Gonçalves V, Ritter C, Marques H, Teixeira DN, Raposeiro PM. 2021. Diatoms from small ponds and terrestrial habitats in Deserta Grande Island (Madeira Archipelago). *Biodiversity Data Journal.* 9: 1–15. https://doi.org/10.3897/BDJ.9.e59898

Gonzalez A, Descamps-Julien B. 2004. Population and community variability in randomly fluctuating environments. *Oikos.* 106(1): 105–116. https://doi.org/10.1111/j.0030-1299.2004.12925.x

Graff RJ, Westberry TK, Milligan AJ, Brown MB, Olmo GD, Vogels VD, Reifel KM, Behrenfeld MJ. 2015. Analytical phytoplankton carbon measurements spanning diverse ecosystems. *Deep-Sea Research I.* 102: 16–25. https://doi.org/10.1016/j.dsr.2015.04.006

Ignatiades L. 2020. Taxonomic diversity, size-functional diversity, and species dominance interrelations in phytoplankton communities: a critical analysis of data interpretation. *Marine Biodiversity.* 50(4): 1–9. https://doi.org/10.1007/s12526-020-01086-4

Juranek LW, White AE, Dugenne M, Freitas FH, Dutkiewicz S, Ribalet F, Ferrón S, Armbrust EV, Karl DM. 2020. The importance of the phytoplankton "middle class" to ocean net community production. *Global Biogeochemical Cycles.* 34: 1–19. https://doi.org/10.1029/2020GB006702

Kadir MA, Damar A, Krisanti M. 2015. Spatial and temporal dynamics of zooplankton community structure in Jakarta Bay. *Jurnal Ilmu Pertanian Indonesia.* 20(3): 247–256. https://doi.org/10.18343/jipi.20.3.247

Khasanah RI, Sartimbul A, Herawati EY. 2013. Plankton abundance and diversity in the Bali Strait. *Ilmu Kelautan: Indonesian Journal of Marine Sciences.* 18(4): 193–202.

Krebs CJ. 1999. *Ecological Methodology*. 2nd edition. San Fransisco (US): Benjamin/Cummings.

Liwutang YE, Manginsela FB, Tamanampo JFWS. 2013. Phytoplankton density and diversity in the waters around the reclamation area in Manado beach. *Jurnal Ilmiah Platax.* 1(3): 109–117. https://doi.org/10.35800/jip.1.3.2013.2568

Manickam N, Santhanam P, Saravana BP. 2019. Techniques in the Collection, Preservation and Morphological Identification of Freshwater Zooplankton. In: Santhanam P, Begum A, Pachiappan P. (eds) *Basic and Applied*

Zooplankton Biology. Singapore (SG): Springer. https://doi.org/10.1007/978-981-10-7953-5

Mulyadi HA. 2013. Kajian dinamika komposisi dan kelimpahan zooplankton dalam upaya pengelolaan sumberdaya perikanan di Perairan Pesisir Kabupaten Pemalang Provinsi Jawa Tengah. [Master's thesis]. Semarang (ID): Universitas Diponegoro.

Muzammil W, Apriadi T, Melani WR, Handayani KD. 2020. Length–weight relationship and environmental parameters of *Macrobrachium malayanum* (J. Roux, 1935) in Senggarang Water Flow, Tanjungpinang City, Riau Islands, Indonesia. *Aceh Journal of Animal Science.* 5(1): 18–25. https://doi.org/10.13170/ajas.5.1.14858

Muzammil W, Zahra A, Oktavia Y. 2021a. Public awareness enhancement of protected marine life in Riau Islands through pocketbook and video. *Panrita Abdi. Jurnal Pengabdian pada Masyarakat.* 5(3): 356–364.

Muzammil W, Apriadi T, Melani WR, Damora A. 2021b. Bioinformation of blue swimming crab (*Portunus pelagicus*) during Covid-19 pandemic in Bintan District, Riau Islands Province. *Journal of Tropical Fisheries Management.* 5(2): 65–72. https://doi.org/10.29244/jppt.v5i2.34442

Pillay KK, Nair NB. 1973. Observations on the incidence and seasonal fluctuations of certain crustacean larvae in the plankton of the South West Coast of India. *Hydrobiologia.* 43(3): 443–461. https://doi.org/10.1007/BF00015362

Poulton AJ, Holligan PM, Hickman AE, Kim YN, Adey TR, Stinchcombe MC, Holeton C, Root S, Woodward EMS. 2006. Phytoplankton carbon fixation chlorophyll-biomass and diagnostic pigments in the Atlantic Ocean. *Deep-Sea Research Part II–Topical Studies in Oceanography.* 53(14): 1593–1610. https://doi.org/10.1016/j.dsr2.2006.05.007

Ramesh CH, Mohanraju R, Karthick P, Murthy KN. 2015. Phototaxis response of some zooplankton. *International Journal of Science and Nature.* 6(2): 245–247.

Romimohtarto K, Juwana S. 2007. *Biologi Laut.* Jakarta (ID): Djambatan.

Santhanam P, Pachiappan P, Begum A. 2019. A Method of Collection, Preservation and Identification of Marine Zooplankton. In: Santhanam P, Begum A, Pachiappan P. (eds) *Basic and Applied Zooplankton Biology.* Singapore (SG): Springer. https://doi.org/10.1007/978-981-10-7953-5

Satrioajie WN, Peristiwady T, Pay L. 2012. Fish diversity in the seagrass areas at Banggai Islands Waters, Central Sulawesi. *Bawal.* 4(1): 9–17.

Steiner CF, Long ZT, Krumins JA, Morin PJ. 2006. Population and community resilience in multitrophic communities. *Ecology.* 87(4): 996–1007. https://doi.org/10.1890/0012-9658(2006)87[996:PACRIM]2.0.CO;2

Sunesen I, Romero S, Toubes E, Sar EA. 2015. Morphology and distribution of three araphid diatoms (Fragilariophyceae, Bacillariophyta) from marine coastal waters of Argentina. *Iheringia.* 70(2): 265–278.

Tanaka M. 2019. Changes in vertical distribution of zooplankton under wind-induced turbulence: A 36–years record. *Fluids.* 4(4): 195. https://doi.org/10.3390/fluids4040195

Verbeek L, Gall A, Hillebrand H, Striebel M. 2018. Warming and oligotrophication cause shifts in freshwater phytoplankton communities. *Global Change Biology.* 24(10): 4532–4543. https://doi.org/10.1111/gcb.14337

Wijayanti. 2011. Keanekaragaman jenis plankton pada tempat yang berbeda kondisi lingkungannya di Rawa Pening Kabupaten Semarang. [Undergraduare thesis]. Semarang (ID): IKIP PGRI Semarang.

Wulandari DY, Pratiwi NTM, Adiwilaga EM. 2014. Spatial distribution of phytoplankton on the coast of Tangerang. *Jurnal Ilmu Pertanian Indonesia.* 19(3): 156–162.

Yamaji MS. 1979. *Illustration of the Marine Plankton of Japan*. Osaka (JP): Hoikusha Publ.

Yanto F, Susiana S, Muzammil W. 2020. Utilization rate of brown strip red snapper (*Lutjanus vitta*) on Mapur waters that landing in Kelong Village, Bintan Pesisir Subdistrict, Bintan Regency. *Journal of Tropical Fisheries Management.* 4(2): 1–9. https://doi.org/10.29244/jppt.v4i2.31955

Yolanda OAP, Melani WR, Muzammil W. 2020. Karakteristik sedimen pada Perairan Sei Carang, Kota Tanjungpinang, Indonesia. *Habitus Aquatica.* 1(2): 11–20. https://doi.org/10.29244/HAJ.1.2.11

Yuliana AEM, Haris E, Pratiwi NTM. 2012. Hubungan antara kelimpahan fitoplankton dengan parameter fisik-kimiawi perairan di Teluk Jakarta. *Jurnal Akuatika.* 3(2): 169–179.

Zingone A, D'Alelio D, Mazzocchi MG. 2023. The Gulf of Naples as a model system for plankton ecology studies. *Marine Ecology–An Evolutionary Perspective.* e12779. https://doi.org/10.22541/au.170664093.38043491/v1