JURNAL BIOLOGI

El-Hayah

Journal Homepage: http://ejournal.uin-malang.ac.id/index.php/bio/index
e-ISSN: 2460-7207, p-ISSN: 2086-0064

Original research article

Analysis of Phytoplankton on The Common Carp (*Cyprinus carpio*) Pond and Tilapia (*Oreochromis niloticus*) Pond at IBAT Punten, Batu, East Java

Diana Arfiati, Purwanti, Setya W. A. Permanasari, Asthervina Widyastami Puspitasari

Faculty of Fisheries and Marine Science University of Brawijaya, Malang

*Corresponding author
Email: : d_arfiati@yahoo.com
DOI: 10.18860/elha.v7i1.7242

Article Info

Article history:
Received 01 September 2018
Received in revised form
02 December 2018
Accepted 2 January 2019

Keywords:
Carp Pond,
IBAT Punten,
Phytoplankton,
Tilapia Pond,
Water Quality

Abstract

Phytoplankton plays an important role in the aquatic ecosystem for supporting the survival of organisms, such as zooplankton and fish. The aim of this research was to observe the phytoplankton in the common carp ponds and tilapia ponds with water quality parameters at IBAT Punten, Batu, East Java. The survey method was used in this research. The water quality assay was temperature, brightness, pH, DO, CO_2, Nitrate, and Orthophosphate, and the phytoplankton analysis was phytoplankton abundance, diversity index, dominance index, relative abundance, similarity index, and evenness index. The water quality on the carp ponds and tilapia ponds was quite good for common carp and tilapia growth. The average of phytoplankton abundance in common carp ponds were 1538 cell/ml which classified oligotrophic and tilapia ponds were 4900 cell/ml which included mesotrophic respectively, diversity index was moderate in both ponds, no dominance specific phytoplankton in both ponds the relative abundance in both ponds showed different phytoplankton availability, the similarity, and evenness index showed the same in both ponds and evenly on tilapia ponds and equally on common carp pond respectively. The carbon dioxide (CO_2), nitrate, and orthophosphate have a strong correlation to phytoplankton abundance with value 0.882; 0.949; and 0.967 respectively. In the future, pond management will be needed in IBAT Punten with growing natural food.

1. INTRODUCTION

Phytoplankton is the basis of the food web in the aquatic environment, which means they are primary producers (Vergas *et al*., 2006). Commonly, all phytoplankton contains chlorophyll-*a;* and some species have another pigment such as chlorophyll-*b* and chlorophyll-*c*, as well as photosynthetic carotenoids (Barlow *et al*., 1999; Kirk, 1994). The main types of phytoplankton are *Cyanobacteria, Diatoms, Dinoflagellates, Green algae and Coccolithophores* (Oliveira *et al*., 2005 and Duarte *et al*., 2005).

Tilapia and crucian carp such kind of omnivorous fish with periphyton and also macrophytes in their diets (Doupé *et al*., 2010; Penttinen and Holopainen, 1992; Rao *et al.*, 2015). Nile tilapia (*Oreochromis niloticus*) is an exotic omnivorous filter-feeding fish which kind of planktivorous fish origin from Africa (Menezez *et al.*, 2010). Thus, is highly invasive and the most widely distributed exotic fish in the world after common carp (*Cyprinus carpio* Carpio L.) (Canonico *et al*., 2005; Zambrano *et al.,* 2006). Plant material and benthic organisms are the variety of common carp mainly feeds (Froese and Pauly, 2012). Mondol *et al*., (2013) explained that *Cyprinus carpio* is an omnivore fish with feeding almost equally on phytoplankton and zooplankton.

Instalasi Budidaya Air Tawar (IBAT) Punten, Batu, East Java is one of the locations in Indonesia that provided fish farming activities, and sustainable aquaculture activities on a daily basis by utilizing the Brantas river as a water source. Common carp and tilapia are the major in-demand fish in Punten, Batu, East Java. Common carp and tilapia are an omnivorous fish species, which are both phytoplankton eaters, but they have differences to eat pattern. This study was necessary to observe the analysis of phytoplankton in the common carp pond and tilapia pond with water quality (physical and chemical parameters) assay in IBAT Punten, Batu, East Java, Indonesia.

2. MATERIALS AND METHODS

Study area

This study was focused on IBAT Punten, Batu City, East Java, Indonesia (7°50'41,74"S; 112°31'29,43° E) (**Figure 1).** Geographically, IBAT Punten located in the slopes of Mount Arjuna with 1100 MASL. The aerial extent of the study area is approximately 3.8 hectares with 2.6 hectares for aquaculture activities and 1.2 hectares for an office building. The field survey areas were considered in 4 stations. Station 1 and 2 were common carp ponds, and station 3 and 4 were tilapia ponds. The pond was chosen in this study was maintenance pond with large 280 m^2 with fish size about 15 to 25 cm, 4 to 5 months old, and weight about 300 to 500 grams. The density of this ponds was 3 to 4 fish m^{-1}.

Figure 1. Location of IBAT Punten, Batu, East Java, Indonesia

Procedures

Sample Preparation

Water and Phytoplankton were taken by using Kemmerer Water Sampler with a volume of 2 liters in a composite (a mixture of water from the bottom, middle and surface of the pond) followed Settley et al., 2017. For phytoplankton, water was spilled out to the plankton net no. 25 mesh size 64 until 4 repetitions to collect the phytoplankton and put into the 25 ml bottle sample then added 0,3 ml lugol and keep into the coolbox with ice to maintain the quality until use.

Water Quality Assay

The water quality parameters assay in this study formed of physical and chemical tests. On the water physics assay were temperature (alcohol thermometer) and brightness (Secchi disk). while the water chemistry assay was pH (Testr 30), DO (Lutron DO-5510), CO2 (Indicator Na2CO3 0.0454 N), Nitrate and Orthophosphate. Measurements of temperature, brightness, pH, DO and CO2 were carried out in situ while Nitrates and Orthophosphates were tested in the Hydrobiology Laboratory, Faculty of Fisheries and Marine Science, University of Brawijaya, Malang. Sampling was held from February to March 2018 then the sample was conducted in 6 days with a span of 5 days for 5 weeks.

Phytoplankton Analysis

Phytoplankton analysis in this study included phytoplankton abundance, diversity index, dominance index, relative abundance, similarity index, and evenness index and the correlation between phytoplankton abundance with water quality

Phytochemical Screening

Phytochemical screening in this research follows the standard method Harborne (1984). Phytochemical screening includes tests of flavonoids, terpenoids, polyphenols, gallate tannins, catechol tannins, saponins, and alkaloids.

Data analysis

For phytoplankton analysis, the data analysis was used Shannon-Weiner method, Simpson method, and Sorensen method. The analysis of phytoplankton dominance was determined by T-test in SPSS 20 software. Pearson's correlation was used to analyze the correlation between water quality parameters with phytoplankton abundance.

3. RESULTS

Water Quality Assay

On water quality assay, the physical and chemical test was observed in this study. The results show that between carp and tilapia ponds showed a different result. For physical parameters, temperature and brightness were measured. The range temperature of station 1 was 22.8 to 30.4°C, station 2 was 21.3 to 29.7°C, station 3 was 22.6 to 28°C, station 4 was 22.3 to 26.8°C **(Figure 2)**. The brightness wide range of station 1 was 25-28 cm, station 2 was 28- 32 cm, station 3 was 30-33.5 cm, station 4 was 31 to 34 cm **(Figure 3)**. For chemical parameters assay were pH, DO, CO_2, Nitrate, and Orthophosphate. The pH range on station 1 was 7 to 8.2, station 2 was 7.1 to 8.3, station 3 was 7 to 7.4, and station 4 was 6.8 to 7.9 **(Figure 4)**. The DO range on the station 1 was 6.09 to 9.33 mg/L, station 2 was 6.33 to 9.66 mg/L, station 3 was 5.37 to 7.06 mg/L, station 4 was 5.37 to 7.06 mg/L **(Figure 5)**. The CO_2 wide range on the station 1 and 2 was 4.7 to 9.59 mg/L, station 3 and 4 was 11.19 to 17.58 mg/L **(Figure 6)**. On station 1 the nitrate and orthophosphate results **(Figure 7 and 8)** showed 0.065 to 0.102 mg/L and 0.912 to 1.099 mg/L, station 2 was 0.037 to 0.061 mg/L and 0.750 to 0.816 mg/L, station 3 was 0.247 to 0.502 mg/L and 1.198 to 1.699 mg/L, and station 4 was 0.432 to 0.525 mg/L and 1.366 to 1.974 mg/L.

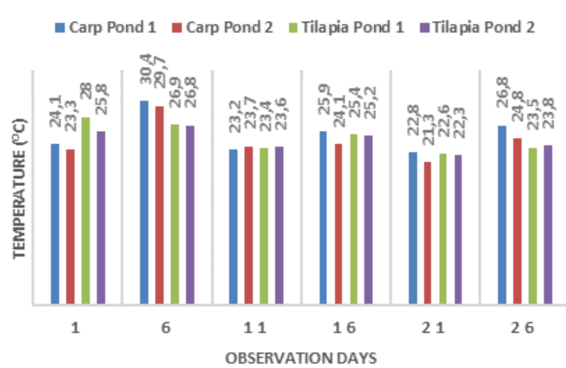

Figure 2. Temperature parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

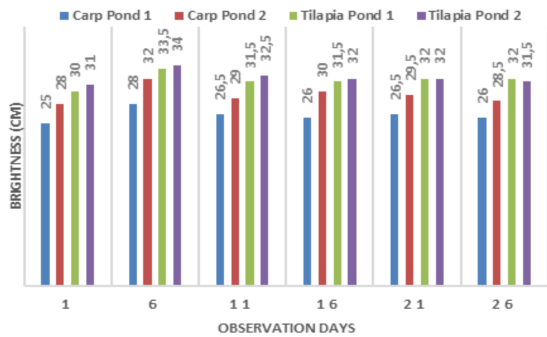

Figure 3. Brightness parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

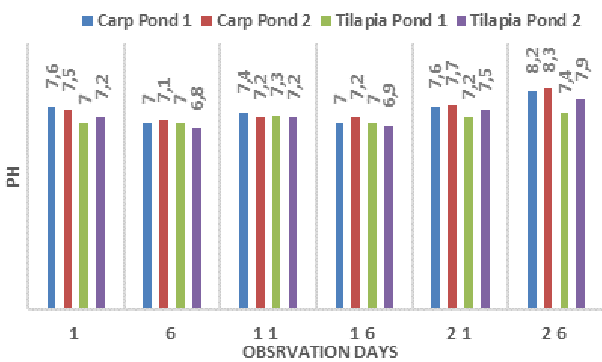

Figure 4. pH parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

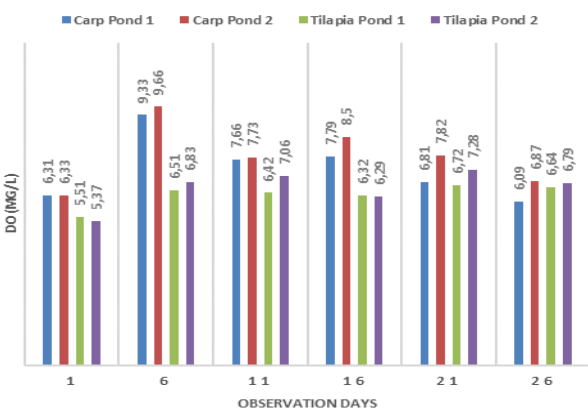

Figure 5. DO parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

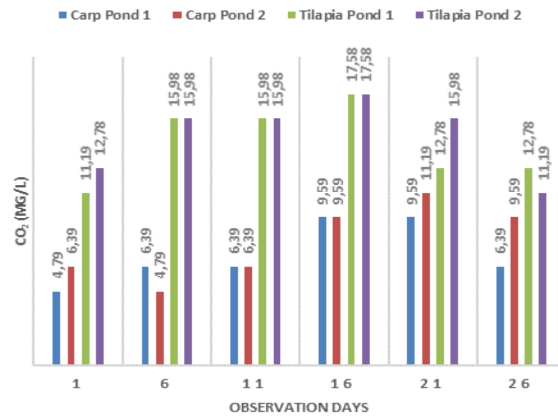

Figure 6. CO2 parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

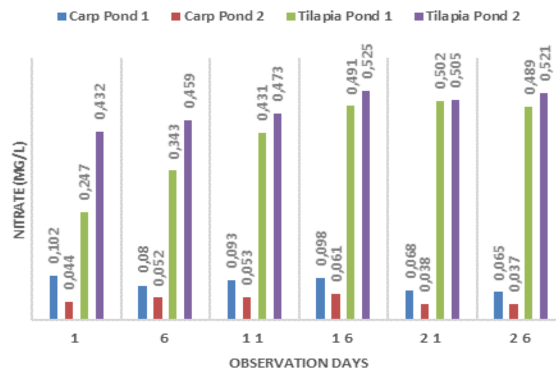

Figure 7. Nitrate parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

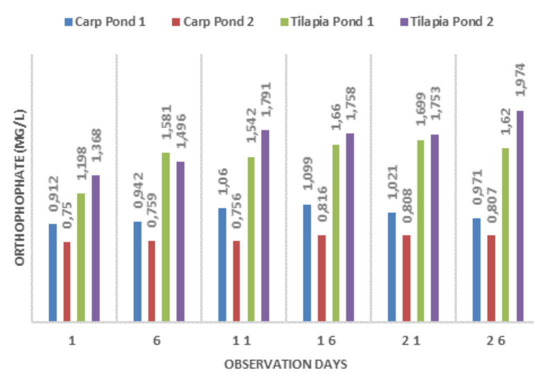

Figure 8. Orthophosphate parameter result with all ponds (carp ponds and tilapia ponds) on all days observation

Phytoplankton Analysis

The abundance of phytoplankton in the common carp ponds and tilapia pond showed a different result, whereas in the common carp pond found the higher phytoplankton than in the tilapia pond **(Figure 9 and 10)** with the average value 1538 cell/ml on common carp ponds which classified oligotrophic and 4900 cell/ml on tilapia ponds which classified mesotrophic, respectively followed by Landner (1978). The diversity index of phytoplankton (Shannon-Weiner method) showed that in the common carp ponds, H' was 1.918 and in the tilapia ponds, H' was 1.875. The dominance index of phytoplankton (Simpson method) showed that in the common carp ponds, D' was 0.128, and in the tilapia ponds, D' was 0.153. the relative abundance of phytoplankton in the common carp ponds was 51% *Chrysophyta*, 36% *Chlorophyta*, 12% *Cyanophyta,* and 1% *Cryptophyta,* While, in the tilapia ponds, the relative abundance of phytoplankton was 40% *Cyanophyta,* 33% *Chrysophyta*, and 27% *Chlorophyta.* The average similarity index (IS) of phytoplankton (Sorensen method) in 4 stations showed 51.4 %, but in the 11 days, the IS showed lowest than another day was 37.5%. And the evenness index (E) showed 0.98 and 0.86 in the common carp ponds and tilapia ponds respectively.

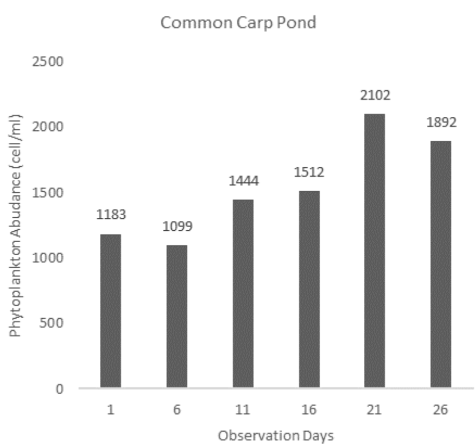

Figure 9. Average of phytoplankton abundance on common carp pond from two ponds of common carp in 6 observation days each.

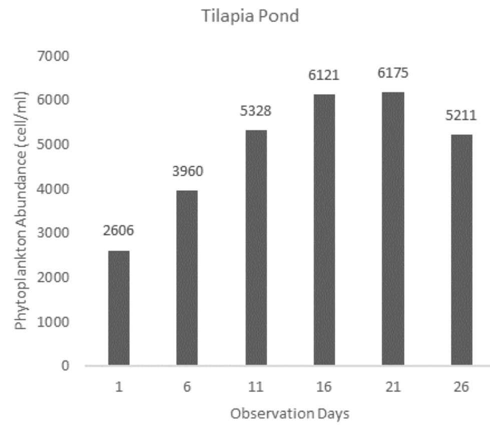

Figure 10. Average of phytoplankton abundance on tilapia pond from two ponds of tilapia in 6 observation days each

Based on the results of correlation analysis between water quality and phytoplankton abundance followed Pearson's analysis method showed that there was a strong correlation between CO2, Nitrate, and Orthophosphate towards phytoplankton abundance with (r) value 0.882; 0.949; and 0.967 respectively. Gogtay and Thatte (2017), explained that the correlation level could be seen by (r) value, if (r) approaches 1 or -1 means the correlation is very strong (positive or negative), but if (r) value less than 0.5 and approaches to 0 means the correlation is low until no correlation.

4. DISCUSSION

The result of water quality analysis showed that was quite good for both physical and chemical analysis except in Tilapia pond which bit higher on Orthophosphate parameter results according to Indonesian Government Regulation Number 82 of 2001, which has standard for water aquaculture (type III) such as pH about 6 to 9; DO ≥ 3 mg/l; Phosphate 1 mg/l; and Nitrate 20 mg/l. Arfiati et al., (2018), reported that at IBAT Kepanjen, Malang on tilapia pond, the temperature, pH and DO were 25 to 31oC; 6.5 to 8.1; and 5.1 respectively (Figure 2, 4, 5, 7, and 8). These results have different from this study. It might occur because the location of IBAT Punten, Batu is a classified plateau. So, the water quality parameters showed different results. Temperature and irradiance have positively correlated on phytoplankton experience (Edwards et al., 2016). Temperature affects as the primary abiotic factor to control the physiological, biochemical and life history processes of fish (Beitinger and Fitzpatrick, 1979). In the cool water contains dissolved oxygen higher in the warm water (Zumdahl, 1992). It might be caused when the fish life in the cool water, they will reduce its movement and minimize the excessive respiration and decrease of oxygen utilization which mean lower carbon dioxide production. Dissolved oxygen is necessary for aquatic life (Abowei, 2010). And carbon dioxide (CO_2) is necessary for phytoplankton, because they have mechanism to absorb solar energy using its pigment and convert the carbon dioxide and water into high-energy carbon compounds as a fuels to growth by synthesizing the vital components required such as polysaccharides, amino acids, lipids, protein, pigments, and nucleic acids (Kyewalyanga, 2012).

The result of phytoplankton abundance showed different result between common carp ponds and tilapia ponds. The abundance of phytoplankton in common carp ponds was lower than phytoplankton abundance in the tilapia ponds (Figure 9 and 10), it has been suspected that the common carp fish prefer to consume phytoplankton compared to tilapia fish. Even though the tilapia look does not prefer to consume phytoplankton, but phytoplankton has a strong correlation to the growth of tilapia. It has been supported by Ramadhan (2018), explained that based on regression analysis, 1% of phytoplankton abundance would be increasing 5.290% of tilapia growth, but when there was no phytoplankton abundance, the tilapia growth would increase 0.062%. Based on relative abundance, this study showed that the highest phytoplankton division was Chrysophyta on the common carp ponds and Cyanophyta on the tilapia ponds. Amallah (2018), reported that the highest phytoplankton was found in common carp pond and tilapia pond was Chlorophyta. Therefore, it has been known that common carp does not prefer to consume Chrysophyta and Chlorophyta, and tilapia does not prefer to consume Cyanophyta and Chlorophyta. Besides, the different result may cause by different time points of research, so the nutrient abundance affects the phytoplankton species. The availability of a high nutrient in the water would increase the phytoplankton growth, and change the nutrient composition or N/P ratio will lead the community composition (species composition) changing (Gilbert et al., 2005, 2008). On the other hand, the different phytoplankton abundance in both ponds might be caused there was a correlation between nitrate and orthophosphate levels in both of ponds means the fertility level of phytoplankton were different. In the aquatic environment, phytoplankton plays an important role to determine water fertility and strongly influenced by CO_2, nitrate, and orthophosphate. Kumar and Cini (2011), explained that Chlorophyceae and Diatoms growth supported by high water temperature, phosphate, nitrate, low DO and CO_2. Egge and Askne (1992), reported that the most important factors for phytoplankton growth are nitrogen and phosphorus, especially for diatoms silicate. Naturally, phytoplankton will take the nitrate under high nutrient conditions (Mercado et al, 2014).

The dominance index on the common carp ponds and tilapia ponds showed no phytoplankton dominates. It has been proved by the number of dominance index approach to zero. The diversity index of phytoplankton in both ponds showed moderate diversity index which means the diversity of phytoplankton in both ponds was stable. Phytoplanktons are an integral component which significantly contributes towards succession and dynamics of aquatic organisms especially zooplankton and fish (Tortell *et al.*, 2008). Thomas (2013), explained that the range optimum temperature of phytoplankton was 20 to 30 ^{o}C. The value of the similarity index (IS) showed more than 50%, which mean the similarity community of phytoplankton in every pond was the same. The evenness index (E) of phytoplankton including almost evenly on the tilapia pond and equally on common carp pond.

5. CONCLUSION

The water quality parameters of common carp ponds and tilapia ponds are qualified based on Indonesian Government Regulation Number 82 of 2001. Common carp mostly prefer to consume the phytoplankton compared to tilapia Phytoplankton abundance has a strong correlation with CO2, Nitrate, and Orthophosphate with a value 0.882; 0.949; and 0.967 respectively. Pond management will be necessary for growing the natural food at IBAT Punten, Batu, East Java.

6. REFERENCES

Abowei, J.F.N. 2010. Salinity, Dissolved Oxygen, pH and Surface Water Temperature inNkoro River, Niger Delta, Nigeria. Advance Journal of Food Science and Technolgy Vol 2 (1): 36-40.

Amallah, S. 2018. Analysis of Nitrate and Phosphate Relationship to Phytoplankton Community Structure in the Semi-Intensive Freshwater Pond, Punten, Batu, East Java (Skripsi). The University of Brawijaya. Malang

Arfiati, D., Rizal P., Asthervina W.P. 2018. Analysis of Organic Matter on Tilapia (*Oreochromis niloticus*) Culture Water Treatment. Prosiding Masyarakat Iktiologi Indonesia. 2018

Barlow, Cambridge, R.G., Mantoura, R.F.C. and Cummins, D.G. (1999). Monsoonal influence on the distribution of phytoplankton pigments in the Arabian Sea. *Deep Sea Res. Part II Top. Stud. Oceanogr.* 46(3), 677–699

Barus, T.A. 2004. Abiotic Environmental Factors and Plankton Diversity as Indicators of the Quality of Lake Toba. Journal of Human and Environmental 11 (2): 64-72 (Indonesia Translate)

Beitinger, T.L. and L.C. Fitzpatrick, 1979.Physiological and Ecological Correlates of Preferred Temperature In Fish. AMER. ZOOL., 19(1): 319-329.

Canonico G.C., Arthington A., Mccrary J.K. & Thieme M.L. 2005. The Effects Of Introduced Tilapias On Native Biodiversity. Aquatic Conservation Marine And Freshwater Ecosystems, 15, 463–483.

Doupé, R.G.; Knott, M.J.; Schaffer, J.; Burrows, D.W.; Lymbery, A.J. 2010. Experimentalherbivory of native Australian macrophytes by the introduced Mozambique tilapia *Oreochromis mossambicus*. Aust. Ecol. 2010, 35, 24–30. [CrossRef]

Duarte, C.M., Middelburg, J.J. and Caraco, N. 2005. Major role of marine vegetation on the oceanic carbon cycle. *Biogeosc.* 2, 1-8

Edwards, K. F., Thomas, M. K., Klausmeier, C. A., & Litchman, E. 2016. Phytoplankton growth and the interaction of light and temperature: A synthesis at the species and community level. *Limnology and Oceanography*, *61*(4), 1232-1244

Egge JK, Aksne DL. 1992. Silicate As Regulating Nutrient In Phytoplankton Competition. Mar Ecol Prog Ser 83: 281-289.

Froese, R. and D. Pauly (Eds) 2012. *Fishbase 2013.*

Gilbert PM, Burkholder JM, Graneli E, Andersen DM. 2008. Advance And Insights In The Complex Relationships Between Eutrophication Ans Habs: Preface To Special Issue. Harmful Algae 8: 1-2.

Gilbert PM, Seitzinger S, Heil CA, Burkholder HM, Parrow MW, Codispoti LA, Kelly V. 2005. The Role Of Eutrophication In The Global Proliferation Of Harmful Algal Blooms. Oceanography 18 (2): 198- 209.

Gogtay, NJ., and UM Thatte. 2017. Principles of Correlation Analysis. Journal of The Association of Physicians of India Vol 65 ; 78-81

Kirk, J.T.O. 1994. *Light and Photosynthesis in Aquatic Ecosystems*. 2nd edition. Cambridge University Press.

Kumar, N., J.I Cini Oommen. 2011. Phytoplankton Composition in Relation to Hydrochemical Properties of Tropical Community Wetland, Kanewal, Gujarat, India. Journal of Applied Ecology and Environmental Research 9 (3): 279-292

Kyewalyanga, M. 2012. Phytoplankton Primary Production. Regional State of Coast Report.

Landner. 1978. Eutrophication of lakes. Analysis of Water and Air Pollution Research Laboratory Stockholm. Sweden

Menezez, R.F., Jose´ L.A., and Francisco Rivera. 2010. Effects of Omnivorous Filter-Feeding Fish and Nutrient Enrichment on the Plankton Community and Water Transparency of a Tropical Reservoir. Journal of Freshwater Biology Vol 55: 767-779

Mercado, J.M., C. Sobrino., P.J. Neale., M. Segovia., A. Reul., A.L. Amorim., P. Carrillo., P. Claquin., M.J. Cabrerizo., P. Leon., M.R. Lorenzo., J.M. Medina-Sánchez., V. Montecino., C. Napoleon., O.Prasil., S.Putzys., S. Salles., L. Yebra. 2014. Effect of CO_2, Nutrients and Light on Coastal Plankton. II. Metabolic Rates. Journal of Aquatic Biology Vol. 22: 43-57.

Mondol, M. M. R., Rahman, M. M., Ahamed, F., Sarker, M. A. A., Subba, B. R., & Hossain, M. Y. 2013. Diet and feeding habits of *Cyprinus carpio* in relation with water quality of integrated rice-fish farming ecosystem. *Our Nature*, *11*(2), 138-151.

Oliveira, E.C., Osterlund, K. and Mtolera, M.S.P. 2005. Marine Plants of Tanzania: A Guide to the Seaweeds and Seagrasses. Botany Department, Stockholm University. Sweden

Penttinen, O.P.; Holopainen, I.J. 1992. Seasonal Feeding Activity And Ontogenetic Dietary Shifts In Crucian Carp, *Carassius Carassius*. Environ. Biol. Fishes. 1992, 33, 215-221 [CrossRef]

Ramadhan, S. 2018. Analysis of Phytoplankton as Natural Feed and Growth Rate of Nile Fish (*Oreochromis niloticus*) on Fish Pond Cultivation at IBAT Punten, Batu City, East Java. (Skripsi). The University of Brawijaya. Malang.

Rao, W.; Ning, J.; Zhong, P.; Jeppesen, E.; Liu, Z. 2015. Size-dependent feeding of Omnivorous Nile Tilapia in a Macrophyte-dominated lake: Implications for Lake Management. Hydrobiologia. 2015, 749, 125-134 [CrossRef]

Sattley, W., Burchell, B., Conrad, S., & Madigan, M. 2017. Design, construction, and application of an inexpensive, high-resolution water sampler. *Water*, 9(8), 578.

Thomas, M. K. 2013. The effect of temperature on the ecology, evolution, and biogeography of phytoplankton. Michigan State University.

Tortell PD, Payne CD, Li Y, Trimborn S and others .2008. CO2 sensitivity of Southern Ocean phytoplankton. Geophys Res Lett 35: L04605, doi: 10.1029/2007GL032583

Vergas, C.A., Ruben E., Serge P. 2006. Phytoplankton Food Quality Determines Time Windows for Successful Zooplankton Reproductive Pulses. Journal of Ecology 87 (12): 2992-2

Worldwide web electronic publication. Available at: http://www.fishbase.org (Accessed on April 5th, 2019).

Zambrano L., Martinez-Meyer E., Menezes N. & Peterson A.T. 2006. Invasive potential of common carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus*) in American Freshwater Systems.

Canadian Journal of Fisheries and Aquatic Sciences, 63, 1903–1910.

Zumdahl SS. 1992. *Chemical Principles*. DC Heath. Canada.