ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

The Water Quality Changes and Phytoplankton of an "Acadja" System in a Tropical Estuarine Lagoon in Lagos

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ABSTRACT

The water quality changes and phytoplankton of an "Acadja" system in the Lagos lagoon were investigated between October 2010 and March 2011. There were variations in the water quality parameters and phytoplankton diversity and distribution. For instance Salinity (0.5 - 22.05‰), Conductivity (195 - 17550 µS/cm), Alkalinity (3.8-60.8mg/L), Total Dissolved Solids (126-10,200 mg/L), Transparency (3-148cm) and Nitrate (5.7-14.9 mg/L), Dissolved Oxygen (4.0-5.0 mg/L) were higher in the dry than wet season months. Conversely, Rainfall (1.1-376.1mm), Total Suspended Solids (7 - 41 mg/L), Phosphate (0.08-0.8 mg/L) and Acidity (4.3-9.0 mg/L) recorded lower values in the same period. Phytoplankton biomass (in terms of cell numbers) was higher in the dry than wet season. In terms of diversity a total of 64 species were recorded from three groups, namely diatoms (71.2%), the blue-green algae (17.2%) and the Chlorophytes (11%). Ecological indices reflected changes in diversity and abundance of species. Whereas Log of Species diversity (Log S), Log of abundance (Log N), Equitability (j) and Simpson's Dominance Index (C) were generally higher in the dry season, Shannon-Wiener (Hs), Menhinicks (D) and Margalef (d) indices recorded lower values in the same time. Existing results show increased phytoplankton numbers in the dry season and this would portend more fish availability than in the wet season within the "Acadjas" setups in the Lagos lagoon.

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INTRODUCTION

The Lagos lagoon is an estuarine lagoon in Lagos, Nigeria which serves as a fertile realm for feeding, breeding and as a nursery ground for a number of aquatic organisms [32]. It provides habitation for a number of anadromous, catadromous and estuarine fish species [38] while being a site for fin and shellfish capture and culture. With regards to capture and culture of fish in the Lagos lagoon, the brush parks or "Acadja" and other semi-extensive systems in the lagoons of South-western Nigeria and adjoining creeks are noteworthy [29, 30].

"Acadja" or brush park is a traditional aquaculture / fish rearing practice that is common in natural river basin areas, open wetlands and lagoons. According to Nwankwo [14] fish fences or 'Acadja' are common sights in coastal waters of south-western Nigeria. They are constructed by artisanal fisher folks to give fish some 'sense of security' from predators and thereafter trapped. Furthermore, the term 'Acadja' describes a family of installation of the fish-park type that is currently found in several of the West African coastal lagoons [3]. Emmanuel *et al*., [3] citing Welcomme and Batley listed fish shelter as one of the techniques for fish stock enhancement. "Acadja" is also a kind of Fish Aggregating Device (FAD). They can take an array of shapes, with the spherical (circular) form as the most common. "Acadjas" provide shade, hiding place, shelter as well as food for fishes and could also serve as breeding, spawning or nursery areas for these aquatic organisms [3]. Additionally, the cut stems, shrubs, fronds, branches, bamboos and planks used for the construction of the "Acadja" are progressively colonized by bio-fouling forms such as bacteria, fungi, algae, nematodes, annelids, molluscs and other invertebrates forms which all serve as food for a wide array of fishes [9, 4]. The artificial habitat affords fishes a number of merits. These include protection from predators, more favourable feeding and spawning ground.

Studies on the food and feeding habits of fish in the Lagos lagoon complex have shown that phytoplankton algae are important components in the diet of phytophagous fish[20].The phytoplankton play in a key role in the diet of aquatic organisms especially fishes. They are important in aquatic biological monitoring systems as bio-indicators. However, a number of published reports exist on the phytoplankton of the Lagos lagoon. They include Nwankwo, Onyema *et al*., Onyema, Nkwoji *et al.*, [28] has already provided additional information on the phytoplankton of the Lagos lagoon. There is also a report by Emmanuel *et al*., [3] on macro invertebrates fauna and fish production of "Acadja" fishing sites in the Lagos lagoon while Onyema and Onyema *et. al*., [29,30] had considered the water chemistry and periphytic algae at a cage culture site in the same lagoon.

The aim of this study was to investigate the phytoplankton within an "Acadja" structure in the Lagos lagoon in relation to the water quality characteristics and regimes.

MATERIALS AND METHODS

The Lagos lagoon and “Acadja” system

The Lagos lagoon has an area of 208km^2 and an average depth of 1.5m for most of its expanse. It is situated in Lagos, Nigeria and falls within the rainforest zone, which experience a well marked dry and wet season. Two peaks of rainfall linked with excessive floods are generally associated with this area, a major peak in June and a lesser peak in September. The brackish water environment is therefore a consequence of tidal seawater incursion and freshwater discharge from the adjoining creeks and rivers [8]. Sand minning is common in the Lagos lagoon. The particular “Acadja” framework for this study is located off the University of Lagos shoreline in the Lagos lagoon (Fig. 1). The region experiences semi-diurnal tidal regime and the activities of boatmen and fisher folks are high in the area. The use of brush packs (“Acadja”) within the lagoon is a common practices.

In constructing an “Acadja”, branches are cut from trees in neighboring wetlands, swamps or forest areas. The materials are then transported by canoes or boat in bundles to the lagoon for the construction by incision of the cut stems, fronds, bamboos and branches in usually spherical forms. Construction of “Acadja” can be at anytime of the year but it especially occurs in the late wet season to early dry season (November-January) and they are harvested in 4 - 6 months or later, usually before the unset of the raining season (April-May) due to the possibility of seasonal migration of fish species. Havesting of “Acadjas” have also been observed at other times even between October and January. The common fish species caught from Acadja systems in the Lagos lagoon include *Sarotherodon melanotheron*, *Chrysichthys nigrodigitatus*, *Ethmalosa fimbriata*, *Hemichromis fasciatus*, *Pomadasys jubelini*, *Mugil cephalus* and *Tilapia guineensis*. Shell fishes are usually dorminated by *Callinectes amnicola* and *Penaeus* spp. Artisanal fisher folks in the region are known to practice the “Acadja” or brush park method. This method has existed for tens of years and is practiced in a number of countries of the world Emmanuel *et al.,* [3].

According to some others in the Lagos lagoon [9, 29, 30], fishes (herbivores feeders) are known to forage on clusters of algae that develop on submerged surfaces including “Acadjas”. “Acadjas” are usually constructed with mangrove stems (especially *Rhizophora racemosa*) or even (palm) fronds from palms, coconut or even Raphia trees. They are usually pegged to the lagoon floor in areas that are less than 1.5m in depth.

Notable invertebrates on the ‘Acadja’ fences in the study area include Crabs - *Uca tangeri, Sersama huzardii* and *Callinectes amnicola,* Periwinkle - *Pachymelania aurita* and *Tympanotonus fuscatus* var. *radula,* bivalve - *Gryphea gasar.* Others are the Annelid-*Mecierella enigmatica*, Crustacean - *Balanus pallidus* and the hermit crab - *Clibernarius africana* inhabiting shells of *Tympanotonus fuscatus* var. *radula* and *Pachymelina aurita* and the mud skipper - *Peripthalmus* sp. are also notable members of the brush parks in the region [4]

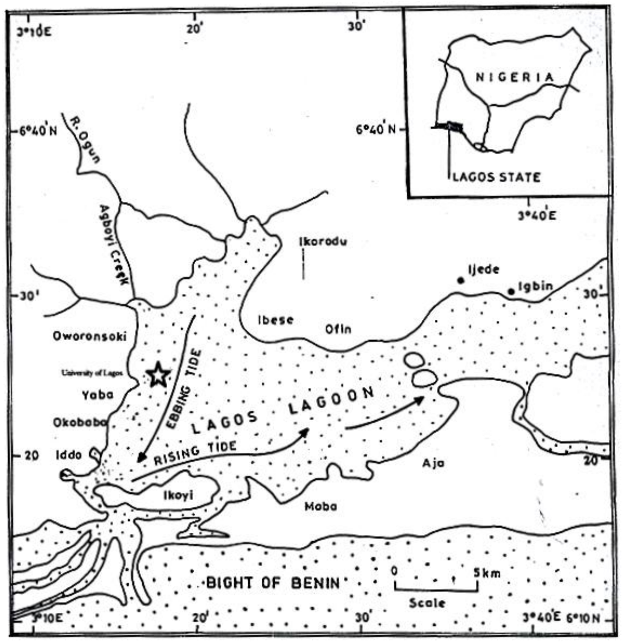

Fig. 1: Lagos lagoon showing the location of the studied "Acadja site".

Collection of Samples

Surface water samples were collected once monthly (Oct. 2010-Mar. 2011) for water quality characteristics with 75cl plastic container with screw cap within the "Acadja" system off the University of Lagos shoreline between 13 and 16hr. On getting to the "Acadja", the fences were pathed and the sampling boat rowed in. Sampling then takes place at about the center of the spherical "Acadja" which was about 35m in diameter. The co-ordinates for collection were Longitude 3.402886E and Latitude 6.520961N**,** All water samples were transported directly to the laboratory after collection for determination of estimates for water quality parameters. Phytoplankton samples were collected by filtering 100 liters of water through a 55µm plankton net at the center of the "Acadja" arrangement. Samples were properly labeled and preserved with 4% unbuffered formalin in a screw capped container.

Analysis of water samples

Air and surface water temperatures were measured using a mercury thermometer. Rainfall values were obtained from the Nigerian Meteorological Agency, Lagos (NIMET). Transparency was estimated by the secchi disc method, Total Dissolved Solids by Cole Palmer TDS meter, pH by Electrometric / Cole Parmer Testr3, Measurement of Total Suspended Solids, Chloride, Total hardness, Conductivity, Salinity, Alkalinity, Acidity, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand, Nitrate-nitrogen, Phosphate-phosphorus, Sulphate, Silica, Calcium and Magnesium where measured using methods according to American Public Health Association (1998) for water analysis. Copper, Iron and Zinc were estimated with an

Atomic Absorption Spectrophotometer PerkinElmer 5000 AAS and using Perkin Elmer Application methods (2002).

Biological Parameter Analysis

Phytoplankton Analysis

In the laboratory, plankton samples were concentrated to 10ml. Five drops of the concentrated sample (10ml) were investigated for diatoms only at different magnifications and the average recorded according to Nkwoji *et al*., Phytoplankton organisms were recorded as numbers of organisms per ml. Identification aids used included Desikachary, Hendey, Patrick and Reimer, Barber and Harworth, Vallandingham, Whitford and Schmacher and Nwankwo.

Community Structure Analysis

A number of ecological indices were employed to analyze the data further. They include Species richness (d), Shannon and Wiener (Hs), Equitability (j) Menhinick (D) indices and Simpson Dominance Index (D).

RESULT

The data obtained for the monthly variation in the physico-chemical parameters at the Acadja system from October, 2010 to March, 2011 are represented in Table 1.

Air temperature ranged between 23^{o}C (January) and 34 ^{o}C (February). The water temperature was between 25^{0}C (January), while the highest was 32.5^{0}C recorded in March. The total suspended solid was lowest in February (7mg/L) while the highest value was recorded in October (41mg/L). Salinity showed monthly variation. The highest salinity was estimated in January (22.5‰) and the lowest in November (0.04 %$_{o}$). Conductivity study ranged widely from 195 (October) to 17550µS/cm (January). The total hardness was between 125mg/L (November) and 3120 mg/L (March). pH value was between 7.0 and 7.1. 4.3 (January) to 9mg/L (November) was reported for Acidity, while Alkalinity was between 13.8 (October) and 60.8mg/L (March). Dissolved oxygen varied from 4.5 mg/L in January to 5.1 mg/L in October. The Biochemical oxygen demand ranged from 5mg/L in December to 10mg/L in March. Chemical oxygen demand ranged between 22mg/L (December and January) to 35mg/L recorded in March. With regard to the cations, Calcium was between 38.3 (November) and 320 mg/L (December). Magnesium was between 7.3 (November) and 598mg/L (March). With respect to the nutrients, Nitrate was 5.7 (October)-14.9mg/L (January), Phosphate 0.08 (March) - 0.3mg/L (October), Sulphate 6.3 (October) to 186mg/L (January) and Silica 1.2 (January)-5.8mg/L (October). The heavy metal levels for Copper 0.001 (November, January, February and March) - 0.004 mg/L (December), Iron 0.11 (December) - 0.32 mg/L (October) and Zinc 0.001(November and January) - 0.003 mg/L (October and March) were estimated.

Table 1: Monthly Variations in the Physico-Chemical Parameters in an "Acadja" system on the Lagos Lagoon (Oct., 2010-March 2011).

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Air temperature (°C)	32	30	29	23	34	31
Water temperature (°)	30	29.5	29	25	30.5	32.5
Transparency (cm)	45	74	148	84	31	73
pH	7.1	7.05	7.1	7.01	7.0	7.0
Conductivity (µS/cm)	195	319	12005	17550	12015	15810
Total Suspended Solids (mg/L)	41	18	11	8	7	12
Total Dissolved Solids (mg/L)	126	206	5700	7800	7750	10200
Rainfall (mm)	376.1	54.2	2.6	1.1	61.2	28.7
Salinity (‰)	0.05	0.04	14.88	22.05	13.5	12.41
Acidity (mg/L)	8	9	7.1	4.3	5	5.2
Alkalinity (mg/L)	13.8	18.5	22.3	60.8	52.5	54.6
Total hardness (mg/l)	360.8	125	1150	3000	3055	3120
Calcium (mg/L)	85.2	38.3	320	240	256.1	266.2
Magnesium (mg/L)	36.3	7.3	370.2	571.2	585	598
Zinc (mg/L)	0.003	0.001	0.002	0.001	0.002	0.003
Iron (mg/L)	0.32	0.26	0.11	0.16	0.2	0.19
Copper (mg/L)	0.002	0.001	0.004	0.001	0.001	0.001
Chloride (mg/L)	16.5	13	5160	10320	12600	10000
Nitrate (mg/L)	5.7	6.2	8.1	14.9	10.2	7.5
Sulphate (mg/L)	6.3	30.5	10.2	186	75.1	85.2
Phosphate (mg/L)	0.3	0.21	1.9	0.1	0.12	0.08
Silica (mg/L)	5.8	3.3	3.6	1.2	1.3	1.6
Biological Oxygen Demand (mg/L)	7	8	5	6	7	10
Chemical Oxygen demand (mg/L)	28	33	22	22	29	35
Dissolved Oxygen (mg/L)	4.2	4	4.8	4.8	5	5

Phytoplankton Spectrum

The phytoplankton recorded 3 (three) group of species. They were the Diatoms (Division-Bacillariophyta), the Blue-green algae (Division-Cyanophyta) and the Green algae (Division-Chlorophyta). The dominant group of phytoplankton was the Diatoms in terms of diversity. Whereas the Diatoms recorded 71.8% (Pennales-39.4% and Centrales-32.8%), the Blue-green algae reported 17.2% (Chroococales-3.1% and Hormogonales-14.1%) (Fig. 2) and Green algae reported 11% (Ulothricales-3.1%, Cladophorales-1.6%, Chlrooccolales-1.6% and Zygnematales-4.7%).

A checklist of the phytoplankton spectrum is presented within Table 1a alongside the distribution of the phytoplankton species for six months investigated (October, 2010 to March, 2011). In all a total of sixty-four (64) species were recorded. Total number of species recorded ranged between 16 and 23 taxa. October recorded the highest number of species (23 species) while December recorded 16 species only. Furthermore, March recorded the highest number of individuals (350 individuals per ml) while December recorded 175 individuals per ml. Log of Species diversity recorded ranged from 1.20 (December) to 1.36 (October). Log of phytoplankton abundance was between 2.24 (December) and 2.54 (March). Whereas Shannon-Wiener Index (Hs) was between 0.94 (March) and 1.28 (October), Menhinick Index (D) was between 0.91 (March) and 1.47 (October). Margalef Index (d) values were from 2.73 (March) to 4.00 (October) while Equitability on the other hand was between 0.76 (March) and 0.96 (February). Simpson's Dominance Index ranged between 0.06 (October and February) and 0.22 (March). Graphical representations of the phytoplankton ecological indices are shown in Fig. 3. The key species occurring for the study were *Coscinodiscus centralis* (Diatoms) and *Oscillatoria limnosa* (Cyanophytes) in terms of occurrence and abundance.

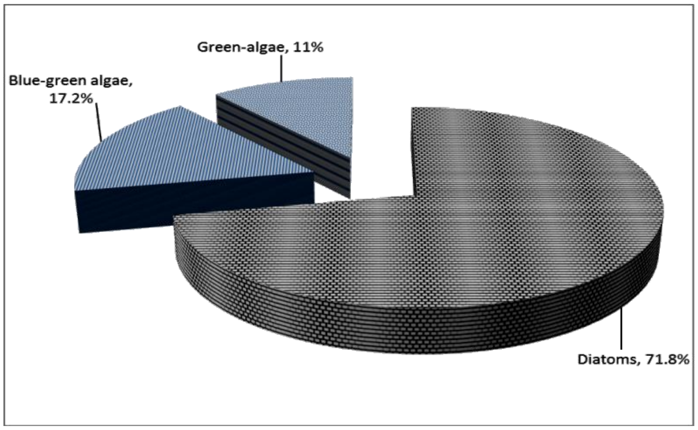

Fig. 2: Percentage occurrence of major phytoplankton classes in terms of diversity at an "Acadja" structure within the Lagos lagoon.

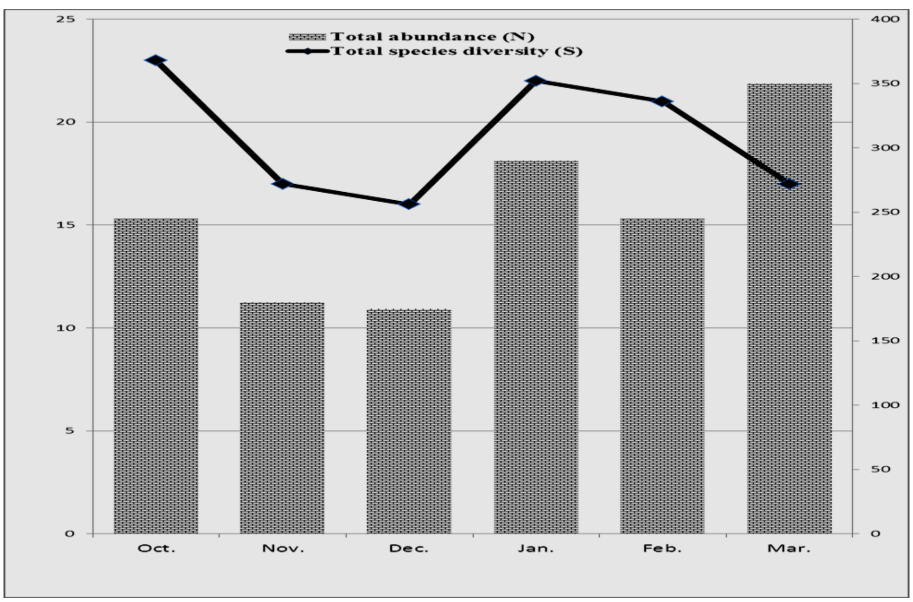

Fig. 3: Phytoplankton Total number of species (S) and abundance (N) at an "Acadja" structure within the Lagos lagoon.

ISSN: 0975-8585

Table 2: Composiion and distribution of phytoplankton species in an "Acadja" system in the Lagos lagoon.

PHYTOPLANKTON TAXA	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
DIVISION-BACILLARIOPHYTA						
CLASS-BACILLARIOPHYCEAE						
ORDER I-CENTRALES						
Actinoptychus splendens Ehrenberg	-	5	10	5	-	-
Amphiprora alata Ehrenberg	-	-	-	5	15	10
Aulacoseira granulata Ehrenberg (Ralfs)	25	15	-	-	-	-
Aulacoseira granulata var. *angstissima* Muller	35	20	-	-	-	-
Aulacoseira islandica (O.F. Muller) Simonson	-	5	-	-	-	-
Aulacoseira varians Agardh	5	-	-	-	-	-
Chaetoceros convolutus Castracane	-	-	-	10	25	10
Chaetoceros decipens Cleve	-	-	5	-	15	-
Coscinodiscus centralis Ehrenberg	-	25	10	45	20	15
Coscinodiscus eccentrius Ehrenberg	-	5	-	10	5	-
Coscinodiscus lineatus Ehrenberg	-	-	-	-	-	25
Coscinodiscus marginatus Ehrenberg	-	-	-	-	-	5
Coscinodiscus radiatus Ehrenberg	-	-	5	5	15	10
Cyclotella menighiniana Kutzing	5	10	-	-	-	-
Cyclotella striata (Kutzing) Grunow	5	-	-	-	-	-
Meloseira moniliformis Agardh	-	-	5		10	25
Meloseira nummuloides Agardh	-	-	10	15	-	15
Odontella aurita (Lyngbe) Brebisson	-	-	-	10	-	-
Odontella mobilensis Bailey	-	-	-	-	5	15
Odontella regia (Schultze) Ostenfeld	-	-	-	-	5	10
Odontella sinensis Greville	-	-	5	-	-	
Rhizosolenia alata Brightwell	-	-	-	-	5	10
Skeletonema coastasum Cleve	-	-	-	-	10	-
Terpsinoe musica (Her.) Hustedt	15	5	-	-	-	-
Triceratium favus Ehrenberg	-	5	-	-	-	-
Order II-PENNALES						
Achnanthes longipes Agardh	-	-	5	10	-	-
Amphora ovalis Kutzing	-	-	-	-	15	
Bacillaria paxillifer (O.F. Muller) Hendey	-	-	-	10	10	
Fragillaria construens Ehrenberg	-	10	-	-	-	-
Fragillaria islandica Grunner	5	-	-	-	-	-
Gyrosigma balticum (Ehr.) Rabenhorst		10	5	-	-	-
Gyrosigma spenceri W. Smith	-	-	-	5	5	10
Gyrosigma scalproides (Rabh) Cleve	-	-	-	-	-	5
Hantzschia amphioxys (Her) Rbenhorst	-	-	-	-	-	5
Navicula bicapitata Ehrenberg	5	10	-	-	-	-
Navicula cryptocephala (Kutz) Hustedt		5	10	5	-	-
Nitzschia closterium Wm. Smith	-	-	-	-	15	
Nitzschia sigmoidea (Witesch) W. Smith	-	-	-	-	5	20
Nitzschia sigma Grunow	-	-	-	5	-	-
Pleurosigma angulatum (Quekett) Wm Smith	-	-	-	10	15	5
Pleurosigma elongatum Wm Smith	-	-	-	5	-	-
Surirella ovata Kutzing	15	-	-	-	-	-

Surirella splendida Wm. Smith	10	-	-	-	-	-
Surirella striatula Turpin	10	-	-	-	-	-
Synedra ulna (Nitzsch) Ehrenberg	-	15	10	25	-	-
Synedra crystallina (Ag) Kutzing	-	-	-	25	20	-
DIVISION-CYANOPHYTA						
CLASS-CYANOPHYCEAE						
ORDER I-CHROOCOCCALES						
Chroococcus turgidus (Kutz.) Lemm	10	-	-	-	-	-
Microcystis aureginosa Kutzing	15	-	-	-	-	-
Order II-HORMOGONALES						
Lynbgya limnetica Lemm	5	-	10	-	-	-
Lynbgya martensiana Meneghini		25	45	-	-	-
Oscillatoria borneti Zukal	5	-	-	-	-	-
Oscillatoria chalybea Gomont	5	5	-	-	-	-
Oscillatoria curviceps C.A. Agardh	-	-	15	15	10	
Oscillatoria formosa Bory	-	-	-	10	-	-
Oscillatoria limnosa Agardh			15	10	5	155
Oscillatoria tenius Agardh	10	5	-	-	-	-
Spirulina platensis Geitler	-	-	-	45	-	-
DIVISION-CHLOROPHYTA						
CLASS-CHLOROPHYCEAE						
ORDER I-ULOTHRICALES						
Microspora flocca (Vaucher) Thuret	15	-	-	-	-	-
Spirogyra africana Fritsch Cruda	10	-	-	-	-	-
ORDER II - CLADOPHORALES						
Cladophora glomerata (L) Kutzing	-	-	10	5	15	-
ORDER III - CHLOROCOCCALES						
Scenedesmus quadriquada (Turp.) de Brebisson	15	-	-	-	-	-
ORDER IV - ZYGNEMATALES						
Closterium ehrenbergii Meneghini	5	-	-	-	-	-
Gonatozygon monotaenium De Bary	10	-	-	-	-	-
Gonatozygon sp.	5	-	-	-	-	-
Total species diversity (S)	**23**	**17**	**16**	**22**	**21**	**17**
Total abundance (N)	**245**	**180**	**175**	**290**	**245**	**350**

Table 1b: Phytoplankton community composition parameter at an "Acadja site" on the Lagos lagoon

Bio-indices	Oct.	NoV.	Dec.	Jan.	Feb.	Mar.
Total species diversity (S)	23	17	16	22	21	17
Total abundance (N)	245	180	175	290	245	350
Log of Species diversity (Log S)	1.36	1.23	1.20	1.34	1.32	1.23
Log of abundance (Log N)	2.39	2.26	2.24	2.46	2.39	2.54
Shannon-Wiener Index (Hs)	1.28	1.15	1.10	1.21	1.27	0.94

Menhinick Index (D)	1.47	1.27	1.21	1.29	1.34	0.91
Margalef Index (d)	4.00	3.08	2.90	3.70	3.64	2.73
Equitability Index (j)	0.94	0.93	0.91	0.90	0.96	0.76
Simpson's Dominance Index (C)	0.06	0.08	0.11	0.08	0.06	0.22

DISCUSSION

Mangrove biosystems and adjourning areas are known to be nutrient rich, shallow, sheltered and productive systems that serve as breeding, nursery and feeding grounds for aquatic organisms [26]. The extent of water quality characteristics recorded from this study are trends and condition that have been previously recorded by some workers in the region [18, 29, 30]. For instance, air and water temperature values reported were similar to those recorded by Nwankwo and Akinsoji and Onyema [16,22]. However the low air and water temperatures recorded in January, may be due to the harmattan phenomenon associated with dust haze and reduced isolation. A similar situation has been reported for the Lagos and Iyagbe lagoons [22]. Air temperature values are also known to appreciably impact water temperatures [25, 27]

Values for salinity, total dissolved solids and cation reflected trends that are known for the Lagos lagoon [12, 31]. It is important to note that Transparency, Total suspended solids and Chemical Oxygen demand for this study were higher than for other previous studies. Noticeably, the stems and structures that form the "Acadja" are known to reduce the flow of water hence increasing its resident time. Water slows down more and stays longer within the acadja system. According to Emmanuel *et al*., [10]. Acadja harvests over the years have been shown to be higher during the dry season as correlated with high phytoplankton (as collaborated by this study) and zooplankton productivity. Furthermore, nutrient levels especially nitrate were higher comparatively to other studies. According to Nwankwo the fishes may be more interested in the attached algal forms growing on the stems structures than just the sanctuary they provide. Nwankwo [10] is of the view fish visit the 'Acadja' not only for safety but possibly for food. Within the "Acadja" system higher diversity and abundance of algae were recorded; this may be as a result of the higher load of nutrients and increased stability (reduced flow) of the water within the acadja system. These condition likely increased primary productivity. Additionally the provision of suitable loci or attachment surfaces by the cut stems of the "Acadja" provided favourable areas for attachment by periphytic algal forms. Water hyacinth (*Eichhonia crassipes*) and seldom times *Vossia cuspidata* are usually trapped within "Acadja" system in the Lagos lagoon particularly around September to November / December from year to year. These aquatic macrophytes are known to further make the FAD or "Acadjas" more conducive for resident fish fauna and further slowdown the water flow within the system. Also, after their death from increasing salinity in the dry season, they sink and continually deteriorate on the substratum the Acadaja setup. These may continually provide nutrients and other ecological inputs over time.

The occurrence of *Closterium, Gonatozygon* spp., *Scendesmus, Microspora* and *Spirogyra* species were indicators of low salinity, higher than usual volume of rainfall and associated flood run off conditions. These Chlorophytes occurred only in October during the study. Species of *Aulacoseira granulata* and *Aulacoseira granulata* var. *angstissima* also represent similar conditions.

Whereas the centric diatoms generally reflected in-coming sea conditions, especially with species like *Coscinodiscus, Odontella, Rhizosolenia* and *Melosira* spp; The pennate forms indicated shallow conditions especially during the rains within the lagoon. Species of *Navicula, Nitzschia, Pleurosigma, Surirella, Gyrosigma* and *Synedra* are notable in this regard. They are also indicators of a hydrologically mixed environment. Members of the phytobenthic algae communities are re-suspended due to floodwater mixed flow and additional scouring of the lagoon substratum. Species of *Microcystis* and *Chroococcus* spp were also found within the "Acadja" system in the month of October (Wet Season/low salinity period). Water quality characteristics within the "Acadja" were similar to that of the adjoining Lagos lagoon. However, the structures of the brush parks slightly mordifies the flow characterisics within the setup, hence affecting such hydrodynamics related factors like current speed, transparency, suspension of already suspended particulate. These mordification impacted the water condition and hence the phytoplankton spectrum.

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