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Nematodes of new calabar river: A tropical freshwater body

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ABSTRACT

A study to determine the response of nematodes as bio-indicators of environmental alterations was carried in the New Calabar River in the Niger Delta. Samples were randomly collected from the benthic zone of the River using the modified Baermann's technique. The study yielded sixteen (16) nematodes belonging to three (3) families and eight (8) species. The nematode speciation include: The nematode speciation include: include: Aphelenchoidesritzemabosi. 1 (6.25%), Dorylaimusstagnalis 2(12.5%), Mononchusaquaticus 1(12.5%), Plectus spp.(12.5%), Pratylenchusspp 2(12.5%), Rhabdolaimus spp. 1(6.25%), Tylenchusdavainei 2(12.5%) and Tylenchorhynchusdubius 4(25%). The low species richness and abundance observed in the study were attributed to ecological factors such as seasonality, ecological characteristics of the river and anthropogenic activities. The influx of organic pollutants and other municipal wastes were associated with the occurrence of hydrobiont nematode species while the influx of run-offs into the river resulted to the occurrence of terrestrial nematodes; edaphobionts. However, the variability observed in the occurrence of the r-strategist and k-strategist nematodes depict a flux in ecological characteristics of the habitat. The study buttresses the sensitivity of nematodes to negligible ambient bio-physicochemical alterations in the ecosystem.

Keywords: Species richness and abundance, hydrobiont, edaphobiont, r-strategist, k-strategist and bio-physicochemical alterations

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INTRODUCTION

The physicochemical characteristics of any plane determine the integrity of the life forms it will accommodate. The ambient physicochemical status of such environment specifically can impact the behaviour, spatial distribution, abundance, species diversity of organisms such as the meiofauna; nematodes, found in such habitats (Poiras, 2008; Poiras*etal*., 2008, Antofica, 2010, Hagerbaumer, *etal*., 2015). Generally, nematodes life strategies (functional guilds) fluctuate constantly due to the presence of pollutants that alter the physicochemical characteristics of their environment (Bongers and Bongers, 1998). Studies by Shabdin and Othman,(1999) and Moreno *et al.*, (2008) state that dissolved oxygen (DO), temperature, salinity and pH show great variability in the environment however, they are the most influencing physicochemical parameters. According to Gerlach and Schrage, (1992) temperature seems to be the most important physicochemical property that affects the adaptability of free- living nematodes in aquatic media. They stated that nematodes life cycle alter greatly in relation to temperature variation (between 13-30months at ±7˚C and 2-30days at 18-30˚C).

Nematodes as Bioindicators
The Phylum Nematodahouses many free-living and parasitic worms that play prominent roles in mineralization and help to mop-up contaminants in the environment including heavy metals which usually arise from industrial wastes (Tsugino, 2002;Gupta and Yeates, 2004). However, the parasitic forms parasitize the skin and internal organs of other organisms including plants (Hugot*et al*., 2001).Nematodes are common in almost every kind of habitat, including water bodies, and as such can be used as temporal bio-indicators of environmental conditions (Bongers*et al*., 2008; Padma and Rahza, 2008). Their trophic level and role in the food web enable them ensure continuity of the complex balance in the ecosystem's energy flow making them reliable indicator agents of negligible alterations in the physicochemical–biological status of a habitat (Boyd *et al*., 2000; Brussard and McSorley, 2006; Nzeako*et al*., 2011).

The characteristics of nematodes; relatively stationary life habits, large numbers and diversity, benthic larvae and intimate association with the sediments which are sites for various contaminant accumulations and short life cycle time, support their usage in pollution studies as bio-indicators (Warwick, 1993; Chen *et al*., 2012). As a significant component of the indicator system they are of great use in identifying habitats with poor ecological status and to link this status to the presence of chemical pollution or other types of stress, including hydro-morphological modifications and climate change (e.gVon der Ohe et al., 2007, Vob der Ohe and Goedkoop, 2013). Nematode population dynamics studies have been frequently used to deduce the level of pollution in terrestrial and aquatic environments (Ferris and Benelman, 2003). The free living nematodes species have given nematologists insight about the intricacies involved insoil nutrient cycle in polluted environments. Nematode species, abundance, diversity, distribution patterns and community structure can be used in ecological monitoring and assessment. Their numerous quiescent strategists; cryptobiosis, osmobiosis, anoxybiosis as well as throbiosis involving sulphide detoxification mechanism make them very sensitive organism for environmental impact assessment studies. These inactive resistant stages allow these worms to survive adverse environmental conditions including; high pollution phases (Bongers, 2000: Mcmullin*et al*., 2000; Tahseen, 2012).

According to Balsamo(2012) the input of organic matter into the aquatic environment usually has deleterious effects on the benthic community due to up-shoots in nutrient levels that eventually initiate stiff competition for bio available oxygen amongst inhabiting organisms. The channeling of wastes into the aquatic environment is a global problem that most times leads to eutrophication. Eutrophication results tosignificant alterations in the nematode population of any water body due to dysoxic-anoxic conditions (Alves, 1995). The Niger Delta region of Nigeria is bedeviled by immense hydrocarbon exploitation occasioning theinflux of industrial wastes and oil spills into the water bodies.This scenario consequently fuels the incessant reports of ecological degradation and its impact on the faunal integrity in the region. However, little or nothing is heard of a major animal taxon nematodes; nematodes in the evaluation of the environmental health status (Asimiea and Gobo, 2012, Nzeako*etal*., 2015). It is pertinent to evaluate the physicochemical characteristics of the New Calabar River and its influence on the nematodes composition.

MATERIALS AND METHODS

Study Area
Samples were collected from the lower reaches of the New Calabar River of Rivers State in the Niger Delta region of Nigeria (Figure 1). 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 serves as a receptacle to industrial and municipal wastes (sewage). Dredging and fishing activities are common practices sustained by the river. The river also houses a number of industries, an abattoir and a market.

The study encompassed the entire course of the lower reaches of the river consisting of five (5) sampling points (0-20cm of bottom sediment). The sampling stations include: Core 1: lies on longitude 6°53′34.1″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.

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.

Nematode Extraction andMicroscopy
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 reported by Baker(1985) and modified by Nzeako, *etal*., (2015). Microscopy was done using the binocular microscope at x10 and x40 magnification and Stereoscopic microscope. Nematodes were identified using the key by Goodey and Goodey (1963).

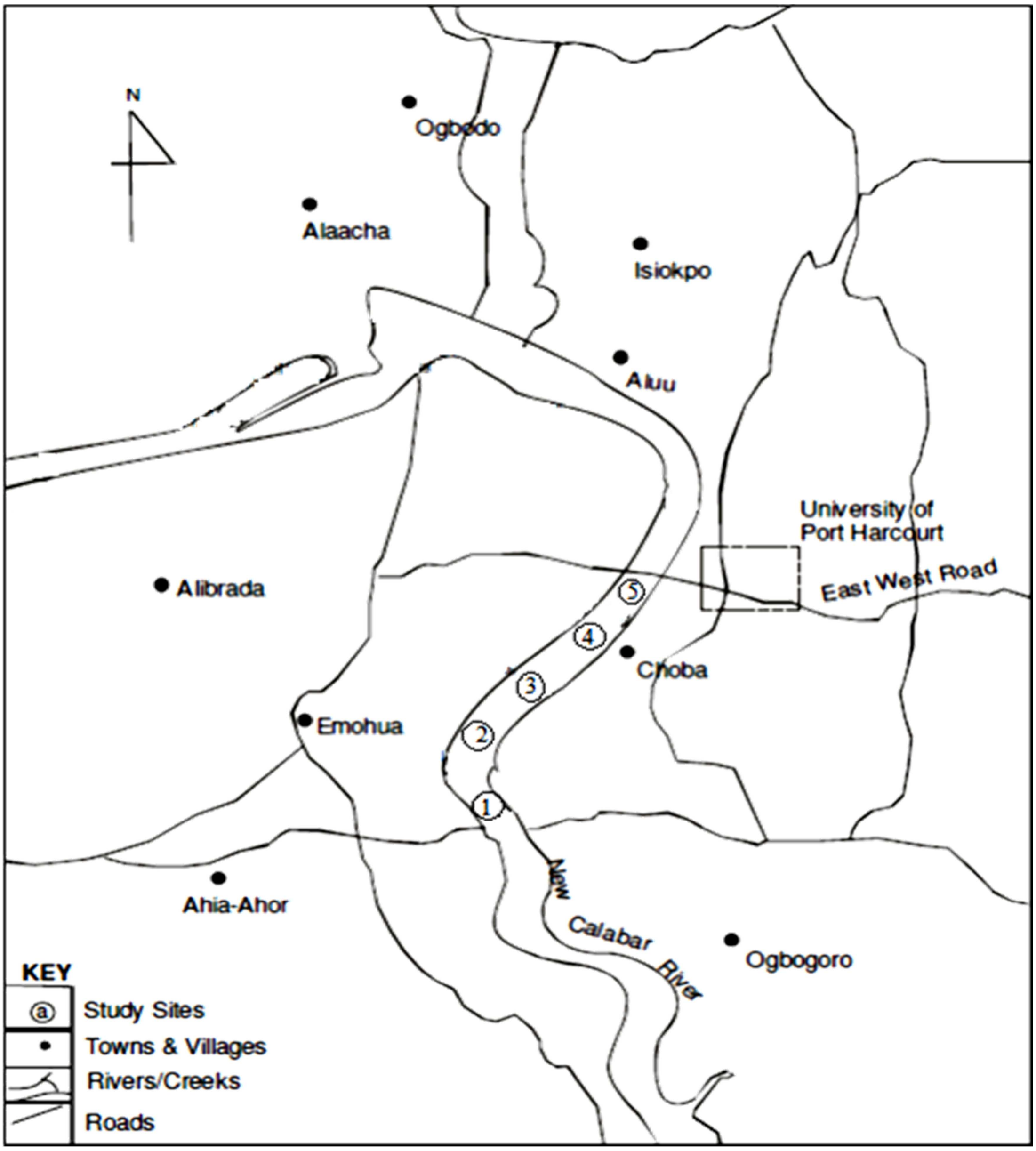

Figure 1: Map of the study area

RESULTS

Physicochemical parameters of the New Calabar River

The physicochemical parameters of the river are as follows; dissolved oxygen ranged from 3.80-3.98mg/L; salinity ranged from 0.02-0.05°/∞; conductivity ranged from 0.05-0.11ms/m-1; temperature ranged from 24.5-25.7°C and pH ranged from 4.82-5.18(Table 1).

Table 1;Physicochemical parameters of the New Calabar River

Core	Dissolved Oxygen (Mg/L)	Salinity (°/∞)	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

Nematode Distribution in the New Calabar River

A total of 50 samples were obtained from five (5) sampling cores designated- A, B, C, D and E in the study. A total of 16(32.0%) nematodes were recovered from all the samples. Data also indicated variability in the population of nematodes recovered from the various sampling points (Table 2.) 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. A total of sixteen (16) nematode belonging to three (3) families and eight (8) were recovered from the examined sediment(Table 3.) The species diversity include: *Aphelenchoidesritzemabosi*1(6.25%), *Dorylaimusstagnalis* 2(12.5%),*Mononchusaquaticus*1(12.5%), *Plectus*spp. 2(12.5%), *Pratylenchus*spp2(12.5%), *Rhabdolaimus*spp.1(6.25%),*Tylenchusdavainei*2(12.5%)and *Tylenchorhynchusdubius*4(25%).

Table 2., Nematode Distribution in the New Calabar River in Relation to Site

No of Samples	Core Designation					Overall Total(%)
	A	B	C	D	E	
1	2	0	0	0	0	2(12.5%)
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(6.25%)
6	0	0	1	0	0	1(6%.25)
7	0	0	1	0	0	1(6.25%)
8	0	0	9	0	0	9(56.25%)
9	0	0	1	0	0	1(6.25%)
10	0	0	1	0	0	1(6.25%)
Total (%)	2(12.5)	1(6.25)	13(81.25)	0(0.0)	0(0.0)	16

***** *Mean Population of nematode in 1ml of aliquot*

Table 3: Nematode Specie Distribution in the New Calabar River

Nematode Genera/Species	Population (%)	Feeding type	Life strategy(c-p value)
Aphelenchoidesritzemabosi	1(6.25)	1b,e,f or 2	c-p2(r-strategist)
Dorylaimusstagnalis	2(12.5)	8	c-p5 (k-strategist)
Mononchusaquaticus.	2(12.5)	5a	c-p4 (k-strategist)
*Plectus*spp.	2(12.5)	3	c-p2 (r-strategist)
*Pratylenchus*spp.	2(12.5)	1b	c-p3(plant parasitic)
*Rhabdolaimus*spp.	1(6.25)	3	c-p3(k -strategist)
Tylenchusdavainei	2(12.5)	1f, or 2	c-p2(plant parasitic)
Tylenchorhynchusdubius	4(25)	1d	c-p1(plant parasitic)
Total	**16**		

***** *Mean Population of nematode in 0.1ml of aliquot, Numbers represent the feeding type typology according to Yeates et al., (1993) and Neheret al.,(2004). rand k-strategists…Bongers, (1990).*

DISCUSSION

The nematode fauna of New CalabarRiver a rare tidal freshwater body located in the heart of the Niger Delta comprised of eight (8) species of nematodes (Table 3.3). The recorded low species richness and abundance agrees with Asimiea and Gobo (2012), however, sampling and extraction factors are also opined to have significantly influenced this outcome (McSorley 1987 and 2003). However, the Simpsons Index of diversity indicates that the river has a value of 0.908, indicating a high species diversity (Appendix 1).It is envisaged that seasonality and influx of pollutants into the river from abattoirs, markets, agricultural establishments and other numerous anthropogenic factors may have impacted the River (Nzeako*etal*., 2014 and 2015). Continuous dredging of the water body for economic purposes had made the entire river course vulnerable to exploitation which invariably influences the microfaunal population structure of the habitat. These anthropogenic disturbances manifested in the skewed population of the k-*strategists* nematodes in relation to the r-*strategists*nematodes in the study (Table 3).

This result points out that the water body is slightly polluted hence the moderate population of colonizers observed in the study. This assertion is not entirely true, because, the nematodes with low (c-p values;1-2) c-p values were relatively more if the plant parasitic nematodes are added. Bongers*etal*., (1991) stated that environmental stress encourages the increase in r-strategists nematodes with a corresponding decrease in the k-strategists nematodes. Considering, the impression created by MacArthur and Wilson (1967), it could be inferred that the occurrence of k-strategists nematodes in the study indicates relative competiveness in a crowded population. However, this scenario does not include the presentation of plant parasitic nematodes in the brackish system. The river's status as a receptacle for run-off and municipal wastes from the hinder land must have influenced this occurrence. This result is in agreement with Nzeako*etal.,* (2015) who reported the occurrence of terrestrial nematodes in the aquatic environment of River Nun.

The continuous dredging of the river is believed to harbour grave consequences on the benthic community due to the inconsistency in the composition of sediment. This inconsistency is reflected in the population dynamics of the microfauna for instance; nematode community composition where larger predatory nematodes disappear and smaller opportunistic deposit feeders abound (Simonini*et al.*, 2005;Vanaverbeke*et al.*, 2007). There is the possibility that the nematode community in the river frequently assume extreme survival mechanisms such as quiescence in this highly variable environment as outlined by (Cooper, *etal*., 1971; Wharton 1986; McSorley, 2003).

The physicochemical parameters as shown in 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)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. This result further confirms the studyby Takeuchi *et al.,* (1997) who reported drastic impacts on nematodes and bacteria under conditions of pH 5.5-6 or less.

The study chronicles the presence of *D. stagnalis* and *M. aquaticus*; hydrobionts that flourish in organic waste impacted aquatic environments (Antofica*etal*., 2010). The presence of *Aphelenchoides* spp. and *Plectus*spp. a typical fungiphorous and bactriophorous nematodes respectively show great diet flexibility and availability mycelial biomass or alternate substrates that encourage microbial growth in the River (Peach, 1950, Hao, *etal*., 2005, Swe*et* al., 2009 and Nabil and Walter, 2015). On the other hand, *Plectus* spp. occurrence points at a high biomass of bacteria cells occasioned by influx of However, the dominance of the endophobionts; nematodes belonging to the Orders- Rhabditida, Aphelenchida, Tylenchida and Dorylaimida indicate the significant role of flooding on the nematode assemblage in the studied water body. Antofica*etal*., (2010) describes the endophobionts as terrestrial nematode species that occur in aquatic environment casually. The intrusion of salt into the river through its tidal effect causes silting of shoreline (Haruko*et al.*, 2007), nutrient enrichment (from abattoirs, poultry, industriese.t.c) and human disturbances which cause decline in the population of *k-strategists* and an increase in proportion of *r-strategists* of which some were "ideal" terresterial nematodes (Bongers*et al.*, 1991).

CONCLUSION

The study documents the presence of *D.stagnalis* and *M. aquaticus*; hydrobionts that flourish in organic waste impacted aquatic environments and the abundance of edaphobionts. The edaphobionts showed great oscillation between the obligatory parasitic life style of hydrophytes or ephemeral amphibiontsor typical terrestrial nematodes of agricultural importance. This wide ecological adaptability of the majority of nematodes in this study suggests nutrient enriched environment and a habitat with inconsistent ecological characteristics. This study buttresses the significance of nematode population dynamics and community composition in environmental health assessment studies. The study also reveals occurrence of terrestrial nematodes in aquatic ecosystem predisposed by inflow of run-offs into rivers, lakes and ponds.

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APPENDIX 1 SPECIE INDEX OF DIVERSITY

Nematode Genera/Species	Population	n*(n-1)	D=∑n(n-1)/N(N-1)	Simpson's Index (1-D)
Aphelenchoidesritzemabosi	1	0.0000	0.092	0.908
Dorylaimusstagnalis	2	2.0000		
Mononchusaquaticus.	2	2.0000		
*Plectus*spp.	2	2.0000		
*Pratylenchus*spp.	2	2.0000		
*Rhabdolaimus*spp.	1	0.0000		
Tylenchusdavainei	2	2.0000		
Tylenchorhynchusdubius	4	12.0000		
Total	**16**	**22.0000**		