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The Distribution and Seasonality of Zooplankton in Sombreiro River, Niger Delta, Nigeria

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Abstract: The distribution and seasonality of zooplankton in Sombreiro River of the, Niger Delta area in Nigeria was studied for a period of two years (August, 2007-July, 2009). All the zooplankton species occurred in all the stations except *Mysis* sp that was not recorded in station 4 (Odiemudie). Also all the stations recorded seventeen species (17) each except station 4 (Odiemudie) that had sixteen (16) species. Five species of Cladocera occurred in all the stations and were fairly distributed. In station 2 *Alonella costata* was the highest (35.7%). This was followed by *Moina cacrocapa* (34.2%) station 2 (Ogbele). Five species of Copepoda were fairly distributed in all the stations. *Acanthocyclops, carinetus* (53.1%) was the highest in station 1. This was followed by *Cyclops stenuis* (47.2%) station 1. Only one specie of Decapod crustacean was recorded. This was recorded in station 1, 2 and 3 but absent in station 4. Station 1 had the highest percentage of 44.9 followed by station 3 with 28.6%. Only one specie of Euphasiacea (*Meganicilphanes norvegia*) was recorded and it occurred in all the stations with station 1 having the highest percentage of 41.8 followed by station 4 (24.1%). Three species of Protozoa were recorded in all the stations. They were fairly distributed. *Tintinopsis senensis* was the highest in station 3 with a percentage occurance of 45.8. This was followed by *Halteria* sp. (39.2%) in station 3 also. The two species of Rotifera were also fairly distributed in all the stations. *Brachionus falcatus* was the highest in station 3 followed by *Brachionus calyciflorus* (32.3) in station 3 also. Annual variation result showed that *Paracyclops fimbriatus* had the highest mean value 20.417±10.422 (August 2007 - July 2008), 17.333±9.306 (August 2008 - July 2009). This was followed by *Cyclops stenuis* 18.167±12.494 (August 2007 - July 2008) 16.250±10.847 (August 2008 - July 2009) and *Meganicliphanes norvegia* 17.417±11.540 (August 2007 - July 2008), 14.667±6.596 (August 2008 - July 2009). The least was *Mysis* sp. 2.083±2.539 (August 2007 - July 2008), 2.833±3.857 (August 2008 - July 2009). There was no significant variation in the mean values of the two years studied 10.123±0.5656 (August 2007 - July 2008), 9.220 ± 0.4679 (August 2008 - July 2009). Seasonal variations occurred in the abundance of *Acanthocyclops carinetus* (10.822±8.176 Wet, 22.714±10.209 Dry) and *Mysis* sp. (1.236±2.411 Wet, 5.429±3.101 Dry). Other species did not show significant variations. The mean of the wet and dry season showed significant variation 8.799±0.418 wet and 11.790±0.707 dry. For the 4 stations studied diversity (S) ranged between 16 species (Odiemudie) and 17 species (Degema, Ogbele and Ihuaba). Abundance of individuals (N) of the stations ranged between 708 (Odiemudie and 1202 (Degema). Margalef index (d) values ranged between 2.256 (Degema) and 2.345 (Ogbele). The values for Shannon-Wiener index (H) ranged between 1.074 (Degema) and 1.204 (Ogbele). Pielou's index of relative density or evenness were between 0.870 (Degema) and 0.978 (Ogbele). Simpsin's Dominance Index (C) ranged between 0.065 (Ogbele) and 0.107 (Degema).

Key words: Distribution, Niger Delta, Nigeria, seasonality, Sombreiro River, Zooplankton

INTRODUCTION

Zooplanktons are animal that drift in water column. They graze on primary producers and on organic debris in the water column and thereby play an important role in the integration of energy budget of the ecosystem (Anene, 2003). Zooplanktons are useful indicator of future fisheries health because they are a food source of organisms at higher trophic levels (Davies *et al*., 2008). The biomass, abundance and species diversity of zooplankton are used to determine the conditions of aquatic environment (MBO, 2007).

Zooplankton organisms are identified as important component of aquatic ecosystems (Okogwu, 2010). They

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help in regulating algal microbial productivity through grazing and in the transfer of primary productivity to fish and other consumers (Dejen *et al*., 2004), Okogwu (2010) reported that by grazing on phytoplankton and bacteria zooplankton help in improving water quality. Pinto-Coetuo *et al*. (2005) reported that zooplanktons are considered indicators of water quality.

Zooplanktons make up an invaluable source of protein amino acids, lipids, fatty acids, minerals and enzymes and are therefore an inexpensive ingredient to replace fishmeal for cultured fish (Kibria *et al*., 1997). Zooplanktons are of great importance in bio-monitoring of pollution (Davies *et al*., 2008). They are key component of marine ecosystem. The nature of species occurring, diversity, biomass and season of maximum abundance of zooplanktonic organisms differ in water bodies (FAO, 2006).

The copepod crustaceans are free-living filter feeder zooplankton and are used in bio-monitoring of pollution. They are homoiosmotic; thus any information of pollutants into the ecosystem unit have effect on the metabolism of the fauna and will also cause ecological disturbance in the system. The abundance and species composition of zooplankton are used to assess the biological integrity of the water body. Carney (1990) reported that most zooplankton migrate upward from deeper strata as darkness approaches and return to the deeper areas at dawn. Zooplankton density may be limited by both turbidity (which limits phytoplankton production upon which the zooplankton depend) and by river flow (Mclusky, 1981).

Sombreiro River is one of the numerous water bodies in the Niger Delta of Nigeria providing nursery and breeding grounds for a variety of fish species and other aquatic fauna. The large wetlands and coastal waters of Nigeria, in particular the Niger Delta have great potentials for commercially important fishery (Powell, 1985). The Niger Delta is the richest part of Nigeria in terms of natural resources with large deposits of petroleum products (Moffat and Linden, 1995; Braide *et al*., 2004).

Similarly, the vast coastal features which include forest swamps, mangrove, marsh, beach ridges, rivers, streams and creeks serve as natural habitats for various species of flora and fauna (Alalibo, 1988; Jamabo, 2008). The stretch of the Sombreiro River is one of the most important river systems in the Niger Delta providing nursery and breeding grounds for a large variety of fish species (Ezekiel *et al*., 2002). Research into the composition an abundance of zooplankton in Sombreiro River is important to determine their occurrence in natural conditions.

MATERIALS AND METHODS

Study area: The study was carried out in Sombreiro River, in the Niger Delta of Nigeria for a period of two years (August, 2007-July, 2009). It is one of the rivers that drains the western part of Rivers State. The river provides nursery and breeding grounds for a large variety of fish species (Ezekiel *et al*., 2002). Four sampling stations were established along the length of the Sombreiro River whenever, it was accessible by road. Sombreiro River is located in three local government areas of Rivers stale-Ogba/Egbema/Ndoni and Degema between Latitude 6º30′ and 7º0′ E and Longitude 4º12′ and 6º17′ N. It is a distributary of the River Niger which arises from northern boundary of Rivers State with Imo State. it is one of the series of the Niger Delta rivers which drain into the Atlantic Ocean and is connected to other rivers via creeks in the coastal area of the Niger Delta (Ezekiel, 1986, 2001).

The river is narrow and steep as it flows southwards, it widens and the steep sidedness gradually disappears starting from the middle reaches. The system is lotic throughout the year; the lotic period reaches its peak in January to February (dry season) when the water level has fallen to the maximum. In August-September (wet season), the lotic nature of the river is reduced due to flooding (Ezekiel, 1986). The river is contained within the tropical rainforest although the lower reach is within the brackish mangrove zone.

From upstream the river bed consists of stones and gravels, the middle zone tending to be sandy with the sand bed giving way to a muddy one at the lower reach of the river (Ezekiel, 1986). A part from areas of human disturbance, the river is fringed by riverine forest. Numerous human activities such as fishing, sand nuning, dredging, mangrove cutting, logging of timber and transportation. These may be potential sources of pollution to the environment. Public toilets were observed at each of the sampling stations. Also observed were refuse dumps and run-offs into the river from the rivernie communities. The wastes from the comities may constitute source of pollution to the river.

Four sampling stations were established along the length of Sombreiro River. Stations were chosen in a such a manner to provide for even spread for effective sampling. Each of the stations was visited once a month, usually between the 15th and 22nd. Photographs were taken of each station to illustrate the habitat. Only qualitative description of stations were made in order to classify the stations according to general habitat types. The four stations investigated in this study are described below on the basis of personal visual observations.

Station 1 (Degema): This is the largest of all the sampling stations. The vegetation fringing the river at the left and right banks consists of mangrove plants such as Rhizophora, Avicennia and Nypha Fruticans (Nypa palm), arising from a characteristic muddy substrate that produces a foul odor. The water is highly turbid in the rainy months and clear in the dry months. This station is

a brackish and tidal environment. There is no observable unidirectional flow of the water at this station due to the very wide nature of the river; thus the surface current is not very distinct to be determined. The bed of the river at this station is a mosaic mud and sand. No farmland was observed at this station but there were public toilets which discharge human wastes directly into the river.

Station 2 (Ogbele): At station 2, mangrove vegetation is replaced by riverine forest consisting mainly of *Raphia*, *Pandanus*, *Sanderiana*, *Calamas* sp. (swamp cane), *Khaya* sp. (Mahogany), *Vapaca* sp., *Ficus Vogeliana* and *Triculia african*. Aquatic marcophytes include *Nymphace* sp., *Eichornia crassipes*, *Sagittana* sp., *Pistia stratictes*. The station was flooded in the rainy season when the current velocity is slow. The station has a little tidal influence from the immediate tidal mangrove zone. The bed of the river at this station consists of sand and small gravel. No farmland was noticed but there were public toilets which discharge human wastes directly into the river.

Station 3 (Ihuaba): The vegetation fringing the river at this station is a mixture of riverine and terrestrial vegetation although no farmland was seen. The common plants noticed here are the Raphia and *Elaeis guineensis* (palm trees). The aquatic macrophytes include *Typha lotifolia* (cat tail) and *Potamogetom* sp. (pond weed). The station was flooded from August to October with the flood receding from November to February. The speed of the current is slow in the rainy season. The bottom of the river at this station consists of sand and gravel of various sizes. No farmland was observed but there were public toilets which discharge human waste into the river.

Station 4 (Odiemudie): The vegetation consists of a terrestrial vegetation in which can be seen farmland, and riverine vegetation extending into a large area of swamps. Some include *Raphia*, *Pandanus Sanderiana Elaeis guineensis* (palm trees) Aquatic macrophytes include/ Pomea aquatica, *Lemna* sp. (duck weed), *Utricularia* sp., *Nympaea* sp. and *Pistia stratiotes* (water lettuce). Current is moderate in the rainy months, becoming fast in the dry months when the flood recedes. The water is clear and the bottom consists of small stones, gravel of various sizes and sand.

Sample collection: In each of the sampling stations zooplankton samples were collected. Zooplankton was collected by filtration technique. 25 µm mesh size plankton net was towed from a dugout boat at about 5 - 105^{-1} for about a minute. The net content was washed out into a wide mouth plastic container and preserved in 10% formalin solution after proper labeling. This was stored in a cool box and taken to the Laboratory (APHA, 1998)

The samples were allowed to stand for at least 24 h in the laboratory for the zooplankton to settle before the supernatant pipetted to concentrate the samples. The concentrated sample was agitated to homogenize before pipetting 1 mL sub sample with sample pipette (ibid). The content was placed in a sedge Wick-Rafter plankton - counting chamber and examined with Leltz-Wetzlar binocular microscope at a magnification of 200x (APHA, 1998). The plankton was identified and total number per species recorded using keys and checklists of Hutechinson (1981). Enumeration of zooplankton was done on natural unit count and reported as units or organisms per mL (APHA, 1998).

RESULTS

Table 1 shows the distribution patterns of zooplankton species and their relative abundance in the stations. All the zooplankton species occurred in all the stations except *Mysis* sp. that was not recorded in station 4 (Odiemudie). Also all the stations recorded seventeen species (17) each except station 4 (Odiemudie) that had sixteen (16) species. Five species of Cladocera occurred in all the stations and were fairly distributed. In station 2 *Alonella costata* was the highest (35.7%). This was followed by *Moina cacrocapa* (34.2%) station 2 (Ogbele).

Five species of Copepoda were fairly distributed in all the stations. *Acanthocyclops, carinetus* (53.1%) was the highest in station 1. This was followed by *Cyclops stenuis* (47.2%) station 1. Only one specie of Decapod crustacean was recorded. This was recorded in station 1, 2 and 3 but absent in station 4. Station 1 had the highest percentage of 44.9 followed by station 3 with 28.6%. only one specie of Euphasiacea (*Meganicilphanes norvegia*) was recorded and it occurred in all the stations with station 1 having the highest percentage of 41.8 followed by station 4 (24.1%). Three species of Protozoa were recorded in all the stations. They were fairly distributed. *Tintinopsis senensis* was the highest in station 3 with a percentage occurance of 45.8. This was followed by *Halteria* sp. (39.2%) in station 3 also. The two species of Rotifera were also fairly distributed in all the stations. *Brachionus falcatus* was the highest in station 3 followed by *Brachionus calyciflorus* (32.3) in station 3 also.

The annual and seasonal variations of zooplankton are presented in Table 2 and 3. Annual variation result showed that *Paracyclops fimbriatus* had the highest mean value 20.417±10.422 (August 2007 - July 2008), 17.333±9.306 (August 2008 - July 2009). This was followed by *Cyclops stenuis* 18.167±12.494 (August 2007 - July 2008) 16.250±10.847 (August 2008 - July 2009) and *Meganicliphanes norvegia* 17.417±11.540 (August 2007 - July 2008), 14.667±6.596 (August 2008 - July 2009). The least was *Mysis* sp. 2.083±2.539 (August 2007 - July 2008), 2.833±3.857 (August 2008 - July

Table 1: Distribution and Relative Abundance of Zooplankton in the Stations of Sombrerio River, August 2007 – July 2009

		Stations			
	Taxa	1 Degema	2 Ogbele	3 Ihuaba	4 Odiemudie
CLADOCERA					
1	*Alonella costata*	35 (16.9)	74 (35.7)	52 (25.1)	46 (22.2)
2.	*Bosmina fatalis*	44 (22.6)	49 (25.1)	57 (29.2)	45 (23.1)
3.	*Daphnia carinata*	16 (9.2)	51 (29.5)	55 (31.8)	51 (29.5)
4.	*Daphnia longippina*	25 (14.0)	59 (33.1)	47 (26.4)	47 (26.4)
5.	*Moina cacrocapa*	47 (25.5)	63 (34.2)	46 (25.0)	28 (15.2)
COPEPODA					
6.	*Acanthocyclops carinetus*	178 (53.1)	49 (14.6)	66 (19.7)	42 (12.5)
7.	*Acanthocyclops viridis*	85 (37.0)	56 (24.3)	53 (23.0)	36 (15.7)
8.	*Cyclops stenuis*	193 (47.2)	97 (23.7)	93 (22.7)	26 (6.4)
9.	*Paracyclops afinis*	94 (29.4)	63 (19.7)	108 (33.8)	55 (17.2)
10.	*Paracyclops fimbriatus*	180 (38.2)	72 (15.3)	120 (25.5)	99(21.0)
DECAPOD CRUSTACEAN					
11.	*Mysis* sp.	22 (44.9)	13 (26.5)	14 (28.6)	0 (0)
EUPHACIACEA					
12.	*Meganicliphanes norvegia*	163 (41.8)	66 (16.9)	67 (17.2)	94 (24.1)
PROTOZOA					
13.	*Halteria* sp	21 (15.0)	41 (29.3)	55 (39.2)	23 (16.4)
14.	*Spirostomum* sp.	14 (9.3)	45 (30.0)	54 (36.0)	37 (24.7)
15.	*Tintinopsis senensis*	23 (12.0)	48 (25.0)	88 (45.8)	33 (17.2)
ROTIFERA					
16.	*Brachionus calyciflorus*	41 (21.4)	44 (22.9)	62 (32.3)	45 (23.4)
17.	*Brachionus falcatus*	21 (16.9)	30 (24.2)	46 (37.1)	27 (21.8)
Total Number of species per station		17	17	17	16

Table 2: Annual mean variance of zooplankton species abundance from Sombreiro River

	Species	Year 1 Aug 2007 - July 2008	Year 2 Aug 2008 - July 2009
1.	*Alonella costata*	8.750 ± 4.136^{C}	8.500 ± 2.022^{d}
2.	*Bosmina fatalis*	8.250 ± 4.002^{C}	7.667 ± 4.119^{d}
3.	*Daphnia carinata*	7.917 ± 3.800^{C}	6.833 ± 2.757^{de}
4.	*Daphnia longippina*	7.500 ± 4.166^{C}	7.250 ± 4.180^{d}
5.	*Moina cacrocapa*	8.083 ± 4.003^{C}	7.333 ± 4.097^{d}
6.	*Acanthocyclops carinetus*	15.250 ± 11.529^{b}	13.417 ± 9.080^{ab}
7.	*Acanthocyclops vividis*	9.833 ± 4.969^{C}	9.000 ± 4.472^{cd}
8.	*Cyclops stenuis*	18.167 ± 12.494^{ab}	16.250 ± 10.847^{ab}
9.	*Paracyclops afinis*	14.333 ± 6.624^{b}	12.750 ± 6.001^{bc}
10.	*Paracyclops fimbriatus*	20.417 ± 10.422^{a}	17.333 ± 9.306^{a}
11.	*Mysis* sp.	2.083 ± 2.539^{d}	2.833 ± 3.857^{e}
12.	*Meganicliphanes norvegia*	17.417 ± 11.540^{ab}	14.667 ± 6.596^{ab}
13.	*Halteria* sp.	5.667 ± 2.933^{ab}	6.083 ± 3.502^{de}
14.	*Spirostomum* sp.	6.667 ± 3.143^{cd}	6.167 ± 3.186^{de}
15.	*Tintinopsis senensis*	8.417 ± 3.964^{C}	7.583 ± 3.396^{d}
16.	*Brachionus calyciflorus*	7.917 ± 4.337^{C}	8.250 ± 4.413^{d}
17.	*Brachionus falcatus*	5.417 ± 3.342^{cd}	4.833 ± 2.823^{de}
Mean Sem		10.123 ± 0.5656^{a}	9.220 ± 0.4679^{a}

Means with the same superscript are not significantly different $p<0.01$

2009). There was no significant variation in the mean values of the two years studied 10.123±0.5656 (August 2007 - July 2008), 9.220±0.4679 (August 2008 - July 2009).

Seasonal variations occurred in the abundance of *Acanthocyclops carinetus* (10.822±8.176 Wet, 22.714±10.209 Dry) and *Mysis* sp. (1.236 ± 2.411 Wet, 5.429±3.101 Dry). Other species did not show significant variations. The mean of the wet and dry season showed significant variation 8.799±0.418 wet and 11.790±0.707 dry.

Table 4 shows the spatial variation in zooplankton community composition of Sombreiro River. For the four (4) stations studied diversity (S) ranged between 16 species (Odiemudie) and 17 species (Degema, Ogbele and Ihuaba). Abundance of individuals (N) of the stations ranged between 708 (Odiemudie and 1202 (Degema). Margalef index (d) values ranged between 2.256 (Degema) and 2.345 (Ogbele). The values for Shannon-Wiener index (H) ranged between 1.074 (Degema) and 1.204 (Ogbele). Pielou's index of relative density or evenness were between 0.870 (Degema) and 0.978

Table 3: Seasonal variance of zooplankton species abundance from Sombreiro River

	Species	SeasonWet	dry
1.	*Alonella costata*	8.412±3.641^{bced}	9.143±1.772^{cd}
2.	*Bosmina fatalis*	7.647±3.999^{cde}	8.714±4.151^{cd}
3.	*Daphnia carinata*	6.941±3.306^{de}	8.430±3.258^{cd}
4.	*Daphnia longippina*	6.470±2.552 ^{de}	9.571±6.214^{cd}
5.	*Moina cacrocapa*	6.882±3.179^{de}	9.714±5.250^{cd}
6.	*Acanthocyclops carinetus*	10.882±8.176^{bc}	22.714±10.209^{a}
7.	*Acanthocyclops vividis*	9.294±5.071^{bcd}	9.714±3.728^{cd}
8.	*Cyclops stenuis*	15.118±11.218^{a}	22.286±11.294^{a}
9.	*Paracyclops afinis*	11.412±5.679^{b}	18.714±4.347^{ab}
10.	*Paracyclops fimbriatus*	17.118±10.798^{a}	23.143±5.145^{a}
11.	*Mysis* sp.	1.236±2.411^{f}	5.429±3.101^{de}
12.	*Meganicliphanes norvegia*	16.764±10.784^{a}	14.286±4.029^{bc}
13.	*Halteria* sp.	6.000±3.020^{de}	5.571±3.735^{d}
14.	*Spirostomum* sp.	6.294±3.584^{de}	6.714±1.603^{d}
15.	*Tintinopsis senensis*	7.000±3.708^{de}	10.429±2.070^{cd}
16.	*Brachionus calyciflorus*	7.176±3.956^{de}	10.286±4.533^{cd}
17.	*Brachionus falcatus*	4.941±2.703^{e}	5.571±3.952^{d}
Mean Sem		8.799±0.418^{b}	11.790±0.707^{a}

Means with the same superscript are not significantly different p<0.01

Table 4: Species diversity and richness indices of zooplankton in Sombreiro River

	Stations			
	1 Degema	2 Ogbele	3 Ihuaba	4 Odiemudie
Total No. of Species (S)	17	17	17	16
Total No. of Individuals (N)	1202	920	1083	708
Margalef Index (D)	2.256	2.345	2.290	2.286
Shanno-Wienner Index (H)	1.074	1.204	1.197	1.142
Pielou's Evenness (E)	0.870	0.978	0.972	0.948
Simpsins Dominance (C)	0.107	0.065	0.068	0.080

(Ogbele). Simpsin's Dominance Index (C) ranged between 0.065 (Ogbele) and 0.107 (Degema).

DISCUSSION

The zooplankton community groups were well distributed in the sampling stations except the Decapod crustacean *Mysis* sp. in station 4 might be due to the fact that the river is narrow at this station which may give rise to limited micro-habitat. Added to this may be the intensive sand dredging going on at this station that causes constant disturbance of the surface water column. There is the need to monitor human activities in the Sombreiro River as MBO (2007) had earlier reported that the distribution, abundance, species diversity, species composition of plankton are used to assess the biological integrity of the water body. This assertion is further supported by the report of Davies *et al*. (2008) that zooplankton are of great importance in bio-monitoring of pollution.

There was no significant variation in the mean values of the two years in the study area. This may be attributed to good water quality during the period of study. However, seasonal variations occurred between the two years and two species of zooplankton - *Acanthocyclops carinetus* and *Mysis* sp. The mean values for the two years showed higher dry season than wet season variations. Egborge (1994) reported that seasonal pattern of zooplankton densities in Nigerian freshwater bodies peaks in the dry season and are low in the dry season. Similar observations have been reported by Emmanuel and Onyema (2007), Okogwu (2010) and Nkwoji *et al*. (2010).

The biotic indices of Margalef's species richness, Shannon - Wiener information function, Pielou's evenness and Simpsins Dominance were fairly distributed in the stations. This showed that the zooplankton community structure in the study area was stable. The Pearson product correlation matrix calculated in order to determine whether any relationship exited between zooplankton abundance and physico-chemical parameters were not significant.

CONCLUSION

- The zooplankton community groups were well distributed in the sampling stations except the Decapod crustacean *Mysis* sp. in station 4 might be due to the fact that the river is narrow at this station which may give rise to limited micro-habitat. Added to this may be the intensive sand dredging going on at this station that causes constant disturbance of the surface water column.
- There was no significant variation in the mean values of the two years in the study area. This may be attributed to good water quality during the period of study.
- However, seasonal variations occurred between the two years and two species of zooplankton - *Acanthocyclops carinetus* and *Mysis* sp.

- The mean values for the two years showed higher dry season than wet season variations.
- The biotic indices of Margalef's species richness, Shannon - Wiener information function, Pielou's evenness and Simpsins Dominance were fairly distributed in the stations indicating that the zooplankton community structure in the study area was stable.

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