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Impact of Abattoir Wastes on the Abundance of Plankton in Woji Creek Portharcourt Rivers State

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Abstract:- This study was carried out between June 2019 and January 2020 within which plankton samples were collected in the wet and dry seasons, for four months and across four stations of the Creek. Samples for Phytoplankton analysis were collected by obtaining 1litre of the water sample fetched 5 cm below the surface at each sampling station. Whereas samples for Zooplankton analysis were obtained by straining 50 liters of water through a plankton net of (55 µm). both samples for Phytoplankton and Zooplankton analysis were preserved with 4% formalin in which a few drops of Rose Bengal stain had been added. Measurement, Identification, and Counting of plankton species were carried out in the laboratory using standard methods, equipment, and checklists. A total of 16 species of Phytoplankton belonging to 4 classes and 21 species of Zooplankton belonging to 7 classes were encountered and identified during the study periods for all stations, months, and seasons. The result shows that *BACILLARIOPHYCEAE* was the most abundant Phytoplankton class with a percentage composition of 42% and 44% in wet and dry seasons respectively. Whereas, *CHLOROPHYCEAE* and *CYANOPHYCEAE* had a percentage composition of 37% and 15% for the wet season and 24% and 17% for the dry season. *EUGLENOPHYCEAE* had the lowest percentage of 6% and 15% for wet and dry seasons respectively. *Crucigenia sp* (25±15) were the most abundant Phytoplankton species in Station 1. For Station 2, the most abundant species observed were *Melosira varians* (25±19), whereas *Melosira radiate* was the most abundant species observed in Station 3 (35±29) and Station 4 (37±31). There was no significant difference (p>0.05) in the spatial variation of different species of Phytoplankton. For Zooplankton species, COPEPODA were the most abundant Zooplankton class with a percentage composition of 60.2% and 39.5% for wet and dry season respectively. PROTOZOA, CLADOCERA, and ROTIFERA had a percentage composition of 19.7%, 6.8%, and 10.3% for the wet season and 22.9%, 12.7%, and 11.9% for the dry season respectively. The least abundant class was CRUSTACEA with 0.2% in the wet season and INSECTA with 1.2% in the dry season. *Centropages typicus* (27±22) were the most abundant Zooplankton species in Station 1. For Station 2, the most abundant species observed were *Anomalocera patersoni* (10±6) whereas *Eucyclops serrulatus* were the most abundant species observed in Station 3 (27±24) and Station 4 (45±37). There was no significant difference (p>0.05) in the spatial variation of the different species of Zooplankton. The study showed that the discharge of abattoir wastes into Woji Creek resulted in an increase in the abundance of Phytoplankton especially those of algal origin which are pollution bio-indicators thereby causing eutrophication of the waterbody, the study also showed seasonal implications to the abundance of the plankton species.

Keywords:- *Phytoplankton, Zooplankton, Abattoir Wastes, and Creek.*

I. INTRODUCTION

Livestock production is regarded as a potential source of food for the world's burgeoning population. When slaughter wastes are not properly managed and, in particular, discharged into waterways, it becomes a major pollutant of the countryside and cities, as such practices can introduce enteric pathogens and excess nutrients into surface water (Alonge, 1991; Meadows, 1995). Abattoir wastes, which are frequently separated into solid, liquid, and fats, could be highly organic. Condensed meat, undigested ingest, bones, hairs, and aborted fetuses make up the solid portion of the wastes. The liquid component, on the other hand, is made up of dissolved solids, blood, gut contents, urine, and water, whereas fat waste is made up of fat and oil. Pollution of water resources frequently results in the destruction of primary producers, which has an immediate negative impact on fish yields Aina and Adedipe (1991). Plankton (phytoplankton and zooplankton) in the marine ecosystem play an important role for humans in terms of fish production and aquatic environmental health as pollution indicators (Ukaonu et al.,2015). The presence of adult and developmental stages of planktonic organisms in any body of water indicates that the environment is suitable for aquatic life. Zooplankton feeds on primary producers (Phytoplankton) and organic debris in the water, playing an important role in the trophic relationship in the ecosystem (Kigbu et al., 2015, Ovie et al., 2015). The interaction of phytoplankton and zooplankton in the aquatic ecosystem is linked to fisheries, either directly or indirectly (Wiafe and Frid, 2001, Ukaonu et al., 2015). Their abundance can have a negative impact on future fish stocks by preying on the eggs and larvae of predators such as salps, medusa, and ctenophores (fish, eggs, and larva). These organisms serve as food sources for organisms at higher trophic levels, making them useful indicators of water quality and fisheries' health (Davies et al., 2008). Some indices that can be used to assess the biological status of an aquatic system include species composition, abundance, distribution, and diversity of plankton (Izonfou and Bariweni, 2001, Ukanonu et al., 2015). According to Dejen et al. (2004) and Ezekiel et al. (2011),

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zooplankton plays an important role in regulating microbial and algal productivity in aquatic ecosystems through their grazing effect, transferring productivity to fish and other aquatic organisms. Zooplankton, particularly copepods, are used as indicators in the biological monitoring of pollution in aquatic ecosystems (Davies et al., 2008, Ukaonu et al., 2015). Zooplankton migrates upward from the deeper strata at night and backs down at dawn. Changes in the physicochemical parameters of the aquatic environment, particularly turbidity (which limits phytoplankton production, causing zooplankton to deepen), and river flow can have an impact on zooplankton population and distribution (Ajuonuet al., 2011, Kigbuet al., 2015, Ukaonu et al., 2015). Climate change and anthropogenic activities such as pollution and fishing operations have an impact on the species, biomass, abundance, spatial and temporal distribution of aquatic organisms, all of which are indicators of the environmental health or biological integrity of water bodies (Ukaonu et al., 2015). According to research, there is a close relationship between water quality and the composition and abundance of plankton in any aquatic system. Several studies on plankton in various water bodies in Nigeria have been conducted over the years, with a focus on the species composition and phytoplankton checklist. To name a few, Nwankwo et al. (2003), Ekwu and Sikoki (2006), Onuoha et al. (2010), Francis and Ikpewe (2012), Ekwu and Udo (2013), and Kigbuet al. (2015).

II. STUDY AREA

Port Harcourt is in the southernmost section of Nigeria, east of the Niger Delta, and lies between longitude 6°07'E and latitude 4°44'N on the Equator. It has a flat topography and sits at a height of around 5 meters above sea level Obi and Ibe (2011). This plain is well-drained, with a great number of creeks and channels connecting it to the sea (Gulf of Guinea).

The Port Harcourt Metropolis is drained by numerous streams that join multiple rivers that lead to the sea. The climate in Port Harcourt is classified as sub-equatorial. Throughout the year, the temperature and humidity are high. The region's weather and climate reveal a mean annual temperature of 28°C, with an annual range of 38°C, and average humidity of 85 percent. Rainfall in Port Harcourt follows a double maxima pattern, with July and September being the wettest months. The highest monthly rainfall totals were 3496.1mm and 3578.4mm in July and August, respectively Umunnakwe *et al* (2009). The area is characterized by two distinct seasons: wet and dry, with 70 percent of yearly precipitation occurring between April and August and 22 percent falling between September and November. December to February are the driest months Obi and Ibe (2011). The soil type is primarily poorly drained silt (clay mixed with sand) that belongs to the Benin formation geologically. The city was founded in 1912, and it now has two local government areas: the Port Harcourt city local government and the Obio Akpor local government councils. The oil and gas industry in Nigeria is centered in Port Harcourt, the capital city government of Rivers State. Drill cuttings, fluids, lubrication oil, paper printer cartridges, food waste, batteries, tires, related gas, scrap metals, and other solid, liquid, and gaseous waste are all generated by these oil firms, contributing to the city's ever-increasing waste load. The peculiarity of the terrain in which Port Harcourt is located is one of the most outstanding qualities of the region. According to Umunnakwe *et al* (2009), the area's drainage is poor, owing to a combination of low relief, high water tables, and excessive rainfall. The region's low relief results in remarkably soft slopes, which tend to keep river flow velocities modest. As a result of this condition, well-developed river meanders emerge. Obi and Ibe (2011) claim that With an average width of 0.5km, the Bonny River is the largest in the area.

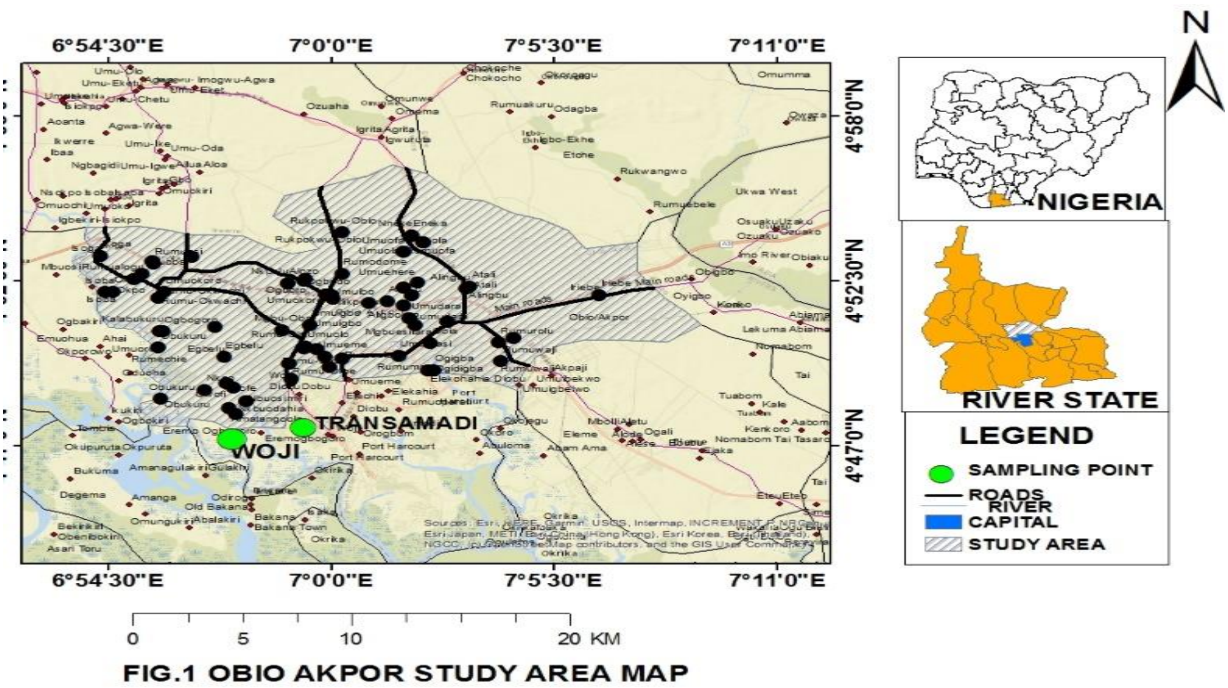

Fig 1 Map of the study Area

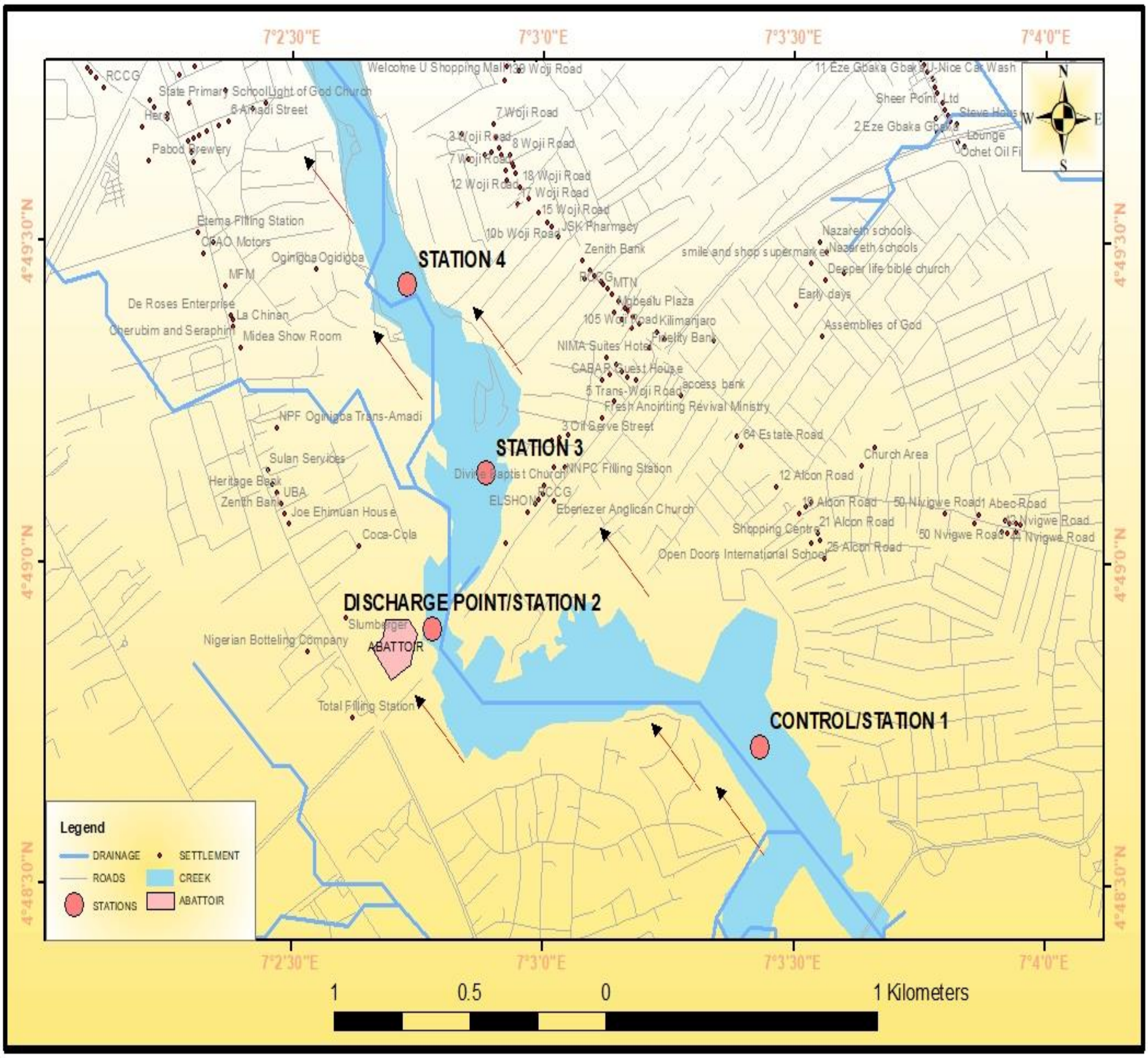

Fig 2 Map showing the sampling points in the study Area

III. METHODOLOGY

➢ *Sample collection, preservation, and measurement.*

Phytoplankton samples were collected by obtaining 1litre of the water sample, fetched 5cm below the surface at each sampling station. The samples were preserved with 4% formalin to which a few drops of Rose Bengal stain had been added, the samples were allowed to stand for 48 hours in the laboratory before decanting the supernatant to concentrate the sample. The concentrated sample was agitated to homogenize. 1ml of Subsamples from the concentrated supernatant was collected with a sample pipette the content was placed in a Sedgwick-rafter counting chamber and examined with Leitz Wetzlar microscope for identification and counting using appropriate keys and checklists.

Zooplankton samples were collected by straining 50liters of water through a plankton net (55µm). The retained sample on the collecting tube was preserved with 4% formalin in which Rose Bengal stain had been added. All samples were collected between 11:00hrs and 14:00hrs so as to minimize the variations in zooplankton distribution that could occur due to diurnal migrations (Bainbridge, 1972). Preparation, Identification, and counting of the zooplankton were done in the same way as the Phytoplankton.

A total of 16 species of Phytoplankton belonging to 4 classes and 21 species of Zooplankton belonging to 7 classes were encountered for all stations and seasons.

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IV. RESULTS

Table 1: Seasonal Variation of Phytoplankton Abundance

Family	Species	Dry	Wet	T-test p Value
CHLOROPHYCEAE	***Netrium digitus***	33±8	13±4	**<0.0001***
	Crucigenia sp	34±6	12±5	**<0.0001***
	Spirogyra sp	6±5	13±6	**0.0210***
	Micrataria radiate	45±21	10±2	**0.0003***
BACILLARIOPHYCEAE	***Cymbella lacustris***	33±11	4±5	**<0.0001***
	Tabellaria fenestrate	24±15	1±2	**0.0009***
	Melosira distans	36±10	13±6	**<0.0001***
	Melosira varians	39±8	8±9	**<0.0001***
	Amphora ovalis	31±12	10±6	**0.0006***
	Synedra sp	28±12	9±2	**0.0007***
	Navicula rubusta	23±13	8±4	**0.0090***
CYANOPHYCEAE	***Oscillatoria limosa***	29±6	8±6	**<0.0001***
	Spirulina tenuis	37±8	8±7	**<0.0001***
	Raphidiopsin sp	19±7	3±3	**<0.0001***
EUGLENOPHYCEAE	***Euglena acus***	42±7	4±2	**<0.0001***
	Euglena gracilis	30±8	3±4	**<0.0001***

The results show that *Bacillariophyceae* were the most abundant phytoplankton class with a percentage composition of 42% and 44% for the wet and dry season respectively as shown in Figure 1. *Chlorophyceae* and *Cyanophyceae* had a percentage composition of 37% and 15% for the wet season and 24% and 17% for the dry season. *Euglenophyceae* had the lowest percentage composition of 6% and 15% for wet and dry seasons respectively. During the dry season, *Micrataria radiate* (45±21) was the most abundant species while *Spirogyra sp* was the least abundant (6±5). In the wet season, *Spirogyra sp* (13±6) was the most abundant species while *Tabellaria fenestrate* was the least abundant (1±2). There was a significant difference ($p<0.05$) in the seasonal variation of all the different species of phytoplankton.

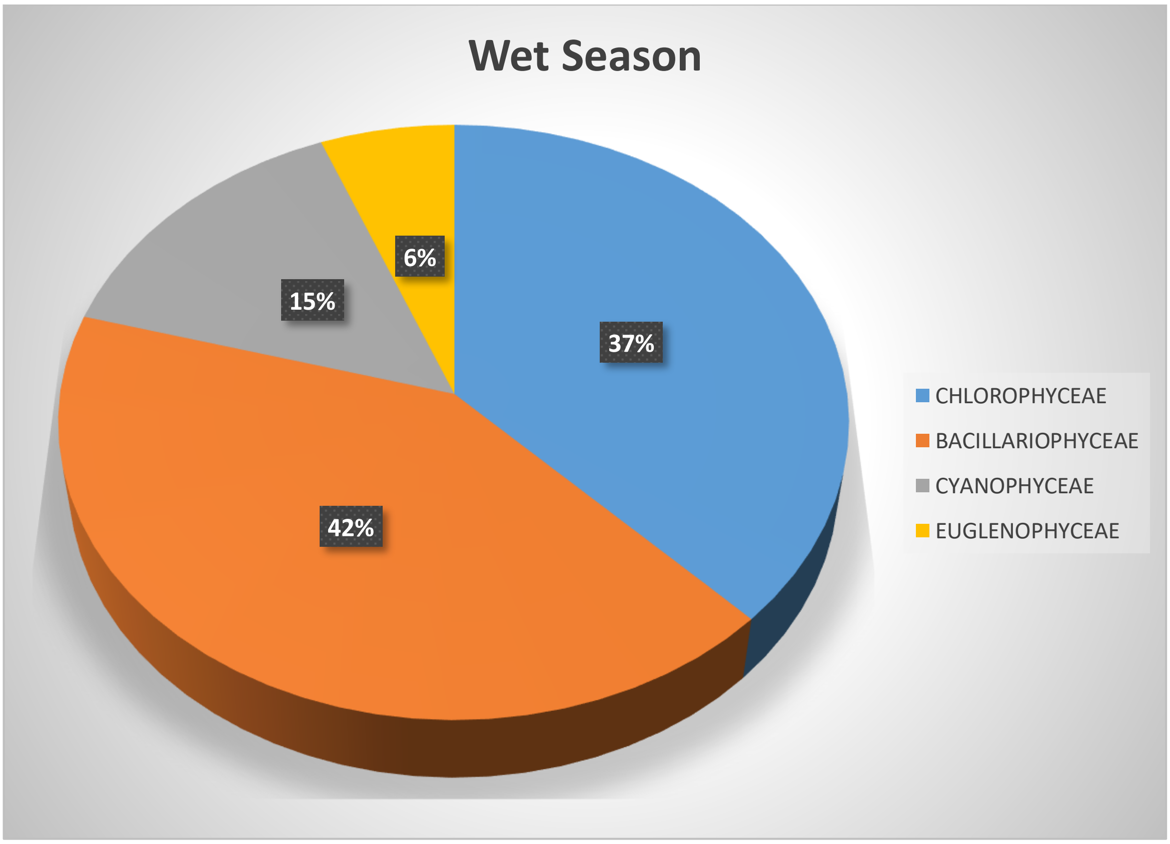

Fig 3 Wet Season abundance of Phytoplankton species

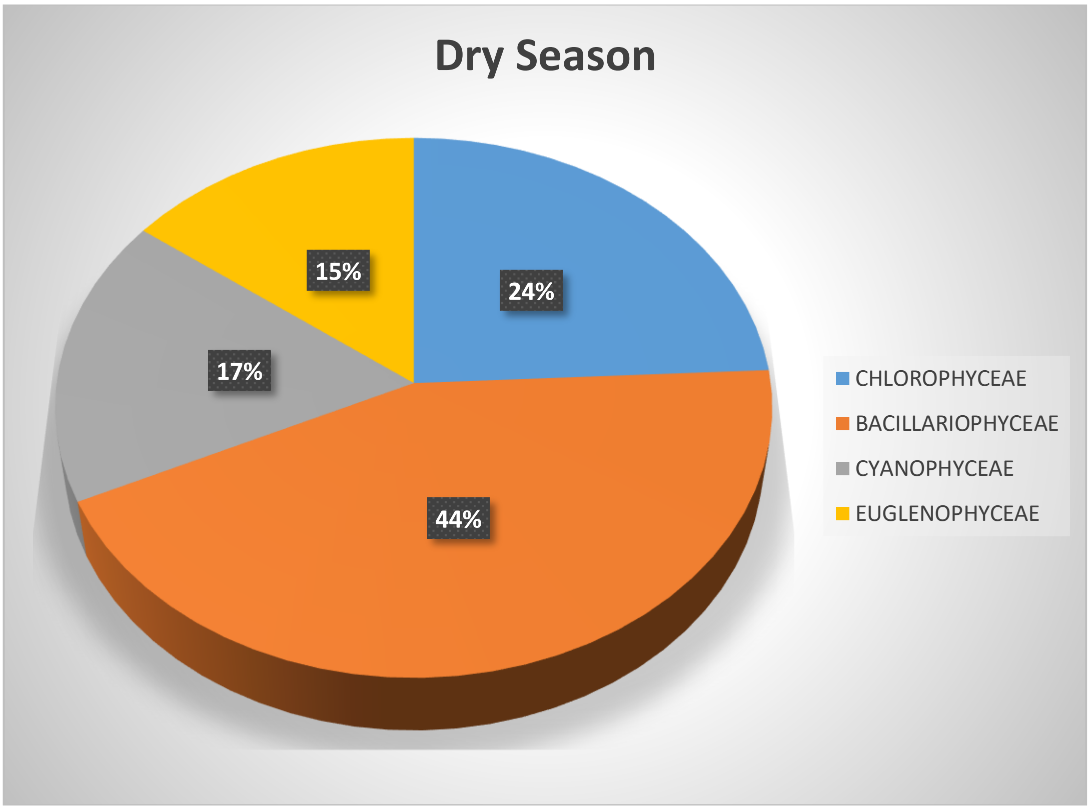

Fig 4 Dry Season abundance of Phytoplankton species

Table 2: Spatial Variation of Phytoplankton Abundance

Family	Species	Station 1	Station 2	Station 3	Station 4	p value
CHLOROPHYCEAE	*Netrium digitus*	19±13	19±8	24±13	31±15	0.5099
	Crucigenia sp	25±15	22±12	22±12	24±16	0.9853
	Spirogyra sp	12±1	11±3	8±6	9±12	0.8797
	Micrataria radiate	21±16	16±12	35±29	37±31	0.5147
BACILLARIOPHYCEAE	*Cymbella lacustris*	21±20	18±17	18±21	18±16	0.9947
	Tabellaria fenestrate	15±23	9±12	11±17	17±17	0.9177
	Melosira distans	20±11	20±11	28±19	29±17	0.7083
	Melosira varians	19±15	25±19	26±25	24±19	0.9514
	Amphora ovalis	22±17	13±9	21±13	28±18	0.5623
	Synedra sp	15±10	15±10	21±13	24±20	0.7046
	Navicula rubusta	11±11	8±4	18±14	24±14	0.2633
CYANOPHYCEAE	*Oscillatoria limosa*	16±8	20±14	15±14	22±16	0.8895
	Spirulina tenuis	24±18	22±20	22±19	24±17	0.996
	Raphidiopsin sp	6±7	11±8	11±10	16±15	0.6707
EUGLENOPHYCEAE	*Euglena acus*	20±19	24±21	23±22	27±27	0.9743
	Euglena gracilis	20±19	16±16	15±15	15±16	0.9625

Mean with different superscript (^{abcd})shows significant difference at 0.05 level

The most abundant species observed in Station 1 was *Crucigenia sp* (25±15) and the least abundant were *Raphidiopsin sp* (6±7). For Station 2, the most abundant species observed was *Melosira varians* (25±19) and the least abundant were *Navicula rubusta* (8±4). *Micrataria radiate* was the most abundant species observed at Station 3 (35±29) and Station 4 (37±31). While *Spirogyra sp* was the least abundant species observed at Station 3 (8±6) and Station 4 (9±12). There was no significant difference (p>0.05) in the spatial variation of the different species of phytoplankton.

Table 3: Seasonal Variation of Zooplankton Abundance

Family	Species	Dry	Wet	T-test p Value
COPEPODA	*Anomalocera patersoni*	30±14	7±3	**0.0004***
	Calanus finmarchicus	37±25	7±6	**0.0048***
	Canthocampu scarinatus	20±14	5±3	**0.0104***
	Centropage stypicus	36±20	8±2	**0.0017***
	Eucyclops serrulatus	37±29	8±6	**0.0140***
	Limnoithona sinensis	14±7	5±6	**0.0136***
CLADOCERA	*Bosmina coregoni*	23±14	1±1	**0.0006***
	Daphnia oristata	15±10	2±1	**0.0028***
	Moina dubia	17±10	2±1	**0.0007***
ROTIFERA	*Colurella obtuse*	19±12	3±2	**0.0021***
	Rotaria citrina	16±7	2±2	**0.0002***
	Philodin roseola	18±10	2±2	**0.0003***
CRUSTACEA	*Crab larvae*	18±9	0±0	**<0.0001***
	Shrimp larvae	18±12	0±0	**0.0009***
OSTRACODA	*Conchoecia spinirostris*	16±13	0±0	**0.0036***
INSECTA	*Chironomus larvae*	5±6	2±1	0.0975
PROTOZOA	*Arcella vulgare*	18±9	4±3	**0.0010***
	Centropyxis aculeate	16±7	4±2	**0.0006***
	Centropyxis constricta	26±12	3±2	**0.0001***
	Euglypha ciliate	21±15	1±1	**0.0022***
	Frontonia sp	21±10	2±1	**<0.001***

The results show that *Copepoda* was the most abundant zooplankton class with a percentage composition of 60.2% and 39.5% for the wet and dry season respectively as shown in Figure 2. *Protozoa, Cladocera,* and *Rotifera* had a percentage composition of 19.7%,6.8%, and 10.3% for the wet season and 22.9%, 12.7%, and 11.9% for the dry season. *Ostracoda* had a relative abundance of 0.4% in the wet season and 3.6% in the dry season. The least abundant was *Crustacea* with 0.2% in the wet season and *Insecta* with 1.2% in the dry season.

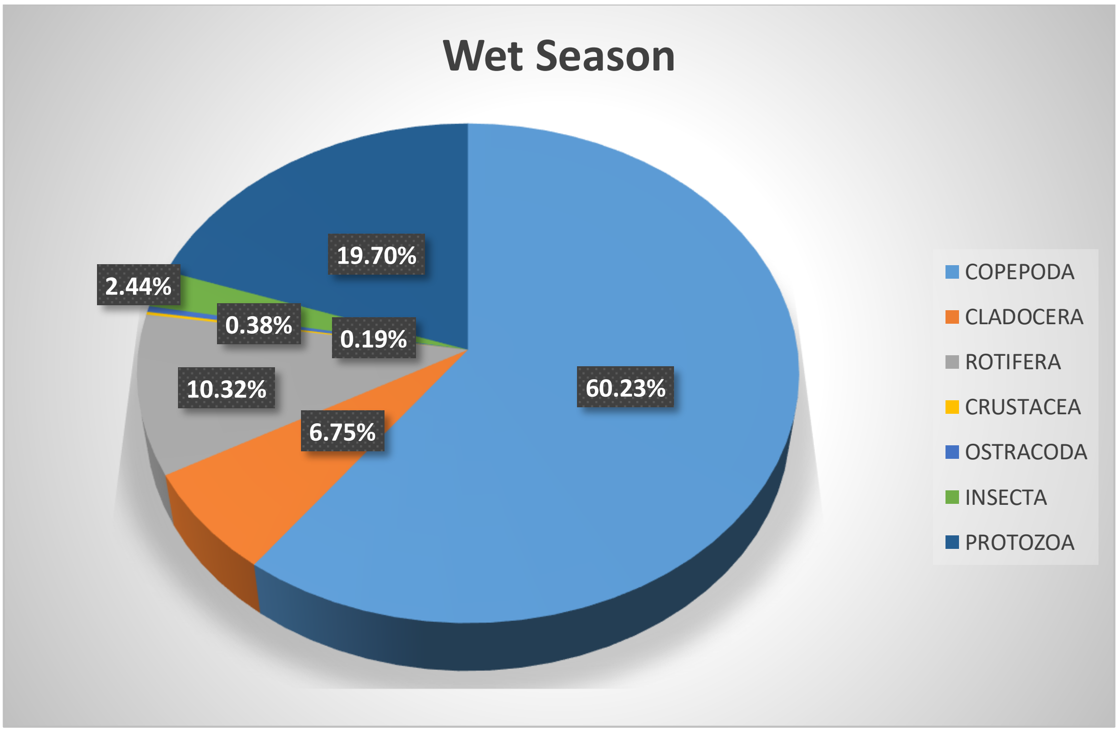

Fig 5 Wet season abundance of Zooplankton species

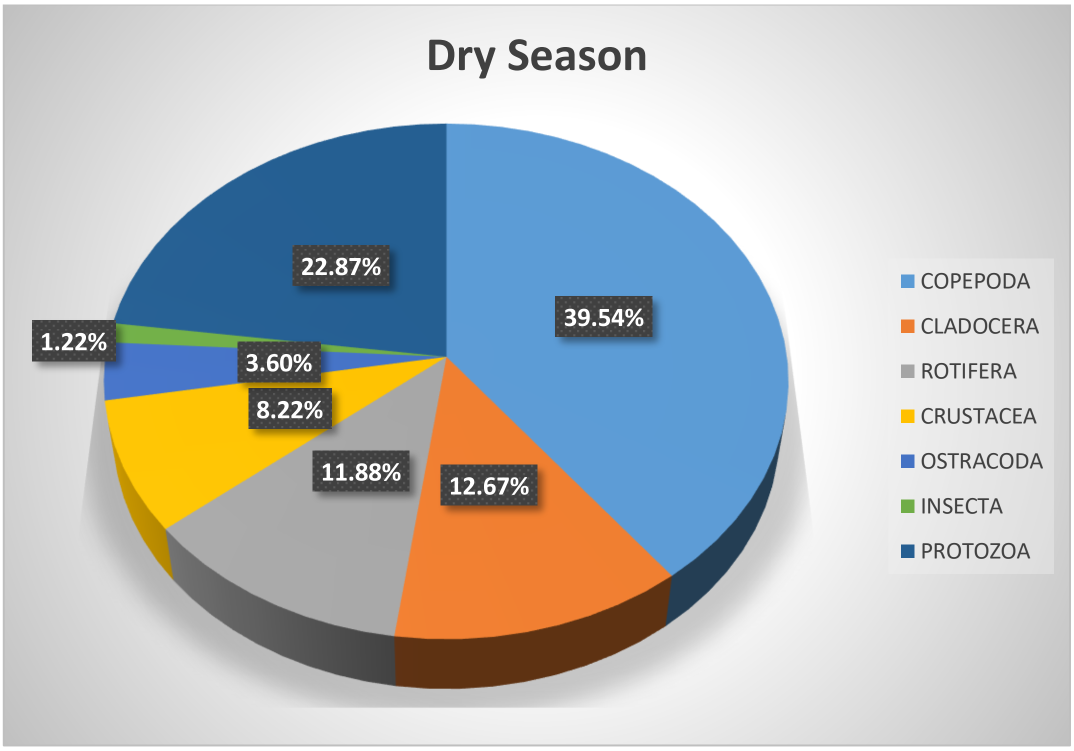

Fig 6 Dry season abundance of Zooplankton species

Table 4: Spatial Variation of Zooplankton Abundance

Family	Species	Station 1	Station 2	Station 3	Station 4	p value
COPEPODA	*Anomalocera patersoni*	18±12	10±6	23±17	25±23	0.5519
	Calanus finmarchicus	22±18	5±2	19±20	40±33	0.1934
	Canthocampus carinatus	9±5	5±3	14±8	23±20	0.1712
	Centropages typicus	27±22	7±2	24±18	31±27	0.3565
	Eucyclops serrulatus	12±6	8±4	27±24	45±37	0.1341
	Limnoithona sinensis	7±6	6±6	12±10	14±10	0.4823
CLADOCERA	*Bosmina coregoni*	9±10	4±3	17±19	19±21	0.5116
	Daphnia oristata	7±9	2±1	11±11	15±13	0.2753
	Moina dubia	13±13	2±2	9±10	14±14	0.3908
ROTIFERA	*Colurella obtuse*	8±10	3±2	15±13	16±16	0.3736
	Rotaria citrina	7±7	7±8	11±10	12±12	0.8076
	Philodin roseola	8±7	4±3	12±13	16±15	0.435
CRUSTACEA	*Crab larvae*	10±13	4±4	12±14	12±14	0.7361
	Shrimp larvae	8±11	3±5	11±14	15±18	0.6426
OSTRACODA	*Conchoecia spinirostris*	6±8	2±3	11±15	14±17	0.5429
INSECTA	*Chironomus larvae*	8±7	3±4	2±1	2±1	0.179
PROTOZOA	*Arcella vulgare*	11±10	7±1	12±10	14±15	0.7905
	Centropyxis aculeate	11±11	7±7	13±11	9±5	0.7912
	Centropyxis constricta	12±13	7±5	21±19	18±18	0.5559
	Euglypha ciliate	10±14	4±3	17±22	14±15	0.6353
	Frontonia sp	11±10	5±5	18±18	12±12	0.5357

Mean with different superscript (^{abcd})shows significant difference at 0.05 level

The most abundant species observed in Station 1 was *Centropages typicus* (27±22) and the least abundant were *Conchoecia spinirostris* (6±8). For Station 2, the most abundant species observed was *Anomalocera patersoni* (10±6) and the least abundant were *Daphnia oristata* (2±1) *Eucyclops serrulatus* was the most abundant species observed at Station 3 (27±24) and Station 4 (45±37). While *Chironomus larvae* were the least abundant species observed at Station 3 (2±1) and Station 4 (2±1). There was no significant difference (p>0.05) in the spatial variation of the different species of zooplankton.

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V. DISCUSSION

Phytoplankton is the primary producer in the Marine ecosystem. Ogamba *et al* (2004) reported that the species with the highest self-sustaining natural mechanisms of natural increase usually become dominant. This may account for the widespread dominance of Bacillariophyceae and chlorophyceae The dominance of phytoplankton of algal origin such as the bacillariophyceae and chlorophyceae during the dry season can also be attributed to the Eutrophication of the Creek caused by the abattoir waste laden with nutrients. The abundance of Spirogyra sp during the wet season can be attributed to the character of the Spirogyra sp being buoyed by the oxygen bubbles released during photosynthesis. This is due to the increased oxygen concentration of the creek in wet seasons. The abundance of the phytoplankton *Micrataria radiate* of algal origin during the dry season can be attributed to its innate ability to thrive at high temperatures and reduced oxygen conditions. The abundance of the diatom *Melosira varians* of algal origin at the discharge station can be attributed to the tolerance of the phytoplankton species for water bodies of poor quality (depleted DO concentration and high BOD).

Poor phytoplankton number could affect the zooplankton abundance and vice versa as observed by Joseph and Joseph (2002) that reduced productivity of phytoplankton and/or algae will have a reduction effect on the other organisms in the environment, such as crustaceans and fish because they serve as food to them and other zooplankton. copepods are usually the dominant members of the zooplankton and are major food organisms for small fish. The dominant abundance of the class of copepoda in the creek during the wet season suggests that these species of zooplankton thrive in a more oxygen-sufficient condition with reduced temperature. *Centropages typicus* and *Eucyclops serrulatus* which are species from the class of copepoda they are omnivorous copepod that feeds on a wide spectrum of prey, from algae to fish larvae were the most abundant zooplankton species in the wet season this further explains the affinity of copepods for increased DO concentration and reduced temperature. *Anomalocera patersoni* another copepod was the most abundant species at the discharge point this further explains the affinity and migration of copepods to points of phytoplanktonic dominance.

The study also revealed that phytoplankton and zooplankton species of the same class showed a similar trend in abundance across the stations this is indicative of affinity and similarity in the conditions required for occurrence. The further explains the migration of zooplanktons to stations of "phytoplanktonic dominance".

VI. CONCLUSION

Planktons, especially (Phytoplanktons) are primary producers in the marine ecosystem as well as pollution bio-indicators. The discharge of abattoir wastes into Woji Creek led to the nutrient enrichment of the Creek and consequent eutrophication of the waterbody. The results obtained showed the dominance of Phytoplankton of algal origin (Bacillariophyceae and Chlorophyceae) The study also revealed imbalances in the abundance of plankton species across the stations of study, Zooplankton species were seen to be migrating to stations of "Phytoplanktonic dominance". With phytoplankton being the primary producers in the marine ecosystem, the study showed imbalances and disruption within the ecosystem as stations with higher Phytoplankton and Zooplankton abundance are likely to have a higher yield in fishes and other aquatic organisms. The study also showed seasonal implications to the discharge as some classes of Phytoplankton species favor the dry season while some classes of Zooplankton species especially *copepoda* favors the wet season for their abundance. This study revealed that the discharge of abattoir wastes into Woji creek brought about imbalances and disruption within the entire marine ecosystem.

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