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PHYSICO-CHEMISTRY, MORPHOLOGY AND ABUNDANCE OF FINFISH OF NKORO RIVER, NIGER DELTA, NIGERIA.

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ABSTRACT

There have been no reliable data on physico-chemical characteristics, morphology and abundance of fish species from Nkoro River in the Niger Delta Area of Nigeria. This is needed to formulate **sound** fisheries management and development programmes in the Nkoro River. This paper therefore provides information to fill that gap in Nkoro River fisheries by studying some physico-chemical parameters and morphology and abundance of five fish species**.** Temperature, pH, dissolved oxygen and salinity were monitored using standard methods. Fish samplings were carried out for twelve months biweekly from January to December 2006 from the artisanal fishers using cast nets, beach seine and canoes. The monthly physico-chemical characteristics showed that, salinity values ranged from 5‰ (September) to 17‰ (February and March). Dissolved oxygen values ranged from 6mg/l(January, April, July and October) to 10mg/l (September). pH values ranged from 6.1(August) to 8.5(November) and Temperature values ranged from 24^{o}C (July) to 32^{o}C (March). There was no significant difference in salinity and pH between stations, but dissolved oxygen, and temperature showed significant differences between stations ($P<0.05$). The monthly catch per unit effort values ranges were: *E. fimbriata* [(0.20 (November) to 8.16 (January)]; *I. africana* [0.1 (May) to 1.6 (February); *S. maderensis* [0.04 (October) to 6.8 (December]; *C. senegalensis* [0.12 (August) to 2.45 (December)] and *C. senegalensis* [0.11 (May) to 1.62 (December)] . There was an increase catch during the dry season. There was significant difference in monthly catch ($P>0.05$). There was no correlation between any of physio-chemical parameters and catch. The test for correlation between the condition factor and the physico-chemical parameters was negative except for temperature (only temperature showed slight correlation). The variation was significant between various stations. Salinity in Nkoro River played a major role in distribution and abundance of the five fish species; higher abundance of fish species during low salinity.

KEYWORDS

Temperature, salinity, fish morphology, abundance, catch effort, Nkoro River

INTRODUCTION

The physico-chemical characteristics of an ecosystem are important parameters to monitor since they affect the distribution and growth of fish fauna [1, 2]. Some of these factors include temperature, dissolved oxygen, pH and salinity. Interrelationships, to some degree exist between these parameters. Temperature, an important abiotic factor in the aquatic ecosystem,

not only affects the abundance, availability and distribution of fishes [3], but also influences their activities such as breathing, growth and reproduction [2]. Nsentip [4] in reviewing Bonga (*Ethmalosa fimbriata)* fisheries of the Cross River State, Nigeria, stated that temperature was possibly the basic limiting factor to the longitudinal distribution of *Ethmalosa fimbriata*.

Temperature is inversely related to dissolved oxygen (DO); which decreases with higher temperatures and vice versa. It has been established that at 0^{o} C dissolved oxygen (DO) is 14.62 mg/I; 11.33 mg/I at 10 ^{o}C, 9.17 mg/I at 20 ^{o}C and 7.3 mg/I at 30 ^{o}C [5]. Dissolved oxygen in the aquatic system is fundamental to the basic metabolic activities of the fish, which is vital to its survival. Fishes grow in waters between pH 6.5 to pH 10 but slightly alkaline waters that are close to neutral pH are best for them. Very acidic water, which does develop in mangrove swamps are lethal to them to affect their wellbeing [6]. Fisheries play a very significant role in the national economy [7]. Fish and fish products provide over 10kg of protein per capita per annum, an equivalent of 40% of all animal protein consumed in the country [7]. Apart from being cheap source of highly nutritive protein, it also contains other essential nutrients required by the body. The fisheries sub-sector is also a high foreign exchange earner generating about 20 million dollars annually through the export of shrimps alone and providing direct and secondary employment to more than one million Nigerians.

Catch Per Unit Effort (CPUE) is a useful index in the assessment of abundance of fish species [8]. It is essential in the determination of maximum sustainable yield (MSY) and potential yield. Tobor [2] reported that the inshore waters of most parts of the West African coast are rich in fish resources in quantities that can support commercial exploitation on a sustainable basis. However, later developments in fisheries studies have pointed to the depletion of the fish stocks [9].

Accurate fisheries statistics in the river; and its adjourning flood plains is vital for the formulation of a sound fisheries management programme in the Nkoro River and similar water bodies. But, this is completely lacking. Apart from Scott [10]; Reed *et al.* [11]; Otobo [12]; Ssentengo and Welcome [13]; FAO [14]; Otobo [15]; Ita and Medahili [16] and Sikoki and Otobotekere [7]; Ezekiel *et al.* [6]; Abowei and Ezekiel [17]; Abowei *et al.*[18]; Abowei and Hart [19]; Abowei *et al.* [20]; Abowei and Hart [21]; Abowei and Hart [22] and Abowei and Davies [23], for different water bodies, there are no reliable data on the physico-chemical characteristics, morphology and abundance of five fish species from Nkoro River. This is essential for formulation of development plan in the fishing industry. This paper therefore provides information to fill that gap in Nkoro River fisheries.

Study Area

The Nkoro River is a distributory of the Andoni River in the Niger Delta area of Nigeria. The Nkoro River lies between latitudes 4^{o} 28' to 4^{o} 45' N and longitudes 7^{o} 45'E. The Niger Delta is one of the world largest wetlands covering an area of approximately 70,000 km^{2}. The area is economical important and rich in biodiversity. Numerous activities such as oil exploration and production and agricultural activities go on in the region. Most of Nigeria's oil and gas reserves and production, which account for over 80% federal government's revenue, is located within the Niger Delta region. The Red and white mangroves (*Rhizophora* and *Avicennia* spp) mangrove swamps and flood plains border the river and its numerous creeks; and these are well exposed at low tides.

MATERIALS AND METHODS

Physico-chemical characteristics

The abiotic factors that were monitored included temperature, pH, dissolved Oxygen and salinity.

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

Dissolved oxygen meter of the model: OxyGuard Handy MK II was used in measuring dissolved oxygen and temperature. pH was measured using pH meter (model: Hanna Instrument model No. H1 8915 ATC) while salinity was measured using salinometer, model: New S-100.for each of the parameters the probe end of the meter was dipped into the river while the value at the pointer of the scale was read off and recorded. The measurements were taken while inside the canoe along Nkontoru – Job Ama which is part of the Nkoro river system. Dissolved oxygen (DO) was measured in milligrams per litre (mg/I); temperature in ^{o}C (degrees centigrade); and salinity was in parts per thousand (ppt or ‰).

Fish sampling

Sampling was carried out for twelve calendar months biweekly from January to December 2006 from the artisanal fishers using cast nets, beach seine and canoes, samples were obtained from four stations which include: Olom Nkoro (Station 1), Job Ama (Station 2), Nkorontoru (Station 3) and Dama Ama (Station 4). The Total length (TL) of the fish in (cm) was measured from the tip of the anterior most part of the snout to the tip of the caudal fin using transparent plastic ruler. The measurement was taken to the nearest centimeter. For weight measurements, the fishes were blotted dry with a piece of clean cotton cloth before weighing with a tabletop weighing balance, to the nearest gram.

Abundance

This was estimated from the weight (kg) of the total catch of each station for each species over the period of this study and compared for difference using Analysis of variance (ANOVA) to test for difference between the stations. Catch per unit effort was calculated by dividing the total monthly catch by the effort (number of fishers per boat) and finally dividing by the number of hours of fishing giving:

CPUE= Total catch/No. of fishers/fishing hours
CPUE = Kg/man/hr [24].

The figures for catch per unit effort were tested for variation on monthly and station basis using ANOVA. The data for each physico-chemical parameter was also tested for variation between stations and for correlation against the catch data and condition factor using ANOVA.

RESULTS

The results for the monthly physio-chemical parameters are shown in Table1. Salinity values ranged from 5‰ (September) to 17‰ (February and March). Dissolved Oxygen values ranged from 6mg/l (January, April, July and October) to 10mg/l (September). pH values ranged from 6.1(August) to 8.5(November) and Temperature values ranged from 24^{o}C (July) to 32^{o}C (March).

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

Table1.
Monthly mean physio-chemical parameters

Month	pH	Temperature (^{O}C)	Salinity (%)	Dissolved Oxygen mg/l)
Jan	7.5	28	15	6
Feb	7.2	27	17	7
Mar	7.0	32	17	8
April	*6.8*	*27*	*15*	*6*
May	*8.0*	*25*	*15*	*9*
June	*7.6*	*25*	*14*	*8*
July	*7.1*	*24*	*13*	*6*
Aug	*6.1*	*27*	*16*	*7*
Sep	*7.5*	*26*	*5*	*10*
Oct	*7.2*	*28*	*10*	*6*
Nov	*8.5*	*29*	*9*	*8*
Dec	*7.0*	*30*	*12*	*7*

Means with different superscripts are significantly different.

Table 2 shows the physico-chemical parameters for various stations. Salinity values ranged from 12.8±0.30^{a} (‰) (Station 4) to 13.3±0.10^{a} (‰) (Station 3). Dissolved Oxygen values ranged from 3.2±0.1 (mg/l) (Station 3) to 7.3±0.16 mg/l (Station 1). pH values ranged from 7.3±0.17 (Station 1) to7.7±0.14 (Station 3) and temperature values ranged from27.3±0.24 (Station 1) to33.7±0.21 (Station 3). There was no significant difference in salinity and pH between stations, but dissolved oxygen, and temperature showed significant differences between stations ($P<0.05$). The morphology five fish species (*Ethmalosa fimbrata, Ilisha africana, Sardinella maderensis, Cynoglossus senegalensis*, and *Elops senegalensis*) are presented in (Plates1-5).

Table 2.
Physico-chemical parameters of stations

Parameter	Stations			
	1	2	3	4
Salinity(‰)	13.3±0.10^{a}	12.8±0.30^{a}	13.2±0.12^{a}	13.2±0.11^{a}
Dissolved Oxygen (mg/l)	7.3±0.16^{a}	6.7±0.13^{a}	3.2±0.1	4.5.3±0.11^{ab}
pH	7.6±0.21^{a}	7.7±0.14^{a}	7.4±0.23^{a}	7.3±0.17^{a}
Temperature (O^{o}C)	33.7±0.21^{b}	27.4±0.33^{a}	27.3±0.24^{a}	27.5±0.31^{a}

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

Means with different superscripts are significantly different.

Plate1. *Ethmalosafimbriata*

Plate 3. *Sardinella maderensis*

Plate 2. *Ilisha africana*

Plate 4. Cynoglossus senegalensis

Plate 5. **Elops enegalensis**

Table 3 shows the monthly catch per unit effort five fish species. The catch per unit effort values range are: *E. fimbriata* [(0.20 (November) to 8.16 (January)]; *I. africana* [0.1(May) to 1.6 (February); *S.*

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

maderensis [0.04(October) to 6.8 (December]; *C. senegalensis* [0.12 (August) to 2.45 (December)] and *E. senegalensis* [0.11(May) to 1.62 (December)]. There was an increase catch during the dry season. There was significant difference in monthly catch (P>0.05). There was no correlation between any of the physico-chemical parameters and catch. The test for correlation between the condition factor and the physico-chemical parameters was negative except for temperature (only temperature showed slight correlation).

Table 3.

Monthly catch per unit effort of five fish species from Nkoro River

Month	*E. fimbrata*	*I. africana*	*S. maderensis*	*C. senegalensis*	*E. sensgalensis*
Jan	8.16	0.90	0.38	1.60	1.12
Feb	4.21	1.60	3.40	0.81	1.01
Mar	1.40	1.00	1.10	0.64	0.64
Apr	1.11	0.00	1.60	0.92	0.12
May	1.65	0.10	0.00	0.00	0.11
Jun	0.84	0.00	0.00	1.10	1.10
Jul	0.14	0.00	0.00	1.10	0.28
Aug	0.00	0.00	0.00	0.12	1.41
Sep	0.00	0.00	0.20	0.00	0.59
Oct	1.10	0.00	0.04	0.00	0.14
Nov	0.20	0.00	4.10	0.00	0.62
Dec	0.32	0.60	6.80	2.45	1.62

0.0 indicates no catch

Table 4 shows the catch per unit effort of the five fish species studied at various stations. The catch per unit effort values range for various stations are: *E. fimbrata* [(3.72 (station 3) to 5.62 (Station 2)]; *I. africana* [0.72(Station3) to 1.13 (Station 2 and 4); *S. maderensis* [1.26 (Station 3) to 6.42 (Station 1]; *C. senegalensis* [1.01 (Station 3 and 4) to 2.79 (Station 2)] and *E. senegalensis* [0.12(Station 3) to 3.42 (Station 1)] . The variation was significant between various stations.

Table 4.

Catch per unit effort at each station.

Species	Stations			
	1	2	3	4
E. fimbrata	5.04	5.62	3.72	4.75
I. africana	1.12	1.13	0.72	1.13
S. maderensis	6.42	6.34	1.26	3.42
C. senegalensis	2.78	2.79	1.01	1.01
E. senegalensis	3.42	3.11	0.12	2.11
Mean	3.76 ± 0.41^{a}	3.80 ± 0.43^{a}	1.37 ± 0.28^{c}	2.48 ± 0.32^{b}

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

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DISCUSSION

Physico-chemical characteristics

The salinity values ranging from 5‰ to 17‰ observed in this study are typical of brackish water. Salinity and the other physico-chemical parameters of brackish waters are liable to fluctuations since the water ebbs and flows on regular basic [25]. Sikoki and Otobotekere [7] reported that the Andoni River fluctuates between 10 and 25%o; while the salinity of most ocean water is within the range of 34-36‰. From the work of Ezenwa *et al*. [26]; the Nigerian water environment as classified according to salinity consists of marine waters (salinity is above 30 ‰); high brackish waters (20-29.9‰ salinity), mid-brackish water (0.0 – 0.5‰ salinity).

According to Ibe [3] salinity is not as regulatory as temperature, although it affects osmo-regulation and development of the eggs of fish thereby making the quantity of future stocks as least in part dependent on salinity. Scott [10] reported that salinity in the brackish waters of the Niger Delta is higher in the dry season when sea water penetrates far up the rivers, than in wet season when rain water and the flood waters from the Niger and Benue drive the salt water back towards the sea.

The study area with surface temperatures ranging from 25°c to 30°c is typical of African rivers. Water temperatures were generally higher from November during the receding flood to May, which marked the beginning of the dry season. This period also encompassed the dry season. The slight drops in surface water temperature for December and January are attributed to the drop in air temperature during the harmattan. Several investigations have revealed that surface water temperatures closely follow the ambient air temperatures [27].

Tropical stream temperatures increase downstream until they reach equilibrium with air temperature. The lowest temperatures occurred in August and September during the flood. Apart from the relatively low air temperatures associated with the rainy season, the water temperature was believed to be affected by underground water and run off water that enters the river. Spring water and surface run off are common features in Nkoro River between June and August. In September, the River water spills over the levees and mixes with the colder water of the floodplains and forests. Water from the floodplain or fringing forest tends to be colder than that exposed to direct sunlight [27].

The pH values range of 6.1 to 8.5 showed variations ranging from acidic to alkaline conditions. The water however exhibits more neutral than alkaline conditions within the study period. The pattern of variation could be properly accounted for as both conditions were observed in the flood period. Factors affecting pH changes in the flood plains have been attributed to animal droppings and the soil type. Seasonal changes in parameters were very apparent though within seasonal fluctuation were observed for pH.

The dissolved oxygen values ranging from 6mg/l to 10mg/l is within the tolerable limit. There was a general trend in which values were higher in early rainy season due to increase rainfall and river run off resulting in increased currents and high mixing rates [28]. The dissolved oxygen values are typical of fresh water systems [15]. Nkoro River compared favorably with similar tropical African Rivers in physical and chemical characteristics.

The catch per unit effort values range are: *E. fimbrata* [(0.20 (November) to 8.16 (January)]; *I. africana* *[*0.1(May) to 1.6 (February); *S. maderensis* [0.04(October) to 6.8 (December]; *C. senegalensis* [0.12(August) to 2.45 (December)] and *E. sensgalensis* [0.11(May) to 1.62 (December)] from this study also varied from the results obtained from

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

other studies. Scott [10] reported that rivers, lakes and swamps of the Niger Delta produced about 2,000 tonnes of fish per year. Moses [1] estimated a mean annual catch of 4,791 tonnes from the cross river over a period of twelve years. Sikoki and Hart [29] in the Brass river, estimated the total biomass of 160.20 of fish per boat, total catch of 254,554kg, annual production of 610.93 tonnes, estimated mean catch per boat of 384.90kg and a standing stock of 1.19km^{-2}.

Variation in the total estimate values Nkoro River could be attributed to differences in fishing and industrial activities in the different rivers. The reason for the low estimates in the Nkoro River could be as a result of high mortality of both juveniles and brood stock of various fish species as a result of predatory activities, which is typical of the study area. A similar remark was made by Ssentengo *et al.* [30]. Satia [31] also noted the controversy surrounding fish production statistics. In the lower Nun River, much of the problem hampering the acquisition of reasonably accurate fisheries statistics and resource appraisal appear to stem mainly from lack of, or inadequate investment and lack of trained personnel to handle data collection.

Factors affecting fish distribution and abundance have already been reported by different workers. Availability of food, spawning rates, breeding grounds coupled with shelter, presence of current, vegetation, depth of water, breeding rabbits migration and low predation have been suggested as major limiting factors affecting the distribution and abundance of various fish families in Kainji Lake [32]. Angelescu *et al.* [33] reported fish catch varied with type of year used, tidal condition and period of capture, diurnally and seasonally. From the work of King [24], it is clear that most commercially and scientifically important fish species occurring in the Niger Delta waters can be landed all year round by artisanal fishers but there are months when they are more abundant.

The predominant family in the brackish waters of the Niger Delta and West Africa is the Clupeidae of which, *Ethmalosa fimbriata* and *Sardinella* are the most important species [10]. Another family containing species that occur in abundance almost all the year round is the Cichlidae: *Tilapia guinensis* and *Sarotherodon melanotheron*. They occur together and breed about three to four times a year [26].

Oyatoye [34] reported that it was felt that production level of artisanal fishery should double considering the extent of the Nation's coastline and continental shelf. This is because the FAO [36] estimate put the production per canoe per fisher man operating in the coastal and brackish water environments to be comparatively low ranging between 0.5 and 7.1 tonnes per capital per month.

King [24] observed seasonality in the abundance of *Tilapia mariae* caught in the fresh water stream of Iba Oku; the average monthly CPUE reported ranged from 0.16kg in February to 0.83 kg in July with a mean of 0.45 $\pm$ 0.07 kg. The catches were higher during the rains (mean CPUE = $\pm$ 0.08 kg; range = 0.2 – 0.83 kg) than during the dry season (mean CPUE) = 0.32 $\pm$ 0.08 kg; range = 0.16 – 0.50 kg).

Factors that affect the abundance of desired brackish water fish fingerlings and by extension the adult as proffered by Ezenwa *et al.* [26] include the use of explosives, over fishing, destruction of juvenile schooling areas by modern coastal development, oil pollution, industrial and human waste dumped into the aquatic environment.

Seasonal Occurrence Of Fish Species In Brackish Water In The Niger Delta

From the works of Ezenwa *et al.* [26], King [24] and Hart [35], it is clear that most of these commercially and scientifically important fish species (*C. nigrodigitatus, Lutjanus sp, Pomadasys*

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

species, *Liza sp, Mugil* sp, *Tilapia* sp, *Sarotherodon* sp and *E. fimbriata*) occurring in brackish waters in the Niger of Nigeria can be landed all the year round by artisanal fishers but there are months when they are more abundant.

Tobor [2] reported that most of these artisanal fisheries are dry season fishery, that is, the fishes are most abundant during the dry season. The fingerlings of some of the brackish water fish species occur in large quantities in some months. The various mullet species (*Liza spp* and *Mugil* spp) spawn at different times of the year; they appear to be abundant all year-round. Hart [35] reported that *Mugil cephalus* in the Bonny River occurred all the year round, but was more abundant during the dry season than the rainy season.

Nsentip [4] observed that *E. fimbriata* was most abundant from the beginning of the dry season that is, from November, which is actually the beginning of the Bonga (*E. fimbriata*) fishery and ending in May in the Cross river estuary (brackish water); January to March portion representing the peak period of the fishery with no catch at all in August to October. Nsentip [4] also observed that in certain parts of the coast, and in particular the open sea off the Niger Delta, that *E. fimbriata* is caught all-year round whenever the canoes venture to sea.

In the FAO [36] publication, it was explained that the occurrence of *E. fimbriata* near the shore at the beginning of the fishing season was linked with salinity of the water. When the brackish water of low salinity prevailed, no *Ethmalosa* spp was caught, but as soon as the estuarine water was replaced by clear, salt seawater, good catches were obtained. This explanation also goes for all the fish species caught during the dry season mentioned above.

Scott [10] also reported that there is seasonal movement of fish stock away from the coast in the wet season and towards the coast in the dry season leading to concentration of fish within the brackish water system.

REFERENCES

1. Moses, B. S. 1983.Introduction to tropical Fisheries. Ibadan University Press Nigeria. 38pp.
2. Tobor, J. G. 1992. Fin and shellfish of conservation interest in Nigeria. NIOMR Tech Paper No 79:1-23.
3. Ibe, A. C. 1987. The role of oceanography in fisheries reasources exploitation. In : Proceedings of Fourth Annual Conference of the Fisheries Society of Nigeria (FISON), Port Harcourt. Pp 162-170.
4. Nsentip, N U. 1987. Review of Bonga (Ethmalosa *fimbrata*) fisheries of the Cross River State . Nigeria . In ; Proceedings of the 4th Annual Conference of the Fisheries Society of Nigeria (FISON) Port Harcourt.
5. Onuoha, G. C. and Nwadukwe, F.O. 1989. Water quality monitoring; Proceedings of the Aquaculture Training Programme (ATP). African Regional Aquaculture Centre (ARAC) 12-23pp.
6. Ezekiel, E.N., Abowei, J.F.N., and Hart A. 2002. The Fish Species Assemblage in the Flood Plains of Odhioku-Ekpeye, Niger Delta. *International Journal of Science and Technology* (IJST), 1: 54-59.
7. Sikoki, F. D. and Otobotekere A. J. T. 1999. Fisheries. In: The land people of Bayelsa State Central Niger Delta (ed.) Alagoa E. C. Port Harcourt, 301-319.
8. Gulland, J. A. 1975. Manual of sampling and statistical methods for fisheries biology. Part 1 sampling methods. FAO manuals in Fisheries Science. No 3 FRs/M 3:1-87.
9. Okpanefe, M. O. 1977. Agriculture and National Resources Fisheries Statistics

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

survey of Nigeria . *Fed .Rep of Nig. Occassional Paper* 23:5.

10. Scott, J. S. 1966. Report on the fisheries of the Niger Delta Special Area. NDDB 109pp.
11. Reed, W., Burchad, T., Hopspn, A.J. Jenness, J. and Varo, 1. 1967. Fish and fisheries of Northern Nigeria. Ministry of Agriculture, Northern Nigeria. 226p.
12. Otobo, A. J. T. 1991. Threats from siltation and use of pesticides of fish Production in the fresh water swampy lake of the Niger Delta, Rivers State. Paper presented at the 6th Annual Conference of Nigerian Association of Aquatic Sciences, Benin City, Edo State.
13. Ssentengo, G. W. and Welcome, R. L. 1985. Past history and current tends in the fisheries of Lake Victoria. *FAO Fish. Resp.* 335:123 – 138.
14. Food and Agricultural Organization (FAO). 1994. Report of the study on exploration and use of small pelagic spp. in West Africa, *FAO Fish Circular* No.880, 18-28.
15. Otobo, A. J. T. 1993. The ecology and fishery of the Pygmy Herring *Sierrathensa leonensis* (Thysvan Den Audenaerde, 1969) in the Nun River and Taylor Creek of the Niger Delta. Ph. D. Thesis. University of Port Harcourt, 298pp.
16. Ita, E. O. and Mahahili, M. 1997. The current status of fish stock and fisheries in Kainji Lake. Consultancy report on fish stick assessment in Kainji Lake. The Nigerian German (GTZ) Kanji lake fisheries promotion Project, New Bussa. 128pp.
17. Abowei, J.F.N. and Ezekiel, E.N.2003. Aspects of Some Physicochemical Parameters Of The Fresh Water Reaches of the Lower Num River, Niger Delta. *International Journal of Science Technology* (IJST), 2 (1): 5-9.
18. Abowei, J.F.N., Sikoki, F.D., Hart, A.I. and Allison, M.E. 2007. Catch composition and seasonality of Fin fish in the fresh water reaches of the Lower Nun River, Niger Delta. *Journal of Field Aquatic Studies,* 3*:* 8-21.
19. Abowei, J. F. N. and Hart, A. I. 2007. Size composition, age, mortality and exploitation rate of *Chrysichthys nigrodigitatus* from Nun River, Niger Delta, Nigeria. *African journal of Applied Zoology and Environmental Biology*, www.uniportjournals.com/ajazeb; 9: 44-50.
20. Abowei, J. F. N., Tawari, C. C., Hart, A. I. and Garicks, D. U. 2008. Finfish species composition, abundance and distribution in the lower Sombreiro River, Niger Delta, Nigeria. *International Journal of Tropical Agriculture and Food Systems,* 2(1): 46-53.
21. Abowei, J. F. N, and Hart, A. 1. 2008. Artisanal fisheries characteristics of the fresh water reaches of lower Nun River, Niger Delta, Nigeria. *Journal Applied Science and Environmental Management*, www.bioline.org.br/ja. 12(1): 5 - 7.
22. Abowei, J. F. N. and Hart, A. I. 2009. Some morphormetric parameters of ten finfish species from the lower Nun River, Niger Delta, Nigeria. Medwell Journals (Pakistan). *Research Journal of Biological Sciences*, 4 (3): 282-288.
23. Abowei, J. F. N. and Davies, O.A. 2009. Some population parameters of *Clarotes laticeps* (Rupell, 1829) from the fresh water reaches of the lower river, Niger Delta, Nigeria. *American Journal of Scientific Research,* 2: 15-19. http://www.eurojournals.com/ajsr.htm.

PHYSICO-CHEMICAL CHARACTERISTICS, MORPHOLOGY AND ABUNDANCE OF FIVE FISH SPECIES FROM NKORO RIVER, NIGER DELTA, NIGERIA

24. King, R. P. 1991. The biology of *Tilapia mariae* (Bovlenger, 1899) (Perciformes: Cichlidae) in a Nigeria Rainforest stream PhD. Thesis, department of Zoology, University of Port Harcourt, Nigeria.
25. Lowe- McConnell, R. H. 1977. Ecology of tropical waters, the Institute of Biology Studies in Biology No. 76. Edward Arnold Publ. Great Britain. 1-59pp.
26. Ezenwa, B. I., Alegbeleye, W. and Ugwumba, O. A. and Anyanwu, P. E. 1987. Cultivable fish seeds in Nigerian coastal waters. A reseach survey (second phase 1978-1985). Proceedings of the Fisheries Society of Nig (FISON), Port Harcourt, Rivers State, 99-112.
27. Welcome, R.L. (1979): Fisheries Ecology of flood plain rivers London Longman press. 317pp.
28. Yakubu, A. F., Sikoki, F.D. and Horsefall, J. P. M. 1998. An investigation into the physico-chemical conditions and planktonic organisms of the lower reaches of the Nun River Nigeria. *Journal of Applied Science and Environmental Management*, 1(1): 38-45.
29. Sikoki, F. D. and Hart S. A. 1997. Studies on the fish and fisheries of the Brass river system and adjoining coastal waters in Bayelsa State Nigeria. *Journal of Applied Sciences and Environmental Management*, (2): 63 – 67.
30. Ssentengo, G. W., Ukpe. E. T. and Ajayi, T. O. 1986. Marine fishery resources of Nigeria. Reviews of exploited fish stock CECAF/ECAC series, 86/40/ FAO. Rome 52pp.
31. Satia, B. P. 1990. National review for aquaculture development in Africa. Nigeria. FAO fish Girel: 770. 29. 191pp.
32. Ita, E. O. 1978. An analysis of fish distribution in Kainji Lake, Nigeria. *Hydrobiologia*, 58: 233-244.
33. Angelescu, V., Gneri, F. S. and Nani, A. 1958. La merluza del mar argentino (biologia e taxonomia). Secr. Mar. Serv. Hidrog. Nav. Publico, H1004: 1-224.
34. Oyatoye, E. T. O. 1986. An investigation of the organization of Canoe Fisheries in Nigeria ; A case study of Iiaje/ Eseodo Local Government area of Ondo State In; Proceedings of the 3rd Annual Conference of Fisheries Society of Nigeria (FISON) Maiduguri, 1983:137-140.
35. Hart, S. A. 1997.The biology of *Mugil cephalus,* Linnaenus , 1758, perciformes (Muglidae) in Bonny River Estuary. Msc Thesis. Department of Zoology University of Port Harcourt Nigeria 102pp.
36. FAO. 1997. Fisheries by catch and discards Committee on fisheries. Twenty- second session, FAO, 17-20 March, Rome.