Species composition and individual abundance of plankton in acid sulfate soil brackishwater ponds in Kotabaru Regency, South Kalimantan Province

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Abstract. This study aims to determine the composition of species and individuals abundance of plankton in acid sulfate soil brackishwater ponds in Kotabaru Regency, South Kalimantan Province. The plankton was collected and preserved with 1% Lugol solution and species was identified by microscope and calculated with cell counting methods. Water quality variables measured in situ; temperature, transparency, salinity, DO, and pH, which existed; total organic matter, NO$_2$-N, NO$_3$-N, NH$_3$-N, PO$_4$-P and total suspended solids. The results showed that in acid sulfate soil ponds, were found 8 species of phytoplankton, classified into 4 classes i.e., Bacillariophyceae (4 species), Cyanophyceae (1 species) Dinophyceae (2 species) and Chlorophyceae (1 species) with an abundance of 10–410 ind./L while zooplankton type were found 9 species classified into 2 classes, i.e. Crustaceae (8 species) and Rotatoria (1 species) with an abundance of 14–637 ind./L. The dominant species of phytoplankton is Nitzschia sp from the Bacillariophyceae class with abundance are 482 ind./L, while the zooplankton type dominated by Copepoda sp from the Crustaceae class with an abundance are 482 ind./L, while the zooplankton type dominated by Copepoda sp from the Crustaceae class with an abundance are 583 ind./L. Value of dissolved oxygen, pH, NO$_3$-N and total suspended solids in the pond are increased parallel with the increasing abundance of Nitzschia sp; otherwise, abundance Nitzschia sp decreased with increasing NH$_3$-N. An abundance of Copepoda sp increased in line with increasing value of dissolved oxygen and pH while decreased with high temperature and NH$_3$-N value.

1. Introduction
Kotabaru Regency in South Kalimantan Province has an 825 km coastline length with a potential brackishwater pond area of 17,758 ha and sustainable fish production of 98 tons per year and 15 tons of shrimp per year. The pond area is spread in 14 subdistricts from 21 coastal subdistricts, which mostly originate from the conversion of mangrove with a traditional ponds culture technology and commodities consisting of milkfish, vannamei shrimp, tiger shrimp, crabs and seaweed which are carried out both monoculture and polyculture [1]. The ponds are built with generally low of the dike, water levels range from 40-60 cm, simple irrigation system with inlet and outlet for water replacement through one door by gravity (depends on tidal differences), and most of the pond soil are classified as acid sulfate soil [2]. The pond soils that are dominated by acid sulfate soils are characterized by high acidity potential, high toxic content, low macronutrient content, and relatively coarse texture [3]. The pond conditions will impact to degraded in water quality that can limit the abundance and diversity of plankton to grow up and expand, such as the pond production achieved is still relatively low, an average of 765.50 kg/ha/yr [4]. The production still has a big chance to be increased by remediation of...
the ponds both through soil improvement and water quality, especially the management of plankton
which is equipped with improved construction and pond irrigation networks.

In the aquaculture of ponds, phytoplankton is one important element to support production. The
growth and development of phytoplankton in pond waters require energy from nutrient uptake
resulting from the decomposition of organic matter and inorganic fertilizers (urea and SP36). In the
pond waters environment, phytoplankton also acts as a producer of oxygen through the process of
photosynthesis so as to prevent the environment from degradation of organic waste and can ensure
oxygen is available properly for shrimp, maintain an environmental balance and can absorb toxic
compounds in water so as to spur growth and suppress the mortality rate of shrimp cultivated [5-7].

Phytoplankton is an abiotic component of the food chain in the structure of the plankton
community in ponds, which has the role of transferring energy and can affect the stability of the food
chain to a higher trophic level, including shrimp that is cultivated. One of the factors that greatly affect
the growth of phytoplankton in ponds is nutrient supply, which is closely related to the availability of
macro and micronutrients and is influenced by physical and chemical environmental conditions [8].

The effectiveness and amount of nutrient uptake by phytoplankton in pond waters is highly
dependent on the availability and level of NO\textsubscript{3}-N, PO\textsubscript{4}-P absorption, and organic matter, which is
influenced by pH, dissolved oxygen, temperature, brightness, salinity, NO\textsubscript{2}-N and NH\textsubscript{3}-N and
suspended solids. For acid sulfate soil ponds that are traditionally managed and water, changes are
only carried out at high tide, will have an impact on water quality decline so that the absorption
process of nutrients by phytoplankton is less effective with a relatively low absorption rate, this can
reduce the composition of species and abundance of plankton.

Water quality of the pond which is well managed, has in a range that is in accordance with the
growth of plankton as a natural feed for aquatic organisms can increase pond productivity [9]. Nutrient
concentration, pH, dissolved oxygen, temperature, salinity, NO\textsubscript{2}-N, NH\textsubscript{3}-N and suspended solids in
acid sulfate soil ponds that are traditionally managed are thought to reduce the composition of species
and abundance of plankton so this research is needed to determine the species composition and
abundance and relationship of the dominant plankton species with water quality parameters in acid
sulfate soil ponds in Kotabaru Regency, South Kalimantan Province.

2. Data and Methods

2.1. Location and Time of Data Collection
Data collection was carried out from March 29 to April 10, 2016, on extensive acid sulfate soil ponds
in 4 coastal subdistricts, i.e., Pulau Laut Barat (PLB), Pulau Laut Timur (PLT), Pulau Laut Utara
(PLU), and Pulau Laut Tengah (PLTeng), Kotabaru Regency, South Kalimantan Province. Each
observation station point is determined using GPS (Global Positioning System) and can be seen in
Figure 1.

2.2. Data Collection
Plankton and water sample were carried out simultaneously at an extensive pond representing 4
subdistricts. Plankton and water sample collected from the operated pond and are done randomly,
where every subdistrict, there are 3 sampling points and each sampling point gets 3 samples. Plankton
is taken by filtering water as much as 100 L until the remaining 100 mL using a plankton net with a
mesh size of 60 µm, then preserved with a solution of Lugol 1%. Plankton and water samples are then
taken to the Laboratory for observation and analysis.

The measured water quality consists of physical and chemical parameters, which are considered to
affect the species composition and abundance of plankton, as presented in Table 1. Water quality
variables which observed directly in ponds are temperature, brightness, pH, salinity, and dissolved
oxygen, while NO\textsubscript{3}-N, NO\textsubscript{2}-N, NH\textsubscript{3}-N, PO\textsubscript{4}-P, organic matter, and total suspended solids, were
analyzed in the laboratory. Water samples taken at the site are considered to represent the
environmental conditions of the pond waters and the method of analysis is guided by [10-11].
2.3. Data Analysis
Plankton identification in the laboratory is carried out using a microscope guided by [12-14]. Then to estimate the quality of pond waters, an abundance analysis of plankton individuals was carried out using *Sedgwick Rafter Counting Cell* based on [15].

![Map of sampling locations for plankton and water quality in acid sulfate soil ponds, Kotabaru Regency, South Kalimantan Province.](image)

**Figure 1.** Map of sampling locations for plankton and water quality in acid sulfate soil ponds, Kotabaru Regency, South Kalimantan Province.

**Table 1.** Water quality parameters observed in acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province

| Parameters                        | Tools/ Methods                  | Laboratory/ Field Analysis |
|-----------------------------------|---------------------------------|----------------------------|
| Physical                          |                                 |                            |
| Temperature (°C)                  | DO-meter                        | Field                      |
| Brightness (cm)                   | Secchi-disk                     | Field                      |
| Chemical                          |                                 |                            |
| Dissolved oxygen (mg/L)           | DO-meter                        | Field                      |
| Salinity (ppt)                    | Hand refractometer              | Field                      |
| pH                                | pH-meter                        | Field                      |
| Total suspended solid (mg/L)      | Gravimetry                      | Field                      |
| NO₂-N (mg/L)                      | Sample bottle, spectrophotometer| Laboratory                 |
| NO₃-N (mg/L)                      | Sample bottle, cadmium reduction| Laboratory                 |
| NH₃-N (mg/L)                      | Sample bottle, phenantrolin     | Laboratory                 |
| PO₄-P (mg/L)                      | Sample bottle, ascorbic acid    | Laboratory                 |
Total organic matter (mg/L)  Titrimetri  Laboratory
Plankton (Phytoplankton dan zooplankton)  Plankton net mesh size 60 µm, sample bottle, preservatives, microscope  Laboratory

To find out the correlation between the abundance of phytoplankton and zooplankton individuals on water quality variables in acid sulfate soil ponds, only 1 dominant phytoplankton species, namely Nitzschia sp and Zooplankton, Copepoda sp. The first begins by simplifying the water quality variable using the Principal Component Analysis (PCA) method by reducing its dimensions. This is done by removing the correlation between the independent variables through the transformation of the original independent variable into a new variable that does not correlate at all. After several components of PCA results that are free of multicollinearity are obtained, then these components become new independent variables (X) which will be regressed or analyzed for the independent variables (Y), namely the abundance of individual Nitzschia sp and Copepoda sp in acid sulfate ponds using multiple regression analysis [16-17].

3. Results and Discussion

3.1. Species composition and Individuals Abundance of Plankton

The species composition of plankton (phytoplankton and zooplankton) found at this study site is shown in Table 2. On acid sulfate soil ponds totaling 12 sampling points and 36 samples in 4 subdistricts i.e; Pulau Laut Utara, Pulau Laut Tengah, Pulau Laut Barat, and Pulau Laut Timur obtained 8 species of phytoplankton divided into 4 classes, i.e; Bacillariophyceae (4 species), Cyanophyceae (1 species) Dinophyceae (2 species) and Chlorophyceae (1 species) and 9 species of zooplankton divided into 2 classes i.e; Crustacea (8 species) and Rotatoria (1 species).

The results of the plankton analysis showed that the highest species composition of phytoplankton (11 species) was found in acid sulfate soil ponds in Stagen Village, Pulau Laut Utara Subdistrict and the smallest (4 species) were in Sigam and Sejaka Villages, Pulau Laut Timur subdistrict. The composition species of phytoplankton in ponds is strongly influenced by the presence of aquatic nutrients, especially nutrients from the inorganic nitrogen and phosphorus groups. The availability of nutrients depends on the amount of organic matter and the level of decomposition by bacteria. The organic material is derived from dead moss and dead moss, litter, and leftover food from decomposition and excretion of farmed shrimp [18]. Pond conditions in Sigam and Sejaka villages have shallow water and subtle water changes causing water quality conditions to fluctuate or extreme, the application of urea and SP36 fertilizers are less effective and inhibits the response of nutrient uptake levels by phytoplankton which can further reduce plankton species abundance and abundance.

The use of fertilizers or supplementary nutrition in traditional ponds can provide a longer period for the phytoplankton community to grow and increase its density until it finally decreases in density when the environmental supporting factors are no longer able to support the growth of phytoplankton [8]. This was also added by [19] that the main factor influencing the species composition and abundance of phytoplankton is the change in pond waters’ environmental conditions caused by seasons and tides.

Phytoplankton species composition in acid sulfate soil ponds, dominated by the Bacillariophyceae class (Figures 1 and 2). Among the four species of phytoplankton obtained from the Bacillariophyceae class, the dominant found in the ponds in the Bekambit Village, Pulau Laut Timur Subdistrict is Nitzschia sp with the largest abundance of 482 ind./L, then Navicula sp 30 ind./L in the ponds of Sebelimbingan Village, Pulau Laut Utara Subdistrict and Coscinodiscus sp 15 ind./L in the ponds of Sebanti Village, Pulau Laut Barat Subdistrict, and Pleurosigma sp with the smallest abundance of 9 ind./L in the ponds of Bekambit Village, Pulau Laut Timur Subdistrict. Phytoplankton that is expected
to grow is from the Chlorophyceae and Bacillariophyceae classes because these two classes can be used as natural feed for shrimp in addition to being an oxygen enhancer in the pond water column [20].

The Bacillariophyceae class is a diatom that contains silicates, while silicates themselves are essential elements in the formation of cell walls and shells and can be attached to the substrate. Bacillariophyceae are a group of microalgae that are yellow to brown, commonly called diatoms. Diatoms are cellular microalgae, can form colonies, the cell walls contain silicates and consist of two valves. The shape is bilateral symmetry and radial symmetry. The Bacillariophyceae or diatom class is a phytoplankton community that is better and responds more rapidly to nutrient increases than other phytoplankton communities [8].

Table 2. Species composition (species/L) and abundance (ind./L) plankton which obtained in acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province

| Group/Class/Species | St1 | St2 | St3 | St4 | St5 | St6 | St7 | St8 | St9 | St10 | St11 | St12 |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| **Phytoplankton**   |     |     |     |     |     |     |     |     |     |      |      |      |
| Bacillariophyceae   |     |     |     |     |     |     |     |     |     |      |      |      |
| 1. *Navicula* sp    | 9   | 30  | 10  | -   | -   | -   | -   | -   | -   | 9     | 10   |      |
| 2. *Nitzschia* sp   | 20  | -   | -   | -   | -   | 482 | -   | -   | -   | 10    | 10   |      |
| 3. *Pleurosigma* sp | 10  | -   | -   | 10  | -   | 9   | 10  | 10  | 10  | 10    | -    |      |
| 4. *Coscinodiscus* sp | 11 | -   | -   | 10  | -   | -   | 10  | -   | 9    | 15    |      |      |
| Cyanophyceae        |     |     |     |     |     |     |     |     |     |      |      |      |
| 5. *Oscillatoria* sp | 118 | 380 | 21  | -   | -   | 10  | 10  | -   | 81   | 10    | 26   |      |
| Chlorophyceae       |     |     |     |     |     |     |     |     |     |      |      |      |
| 6. *Thalassionema* sp | 11 | -   | -   | -   | -   | -   | -   | -   | -    | -     |      |      |
| Dinophyceae         |     |     |     |     |     |     |     |     |     |      |      |      |
| 7. *Prorocentrum* sp | -   | -   | -   | -   | -   | -   | -   | -   | -    | 10    |      |      |
| 8. *Globigerina* sp | 10  | -   | -   | -   | -   | -   | -   | -   | -    | 11    |      |      |
| **Zooplankton**     |     |     |     |     |     |     |     |     |     |      |      |      |
| Crustaceae          |     |     |     |     |     |     |     |     |     |      |      |      |
| 9. *Apocyclops* sp  | 23  | 10  | 41  | 26  | 30  | 68  | 10  | 10  | 16   | 127   |      |      |
| 10. *Copepoda* sp   | 583 | 66  | 35  | 69  | 43  | 39  | 10  | 36  | 23   | 203   | 14   | 20   |
| 11. *Microstella* sp | -   | -   | -   | -   | -   | -   | -   | -   | 21   | -     |      |      |
| 12. *Acartia* sp    | 22  | -   | -   | 30  | 10  | 10  | 10  | 40  | 20   | 13    | -    | 16   |
| 13. *Oithona* sp    | -   | 10  | -   | 10  | -   | 50  | 10  | -   | 10   | -     |      |      |
| 14. *Temora* sp     | -   | 10  | -   | -   | -   | -   | -   | -   | -    | -     |      |      |
| 15. *Nitroca* sp    | -   | -   | -   | 10  | -   | -   | -   | -   | -    | -     |      |      |
| 16. *Tintinnopsis* sp | - | -   | -   | -   | -   | -   | -   | -   | -    | 19    |      |      |
| **Rotatoria**       |     |     |     |     |     |     |     |     |     |      |      |      |
| 17. *Brachionus* sp | 9   | 10  | 31  | -   | -   | 16  | 10  | 187 | -    | 103   | -    |      |

Species composition: 11, 7, 4, 7, 4, 8, 6, 5, 6, 8, 7, 7
Individual abundance: 826, 516, 128, 165, 93, 684, 60, 283, 160, 497, 88, 101

Note: St1= Stagen village, PLU; St2= Sebelimbingan village, PLU; St3= Sigam village, PLT; St4= Batutunau village, PLT; St5= Sejaka village, PLT; St6= Bekambit village, PLT; St7= Betung village, PLT; St8= Karangsari Indah village, PLT; St9= Sungai Limau village, PLT; St10= Sungai Pasir village, PLTeng; St11= Puntai Baru village, PLTeng; St12= Sebanti village, PLB.

Generally, phytoplankton species from the Bacillariophyceae class dominate the ponds because of the availability of nutrients that are important for their growth in the form of NH$_3$-N, NO$_3$-N and NO$_2$-N due to artificial feeding and the rest of shrimp metabolism for 3 months. This is consistent with the
results of research conducted by [21] that one of the beneficial phytoplankton that is expected to grow in ponds is the Bacillariophyceae class which grows optimally at the age of shrimp between 70 and 90 days where conditions such as these experience enrichment of nutrients resulting in ecological changes and changes productivity. According to [22], the phytoplankton component of the Bacillariophycaceae or diatom class is cosmopolitan, rapidly developing in waters and most commonly found in the sea, starting from coastal areas including ponds to the high seas.

*Oscillatoria* sp species are phytoplankton of the Cyanophyceae class obtained in acid sulfate soil ponds (Figure 2). The dominance of *Oscillatoria* sp in the pond was due to the application of fertilizer up to 100 days of shrimp maintenance with a low N/P ratio; this was due to the nutrient condition in the pond being more dominated by P nutrient. This was in accordance with what [18], at the age of 100 days of shrimp rearing, the abundant species of phytoplankton community from the Dynophyceae and Cyanophyceae classes dominated pond waters in all plots, due to nutrient conditions being more dominated by P with a low N/P ratio.

![Figure 2. Plankton individual abundance at class level in acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province.](image-url)

The dynamics or variations in the composition of zooplankton species are generally influenced by food availability, suitable environmental conditions, competition and predation factors and the influence of zooplankton vertical migration. Food availability is an important component of the presence of zooplankton in waters [23].

The composition of zooplankton species found in acid sulphate ponds, dominated by Crustaceae (Figure 2). Type of zooplankton from Crustaceae class in ponds, dominated by *Copepoda* sp with the largest abundance of 583 ind./L, then *Apocyclops* sp 127 ind./L, *Oithona* sp 50 ind./L, *Acartia* sp 40 ind./L, *Tintinnopsis* sp 19 ind./L, and the smallest abundances are *Temora* sp and *Nitroca* sp 10 ind./L, respectively. Type of zooplankton from the Rotatoria class in acid sulfate soil ponds, dominated by *Brachionus* sp with abundance ranging from 9-187 ind./L. The largest abundance of this type was found in the ponds of Karangsari Indah Village, Pulau Timur Timur Subdistrict, and the smallest abundance was found in the ponds of Stagen Village, Pulau Laut Utara Subdistrict.
3.2. Water Quality Conditions

Phytoplankton and zooplankton are microorganisms that live in the water and move with the flow and have a tolerance limit to the environment. The life of zooplankton in addition to being determined by the presence of phytoplankton as its main feed, is also based on environmental changes. Tolerance limits for environmental changes vary for each organism. The response to the effectiveness and level of nutrient uptake by phytoplankton communities in acid sulfate ponds varies, based on the influence of water quality parameters. Acid sulfate soil pond water quality parameters measured include temperature, brightness, salinity, pH, dissolved oxygen, NO$_3$-N, NO$_2$-N, NH$_3$-N, PO$_4$-P, organic matter and total suspended solids (Table 3).

Water temperatures obtained in acid sulfate soil ponds which are generally shallow range from 27.6 to 37.1 °C. The high temperature, in addition to being caused by shallow ponds, also in the course of this research coincided with the dry season that occurred during the daytime and the impact of the rapid evaporation process. Water temperature requirements for shrimp pond range from 26-33°C and the optimum range is 29-31°C [24]. The temperature range that supports the growth of phytoplankton and shrimp ranges from 20-30°C [25].

Table 3. Water quality variable of acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province

| Variable                  | Range            |
|---------------------------|------------------|
| Temperature (°C)           | 27.6-37.1        |
| Brightness (cm)           | 25.5-37.6        |
| Salinity (ppt)            | 0.18-23.40       |
| pH                        | 2.92-8.60        |
| Dissolve oxygen (mg/L)    | 2.4-9.7          |
| NO$_3$-N (mg/L)           | 0.0197-0.9218    |
| NO$_2$-N (mg/L)           | 0.0007-0.0008    |
| NH$_3$-N (mg/L)           | 0.0560-8.9540    |
| PO$_4$-P (mg/L)           | 0.0029-0.2954    |
| Total organic matter (mg/L)| 8.75-72.57      |
| Total suspended solid (mg/L)| 30-338         |

The rate of metabolic processes will increase with increasing temperature. The optimum rate of the metabolic process can be achieved in the temperature range of 24-31°C [26]. Phytoplankton from the Bacillariophyceae and Chlorophyceae classes tend to be more prevalent and stable. Phytoplankton species from both classes grow well, respectively in the range of 30-35°C and 20-30°C and Cyanophyceae can tolerate a higher temperature range (above 35°C) compared to the temperature range in the Bacillariophyceae and Chlorophyceae classes [21].

The range of brightness values in acid sulfate ponds that is 25.5-37.6 cm means the intensity of the sunlight can still enter the pond waters column so that it will affect the phytoplankton community as an autotrophic organism in the process of photosynthesis [27]. The abundance of phytoplankton during shrimp rearing in ponds is shown by the decreasing brightness value at each observation time. The higher abundance of phytoplankton will increase turbidity (turbidity) or decrease water brightness [18]. When measuring brightness using a disk visible from the surface of the pond, the brownish-green watercolor which is an indication of the abundance of phytoplankton species from the Bacillariophyceae class is good natural food for shrimp culture and can guarantee that dissolved oxygen is still available properly for shrimp cultivated [28, 5].

Salinity in acid sulfate soil ponds that is 0.18-23.40 ppt has a wide range and when sampling is in the area of freshwater ecosystem ponds with low salinity (0.18 ppt) and in the pond area of seawater ecosystems with relative salinity high (23.40 ppt) and for ponds that use seawater with shallow pond conditions will accelerate evaporation and have an impact on increasing salinity. The types of phytoplankton and zooplankton obtained in these ponds have a high tolerance to changes in salinity.
and the high salinity of ponds is thought to be a limiting factor for the growth of several types of plankton and shrimp. Oscillatoria sp is one type of Cyanophyceae class that can adapt to salinity, reaching 90 ppt and temperature reaches 37°C [9].

The pH of pond water is usually not a direct threat to the survival of the plankton community because rarely in the water column, there is a pH above 9.0 or in pond bottom sediments, the pH is below 6.0. The range of pH values in acid sulfate ponds is 2.92-8.60. High pH values up to 8.60 are generally found in ponds of relatively long age and remediation is often carried out during maintenance by means of ponds dried, ground treated, replaced with water and dried again, then fertilized and calcified with adequate doses to increase pH and maintain pH so that the pond pH conditions remain stable which affects the species composition and abundance of phytoplankton which in turn affects the development of the plankton community. Whereas pond water which has a low pH (2.92) is found in ponds that have just been opened in the mangrove area and have not been reclaimed [24].

The range of dissolved oxygen in acid sulfate soil ponds is 2.4-9.7 mg/L. Water quality requirements for shrimp ponds with dissolved oxygen range from 3–10 mg/L and the optimum range from 4–7 mg/L [24]. Low dissolved oxygen (2.4 mg/L) is found in ponds that have never been remediated, which are characterized by high organic matter content so that more oxygen is used for the oxidation process. High dissolved oxygen (9.7 mg/L), obtained in ponds that were long mediated due to additional oxygen from phytoplankton photosynthesis. Increased phytoplankton abundance is generally in line with an increase in chlorophyll-a content.

3.3. Relationship between Water Quality and Plankton Individual Abundance in Ponds

3.3.1. Relationship of Water Quality with an Abundance of Nitzschia sp

To simplify the water quality variables observed in acid sulfate soil ponds by reducing their dimensions using the principle of component analysis (PCA) can be seen in Figure 3.

Water quality parameters consist of 10 components (PC1 to PC10) namely dissolved oxygen (DO), salinity, temperature, pH, NO$_3$-N, NO$_2$-N, PO$_4$-P, total organic matter, total suspended solids (TSS) and NH$_3$-N. Eigenvalue is the value of the main component variant (PC). Eigenvalues for PC1, PC2, and PC3 are 3.254; 2.1673 and 1.5043. The eigenvalues of the three main components (PC1, PC2 and PC3) represent 35.4%; 21.2% and 19.1% of all variability. This means that if 10 variables are reduced to 3 variables, then the three new variables can explain 75.7% of the total variability (10 variables). Furthermore, when compacted into 4 variables, namely PC4 11.2%, the four variables can already explain 86.9% of the total variability (10 variables). There are four main components of pond water quality variables that correlate significantly with the abundance of Nitzschia sp, namely DO, pH, total suspended solids, and NH$_3$-N. The magnitude of the influence of these four components on the abundance of Nitzschia sp in acid sulfate soil ponds is shown by the R2 value (terminating coefficient) of 0.869 = 86.9%, meaning that the magnitude of the influence of the four components comes from the analysis of the regression model and 13.1% comes from outside this regression model.
The results of component PCA between the abundance of *Nitzchia* sp with water quality variable in acid sulfate soil ponds which multicollinearity-free.

The relationship between the four components of pond water quality with *Nitzchia* sp abundance can be seen in Figure 4. Thus the regression model can predict the abundance of *Nitzchia* sp in acid sulfate soil ponds from the following equation:

\[ Y = 125,764 + 33,549X_1 + 28,617X_2 + 30,358X_3 - 39,588X_4 \]  

(1)

where: \( Y \) = Abundance of *Nitzchia* sp (ind./L); \( X_1 \) = DO (mg/L); \( X_2 \) = pH; \( X_3 \) = TSS; \( X_4 \) = NH\(_3\)-N

From this equation, it can be explained that increasing water quality parameters in acid sulfate soil ponds such as DO, pH, TSS along with an increasing abundance of *Nitzchia* sp and high NH\(_3\)-N, can reduce *Nitzchia* sp abundance [29].

**Figure 3.** The results of component PCA between the abundance of *Nitzchia* sp with water quality variable in acid sulfate soil ponds which multicollinearity-free.

**Figure 4.** Relationship between DO, pH, TSS, and NH\(_3\)-N with the abundance of *Nitzchia* sp in acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province.
3.3.2. Relationship of Water Quality with an Abundance of Copepoda sp

To simplify the water quality variables observed in acid sulfate soil ponds by reducing their dimensions using the principle of component analysis (PCA) can be seen in Figure 5.

Water quality parameters consist of 10 components (PC1 to PC10) i.e; DO, salinity, temperature, pH, NO$_3$-N, NO$_2$-N, PO$_4$-P, total organic matter, total suspended solids, and NH$_3$-N. The eigenvalue is the value of the main component variant (PC). Eigenvalues for PC1, PC2, and PC3 are 2.865; 1.3764 and 1.2933. The eigenvalues of the three main components (PC1, PC2, and PC3) represent 30.7%; 22.1%, and 18.7% of all variability. This means that if 10 variables are reduced to 3 variables, then the three new variables can explain 71.5% of the total variability (10 variables). Furthermore, when compacted into 4 variables, namely PC4 12.3%, the four variables can already explain 83.8% of the total variability (10 variables). There are four main components of pond water quality variables that correlate significantly with Copepoda sp abundance, namely DO, pH, temperature, and NH$_3$-N. The magnitude of the influence of these four components on the abundance of Nitzschia sp in acid sulfate soil ponds is shown by the R$^2$ value (terminated coefficient) of 0.838 = 83.8%, meaning that the magnitude of the influence of the four components comes from the analysis of the regression model and 16.2% comes from outside this regression model. The relationship between the four components of pond water quality with Copepoda sp abundance can be seen in Figure 5. Thus the regression model can predict the abundance of Copepoda sp in acid sulfate soil ponds from the following equation:

$$Y=132,832+31,425X_1+30,744X_2-32,592X_3+47,369X_4$$

(2)

where: $Y$=Abundance of Copepoda sp (ind./L); $X_1$= DO (mg/L); $X_2$= pH; $X_3$= temperature; $X_4$=NH$_3$-N

From this equation, it can be explained that increasing water quality parameters in acid sulfate soil ponds such as DO and pH, along with the increasing abundance of Nitzschia sp and high temperature and NH$_3$-N, can reduce the abundance of Copepoda sp [29].
Figure 6. The relationship between DO, pH, temperature, and NH$_3$-N with the abundance of Copepoda sp in acid sulfate soil ponds in Kotabaru Regency, South Kalimantan Province

4. Conclusion
The composition of phytoplankton species obtained in acid sulfate soil ponds in Bekambit Village, Pulau Laut Timur Subdistrict, was dominated by Bacillariophyceae of Nitzschia sp species with the largest abundance of 482 ind./L, then Navicula sp 30 ind./L, Coscinodiscus sp 15 ind./L and Pleurosigma sp with the smallest abundance of 9 ind./L in the ponds of the Bekambit village, Pulau Timur Timur Subdistrict.

The composition of zooplankton species obtained in acid sulfate soil ponds in Karangsari Indah Village, Pulau Laut Timur Subdistrict, is dominated by Crustaceae from Copepoda sp species with the greatest abundance of 583 ind./L, then Apocyclops sp 127 ind./L, Oithona sp 50 ind./L, Acartia sp 40 ind./L, Tintinnopsis sp 19 ind./L, and the smallest abundance of Temora sp and Nitroca sp 10 ind./L respectively are found in the ponds of Stagen Village, Pulau Laut Utara Subdistrict.

Regression analysis results can be explained that the value of dissolved oxygen, pH, NO$_3$-N, and total suspended solids increases with an increasing abundance of Nitzschia sp and high NH$_3$-N, Nitzschia sp abundance decreases. Increased dissolved oxygen and pH with an increasing abundance of Copepoda sp and high temperature and NH$_3$-N, Copepoda sp abundance decreases.

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