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Plankton Composition and Density in Cayanga River, San Fabian, Pangasinan, Philippines

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ABSTRACT

This study investigated the plankton composition and density in the three fishery structures (stationary lift net, fish pen and oyster farm) in Cayanga River, San Fabian, Pangasinan. A total of 40 taxa of plankton were identified in the Cayanga River. These were categorized into 4 major groups; diatoms, chlorophytes, dinoflagellates and zooplankton, of which the diatoms comprised the bulk of the plankton with 40%, followed both by zooplankton and chlorophytes with 23% and dinoflagellates (14%). The diatoms have significantly ($P<0.01$) obtained the highest aggregate mean density of 276,611.33 cells L^{-1}, over the dinoflagellates (150,24.89 cells L^{-1}), chlorophytes (141,78.67 cells L^{-1}) and zooplankton (17260.44 cells L^{-1}). In terms of mean density of plankton by fishing structures, the stationary lift net had the highest with 158,780.00 cells L^{-1}, followed by fish pen (49,059.00 cells L^{-1}) and oyster farm (34,467.50 cells L^{-1}) though they were not significantly different ($P>0.05$). Diatoms comprised the highest relative density with 86% (2,489,505 cells L^{-1}) and consistently dominated the other major groups of plankton in the three fishery structures.

Keywords: Plankton, composition, density, fishery structures

INTRODUCTION

Plankton growth played pivotal role in sustaining the productivity and biodiversity of a riverine ecosystem. The study of these biological components of a river is very important because they serve as a base upon which the aquatic ecosystem is supported [1]. Tropical plankton communities are highly diverse, containing organisms from almost all kingdoms, phyla and families. These organisms use their environment, its resources, and each other, in a wide variety of ways. Plankton is at the base of the system's productivity. Plankton communities are diverse and cosmopolitan in character. They are generally categorized as phytoplankton and zooplankton. Phytoplankton are the primary producers where the zooplankton grazed on them [2].

A suitable plankton community enriches the systems with oxygen through photosynthesis during day light hours and lowers the levels of carbon dioxide, ammonia, nitrite, hydrogen sulfide, methane etc. Thus, maintaining a viable population of plankton is a key factor in river's water quality management. However, the continuous utilization of an aquatic body like the Cayanga River may cause an adverse effect on the community of plankton. The irreversible effect can debilitate productivity and recovery of fish population.

Likewise, the presence of fishery structures installed in the river may reduce water flow that will result to the decrease rate of organic load flushing. Unregulated nutrient load may cause eutrophication and could increase the level of metabolites. This could greatly affect productivity of the river and essential plankton population vulnerable. However, the phenomenon is inevitable when there is high accumulation of organic load [3].

Assessment of plankton population is highly indispensable in water quality management. However, not much work has been carried out on the plankton composition and abundance in Cayanga River. This study serves as baseline information in generating the state of the river in terms of the plankton composition and density and how the presence of those fishery structures in the river affect their abundance.

MATERIALS AND METHODS

Location of the Study

The study was conducted in Cayanga River located in San Fabian, Pangasinan. The river was 6.53 km long and 140.2 m wide. The river runs from the coordinates 16°5’16.45” N and 120°24’31.27” E (Connection from Angalacan and Bued Rivers) to 16°6’43.31” N and 120°22’33.62” E (River mouth). The distances of each sampling stations from each other were N 16.112120 E 120.377140 (Stationary lift net), 808 meters N 16.110160 E 120.384320 from the Stationary lift net to the fish pen and 1.16 kilometer N 16.110030 E 120.395360 from the fish pen to the Oyster farm.

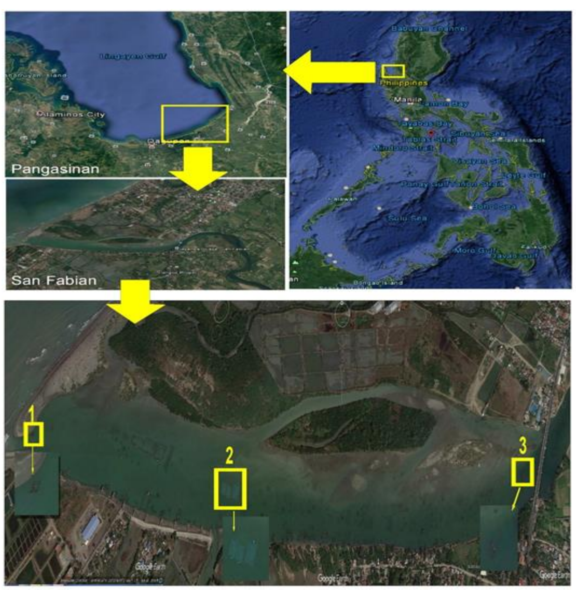

Figure 1. Map showing the location of the study in Cayanga river, San Fabian, Pangasinan

Collection of Plankton Samples

Plankton net having a mouth diameter of 29.5 cm and mesh size of 40 microns was used in collecting water samples for plankton analysis. Collection of water samples are via vertical tow method. A plankton net that is fitted with a stopcock at the lower end to allow opening and closing. The net was lowered according to the measured depth of the sampling stations, approximately about 1-5 meters above the bottom and was allowed it to settle for 15-30 seconds and was then pulled it slowly to the surface in a zigzag manner. The stop cock mouth was positioned into a clean sample-collecting bottle and drained the sample. To produce an adequate sample the process was repeated for three times. Samples were placed in a clean sample bottles and each sample bottle contains 1-2 mL of buffered formalin solution to preserve the samples. The samples were stored in a well-ventilated room at temperature less than 25˚C and labeled with the date, time and location of collection.

Species Identification

Species of plankton present in different stations with variations in sampling period were identified through microscopic analysis using research microscope at 100x magnification and Sedgewick rafter (glass slide) which was conducted at the Natural Food and Biology laboratory of BFAR-NIFTDC.

Volume of samples was measured using the graduated cylinder. The samples were placed in 200 ml beaker, using the 1 ml dropper the specimens or samples were transferred to the Sedgewick rafter and placed it in the mechanical stage with slide holder of microscope.

Classification and identification of plankton were undertaken based on the plankton guides [4-6] and were categorized into phytoplankton (major groups: diatoms, chlorophytes and dinoflagellates) and zooplankton.

Treatment of Data

Data on plankton density were presented in tabular and graphical form. Significant differences among sampling stations and sampling months were determined using two-way analysis of variance.

RESULTS AND DISCUSSION

Plankton Composition

The plankton composition from the three (3) fishery structures; stationary lift net, fish pen and oyster farm is composed of four (4) major groups namely; diatoms, chlorophytes, dinoflagellates and zooplankton. A total of 40 genera of plankton were collected and identified plus 3 unidentified zooplankton in the three fishery structures of which the diatoms comprised the bulk of the plankton with 40%, followed both by zooplankton and chlorophytes with 23% and dinoflagellates (14%) (Figure 2).

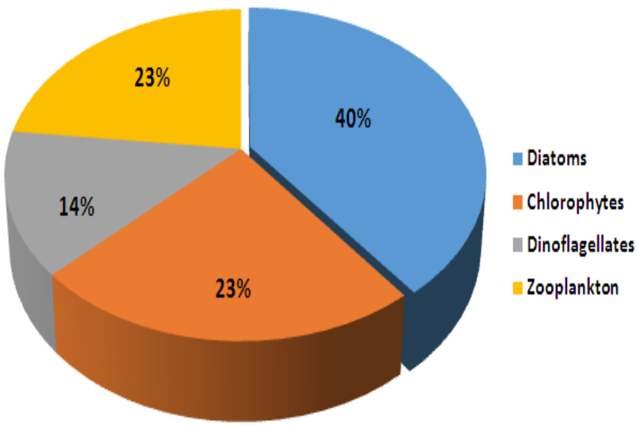

Figure 2. Percentage composition of plankton groups from the three fishery structures

Of the 40 genera of plankton collected, 33 were phytoplankton while the remaining 7 were zooplankton. The diatoms have the highest number with 17, namely; *Amphora sp., Asterionella sp., Bacteriastirum sp., Biddulphia sp., Chaetoceros sp., Cerianthus sp., Coscinodiscus sp., Cyclotella sp., Ditylum sp., Diploneis sp., Navicula sp., Nitzschia sp., Pinnularia sp., Stephanopyxis sp., Thalassionema sp., Thalassiosira sp.,* and *Thalassiotarix sp*. The zooplankton group is composed holoplankton and meroplankton. The holoplankton has 7 genera namely; *Acartia sp., Balanus sp., Brachionus sp., Calanus sp., Microselella sp.*, *Oithana sp*. and *Paraculans sp*., while the meroplankton has 3, namely; polychate larvae, veliger and fish larvae. For the chlorophytes, 10 genera were identified, namely; *Chlorella sp., Chodatella sp., Dictyosphaerium sp., Grossleria sp., Guinardia sp., Oocystis sp., Pediatrium sp., Planktonella sp.,* and *Rhizosolenia sp*. The least group which are the dinoflagellates have 7 genera, namely; *Ulothrix sp., Ceratium sp., Dinophysis sp., Peridinium sp., Prorocentrum sp., Pyrophacus sp.* and *Triceratium sp.* (Table 1).

Four (4) genera of diatoms were present in the 3 fishery structures for the whole sampling months, namely: *Biddulphia sp., Chaetoceros sp., Coscinodiscus sp.,* and *Thalassionema sp*. For the chlorophytes, only *Rhizosolenia sp*. appeared consistently in the 3 fishery structures for the duration of the study. Likewise, the copepod *Acartia sp*. was the only zooplankton that emerged in the 3 fishery structures for the whole sampling periods. None of the genera of dinoflagellates that appeared consistently in the 3 fishery structures for the whole study periods.

The result of this study differed to the findings of Galinato and Evangelio (2016) where they collected 58 genera of phytoplankton and 7 genera of zooplankton during the dry season in the Banahao-Palhi river in Leyte, Philippines [7]. During the wet season, the number of genera of phytoplankton increased to 68 while the zooplankton was down to 5 genera in the same river. In Mainit Lake in Mindanao there were 26 species of phytoplankton recorded of which 9 species were diatoms, 9 chlorophytes, 4 cyanophyes, 2 dinoflagellates, and 1 species of euglenophyte [8]. Conversely, only 18 genera of phytoplankton were reported of which 11 were dinoflagellates and 7 were diatoms in the mangrove estuary in Tubajon, Philippines [9]. Elsewhere, 61 phytoplankton species representing 37 genera that belong to diatoms (44 species), dinoflagellates (15 species), and cyanobacteria (2 species) were observed in a mangrove estuary in Panguil Bay [10]. In the southern part of Luzon, 115 phytoplankton species belonging to four major groups (Bacillariophyceae: 72 species, Dinophyceae: 41 species, Dictyochophyceae: 1 species, and Cyanophyceae: 1 species) in the waters of Casiguran, Aurora Province were observed [11]. A total of 60 zooplankton taxa belonging to 9 major groups (Protozoa, Cnidarian, Annelida, Chaetognatha, Protochordata, Arthropoda, Mollusca, Echinodermata and Chordata) were also identified in San Ildefonso Cape, Casiguran, Aurora Province by the same author [12]. In Lake Taal, few species of zooplankton were identified; 15 species of rotifers, 6 cladocerans, and 3 copepods [13].

Table 1. Plankton composition in the three fishery structures in Cayanga River, San Fabian, Pangasinan from October to December 2016.

	Genera	Stationary lift net			Fish Pen			Oyster Farm		
		Oct	Nov	Dec	Oct	Nov	Dec	Oct	Nov	Dec
	Diatoms									
1	*Amphora sp.*								■	
2	*Asterionella sp.*	■					■		■	
3	*Bacteriastirum sp.*	■	■	■	■	■			■	
4	*Biddulphia sp.*	■	■	■	■	■	■	■	■	■
5	*Chaetoceros sp.*	■	■	■	■	■	■	■	■	■
6	*Cerianthus sp.*						■			■
7	*Coscinodiscus sp.*	■	■	■	■	■	■	■	■	■
8	*Cyclotella sp.*	■								
9	*Ditylum sp.*	■	■		■			■	■	
10	*Diploneis sp.*	■				■				
11	*Navicula sp.*		■	■		■	■	■		
12	*Nitzschia sp.*	■	■	■	■	■		■	■	■
13	*Pinnularia sp.*					■				
14	*Stephanopyxis sp.*		■						■	
15	*Thalassionema sp.*	■	■	■	■	■	■	■	■	■
16	*Thalassiosira sp.*			■			■			■
17	*Thalassiotarix sp.*		■						■	
	Chlorophytes									
18	*Chlorella sp.*			■						
19	*Chodatella sp.*	■			■	■		■		
20	*Dictyosphaerium sp.*							■		
21	*Grossleria sp.*									■
22	*Guinardia sp.*	■								
23	*Oocystis sp.*	■				■				
24	*Pediastrium sp.*	■			■	■		■	■	■
25	*Planktonella sp.*		■	■	■	■		■	■	■
26	*Rhizosolenia sp.*	■	■	■	■	■	■	■	■	■
	Dinoflagellates									
27	*Ulothrix sp.*	■			■	■		■		
28	*Ceratium sp.*	■	■	■		■	■		■	
29	*Dinophysis sp.*	■	■	■	■	■		■		
30	*Peridinium sp.*	■	■	■		■		■	■	
31	*Prorocentrum sp.*		■							
32	*Pyrophacus sp.*		■	■		■	■			
33	*Triceratium sp.*	■	■		■			■		
	Zooplankton									
34	*Acartia sp.*	■	■	■	■	■	■	■	■	■
35	*Balanus sp.*						■			
36	*Brachionus sp.*	■	■		■		■	■	■	■
37	*Calanus sp.*	■				■	■	■		
38	*Microseiella sp.*							■	■	
39	*Oithana sp.*						■			■
40	*Paraculans sp.*						■			■
41	*Fish larvae*					■	■			■
42	*Polychaete larvae*					■	■			■
43	*Veliger*		■	■			■	■	■	■

Mean Density

The mean density of plankton varied by major groups. The diatoms significantly (P<0.01) obtained the highest aggregate mean density of 276,611.33 cells L^{-1}, followed by zooplankton (17260.44 cells L^{-1}), dinoflagellates (150,24.89 cells L^{-1}), and chlorophytes (141,78.67 cells L^{-1}). In terms of mean density of plankton by fishing structures, the stationary lift net had the highest with 158,780.00 cells L^{-1}, followed by fish pen (49,059.00 cells L^{-1}) and oyster farm (34,467.50 cells L^{-1}), though they were not significantly different (P>0.05).

The discrepancy of mean density of plankton by major groups can be visualized in Figure 3. The mean density of the diatoms has a clear edge compared to the plankton groups. Diatoms were abundant in the stationary lift net over 500,000 cells L^{-1} as compared to the fish pen and oyster farm where mean density was below 200,000 cells L^{-1}.

The mean density of plankton obtained from this study was higher from the finding of a study done in Alinsaog River in Zambales, Central Luzon where the researchers collected fewer plankton [14]; diatoms (21.25 cells L^{-1}), chlorophytes (0.28 cells L^{-1}), dinoflagellates (303,697.92 cells L^{-1}) during the dry season. In the wet season, diatoms registered 40.97 cells L^{-1} followed by chlorophytes (5.69 cells L^{-1}), and cyanophytes (0.28 cells L^{-1}). The high density of dinoflagellates (*Peridinium sp*.) was attributed to increased phosphate concentrations in the river during the wet season. In like manner, lower density of plankton were observed in Banahao-Palhi River in Leyte where diatoms listed 2569 individuals m^3, followed by chlorophytes (1300 ind. m^3), Chrysophytes (8 ind. m^3) and cyanophytes (221 ind. m^3) [7]. In the case of zooplankton, cyclopoida registered the highest density of 5.20 ind. m^3. In Mainit Lake, the diatoms dominated the phytoplankton group with 2737 cells ml^{-1} while the dinoflagellates recorded 217 cells ml^{-1} [8].

The closeness of the three fishery structures sites may have influenced the insignificant effect on the density of plankton. Besides, since the river is a lotic environment, the constant flow of water may have distributed evenly the nutrients for the growth of plankton. It was suggested that the nutrients may influence the abundance of plankton [15]. The dominance of diatoms may be attributed to the nutrients in the river. In similar manner, higher concentrations of diatoms in some of the estuaries in Brazil where increased nutrients such as phosphorus and inorganic nitrogen were observed [16]. Besides, diatoms are predominantly found in the shallow waters like the rivers owing to their size and sinking rate [17]. Likewise, the alkaline conditions of the river might influence the abundance of diatoms [18].

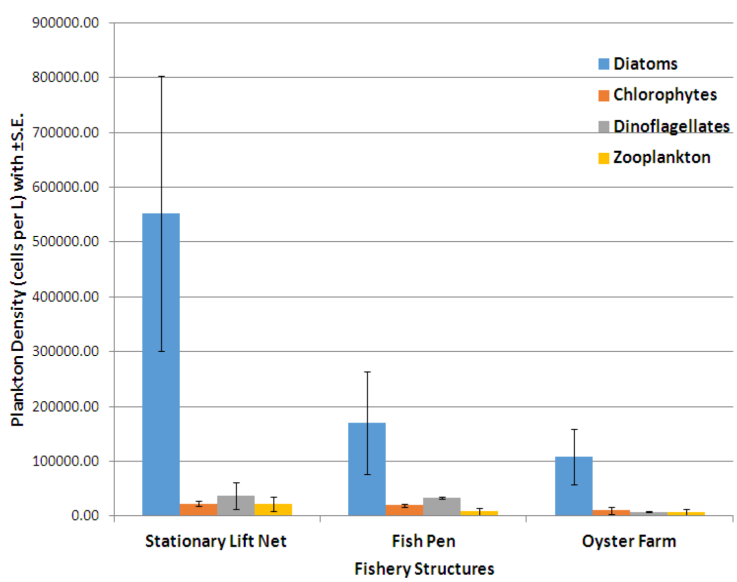

Figure 3. Mean Density (cells L^{-1}) of major plankton groups in the three fishery structures in Cayanga River, San Fabian, Pangasinan.

Relative Density

The aggregate density of plankton found in the three fishery structures in Cayanga river, San Fabian, Pangasinan from October to December, 2016 totaled to 2,907,678 cells L^{-1} (Figure 4). Of these numbers, diatoms comprised the highest relative density with 86% translating to 2,489,505 cells L^{-1} followed by zooplankton with 5.34% (155345 cells L^{-1}), dinoflagellates with 4.65% (135,224 cells L^{-1}) and chlorophytes with 4.39% (127,605 cells L^{-1}).

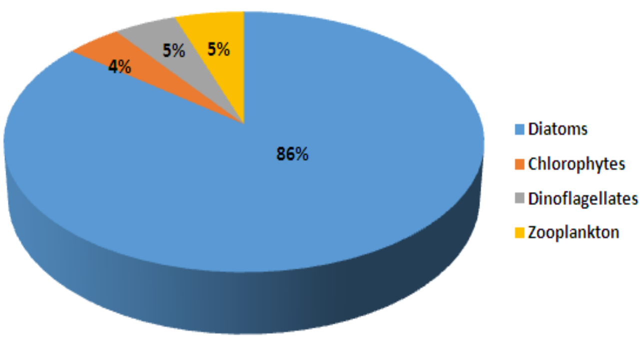

Figure 4. Relative Density (%) of major plankton groups found in the fishery structures in Cayanga river, San Fabian, Pangasinan from October to December, 2016.

With regards to the relative density of plankton by fishery structures (Figure 5), the diatoms dominated the groups in the whole fishery structures; 86.93% (1,656,297 cells L^{-1}), 86.49% (509,163 cells L^{-1}) and 78.35% (324,044 cells L^{-1}) for stationary lift net, fish pen and oyster farm, respectively. The zooplankton obtained its highest relative density in the oyster farm with 10.86% (44,904 cells L^{-1}), and recorded 7.12% (41,942 cells L^{-1}) and 3.60% (68,499 cells L^{-1}) in the fish pen and stationary lift net, respectively. Likewise, the chlorophytes attained its highest relative density of 9.69% (40,063) in the oyster farm and got a lower relative density of 3.64% (69,276 cells L^{-1}) and 3.10% (18,266 cells L^{-1}). In the case of the dinoflagellates, its highest relative density was obtained at the stationary lift net with 5.84% (111,288 cells L^{-1}). Lower relative densities were observed at fish pen and oyster farm with 3.28% (19,337 cells L^{-1}) and 1.11% (4,599 cells L^{-1}), respectively.

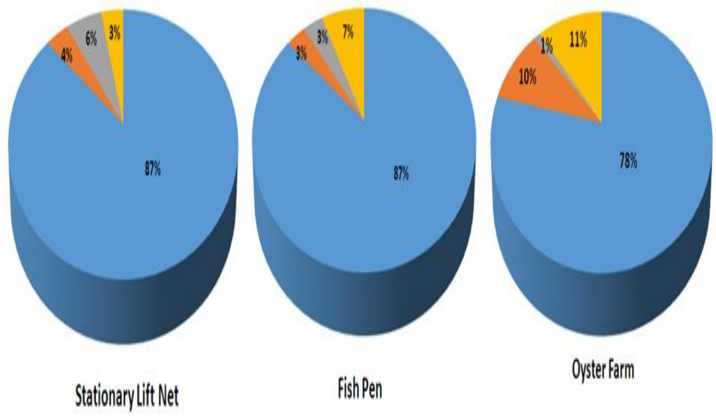

Figure 5. Relative Density (%) of major plankton groups by fishery structures.

The abundance of diatoms in the different aquatic bodies was supported by several studies. The team of Angara et al. (2013) [12] disclosed abundance of diatoms in the Casiguran waters in Aurora registering a whopping 90% while the other groups; Dinophyceae, Dictyochophyceae and Cyanophyceae obtained a lower relative abundance (< 23 %). In Paoay lake, rotifers Rotifers were the most abundant of the 3 zooplankton groups comprising 61.90% of the total number of organisms, followed by the cladocerans at 22.39% and Copepoda with 15.71% [19]. Comparing phytoplankton density between aquaculture sites and non-aquaculture sites, it was revealed that there is significant density of phytoplankton in the aquaculture sites [20]. For the zooplankton, in a study in Taal Lake, the researchers obtained higher zooplankton biomass in intensive fish cage aquaculture area with 490.7 ind./L over open water with no aquaculture (341.4 ind./L) [21]. In Mainit lake, both diatoms and chlorophytes dominated the phytoplankton with 31% each while cyanophytes had 14% followed by dinoflagellates (7%), euglenophytes (3%) and unidentified species (14%) [8].

With respect to the relative density of plankton groups by sampling months (Figure 6), the diatoms again got the sizable share with 89.68% (1,256,888 cells L^{-1}) in October, 83.59% (1,003,468 cells L^{-1}) in November and 74.98% (229,146 cells L^{-1}) in December. The zooplankton gained its highest relative density of 16.17% (49,417 cells L^{-1}) in December and registered a lower relative density of 4.40% (61,612 cells L^{-1}) and 3.69% (44,315 cells L^{-1}) in October and November, respectively. In the case of the dinoflagellates, its highest relative density was observed during the month of November with 7.71% (92,585 cells L^{-1}) and its lowest was in the month of October with 2.31% (32,388 cells L^{-1}). The chlorophytes registered its highest relative density of 5.50 during the month of December with 5.50% (16,797 cells L^{-1}) and the lowest in October with 3.62% (50,697 cells L^{-1}).

The findings of this study showed that there was a decreasing trend on the relative density of diatoms at the onset of northeast monsoon. The decreasing trend may be attributed to nutrients availability during this period. The group of Canini et al. [10] observed the peak abundance of centric diatom (*Coscinodiscus wailesii*) during southwest monsoon (August) while dinoflagellate (*Ceratium furca*) peaked during northeast monsoon (February). Likewise, researchers investigated the phytoplankton density in Manila bay and revealed that their peak occurred during southwest monsoons while the dinoflagellates and blue-green algae were abundant during trade winds [22]. For the zooplankton, it was disclosed that the abundance of zooplankton dominated by copepods during the months of May, July and November and their abundance is associated with nutrient-rich waters [15]. Temporal abundance of phytoplankton in Mohicap lake in Laguna showed that the diatoms and cyanophytes co-dominated during rainy seasons (June-November), diatoms, cyanophytes and chlorophytes in cool dry season (December to February) and diatoms and cyanophytes during hot dry season (March to May) [23].

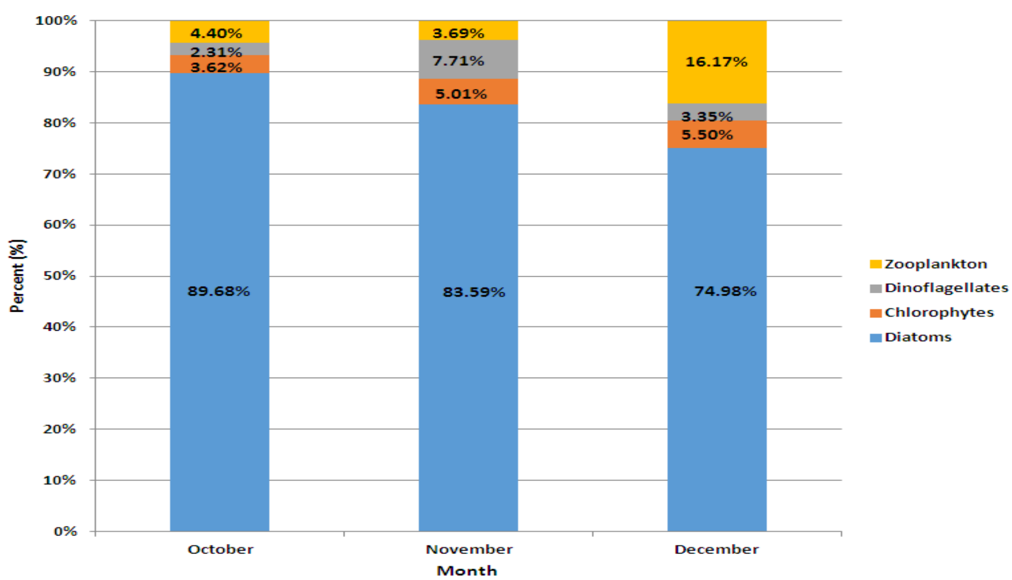

Figure 6. Relative Density (%) of major plankton groups by sampling months.

CONCLUSIONS

1. There were 40 taxa of plankton found in the fishery structures in Cayanga river, San Fabian, Pangasinan;
2. Diatoms are the most abundant group of plankton in the Cayanga river, San Fabian, Pangasinan; and
3. Plankton density was comparable among fishery structures and sampling months.

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