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ABUNDANCE AND DISTRIBUTION OF ZOOPLANKTON IN RELATION TO TIDES AND PHYSICOCHEMICAL CONDITIONS IN THE CALABAR RIVER, SOUTH EASTERN NIGERIA.

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Abstract

The zooplankton constitutes major secondary producers in many aquatic ecosystems. This study investigated the species composition, abundance and distribution of zooplankton in the Calabar River of South Eastern Nigeria. Water samples for Zooplankton and Physico-chemical analyses were collected at low and high tides for two Months (December, 2019 – January, 2020) from three stations along the lower tidal reaches of the Calabar River. Water samples were collected using 20 liters' plastic bucket, filtered through 55µm plankton net, preserved in four percent (4%) formalin solution and analyzed in the laboratory using plankton inverted microscope. Samples for water quality analysis were collected into one-liter sterile bottles for laboratory analysis. Water temperature was measured in-situ while water samples for nitrate, silicate and phosphate were analyzed in the laboratory. The zooplankton belonged to 6 divisions namely, Copepoda, Rotifera, Cladocera, Ciliata, Anelida and Pieces, composed of 12 species(*Asplanchna brightwelli, Brachionus plycatilis, Filinia longiseta, Keratella tropica, Lecane lunaris, Polyarthra vulgaris, Cyclops sp, Cyclops nauplii, Bosmina sp, Vaginicola ingenita,* Oligochaete, Fish eggs) with Copepoda having the highest relative abundance of 62.9% and Anelida, the lowest with 0.47% abundance. There was no significant spatial difference in the abundance of Zooplankton (P>0.05). Zooplankton species diversity was low, dominated by Cyclops and Cyclops nauplii, the highest temperature recorded during the study was 31°C. Concentrations of nitrate, silicate and phosphate were very low., as mean value for Nitrate was 0.04 at low and high tide, phosphate was 0.06 at both low and high tide, while SiO2 was 0.05 at low tide and 0.12 at high tide. Besides nutrients, the composition and abundance of Zooplankton also varied strongly with tide. There was high abundance of Zooplankton recorded during the low tide than high tide. Marg alef's diversity index was 7.13 in station 1, 3.03 in station 2 and 2.43 in station 3, while Shanonn-wiener index was 1.69 in station 1, 0.86 in station 2 and 0.99 in station 3, both indicating high species diversity.

Keywords: Zooplankton, Water quality, Tides, Calabar River.

1.0 Introduction

Zooplankton plays a vital role in aquatic food web; they serve as intermediaries between fish and lower trophic levels. Many zooplankton feed largely on algae and bacteria and in turn fall prey to numerous invertebrates and fish predators (Ogbeibu & Obanor, 2002). Recent studies have shown remarkable variations in the distribution and abundance of Zooplankton in tropical waters due to seasonal environmental fluctuations and various physicochemical factors (Pandiyarajan *et. al*., 2012, Julius & Kaholongo.2013, MarineBio Conservation society,2017, Obialor & Antai, 2022). The major Zooplankton species are adapted to pelagic, littoral and benthic environments and their diversity serves as an ecological indicator of aquatic environment due to their rapid response in relation to environmental changes (Akpan, 2015). Tide is another important component that affects the species composition, variety, distribution, abundance, and nutrient level of the marine environment (Davies & Ugwumba, 2013). Temperature, on the other hand, has an impact on photosynthesis, respiration, and nutrient level (Erodogan & Yerli, 2014). The current study was designed to study zooplankton distribution in the river, in relation to dominant natural forces such as tides and physicochemical conditions.

2.0 Methodology

Calabar River, a tributary of the Cross-River Estuary, lies between 04°54'15 " N and longitude 08°16'08 " E; and latitude 04°56'40 " N and longitude 08°18'14 " E", (Fig. 1) The river basin is located in the south eastern part of Nigeria within Cross River State. The delimited catchment falls within Odukpani, Akamkpa, and Biase Local Government Areas of Cross River State in Nigeria. This area is characterized by a double maxima rainfall, which starts from April and ends in October, reaching its peak in June and September. Temperature rarely falls below 19^0C and averages 27^0C all year round. The current development associated with the export processing zone of Nigeria in Calabar city pose a threat of pollution as discharge of lubricating oils and other hydrocarbon into the river increases (Akpan *et al*.,2003).

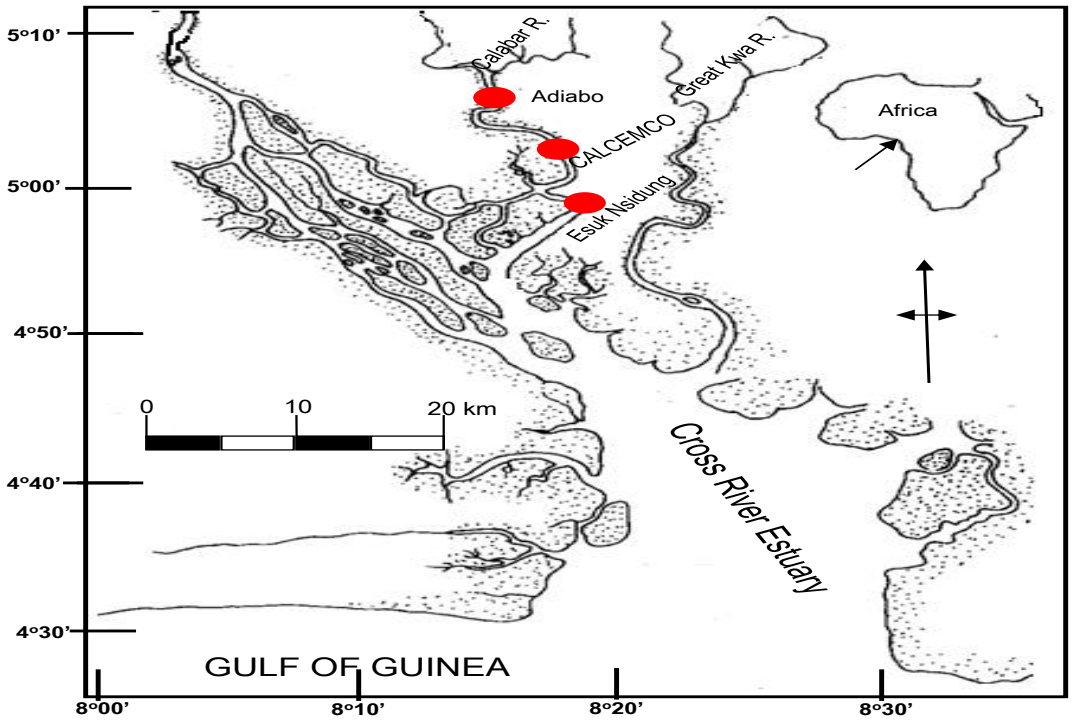

Fig. 1 Map of Study area showing sampling locations

Water samples were collected during high and low tide from three (3) locations along the lower tidal reaches of the river the study area. Twenty liters (20l) of water was filtered through a plankton net of 55µm pore size, the residue was then transferred into labeled sterile plastic containers with screw cap, fixed with 4% formalin solution and placed in an ice chest and transported to the laboratory for analysis. Samples for water quality parameters and nutrients analysis were collected into one liter (1L) sterile sampling bottles and transported to the laboratory for analysis. The water temperature was measured in-situ, using Mercury -in- glass thermometer.

The Cadmium Reduction method was used to determine Nitrate concentration which was measured with a spectrophotometer at 540nm.

The Molybdenum blue method was used to measure for silicate and phosphate, the absorbance of the resultant color was read with a spectrophotometer at 810 nm and 885 nm respectively.

Qualitative and quantitative analysis of plankton was performed using Accu-Scope Inverted Plankton microscope at 250x magnification (25 x objective and 10x ocular). Sub-samples were mixed by swirling and filled into 5 ml Hydro-Bios plankton chambers using bulb pipette. After allowing for complete sedimentation (~4hr.), microscopic analysis was performed according to UNESCO (1998) using identification schemes of Edmondson (1959), Prescott (1970) and Sharma (1986) and Newell and Newell (1975) and a wide range of internet resources.

Statistical analysis was carried out with the aid of Microsoft Excel (2016). Significant

difference in the composition of plankton within the three sampling stations was determined by ANOVA.

Descriptive statistics provided the means and standard deviations of the physicochemical parameters while the significant correlations between Zooplankton species and physicochemical parameters were determined by the correlation coefficients (r) using regression analysis.

3.0 Results

A total of 852 individuals made up by 12 species of Zooplankton belonging to 6 families was identified during the study (Table 1). The families were Rotifers represented by 6 species, Copepoda represented by 2 species, Cladocera, Ciliata, Annelida and Pieces were represented by a single species. Copepoda were the most abundant with 536 individuals constituting 62.9% of the total zooplankton population followed by Rotifers which was represented by 276 individuals with relative abundance of 32.4% , Cilliata was represented by 16 individuals with a relative abundance of 1.89%, followed by Pieces having 12 individuals with a relative abundance of 1.41%, Cladocera was represented by 8 individuals with a relative abundance of 0.9% while Anelida recorded 4 individuals with a relative abundance of 0.47%. (Fig. 2). The most dominant zooplankton species was *Cyclops nauplii* (468 individuals) followed by *Keratella tropica* (76 individuals) and *Cylops sp* (64 individuals). The least dominant species were *Brochionus plycatilis, Lecane lunaris,* and *Bosmia sp* with 8 individuals each. These were followed by Oligochaete with 4 individuals. Station 1 recorded the highest number of species with Rotifers dominating the species.

Summary results of water temperature and nutrients in the Calabar River are presented in Table 2. Water temperature was 30.33°C at low tide and 30.67°C at high tide. Nitrate was 0.04 mg/l at low and high tide, Silicate was 0.05mg/l at low tide and 0.12mg/l at high tide while phosphate was 0.06mg/l at both low and high tide (Table 2).

Table 1: Taxonomic listing, distribution and abundance of the Zooplankton species in the lower Calabar River

S/N	family	Species	Station 1 Density/ml	Station 2 Density/ml	Station 3 Density/ml	Total
	Rotifera					
1		*Asplanchna brightwelli*	4	28	12	44
2		*Brachionus plycatilis*	0	8	o	8
3		*Filinia longiseta*	0	14	12	28
4		*Keratella tropica*	36	36	4	76
5		*Lecane lunaris*	8	0	0	8
6		*Polyarthra vulgaris*	48	64	0	112
	Copepoda					
7		*Cyclops sp*	20	40	8	68
8		*Cyclops nauplii*	88	332	48	468
	Cladocera					
9		*Bosmina sp*	8	0	0	8
	Cilliata					
10		*Vaginicola ingenita*	8	0	8	16
	Anelida					
11		Oligochaete	4	0	0	4
	Pieces					
12		Fish eggs	12	0	0	12
		Number of species (S)	10	7	6	
		Individuals (N)	236	522	92	852
	Margalef's diversity index		7.13	3.03	2.43	
	Shannon diversity index		1.69	0.86	0.99	

Table 2: Mean values of physicochemical parameters of the surface water from Calabar River during low and high tides.

Parameters	Tidal phase Low tide	High tide	Permissible limits for freshwater body (WHO, 2003 and FEPA, 1971)
Temperature (°C)	30.33±0.58	30.67±0.58	27.0 – 29.0
PO_4 (mg/l)	0.06±0.02	0.06±0.03	350.0
NO_3 (mg/l)	0.04±0.02	0.04±0.02	40.0 – 45.0
SiO_2 (mg/l)	0.05±0.05	0.12±0.00	250.0 – 400.0

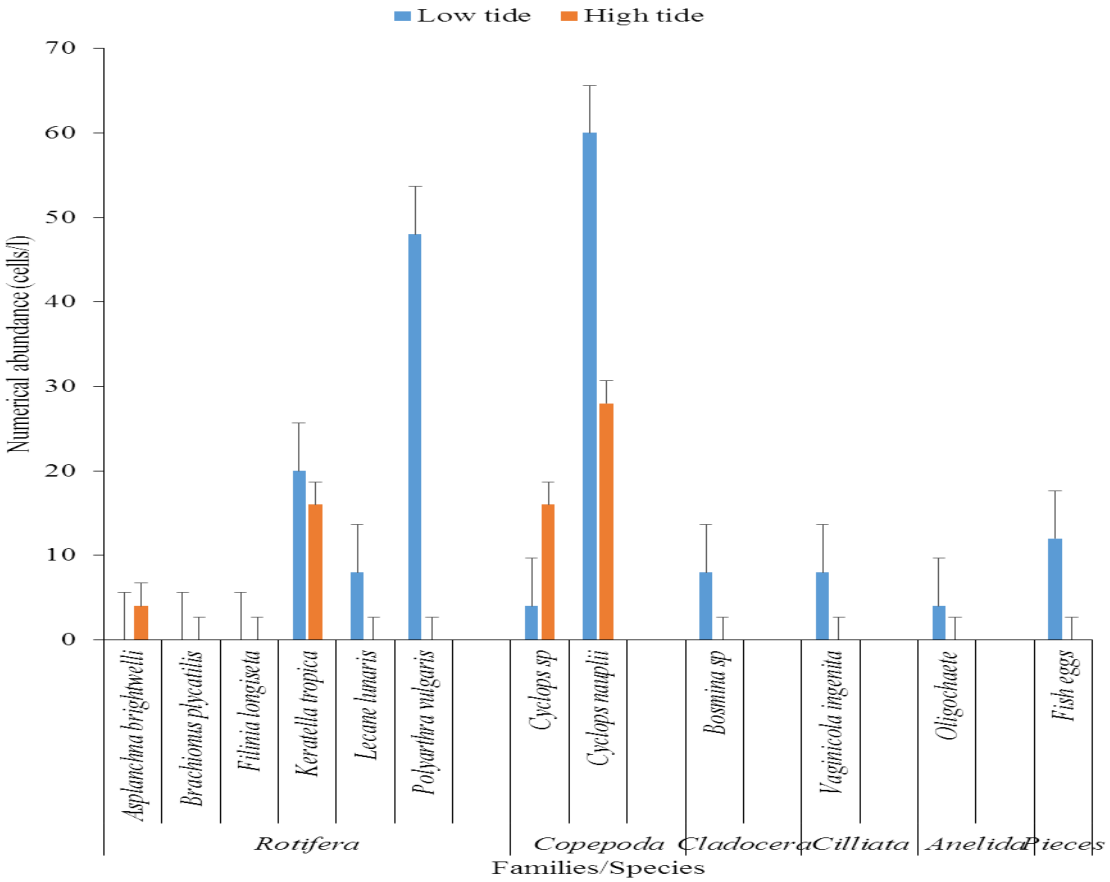

Fig. 2 Zooplankton distribution and abundance in relation to Tide at station1, during the study

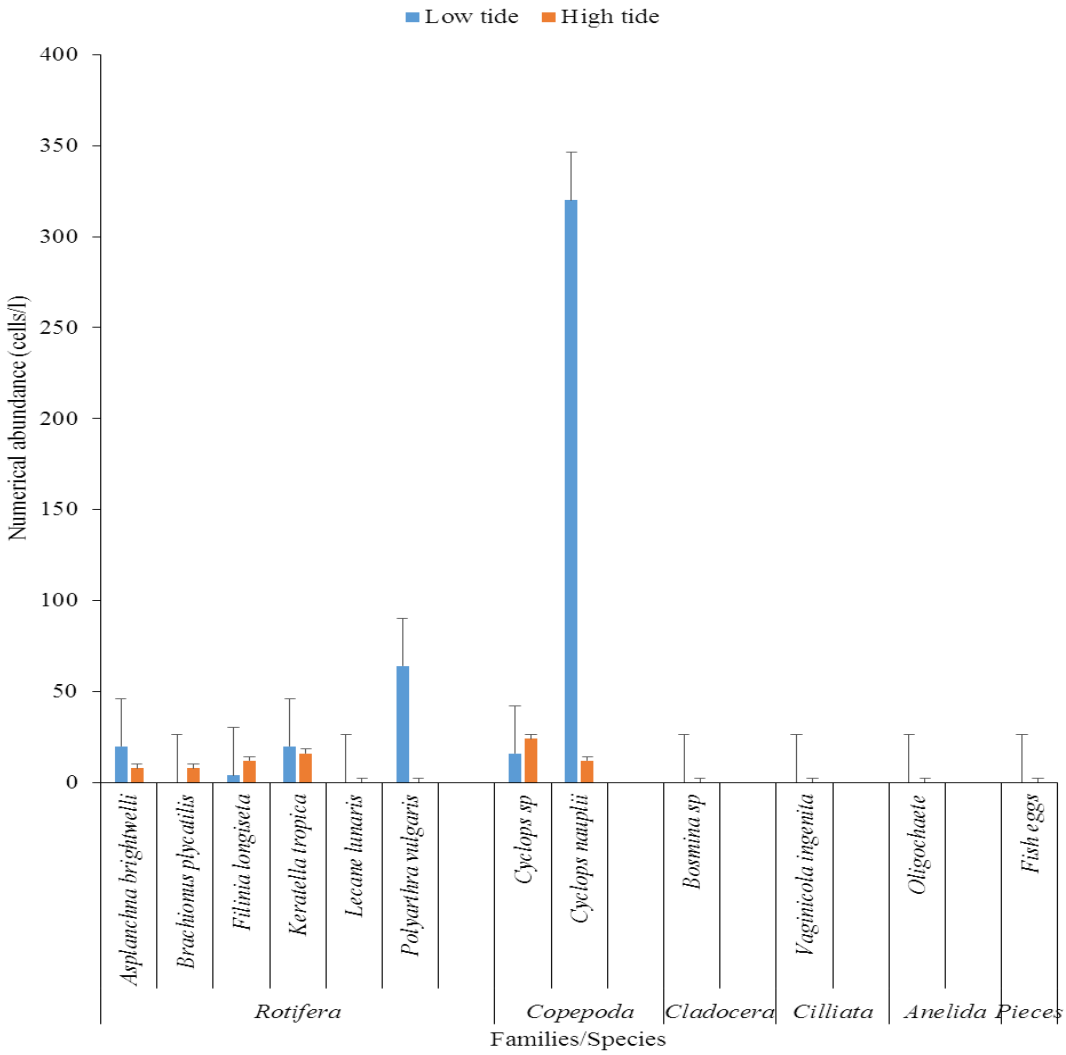

Fig. 3 Zooplankton distribution and abundance in relation to Tide at station 2, during the study

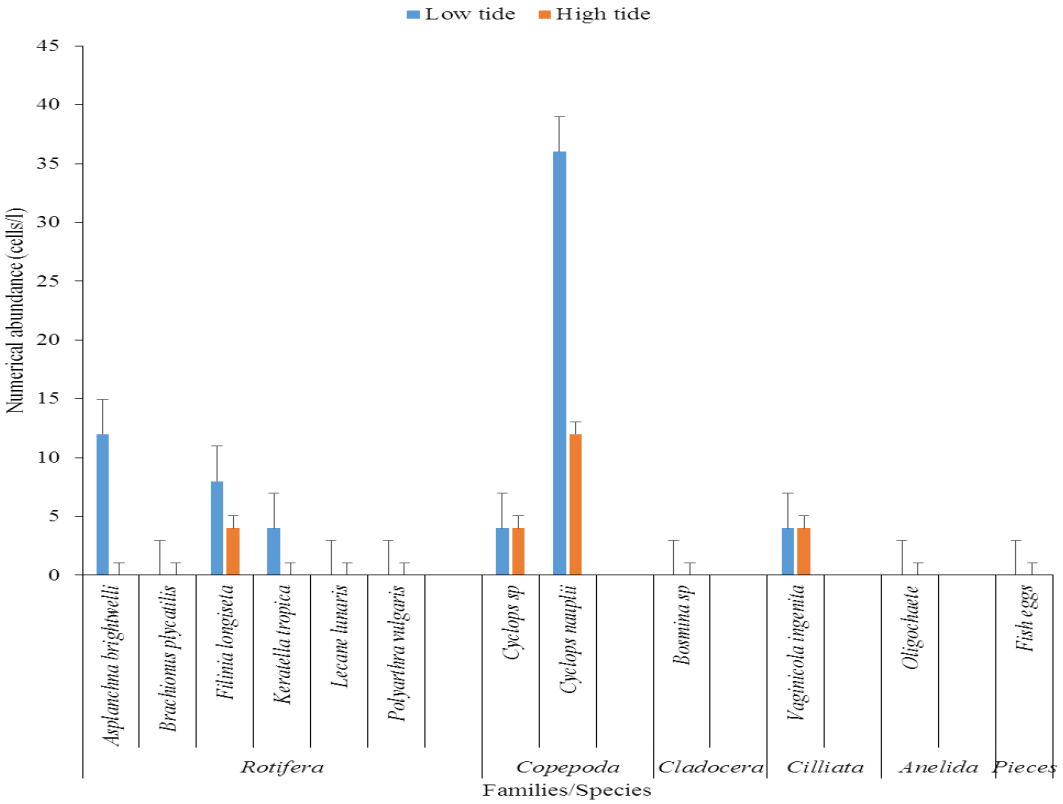

Fig. 4 Zooplankton distribution and abundance in relation to Tide at station 3, during the study

4.0 Discussion

In the study, 6 divisions of Zooplankton ranging from Copepoda, Rotifera, Cladocera, Ciliata, Anelida and Pieces were observed. They have a total of 12 species with Copepoda having the highest abundance of 62.9% and Anelida as the lowest with 0.47% abundance. This result agrees with that of Ajuonu *et al*.2011; Krumme and Liang (2004); Eyo *et al*., (2013); Akpan, (2015); Egwu and Sikoki (2005), Obialor *et al* (2019), they all reported a relatively high abundance of the Copepod family in their studies. This is because Copepods often make up the majority of the Mesozooplankton species in estuaries and the ocean. Highest temperature of 31°c was observed during the study. Most of the species (*Cyclops sp* and *Cyclops nauplii)* were considered harmful and dangerous for human health because Cyclops is intermediate host of dracunculiasis (Guinee-worm disease) and fish tape worm (*Diphyllobothrium latum*) infection, this disease can be passed to humans through drinking infected water. The most diverse order was the Rotifera with 6 species, this is because of their rapid habitation of available niches and great degree of adaptation to a variety of environmental conditions. As would be expected in an unpolluted aquatic system when considering Zooplankton species composition, the abundance and diverse nature of Copepods usually indicates clean and unpolluted system, this is similar to Varad-harajan and Soundarapandian, (2013) who reported a dominance of Copepod species (*Acartia spp, paracalanus spp* and

Temera turbinata) indicating an unpolluted water body in their study and Badsi *et al*., (2010) who reported Copepods large diversity(26%) as a qualitative point of view indicating a favorable environment for the successive development of several species. Zooplankton abundance was low at high tides than low tides, a result which agrees with those of James and Ajah (2013) who reported high dominance of Copepods during low tide in the Great Kwa river, Nigeria and Bubu-davies and Ugwumba(2013) who also reported a dominance of Zooplankton species at low tide in a tributary of Upper Bonny Estuary, Niger Delta, Nigeria. Zooplankton have been reported to always show less abundance in flowing freshwater systems when compared to stagnant water systems (Goswami and Mankodi, 2012, Erdogan and Ertan, 2015). The highest temperature was 31°c during the study and did not differ significantly between the stations (P>0.05). Water temperature influences a lot of metabolic and Physiological activity and life process which may include feeding, reproduction, movement and distribution of aquatic organisms. Surface temperature was the same with ambient air temperature. This finding is in conformity with Moses, (1996). The amount of Nitrate ranges from 0.02mg/l to 0.04mg/l which was low during the study period and within WHO,2003 and FEPA, 1971 permissible limits for primary productivity and fisheries production. Nitrates find their way into freshwater through sewage discharge, industrial wastes and runoff from agricultural fields (Anderson, Cembella and Hallegraeff, 1998). The amount of Phosphate recorded in the study ranges between 0.03mg/l to 0.06 mg/l. Phosphate plays a vital role in the growth of Phytoplankton and weeds in freshwater systems (Hulyal and Kaliwal,2011; Verma, Purohit and Patel, 2012). The presence of Phosphate in the River may be due to release of phosphate from bottom sediment and organic load of the water.

The amount of silicate ranges from 0.05mg/l to 0.12mg/l which is within WHO, (2003) and FEPA (1971) permissible limits for primary productivity and fisheries production. There is a strong need for time series studies on the Zooplankton community of the Calabar River to assess whether there could be an occurrence of invasive species with season, nutrient variability and tidal incursions.

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