Plankton community profile in silvofishery ponds

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Abstract. The aim of research it was to analysis of the plankton community profile in silvofishery ecosystems. The research method used in this study is a descriptive method with research data collection using the concept of causal ex-pose facto design in 4 adaptive silvofishery ponds. The results showed that plankton in 4 research ponds was found in as many as 5 classes consisting of 15 genera of plankton. The plankton abundance in the ponds ranged from 2.50E+03-2.63E+06 cells/ml. The most plankton dominant was *Chlorella* sp. 2.63E+03 cell/ml and *Oschillatoria* sp. 6.33E+05 cell/ml. Plankton abundance by class was Chlorophyta 2.88E+06 cell/ml, Cyanophyta 6.83E+05 cell/ml, Dinoflagellates 1.95E+05 cell/ml, Chrysophyta 9.50E+04 cell/ml, and Protozoa 1.75E+04 cell/ml. Water quality conditions at the silvofishery pond site were pH 7.85, dissolved oxygen 12.25 mg/L, salinity 7 g/L, temperature 28.83^{0}C, nitrate 1.00 mg/L, nitrite 0.05 mg/L, ammonia 0.08 mg/L, and phosphate 0.07 mg/L, overall the water quality parameters are still following water quality standards for fish farming. The conclusion from this analysis is that the most dominant type of plankton class in this adaptive silvofishery culture is Chlorophyta with the most dominant genus *Chlorella* sp. which has an abundance level far above another genus.

1. Introduction

Silvofishery is a fish farming concept that combines mangrove ecosystems and aquaculture ecosystems in an integrated manner to minimize the number of aquaculture inputs and the impact of environmental pollution [1]. Silvofishery is widely developed in areas that have active mangrove tree habitat communities. The silvofishery advantages include an environmentally friendly cultivation system, based on mangrove conservation, and a stable level of aquaculture production [2]. Silvofishery is widely developed because it is considered more adaptive to environmental conditions in coastal areas today [3].

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Fish commodities in silvofishery ecosystem include shrimp, fish, and crabs combined with mangrove ecosystem habitats [4]. Some types of mangrove plants used for silvofishery cultivation include Rhizophora, Avicennia, Sonneratia, Bruguiera, and Xylocarpus [5]. The development of silvofishery culture which is integrated aquaculture will provide more economic benefits than conventional fish farming systems [6]. In silvofishery, several parameters need to be monitored regularly such as water quality parameters, soil quality, biological parameters and other supporting technical parameters [7]. One of the parameters that are very important and need to be observed in aquaculture activities is the presence of plankton [8].

Plankton is microscopic organisms that live floating with low movement resistance in waters [8-9]. Plankton in aquaculture are as life food and bioindicators of the aquatic environment [9]. Several plankton genera such as diatoms, green algae, and rotifers are some plankton genera that can be used as lefe food for fish [10]. Silvofishery ponds located in mangrove ecosystems allow the dominance index and abundance of plankton to occur dynamically [1]. Plankton in aquaculture ecosystems acts as buffers and indicators of aquatic ecology [11].

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2. Materials and Methods

This research implementation was conducted on silvofishery ponds in Krapyak, Pekalongan City in June-September 2023. The observed silvofishery ponds totaled 4 plots. The research was conducted with the research causal concept of *ex-pose facto* design and data collection by random sampling. The parameters observed in this study were the plankton abundance species and water quality parameters. Sampling was done every day at 10:00 for plankton samples, and at 08:00 and 16:00 for water quality samples.

2.1 Water quality

The abundance of plankton was calculated using an Olympus CX22 microscope and a NEUBEUR© hemocytometer. Furthermore, the abundance of plankton was estimated use the following formula APHA, (1998):

$$N = Z \times \frac{x}{y} \times \frac{1}{v} \quad (1)$$

Exct :
N : plankton abundance (ind/L)
Z : plankton individual number
X : Volume of sample filtered (40 ml)
Y : Volume drop water (0.06 ml)
V : Volume of water filtered (100 L)

2.2 Pond water quality parameters

The water quality parameters observed in this study included pH, dissolved oxygen, ammonium, salinity, nitrate, nitrite, phosphate, and temperature. Measurement of water quality parameters was carried out in a structured manner during the research period in silvofishery ponds.

3. Results and Discussion

3.1 Plankton Abundance

Plankton abundance by class and genus in 4 silvofishery ponds present on Table 1. Total found as many as 5 classes consisting of 15 genera of plankton in silvofishery ponds. Classes found are Chlorophyta, Cyanophyta, Dinoflagellates, Chrysophyta, and Protozoa. The plankton genus found in silvofishery pond waters is *Euplotes* sp., *Ciliata* sp., *Acantocystis* sp., *Prorocentrum* sp., *Peridinium* sp., *Noctiluca* sp., *Gymnodinium* sp., *Chryptomonas* sp., *Diploneis* sp., *Amphora* sp., *Oschillatoria* sp., *Microcystis* sp., *Chlorella* sp., *Chlamydomonas* sp., *Dicthyospaerium* sp. The plankton uniformity found in silvofishery ponds indicates the distribution of plankton genus tends to be evenly distributed. The plankton selectivity will have a major influence on the aquatic ecosystems balance [12]. The mixing of chemical elements will also affect of the plankton structure on waters [13]. The dynamics of primary productivity and changing seasons also affect to plankton structure in waters [14].

Table 1. Plankton genus in silvofishery ponds

Classes	Genus			
	Pond 1	**Pond 2**	**Pond 3**	**Pond 4**
Chlorophyta	*Chlamydomonas* sp. *Chlorella* sp.	*Dicthyospaerium* sp *Chlamydomonas* sp. *Chlorella* sp.	*Chlamydomonas* sp. *Chlorella* sp.	*Dicthyospaerium* sp *Chlamydomonas* sp. *Chlorella* sp.
Cyanophyta	*Microcystis* sp. *Oschillatoria* sp.	*Microcystis* sp. *Oschillatoria* sp.	*Microcystis* sp. *Oschillatoria* sp.	*Microcystis* sp. *Oschillatoria* sp.
Chrysophyta			*Amphora* sp. *Diploneis* sp.	*Amphora* sp.
Dinoflagellata	*Peridinium* sp.	*Gymnodinium* sp. *Noctiluca* sp. *Peridinium* sp.	*Peridinium* sp.	*Peridinium* sp. *Prorocentrum* sp. *Gymnodinium* sp. *Chryptomonas* sp.
Protozoa	*Acantocystis* sp. *Ciliata* sp.	*Euplotes* sp.		*Euplotes* sp.

3.2 Plankton Classes

Plankton classes found in silvofishery ponds are Chlorophyta, Cyanophyta, Dinoflagellates, Chrysophyta, and Protozoa. Plankton abundance ranged from 2.50E+03-2.63E+06 cell/ml (Fig 1.). Chlorophyta is a plankton class that is often found in aquaculture waters. Chlorophyta is a plankton class that is phototropic organism [15]. In sub-tropical waters, Chlorophyta can be used as a bioindicator of the aquatic environment status [16].

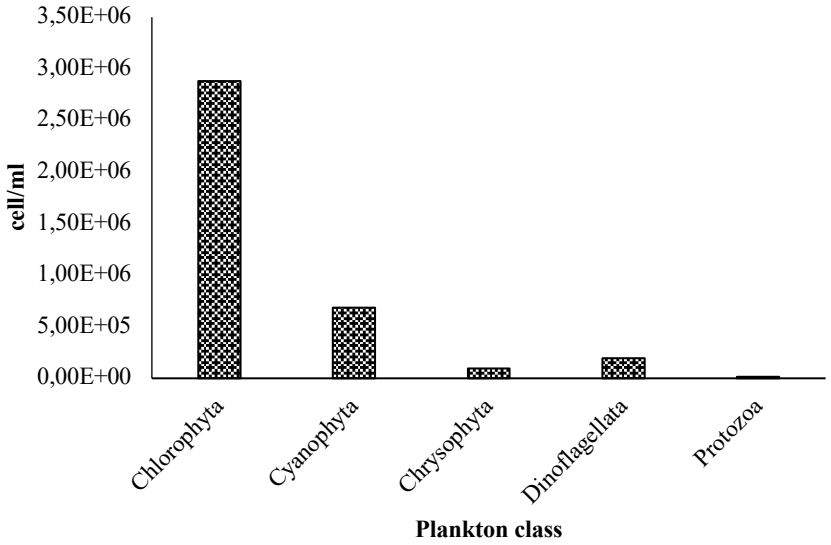

Fig. 1. Plankton class in silvofishery pond

3.3 Plankton Genus

There were 15 genera of plankton found in total community (Fig 2.). The plankton genera dominant were *Chlorella* sp. and *Oschillatoria* sp. (Fig 2.). The growth phase of *Chlorella* sp. is influenced by the nutrient abundances and the sunlight [17]. *Chlorella* sp. will grow massively during the dry [18]. Chlorophyta itself will experience an explosive increase if the presence of nutrients in the waters is abundant.

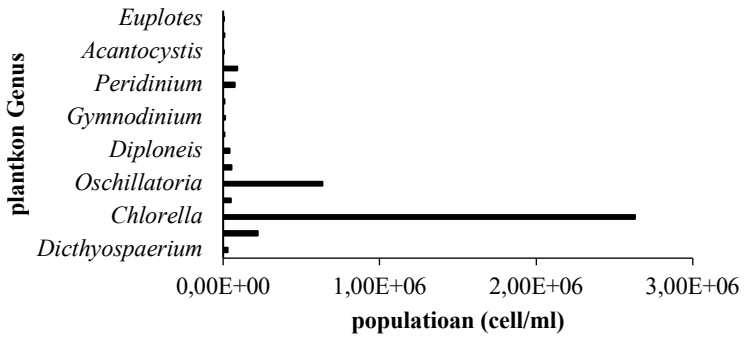

Fig. 2. Plankton genus dominance in silvofishery ecosystems

The *Chlorella* sp. abundance was 2.63E+06 cell/ml. This figure is the highest compared to the plankton abundance from other genera. *Chryptomonas* sp., *Noctiluca* sp., and *Ciliata* sp. are plankton genera with the lowest abundance of 1.00E+04 cell/ml. *Ciliata* sp. were also found here, that there is a balanced process in the grazing process of algae. The presence of *Ciliata* sp. provides an option for the assessment of a water site itself [19]. In addition, there is also *Chlamydomonas* sp. in each pond. *Ciliata* sp. in silvofishery ponds is quite a bit. Plankton development will take place dynamically and fluctuate following the presence of nutrients and light for photosynthesis [20].

3.4 The Abundance of Chlorella sp. and Chlamydomonas sp.

Chlorella sp. and *Chlamydomonas* sp. are the dominant plankton genera in silvofishery waters. A comparison of their abundance is presented in Fig 3. *Chlorella* sp. has a dominant abundance level compared to *Chlamydomonas* sp. (Fig 3.). During the dry season conditions is water temperature tends to stabilize *Chlorella* sp. will grow massively [21] *Chlamydomonas* sp. can grow well in nutrient-rich waters [22]. *Chlamydomonas* sp. will make physiological adaptations when there are extreme changes in environmental conditions [23]. In general, *Chlorella* sp. and *Chlamydomonas* sp. have the same characteristics in aquatic ecosystems.

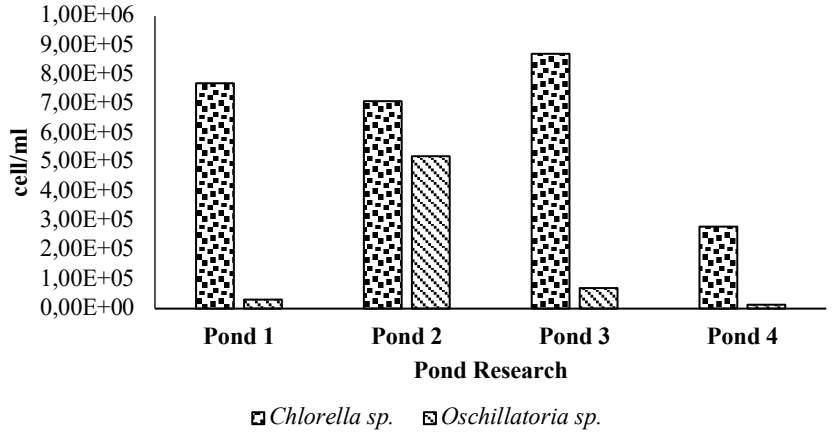

Fig. 3. Abundance of *Chlorella* sp. and *Chlamydomonas* sp.

Chlorella sp. is a single-cell alga with a size of 2-10 um [24]. *Chlorella sp.* contains proteins, carbohydrates, fatty acids, and pigments [25-26]. The Chlorophyta class dominance is also supported visually by the green water on silvofishery pond. Green aquaculture waters are good enough to be used as fish farming habitats [27]. Plankton stability in green waters tends to be more stable with moderate status. In trophic waters, the abundance of *Chlorella* sp. and *Chlamydomonas* sp. will complement each other.

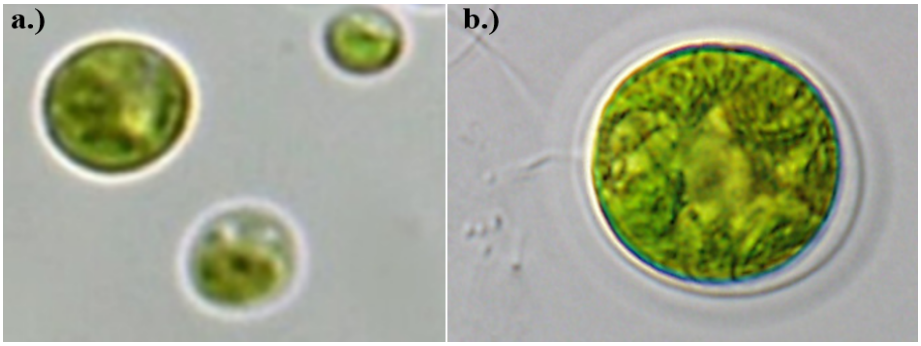

Fig. 4. Picture plankton for Microscope Olympus CX22; a.) *Chlorella* sp., b.) *Chlamydomonas* sp.

The high abundance of *Chlorella* sp. and *Chlamydomonas* sp. is evident from the visibly dense green color of the water. (Fig 5.). Green pond water has a low level of physicochemical parameters variation [28]. The waters stabilization will correlate with better aquaculture productivity [18].

Fig. 5. Picture of a.) silvofishery ponds, b.) silvofishery waters

3.5 Water Quality Parameters

Table 2 presents the water quality parameters in the silvofishery pond. According to the data, all parameters in the pond are generally favorable, except for salinity, which was measured at 7 ppt. Water quality parameters are crucial for ensuring the sustainability of aquaculture [3], as they can vary dynamically with seasonal changes and other limiting factors [29]. In this study, phosphate levels of 0.07 mg/L, ammonia 0.08 mg/L, nitrite 0.05 mg/L, and nitrate 1.00 mg/L were found to be adequate, contributing to the healthy growth of the plankton community. The stability of nutrient solubility plays a role in plankton succession and grazing processes [30].

Table 1. Water quality parameters in silvofishery ponds

Parameters	Concentrations			*Standard
	min	max	average	
Phosphate (mg/L)	0.03 (±0.23)	0.10 (±0.27)	0.07 (±0.25)	<0.10
Ammonia (mg/L)	0.01 (±0.33)	0.15 (±0.37)	0.08 (±0.35)	<0.10

Parameters	Concentrations			*Standard
	min	max	average	
Nitrite (mg/L)	0.00 (±0.42)	0.10 (±0.52)	0.05 (±0.49)	<1.00
Nitrate (mg/L)	0.50 (±0.47)	1.50 (±0.48)	1.00 (±0.47)	<1.00
Temperature (mg/L)	26.25 (±0.20)	31.40 (±0.25)	28.83 (±0.23)	24-32
Salinity (mg/L)	2.00 (±0.19)	11.00 (±0.16)	7.00 (±0.18)	25-35
Dissolved oxygen (mg/L)	4.50 (±0.22)	20.00 (±0.26)	12.25 (±0.24)	>4
pH	7.5 (±0.31)	8.2 (±0.29)	7.85 (±0.30)	7.5-8.5

**Sources:* Ariadi *et al.,* (2021)

Overall, the aquatic ecosystem in the silvofishery pond was quite good. The discovery of 5 classes (Chlorophyta, Cyanophyta, Dinoflagellates, Chrysophyta, and Protozoa) consisting of 15 plankton genera indicates a high level of plankton diversity. *Chlorella* sp. and *Chlamydomonas* sp. were the two most dominant genera. *Chlorella sp.* and *Chlamydomonas* sp. were identified as the two most dominant genera, both belonging to the Chlorophyta class, which thrive in eutrophic waters [15,31]. The stability of plankton abundance aligns with the favorable water quality conditions in silvofishery ponds. Water quality parameters play a crucial role in the dynamics of the aquatic ecosystem in ponds [21], as they significantly influence the ecosystem's carrying capacity and overall performance. In this study, we found plankton in silvofishery culture is quite diverse with the genus *Chlorella* sp. and *Chlamydomonas* sp. the most dominant compared to other genus. Overall, the silvofishery ponds found plankton from the Chlorophyta, Cyanophyta, Dinoflagellate, Chrysophyta, and Protozoa classes whose dominance was dynamic.

4. Conclusions

Plankton in silvofishery culture is quite diverse with the genus *Chlorella* sp. and *Chlamydomonas* sp. the most dominant compared to other genus. Overall, the silvofishery ponds found plankton from the Chlorophyta, Cyanophyta, Dinoflagellate, Chrysophyta, and Protozoa classes whose dominance was dynamic.

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