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RESEARCH ARTICLE

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Effects of Flooding on zooplankton in Amassoma Flood Plain Niger Delta, Nigeria

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ABSTRACT

The Effects of Flood on zooplankton in Amassoma Flood Plain, Niger Delta, Nigeria was studied for a period of six months (November – December, 2012 and January, 2013 for the dry season and April, May and June; 2013 for the Wet season) and compared with previous results obtained in the study area. A total of seventeen (17) zooplankton species belonging to six (6) families were present in both before and after flooding. These include: CLADOCERA: Alonella costata, Bosmina fatalis, Daphnia carinata, Dophinia longippina and Moina cacrocapa; COPEPODA: Acanthocyclops viridi, A. carinetus, Cyclopps stenis, Paracyclops afinis and P. fimbriatus; DACAPOD CRUSTACEANS: Mystis sp; EUPHACIACEA: Meganicliphanes sp; PROTOZOA: Halteria sp, Spirostomum sp and Tininopsis senensis; ROTIFERA: Brachionus falcatus and Brachionus calyciflorus. There was significant difference in zooplankton population between before and after flooding, but no significant difference between sampling stations ($p > 0.5$).

Key words: Flooding effects, zooplankton, Flood plain, Niger Delta, Nigeria

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 [1]. 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 [2]. Zooplankton organisms are identified as important component of aquatic ecosystems [3]. They help in regulating algal microbial productivity through grazing and in the transfer of primary productivity to fish and other consumers [4], Okogwu (2010) reported that by grazing on phytoplankton and bacteria zooplankton help in improving water quality [3]. Pinto-Coetuo *et al* (2005) reported that zooplanktons are considered indicators of water quality [5]. Zooplanktons make up an invaluable source of protein amino acids, lipids, fatty acids, minerals and enzymes. They are therefore an inexpensive ingredient to replace fishmeal for cultured fish [6].

Zooplanktons are of great importance in bio-monitoring of pollution [7]. 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 [8]. 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 has 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 [9]. Zooplankton density may be limited by both turbidity (which limits phytoplankton production upon which the zooplankton depend) and by river flow [10].

Floodplain or flood plain is an area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge. It includes the floodway, which consists of the stream channel and adjacent areas that actively carry flood flows downstream, and the flood fringe, which are areas inundated by the flood, but which do not experience a strong current. In other words, a floodplain is an area near a river or a stream which floods when the water level reaches flood stage. Flood plains are made by a meander eroding sideways as they travel downstream. When a river breaks its banks and floods, it leaves behind layers of alluvium (silt). These gradually build up to create the floor of the flood plain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, the water drawn from them being pre-filtered compared to the water in the river.

Geologically ancient floodplains are often represented in the landscape by fluvial terraces. These are old floodplains that remain relatively high above the present floodplain and indicate former courses of a stream. Sections of the Missouri River floodplain taken by the United States Geological Survey show a great variety of material of varying coarseness, the stream bed having been scoured at one place and filled at another by currents and floods of varying swiftness, so that sometimes the deposits are of coarse gravel, sometimes of fine sand or of fine silt. It is probable that any section of such an alluvial plain would show deposits of a similar character.

The floodplain during its formation is marked by meandering or anastigmatic streams, ox-bow lakes and bayous, marshes or stagnant pools, and is occasionally completely covered with water. When the drainage system has ceased to act or is entirely diverted for any reason, the floodplain may become a level area of great fertility, similar in appearance to the floor of an old lake. The floodplain differs, however, because it is not altogether flat. It has a gentle slope down-stream, and often, for a distance, from the side towards the centre. Floodplains can support particularly rich ecosystems, both in quantity and diversity. Amassoma forests form an ecosystem associated with floodplains. They are a category of riparian zones or systems. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly; however the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture.

The word "flood" comes from the Old English </wiki/Old_English_language> /flod/, a word common to Germanic languages (compare German /Flut/, Dutch /vloed/ from the same root as is seen in /flow, float/; also compare with Latin /fluctus/, /flumen/). Deluge myths are mythical stories of a great flood sent by a deity or deities to destroy civilization as an act of divine retribution, and are featured in the mythology of many cultures. Floods can also occur in rivers, when flow exceeds the capacity of the river channel, particularly at bends or meanders.

Fig 1 Amassoma Floodplain

Floods often cause damage to homes and businesses if they are placed in natural flood plains of rivers. While flood damage can be virtually eliminated by moving away from rivers and other bodies of water, since time out of mind, people have lived and worked by the water to seek sustenance and capitalize on the gains of cheap and easy travel and commerce by being near water. That humans continue to inhabit areas threatened by flood damage is evidence that the perceived value of living near the water exceeds the cost of repeated periodic flooding [11].

Floods (Plate 1) are also known to renew wetland areas which in turn host a wide range of flora and fauna. Preventing flood waters from entering such wetland areas will create imbalance to the natural state of things resulting in destruction of natural habitats and even extinction of various species of animals and plants. Floods play an important part in various ecosystems. Humans, therefore, should be careful when they try to prevent or control floods. Oftentimes, human intervention causes more harm than good [12]. Flooding of the rivers in the country is not uncommon; the September 2012 devastating flood which was clearly a natural disaster was a pointer to prior preparations being a proactive effort at mitigation of impacts of such disasters, but little information exits on how these flood events affect water and overbank sediment quality within the affected areas

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Source:Nayanet.com/news/source/1092p.html

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Source:www.nairalard.com/992375/niger-delta university

Plate1. Cases of flooding in Amassoma flood plain

Floods are caused by many factors: heavy rainfall, highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, or failure of dams, levees, retention ponds, or other structures that retain water. Flooding can be exacerbated by increased amounts of impervious surface or by other natural hazards such as wildfires, which reduce the supply of vegetation that can absorb rainfall. Periodic floods occur on many rivers, forming a surrounding region known as the flood plain. During times of rain, some of the water is retained in ponds or soil, some is absorbed by grass and vegetation, some evaporates, and the rest travels over the land as surface runoff. Floods occur when ponds, lakes, riverbeds, soil, and vegetation cannot absorb all the water. Water then runs off the land in quantities that cannot be carried within stream channels or retained in natural ponds, lakes, and man-made reservoirs. About 30 percent of all precipitation becomes runoff and that amount might be increased by water from other flood causing factors.

River flooding is often caused by heavy rain, sometimes increased by melting snow. A flood that rises rapidly, with little or no advance warning, is called a flash flood. Flash floods usually result from intense rainfall over a relatively small area, or if the area was already saturated from previous precipitation. Even when rainfall is relatively light, the shorelines of lakes and bays can be flooded by severe winds that blow water into the shore areas. Coastal areas are also sometimes flooded by unusually high tides, such as spring tides, especially when compounded by high winds and storm surges. Tsunamis which are high, large waves, typically caused by undersea earthquakes, volcanic eruptions or massive explosions also cause flood.

There are many disruptive effects of flooding on human settlements and economic activities. However, floods (in particular the more frequent/smaller floods) can also bring many benefits, such as recharging ground water, making soil more fertile and providing nutrients in which it is deficient. Flood waters provide much needed water resources in particular in arid and semi-arid regions where precipitation events can be very unevenly distributed throughout the year. Freshwater floods, particularly, play an important role in maintaining ecosystems in river corridors and are a key factor in maintaining floodplain biodiversity.

Flooding adds a lot of nutrients to lakes and rivers which leads to improved fisheries for a few years; also because of the suitability of a floodplain for spawning (little predation and a lot of nutrients). Fish like the weather fish make use of floods to reach new habitats. Together with fish birds also profit from the boost in production caused by flooding. Periodic flooding was essential to the well-being of ancient communities along the Tigris-Euphrates Rivers, the Nile River, the Indus River, the Ganges and the Yellow River, among others. The viability for hydrological based renewable sources of energy is higher in flood prone regions. The effect of flooding on zooplankton in Amassoma flood plain in the Niger Delta region of Nigeria will provide relevant information on flooding, Amassoma flood plain and similar water bodies.

MATERIALS AND METHODS

Study Area

The Niger Delta (Fig. 1) covers 20,000 km² within wetlands of 70,000 km² formed primarily by sediment deposition. Home to 20 million people and 40 different ethnic groups, this floodplain makes up 7.5% of Nigeria's total land mass. It is the largest wetland and maintains the third-largest drainage basin in Africa. The Delta's environment can be broken down into four ecological zones: coastal barrier islands, mangrove swamp forests, freshwater swamps, and lowland rainforests [13]. This incredibly well-endowed ecosystem contains one of the highest concentrations of biodiversity on the planet, in addition to supporting abundant flora and fauna, arable terrain that can sustain a wide variety of crops, lumber or agricultural trees and more species of freshwater fish than any ecosystem in West Africa [14]. The region could experience a loss of 40% of its inhabitable terrain in the next thirty years as a result of extensive dam construction in the region. The carelessness of the oil industry has also precipitated this situation, which can perhaps be best encapsulated by a 1983 report issued by the NNPC, long before popular unrest surfaced. There has been the slow poisoning of the waters of this country and the destruction of vegetation and agricultural land by oil spills which occur during petroleum operations. But since the inception of the oil industry in Nigeria, more than twenty-five years ago, there has been no concerned and effective effort on the part of the government, let alone the oil operators, to control environmental problems associated with the industry[15]. It is estimated that:

- 1.5% of the country is at risk from direct flooding from the sea
- About 7% of the country is likely to flood at least once every 100 years from rivers
- 1.7m homes and 130,000 commercial properties, worth more than £200 billion, are at risk from river or coastal flooding in England
- Many more properties are also at risk from flash floods.

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Source: www.nairaland.com/922604/Yoruba-woman-ple
Fig.1. Location of the Niger Delta

Sample collection

The study was carried out in Amassoma flood plain, in the Niger Delta of Nigeria for a period of six months (November – December, 2012 and January, 2013 for the dry season and April, May and June; 2013 for the Wet season) and compared with results obtained by Ezekiel, 2001 and Abowei, 2010 [16][17]. Four sampling stations were established along the length of the Amassoma River whenever, it was accessible by road. In each of the sampling stations, qualitative sampling of the surface waters was carried out by towing the net slowly behind a boat, at one to three knots for ten minutes. If all the water is filtered through the net (assuming no clogging of mesh by phytoplankton), the volume of water filtered can be calculated using the formula:

$$V = \pi r^2 L$$

Where, r = the radius of the hoop at the front of the net
L = the distance through which the net is hauled.

Hauls of this type are often used to assess the quantity of plankton in a given water column, but there are inaccuracies. The nets have been modified with fitted flow meters. These nets also collect the larger zooplanktons.

A quantitative method of sampling plankton populations is to centrifuge a small water sample and count the plankton in it. Although it is better to examine the plankton alive; examination is delayed for the preservation of the sample. Lugols iodine (10gm of iodine added to 20gk and increased to 200ml of H_2O plus 20g acetic acid) or ten percent neutral formalin is used as fixative. The preservative is added in the ratio of 1:100ml.

In a rough field method, developed for estimation of plankton, 50 liters of water are collected from different sections of the pond. These are filtered through an organdi or a muslin ring net with a 2.45cm diameter glass specimen tube tied to the lower narrow end of the net. Add a pinch of common salt to water in the tube. Detach the tube from the net. Within 15-20 minutes of post salt addition, the plankton settles at the bottom of the tube.

If the resultant sediment is from 6.4 to 8.5 mm of the tube, 50,000 to 75,000 spawn per ha can be stocked in the pond. The animal or plant nature of plankton is differentiated by, either a pace brownish (zooplankton) or greenish (phytoplankton) color. The plankton in the tube can be fixed in 2% formalin for detailed study. It can be concentrated into the Sedgwick – Rafter counting chamber. Carefully position the cover glass over the chamber without forming an air bubble. The glass diagonally across the chamber and slowly rotating the cover glass as the sample is introduced from the pipette.

Place the counting chamber beneath the microscope, select a random microscope field, identify and count planktons seen within the ocular micrometric grid using appropriate keys. Repeat this procedure at least ten times.

Calculation:
The Sedgwick Rafter counting chamber contains 1.00ml (50mm long, 20mm wide x 1mm deep).

$$\text{No of planktons per ml} = \frac{1000Tx}{AN}$$

Where,
T = Total number of plankton counted
X = concentrate volume (ml)
A = Area of grid in (mm)
N = Number of grids employed
1000 = Area of the counting chamber, n (mn^2).
In well managed ponds, with high nutrient concentrations; there is a dense algal growth. Such ponds have denser algae communities than unmanaged ponds and other natural waters [18].

RESULTS

Table 1 shows zooplankton species present before and after flooding in the study area. A total of seventeen (17) zooplankton species belonging to six (6) families were present in both before and after flooding. These include: CLADOCERA: *Alonella costata, Bosmina fatalis, Daphnia carinata, Dophinia longippina and Moina cacrocapa*;

COPEPODA: *Acanthocyclops viridi, A. carinetus, Cyclopps stenis, Paracyclops afinis* and *P. fimbriatus*; DACAPOD CRUSTACEANS: *Mystis sp*; EUPHACIACEA: *Meganicliphanes sp*; PROTOZOA: *Halteria sp, Spirostomum sp and Tininopsis senensis*; ROTIFERA: *Brachionus falcatus and Brachionus calyciflorus*. The zooplankton population decreased drastically after the flooding though there was no significant variation between sampling stations. There was significant difference in zooplankton population between before and after flooding, but no significant difference between sampling stations (p> 0.5).

Table 1 Zooplankton species present in the study area

Zooplankton species	Before flooding				After Flooding			
	Station 1	Station 2	Station 3	mean	Station 1	Station 2	Station 3	Mean
CLADOCERA								
Alonella costata	35	74	52	53	-	20	15	12
Bosmina fatalis	44	49	57	50	11	-	9	7
Daphnia carinata	16	51	55	40	6	11	-	6
Daphinia longippina	25	59	47	44	13	-	5	6
Moina cacrocapa	47	63	46	52	-	14	7	7
COPEPODA								
Acanthocyclops viridi	178	49	66	97	13	18	4	13
A. carinetus	85	56	53	65	20	14	18	14
Cyclopps stenis	193	97	93	128	-	28	17	14
Paracyclops afinis	94	63	108	85	-	10	-	3
P. fimbriatus	180	72	120	124	-	-	3	1
DACAPOD CRUSTACEANS *Mystis sp*	22	13	14	17	2	1	-	1
EUPHACIACEA								
Meganicliphanes sp	163	66	67	99	13	6	8	9
PROTOZOA								
Halteria sp	21	41	55	65	11	5	15	11
Spirostomum sp	14	45	54	38	8	-	-	3
Tininopsis senensis	23	48	88	53	-	17	5	7
ROTIFERA								
Brachionus falcatus	41	44	62	49	3	15	-	6
Brachionus calyciflorus	21	30	46	32	4	-	-	1

DISCUSSION

There was significant difference in zooplankton population between before and after flooding, but no significant difference between sampling stations (p> 0.5). This result compared favorably with the on Bariweni *et al*, 2012. They also reported that zooplankton reduced drastically after flooding. The decline in zooplankton population after flooding could be attributed to the fact that, the abundance and species composition of zooplankton are used to assess the biological integrity of the water body [19]. Carney (1990) reported that most zooplankton migrate upward from deeper strata as darkness approaches and return to the deeper areas at dawn before the flooding [9]. Zooplankton density may be limited by both turbidity (which limits phytoplankton production upon which the zooplankton depend) and by river flow after the flooding [10]

The zooplankton community groups were well distributed in the sampling stations except the Decapod crustacean *Mysis* sp. in station. This may be due to human and industrial activities in the study area going on at this station that causes constant disturbance of the surface water column. There is the need to monitor human activities in the study area 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 [2]. 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 in various stations. This may be attributed to good water quality during the period of study. However, seasonal variations occurred and two species of zooplankton – *Acanthocyclops carinetus* and *Mysis* sp. 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 [20]. Similar observations have been reported by Emmanuel and Onyema (2007) and Okogwu (2010) [21][3]. 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.

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