Proceeding SYMBION
(Symposium on Biology Education)
http://seminar.uad.ac.id/index.php/symbion
2540-752X (print) | 2528-5726 (online)

Abundance and Biomass Analysis of *Nostoc commune* in Rice Field Habitat in Madura

Aminatun Najah [a, 1,] *; Indah Wahyuni Abida [b, 2,]
[a,b] Manajemen Sumberdaya Perairan, Universitas Trunojoyo Madura, Madura, Indonesia
[1] Sarramimi7@gmail.com* ; [2]indahwahyuniabida@trunojoyo.ac.id
* Corresponding author

ARTICLE INFORMATION

Article history
Submission Dec 10th , 2022
Revision May 10th , 2023
Accepted May 17th , 2023

Keywords
Nostoc commune
Abundance
Biomass
Rice Paddies

ABSTRACT

Nostoc commune is often found in terrestrial habitats as well as aquatic habitats. *Nostoc commune* has the ability to fix nitrogen from the atmosphere, besides being used as food or medicine. *Nostoc commune* in Indonesia is still little utilized, this is because its existence is often misinterpreted as a weed in rice fields. The purpose of this study was to determine the abundance and biomass of *Nostoc commune* in rice field habitats. This research was conducted from 5 September 2022- September 23, 2022. The sampling method of *Nostoc commune* and water used was *purposive sampling* in the rice fields of Gilianyar Kamal Village, Bangkalan Regency, with three sampling location points. The measured water quality parameters include, nitrate, phosphate, water TOM, sediment TOM, and sediment C/N ratio. *Nostoc commune* data were identified to determine the biomass and abundance at each station. The results of the study of the abundance of *Nostoc commune* found that the first week of September and the second of September, respectively got an average of 695.1 colonies/m^2 with a biomass of 1,576.2 g and 768.9 colonies/m^2 with 1,799.7 g of biomass. *Nostoc commune* found in the rice fields is classified as abundant in each m^2.

Introduction

One of the organisms in terrestrial and aquatic ecosystems that is often found is microalgae. Microalgae are microscopic organisms, their existence is widespread in nature and can be found in all environments where there is sunlight, as well as their diverse morphologies and characteristics[1]. Microalgae are well known for their ability to fix nitrogen and survive under critical circumstances[2].

Microalgae that are often found come from the *Cyanobacteria* or *Cyanophyta* group, which are found in fresh waters. One species of *Cyanobacteria* that is often found is *Nostoc commune*[3]. *Cyanobacteria* or blue green algae are photoautotrophic microflora that play an important and dominant role in terms of total biomass and productivity in aquatic and terrestrial ecosystems[4].

Nostoc is a type of *blue green algae* and is often referred to as *Cyanophyta*, while *Nostoc commune* is a blue-algae called *Cyanobacteria*. *Nostoc commune* is often found in terrestrial and aquatic habitats. *Nostoc* has the use of binding nitrogen from the atmosphere, besides that, in Indonesia and the Philippines, *Nostoc commune* can be used as food, while in other countries such as China and Japan, it has been used as a medicinal ingredient[5].

Nostoc commune in Indonesia is still little utilized, this is because its existence is often misinterpreted as a dangerous plant, such as plants that are harmful to grass, often referred to as rice field weeds. Its presence in water also often causes unpleasant odors in the water concerned and can also damage the surrounding buildings[6]. Its existence is often used in agriculture as a biofertilizer, because it can help maintain the amount of nitrogen in the soil or substrate and can also increase plant growth[7]. The current situation of *Nostoc commune* is considered endangered because of the widespread use of herbicides, pesticides, and chlorine-containing fertilizers, which are considered important factors limiting the distribution of *Nostoc commune* in rice fields[8].

Soils enriched with phosphorus will contain more microbes than those that do not use fertilizers. The nutrients needed to support the growth of the most important microbes can be seen from the nitrogen content in it, in addition, they can be seen from phosphate compounds, and other organic matter, so that they will affect the growth of both the abundance and biomass of these plants[9]. Therefore, it is necessary to study the abundance and biomass of *Nostoc commune* growing in rice fields. This study aims to determine the abundance and biomass of *Nostoc commune* in the rice fields.

Method

This study was carried out in September 2022 at three sampling stations in the rice field area in Gilianyar, Kamal, Bangkalan. Sampling was carried out once a week for two weeks at three different stations using the *purposive sampling* method. Point 1 is a rice field plot that is growing rice; point 2 is a rice field plot with harvested rice; and point 3 is a rice field plot with harvested rice but aquatic plants. The location of the research station can be seen in Figure 1.

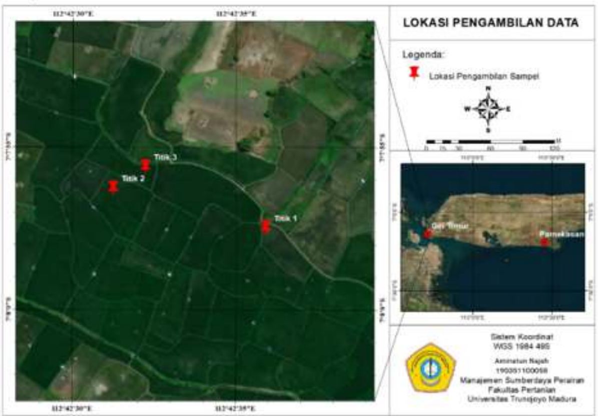

Figure 1. Location of the Research Station

Sampling

Water samples were taken at the surface in a 1 x 1 m transect line. Water sampling is done by placing water into a 1.5 liter sample bottle. Water samples are used to determine the levels of nitrate, phosphate, Total Organic Matter (TOM). Sediment samples are taken from the substrate with a thickness of 0-10 cm. Sediment samples are used to determine the levels of sediment organic matter (TOM), and the C/N ratio. Sampling of *Nostoc commune* was taken on as a whole using a 1 x 1 m line transect. Samples of *Nostoc commune* obtained to determine biomass, while the abundance of *Nostoc commune* is determined by weighing colonies at various sizes one by one, taken randomly from the population obtained, which is then leveled and calculated as the total number of colonies.

Water Quality Parameters

Water quality parameters, including physical and chemical parameters, were measured as supporting data to strengthen the abundance and biomass of *Nostoc commune*, consisting of water temperature, light intensity, water pH, sediment pH, DO (*Dissolved Oxygen*), nitrate (SNI 06-2480-1991), phosphate (SNI 06-6989.31-2005), water TOM (SNI 06-6989.3-2004), sediment TOM, and C/N ratio.

Data analysis

The research was conducted using a quantitative descriptive method that can provide an overview of the phenomena of an actual condition at this time, while the determination of sampling points was carried out using a purposive sampling method. The observation data were processed using Excel 2016 software to calculate the average value of abundance and biomass of *Nostoc commune*, water temperature, light intensity, water pH, sediment pH, DO (*Dissolved Oxygen*), nitrate, phosphate, water TOM, sediment TOM, and C/N ratio.

Results and Discussion

Abundance and Biomass of *Nostoc commune*

The percent cover and biomass abundance of *Nostoc commune* at the Gilianyar rice field side of Bangkalan, which were observed in September 2022, are presented in Table 1.

Table 1. Biomass of *Nostoc commune*

Location	Time	Point			Average (g)
		1 (gr)	2 (g)	3 (g)	
Ricefield	Week 1	1.560,3	1.555,5	1.612,8	1.576,2
	Week 2	544	2.111	2.744,3	1.799,7

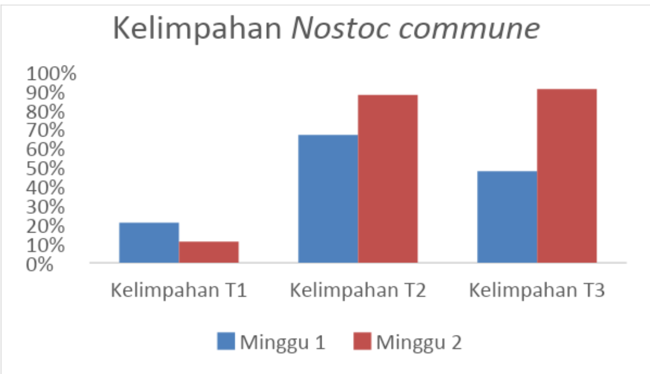

Figure 2. Abundance of *Nostoc commune*

The results of the observations in Table 1 show that the average value of *Nostoc commune* biomass in rice fields in the first week was 1,576.2 g and point 3 had the highest biomass of 1,612.8 g and the lowest at point 2 was 1,555.5 g. In the second week, the average value of biomass was higher than the first week, which got as much as 1,799.7 g with point 3 having the highest biomass of 2,744.3 g and the lowest at point 1 as much as 544 g.

The abundance of *Nostoc commune* in this study can be seen based on the percent cover of the transect at each point. The abundance of *Nostoc commune* in this rice field location in the first week at point 1 was 21% cover of *Nostoc commune* with a colony count of 759.3 colonies/m^2, while in the second week it was 11% cover of *Nostoc commune* with a colony count of 253.2 colonies/m^2, (Llamas *et al*, 2018) explains that the percent cover range of 5-25% is a relative abundance that is classified as frequent, but the species present do not share in dominance but are still significant to the abundance therein, the percent cover range of 25-50% is a relative abundance that is classified as common with dominance owned by 2 to 3 species therein, while the percent cover range of 50-100% is a relative abundance that is classified as very common characteristic by a single species and its presence is very dominant, based on previous research in this study at point 1 the percent cover range abundance of *Nostoc commune* is classified as frequent, this is because there are growing rice plants, so the presence of colonies of *Nostoc commune* is not evenly distributed and covered by rice so that it hinders photosynthesis, besides that at point 1 it is located close to rice field irrigation, where the water at point 1 is relatively easy to flow and not stagnant, so that at point 1 *Nostoc commune* is very easy to move places because it is carried away by the flow of the irrigation[10].

The abundance of *Nostoc commune* in this rice field location in the first week at point 2 was 67% cover of *Nostoc commune* with a colony count of 626.8 colonies/m^2, while in the second week it was 88% cover of *Nostoc commune* with a colony count of 941.7 colonies/m^2, based on previous research in this study at point 2 of the range of percent cover of *Nostoc commune* abundance is very common, this is because at point 2 the presence of *Nostoc commune* is very dominating and the absence of rice plants, so that the presence of *Nostoc commune* is scattered and nothing prevents *Nostoc commune* from photosynthesizing, besides that the water at point 2 is relatively stagnant so that it supports the growth of *Nostoc commune*.

The abundance of *Nostoc commune* in this rice field location in the first week at point 3 was 48% cover of *Nostoc commune* with a colony count of 669.2 colonies/m^2, while in the second week it had a much higher value of 91% cover of *Nostoc commune* with a colony count of 1,111.8 colonies/m^2, based on previous research in this study at point 3 of the range of cover percent abundance of *Nostoc commune* is classified as very common, this is because at point 3 the presence of *Nostoc commune* is very dominating and can grow well due to the absence of rice plants even though there are aquatic plants of the *apu-apu* type in it, so that the presence of *Nostoc commune* is spread and nothing prevents *Nostoc commune* from photosynthesizing, besides that the water at point 3 is relatively stagnant so that it supports the growth of *Nostoc commune.*

Figure 3. *Nostoc commune*

Nostoc commune in the rice field habitats gets different biomass and abundance results. At the location of *Nostoc commune* rice field, station 3 has the highest biomass and abundance compared to points 1 and 2. This happens because station 3 has complex nutrients and a finer substrate. Nutrient content can affect the growth of *Nostoc commune* because it is used to photosynthesize, which helps metabolic processes. Besides that, it can affect the ability of hydroxyl groups to form hydrocolloids, which are useful for texture formation. Hydrocolloid polymers are used as gelling agents, thickeners, emulsifiers, adhesives, stabilizers, and film formers[11]. Macroscopically and microscopically, the texture of *Nostoc commune* at the rice field location has a dense shape with a large number of cells, thus affecting the biomass at that location. The abundant presence of *Nostoc commune* can be used as a nitrogen fertilizer in rice fields because of its ability to contribute nitrogen needs. Microalgae culture in rice fields can contribute nitrogen needs of 16.23% - 48.71% with an abundance of 7.48 cells/ml, with nitrogen fertilizer needs of rice plants of 45 -135 kg/ha[12].

Water Quality Parameters

The results of the measurement of water quality parameters at the location of Gilianyar rice fields in Bangkalan can be seen in Table 2.

Table 2. Water Quality Parameters

Parameter	Point 1		Point 2		Point 3	
	M. 1	M. 2	M. 1	M. 2	M. 1	M. 2
Temperature (^{O}C)	26.6	27.3	30.3	24.8	33.4	26.4
Light Intensity (Lux)	1918	1642	1559	1647	1918	1642
pH Air	7.8	7.6	7.1	7.2	7.8	7.6
Sediment pH	5.8	5.8	5.2	5.8	5.8	5.8
DO (mg/L)	3.46	6.62	1.39	2.59	3.46	6.62
Nitrate (mg/L)	4.69	4.55	2.91	5.27	3.30	5.73
Phosphate (mg/L)	1.04	0.59	3.23	0.82	0.34	0.43
TOM Air (mg/L)	12.64	44.24	12.64	12.64	69.52	25.28
TOM Sedimen (mg/L)	65.95	57.84	74.05	90.27	98.37	82.16
Total N (%)	0.25	0.18	0.23	0.38	0.41	0.32
Total C (%)	2.24	1.91	2.34	2.50	2.38	2.61
C/N Ratio (%)	8.96	10.61	10.17	6.58	5.80	8.16

Water Temperature

The results of temperature measurements in Table 2 explain that the lowest temperature in the rice field location in the second week was at point 2 with a temperature value of 24.8^{O}C and the highest in the first week was at point 3 with a temperature value of 33.4^{O}C. Data collection was carried out in September during the rainy season. The difference in temperature values is thought to be due to differences in solar intensity and is influenced by the time of sampling, this causes the temperature to decrease. The optimum temperature limit for microalgae growth is around 20-30^{O}C. The optimal temperature range for microalgae growth in Lake Aur is 29^{O}C[13]. The measurement of temperature values is obtained by measuring the temperature of the water at the surface of the water at each location.

Light intensity

The results of light intensity measurements in Table 2 explain that the lowest light intensity in the rice field location in the second week was at point 1 with a light intensity value of 1559 lux and the highest in the first week was at point 1 with a light intensity value of 1918 lux. High light intensity was obtained at station 3, where data collection was carried out during the day. The difference in the value of light intensity obtained is thought to be influenced by differences in sampling time. This is because during the day, the intensity of sunlight obtained is very high, so that the sunlight that occurs is classified as being scorching during the day. The range of light intensity estimated to be suitable for microalgae growth ranges from 1000-10000 lux or equivalently to 14-140 µmol photon/m^2/second. Low sunlight intensity can affect the decrease in the abundance of microalgae, so the lower the intensity of light entering the waters, the smaller the impact on the number of microalgae found[14].

pH of Water

The results of pH measurements in Table 2 explain that the lowest pH in the rice field location in the first week was at point 2 with a pH value of 7.1 and the highest in the first week was at point 1 with a pH value of 7.8. The difference in the high and low pH values obtained is thought to be influenced by the presence of waste discharges from land, chemical industries, and fossil fuels that enter water bodies. The results of pH measurement in their research range from 7-7.6[15], while distribution of *Nostoc commune* found was associated with water sources and the pH value of the water suitable for growth was 6.2–6.3[8]. Low pH can cause hydrolytic reactions that result in disruption of metabolic processes and changes in cell components[16].

pH of Sediment

The results of sediment pH measurements in Table 2 above show that the lowest sediment pH measured in the first week of observation was at points 2 and points 3 with a sediment pH value of 5.2, while the highest value in the first and second weeks was at points 1, 2 and 3 with a sediment pH value of 5.8. The high or low pH of the sediment is thought to be influenced by substrate organic matter, substrate type, and oxygen content. The optimum value of sediment pH ranged from 6-7. This is in accordance with the research results which got the sediment pH value in their research ranging from 5.8-8.2[17]. Based on the above statement, it can be said that the pH content in the three research locations tends to be acidic. This slightly acidic pH value is due to the decomposition of litter or organic matter by soil microorganisms so as to produce organic acids that can reduce the pH value of sediment.

DO (*Dissolved Oxygen*)

The results of DO measurements in Table 2. show that the lowest DO value was obtained in the first week of measurements at point 1 with a DO value of 1.39 mg/L and the highest in the second week at point 1 with a DO value of 6.62 mg/L. The difference in the high and low DO values obtained is thought to be influenced by the increase and decrease in temperature, water fluctuations, and the activity of microorganisms in the process of decomposition of organic matter in the substrate, which also requires dissolved oxygen. This can also be seen from the pH value, which is also lower when the dissolved oxygen value is also low. The highest DO was obtained in the second week, this was due to the fact that at the time of measurement it was carried out after rain, so that it could cause the process of oxygen diffusion from the air, and the process of photosynthesis in rice plants to produce oxygen. The optimum DO for microalgae growth ranges from 1-6 mg/L. This is in accordance the DO content measured in their research ranged from 3.23 – 5.11 mg/L[15].

Nitrate

The results of Nitrate measurements in Table 2 show that the highest nitrate in the second week was at point 3 with a nitrate value of 5.73 mg/L, while the lowest value obtained in the first week was at point 2 with a nitrate value of 2.91 mg/L. The difference in the high and low nitrate values obtained is thought to be influenced by the result of the overhaul or decomposition of organic matter at the research site. The high nitrate value at point 3 is also due to the ability and abundance of *Nostoc commune* at this point, where it has been explained that *Nostoc commune* has the ability to bind nitrogen so that it can be used as a biofertilizer. The optimum nitrate content for microalgae growth ranges from 0.9-3.5 mg/L. This is in accordance with the research results of the nitrate values obtained in the study ranged from 0.06-1.51 mg/L[18], so that the nitrate content is still at the optimum limit for microalgae growth.

Phosphate

The result of the phosphate measurement is shown in Table 2. The lowest phosphate was found in the first week at point 3 with a phosphate value of 0.34 mg/L and the highest in the first week was at point 2 with a phosphate value of 3.23 mg/L. The difference in the high and low phosphate values obtained is thought to be influenced by the input of organic matter into the study site. The optimum limit for microalgae growth is the optimum phosphate content for microalgae growth range from 0.09-1.8 mg/L. This is in accordance with the research results of the phosphate values obtained in the study ranged from 0.17-0.68 mg/L[19], so that the phosphate content was quite concentrated.

TOM of Water

The results of water TOM measurements in Table 2. explain that the lowest water TOM was found in the first week and second week at points 1 and 2 with a water TOM value of 12.64 mg/L and the highest in the first week was at point 3 with a water TOM value of 69.52 mg/L. The high value of total organic matter at point 3 is in line with the high abundance of *Nostoc commune* and the high measured nitrate value as well, which will result in the high presence of the organic matter. The difference in the high and low values of water TOM obtained is thought to be influenced by plant and animal remains in the soil, so that it changes. The optimum limit for cultivation ranges from 20-30 mg/L. High TOM content in water will cause high oxygen demand (DO) to decompose the material both biologically and chemically[20].

TOM of Sediment

The results of sediment TOM measurements in Table 2. explain that the lowest sediment TOM was obtained in the second week at point 1 with a sediment TOM value of 57.84 mg/L and the highest in the first week at point 3 with a water TOM value of 98.37 mg /L. The high and low sediment TOM obtained are thought to be influenced by plant and animal remains in the soil so that they change. The optimum limit for cultivation ranges from 20-30 mg/L. Organic matter that settles a lot in the sediment is influenced by the size of sediment grains. Larger grain sizes, such as sand, greatly affect the absorption/deposition of organic matter, so the finer or softer the sediment grains the higher the organic matter content.

C/N Ratio

The results of the C/N ratio measurements in Table 2. explain that the lowest C/N ratio in the rice field area in the first week was at point 3 with a C/N ratio value of 5.8% and the highest in the second week was at point 1 with a C/N ratio value of 10.61%. The high and low C/N ratios are thought to be due to the content of nutrients in them, besides the provision of organic matter to the soil. Total N was highest in the first week at point 1 with a value of 25%, while it was lowest in the first week at point 2 with a value of 0.23%. Total C was highest in the first week of point 3 with a value of 2.38%, while the lowest was in the first week of point 2 with a value of 0.23%. The optimum limit of the C/N ratio value ranges from 20-30 which means that mineralization is balanced with immobilization. The SNI C/N ratio in the allowable compost is 10 – 20[21]. A C/N ratio value smaller than 20 indicates mineralization of the N element, if greater than 30, there is immobilization of the N element. Organic matter that has a critical value of the C/N for decomposition is below 30, above this value, the organic material will be difficult to decompose, N levels with critical levels have values ranging from 1.9% to 1.1%; below this value, immobilization will occur. Some other researchers stated that the minimum N content required for N mineralization to occur must be higher than 1.73% and the C/N ratio value lower than 20[22].

Conclusion

The abundance of *Nostoc commune* in rice fields in Gilianyar, Bangkalan in the first and second week, respectively, gets an average of 695.1 colonies/m^2 and 768.9 colonies/m^2. The biomass of *Nostoc commune* in rice fields in the first and second week, respectively, an average of 1,576.2 g and 1,799.7 g. Based on the results of water quality measurements *in site* or *ex situ*, it shows that the results of water quality measurements support the growth of *Nostoc commune*, so that it affects the abundance and biomass of *Nostoc commune*.

Acknowledgment

The author would like to thank LPPM Trunojoyo Madura University for funding independent research in 2022 on behalf of Mrs. Indah Wahyuni Abida and also the research team of Kristin Natalia Ambat, Amalia Khofifah, who have helped in this research. This research is part of a thesis entitled Abundance and Biomass of *Nostoc commune* from Different Habitats.

References

1. Sobari, R., Susanto, A. B., Susilaningsih, D., & R, D. Y. *Lipid Content of Several Types of Marine Cyanobacteria as Biodiesel Producing Sources*. **2**, 112–119 (2013).
2. Mishbach, I., Permatasari, N. S., Zainuri, M., Kusumaningrum, H. P., Science, J., Mathematics, F., Nature, P., Biology, J., Science, F., Diponegoro, U., Fisheries, F., & Diponegoro, U. *Potential of Anabaena sp . As Main Material of Bioethanol Potential of the Microalgae Anabaena sp. as Bioethanol Feedstock Indonesia is a maritime country with a wider sea area consisting of primitive algae and the Tool and Ba groups*. **07**, 69–76 (2022).
3. Prihantini Betawati, N., Wardhana, W., Hendrayanti, D., Widyawan, A., Ariyani, Y., Ronny Rianto Department of Biology, D., & Mathematics and Natural Sciences, F. Cynibacteria Biodiversity from Several Lakes/Situations in the Jakarta-Depok-Bogor Region, Indonesia.*Science Papers*, **12**, 44–54 (2008).
4. Nofdianto, N., & Tanjung, L. R. Macrophyte Population Density Affects the Abundance and Diversity of Epiphyton Microalgae in Lake Tempe.*Limnotek: Tropical Inland Waters in Indonesia*, **26**, 131–151 (2019). https://doi.org/10.14203/limnotek.v26i2.275.
5. Martinez-goss, M. R., Arguelles, E. D. L. R., Sapin, A. B., & Almeda, R. A. *Properties of the Edible*. *14*. (2021).
6. Asril, M., Ginting, M. S., Suyono, S., Arsi, A., Septariani, D. N., Risnawati, R., Joeniarti, E., Adiwena, M., Pradana, A.P., Susanti, Y., Ramdan, E.P., & Junairiah, J.. *Pengantar perlindungan tanaman*. ISBN: 978-623-342-481-3. Cetakan 1, Mei 2022. *(*Penerbit Kita Menulis*,* 2022).
7. Hendrayanti, D., Kusmadji, L. R., Yuliana, P., Amanina, M. A., & Septiani, A. Phylogeny of Indonesian Nostoc (Cyanobacteria) Isolated from Paddy Fields as Inferred from Partial Sequence of 16S rRNA Gene. *MAKARA of Science Series*, **16**, 203–208 (2013). https://doi.org/10.7454/mss.v16i3.1483.
8. Qiu, B., Liu, J., Liu, Z., & Liu, S. Distribution and ecology of the edible cyanobacterium Ge-Xian-Mi (Nostoc) in rice fields of Hefeng County in China. *Journal of Applied Phycology*, **14**, 423–429 (2002). https://doi.org/10.1023/A:1022198605743.
9. Patti, P. S., Kaya, E., & Silahooy, C. Analysis of Soil Nitrogen Status in Relation to N Uptake

by Lowland Rice Plants in Waimital Village, Kairatu District, West Seram Regency.*Agrologia*, **2**, 51–58 (2018). https://doi.org/10.30598/a.v2i1.278.

10.J.C. Emmanuel G. Llamas, L. A. B. and B. T. W. Standing-Stock Biomass And Diversity Of Caulerpa (Chlorophyta) In Solong-On, Siquijor Island, Philippines. *Scientific Journal of Science*, **18**, 86–95 (2018).

11.Herawati, H. The Potential of Hydrocolloids As Additives in Quality Food and Non-Food Products.*Journal of Agricultural Research and Development*, **37**, 17 (2018). https://doi.org/10.21082/jp3.v37n1.2018.p17-25.

12.Buyana, N., Gofar, N., & Rohim, A.M.. N Absorption in Nontidal Rice Fields Treated with Microalgae and Nitrogen Fertilizer Application. *PLANTA TROPIKA: Journal of Agro Science*, **7**, 19-25 (2019). https://doi.org/10.18196/pt.2019.089.19-25.

13.Harmoko, & Krisnawati, Y. Microalgae of the Bacillariophyta Division Found in Lake Aur, Musi Rawas Regency.*Journal of Biology Unand*, **6**, 30 (2018). https://doi.org/10.25077/jbioua.6.1.30-35.2018.

14.Silviani, O., Karyadi, B., Jumiarni, D., & Rahman Singkam, A. Study of Microalgae Diversity in Bengkulu Rivers and Lakes as Aquatic Bioindicator.*Journal of Biosilampari: Journal of Biology*, **4**, 127–138 (2022). https://doi.org/10.31540/biosilampari.v4i2.1614.

15.Gurning, L. F. P., Nuraini, R. A. T., & Suryono, S. Phytoplankton Abundance Causes Harmful Algal Bloom in Bedono Village Waters, Demak.*Journal of Marine Research*, **9**, 251–260 (2020). https://doi.org/10.14710/jmr.v9i3.27483.

16.Mardawati, E., Daulay, D. N., Wira, D. W., & Sukarminah, E. The Effect of Initial Cell and pH on Xylitol Fermentation from Oil Palm Empty Fruit Bunch. *Industria: Journal of Agro-industry Technology and Management*, **7**, 23–30 (2018). https://doi.org/10.21776/ub.industria.2018.007.01.3.

17.Permatasari, I. R., Barus, B. S., & Diansyah, G. Analysis of Nitrate and Phosphate in Sediments at the Banyuasin Estuary, Banyuasin Regency, South Sumatra Province.*Journal of Science Research*, **21**, 140 (2019). https://doi.org/10.36706/jps.v21i3.545.

18.Purnamaningtyas, S. E., & Tjahjo, D. W. H. Phytoplankton Composition and Abundance in Djuanda Reservoir, West Java.*Limnotek: Tropical Inland Waters in Indonesia*, **23**, 26–32 (2016). https://limnotek.limnologi.lipi.go.id/index.php/limnotek/article/view/126.

19.Arizuna, M., Suprapto, D., & Muskanonfola, M. R. Nitrate and Phosphate Content in Sediment Pore Water in the Wedung Demak River and Estuary.*Management of Aquatic Resources Journal (MAQUARES)*, **3**, 7–16 (2014). https://doi.org/10.14710/marj.v3i1.4281.

20.Arifin, N., Siregar, S. H., & Nasution, S. Determination of Water Quality in Physic and Chemical Use Storet Index and Pollution Index in Coastal Waters Dumai Riau Province. *Aquasains*, **8,** 743 (2019). https://doi.org/10.23960/aqs.v8i1.p743-752.

21.Erickson Sarjono Siboro, Edu Surya, & Netti Herlina. Making Liquid Fertilizer and Biogas From A Mixture Of Vegetable Waste.*USU Chemical Engineering Journal*, **2**, 40–43 (2013). https://doi.org/10.32734/jtk.v2i3.1448.

22.Dewi, E. K., Nuraini, Y., & Handayanto, E. The Benefits of Local Plant Biomass to Increase the Availability of Soil Nitrogen in the Southern Drymalang Land.*Journal of Land and Land Resources*, **1**, 17–26 (2014).