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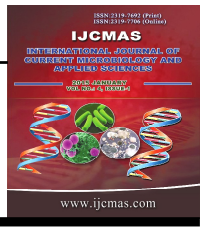

Original Research Article

Assessment of Creek integrity using Phytoplankton in Taylor Creek, Biseni, Bayelsa State, Nigeria

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A B S T R A C T

An assessment of creek integrity of Taylor creek Niger Delta was carried out, using phytoplankton as the measurable criteria. The creek was sampled monthly for one year taking samples from six stations. Samples were collected and analysed using standard criteria and procedures. Data were analysed for percentage numerical abundance, species richness and diversity indices calculated using the Microsoft Soft Excel descriptive statistic tool. T-test was also conducted to determine the degree of variability or relationship between sample stations at the 95% confidence limit for these indices. Result from the t-test revealed that there are significant differences ($p<0.05$) in some of the calculated indices in both wet and dry seasons in the different sampling stations. There was however no established pattern in this difference across stations. This suggests an indefinable trend in station contribution to phytoplankton dynamics. Diatoms dominated the creek, and are known to populate unpolluted waters. It can be concluded that Taylor creek is not under pollution threat.

Keywords

Phytoplankton, Diatoms, Taylor creek, Nigeria

Introduction

Phytoplanktons play a pivotal role in the structure and functioning of fresh water ecosystems. In many waters, algae and cyanobacteria contribute to a large proportion of the primary production and may exert a heavy influence on other ecosystem components (Pasztaleneic and Poniewozik, 2010).

Changes for instance, in plankton primary production will definitely have an effect on higher trophic levels of macro-invertebrates and fish production. Therefore, the use of phytoplankton as indicator organisms in short-term impact in water quality assessment and ecological status is well established.

A plethora of literature does exist for both phytoplankton and zooplankton assemblages. However, there is a dearth ofliterature of studies done on the Taylor creek. This work provides useful information and an impetus for future research.

Materials and Methods

Description of Study Area

Taylor creek is a lotic, non-tidal fresh water environmental unit. It is situated inBiseni clan, although the creek stretches into Gbaran in Yenagoa local government area of Bayelsa State in the Niger Delta. The creek lies between longitude 006^0 17' to 006^0 21'E and latitude 05^0 01' to 05^0 05'N. The locations of the sampling sites are at Kalama, Tien and Iturama, all in Biseni clan.

Station 1 is located at longitude 05^0 14' 29.4''N and latitude 006^0 32' 06.''E. The station has an elevation of 10.5. Station 1 is situated adjacent to a makeshift market facility adjacent to the creek at Kalama, Biseni.

Station 2 is located at longitude $05^0$14' 32.4'' and latitude 006^0 32' 09.1''. The station has an elevation of 0.8. This station is up stream relative to station 1. It has notable features such as floating aquatic weeds and vegetation in the adjacent catchments at Kalama, Biseni.

Station 3 is situated at Tien Biseni at longitude 05^0 14' 36.7'' and latitude 006^0 32' 11.0''. This station lies at an elevation of 4.0. This station is characterized by relatively clearer water surface but with plentiful amounts of bathing and laundry activities going on there.

Station 4 is situated almost mid-way between all sampling stations. It is up stream of stations 1, 2 and 3. It is also located at Tien Biseni at longitude 05^0 14' 39,8'' and latitude 006^0 32' 15.6''. The station has an elevation of 14.9. The activities in station 4 are similar to those in station 3 with lots of bathing and washing activities. There are sparse distributions of aquatic plants in that area.

Station 5 is located upstream of Taylor creek at IturamaBiseni. The creek is widest at this point and has a display of aquatic plants. It is located at longitude 05^0 14' 3.4'' and latitude 006^0 32' 19.8''. It has an elevation of 15.0 and characterized by laundry activities.

Station 6 is situated uppermost upstream of all sampling points. It is also located at Iturama in Biseni clan. It sits on longitude 05^0 14' 40.4'' and latitude 006^0 32' 24.2'' with an elevation of 9.9. The overlying catchments are relatively uninhabited and coloured by aquatic macrophytes and dense vegetation. It is nearest of all sampling points to a portable water processing plant. This station serves as control in this study.

Collection of plankton samples

Phytoplankton samples were collected using glass sample collection bottles. In each station, the glass bottles were partially immersed in water against the water flow pattern and drifting plankton collected. Each collected sample was fixed immediately with 4% formalin reagent.

Phytoplankton analyses

Analyses for plankton samples were done at the Institute of Pollution Studies (IPS) Rivers State University of Science and Technology, Port Harcourt. Formaline fixated samples were analysed for species abundance and Taxa-richness of both phytoplankton. The samples were allowed to stand for 46 hours before 50ml of pipetted concentrated sample volumes were obtained. A sub sample of 1ml was then taken and transferred into a sedge-wick rafter counting chamber (slides).

Identification and enumeration was done using a leitzwetzlar binocular dissecting

microscope at a magnification of between 20-400 for phytoplanktonfor each sample using standard keys. The amounts of organisms in the 1ml sample were estimated by counting the total amount of grid squares covered by the water sample. Five grid squares were taken at random and the amount of organism in the five squares noted. The total number of grid squares covered by water was then divided by five and the resulting figure multiplied by the amount of organisms counted on the five grid squares. That gave the total amount of organisms present in the 1ml water sample.

Data analysis

Percentage occurrence, species richness, evenness, dominance and relative numerical abundance of phytoplankton were calculated using the Excel Descriptive Statistic Tools (EDST).

Diversity of the aquatic fauna was determined using the Shannon – Weaver index, equitability (E) of species (Ajao, 1990) and Margalef's diversity as follows:

Diversity of the aquatic fauna (Phytoplankton) were determined using Shannon – Weiner index, equitability (E) of species and Margalef's diversity

Shannon-weaver diversity index given by the formula:

$Hs = \sum Pi \ In \ Pi$ (Shannon – Weaver, 1963)

Where Hs = Shannon – Weaver diversity index.
I = Count denoting the i^{th} species ranging from 1 – n.

Pi = Proportion that the i^{th} species represents in terms of number of Individuals with respect to the total number of individuals.

Equitability or Evenness by the formula:

$E=Hs/Log_2S$

Where:

E = Equitability index.
Hs = Shannon and Weaver index.
S = Number of species in a population.

Species richness by Margalefs(1967) formula:
$d= (S-1)/Log_2N$

Where:

d = species richness index.
S = number of species in a population.
N = total number of individuals in S species.

Result and Discussion

Species occurrence/abundance

The result of the species occurrence obtained for the different phytoplankton taxa showed variation in station and seasons during the study period (Table 1) More Species individuals were prevalent in dry season than in the wet season.

Species richness

Species richness of phytoplankton in the dry season revealed that bacillorophyceae had the highest species richness of 44 species (53.0%), euglenophyceae 14 species (16.86%), cyanobacteria 11 species (13.25%), chlorophyceae 9 species (10.84%) and lastly pyrrophyceae 5 species (6.02%).

Species richness in the wet season revealed that bacillorophyceae with 28 species (58.33%) was the highest in species richness. Chlorophyceae 8 species (16.66%), euglenophyceae 5 species (10.41%),

pyrrophyceae 4 species (8.33%) and lastly cyanobacteria 3 species (6.27%).

On station basis, the total number of individual species observed in the dry season was highest in stations 6 and 3 followed by stations 5, 1, 2 and lastly station 4.

In the wet season, total number of individual species observed was highest in station 4 and stations 3, 5, 6, 1, and 2.

Seasonally, the total number of individual species was greater in the upstream than the downstream stations.

Margalef's index (d) showed variations in stations and seasons during the study period. In the dry season, it ranged from 9.21 – 11.02, while the wet season values ranged from 6.23 – 7.21. The lowest value of margalef's index (d) in the dry season was observed in station 4 and the highest value was observed in station 1. The highest value in the wet season was observed in station 2 while the lowest value was observed in station 6.

Species diversity

Shannon – weaver index (H) also show the diversity of phytoplankton in the study stations. In the dry season, Shannon – weaver index showed that the range values fell between 1.43 – 1.59. The highest values were found in stations 4, 1, 3 and 2 consecutively. The lowest values were seen in stations 5 and 6 respectively.

In the wet season, Shannon – weaver index ranged from 1.32 – 1.45.

The highest value is found in station 5 then 2, 4, 1 and 6 while the lowest value was seen in station 3.

Evenness index (E')

Data obtained from the evenness index for all sampling stations and across seasons for phytoplankton showed no definite pattern.

In the dry season, evenness index ranged from 0.78 – 0.88.
In the wet season the values for evenness ranged from 0.80 – 0.87.

The evenness index shows that there were no significant seasonal differences in values obtained for both wet and dry seasons.

In the dry season, station 4 had the highest value followed by stations 3, 1, 2 and 6. Station 5 had the lowest value.

In the wet season, the highest value was observed in station 5, stations 2, 4, 6 and 1 respectively. Station 3 had the lowest value.

Simpson's Dominance Index (c).

The result of the dominance index of phytoplankton showed no particular trend. In the dry season, dominance index (c) ranged from 0.04 – 0.08. The highest value was found in station 5, then stations 2, 3, 6, 1 and station 4 consecutively.

In the wet season dominance index displayed a consistent trend from stations 1, 2 and 3 and between stations 5 and 6. Dominance index ranged between 0.05 – 0.08. The highest value of 0.08 was observed in station 3.This was followed by stations 4, 6, 2, 1 and lastly station 5.

The study recorded a high diversity of plankton communities. This high diversity is essentially related to the number and longevity of simultaneously co-existing exploitable niches. In most ecosystems there are always in existence temporary niches in

which growth conditions differ from that elsewhere; such niches are frequently obliterated and reconstructed at random (Yakub, 2004).

There was a dominance of the phytoplankton community by diatoms in the wet season. This type of dominance of communities by diatoms has been confirmed in previous studies (Erondu and Chindah, 1991; Chindah and Pudo, 1991). The dominance of the phytoplankton community by diatoms in the biotopes studies confirm the statement that diatoms predominates unpolluted natural lotic water bodies in the tropics (Archibald, 1972; John and Lawson, 1990). In addition, diatoms and dinoflagillates are important component that form the base of the aquatic food chain (Davis, 1955).

In contrast, the occurrence of such species as *Nitzchiapalea, Gamphonema parvalum*, *Microcystis aeruginosa* and the euglenoids in this study may be an indication of pollution. Occurrence is determined by many factors and for any given species may be related to temperature, salinity, irradiation and pollution (Mandell, 1969).Thus some species of phytoplankton were either absent or very few across seasonal boundaries.

There was a greater prevalence of cyanophyta than chlorophyta for example in the dry season. Talling (1965) suggested that blue-green algae are not harmed by high temperature and intense illumination in summer and therefore may be selected because of this adaptation. Another reason may be that there may be low concentration of nitrogen and phosphorous in water. The ability of cyanophytes to fix nitrogen may give them a competitive advantage in their prevalence when nitrogen is very low in water (Fogg et al, 1973).

This seasonal trend of higher and lower densities of phytoplankton during the dry and wet seasons respectively, agrees with the result of other investigators in tropical West Africa (Chindah and Braide, 2003).The proliferation of the cyanophyta and other plankton species encountered in the above studies were controlled by the nutrient levels. High nutrient loads in coastal ecosystems results in increased algal blooms (Boynton *et al*, 1982).

The distribution of phytoplankton showed no specific trends from station to station. A reason for this may be that Taylor creek is a lotic water body with fast currents. Therefore, confirming the assertion that lotic waters are hardly impacted by human activities. Phytoplanktons can undergo blooms, the causes of which might be indeterminate at varying frequencies.

The study considered the use of phytoplankton as indicator organisms to assess ecological health of Taylor creek. The study also considered phytoplankton dynamics in relation to season and location of sampling. The result indicates that season did affect phytoplankton diversity and abundance, while the location of sampling did not show any logical trend (either upstream or downstream). The dominance of the creek by diatoms in this study indicates a water body with good ecological status, as diatoms is known to populate unpolluted waters. The presence, but not the preponderance of harmful algae and cyanophytes suggest that the creek may be exposed to periodic stress.

Based on the foregoing, it may be concluded that the creek is in good ecological health. The finding from this work provides us with a better ecological understanding of aquatic resource management.

Table.1 Relative abundance and diversity indices of phytoplankton in dry season

	STATIONS					
	Iturama		Tien		Kalama	
Taxa	ST1	ST2	ST3	ST4	ST5	ST6
Bacillophyta	187	290	176	153	243	362
Cynobacteria	163	30	54	48	57	38
Chlorophyta	88	46	68	27	27	66
Euglenophycaea	95	53	164	188	217	129
Pyrrophycaea	153	116	290	74	179	181
Total no. of individuals	686	535	752	490	723	776
Margalef's index (d)	11.02[a]	9.72[b]	9.21[c]	10.17[d]	9.40[bc]	9.77[b]
Shannon – weaver index (H)	1.52[a*]	1.46[b]	1.47[b]	1.59[c]	1.42[a]	1.45[b]
Evenness (E)	0.82[a]	0.81[a]	0.82[a]	0.88[a]	0.78[a]	0.80[a]
Simpson dominance (C)	0.05[a]	0.06[ab]	0.06[ab]	0.04[a]	0.08[b]	0.06[ab]

*Indices with the same superscript on the same row are not significantly different

Table.2 Relative abundance and diversity indices of phytoplankton in wet season

	STATIONS					
Taxa	Iturama		Tien		Kalama	
	ST1	ST2	ST3	ST4	ST5	ST6
Bacillophyta	201	173	265	334	308	301
Cynobacteria	9	12	26	31	35	33
Chlorophyta	187	129	49	54	59	46
Euglenophycaea	21	19	86	129	53	53
Pyrrophycaea	102	179	301	261	228	219
Total no. of individuals	523	512	729	809	682	652
Margalef's index (d)	6.86[a]	7.21[b]	6.52[c]	6.72[d]	6.74[d]	6.32[c]
Shannon- weaver index (H)	1.38[a]	1.42[b]	1.32[c]	1.41[b]	1.45[d]	1.36[a]
Evenness index (E)	0.84[a]	0.85[a]	0.80[b]	0.85[a]	0.88[c]	0.84[a]
Simpson's dominance index C)	0.07[a]	0.66[b]	0.08[a]	0.07[a]	0.05[a]	0.07[a]

*Indices with the same superscript on the same row are not significantly different

Table.3 Species abundance/richness of phytoplankton in dry season

	STATIONS							No		
	Iturama		Tien		Kalama		Total	of	%	%
Taxa	ST1	ST2	ST3	ST4	ST5	ST6	Indiv.	Spp	Abund.	Richness
Baccilirophyta	187	290	176	153	243	362	1141	44	35.61	53.01
Cyanobacteria	163	30	54	48	57	38	390	11	9.84	13.25
Chlorophyta	88	46	68	27	27	66	322	9	8.12	10.84
Euglenophycea	95	53	164	188	217	129	846	14	21.35	16.86
Pyrrophyceae	153	116	290	74	179	181	993	5	25.06	6.02
Total	686	535	752	490	723	776	3,962	83	100	100

Table.4 Species abundance/richness of phytoplankton in wet season

	STATIONS							No.		
	Iturama		Tien		Kalama		Total	of	%	%
Taxa	ST1	ST2	ST3	ST4	ST5	ST6	Indiv.	Spp	abund.	richness
Baccilorophyta	204	173	265	334	308	301	1565	28	40.57	58.33
Cyanobacteria	9	12	26	31	35	33	146	3	3.73	6.25
Chlorophyceae	189	129	49	54	59	46	524	8	13.41	16.66
Euglenophycea	21	19	86	129	53	53	361	5	9.24	10.41
Pyrrophyceae	102	179	301	261	228	219	1290	4	33.02	8.35
Total	523	512	727	809	683	652	3,906	48	100	100

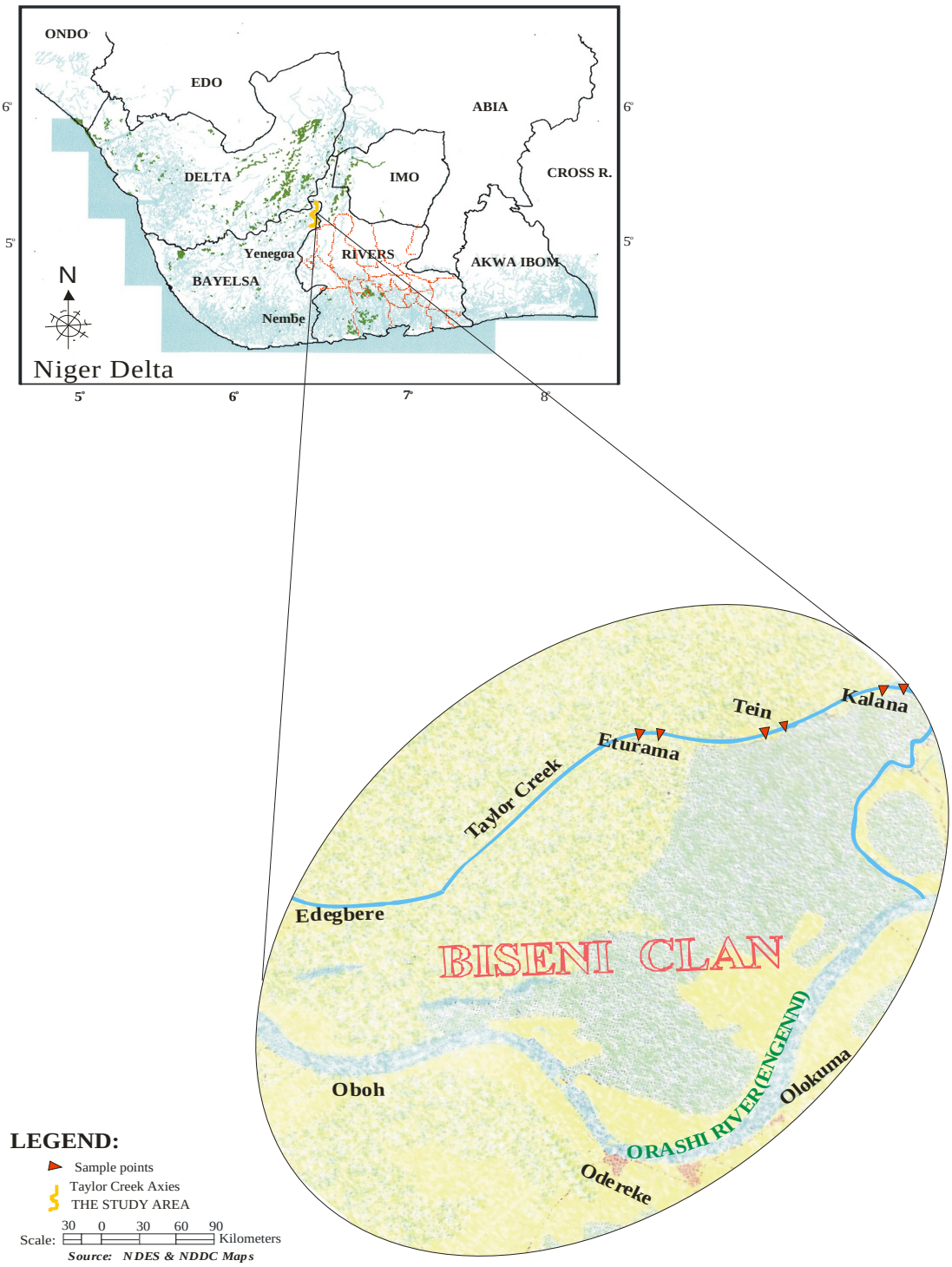
Table.5 Check List of Phytoplankton in Taylor Creek

	STATIONS					
Taxa:						
Organisms	ST1	ST2	ST3	ST4	ST5	ST6
Bacillariophyta						
Cosinodiscus sp.	+	+	+	-	+	+
Nitzschiasp	+	+	+	+	+	+
N. palea	+	-	+	+	+	+
N. vermicularis	+	+	+	+	+	+
N. sigma	+	+	-	+	+	+
N. longissima	+	+	+	+	+	+
N. dissipata	+	+	+	+	+	-
N. holsalica	+	+	+	+	+	+
N. sigmoides	+	+	+	+	+	+
Stauroneissp	+	+	+	+	+	+
Stauroneisancep	+	+	+	+	+	+
Pinnulariasp	+	+	+	+	+	+
P. appendiculata	+	+	+	+	+	+

P. microstauron	+	+	+	+	+	+
P. subcapitata	-	+	-	+	+	+
P. maior	-	+	+	+	+	+
P. mesolepta	+	+	+	+	+	+
Achinantheslanceolata	-	+	+	+	-	+
Achinanthesspp	+	+	+	+	+	+
A. olivercium	+	+	+	+	+	+
Pinnulariafenestrata	+	+	+	+	+	+
Gamphonemaolivaceum	+	+	+	+	+	+
Gomphonitzchiaungeri	+	+	+	+	+	+
Diatomahiemale	+	+	+	+	+	+
Diatomaancep	+	+	+	+	+	+
Diatomaelongatum	+	+	+	+	+	+
Eunotiaspp	+	+	+	+	+	+
Diatomellabalfouriana	+	+	+	+	+	-
Surrirellaovalis	+	+	+	+	+	+
Asterionellagacillima	+	+	+	+	+	+
Melosiraspp	+	+	+	+	+	+
M. italic	+	+	+	+	+	+
Synedra ulna	+	+	+	+	+	+
S. nana	+	+	+	+	+	+
Naviculaspp	+	+	+	+	+	+
N. rhychocephala	+	+			+	+
Cymbellacistula	+	+	+	+	+	+
Eunotialinearis	+	+	+	+	+	+
Diatomaspp	+	+		+	+	+
Flagillariaspp	+	+	+	+	+	+
Achinanthestrinodis	+	+	+	+	+	+
Achinanthesflexalla	+	+	+	+	+	+
Compylosiracymbelliformis	+	+	+	+	+	+
Plagiotropis Lepidoptera	+	+	+	+	+	+
Hemiaculushaukii	+	+	+	+	+	+
Flagillariaconstreun	+	+	+	+	+	+
Tabellanaspp	+	+	+	+	+	+
Synedraspp	+	+	+	+	+	+
Stephanodiscushantzchi	+	+	+	+	+	+
CYANOBACTERIA:						
Oscillatoriaspp	+	-	-	+	+	+
O. tenuis	+	+	+	-	+	+
O. putrid	+	+	+	+	+	+
O. limosa	+	+	+	+	+	+
O. lacustris	+	+	+	+	+	+
O. kutzingianum	+	+	+	+	+	+
Glocapsaspp	+	+	+	+	+	-
G. turgid	+	+	+	+	+	+
Microsystisspp	+	+	+	+	+	+

M. aeroginosa	+	+	+	+	+	+
Phormidiumfoveolaram	+	+	+	+	+	+
Phormidiumtenue	+	-	+	+	+	+
EUGLENOPHYCEAE						
Phacusspp	+	+	+	+	+	+
Phacuscandadus	+	-	+	+	+	+
Phacuscurvicauda	+	+	+	+	+	+
Euglena spp	+	-	+	+	+	-
Euglena caudate	+	-	+	+	+	+
E. acus	+	+	+	+	+	+
Trachelomonasspp	+	+	+	+	+	+
T. volvocina	+	+	+	+	+	+
T. hispidata	+	+	+	+	+	+
T. similis	+	+	+	+	+	-
T dubia	+	+	+	+	+	+
T. armata	+	+	+	+	+	+
Lepoconchisspp	+	+	+	+	+	+
Lepoconchisteres	+	+	+	+	+	+
L. longistriata	+	-	+	+	+	+
CHLOROPHYCEAE						
Spyrogyraspp	+	+	+	+	+	+
S. fluviatilis	+	+	+	+	+	-
S. porticalis	+	+	+	+	+	+
S. crassa	+	+	+	+	+	+
S. gracillis	+	+	+	+	+	+
S. maxima	+	+	+	+	+	+
Cosmeriummoliniferum	+	+	+	+	+	+
Ulothrixspp	+	+	+	+	+	+
Staurastrumdickier	+	+	+	-	+	+
Tetraediumcirculae	+	+	+	+	+	+
Closterumvenus	+	+	+	+	+	+
C. kuctzingii	+	+	+	+	+	+
PYRROPHYCEAE						
Peridiniumspp	+	+	+	+	+	+
Peridiniumwillei	+	+	+	+	+	+
Peridiniumcinctum	+	+	+	+	+	+
Peridiniumbipes	+	+	+	+	+	+
Glenodinumcinctum	+	+	+	+	+	+

Figure.1 Map of the Niger Delta Showing study Area



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