Phytoplankton Species in Sukol River Bongabong, Oriental Mindoro

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ABSTRACT

Phytoplankton balances the flow of food as the primary top resource for many aquatic organisms. Sukol River is one of the major water resources in the Municipality of Bongabong in Oriental Mindoro that supplies various human activities such as the source of agricultural irrigation, energy production, fishing, etc. This study focused on the phytoplankton diversity abundance at selected sites of Sukol River, specifically in the river mouth namely Brgy. Poblacion, (Site 1) Brgy. Sagana, (Site 2) and Brgy Ipil (Site 3). A total of 3 taxa belonging to Chlorophyta (5), Bacillariophyta (10), and Cyanophyta (1) were identified. The highest taxa occurred in Site 1 with a diversity index value of 1.96, followed by Site 2 (1.71) and Site 3 (1.69), hence relative value still indicates not accounted for high indication of the diversity and not considered as diverse in terms of species found in the area. Likewise in terms of relative abundance, the highest taxa occurred in Site 2 with a diversity index value of 0.82, followed by Site 1 (0.80) and Site 3 (0.77). On the contrary, the highest average cell density was Site 1 (99.2 x 10^6), Site 3 (69.6 x 10^6), and Site 2 (65.8 x 10^6), implying that each site has high uniformity in terms of species and cell density. Remarkably, Navicula sp. is present only in Site 1 and Gyrosigma sp. in Site 3. Results also showed that phytoplankton was greatly affected by flow rate as the movement of water ranges from 31.31 m/s (Site 2). 26.85 m/s (Site 1) and 25.75 m/s (Site 3).

Keywords: *Bongabong river, phytoplankton, species diversity, abundance, distribution*

I. Introduction

Phytoplankton, also known as “microalgae”, are sometimes called “plant of the sea” and are algae that, like terrestrial plants, contain chlorophyll and requires sunlight to live and grow. It serves as the foundation of aquatic food webs. It balances the flow of food as the primary top resource for many of the aquatic organisms food for a diverse range of sea creatures in an ecosystem, specifically, it gives nutrition to the organisms such as fish and other aquatic life that humans consume(Henson et al, 2021; Rosanne Knorr, 2019).

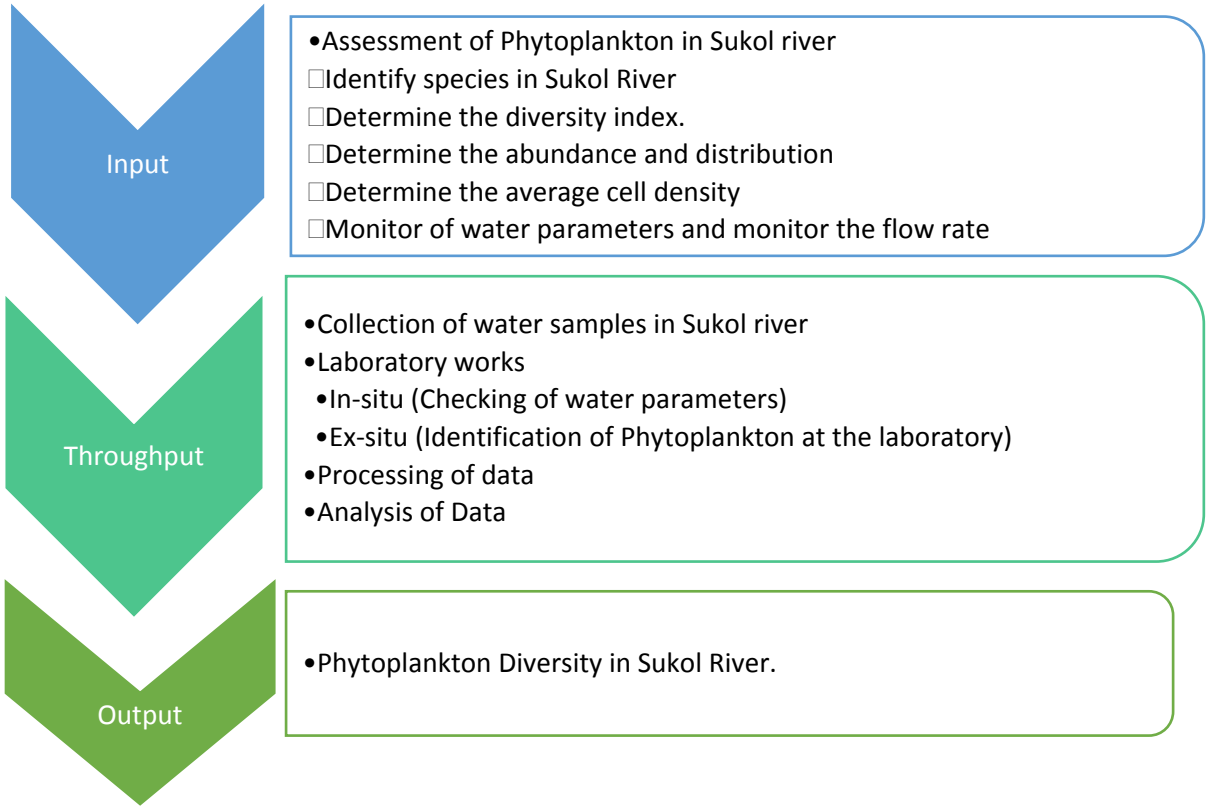
. In this study, Sukolriver, is one of the major water resources in the Municipality of Bongabong, Oriental Mindoro, surrounded by communities from Barangay Aplaya, Sitio K.I of Barangay Población and Sitio Asiatic of Barangay Ipil. It was characterized by riverine and intertidal zone with diverse species ofmangroves(Quitain, 2021). It supplies various human activities such as the sources of agricultural irrigation, energy production, fishing, etc. As a background of this study, phytoplankton species play a vital role in the ecosystem functioning (Otero, 2020), it also serves as biological indicators of water quality (Kumar, 2020). This study focuses on the identification of phytoplankton species, abundance, distribution, and diversity of the Sukol river. Thus, this study also monitors the water parameters and flow rate of the river throughout this study.

II. Objectives:

The study aims to determine the phytoplankton diversity the in Sukol river at Bongabong, specifically it sought to answer the following:

- To identify phytoplankton species, present in Sukol River.
- To determine the diversity index and relative abundance.
- To determine the average cell density.
- To monitor water parameters and flow rate.

Conceptual Framework



III. Methodology

This section discussed the following, study site, research design materials and methods used in this study. The study was conducted at 3 sites in Sukol River (Bongabong), which are under the jurisdiction of 3 Barangays namely Poblacion, Sagana and Ipil.

Study site

Figure 1. Map of the study site (*Credits to Google Earth version 9.174.0.2*)

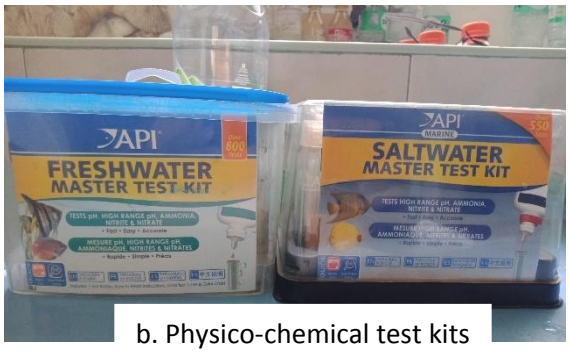
The study was conducted in the 3 sites of Sukol River, Bongabong, Oriental Mindoro. Site 1. Poblacion (12˚44'46"N 121˚29' 21"E), Site 2. Sagana (12˚44'24"N 121˚29' 33"E) and Site 3. Ipil (12˚44'35"N 121˚29' 28"E).

Research Design

The study used quantitative survey research using different laboratory equipment and materials such as microscope for identification and counting of phytoplankton, API test kits such as ammonia, nitrate, nitrite, and pH for physic-parameters, and likewise other equipment for checking of dissolved oxygen using DO meter and thermometer for water temperature. For flow rate, 2 meters of twine, 2 plastic bottles with 320mland meter measuring device. Data gathered were written and calculated. (See Figure 2 below).

Materials and Equipment

a. Water sampler

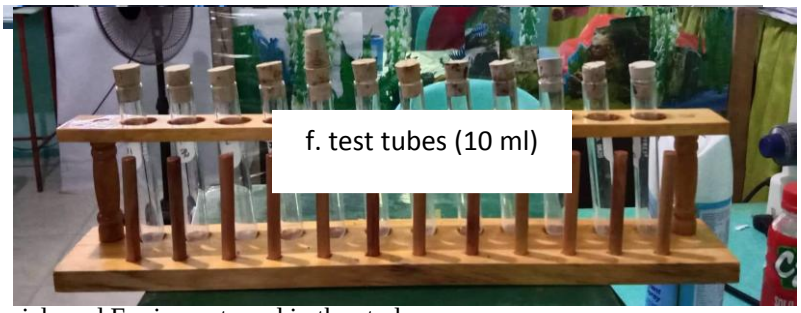


b. Physico-chemical test kits

C. Centrifuge

d. binocular compound light microscope LB220

e. (From the left-clockwise) pH meter, DO meter and Refractometer.



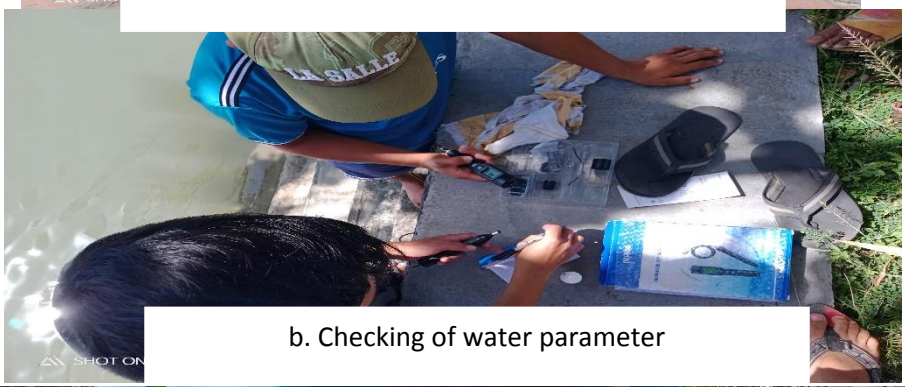
f. test tubes (10 ml)

Figure 2. Materials and Equipment used in the study.

Sampling of Phytoplankton

The collected water samples were gathered from March to May 2022. Using empty bottles with 500mL, water wasused to collect thoroughly in the river with an average depth of 1-1.5 meter in the 3 sample sites. In each sample in the three (3) areas, water collected were replicated three (3) times, one from surface, one from middle and one from bottom. Using a water sampler, the water collected was put into a pail and stirredthoroughly and put into a 500mL of plastic bottle and brought to the laboratory. Each water bottle has 3ml formalin solution for preserving the phytoplankton and to prevent zooplankton eating the phytoplankton present in the bottle. These waters collected into plastic bottles were subjected for the phytoplankton classification. Phytoplankton density analysis was done ex–situ analyzed in the laboratory with a binocular compound light microscope LB220 using 40x magnification lens. Using hemacytometer cell density were listed and calculated with the following formula of Martinez M.R., Chakroff, R.P., and Pantastico, 1975, (*see the formula below*) meanwhile identification of phytoplanktonwas identified through the use phytokey website as guiding tool for identifying various species seen under microscope. A 10 ml of were subjected for centrifuge for about set time of 10 mins, after that 1mL was retained in the 12mL test tube subjected for counting under microscope.Figure 3 shows the photos of procedure in the study.

a. Collection of water sample using water sampler.



b. Checking of water parameter

c. Preserving the phytoplankton present in water using formalin.

Figure 3. Procedure of water sampling.

Identification and counting of phytoplankton

Water sampled that were done through centrifuge were identified through hemocytometer for cell counting and identification. The identification of phytoplankton was validated through phycokey website which is an image-based key for alga, cyanobacteria, and other aquatic object. In the first set up, compound light microscope was focused into 40x magnification for arranging the chambers on the microscope, then phytoplankton that fills the chamber inside the hemocytometerwere counted however those planktons that lies on the outside of the chamber were not counted. Identified phytoplankton were listed and monitored in a laboratory notebook used for counting and monitoring in the study.

Calculation ofDiversity Index

After identifying phytoplankton species, each site was calculated with the following formulas for diversity index. Simpson's diversity index measures the diversity in terms of species present in the area, as well as the relative abundance of each species. Note that the value of D in Simpsons diversity index ranges between 0 to 1, which represents as 1 infinite diverse and 0 to no diversity (Somerfield et al, 2008). Likewise, in Shannon-Weiner Species Diversity Index measures the species richness and evenness of species, notice that in Shannon-Weiner formula (SDI) value ranges from 0 to 5, as 0 represents no diversity and 5 highest diversity, however usual value ranges from 1.5 to 3.5 which rare (Ortiz-Burgos, S. (2016).

Formulas used in this study:

Simpson's Diversity index: $D = 1 - (\frac{\Sigma n(n-1)}{N(N-1)})$

where:

- n_i — Number of individuals in the *i*-th species; and
- N — Total number of individuals in the community.

Shannon WeinerSpecies Diversity index: $H = -\sum[(p_i) * \log(p_i)]$

where:

- H - Shannon diversity index.
- p_i - Proportion of individuals of i-th species in a whole area

$p_i = n / N$,

where:

- n - individuals of a given type/species; and
- N - total number of individuals in an area
- ∑ - Sum symbol; and
- log - Natural logarithm

Hemocytometer Formula for Cell density counting of Phytoplankton.

For Concentrated Sample:

$$\text{Cell/ml} = \frac{\text{total cells counted x } 1/\text{cf}}{10 \text{ x } 1 \text{ x } 10^{-4}}$$

Cf (concentration factor) = initial conc/final conc)

For Diluted Sample:

$$\text{Cell/ml} = \frac{\text{total cells counted x df}}{10 \text{ x } 1 \text{ x } 10^{-4}}$$

Df (dilution factor) = initial conc/ final conc

Computation for the middle square:

$$\text{Cell/ml} = \frac{\text{total cells counted x } k^4}{10 \text{ x } 1 \text{ x } 10^{-4}}$$

Where k= cf or df

Flow rate

Eyeball method

Meanwhile, Water flow rate were monitored and measured using formula of Antoine de Chėzy (1718-1798). Two set points were set from point A to B. Using empty bottle with 320ml mountain dew, set of 10 meters long from point A to point B the empty bottle is put into the horizontal line of point A and relays it in water to reach point B twice. It is done twice in each site. The two recorded measured is being added and divided into two, to get the average flow rate of water. The result is the flowrate of water measured by meters per seconds.

Formula: $\frac{\Sigma \text{ Total number of time}}{\text{Total of number of sample}}$

Data Analysis

Data collected and gathered were calculated using the formulas above.The data were calculated through Microsoft Windows Excel 2011 and analyzed through graphs and percentage.

Result and Discussion

As observed in this study there are a total of 3 taxa belonging to Chlorophyta, Bacillariophyta and Cyanophyta identified.*See Table 1.*

Table 1. Identified species present inBongabong River.

CHLOROPHYTA	BACILLARIOPHYTA	CYANOPHYTA
Micractinium sp.	*Amphora sp.*	*Oscillatoria sp.*
Ulothrix sp.	*Nitzschia sp.*	
Microspora sp.	*Synedra sp.*	
Cosmarium sp.	*Odontella sp.*	
Closterium sp.	*Amphipleura sp.*	
	Melosira sp.	
	Navicula sp.	
	Fragilariopsis sp.	
	Gyrosigma sp.	
	Coscinodicus sp.	

Table 1 presents the identified species in Bongabong River. In this table, a total of 16 species were identified under the 3 family. Remarkably, Bacillariophyta has the highest species identified under its name with 10 species, followed by Chlorophyta, 5 species and only 1 species was identified in Cyanophyta. Table 2 presents the total number of species present in each site. This implies that the 3 different sites have different species of phytoplankton as a source of food for fishes and aquaticspecies present inBongabong river. In addition, phytoplankton also serves as health indicators of aquatic species using plankton as bioindicator in aquatic ecosystem (Jakhar, 2013).

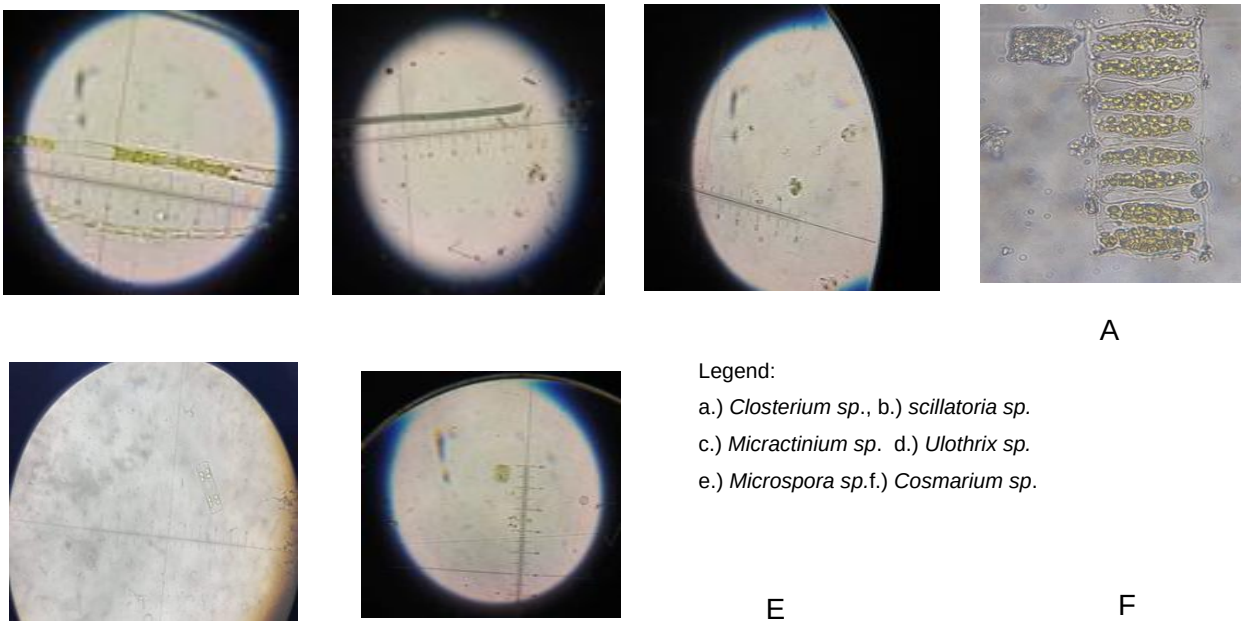
Table 2. Total Number of Phytoplankton Species present in each site.

Legend:*(+) signifies present and(-) signifies absence of phytoplankton in the site.*

Name of Species	**Site 1 (Poblacion)**	**Site 2(Sagana)**	**Site 3(Ipil)**
	Chlorophyta		
Micractinium sp.	-	+	+
Ulothrix sp.	+	+	-
Microspora sp.	-	+	+
Cosmarium sp.	-	+	+
Closterium sp.	+	+	+
	Bacillariophyta		

Amphora sp.	+	+	+
Nitzschia sp.	+	+	+
Synedra sp.	+	+	+
Odontella sp.	+	+	+
Amphipleura sp.	+	+	+
Melosira sp.	+	+	-
Navicula sp.	+	-	-
Fragilariopsis sp.	-	+	+
Gyrosigma sp.	-	-	+
Coscinodicus sp.	+	+	+
	Cyanophyta		
Oscillatoria sp.	-	+	+
Total:	**10**	**14**	**13**

In table 2 presentsthe distribution of phytoplankton in sites. Remarkably, 2 identifies species where both in two sites such as *Navicula sp.* which was present only on Site 1 Poblacion, which was recorded the highest salinity among the other site with a 33 -33.32 ppt observed in the study. Note that 35-45 ppt favors the growth of this species (Saadatkhah, 2020). In addition,pH favors the growth of the species as it measures 7.55-7.56 on site 1, favorable growth ranges from 7.5-8.0 (Ii, Xio et. al 2016).Aside from this, another species also differs from the rest of site, Gyrosigma *sp.* which was present only in Site 3 Ipil. Gyrosigma*sp*lives on brackishwater to marine habitat, though sometimes some species thrived living on freshwater(Phycokey). This indicates that these two species grow common on fine sediment habitats (G.J.C. Underwood 2001), thus implies that the river has a sediment characteristic.



A B

Legend:

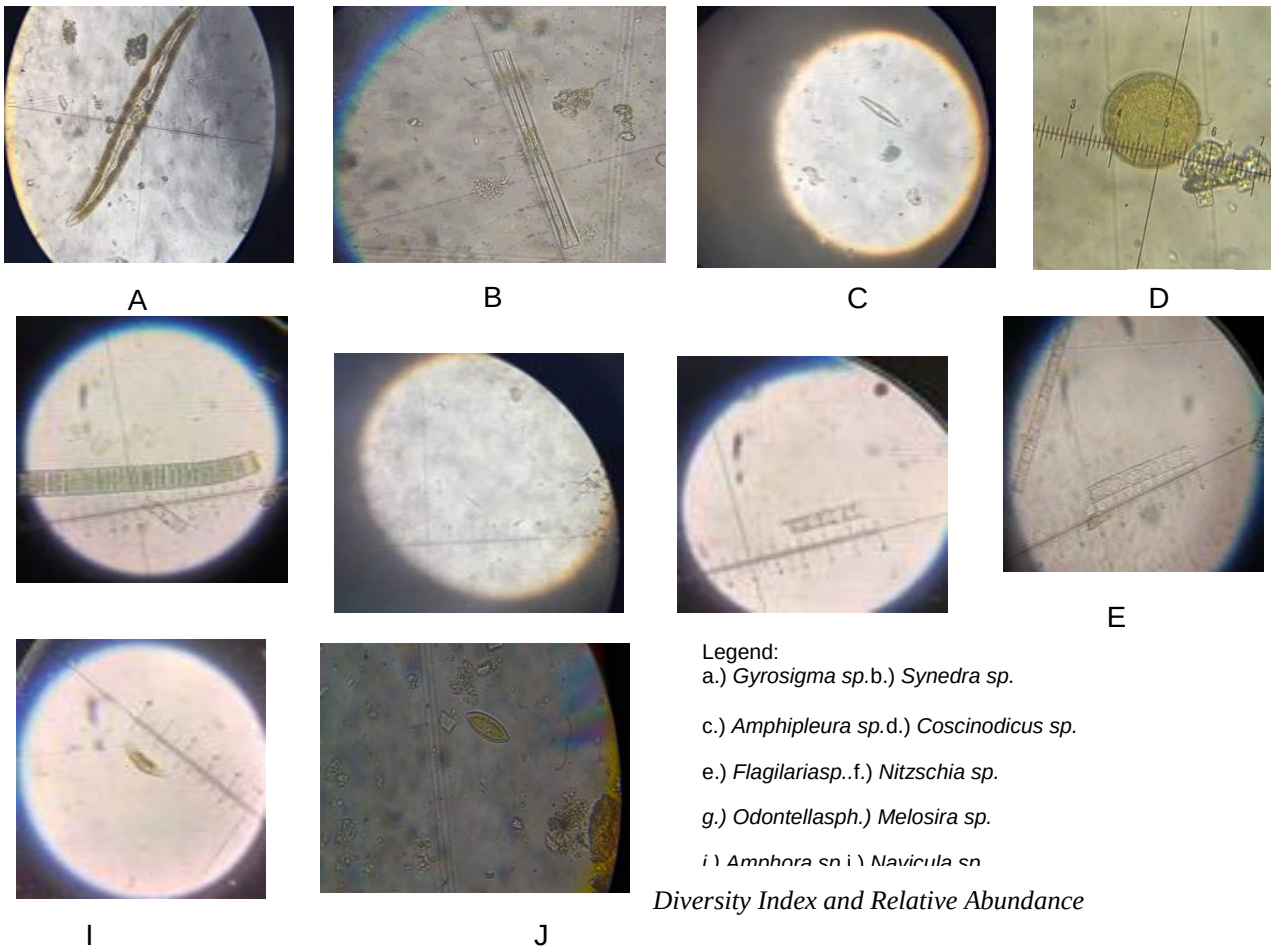
a.) *Closterium sp*., b.) *scillatoria sp.*

c.) *Micractinium sp*. d.) *Ulothrix sp.*

e.) *Microspora sp*.f.) *Cosmarium sp*.

E F

Figure.3 Chlorophyta and Cyanophyta



A B C D

E F

Legend:

a.) *Gyrosigma sp*.b.) *Synedra sp.*

c.) *Amphipleura sp*.d.) *Coscinodicus sp.*

e.) *Flagilariasp*..f.) *Nitzschia sp.*

g.) Odontellasph.) Melosira sp.

i.) Amphora sp.j.) Navicula sp.

I J

Diversity Index and Relative Abundance

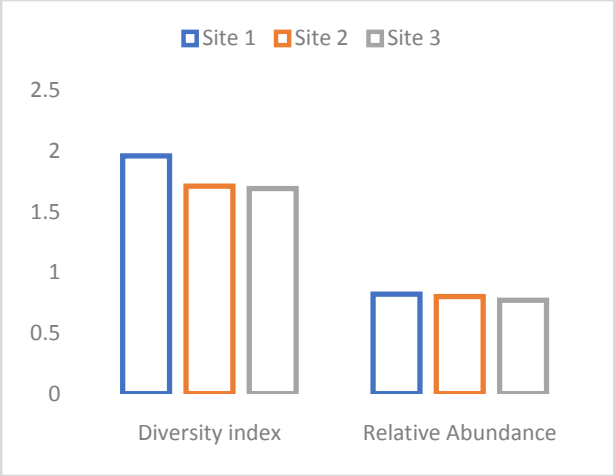


Figure 5. Diversity Index and Relative Abundance of 3 sites.

Figure 5 shows the diversity index and relative abundance of the 3. It shows thediversity index and relative abundance of the sites. In this figure 5,the highest diversity index was Site 1, followed by Site 2 and Site 3. With diversity index of 1.959, 1.708, and 1.686respectively.This relative value is still not accounted for high indication of diversity. According to the Classification Scheme for the Shannon Diversity Index, to declare an area was very high in diversity the value should be 3.50 and above, 3.00-3.49 high, 2.50-2.99 moderate, 2.0-2.49 low, and 1.99 and below is very low (Fernando et al 1998). The diversity index that was calculate from the 3 sites still indicates that sites were still on the very low range category of diversity. This implies that diversity in the 3 sites were still not diverse in terms of species found in the areas.

Relative abundance refers to thefundamental property of communities in terms of biomass or species richness (Weiher, 1999). This study reveals that relative abundance, occurred in Site 2 with a diversity index value of 0.82, followed by Site 1 with 0.80 and Site 3 with 0.77 value. In Simpson's Diversity Index (SDI) it measures the relative abundance of each species that is present in an area, it signifies that the closer the number of values to 1 means it has high diversity in terms of number in abundance (Barcelona, 2022) while 0 represents uniformity (Chiarucci, et al 2011). In this study, the result shows that Site 2 -Sagana has a higher in value among the sites followed by. This implies the chance of getting the same species in the sampling area was 82%, 80% and 77% respectively which represents the uniformity of the species found in the study areas. Therefore, it is a good indication that phytoplankton are still present in the area with relative abundance as it supports aquatic life living in the area.

Average Cell Density of Phytoplankton

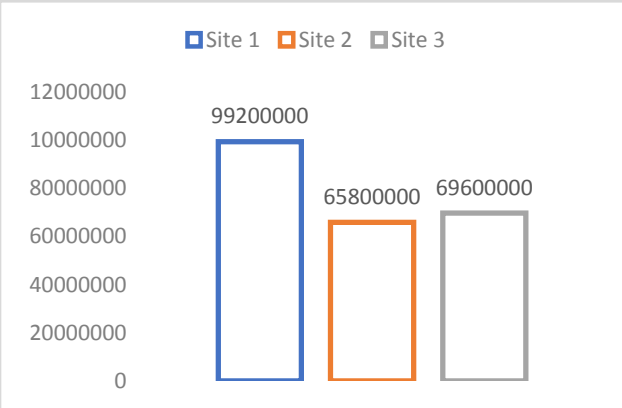


Figure 6. Average Cell Density.

To calculate the cell concentration, take the average number of viable cells in the four sets of 16 squares and multiply by 10,000 to get the number of cells per milliliter. In this study the average amount cell/ml of three site were from the highest average amount cell/ml is 99.2 x 10^6 in site 1 (Poblacion), followed by 69.6 x 10^6Site 3 and lastly site 2 with the average amount of cell/ml of 65.8 x 10^6. The result indicates that Site 1 has a greater cell density among the 3 groups, though in terms of diversity index they have low indication of diversity and relative abundance in the study, the result still show that the population has a greater impact though the number of species are limited in the study. This implies that number of individual species may affect the species diversity and relative abundance.

Water parameters and Flow rate

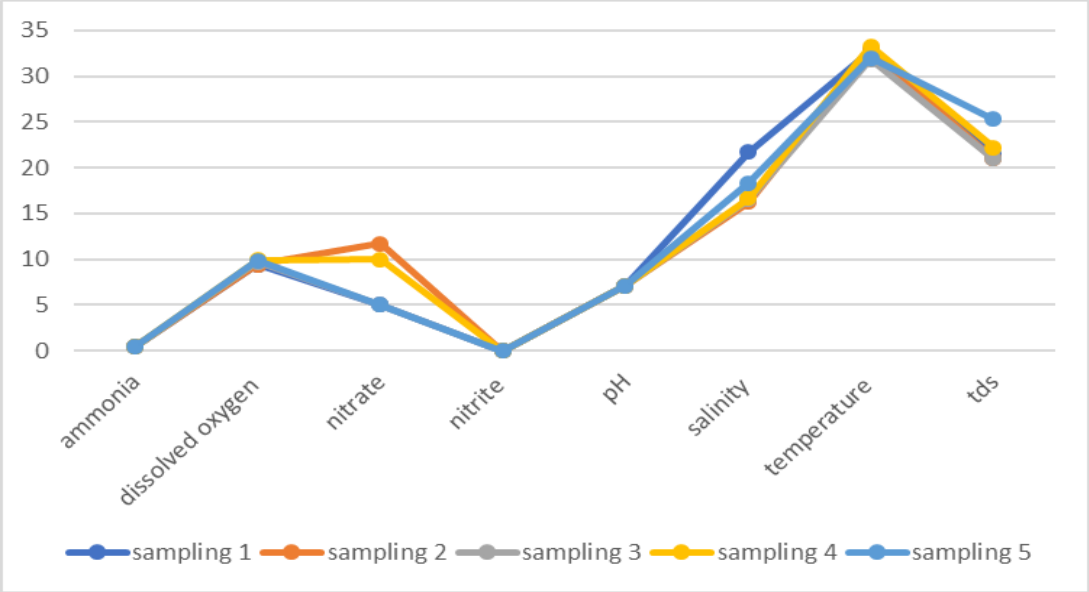


Figure 7. Water Parameter

There are several factors that affect phytoplankton, such as ammonia, nitrite, nitrate, dissolved oxygen, pH, and temperature (Manigandan. V, 2018) In this study, such parameters were monitored for record keeping and for determining factors that affect the species diversity, relative abundance, and cell density of phytoplankton.

Ammonia, Nitrate and Nitrite

Ammonia is a compound of hydrogen and nitrogen characterized by colorless gaseous that naturally occurs in air soil and water as well as in animals and plants (Clifton, 2018) Meanwhile, nitrate and nitrite are nitrogenous compounds that have significant impacts on the population of phytoplankton. (Domingues et al, 2011).As recorded, ammonia in each sitehas a small amount of ammonia from site 1 with 0.5ppm, site 2 with 0.5ppm, and site 3 with 0.25ppm.Meanwhile, nitrate in site 1, has 5-20ppm, site 2, has 10ppm, and site 3 has no presence. Nitrate serves as a good indicator of water quality and level of water. Nitrite was not observed in the 3 sites.

This implies that Sukol river still can support the grow phytoplankton species in the area, which favors the growth of Chlorophyta, Cyanophyta and Bacillioriophyta. Notice that Chlorophyta and Cyanophyta prefer a group of specificammonium which in this study has been the source of their cycle. Remarkably, Cyanophyta relies on ammonium for their source of Nitrogen. This imparts that as ammonium increases in the area, inputs of nitrogen resultin to shift the of phytoplankton community into the domination of cyanobacteria and green algae (Domingues, 2011).

Dissolved Oxgyen

Dissolved oxygen (mg/l) is also one of the factors to be consider in relationship of phytoplankton and level of dissolved oxygen. Insite 1 , DO measures 9.8mg/l-10.3mg/l, while site 2 , DO 9.4mg/l-9.8mg/l, and lastly site 3

DO 8.8mg/l-9.8mg/l. This result indicates that the collected data were in the range of good condition of DO concentration whereas the good water DO concentrations above 6.5 – 8 mg/l were between about 80-120%. (A monitors Guide to Water Quality). Phytoplankton can be an indicator of oxygen depletion in an area, if abundant water the visibility is limited to less than 12 inches, this indicates that oxygen is depleted in the water. Alarmingly, the appearance of cloudy or heavy dense blooms on windless days causes oxygen depletion and causes fish kill (FAO). This reveals that dissolved oxygen can increase algal growth by raising DO level but not essentially limiting the algal biomass (Smith et al, 1988). Also, oxygen depletion were due to algal blooms and die-off of phytoplankton, making it more unsuitable for many aquatic animal (Miller/Harley, 2016).

pH

Some of the species of phytoplankton have a wider range of pH measuring from 6.3-10 pH, during the five (5) samplings, site 1 obtains a range of 7.55-7.56, site 2 range of 7.55-7.58, and site 3 range of 6.1-6.2. This implies that pH influences the growth of phytoplankton, and changes in its equilibrium may amplify ranges of pH and significantly alternate the species present in the site (Hinga, KR. 2002). Likewise,the recommended pH to sustain the growth of phytoplankton wewas.2-8.4 in order that it won't die off (Briola, et al, 2013).

Salinity

Recorded data shows that the 3 sites have different salinity site 1 ranges from 32ppt-33ppt, site 2 ranges from 2ppt-3ppt freshwater, and site 3 ranges from 13ppt-29ppt This indicates that the 3 sites represent different characteristics in term of water salinity such as Site 1 represent the higher salinity which is it is located in the estuarine, while Site 3 represent the average salinity and Site 2 represents the lowest salinity among the 3 sites. This implies that some composition of species in the site may vary according to their suitable salinity. Hence, in this study identified species like *Naviculasp.* which is present only on Site 1 Poblacion, that indicates that the area has higher salinity than the rest of the areas with a 33 ppt -33.32 ppt. Another species was *Gyrosigma sp.* which is present only in Site 3 Ipil. This indicates that the water is in transition of freshwater to brackishwater which in the study states that the salinity in the area was 2ppt-3ppt which favors the growth of *Gyrosigma sp.*

Temperature

Temperature observed in the study was recorded, site 1 range 29°C-35°C, site 2 range 31°C-34°C, and site 3 range 29°C-35°C. The suitable temperature for phytoplankton to grow best was 18 to 25 Degree Celsius and the optimal temperature for growth. In the result of this study,the water temperature was a bit higher than the optimal temperature, one of the reasons behind this was the time of collection of water. Sampling hours took 9:00-10:00 in the morning which may affect the temperature of the water. This indicates that effects temperature has a significant impact on the number of phytoplankton which can alter the chemical and physical characteristics of water whereas this parameter affects the quality of aquatic life and habitats influenced by the increase and decrease of water temperature (Foundriest Environmental Inc. 2014).

Total dissolved solids

Monitored total dissolved oxygen was observes in Site1 range 19ppm-25ppm, Site 2 range 18ppm-24ppm, Site 3 range 20ppm-26ppm. This result states that the TDS affects the turbidity in the area specifiedon the phytoplankton community structures This may be related to the cyanobacteria due to its characteristics of buoyancy leading to water turbidity in the water whereas the suspension of light reflects to the absorption of light in other substances such as bacteria and algae (Smith, 1990).

Flow Rate

Figure 8. Flow Rate

Figure 8 shows that one of the reasons behind the result of the sites were very low is due to the flow rate of the river,which is the amount of water that passes in the given time (H2Ometrics). In this case, in a river flowing by with a high flow rate,may affect the phytoplankton. The flow of water may be driven by the phytoplankton by the strong current of the river since they are freely floating which in this case were drifted away by the flow of water. Therefore, the collect phytoplankton in plastic bottle may be driven away before it enters the container. The highest calculated value of flow rate was in Site 2 followed by Site 1 and lastly Site 3 with the following values of 31.31 m/s, 26.85 m/s and 25.75 m/s respectively. This indicates that each sitewas characterized by a different flow rate. Therefore, the higher the flow rate the fastest it flows in the area.

Implications and Recommendations

The study implies the importance of phytoplankton in this study. Phytoplankton is the primary source of food for aquatic species and likewise it plays a vital role in the community that servesas abiological and ecological indicator in the river.Thus, identification, and indication of their abundance and cell density may give an idea on when and how harmful algal blooms possible appears, which may harm aquatic species like, fish, shellfish, and other species inhabiting sukol river.

The study recommends on the following for further studies:

1. Continuous monitoring of the phytoplankton in the Sukol river, Bongabongas one of the bioindicators for ecological status of the river.
2. Identify the specific aquatic organisms inhabiting in the river.
3. Determine the microorganism present in the study area.

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