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An Assessment of the Nematode Population in the Benthic Zone of a Tidal Freshwater Body using the Lower Reaches of the New Calabar River as a Case Study

Sidney Nzeako[1] Helen Imafidor[1] Arinze Uche[1] Iberedem Udofia[2]
1.Department of Animal and Environmental Biology, Faculty of Biological Sciences, College of Natural and Applied Sciences, University of Port Harcourt
2.Department of Microbiology Technology, School of Science Laboratory Technology, University of Port Harcourt

Abstract
An assessment of the Nematode population in the benthic zone of the New Calabar River, Choba, using the modified baermann's method yielded eight (8) species of nematode. The nematode speciation includes: *Tylenchorhynchus dubius* (8.0%), *Ditylenchus dipsaci* (4.0%), *Rotylenchus uniformis* (4.0%), *Rhabdolaimus sp* (2.0%), *Aphelenchoides ritzemabosi* (2.0%), *Tylenchus davainei* (4.0%), *Pratylenchus sp* (4.0%), and *Xiphenema sp* (4.0%). The low species richness and abundance observed were attributed to a number of factors like seasonality and influx of pollutants into the river from the abattoir, market, poultry and other human disturbances. Furthermore, the intrusion of salt into the river through its tidal effect causes silting shoreline, nutrient enrichment (from abattoirs, poultry, industries, etc), human disturbances have caused a decline in the population of *k-strategists* and an increase in proportion of *r-strategists* of which some were "ideal" soil nematodes.
Keywords: Dredging, Tidal freshwater, Abattoir, nematodes, benthic zone

1.0 Introduction

Nematodes are found in almost every kind of habitat, including water bodies, and as such can be used as bio-indicators of environmental conditions (Bongers *et al.,* 2008; Nzeako and Imafidor, 2013). Their trophic level and role in the food webs enable them ensure a continuity of the complex balance in an ecosystem's energy flow and as such can be used to pin point changes associated with natural and man-made activities in wetlands, fresh, brackish and marine ecosystems (Boyd *et al.,* 2000; Brussard and McSorley, 2006; Nzeako *et al.,* 2011). Nematodes also play a role in mineralisation and help to mop-up contaminants in the environment (including heavy metals which usually arise from industrial wastes.

Nematodes are unsegmented, round, colourless worms with elongated body pointed at both ends and have no appendages. These organisms belong to the Phylum Nematoda which houses many free-living and parasitic forms (Tsugino, 2002; Gupta and Yeates, 2004). The parasitic nematodes parasitize the skin and internal organs of other organisms, sometimes causing various levels of debilitation to the host (Hugot *et al*, 2001).

Physicochemical parameters of water play an important role in the spatial and seasonal distribution of aquatic nematodes in the water bodies all over the world. These parameters vary with different seasons and are constantly changing. The most influencing parameters include: dissolved oxygen (DO), temperature, salinity and pH (Shabdin and Othman, 1999; Moreno *et al.,* 2008).

1.1 Nematodes as Bioindicators

Nematodes have been used in pollution studies as bio-indicators due to their relatively stationary life habits, large numbers, short life cycle time, benthic larvae and intimate association with the sediments which are sites for various contaminant accumulations (Chen *et al.,* 2012). Free living nematodes have been used in both natural and experimental conditions to determine the effect of pollution in terms of nutrient enrichment and human interference. Their abundance or scarcity in any environment can be used to deduce the level of pollution (Ferris and Benelman, 2003). This is possible through their permeable cuticle which allows some to soak up pollutants and respond in a variety of ways (boy diet al., 2000). Nematode species, abundance, diversity, distribution patterns and community structure can be used in ecological monitoring and assessment. They are also able to undergo cryptobiosis, osmobiosis, anoxybiosis as well as throbiosis involving sulphide detoxification mechanism. These are inactive resistant stages which allow them to survive adverse environmental conditions and even high pollution phases (bongers, 2000: Mcmullin *et al.,* 2000; Tahseen, 2012).

Channelling of wastes into the aquatic environment is a global problem which most times leads to eutrophication which could cause an increase or decrease in the nematode population of any given water body. In the Niger Delta region of Nigeria, bedevilled by immense oil exploration, industrial wastes and oil spills have constantly found their way into the water bodies, yet there is scanty information on the impact of the industry on specific nematode fauna of the aquatic system (Asimiea and Gobo, 2012).

On this premise, this study was designed to determine the species density or abundance of nematodes and the effect of physicochemical parameters on the nematode community composition in the New Calabar River.

2.0 MATERIALS AND METHODS

2.1 Study Area

Samples were collected from the lower reaches of the New Calabar River of Rivers State in the Niger Delta region of Nigeria. The river is a rare tidal freshwater body which lies between longitude 7°60'E and latitude 5°45'N and empties into the Atlantic Ocean. The river, which is used as a domestic and industrial waste disposal point for companies and people living close to it, also houses an abattoir, poultry, market and many local toilets where their wastes are channelled into the river untreated. Dredging and fishing are also a common practice found in the river.

The study area, which represents the entire course of the lower reaches of the New Calabar River, consists of five (5) selected points of 0-20cm of bottom sediment in the river includes: Core 1: lies on longitude 6°53'34.19"E and latitude 4°53'12.45"N; Core 2: lies on longitude 6°53'53.08"E and latitude 4°53'19.02"N; Core 3: lies on longitude 6°53'53.40"E and latitude 4°53'28.86"N; Core 4: lies on longitude 6°53'54.39"E and latitude 4°53'37.35"N and; Core 5: lies on longitude 6°53'55.83"E and latitude 4°53'47.36"N.

2.2 Sediment Sample Collection

An Eckman dredge was used to collect bottom sediment from the river from a boat anchored at the desired points in the river. Five (5) cores were collected in properly labelled containers and taken to the laboratory for nematode extraction within 12hours of collection.

2.3 Laboratory Nematode Extraction

Ten (10) sub-samples were collected from the main samples and sediments from each core (1-5) were properly mixed individually to get an even mixture of water and sediment. Out of each of the cores, ten (10) sub-samples were collected and placed on ten (10) already prepared extraction apparatus in line with baermann's method (Baker, 1985) as modified by Nzeako (2013). The extraction apparatus was allowed to stand in normal room temperature for 48hours.

After 48hours, the nematode aliquot was conserved in 50cl beakers and allowed to sediment. 10% formaldehyde was added to each of the beakers containing the nematode aliquot. After 2hours, 10cl of the supernatants were discarded. The contents of the beaker (40cl) were then centrifuged at 1000rpm for 180seconds and the sediments stored in universal sample vials for onward identification.

2.4 Microscopy

Microscopy was done using the binocular microscope at x10 and x40 magnification. Nematodes were identified using Goodey and Goodey (1963).

3.0 RESULTS

3.1 Physicochemical parameters of the New Calabar River

Table 3.1 shows the physicochemical parameters of the river which was taken from the dermasal waters of the river. The dissolved oxygen ranged from 3.80-3.98mg/L, the salinity ranged from 0.02-0.05°/₀₀, conductivity ranged from 0.05-0.11 ms/m-1, temperature ranged from 24.5-25.7°C and pH ranged from 4.82-5.18.

3.2 Nematode Distribution in the New Calabar River

Table 3.2 shows that a total of 50 samples were obtained at 5 sampling cores from The New Calabar River for nematode population. Data shows that a total of 16(32.0%) nematodes were recovered from the 50 sampled sediments. Data also indicated that core C number 8 had the highest population of 9(18.0%) nematodes, followed by core A number 1 where a population of 2(4.0%) of the total recovered nematode were obtained. Core C had the highest nematode population 13(81.3%), followed by core A which had 2(12.5%), core B had the least nematode population of 1(6.3%) while Cores D and E had no nematodes.

3.3 Nematode Specie Distribution in the New Calabar River

Table 3.3 shows a total of 8 nematode species and 2 unknown species extracted in the 50 sediment samples examined, giving a total population of nematode fauna of 16(32.0%). The species diversity include: *Tylenchorhynchus dubius* (8.0%), *Ditylenchus dipsaci* (4.0%), *Rotylenchus uniformis* (4.0%), *Rhabdolaimus sp* (2.0%), *Aphelenchoides ritzemabosi* (2.0%), *Tylenchus davainei* (4.0%), *Pratylenchus sp* (4.0%), and *Xiphenema sp* (4.0%).

4.0 DISCUSSION AND CONCLUSION

4.1 Discussion

The New Calabar River is a rare tidal freshwater body located in the heart of the Niger Delta and its nematode fauna was investigated and a total eight (8) species of nematode were extracted (table 3.3). This low species richness and abundance is in agreement with study by Nzeako *et al.*, (2011) and Asimiea and Gobo, (2012), although nematode speciation differed slightly. This could be attributed to a number of factors like seasonality and influx of pollutants into the river from the abattoir, market, poultry and other human disturbances.

Dredging in the river is still ongoing, this has an effect on the benthic community as the sediment is constantly changing and nematode communities are usually affected. Larger predatory nematodes disappear and smaller opportunistic deposit feeders abound (Vanaverbeke *et al.,* 2007; Simonini *et al.,* 2005).

The physicochemical parameters as shown on Table 3.1, showed that the pH (4.82-5.18) was acidic and disagreed with study by Abu and Egenonu, (2008), Edun and Efiuvwevwere, (2012), while the other parameters were just slightly different or similar in some cases.

Guidelines by ANZECC and ARMCANZ, (2000) and EPA, (2006) freshwater disagreed with the pH level observed in this study. However, the DO level, salinity, conductivity and temperature were in line with the guidelines provided by the aforementioned bodies. The present acidity level of the river can also be a culprit to the new reduced species of nematode extracted in the course of the study. This acidity is brought about by the decay process of wastes from the poultry, abattoir, market, industrial and other human activities. This change in pH level can erode the cuticle of nematodes leading to a decline in their population. Takeuchi *et al.,* (1997) reported drastic impact observed on nematodes and bacteria under conditions of ph 5.5-6 or less.

The intrusion of salt into the river through its tidal effect causes silting shoreline (Haruko *et al.,* 2007), nutrient enrichment (from abattoirs, poultry, industries, etc), human disturbances have caused a decline in the population of *k-strategists* and an increase in proportion of *r-strategists* of which some were “ideal” soil nematodes (Bongers *et al.,* 1991).

4.2 Conclusion

This study calls to heart the effect of pollution in a water body and the possibility of the use of nematodes as bio-indicators of pollution in the Nigerian waters. Nematodes and other aquatic organisms are sensitive to disruptions in the aquatic environment and as such disruptions in form of dredging, waste disposal, and certain structures like poultry and abattoir should be discouraged to ensure a safe environment for these overtly important aquatic resources.

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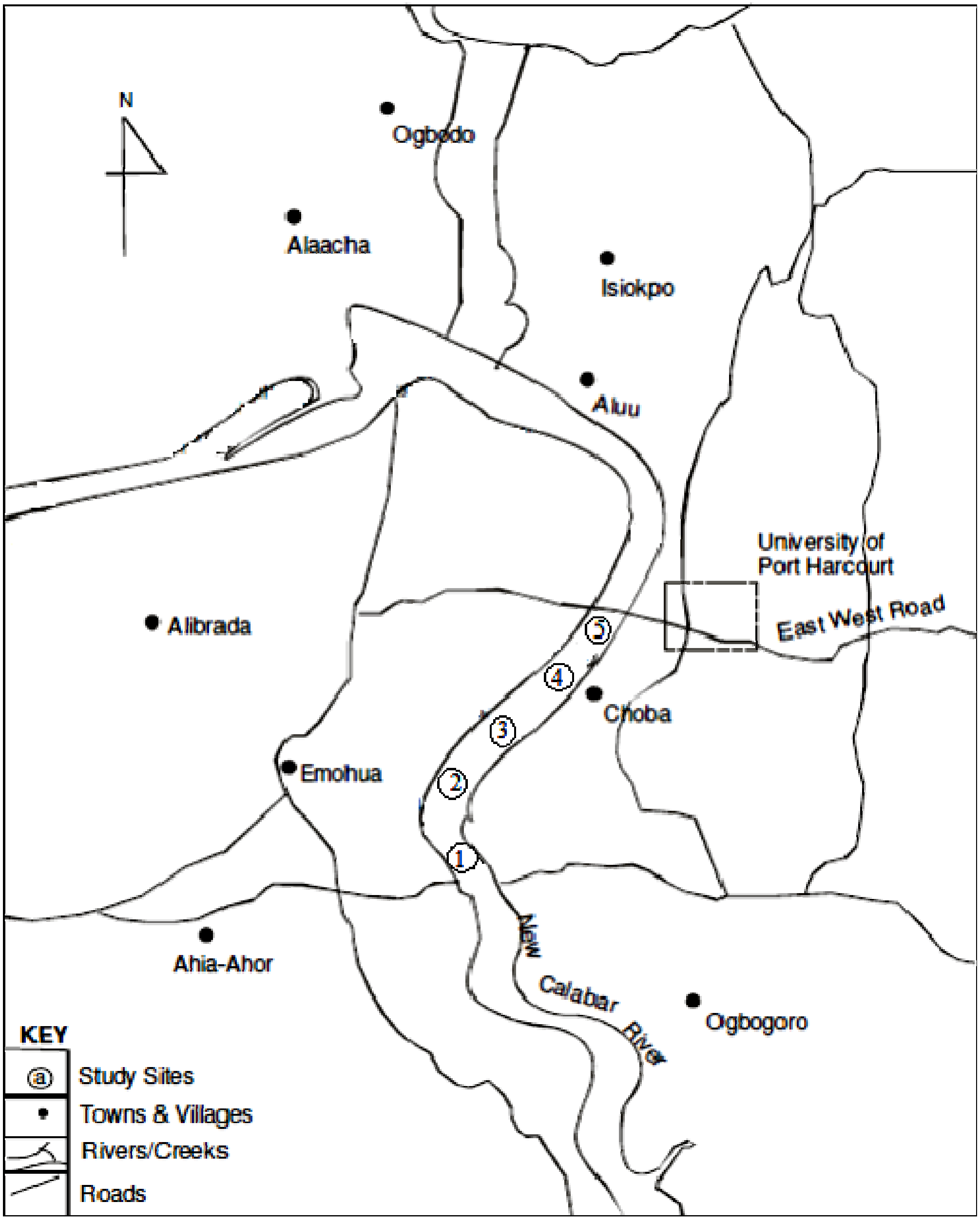

Figure 2.1: Map of the study area

Table 3.1: Physicochemical parameters of the New Calabar River

CORE	DISSOLVED OXYGEN (mg/L)	SALINITY (°/₀₀)	CONDUCTIVITY (ms/m-1)	TEMPERATURE (°C)	pH
A	3.80	0.05	0.08	24.8	4.82
B	3.82	0.05	0.11	25.7	4.92
C	3.97	0.03	0.05	25.5	5.15
D	3.98	0.02	0.05	25.2	5.18
E	3.94	0.03	0.06	24.5	5.10

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Table 3.2: Nematode Distribution in the New Calabar River in Relation to Site

	Core	Designation				
Number	A	B	C	D	E	**Overall Total (%)**
1	2	0	0	0	0	**2(4.0%)**
2	0	0	0	0	0	**0(0.0%)**
3	0	0	0	0	0	**0(0.0%)**
4	0	0	0	0	0	**0(0.0%)**
5	0	1	0	0	0	**1(2.0%)**
6	0	0	1	0	0	**1(2.0%)**
7	0	0	1	0	0	**1(2.0%)**
8	0	0	9	0	0	**9(18.0%)**
9	0	0	1	0	0	**1(2.0%)**
10	0	0	1	0	0	**1(2.0%)**
Total (%)	**2(12.5)**	**1(6.3)**	**13(81.3)**	**0(0.0)**	**0(0.0)**	**16(32.0%)**

* Mean Population of nematode in 1ml of aliquot

Table 3.3: Nematode Specie Distribution in the New Calabar River

Specie	**Population (%)**
Tylenchorhynchus dubius	4(8.0)
Ditylenchus dipsaci	2(4.0)
Rotylenchus uniformis	2(4.0)
Rhabdolaimus sp	1(2.0)
Aphelenchoides ritzemabosi	1(2.0)
Tylenchus davainei	2(4.0)
Pratylenchus sp	2(4.0)
Xiphenema sp	2(4.0)
Total (%)	**16(32.0)**

* Mean Population of nematode in 1ml of aliquot