Available online at www.elixirpublishers.com (Elixir International Journal)

Bio Sciences

Elixir Bio Sci. 88 (2015) 37947-35950

ISSN: 2229-712X

The Effects of Industrial and Domestic Wastes on the Benthic Fauna of New Calabar River

Woke, G.N. and Wonodi O. Emeka
Department of Animal and Environmental Biology, University of PortHarcourt.

ARTICLE INFO

Article history:
Received: 28 October 2015;
Received in revised form:
18 November 2015;
Accepted: 27 November 2015;

Keywords
Effluents,
Sediments,
Species,
Companies
Samples.

ABSTRACT

This study was conducted to ascertain the level of pollution caused by industrial and domestic wastes in New Calabar Rivers and their effects on the benthic fauna of the river between July – September, 2010. Three stations were selected within the study area. Sediments samples were collected using hand trowel twice a month for the period of three months while water samples were aseptically taken from the three stations using sterile screw capped bottles. The result showed that 12 taxa of benthic invertebrates were identified from the New Calabar River. Gastropoda and crustacean were the most abundant classes. The class Gastropoda had the highest number of families (4) with 4 species while crustacean consisted of 3 families with 3 species. Oligochaeta had 2 families and was represented by 2 species other classes such as Hirudinea 2 families and 2 species and Insecta with a single family and 1 speciies. Class Gastopoda had the highest percentage species composition (30.8%). Insecta 23.1%, Oligochaeta, Crustacea and Hirudinea had 15.4%. *Turbificid* sp. and *Libyodrilus* sp. had 33.8% relative abundance, Gastropoda 27.0%, while Hirudinea, Insecta and Crustacea had least abundance of 4.1%. Physico-chemical parameters for the various stations were analyzed as: Biochemical Oxygen Demand ranged from 3.6mg/L – 15.5mg/L, COD (4.0mg/L – 19.3mg/L), Ammonia (0.01mg/L – 0.4mg/L), temperature (24^{0}C – 27^{0}C) and Dissolved Oxygen 8.0mg/L to 0.8mg/L. The deterioration of this water body has cause adverse effects on human and the ecosystem, therefore a constant supervision of companies operating within the area is required to ensure effective treatment of the effluents before discharge.

Introduction

There is an increasing need for industrialization in underdeveloped and developing countries of the world. This need arises due to the huge expenses these countries incur in importation of industrial fish products from developed economies. For instance, in Nigeria which is considered to be a developing country, most of its cities like Port Harcourt and Lagos in the South, Kaduna and Kano in the North have a lot of industries sited within their metropolis; this burning desire for industrialization comes with blessings on one hand and problems on the other (Atlas, 2003).

The magnitude of problems created by environmental pollution globally in developed and particularly developing economics cannot be overemphasized. This ranges from health problems on human, and animals to effects on vegetation and the entire biota. For instance, the contamination of water bodies with crude oil hydrocarbons may constitute public health and socio-economic problems to their immediate communities (Kobayash and Ritman, 2000).

In the past, the quantities of wastes were relatively small in Port Harcourt and other cities in Nigeria consisting mainly biodegradable garbage components which are easily disposed of by feeding pets or by composting (Ideriah*et al*, 2004), but as long as assimilation capacity of receiving water body system, land or air exceeds the pollution load, the importance of environmental degradation would be readily appreciated because the system would always purify itself (Morrison *et al*, 2001). This explains that there was not much need for environmental monitoring since the carrying capacity of the environment was able to hold the quantity of waters in time past.

Since this carrying capacity has been exceeded, there is need therefore for environmental monitoring and protection. Both the quality and quantity of solid wastes generated in Nigeria vary widely from day to day and according to the season of the year and still increasing mainly due to improper waste management (Ademola, 1993; Osibanjo, 1995). This paper is aimed at ascertaining the species composition diversity and abundance of the benthic fauna in New Calabar River with a view to determine the effects of industrial and domestic wastes on physico chemical parameters of the river.

Study Area

Three stations within the New Calabar River were selected for the study. Station 1, longitude 04^{0}53'04N and latitude 006^{0}53'31E, is Emohua village and close to it is Willbros Nigeria Limited (WNL) an oil services industry. Activities here include the building and repair of oil pipelines as well as mini oil rigs. Effluents and wastes from the industry flow into this site. Located near Station 2 (longitude 04^{0}53'56E) is the Choba market with its terminals close to the

Tele:
E-mail addresses: imsubiznessjournals@yahoo.com

river and homes of some markets, domestic effluents and wastes flow into the river, some are deliberately dumped into the river. Station 3 (longitude $04^0 54'41N$ and latitude $006^0 53'15E$) is in the interior part of Aluu village; this site is considered to be isolated from industrial and domestic activities, it serves as a control site for Stations 1 and 2 (Fig. 1).

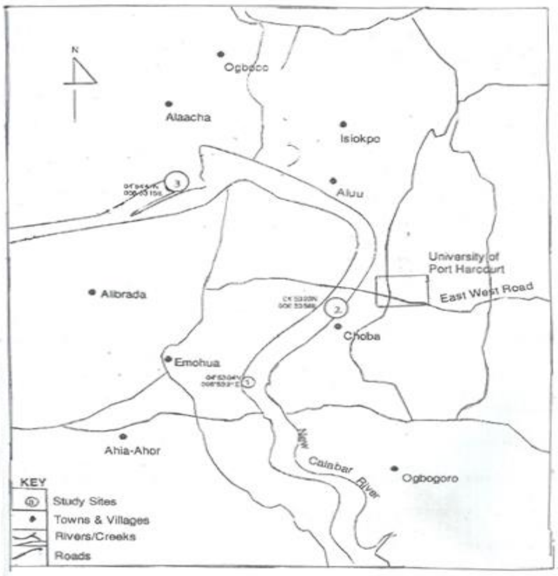

Fig 1. A map showing the three (1-3) georeferenced stations on the New Calabar River.

Materials and Methods

Sample Collection

Hand trowel was used to collect sediment samples from the three stations, the samples were transferred into properly labelled containers. A little quantity of water was added to each sample, 10% formalin and Rose Bengal selectively colored all living materials in the sample. The preserved samples were further transported to the laboratory for subsequent treatment and analysis.

Benthic invertebrates were sorted out by transferring successive quantity of preserved sediment sample into a white plastic tray. Moderate quantity of water was added to the sample in the tray to ease identification or improve visibility. Benthic organisms stained, showed pink coloration and were picked with forceps. All the sorted benthic invertebrates were washed in water to clean up the stain and stored in 10% formalin for further identification and counting (Merrit and Cummins, 1984). The number of each identified species or taxa were counted and recorded. The abundance and density of the benthic fauna were calculated using the formula below.

$$\text{Density} = \frac{\text{Total number of orrganisms}}{\text{Area of sample unit}}$$

Shanon-Wiener's index and Margalef's index were used to calculate diversity and Pielou's index (I) of evenness was also applied to compute relative density. Water samples were aseptically taken from the river using sterile screw capped bottles at the three sites. The bottles were opened at about 10cm depth, allowed to fill, closed under water and transported immediately to the laboratory for analysis. Samples were collected in the early hours of the morning at low tides. Sampling was carried out twice a month for three months. The physico-chemical parameters analysed were the temperature of the water body, measured in-situ at the three sites using mercury-in-glass thermometer, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), were determined using the Winkler's Method (APHA, 1998). Chemical Oxygen Demand was determined using the permanganate oxidant method while Ammonia was determined by distillation method using Magnesium as catalyst.

Results

A total of twelve taxa of benthic invertebrates were identified. Checklist of the fauna is presented in Table 1, 2, 3 and Fig. 2; while the physico-chemical parameters of the three stations are presented in Table 4 and Fig. 3.

Gastropoda and Crustacea were the most dominant classes. The class Gastropoda had the highest number of families (4) with 4 species while Crustacea consisted of 3 families with 3 species. Oligochaeta had 2 families and was represented by 2 species. Other classes recorded included Hirudinea, made up of two families and 2 species. Insecta had a single family and was represented by one species.

However, class Gastropoda had the highest percentage composition (30.8%), Insecta (23.1%), Oligochaeta, Crustacea and Hirudinea (15.4%). *Tubificid* sp. and *Libyodrilus* sp. had relative abundance of 33.8% (Table 2 & Fig. 2), while Gastropoda consists of 27.0% of the overall abundance.Hirudinea, Insecta and Crustacea had least abundance 4.1% (Table 3). The presence of these pollution indicators is supported by the specific increase in BOD which ranged from 3.6mg/L to 15.5mg/L, COD (4.0mg/L – 19.3mg/L), Ammonia (0.01 – 0.04mg/L), Temperature (24^0C – 27^0C) (Table 4), (Fig. 3), while DO decreases from 8.0mg/L to 0.8mg/L.

Table 1. Identification of organisms in various stations

Species	Stations		
	1	**2**	**3**
Tubificid sp.	7	-	2
Libyodrilus sp.	8	-	7
Hirudomedicinalis	10	-	2
Limnobdellaaustralis	2	-	1
Lymneanatalensis	-	-	6
Afrogyrus sp.	-	-	4
Buliniusforskalii	2	-	1
Chironomus sp.	3	-	-
Renatra sp.	-	-	1
Anephehime sp.	2	-	-

Table 2. Percentage abundance of each class of individual benthic fauna.

Class	Total number of individual	Mean number of individuals	Total percentage abundance
Oligochaeta	25	12.5	33.8
Hirudinea	16	8.0	21.6
Gastropoda	20	10.0	27.0
Insecta	10	5.0	13.5
Crustacean	3	1.5	4.1

Table 3. Percentage composition of families and species in each class of benthic invertebrates.

Class	Total number of families	Number of species	Percentage species composition	Percentage family composition
Oligochaeta	1	2	15.4	9.1
Hirudinea	1	2	15.4	9.1
Gastropoda	4	4	30.8	36.4
Insecta	3	3	23.1	27.3
Crustacean	2	2	15.4	18.2

Table 4. Range, mean and standard deviation of the physico-chemical parameters

Parameters	Stations			WHO Standard
	1	2	3	
BOD (mg/L)	12.8-15.6 14.2±5.6	5.6-11.2 8.4±3.3	3.6-4.8 4.2±1.5	0-6
DO (mg/L)	0.8-1.2 1.0±0.2	1.2-2.4 1.8±0.6	6.4-8.0 7.2±2.7	0-20
COD (mg/L)	15.6-19.0 17.3±6.9	15.2-19.3 17.3±6.9	4.0-8.3 6.2±2.4	NA
NH3 (mg/L)	0.01-0.04 0.025±0.04	0.01-0.02 0.015±0.04	0.01-0.01 0.01±0.04	NA
Temperature (^{0}C)	27.0-27.0 27±10.8	26.0-27.0 26.5±10.6	24.0-26.0 25.0±10.0	NA

*NA = Not available

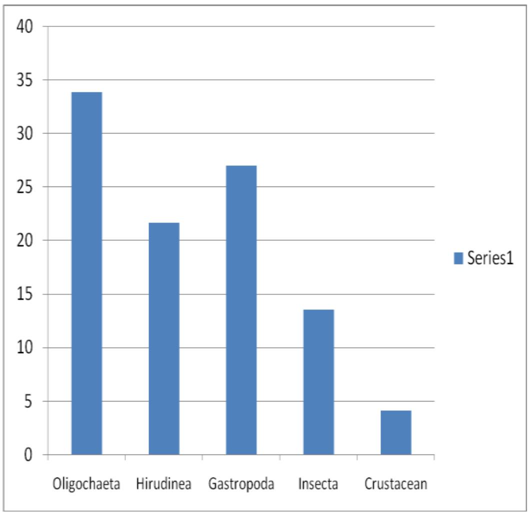

Fig 2. Mean number of individuals

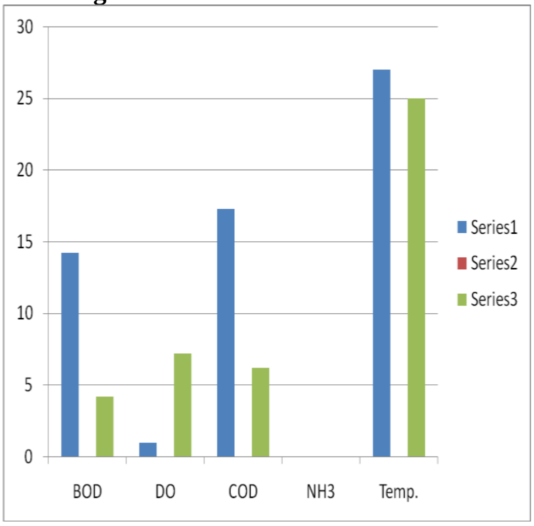

Fig 3. Mean value of the physico-chemical parameters studied in New Calabar River.

Discussion

Most taxa were recovered from a particular station which underscores the importance of such station. *Libyodrilus* sp. were recovered from two stations (1&2) as compared with Station 2 that recorded no species, this was due to slow water current. Woke &Wokoma (2006) pointed out that changes in water quality conditions such as temperature regimes and dissolved oxygen concentrations can cause a decrease in diversity and abundance of 200-benthic communities. They further stated that acute and chronic alterations in fresh water macro benthic communities can be caused by toxic pollutant from surface run off sewage discharge, industrial effluents and toxic materials such as ammonia, chlorine, heavy metals and phenols which usually cause a decrease in number of species and a shift in the species composition.

Absence of benthic organisms in Station 1 (Table 1), could be as a result of some environmental stress (physical, chemical and biological) or high level of pollution. This is supported by the high levels of BOD as well as the low levels of DO observed within the stations. Odokuma and Ijeoma (2003) stated that the pollution potential of industrial effluent discharges in the New Calabarriver was negligible and as such did not contribute to the seasonal variation in the heavy metal content of the river water and sediment during the course of their study.

*Libyodrilus*sp, *Hirudomedicinalis* and *Tubificid*sp appeared to be the most abundant species in the two polluted stations, this is because these species have the ability to withstand or tolerate high level of pollutions. These also revealed that the temperature recorded were within the ranges of 27^{0}C. These values were supported by Ombu (1987) and Chinadah and Hart (2001). They jointly reported that for water bodies in the Niger Delta Region, fluctuation in temperature were considered normal with respect to the geographical characteristics of the Niger Delta which is considered to be humid/semi hot equatorial area. Therefore, at high temperatures, the solubility of oxygen decreases while at low temperature, it increases (Plimmer, 1978).

Conclusion

From the result, it could be seen that the physico-chemical parameters of New Calabar River are determined by the amount of organic and inorganic wastes that are disposed into the river and this determines the abundance and evenness of the benthic invertebrate fauna. Therefore, the differences observed in the distribution of the benthic invertebrates indicate prevailing environmental conditions and the ability of these organisms to exploit and tolerate varied biochemical and physical properties. This paper strongly recommends the strict supervision of companies operating within the area to ensure effective treatment of the effluents before discharge and a proper waste disposal program for the inhabitants of the area.

References

Ademola, T.S. (1993). Environmental crisis and development in Nigeria. University of Port Harcourt Inaugural Lectures Series No. 13: Thompson Nig. Ltd. Pp.9-15.

APHA, (1998).America water works and water pollution control federation, standard methods for water and waste water 20th edition.

Atlas, R.M. (2003). Microbial degradation of petroleum hydrocarbons: An environmental perspective. *Microbial Reviews*, 45:180-209.

Chinadah, A.C. and Hart, A.I. (2001).Occurrence and distribution of epifauna and infauna community in shallow marine wetlands in tropical and West Africa Region.*Afric. Journal of Environmental Studies*, 1(1):76-83.

Ideriah, T.J.K., Omuani, O.T.U. and Adiukwu, U. (2004). Heavy metals contamination of soils around municipal solid waste dump in Port Harcourt, Nigeria. *Global Journal of Environmental Sciences*, 4(1):1-4.

Kobayash, H. and Ritman, B.E. (2000).Microbial removal of hazardous organic compounds.*Environmental Science and Technology*, 19:470-481A.

Margalet, R. (1967). Diversity and stability: A practical proposal and a model of interdependence, Brookhaven Symp. Biol. 20:25-37.

Merit, R.W. and Cummins, O. (1984).Introduction to the aquatic insects of Northern America, Rintech Press, London.

Morrison, G., Fatoki, O.S., Persson, L. and Ekberg, A. (2001).Assessment of the impact of point source pollution from the keiskammahoek sewage treatment plant on the keishamma, River-PH, electrical conductivity, oxygen-demanding substances (COD) and nutrients.*Water* SA, 27(4):475-480.

Odokuma, L.O. and Ijeomah, S.O. (2003). Seasonal changes in the heavy metal resistant bacteria population of the New Calabar River, Nigeria. *Global Journal of Pure and Applied Science*, 9(4): 425-433.

Ombu, E. (1987). Impacts of Okrika oil on Bonny Estuary, M. Phil. Thesis, River State University of Science and Technology, Port Harcourt.

Osibanjo, O. (1995). National waste management profile for Nig. Paper presented at the project steering committee meeting of the International Marine Organization (IMO). FEPA Nig. Case Study. Input into the global waste survey – Presidential Hotel, Port Harcourt. pp.1-15.

Pielou, E.C. (1969). An introduction to mathematical geology.Wilev-interscience. New York. pp.289.

Plimmer, R.J. (1978). Degradation methodology, chemical effects in proceeding of the workshop on microbial degradation.Pansacola Beach, Florida, pp.423-431.

Shanon, C.E. and Wiener, W. (1963).The mathematical theory of communication.University of Illinosis, Press Urban.Illinosis.pp.177.Cited by UNESCO 1991, Manual on Marine Experimental Ecosystem. UNESCO Tech. Papers in Marine Science, 61:1-6.

Woke, G.N. and Wokoma, I.P.A. (2006). Composition and abundance of benthic macro invertebrates of Nta-Wogba stream, Port Harcourt. *Global Journal of Pure and Applied Science*, 13(3):353-357.