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The dynamic relationship of phytoplankton abundance and diversity in relation to white shrimp (*Litopenaeus vannamei*) feed consumption in intensive ponds

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Abstract. Phytoplanktons are a bioindicator that affects the productivity of white shrimp in ponds. The study was conducted in Banyuwangi from February - April 2018 using a descriptive method that observes the water chemistry data in 3 ponds (pond 1, pond 4 and pond 7). The pool area was 3500 m² with a density of 180 tails / m². The data observed included NH₄, NO₂, NO₃, PO₄ and the productivity data of the white shrimp. The best productivity of the white shrimp was in plot 4, while the lowest productivity was in pond 1 where there were stable nitrogen movement fluctuations and nitrogen content sourced from NO₃. Feed is a very important factor in the cultivation of white shrimp because it absorbs 60 - 70% of the total operational costs. The provision of appropriate feed needs will spur on the growth and development of white shrimp optimally so then productivity can be improved. The purpose of this research was to find out the correlation between the dynamics of diversity and phytoplankton abundance and the consumption level of white shrimp feed (*Litopenaeus vannamei*) in intensive ponds. This was in order to maintain the stability of the water or live media in intensive white shrimp farming.

1. Introduction

The level of plankton production in the water can be used to estimate the potential of shrimp and fish production. This includes whether the condition of the water is stable or unstable and whether or not the population of the plankton in saturated water (bloom) can be used as an indicator of biological pollution [1]. Feed is a very important factor in white shrimp cultivation because it absorbs 60 - 70% of the total operational costs. Eating according to needs will optimally increase the growth and development of white shrimp so then productivity can increase. In principle, the denser the supply of shrimp seeds means that the availability of natural food decreases and that the dependence on artificial feed is increasing. The provision of artificial feed is based on the nature and behavior of the white shrimp [2].

The problem formulation in this study was whether phytoplankton abundance and diversity affects the feed consumption in intensive systems of white shrimp; this was also the purpose of this study.



The benefit of this research was that it provided information about the influence of phytoplankton diversity and abundance on the level of feed consumption. This can be a guideline for hatchery entrepreneurs and will be added to the literature for teaching and learning purposes.

2. Materials and Method

2.1 Equipment

The measurement of the water and dissolved oxygen temperature was done using a DO meter YSI 550 A; the pH using a Senz pH pen and a pH paper range of 6.5 - 10 Merck KGaA; nitrite and nitrate using the MColorstest test kit Merck KGaA 1.14658.0001; ammonium using MColorstest Merck KGaA 1.11117.00001; phosphate using MColorstest Merck KGaA 1.14661.0001; alkalinity using the titration method based on IS: 3025 and phytoplankton using the hemocytometer.

2.2 Method of the experiment

This research methodology used a survey method or descriptive method, which is a research method aimed at describing the existing phenomena, which occurred at this point in time or in the past. The descriptive method was used in relation to the real observations and was used directly to provide information, to make comparisons or give an indication of a tendency that was marked by an increase or decrease in the ratio or proportion [3].

The main parameters of the study included the diversity and abundance of the plankton in the shrimp pond culture media and the level of feed consumption as seen from the feeding. The supporting parameters included nitrate and phosphate.

2.3 Identification of the phytoplankton

The plankton observations included the identification of diversity and the abundance in the ponds. The water quality measurements and plankton observations were carried out at 4 points in the pond section. The sampling for the plankton observation was done by taking water from the 4 ponds using a plankton net with 20-micron mesh size. This is because the size of phytoplankton (microplankton) is between 20 - 200 microns. The use of a plankton net with this mesh size means that it can filter diatom, dinoflagellate and other types of plankton types. Zooplankton can still be filtered with the plankton net. In addition, given the size of the mesh, the water can still come out past the plankton net hole [4]. The samples of water that were obtained using the plankton net were labeled with the date, sampling position, and depth of the pond.

The plankton observation was carried out every day when there was both low and high dissolved oxygen in order to determine the dynamics of plankton abundance. This is because plankton abundance fluctuates periodically, and its abundance depends on the available nutrients [5]. The sampling was conducted at 16.00 WIB. The timing was based on a survey that had previously been carried out in the pond.

2.4 Total phytoplankton

The calculation of the plankton density was done by using a hemocytometer and by using a hand counter to simplify the calculations. According to the previous study [6], the calculation of phytoplankton density was carried out using the "Small Block" method by calculating the phytoplankton cells. This started from the left side of the box to the right side of the box, counting the cells that were in the line or near the inner boundary of the box. The second step began by adding up the calculations in blocks A, B, C, D, E in the upper and lower calculation fields of the hemocytometer. After that, the final step was done by calculating the density of phytoplankton (cell / mL) by using the "Small Block" calculation formula.

The calculation conducted using the "Big Block" method involved first calculating the phytoplankton cells starting from the left side of the box to the right side of the box, counting the cells that were in the line or that were close to the boundary of the inner box. The next step was to add up the calculations in blocks A, B, C, D in the upper and lower calculation fields on the hemocytometer.

The last step was to calculate the density of the phytoplankton (cell / mL) using the calculation formula "Big Block" [7].

2.5 Feed consumption

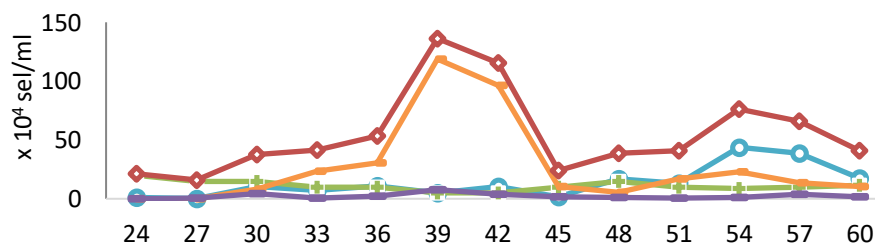
Feed consumption was the amount of feed consumed by the fish/shrimp during the study period in grams. These observations can be seen from the feeding tray at the edge of the pond. Checking the feeding tray is a combination of the amount of food commonly consumed by the shrimp in feeding tray with the time needed to spend it. Checking the feeding tray was needed to monitor the appetite of the shrimp so then their feed needs could be estimated and so there was no under feeding. The feed requirements based on this feeding tray can be cross-checked with the calculations from the data from the sampling and calculation of the shrimp's weight.

3. Results and discussion

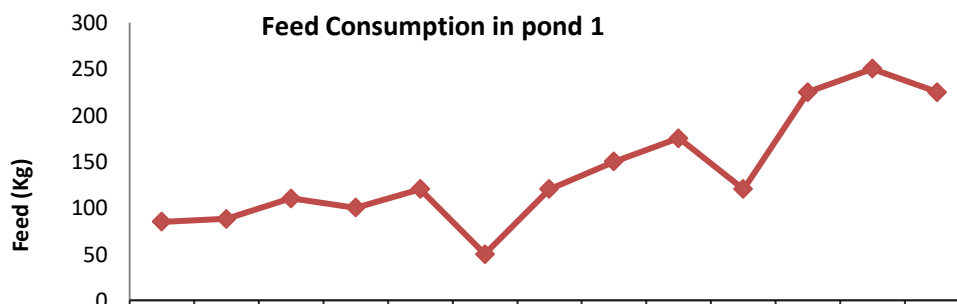
3.1 Results

The plankton abundance in pond 1 contained various kinds of plankton species with the phytoplankton dominance consisting of Chlorophyceae, Cyanophyceae, and Bacillariophyceae. In addition, Dinoflagellate was also found but did not dominate. From DOC 24 to DOC 36, the plankton density was 16×10^4 cells / mL to 53.5×10^4 cells /mL. On DOC 39 and DOC 42, the plankton density increased to 115.5×10^4 cells / mL and 136.2×10^4 cells / mL. On the 45th day, there was a decrease back down to 23.75×10^4 cells / mL, and subsequently, the density of the phytoplankton was found to be stable. This has been shown in Figure 1.

Abundance of the phytoplankton



Feed Consumption in pond 1



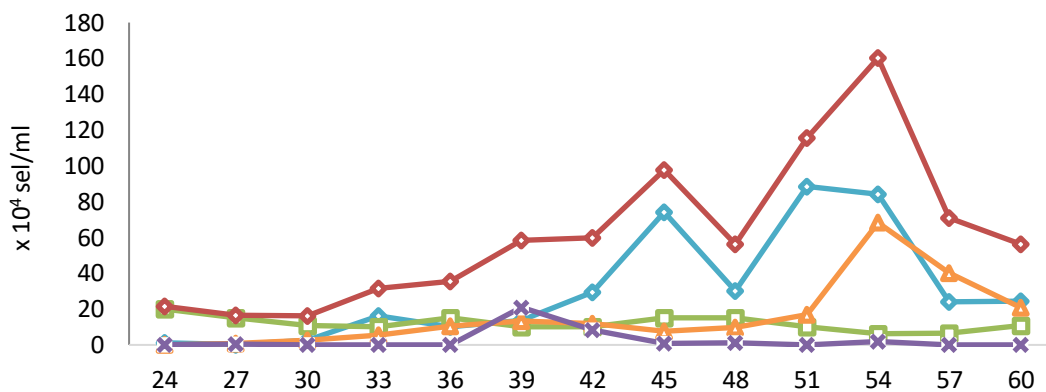
	doc 24	doc 27	doc 30	doc 33	doc 36	doc 39	doc 42	doc 45	doc 48	doc 51	doc 54	doc 57	doc 60
Feed total P1	85	88	110	100	120	50	120	150	175	120	225	250	225

Figure 1. The abundance of phytoplankton and feed consumption in pond 1

The total feed consumption from DOC 24 to DOC 36 experienced a steady increase. But on DOC 39, the feed consumption decreased quite dramatically by a total of 50 kg. Days 42 to 48 showed that the feed consumption experienced a steady increase. After that, on the 51st day, the consumption of feed decreased. On days 54 to 60, the feed consumption experienced a steady increase.

Dinoflagellates were also found but did not dominate. From DOC 24 to DOC 45, the plankton density increased but was quite stable which ranged from 16.25×10^4 cells / mL to 97.75×10^4 cells / mL. However, on day 48, the density of the phytoplankton decreased to 56.25×10^4 cells / mL. The DOC 51 and DOC 54 density increased to 115.5×10^4 cells / mL and 160.25×10^4 cells / mL. However, on the 57th and 60th days, the density of the phytoplankton again decreased to 70.75×10^4 cells/mL and 56.25×10^4 cells / mL. This data is shown in Figure 2.

Abundance of Phytoplankton in Pond 4



Feed Consumption in Pond 4

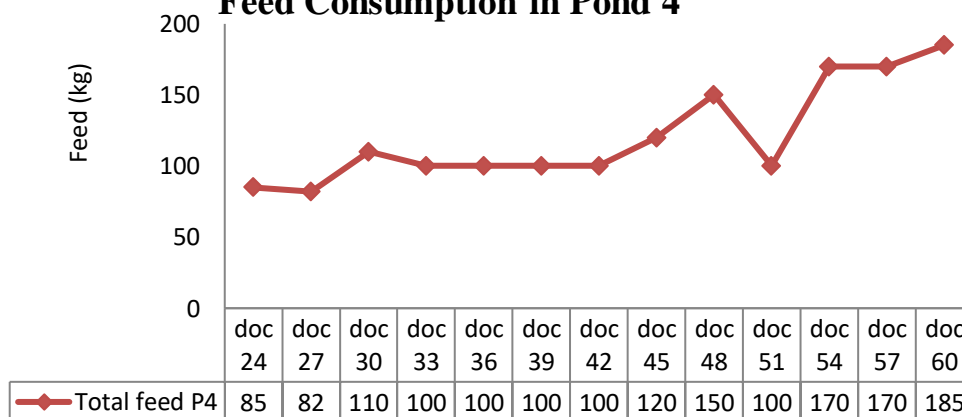


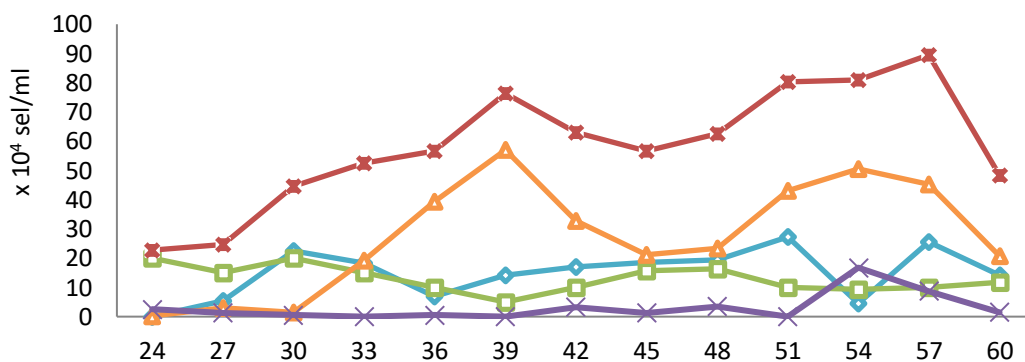
Figure 2. The abundance of phytoplankton and feed consumption in pond 4.

The density of plankton in pond 4 contains various plankton species with the phytoplankton dominance consisting of Chlorophyceae, Cyanophyceae, and Bacillariophyceae. In addition, Dinoflagellate was also found but did not dominate. The total feed consumption on DOC 24 and DOC 27 decreased slightly by 85 kg and 82 kg. Day 30 to DOC 48’s feed consumption experienced a steady

increase. After that, on the 51st day, the consumption of feed decreased. On days 54 to 60, the feed consumption experienced a steady increase.

The abundance of phytoplankton in pond 7 showed there to be various plankton species with the phytoplankton dominance consisting of Chlorophyceae, Cyanophyceae, and Bacillariophyceae. In addition, Dinoflagellate was also found but did not dominate. On DOC 24 and DOC 39, the density of the phytoplankton experienced a steady increase from 22.7 x 10⁴ cells / mL to 76.2 x 10⁴ cells / mL. On days 42 and 45, the density of the phytoplankton decreased to 63 x 10⁴ cells / mL and 56.75 x 10⁴ cells / mL. On day 48 to day 57, there was an increase in the density of the phytoplankton, which was quite stable; from 62.5 x 10⁴ cells / mL to 89.5 x 10⁴ cells / mL. However, on the 60th day, there was a decrease again, quite dramatically down to 48.25 x 10⁴ cells / mL. This data can be seen in Figure 3.

Abundance of the Phytoplankton in Pond 7



Feed Consumption in Pond 7

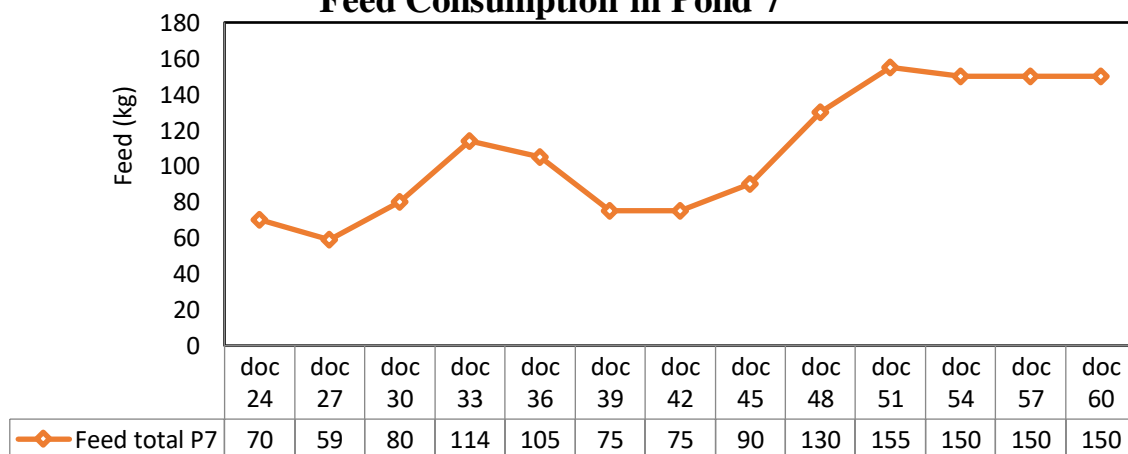


Figure 3. The abundance of phytoplankton and the feed consumption in pond 7

The total feed consumption from days 24 and 27 decreased by 70 kg and 59 kg. Day 30 and 33’s feed consumption increased by a total of 80 kg and 114 kg respectively. After that, on DOC 36 until

DOC 42, the feed consumption experienced a steady decline again. On days 45 to 60, the feed consumption experienced a steady increase.

3.2 Discussion

The drastic decline in the consumption of stubborn food on the 39th and 51st days could be anticipated due to the phytoplankton instability on that day. From the calculations of the previous day, the density of the phytoplankton experienced a change from the whole calculation. This can be expected to cause a reduction in the abundance of phytoplankton and which class dominates the waters. A decrease in the feed on DOC 39 can be seen in the phytoplankton composition on the previous day. Day 30's waters were dominated by the Chlorophyceae and Cyanophyceae classes. On day 33 and 36, diatoms dominated the waters, but the presence of Chlorophyceae and Cyanophyceae phytoplankton in the waters was still quite high. The abundance exceeded 10% of its composition in the water. In this case, the two classes still affect the water even though they do not dominate. A previous study [8] stated that a predominant genus is a genus that has an abundant composition that is $\geq 10\%$ of the total phytoplankton species. The composition was found at each observation station.

The results of pond 4 showed that there was a decrease in food on the 51st day. The conditions were also unstable due to the total phytoplankton density on day 48 and because of the Cyanophyceae phytoplankton that dominated the waters. A decrease in phytoplankton on day 48 can also result in a decrease in oxygen in the water, which can make the shrimp stressed. Environmental stress affects the immune system in shrimp and increases their susceptibility to disease. According to a previous study by [9], their main source of oxygen is photosynthesis. The high oxygen load in the water will be characterized as the high abundance of phytoplankton organisms in the water.

In pond 7, the shrimp's feed consumption on the 24th day experienced instability. From the results of the density of the phytoplankton, day 24 up to the 36th day continued to experience instability. On the 24th and 27th days, the dominant phytoplankton came from the Chlorophyceae class. On the 30th day, the Cyanophyceae and Chlorophyceae classes were dominant in the water. Bacillariophyceae, which is expected to dominate the water, was only 3.37%. As a bioindicator, the potential for diatoms is better than for other groups of organisms. Due to their wide distribution and varied populations, advantages are found in almost all of the substrate surfaces. They are capable of recording the habitat history, short life cycles and rapid reproduction, and many species are sensitive to environmental changes [10].

5. Conclusion

Based on the research into the relationship between phytoplankton diversity and abundance dynamics on the consumption level of white shrimp feed (*Litopenaeus vannamei*) in intensive ponds, the instability of abundance and phytoplankton composition can affect the health and appetite of the shrimp which can reduce the consumption of shrimp feed.

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