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(RESEARCH ARTICLE)

Studies on plankton community and physico-chemical parameters of Elechi Creek, Eagle Island, Port Harcourt

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Abstract

Studies on the plankton communities and physico-chemical characteristics of Elechi Creek were carried out for six months, from January to June. Fourteen physico-chemical parameters were evaluated, and monthly plankton alteration was investigated. Water quality samples and plankton analyses were obtained simultaneously. Water temperature was in the range of (29.4–35.5^{0}C) across the (3) study locations. The results revealed no spatial dissimilarity ($P>0.05$) of all physicochemical factors while results of the monthly variations test showed significant elevations ($P<0.05$) for some parameters between (April and June), except for Turbidity, Nitrate, pH, Sulphate and Chloride. The mean concentration levels in total hardness (1600 mg/L), chloride (1075.8 mg/L) and sulphate (621.6 mg/L), were found considerably above the acceptable levels. Most plankton showed negative changes subsequent to these elevations. Phytoplankton identified comprised two families, of which Bacillariophyceae (diatoms) were higher followed by Cyanophyceae. Bacillariophyceae, cell density (46 cells L^{-1}) contributed the highest (80.7%) sum phytoplankton cell–density while Cyanophyceae had (11 cells L^{-1}) contributing (19.3%). The zooplankton density was from (17 L^{-1} - 1190 L^{-1}). Copepoda recorded the utmost percentage population, contributing (91%) zooplankton, followed by Cladocera (4.8%), Crustaceae (2.9%) and most reduced (1.3%) contribution by Rotifera. Monthly variations of Plankton density showed that most families recorded higher density during the wet months (April–June). The occurrence of these factors and conditions in Elechi Creek underscore pollution therefore, aquatic organisms from such water are almost unsafe for food. Hence, standard checking of the creek is advocated to ensure seafood safety.

Keywords: Plankton; Season; Monthly Variation; Pollution; Physico-chemical parameters; Elechi Creek.

1. Introduction

In underdeveloped nations there has been a methodical loss of creeks through pollution, excessive use and sand-filling which is not an uncommon practice [1]. The South-Western Nigeria creeks and lagoons, excluding their ecological and economic values, function as a sink for dumping and escalating assortment of waste [2]. Creeks are an essential sector for aquatic products, functioning as flood regulators and habitats for wildlife [1]. Creeks connected with Nigerian coastal locations are categorized as tidal fresh water and brackish bounded by mangrove marsh and flawless water from regions further than tidal action. The tide-free creeks are bordered by a clean streams infested by macrophytes [3]. Elechi Creek is a brackish water affected by tidal fluxes, it plays the role of a sink for organic anthropogenic wastes from Diobu, Eagle Island, Ahia-Ogologo, Eremo Ogbogoro, and local industries. The features of materials and chemicals in water are vital factors as they can directly or indirectly alter its quality and appropriateness for animal production and distribution [4]. Creeks are affected by factors such as fertilizers, pesticides, livestock, mangrove cutting, and metropolitan waste. Some human practices, including dredging, transportation, sand mining, fishing, and poor oil handling, affect the creek negatively. Plankton quantity determines water productivity because they are the main

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producers and having a vital role in the aquatic food chain [5]. Based on trophic groups plankton are mainly separated into extensive useful groups, which include phytoplankton which could be unicellular or multicellular algae on the water surface with adequate photosynthesis, they include diatoms, cyanobacteria, dinoflagellates, and coccolithophores. Zooplankton are little protozoans, or metazoans, for instance, crustaceans that feed on phytoplankton. Phytoplankton are autotrophic (self-feeding); they obtain energy through photosynthesis, hence occupying the euphotic region of the water body. Phytoplankton is among the initial biological components for energy transfer to higher organisms through food chains and is imperative in the biomonitoring of pollution [6]. Zooplankton are microscopic, heterotrophic organisms but some are larger enough to be seen with the unaided eye. They are principally transmitted via water currents, and numerous of them possess innate means for escaping predators or to overtaking prey.

The significance of phytoplankton and zooplankton is again noted in fish farming where they serve as food for larger animals, their composition, amount and distribution strongly correlate with factors such as ambient nutrient concentrations, the physical condition of the water column which includes temperature, salinity, dissolved oxygen and the availability of food [7]. Zooplankton assemblages may serve as bioindicators of eutrophication for being coupled to ecological circumstances, responding more rapidly to changes than fishes, and can be promptly detected than phytoplankton. Approximately, 96,000 tons of waste is produced annually in Port Harcourt and not appropriately gathered for effective disposal [8]. Therefore, the aim of this study was to examine the diversity indices and spatial distribution of plankton also the physicochemical parameters of Elechi Creek, Rivers State, Nigeria.

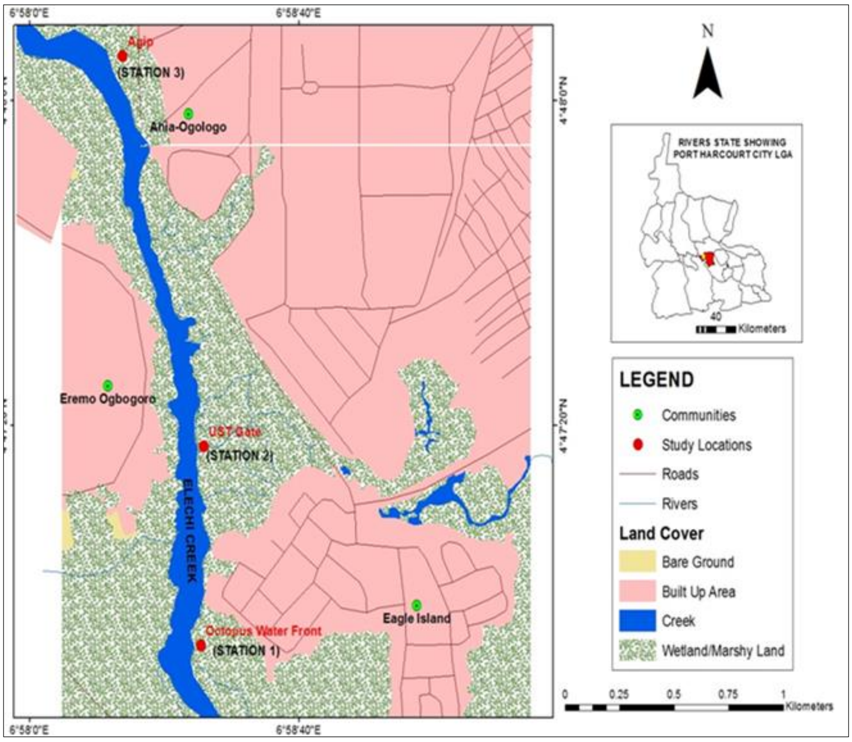

Figure 1 Map of Elechi creek showing the three sampling stations

2. Materials and methods

2.1. Sample collection

Three (3) research stations were chosen along the longitudinal sections of the middle of Elechi Creek, covering a known distance from Agip up to the Octopus waterfront. Sampling was performed at monthly intervals for six consecutive months (January-June) at the three stations at spring tide namely: (1) Octopus waterfront (downstream) (2) UST small gate (middle stream) (3) Agip waterfront (upstream). The sampling stations were sited following ecological niches also taking into cognizance human activities and accessibility (Figure 1).

2.2. Sampling analysis

Physical and chemical parameters were determined following internationally acceptable methods of the American Public Health Association [9]. The temperature was measured in situ with an Extech multi-parameter digital (DO: 700 models) and a reading was taken after the value stabilized. Sulfate was determined using the Turbidimetric technique [10]; Phosphate was evaluated using the stannous chloride protocol [10]; and nitrate quantity was determined by the Brucine protocol [11]. Chloride was examined using the argentometric titration procedure [10]. The complete alkalinity assessment made use of titration of (a 50 ml) sample with five drops of methyl orange and (0.02N) H_2SO_4 solution, with a limit (1.0 mg/l), [10]. Total hardness was determined with the EDTA protocol [10], while turbidity was measured using the Hannah HI98703 Turbidity Portable Meter.

Plankton were sampled with a plankton net of 65µm mesh size. The plankton net was towed for about 5 minutes from each station at the deepness of 30cm. After each collection samples were fixed with (5%) formalin for preservation and were taken to the Animal & Environmental Biology laboratory, University Of Port Harcourt for proper sorting and identification.

2.3. Sample Identification

Plankton was kept for 48 hours in the lab to sediment, and then it was decanted from 20ml to 5ml to concentrate the sample. A rubber Pasteur pipette of 3ml was applied to withdraw 1ml of the plankton sub-sample and dropped on a slide to view the samples for identification. In all samples, 1ml of the concentrate was diluted with 9ml of purified H_2O since there were a large number of cells in the concentration. The sample was thoroughly mixed and five sub-samples of 1ml each were put in a Sedgwick rafter cell and viewed under an Olumpus Binocular microscope Model 107E with a magnification (×200) objective lens. The cells viewed were identified by keys to plankton identification. Cells per liter of samples calculated from the relationship;

$$\mathrm{N/L} = \frac{\mathrm{C(1000)mm^2}}{LDWS}$$

Where C = average amount of organisms or cell in the sample viewed; L = length of Sedgwick rafter cell; D = depth of Sedgwick rafter cell; W = width of strip; S = Number of trips

Standard keys applied to properly identify the plankton such as;

A directive to marine coastal plankton by [12].

A Guide to the common Diatoms at water pollution surveillance system stations, June 1966, U.S Department of the Interior Federal Water pollution Control Administration.

Aids to Algae, invertebrates and fishes recognition by [13].

2.4. Method of Data Analysis

Data were analyzed by SPSS (IBM) version 20, and ANOVA was used for evaluation of the association between sampling stations as regards physico-chemical factors.

3. Results and discussion

The range and mean values of physico-chemical parameters achieved in this study are presented in (Table 1). Water temperatures across the three (3) sampling stations ranged from 29.4 ^{0}C to 35.5 ^{0}C. However, statistical analysis showed no significant difference (P>0.05). The highest mean temperature of 31.3 ^{0}C was observed in station 3.

Table 1 The Mean values and (±SE) of physico-chemical parameters in Elechi Creek for Each Station

Parameters	STN 1	STN 2	STN 3
Temp	30.9 ± 0.39	30.6 ± 0.40	31.3 ± 0.91
PH	6.83 ± 0.10	6.92 ± 0.07	6.79 ± 0.12
DO	7.72 ± 0.89	8.01 ± 0.91	8.27 ± 0.80

Cond	7.33 ± 0.36	7.36 ± 0.98	14.9 ± 0.80
Salinity	4.0 ± 0.23	3.80 ± 0.54	4.11 ± 0.45
TDS	4.45 ± 0.40	4.30 ± 0.76	4.59 ± 0.57
BOD	3.84 ± 0.26	3.66 ± 0.29	3.87 ± 0.38
Turbidity	3.7 ± 1.45	2.0 ± 0.56	26.6 ± 18.4
Hardness	1640 ± 157	1800 ± 253.6	1360 ± 182.4
Alkalinity	2.33 ± 0.33	2.33 ± 0.33	2.33 ± 0.33
Chloride	1012.7 ± 117.9	1247.4 ± 126.6	967.4 ± 133.7
Sulphate	576.9 ± 61.7	645.9 ± 76.6	642 ± 104.9
Nitrate	0.36 ± 0.12)	0.41 ± 0.10	0.47 ± 0.12
Phosphate	0	0	0

Table 2 Comparison of Result with other Standards

Parameters	**Mean±SE**	**WHO**	**FEPA**	**SON**
Temperature	30.92 ± 0.32	≤35	27	Ambient
pH	6.84 ± 0.06	6.5 – 8.5	6 - 9	6.5 – 8.5
Cond (μScm^{-1})	7.40 ± 0.41	300	-	1000
DO (mg/L)	8.0 ± 0.47	4 - 6	8 - 10	-
TDS (mg/L)	4.44 ± 0.32	500	500	-
Total hardness	1600 ± 118	600	-	150
BOD	3.79 ± 0.17	6	10	-
Alkalinity	2.33 ± 0.18	600	-	-
Chloride	1075.8 ± 74.6	250	-	200 – 600
Sulphate	621.6 ± 45.7	500	500	-
Nitrate	0.41 ± 0.06	50	20	-
Turbidity	10.74 ± 6.38	10	≤7	5
Phosphate	BDL	-	-	-

Table 3 Taxonomic listing of phytoplankton species and their spatial distribution in Elechi creek (+ = present, - = absent).

Family/species		**Stations**	
Bacillariophyceae	STN 1	STN 2	STN 3
Fragilaria capucina	-	+	+
Cyclotella operculata	+	+	+
Cyanophyceae			
Anabaena affinis	+	+	+

Table 4 Monthly Variations in Phytoplankton composition in Elechi Creek

Family	**Jan-Mar**	**April-June**	**Total**
Bacillariophyceae	18 (39.1%)	28 (60.9%)	46
Cyanophyceae	4 (36.4%)	7 (63.6%)	11
Total $\times 10^3$ cell/L	22	35	57

Table 5 Taxonomic listing of zooplankton species and their spatial distribution in Elechi creek (+ = present, - = absent).

Family/ species	STN 1	STN 2	STN 3
Sub-class copepod			
Centropages typicus	+	+	+
Anomalocera patersoni	+	+	+
Temora longicornis	+	+	+
Calamus finmarchicus	+	+	+
Nauplius (larva)	+	+	+
Acartia longiremis	+	+	+
Sub-class crustacean			
Shrimp larva	+	+	+
Palaemonetes Africana	+	+	+
Crab larva	+	-	-
Alpheus pontederi	-	+	-
Cladocera			
Colurella abtusa	+	+	+
Rotoria citrina	+	+	+
Rotifera			
Colurella abtusa	-	+	-
Rotoria citrina	+	+	+

Table 6 Monthly variation of zooplankton composition in Elechi creek

Family	**Jan-Mar**	**April-June**	**Total**
Copepoda	466 (39.2%)	724 (60.8%)	1190 (91%)
Cladocera	37 (58.7%)	26 (41.3%)	63 (4.8%)
Rotifera	6 (35.3%)	11 (64.7%)	17 (1.3%)
Crustacea	23 (60.5%)	15 (39.5%)	38 (2.9%)
Total	532	776	1308

4. Discussion

4.1. Spatial Distribution of Physico - Chemical Parameters

The water temperature values obtained from this study were equivalent to those reported by [14], who reported (34ºC) in Lagos lagoon. There was no significant spatial variation across the sampling stations (P>0.05) which could be attributed to superficial profundity. Dissolved oxygen showed statistically significant spatial variation (P<0.05) across the months because of varying degrees of primary productivity and decomposition throughout the month. This work noted an elevated wet month value for DO. These findings is consistent with reports documented by [15] who reported higher DO values during wet-months. This observation can be due to precipitation and run-off discharges resulting in increased water current flow and high mixing rates. The research contrasted with the lower DO values during wet periods reported by [16]. This work generally showed a higher value of Biochemical oxygen demand for wet months than dry months, which conforms to the work carried out by [15] who detected elevated BOD in the wet period in Taylor Creek and related it to an increase in discharge rate (sewage, run-off), which increases bio-degradation. The mean value of TDS was higher in wet than dry months following water inflow from the terrestrial environment.

This finding is at variance with [17], who reported that TDS were higher in dry time due to continual waste matter deposited into Woji-Creek from industries. A higher turbidity value was observed in dry months due to decreased rainfall and elevation in the deposition of particles; these findings disagree with those of [18] who recorded higher turbidity in wet months than in dry and attributed it to run-off and industrial impact. The higher average pH observations were made during dry months than wet, in conformity with [19] observation of periodic alteration in pH values, [16] also marked (5.5 to 7.8) in Woji Creek with the highest values in March (Dry months). Higher alkalinities were obtained in dry months due to the diminution in rainfall and the subsequent reduction in water inflow from the terrestrial environment washing down mineral matter. This report is compatible with [15] who obtained raised alkalinity during dry months.

4.2. Phytoplankton Abundance

Three (3) species from two families were identified during the study, the family Bacillariophyceae (diatoms) was numerous with eight species, accompanied by Cyanophyceae with four species. Several studies on phytoplankton have recorded the Bacillariophyceae majority in rivers and creeks in the Niger Delta. For instance [20] documented that species with independent innate mechanisms of natural increase frequently dominate others, for instance, Bacillariophyceae. The phytoplankton species, diversity, and richness reported were lower than figures shown for other regions of the Bonny Estuary [21] which shows that this phytoplankton may not maintain marketable fisheries [5]. This could be an effect of perturbation, which prevents the buildup of the phytoplankton system. Nutrient availability and light penetration, among others, are parameters that control phytoplankton abundance. The wet months had higher mean phytoplankton abundance than the dry months which as shown by [22] from the sombreiro River.

4.3. Zooplankton Abundance

The copepods were the majority and this is in agreement with [23]. According to [24], the dominance of copepods is an indication of contamination and it is recommended that monitoring of pollution by organisms be based on the belief that naturally uncontaminated environments are characterized by an equilibrium of biological circumstances with a clear distribution of plants and animals without dominance. The observed dominance of Copepoda and Cladocera is equivalent to what [25] from Schelde estuary (Belgium): that cyclopoid copepods together with several cladocerans dominated the freshwater and lower brackish transects of the estuaries. Copepoda and crustaceans are free-living filter-feeding zooplankton, and this accounts for their use in biomonitoring of contamination [26].

5. Conclusion

According to Ruivo, M.R,'The dominance of copepods is an indication for contamination', so the studies of plankton communities in Elechi Creek revealed that the creek is polluted since Copepods had the highest percentage of 91% in the zooplankton population. Also the physico-chemical factors revealed that Chloride and suphate in the creek water are above the guideline standards for water quality. The study also indicates plankton diminution along the Creek in comparison to preceding research, which is explained by the obvious increase in pollution. It therefore shows that the water is unsafe for drinking, lethal to aquatic animals, and hazardous to the inhabitants of the area. These pollutants could cause deleterious effects on aquatic life, and if drastic measures are not taken for restoration of the water quality, it might become too polluted to support aquatic life in the future.

Compliance with ethical standards

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Disclosure of conflict of interest

Author declares that there are no conflicts of interest related to this article.

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