Hydro-Chemistry, Macro-Invertebrate Fauna And Fish Production Of Acdja Fishing Sites In A Tropical Lagoonal Ecosystem

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ABSTRACT: An investigation of the hydrochemistry, macro – invertebrates fauna and fish production of three selected acadja fishing sites was carried out for six months (April – September, 2004) in the Lagos lagoon. Depth, Total suspended solid, total dissolved solid, nitrates, phosphates, sulphates, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand recorded high or increasing values during the rainy season while transparency and salinity showed progressively lower values. The biological oxygen demand (BOD) and chemical oxygen demand (COD) ranged from 70.0 to 115.0mg/l and 20.0 to 75.0mg/l respectively. A total of twenty species and eighteen genera of Macro - invertebrate were recorded. The mollusks were the most abundant and diverse phyla, followed by the crustacean and annelids. The dominant species throughout the study were *Tympanoyonus fuscatus var radula, Balanus pallidus, Aloidis trigona* and *Mercierella enigmatica.* A total of 89.80kg (38.52%) fish was harvested in Site A, 71.30kg (30.59%) in Site B and 72.0 kg (30.89%) in Site C. *Sarotherodon melanotheron* and *Tilapia guineensis* contributed 36.75% of the total weight in Site A, 34.64% in Site B and 38.75% in Site C. Twelve fish species occurred in the Site A and C while eleven fish species occurred in fishing Site B with least species diversity. The profitability indices show that 'acadja' brush park fishing practice is a profitable business in the lagoon. [Journal of American Science 2010;6(1):42-48]. (ISSN: 1545-1003).

Keywords: Hydro – chemistry, macro – invertebrate, fish acadja, lagoonal ecosystem.

INTRODUCTION

Ecological studies of benthos in the Lagos lagoon were initiated several decades a go by Webb and Hill (1958), also Sandison and Hill (1966) and Oyenekan (1988) have also been major contributors. More recently are the investigations by Brown (1998) and Brown and Oyenekan (1998). Oyenekan (1988) put forward a classification of the benthic communities of the Lagos lagoon. The classification was based on the natine of deposit in which they occur and on the characteristics faunal element. Five communities were identified identified in Lagos lagoon: mangrove, pachymelina, estuarine, amphiophus, venus and estuarine rock communities (Oyenekan, 1988). The fish and the fisheries of the Lagos lagoon has been documented by authors like Fagade (1969); FAO (1969), Fagade and Olaniyan (1974), Udolisa and Solarin (1979), Solarin (1998), Solarin and Kusemiju (2003a&b), Emmanuel *et al.,* (2008a &b).

Over the years the Lagos lagoon has continued to be under intensifying pressure from pollution. According to Ajao *et al.,* (1996) coastal waters can be contaminated from both natural and anthropogenic sources of pollution. The anthropogenic sources include sand mining, industrial and domestic effluents, logging and timber transportation by water. The anthropogenic pollutants/waste has an attendant effect on the biodiversity of aquatic resources. Reduction in the composition and density of algae, zooplankton, benthic invertebrates, fish and fisheries resources has been linked to the increasing menace over the years of aquatic pollution in the Lagos lagoon, Nigeria (Akpata *et al.,* 1993; Nwankwo, 1998; Solarin 1998; Emmanuel *et al.,* 2008a&b).

Lagos lagoon has supported decades of small-scale fisheries which have shown signs of over-exploitation. The fishing gears and crafts used include gillnet, stownets traps, liftnets, longline, basket traps etc (Fagade, 1969; Solarin, 1998; Emmanuel 2008; Emmanuel *et al.,* 2008a&b).

The term 'acadja' describes a family of installation of the fish-park type that is currently found in several of the West African coastal lagoon (Welcomme, 1972). Welcomme and Batley (1998) listed fish shelter as one of the techniques for stock enhancement. Acadja fish fence provide shade, hiding place, shelter as well as food for fishes. The acadjas also act as breeding, spawning or nursery areas for fishes and also act as point of attachments for algae and macrobenthic invertebrate. The sticks used for the acadja are progressively colonized by bacteria, fungi algae, nematodes, annelids, mollusk and other invertebrates forms which all serve as food for a wide away of fishes. Hence, the mechanism of fish aggregation is prompted by the shelter, security and colonization of the fish fences by plankton and invertebrates organism which in turn prompts the growth of a large number of small planktophagus and benthophagus fishes which feed on them. It takes about three or more months for the sticks to deteriorate appreciably and then harvest is imminent. Acadja harvests over the years have been shown to be higher during the dry season as correlated with high phytoplankton and zooplankton productivity (Nwankwo, 1991; Nwankwo *et al.*, 1994, Solarin 1998; Emmanuel and Onyema 2007).

The acadja, apart from slowing down the water current occasionally traps aquatic weeds like water hyacinth (*Eichhornia crassipes*) release exudates, tannins, lignins and other leachates which may adversely impair water quality. The study aimed at assessing the hydro-chemistry at the acadja site as well as the fishes and macrobenthic invertebrate composition biomass, temporal variation as these forms are an important component of the fish feed and fish production.

MATERIALS AND METHODS

Description of Study Site

The coastline of south-western Nigeria is a meandering network of lagoons and creeks of which the Lagos lagoon with an area of 208sqkm is the largest **(Fig. 1)**. The Lagos lagoon is shallow with an average depth of 1.5m except at the channels that are dredged occasionally (Webb, 1958), Brown and Oyenekan (1998) citing FAO (1969) records that the Lagos lagoon with an area of 208km^2 is the largest of the four lagoon systems in West Africa. It opens into the gulf of Guinea through the Lagos harbour which is the only opening of any size for fresh and brackish water to the sea for the entire western lagoons of Nigeria (Hill and Well, 1958). The lagoon is shallow and brackish with a salinity range between 0‰ at the mouth of Ogun River and 20‰ at the harbour (Webb, 1958).

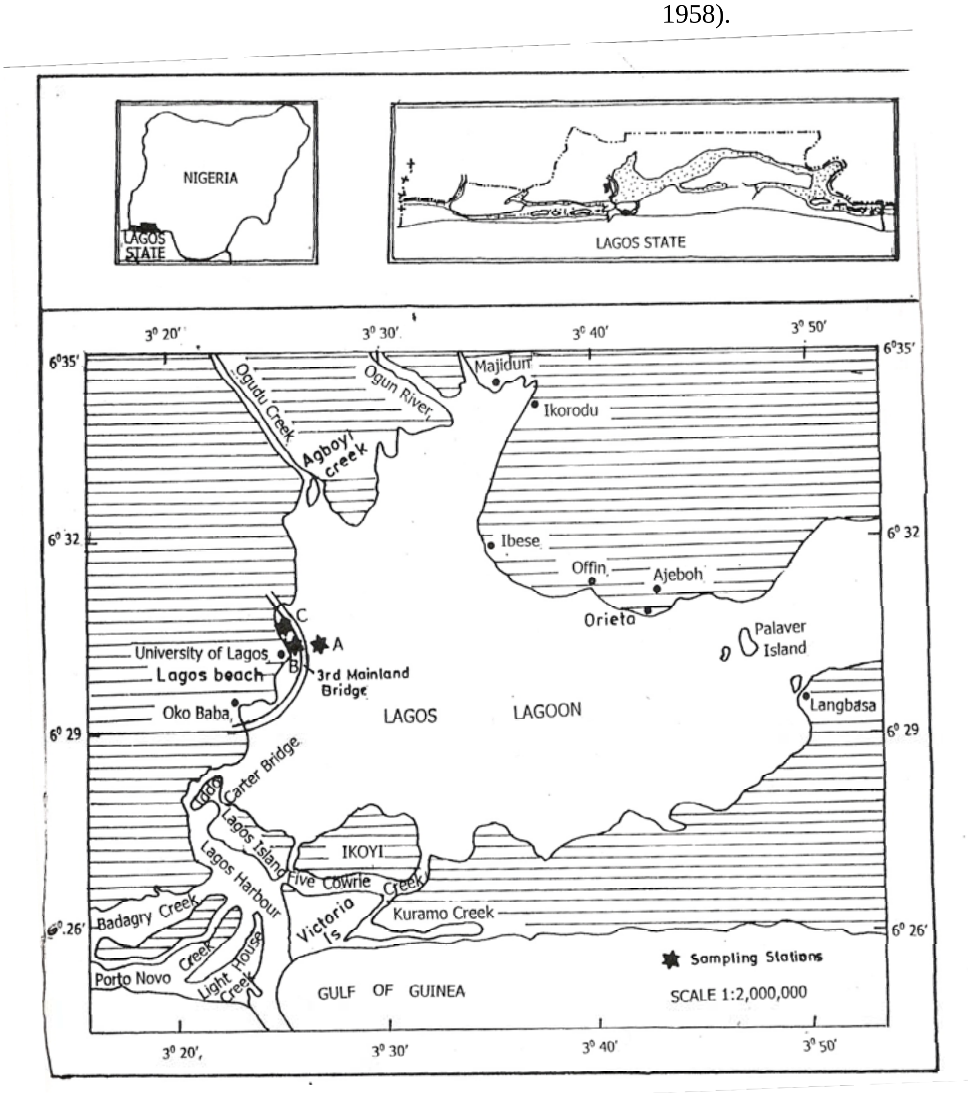

Fig. 1: Map of Lagos Lagoon showing the study sites

The influx of seawater from the sea give rise to brackish conditions in the lagoon and encourages the growth of mangrove which lines the edges of the many waters ways and cover those areas of low lying swampy grounds which are inundated at the high (Spring) tides.

Sampling Stations

For this study, there strategic sites have been chosen for ecological assessment. Station A is a pollution relatively free site within the lagoon whereas Station B is a site where kitchen waste and organic materials from University of Lagos staff club and guest house are channeled into the lagoon. Household or domestic waste and sewage are prevalent in Station C, emanating from household at the edges and within the lagoon.

Collection of water sample and sediment, temperature were measured in-situ on the field with mercury in glass thermometer. Water samples were collected at each site in a 250ml water container between April and September 2002. Van-Veen grab ($0.1m^2$) was used to collect the sediment. The water samples were then transported and stored in a refrigerator for further analysis. The sediment were empted into a black polythene bag and stored in a deep freezer ($<0^0C$).

Physico-Chemical Parameters

Surface water samples were collected about 10cm the water surface. On each trip, temperature (^0C) was recorded with mercury-in-glass thermometer and transparency (cm) measured by a 20cm diameter Secchi disc. Salinity (‰) was determined using the silver-nitrate-chromate method as suggested by Barnes (1980) and Nwankwo (1991) and pH measured in the field a Hackkit (Del, 2001). Dissolved oxygen (mgl^{-1}) was measured by the Griftin oxygen meter (Model 40). Total suspended solids (TSS), (mgl^{-1}) was estimated by the evaporation of a 100ml aliquot.

Sediment Analysis

Sediment particle size analysis was done using the method described by Brown (1991) and total organic matter determined by the rapid ash method employed by Oyenekan (1975).

Macrobenthic Invertebrate and Fish Collection

One of the grab was washed through a 0.5mm sieve in the field. The retained materials were preserved in 4% formalin and kept in labeled jars for further sorting and analysis in the laboratory. Fishes in the acadja sites were collected with enacting net (10mm-mesh polyamide) which was used to form a complete fence. The debris within was removed and gradually the net was drawn together to entrap the fishes.

(1) Statistical Analysis

All statistical methods used were adapted from Ogbeibu (2005). Macrobenthic community structure was estimated using the Margalef's species richness index (d) (Margalef, 1951); Shannon-Weiner information function (AS) (Shannon and Weaver, 1949) and Equitability index or Evenness (Lloyd and Ghellardi, 1964).

(2) Economic and Profitability Analysis

The economic and profitability analyses as described by Ayinde and Aromolaran (1998) and Abdul *et al.*, (2004) were adopted. Net income of fisherman practicing "acadja" fishing was calculated for the six month. This analysis was used in the profitability analysis to calculate return to management, capital and family labour, return to investment, return on fixed cost or gross margin, rate of return on fixed cost, rate of return on variable cost and rate of return on labour cost.

Return to management, capital and family labour (RMCF):
RMCF = TVP – TFC – TVC less cost of capital borrowed and cost of family labour
Rate of Return to Investment (RRI): RRI = (RMCF/TC) x 100
Return on Fixed Cost (RFC) or Gross Margin (GM): RFC = TVP – TVC
Rate of Return on Fixed Cost (RRFC): RRFC = (RFC/TFC) x 100
Rate of Return on Variable Cost (RRVC): RRVC = (RTVP – TFC/TVC) x 100
Rate of Return to Labour (RRLC):
RRLC = TVP – All costs except labour cost/total labour cost (man/day) x 100
Where, TVP = Total value of product
TFC = Total fixed cost
TVC = Total variable cost
TC = Total cost

RESULTS

The monthly variation in the physico-chemical parameter of water at the acadja fishing sites in the lagoon is shown in **Table 1 a&b**. The highest surface water temperature during the study was 32^0C in May and the lowest was 28^0C in July. pH values were essentially alkaline throughout the study period. pH range of 7.2 – 8.0 was recorded for water while that of sediment ranged between 7.0 and 8.0. A neutral pH of 7.0 was recorded in Station A and B in July for sediment and water respectively. Total dissolved solid ranged between 10.0 and 24.0mg/l and the highest (24.0mg/l) was recorded in June while the lowest (10.mg/l) was recorded in April, August and September. Total suspended solids in study areas ranged between 10.0 and 21.5mg/l. Turbidity was generally high for the months of May, June, July, August and September with highest value of 22.5mg/l in Station A. Salinity value was highest in April (20.5‰) while the lowest (2.0‰) was recorded in September. Chloride content of the study areas was fairly constant with a range of 10.0 – 18.0mg/l. The highest chloride value was observed in June and July. Low value of oil and grease was obtained in this study with maximum value of 0.25mg/l in July. The highest nitrate value (2.5mg/l was recorded in April. Phosphate value was high in June with 4.5mg/l and the lowest (2.2mg/l) in July. Dissolved oxygen was high during the early party of the rainy season (April – June) with 6.5mg/l value at Station A and B in June and Station B in May and the lowest (3.0mg/l) in August (Station A & B) and September (Station C). A trend of high chemical oxygen demand was recorded in April, May, June and July with a peak in June (75mg/l). A range of 70 – 115.0mg/l was recorded for BOD in the study area with the maximum value noted at Station B in May and the lowest in Stations A and B in August and Station B in September. The sulphate level was very low with maximum value of 1.5mg/l. Total organic content (TOC) did not show any marked variation both in the station and the study period.

Macrobenthic Invertebrates

A total of twenty (20) species of benthic were recorded in this study. The species constituted three phyla: Mollusca, Annelids and Crustacea (Table 2). The mollusca constituted fifteen species, the annelida crustacean a constituted two and three species respectively. The gastropod molluscs include *Semifusus morio, Pachymelania aurita, Thais haemistoma, Natica flammulata, Neritina glabrata, Nerita* sp, *Tympanotonus fuscatus, var radula, Terebra micans* and *Turritella ungulina*, while the bivalvea molluses include *Aloidis trigona, Dreissena africana, Mactra* sp and *Cryphaea gasar*. The annelids were *Nereis succinea* and *Mercierella enigmatica*. The crustacean were represented by the common lagoon crab – *Callinectes amnicola* and the hermit crab – *Clibenarius africana* and *Balanus pallidus, Tympanotonus fuscatus var radula* was the most abundant organism during the study, followed by *T. fuscatus, Mercienella enigmatica* and *Balanus pallidus*. No specimen was recorded for Station A in April. Figs 2 to 4 show the number of individual organisms, percentage abundance of classes and monthly variation in the abundance of major taxonomic group of macro – invertebrate in the acadja sites respectively.

Three attached form were recorded in this study these are *Balanus pallidus, Mercierella enigmatica* and *Cryphaea gasar*, they were found attached to shells of *Tympanotnus fuscatus* var *radula*. The crustacean and annelids forms *(Balanus pallidus* and *Mercierella enigmatica*) were the more frequent forms on *T. fuscatus* var *radula* shells. Lesser density of these organisms was also found to attach to shells of *Gryphae gasar*. *Pallidus* was also found attached to stones located on the bottom of the study area. Juveniles of the *T. fuscatus* var *radula* were encountered from June, July, August and September.

Fish species composition and production in the acadja sites

The fish species composition of the acadja fishing sites is shown in Table 3. A total of 89.80kg (38.52%) fish was harvested in Site A, 71.30kg (30.59%) in Site B and 72.0kg (30.89%) in Site C. *Sarotherodon melanotheron* and *Tilapia guineensis* contributed 36.75% of the total weight in Site A, 34.64% in Site B and 38.75% in Site C. Twelve fish species occurred in the Site A and C while eleven fish species occurred in fishing Site B with least species diversity. The production of the acadja fishing in Lagos lagoon was estimated in **Table 4**. The production in Site A was ₦19, 463 (US$ 161.92), ₦15, 877 (US$132.07).

In this study the abundance of benthos was related to fish production in the ‘acadja’ fishing sites. **Table 5** shows that, at the end of six month of operation, a total of N23,000 was invested on three ‘acadja’ brush parks out of which N17,000 and N6,000 were variable and fixed costs respectively. Individual fisherman spent N3, 000 on seine-net rentage, N9, 000 on labour, N2, 000 on brush park maintenance and N3, 000 on canoe rentage. On fixed he spent N6, 000 on ‘acadja’ installation. An economic analysis indicated a fisherman net income of N28, 016. Profitability analysis shows that return to management, capital and family labour (RMCF) and Return on fixed cost (RFC) were N28, 016 and N34, 016 respectively. The rate of returns on investment (RRI), Fixed cost (RRFC), Variable cost (RRVC) and labour cost (RRLC) were 121.8%, 566.9%, 264.8% and 411.3% respectively (Table 6).

The performance of acadja fishery is illustrated in **Fig. 5**.

Table 1a: Monthly variations in the Physico-chemistry of water samples at the three acadja fishing sites in the Lagos lagoon

Parameters	April			May			June			July			August			September		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Water temperature	31	31	32	31	32	32	30	30	31	28	28	28	29	28	29	29	30	30
Water pH	7.5	7.2	7.5	7.5	7.2	7.2	7.5	7.5	7.2	8.0	7.0	7.5	8.2	7.4	7.6	8.2	7.5	7.5
TSS	12.0	10.5	12.5	12.5	10.5	10.5	20.0	20.0	21.5	8.5	10.5	10.5	10.0	10.0	12.0	10.0	15.0	15.0
TDS	15.0	12.0	10.0	14.0	15.0	15.5	24.0	22.0	22.5	12.0	11.0	10.5	10.0	12.0	15.0	10.0	15.0	15.5
Turbidity	10.0	9.5	8.2	12.5	10.5	9.5	22.5	21.5	20.0	11.5	10.5	10.0	10.0	10.0	12.5	10.0	15.0	18.5
Salinity	20.5	20.5	18.5	15.0	14.5	14.0	4.0	4.5	4.0	10.0	6.5	5.0	5.0	4.0	3.5	3.0	3.5	3.0
Chloride	10.0	10.0	12.0	-	10.0	12.0	15.0	18.0	0.0	18.0	12.0	15.0	15.0	15.0	12.0	10.0	12.5	12.0
Oil & grease	0.10	0.15	0.09	0.10	0.09	0.12	0.08	0.06	0.10	0.018	0.25	0.20	ND	ND	ND	ND	0.09	0.05
Nitrate	4.5	4.2	3.5	3.5	3.5	3.8	2.5	3.0	4.5	3.0	3.2	2.5	2.5	3.0	3.5	3.0	2.5	3.0
Phosphate	2.5	2.0	2.4	2.8	2.5	3.2	4.5	4.5	3.0	2.5	2.0	2.2	4.0	4.5	3.5	2.5	2.5	3.5
Dissolved 0_2	4.8	5.0	5.5	6.0	6.5	5.0	6.0	6.5	6.5	5.0	4.0	4.5	3.0	3.0	3.5	3.5	4.0	3.0
Chemical 0_2 demand	60.0	55.0	65.0	70	65	75	75	70.0	75	65	70	72	35	20	25	40	35	30
Biochemical 0_2 demand	100.0	95.0	90.0	110.0	115.0	112.5	100.5	95.5	85.0	95.5	85.0	120.0	70	75	95.5	80	75	100
Sulphate	1.5	0.06	0.60	0.15	0.10	0.09	0.10	0.12	0.18	0.15	0.12	0.10	0.09	0.15	ND	0.07	0.12	0.12
Depth	0.95	1.45	1.30	1.51	1.29	1.81	1.71	1.37	1.43	1.24	1.43	1.52	1.86	1.67	1.48	3.8	1.7	2.4
Transparency	0.85	0.68	0.73	0.91	0.65	0.6	0.73	0.56	0.52	0.26	0.33	0.35	0.36	0.35	0.3	0.4	0.35	0.4
Rainfall	159			221			372			296			85			189		

*ND = Not detected

Table 1b: Monthly variations in the Physico-chemistry of sediment samples at the three Acadja fishing sites in the Lagos lagoon

Parameters	April			May			June			July			August			September		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Soil pH	7.4	7.5	7.4	7.6	7.5	7.2	8.0	7.6	7.4	7.0	7.2	7.4	7.5	7.4	7.2	8.0	7.5	7.5
Total Organic Matter	19.93	71.72	12.72	20.52	21.15	17.93	19.45	18.62	14.43	18.85	19.73	17.75	15.57	12.23	14.45	17.75	18.83	20.15

Table 2: Composition and abundance of macrobenthic invertebrates at three Acadja fishing sites in Lagos lagoon, Nigeria (April – September, 2002)

Taxa	April			May			June			July			August			September		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Phylum - Mollusca																		
Class I – Galeodidae																		
Family I – Galeodidae																		
**Semifusus morio*							1											
Family II – Melaniidae																		
**Pachymelania aurita*				6		8	3					10	3					
Family III – Muricidae																		
**Thais haemostoma*										1								
Family IV – Naticacea																		
**Natica flammulata*				1			1	1					1					
**N. flannel*				1			1											
Family V – Neritidae																		
**Neritina glabrata*			2				3						7	1			2	
**Nerita* sp							1						3	1				
Family VI – Potamididae																		
**Tympanotonus fuscatus*						29		1		1		51	1					
**T. fuscatus var radula*		31	60	66	19	91	61	26	75	41	24	56	4		14	14	38	35
Family VII – Terebridae																		
**Terebra micans*																		
Family VIII – Turritellidae																		
**Turritella unqulina*				1	4	3			2	2				1				
Class II – Bivalvia																		
Family I – Aloididae																		
**Aloidis trigona*			3	4	6		3		2	3		4	8	1			3	7
Family II – Dieissenacea																		
** Dreissena africana*				3	1				1			7						
Family III – Mactridae																		
** Mactra glabrata*				5				3	3									
Family IV – Ostreaceae																		
** Gryphaea gasar*				10	1	4	10		1									
Phylum – Annelida																		
Class – Polychaeta																		
Family I – Nereidae																		
**Nereis succinea*			4															
Family II – Serpulidae																		
** Mecierella enigmatica*		2	4		9		21	31	58	2		53		13				3
Phylum – Crustacea																		
Class I – Malacostraca																		
** Callinectes amnicola*				2														
** Clibinarius africana*																		1
Class II – Cirripedia																		
** Balanus pallidus*		3	5			385			45	6		34	5	21	5	12	3	34
Total No. of Species	**0**	**3**	**6**	**10**	**6**	**6**	**10**	**5**	**8**	**7**	**1**	**7**	**8**	**6**	**1**	**2**	**4**	**5**
Total No. of Individuals	**0**	**36**	**78**	**99**	**40**	**520**	**105**	**62**	**187**	**56**	**24**	**215**	**32**	**38**	**14**	**26**	**46**	**80**
Ecological Indices																		
SHANNON WEINER'S	**0**	**0.48**	**0.89**	**1.28**	**1.39**	**0.82**	**1.34**	**0.99**	**1.29**	**1.01**	**0**	**1.66**	**1.89**	**1.08**	**0**	**0.69**	**0.65**	**1.12**
MARGALEF'S INDEX	**0**	**0.56**	**1.15**	**1.96**	**1.36**	**0.79**	**1.93**	**0.97**	**1.34**	**1.49**	**0**	**1.12**	**2.02**	**1.37**	**0**	**0.31**	**0.78**	**0.91**

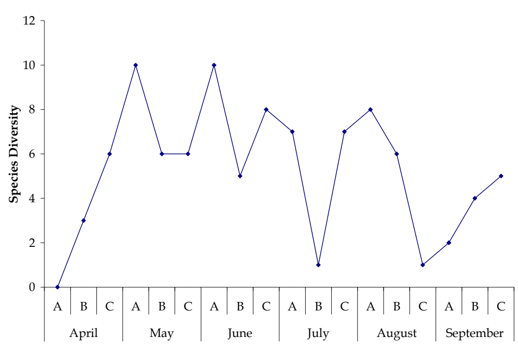

Fig.2: Number of Individual organisms at the Acadja Fishing Site

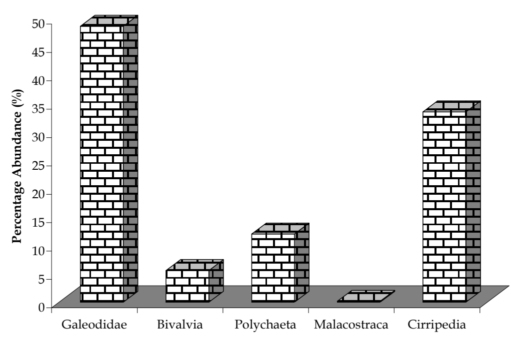

Fig. 3: Percentage Abundance of classes of macro-invertebrate fauna at Acadja Fishing Site at the Lagos Lagoon (April – September, 2002)

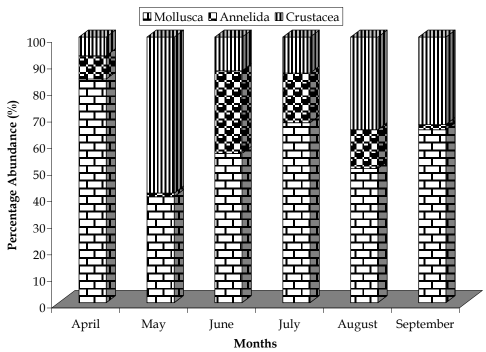

Fig. 4: Monthly variation in the abundance of major taxonomic groups

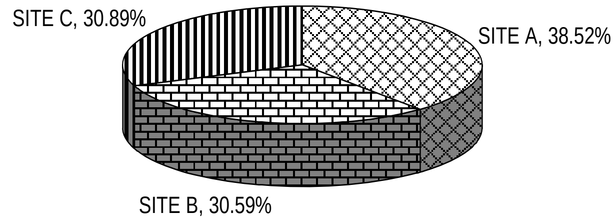

Fig. 5: Percentage weight of fish caught in acadja fishing sites

Table 3: Fish composition of the 'Acadja" fishing sites per six months

Family/Fish Species	Acadja					
	A(kg)	%	B(kg)	%	C(kg)	%
Cichlidae *Sarotherodon melanotheron* (Ruppell)	20.5	22.83	15.6	21.88	19.00	26.39
Tilapia guineensis (Bleeker)	12.5	13.92	9.10	12.76	8.90	12.36
Hemichromis fasciatus (Peters)	6.0	6.68	5.0	7.01	5.20	7.22
Bagridae *Chrysichthys nigrodigitatus* (Lacepede)	7.0	7.80	7.0	9.82	7.10	9.86
Liza falcipinnis (Valenciennes)	8.1	9.02	4.8	6.73	5.6	7.77
Cynoglossidae *Cynoglossus senegalensis* (Kaup)	5.6	5.90	5.0	7.01	5.1	7.10
Elopidae *Elops lacerta* (Cuvier & Valencicnnes)	6.7	7.46	6.0	8.42	5.9	8.19
Lutjanidae *Lutjanus goreensis* (Valenciennes)	7.6	8.46	6.7	9.40	4.7	6.53
Psettras sebae (Cuvier)	3.0	3.34	1.0	1.40	2.1	2.92
Carangidae *Caranx hippos* (Linnaeus)	4.1	4.57	6.2	8.70	2.2	3.06
Trichiurus lepturus (Linnens)	3.1	3.45	0.0	0.0	1.2	1.67
Portunidae *Callinectes amnicola* (DeRochneburne)	5.6	6.24	4.9	6.88	5.0	6.94
TOTAL	**89.8**		**71.3**		**72.0**	
Percentage total weight	**38.52%**		**30.59%**		**30.89%**	

Table 4: Fish production in 'Acadja' Fishing Practice per six months

Fish Species	Station A		Station B		Station C	
	Wt of fish (kg/fishing /ha)	Price (₦)	Wt of fish (kg/fishing /ha)	Price (₦)	Wt of fish (kg/fishing /ha)	Price (₦)
S. melanotheron	20.50	4,305	15.6	3,276	19.0	3,990
T. guineensis	12.50	2,625	9.60	1,911	8.90	1,869
H. fasciatus	6.00	900	5.00	750	5.20	78.0
C. nigrodigitatus	7.00	2,100	7.00	2,100	7.10	2,130
L. falcipinnis	8.1	1,701	4.80	1,008	5.60	1,176
C. senegalensis	5.61	1,400	5.00	1250	5.10	1,275
E. lacerta	6.70	107	6.00	1260	5.90	1,239
L. goreensis	7.60	1,900	6.70	1,675	4.70	1,175

P. sebae	3.00	360	1.00	120	2.10	252
C. hippos	4.10	1,025	6.20	1,550	2.20	550
T. lepturus	3.10	620	0.00	0.00	1.20	240
C. amnicola	5.60	1,120	4.90	980	5.00	1,000
TOTAL	**89.80**	**19,463**	**71.30**	**15,817**	**72.0**	**15,676**

₦120.20 = US$1

Table 5: Economic income analysis of Acadja brush park fishing practice

ITEMS	VALUE	
A. INCOME 1. Sales of fish per six month	 51,016.00	 **51,016.00**
B. COST (i) Variable cost per six month (ii) Seine net (55mm) rent 3 times @ N1,000/day (iii) Labour (3 'acadja') (iv) Maintenance (v) Rentage of 2 canoe @ N500/day for 3 'acadja' for 3 days	 3,000.00 2,000.00 9,000.00 3,000.00	 **17,000.00**
2. Fixed Costs (i) Acadja installation (3)	 6,000.00	 **6,000.00**
TOTAL COST		**23,000.00**
NET INCOME (A – B)		**28,016.00**

N120.22 = US$1

Table 6: Profitability analysis of acadja fishing in Lagos lagoon

PROFITABILITY RATIOS	**VALUE**
Return to management capital and family labour (RMCF)	28,016
Rate of Return to Investment (%)	121.8
Return on Fixed Cost (RFC)/Gross Margin (GM)	34,016
Rate of Return on Fixed Gross (RRFC) (%)	566.9
Rate of Return on Variable Cost (RRVC) (%)	264.8
Rate of Return on Labour Cost (RRLC)	411.3

DISCUSSION

The results of the physico-chemical and biological data in this study showed similarly with results from previous ecological investigations (Webb, 1958; Oyenekan, 1988; Nwankwo *et al.*, 1994; Brown, 1998 and Emmanuel & Onyema, 2007). Depth, total suspended solids, chemical oxygen demand and biological oxygen demand gave high or increasing values during the rainy period (April to September), on the other hand transparency and salinity showed lower(ed) values. Rainfall associated with floodwater conditions have been shown to reduce transparency while increasing turbidity depth and the nutrient levels (Nitrate, phosphate and sulphate) of the same water body (Nwankwo, 1991; Brown, 1998; and Chukwu & Nwankwo, 2004). This studied revealed the linkage among the biological abiotic factors and rainfall pattern in the lagoon. This correlates with the report of Hill and Webb (1958) that there is a close correlation between the salinity and other factors in the Lagos lagoon and harbour and the rainfall of the regions draining into the lagoons. Brown and Oyenekan (1998) also attributed the variability in temporal distribution of physical, chemical and biological parameters in the Lagos lagoon to the two seasons experienced yearly with alternative high and low salinity value being recorded in the lagoon.

Biological data from this investigation reveals reduction in the diversity of species compared with earlier works (Oyenekan, 1988; Akpata *et al.*, 1993; and Brown & Oyenekan, 1998). Ajao *et al.* (1996) identified sand mining, sand filling, industrial effluent discharge, oil wastes, domestic waste, sewage discharges among others as human related activities capable and presently destroying the sensitive coastal environment of Nigeria species.

The Pachymelania community as described by Oyenekan (1988) in the study of benthic macrofaunal communities in the Lagos lagoon seen to be the likely community encountered in all the three sites studied. According to the report, the community is characterised by sand and muddy sand deposit. Nominate member include *T. fuscatus, A. trigona, N. glabrata, N. succinea, P. Aurita* among others. Salinity and sediment type would seem to be the more important factors controlling the community structure and variability (Brown, 1998).

The occurrence of *N. succinea* in Site C in April in this study indicated that the site is polluted. This agreed with Akpata *et al.* (1993) that the presence of *N. succinea* in large numbers in particular site in the Lagos lagoon reveals that the areas has high organic pollutant load. Observed economically important benthic species utilized at the local level, which are highly valued by man as a source of food were: *T. fuscatus* var *radula*, *T. fuscatus* and *P. aurita*. All benthic macrofauna also serve as source of food for fish. Thus, they occupy a significance position in the aquatic food web (William and Feltmate, 1992; Mackie, 1998; Olomukoro and Ezemonye, 2007).

The profitability indices show that 'acadja' brush park fishing practice is a profitable business in the lagoon. Every N1 invested in the business generated N1.22 as profit. According to Ayinde and Aromolaran (1998) and Abudl *et al.* (2004) calculated rate of return to investment is acceptable only if the opportunity cost of capital and family labour utlised in agric-business is zero. For every N1 spent on hired labour asbout double the amount went back to the fisherman. According to Otubusin (2001) and Emmanuel (2009) economic viability of any fisheries business depends on the inter play of various components of the operation. In addition to this the fisherman should endeavour to have more acadja for more profit.

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