THE ARTISANAL FISHING GEARS, CRAFTS TECHNOLOGY AND THEIR EFFICIENCY IN THE LEKKI LAGOON, NIGERIA

By

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CERTIFICATION

This is to certify that the Thesis:

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By

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I certify that the work embodied in this thesis for the degree of Doctor of Philosophy (Fisheries) by Babatunde Eniola Emmanuel has been carried out under my supervision.

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DEDICATION

To the glory of the Almighty God, for His guidance, protection, care and favours throughout my study period, to my wife Ayoleyi Olayinka (nee Oyenusi) and my children, Odunwole (Mofeyimolorun mi), Folashade (Monjolajesu falala) and Ayodeji (Mofaramojesu mi ninu ohun gbogbo).

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TABLE OF CONTENTS

LIST OF TABLES

PAGES

LIST OF FIGURES

PAGES

LIST OF PLATES

PAGES

ABSTRACT

The water quality characteristics, artisanal fishing gear and crafts technology and the fish fauna composition in the Lekki lagoon between March, 2006 and February, 2008 were investigated. The water quality analysis indicated that salinity has drastically increased recently in the lagoon (0.007 to 4.70 ‰). This study identified three possible sources for saline water intrusion, beyond the seasonal input from the two adjacent lagoons (Lagos and Mahin), salt water intrusion by subsurface flow through the barrier beach from the ocean and leaching of ions through lagoon bottom sediments. The highest used fishing gears in the two years of study was gillnet 514 (50.04%) and 485 (48.74%) respectively and the least used fishing gear was boat seine 8 (0.78%) and 8 (0.80%) respectively. A total of 1027 and 995 functional canoes were involved in the artisanal fisheries between March, 2006 and February, 2008. The canoe preservatives used in the lagoon were by painting with bitumen, coating the back hull with cement and bitumen with ground pepper. Two major netting materials, polyamide and polyethylene were observed in the lagoon. The weight of fish caught in monofilament gillnet were more than those of the multifilament gillnet. The most caught fish length for 40mm mesh size was fish of total length 14cm while fish of total length 16cm was mostly caught by 50mm and 75mm gillnet mesh size caught mostly fish of 22cm total length. The 75 – 180mm stretched mesh category of gillnet performed relatively better than the other two categories (30 – 45mm and 50 – 70mm) in terms of fish weight. The efficiency of these net types is influenced by mesh size, exposed net area, flotation, mesh shape and hanging ratio, visibility and type of netting material in relation with stiffness and breaking strength. For most species, there was a clear difference in term of efficiency between the largest hook (no. 7) and the smallest hook (no. 13) used in the lagoon.

The Catch per Unit Effort expressed in terms of the average weight of fish caught per canoe per day ranged between 38.7kg with bamboo and basket traps and 889.1kg with boat seine. The floating island produced 248.09mt catch per annum while gillnet produced a close range of fish weight of 218.73mt per annum. Eighty – one species belonging to 40 families, 56 genera and 14 orders encountered were mostly freshwater, euryhaline and marine species adapted to life in the lagoon. The shell fish included the freshwater prawns *Macrobrachium spp* and the portunid crab *Callinectes amnicola.* The return on investiment (ROI) for unmotorized fisheries at the end of the first year of fishing operation ranged between 11.1% for bamboo trap and 254.7% for longline which targeted the economically important catfishes (*Chrysichthys spp*) and other species like *Caranx hippos, Polydactylus quadrifilis, Trachinotus teraia* and *Sphyreana barracuda.* The initial high loss recorded by motorized fisheries (motorized gillnet 10% loss) was due to high initial capital investment which should be regained in the subsequent operational years. Management measures are suggested to maintain the species biodiversity and avoid over – exploitation of the fish and shell fish resources for sustainable fish production that allows optimal economic yield.

1.0 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The fisheries potentials of the lagoons in South Western Nigeria has been documented by FAO (1969), Fagade and Olaniyan (1974), Kusemiju (1981) and Solarin (1998). According to Solarin (1998) lagoons represent 15% of the world coastal zone and their productivity results from the interaction between oceanic and continental inputs which enable them to pay a considerable biological and economical role far beyond their seemingly limited geographical extent. The fishery resources form a valuable source of fish food, recreation and aesthetic satisfaction throughout the world coupled with the respective employment opportunities (Welcomme, 1983).

Lekki lagoon is one of the most important sources of fresh water fish in Lagos state. The fishery is diverse, highly dispersed and fragmented with about 35 landing sites and more than 6000 fishers. The lagoon is also important in conservation terms because of the great diversity of endemic species. Fish and fishing related activities were among the main occupation of the majority of the people in the surrounding communities.

Published data and information on the fisheries of the lagoon and related reports included FAO (1969) on the fishes and fisheries survey of the lagoon, Kusemiju (1975) on a comparative racial study of *Chrysichthys nigrodigitatus* from Lagos and Lekki lagoons; Kusemiju (1981) on the hydrobiology and fishes of the lagoon; Kusemiju and Awobamise (1981) on the biology of the clupeid, *Pellonula afzeliusi* in Lekki lagoon; Ugwumba and Kusemiju (1994) on the food and feeding habits of the non cichlid fishes in the lagoon.

Welcomme (1983) reported that the lagoons, which support fishery resources is under constant pressure which often conflicts with interest of the fisheries including changes in the aquatic environment which is no longer able to support fish communities in their previous quantity, quality and diversity. It is worthwhile to maintain an optimum balance among the marine and lagoon artisanal fisheries which exploit different life stages of the same species. The lagoon serves also as a waterway for sand mining, logging and transportation. The impacts of these activities on the fisheries resources need to be elucidated. The continuous inventory and study of the nursery area should begin with the lagoons and estuaries which are extremely vulnerable to over-exploitation. As a matter of fact, artisanal fisheries should be given more attention in order to avoid any future risk of over-exploitation and to quantify the prospects available for expansion.

Allen (1963) and Pope *et al.* (1975) evaluated the selectivity of fishing gears such as trawls and gillnets their selection and the influence of behaviour on the capture of fishes with baits. Bjordal (1983) demonstrated that the difference in efficiency between two forms of hooks tends toward zero when the catch rate increases. The brush park fishing was investigated in the coastal lagoon of Benin Republic by Welcomme (1972) where it was reported that the sheltered waters that are free of strong currents are preferred, although many of the acadjas in the Dahomean lagoons are seasonally exposed to a moderate degree of wave action without disintegrating. Fagade (1969), Kusemiju (1973) and Solarin (1998) reported on fish shelters in Lagos, Lekki and Lagos lagoons respectively. Campbell (1987) reviewed the culture of *Sarotherodon melanotheron* in acadja in West African lagoons and Creeks. Suresh

(2000) reported on the floating islands as a unique fish aggregating method, where it was recorded to be a successfully productive fishery for the centuries.

The multi-species nature of the fisheries in the tropics and the associated problems of incidental catches have been highlighted by several authors like Fagade (1969), Kusemiju (1973), Lowe-McConnell (1987), Larson *et al.* (1996) and Solarin (1998).

Despite all these reports, no work has been done on the fisheries and hydrochemical changes of Lekki Lagoon. Information on fishing gears efficiency and craft design, construction, durability and suitability for Lekki Lagoon is lacking.This study therefore was carried out as major contribution to the artisanal fishing gears and crafts technology, their efficiency and management in relation to the fish species composition of this major lagoon.

1.2 STATEMENT OF PROBLEM

Previously Lekki lagoon was referred to as fresh water lagoon (Kusemiju, 1973; Ekpo, 1982) but resently the fisherfolks noted the increase in the salinity of the lagoon which they noticed have resulted in the disappearance of some fresh water endemic species like Nile tilapia, *Oreochromis niloticus*. Thus, this study investigated the possible sources of this salt water intrusion into the major coastal open lagoon.

The artisanal or small scale or canoe fishery employs gear types such as the artisanal purse seine net, beach seine net, the traps, bag nets or stow nets, gillnet, drift net, cast nets, handline and long lines (Solarin, 1992). Tobor (1990) described the characteristics of the sector to include low capital outlay, low operational costs, low technology application, labour intensive, with poor fish distribution network, low generating as well as poor processing methods and high post harvest losses which represents 35-40% of landed weight.

Research of fishing gear refinements and improvisation of inputs to improve the catching efficiency and their environmental friendliness are desirable and should be encouraged (Solarin, 1992).The small-scale or artisanal fisheries employ many fishing gear types with local variation with water body where they are used. Fagade (1969) and Solarin (1998) jointly described the fishing gear types and the operational methods in Lagos lagoon and identified cast net and gillnet as the most common fishing gears. No report of this kind has been documented in Lekki Lagoon.

Hamley (1975) observed that the design characteristics of the rectangular curtain of netting influenced the performance of the net. Udolisa and Solarin (1979) gave detailed technical feature of gillnets in the Lagos Lagoon. Such technical and design details of fishing gears are necessary for coastal aquatic ecosystems such as Lekki Lagoon in order to assess their efficiency.

Welcome and Batley (1998) listed fish shelter as one of the techniques for stock enhancement. Fagade (1969) described the acadja fish shelter in Lagos lagoon as a productive method of fish aggregation. Solarin and Udolisa (1992) investigated brush park fishing in Lagos Lagoon. Solarin (1998) observed that the fish shelters accounted for 25% of the total fish production in the Lagos lagoon. In Lekki lagoon, reports on the peculiar floating island fishery (Iken) do not exist. Therefore, there is a need to study this traditional but productive method of fishing in the Lekki lagoon.

The fishing crafts used in the small-scale fisheries is mostly wooden canoes. The useful life spans become drastically reduced by borers infestation. A lot of fishing time is lost in order to effect canoe repairs and maintenance. Consequently there is a reduction in fish production resulting in low financial returns. Accidents also occur due to leakages in wooden parts that have been badly damaged leading to loss of lives, fishing gears and fish catch. The need to improve the preservation techniques and prolong the service life of the canoes is desirable due to log scarcity, deforestation as well as economic consideration.

Information on fishing gears and crafts design, construction and suitability for Lekki lagoon is lacking. Apart from the work of Kusemiju (1973), no major work has been carried out on the population dynamics of the fishes of Lekki lagoon. This study therefore was carried out as a major contribution to the artisanal fishing gears and crafts technology and their efficiency in relation to the fish species composition of this major lagoon.

1.3 PURPOSE OF STUDY

The major objectives of the present research include:

(i) To investigate the water quality parameters of Lekki lagoon and possible salt water intrusion into this freshwater lagoonal ecosystem.

(ii) To determine the fishing gears, crafts design details and operational methods as indices of units of effort in capture fishery in Lekki lagoon

(iii) To investigate the fish aggregating devices and operational methods in Lekki lagoon.

(iv) To investigate fishing craft preservation techniques against biofouling organisms and environmental hazards.

(v) To investigate the fish species composition and abundance in relation to fishing gear selectivity and efficiency in Lekki lagoon.

(vi) To determine the financial investment and production estimate of the fishing operations in Lekki lagoon.

2.0 LITERATURE REVIEW

2.1 THE COASTAL LAGOONS IN SOUTH – WESTERN NIGERIA

Coastal lagoons are defined as enclosed bodies of water separated from the sea by a sand bar and linked to the ocean by one or more canals which may be closed from time to time by sediment deposits resulting from the action of littoral waves and winds (Saad *et al.*, 2002). According to Kjerfve (1994), a coastal lagoon is an inland body of water, usually oriented parallel to the coast, separated from the ocean by a barrier, connected to the ocean by one or more restricted inlets, and having depths which seldom exceed a couple of meters. In the last decade, studies involving fish communities indicate their importance as indicators of environmental quality levels in freshwater and brackish water systems (Faush *et al.*, 1990; Karr, 1992; Bruschi, Jr. *et al.*, 1998). Kjerfve (1994) reported that the number of canal and the size of such connections with the sea, as well as environmental condition such as winds, tidal streams, rivers and precipitation account for variation in salinity gradients and water circulation, both of which have a direct influence on the hydro-salt balance, water quality and eutrophication levels. Kusemiju (1973) reported a salinity range of 0.04 (August) to 0.30 ‰ (December) for Lekki lagoon more than three decades ago.

Lagoons vary in size and shape in relation to geomorphology and are known to experience forcing from river input, tides, precipitation, wind stress, evaporation and surface heat balance and they respond differently to these forcing functions (Kirk and Lauder, 2000; Suzuki *et al.*, 2002; Nwankwo, 2004). They are often highly productive habitats for a variety of plants and animals; serve as nurseries for prawns and shrimps and also sites for harbours, wharfs, aquaculture, industries and recreation (Akpata *et* *al*., 1993). According to Lawson and John (1982), lagoons can be classified as open, closed and semi-closed depending on whether they retain a permanent connection to the sea, an annual or less frequent connection, or an artificially restricted and hence intermittently closed connection to the sea. Lagoons are important in water transportation, energy generation, exploitation and exploration of some mineral resources including sand; provide natural food resources rich in protein, fish and fisheries farming sites, as well as, sites for the disposal of both domestic and industrial wastes (FAO, 1969; Kirk and Lauder, 2000; Onyema *at al*., 2003, 2007; Chukwu and Nwankwo, 2004).

According to Yanez-Arancibia (1986) evaluations on fishing stocks or productive potential tropical and subtropical systems fish communities still have limited approaches. The coastal lagoons of the south western Nigeria are depressions roughly parallel to the coast, separated from the sea by a biogenic sand bar. Harris and Webster (2004) reported on the anthropogenic impacts on the ecosystems of coastal lagoons, modeling fundamental biogeochemical processes and management implications. Nixon (1982) reported that fisheries yield may range from about 2 to over 800 kg/ha/yr and is 10 – 20 times higher per unit primary production in lagoons than lakes; suggesting either a greater conversion efficiency or greater harvest efficiency or both. Corsi and Ardizzone (1985) and Chauvet (1988) reported that hydrodynamics may directly affect catchability but there are many ways in which the hydrodynamics shape the production dynamics of lagoon systems. Miller *et al*., (1990) reported that it is critical to understand the factors limiting fisheries on aquaculture production in any particular lagoon before any hydrological modification.

Welcomme (1972, 1983 and 1985) reported on the inland waters of Africa, River basins and River fisheries of the World with an in depth appraisal of the hydrology, fishes and fisheries as well as management issue. Miller *et al* (1990) reported that physical processes in coastal lagoons are influenced most by winds, tides and morphometry. Among the most important morphometric factors are pass dimensions, lagoonal width to length to depth ratios; bottom topography and mean depth; Solarin (1998) reported that the precipitation pattern, seasonal changes and fish species composition as well as the fisheries are all linked with or influenced by the hydrological cycles. The relationships between hydraulics and production in lagoons have been highlighted by several authors including Colombo (1977), Cordell (1978) and Miller *et al.* (1990). Ardizzone *et al.* (1988) reported that, the fact that increased yields can be obtained by stocking additional larvae or juveniles in many lagoons suggest that the carrying capacity is not exceeded by the numbers which normally colonize these lagoons.

Ikusemiju (1973) reported the occurrence of 28 species of fish in Lekki lagoon. In the adjoining Epe lagoon, Balogun (1980) reported the occurrence of 56 species while in Lagos lagoon, Fagade and Olaniyan (1974) reported the occurrence of 72 species and solarin (1998) reported the occurrence of 60 species.

Ikusemiju (1973) also reported the distribution and abundance of 28 species of fish in Lekki lagoon of which 24 species were non – cichlid species. Ikusemiju (1976), Ikusemiju and Olaniyan (1977) reported on the biology of non-cichlids fishes in Lekki lagoon. Fagade and Olaniyan (1973) worked on the food and feeding habits of fishes in Lagos lagoon, Balogun (1980) on a biological survey of fishes of Epe lagoon where three broad groups of fishes namely: planktophagus species, predatory species and bottom feeders were reported; Ekpo (1982) reported on the length – weight relationship, food habits and fecundity of non – cichlid fishes in Lekki lagoon where 43 species of fish belonging to 21 families were encountered. Fawole (2002) reported on the morphometry and diet of *Mormyrus rume* in Lekki lagoon where two major fishing methods (cast netting and set netting) were reported for the catching of the fish species. Fafioye and Oluajo (2005) reported on the length – weight relationships of five fish species in Epe lagoon.

2.2 ARTISANAL FISHING GEARS AND FISHING CRAFTS

2.2.1 Artisanal fishing Gear

The types of fishing gears used vary from one particular area to another depending on the water body available. FAO (1969) and Fagade (1969) surveyed the fishing gear types and the operational methods in the western and mid-western region in Nigeria and Lagos lagoon respectively. Udolisa *et al.* (1994) compiled a catalogue of small scale fishing gear in Nigeria, Jennings *et al.* (2001) and Thrush and Dayton (2002) reported on trawling disturbance modification on benthic production processes and the implication of the disturbance caused to benthic habitats by trawling dredging and its implication for marine biodiversity. Hamley (1975) reviewed gillnet selectivity and the characteristics of fish and nets while Karlsen and Bjarnason (1987) and Morimitsu (1990) reported on the fish behaviour and other parameters like swimming behaviour in relation to gill net selectivity.

Kaiser *et al.* (2000), Jennings *et al.* (2001), Thrush and Dayton (2002) all reported that trawl nets cause a significant physical disturbance to the sea bed, altering the spatial structure, species composition and biogeochemistry of the benthic environment, Beaumont and Hadley (2004) reported on the managing the effects of trawl fishing on the benthic environment. Dayton *et al.* (1995), Auster and Langton (1998) reported that marine fishing activity in general, has been identified as causing harmful environmental effects. Messieh *et al.* (1991), Riemann and Hoffmann (1991) and Jones (1992) all outlined the direct and immediate effect of mobile fishing to include scrapping and ploughing of the substrate, sediment resuspension, destruction of benthos, and dumping of processing waste, and the indirect, delayed or long-term effects to include post-fishing mortality and long-term changes to the benthic community structure, while de Groot (1984), Redant (1987), Churchill (1989); Jones (1992) and Prena *et al.* (1996) reported that intensive and repeated trawling in the same area may lead to long-term changes in both benthic habitats and communities and that the magnitude of the effect depends on the types of gear employed, the depth of penetration of the gear into the sediment, the water depth, the nature of the substrate (mud, sand, pebbles, or boulders), the kind of benthic communities being impacted (i.e. epibenthic versus infauna), the frequency with which the area is fished, the weight of the gear on the seabed, the towing speed, the strength of the tides ,currents and the time of the year.

Emmanuel (2004), Emmanuel and Kusemiju (2005) reported on the use of castnet for fish harvesting in the natural pond and they identified cast net as the best fishing gear for partial pond harvesting. Emmanuel (2008) reported on the fishery and bionomics of the swimming crab *Callinectes amnicola* from a tropical lagoon and its adjacent creek and noted that the liftnet was selective for large crab while wire gauze trap was selective for smaller crabs in the creek. Emmanuel *et al.* (2008 a&b) described cast net design characteristics catch composition and selectivity in tropical open lagoon and gill net selectivity and catch rates of pelagic fish in tropical coastal lagoonal ecosystem.They reported that these fishing gears (cast net and gillnet) are highly efficient and may last longer if well maintained.

Gillnet selection is known to depend on a variety of factors besides mesh size net construction, visibility and stretchability of the net, net material and the shape and behaviour of the fish (Hamley, 1975). It was further reported that entangling more than wedging and gilling is affected by net construction. The probability of a fish being entangled is believed to depend on the hanging ratio.

According to Robards (1999) beach seines are used to sample near shore fish communities. It was reported further that the fishing method is effective and non-selective in sampling shallow inshore waters with sandy or smooth bottoms. It was also implicated that variable-mesh net was used and that the nets were effective at catching fish.

The seine nets without bag and the seine nets with bag are both widely used in freshwater fishing (Von Brandt, 1984). It was reported further that seine without bags were frequently used in pond farms for harvesting the fish and in river fishing. The beach seine can also be operated by single boat or by two fishing boats by beginning with one hauling line from an anchored buoy (Von Brandt, 1984).

In his study of the theory of fish capture by gillnets, Andreev (1955) recommended darker coloured nets in good light conditions and clear water and lighter coloured nets in turbid conditions. Kanda and Koike (1958) examined the barring effect of coloured netting on *Trachurus trachurus, Atherion elymus* and *Cyprinus carpio*. The barring effect of twice panels decreased in the following order: red-orange or yellow – blue green. In the clear waters of the Mediterranean, it was found that natural white twine was visible as far as 15m away, green at 13m, tan-brown at 12m and orange 9-10m (Hemmings, 1966). According to Tweddle and Bordington (1988) comparisons of the fish catches from gill nets of different colours in northern Lake Malawi in 1981 showed that plain white nets caught more fish, in terms of both numbers and weight, than did nets of the other colours tested. It was added that in Lake Kainji, Nigeria, black nets were most effective, although this may have been due to the finer twine used in those nets. Baranov (1948, 1976) and Andreev (1955) jointly reported that experiments elsewhere have indicated that dark nets fished well while white nets were much less effective in clear water. Tweddle and Bordington (1988) reported that Lake Malawi water is exceptionally clear with Secchi Disc readings often exceeding 20m (but from 7 to 19m during the course of the experiment). It was concluded that Lake Malawi may be an exception to the rule.

Thrush and Dayton (2002) reported on trawling disturbance modification on benthic production processes and the implication of the disturbance causes to benthic habitats by trawling, dredging and its implication for marine biodiversity. Kaiser *et al.* (2000), Jennings *et al.* (2001), Thrush and Dayton (2002) all reported that trawl nets cause a significant physical disturbance to the sea bed, altering the spatial structure, species composition and biogeochemistry of the benthic environment.According to Solarin (1998) the Lagos lagoon has multi-gear fisheries. The gear types were characterized by various degrees of efficiency and selectivity due to interactions between the fishing methods, the fish behaviours and environmental factors (King 1995). Solarin (1998) also reported that the less cumbersome conical cast nets were good for rapid sampling of the lagoon. Pet-soede *et al* (2001) reported that fishing strategies and the distribution of fishing effort may differ between gear types, yet one feature is common to all which is the fish catch. They further reported that the observed aggregation of fishing effort in this small-scale tropical fishery is not related to patterns in fish abundance.

Knowledge of the size-selectivity of commercial fishing gear is crucial to management of a fishery for purposes of maximizing yield and protecting juvenile fish (Guilland, 1983; Wileman *et al*, 1996). Moreover, fishing gears may be used as research tools for monitoring the length distribution of the stock by using the size-selectivity of the gears to adjust the length distribution of the catches. Gillnets are widely used for this purpose (Hamley, 1975).

Gillnet selectivity experiments are typically implemented by the simultaneous fishing of several gillnets of differing mesh sizes (Miller and Holst, 1997). They reported further that if the length distribution of the fished population is "known" then selectivity can be estimated directly. Good knowledge about the population length distribution is rare and in practice one might consider an experiment that used only the recaptures of a tagged sub-population of fish (Hamley and Regier, 1973; Millar and Holst 1997). They reported that more commonly, direct estimation is not feasible, whence indirect estimates of gillnet selectivity are obtained by comparing the observed catch frequencies across the various meshes fished. Methods for calculating indirect estimates of gillnet selectivity from comparative catch data have been provided by Holt (1963). Regier and Robson (1966), Hamley (1975), Kirkwood and Walker (1986).

Most fishing gears, for example trawl gears are selective for the larger sizes, while some gears (gillnets) are selective for a certain length range only, thus excluding the capture of very small and very large fish. Gear selectivity is important tool for fisheries managers who, by regulating the minimum mesh sizes of a fishing fleet, can more or less determine the minimum sizes of the targets species of certain fisheries (Hamley, 1975).

Fishing gear is dependent on several factors, such as the fishing techniques to be employed, the fish to be caught, the material for nets and ropes (Shimozaki, 1959). The International Organization for Standardization (ISO) defined netting as "a meshed structure of indefinite shape and size, composed of one yarn or of one or more systems of yarns interlaced or joined (ISO, 1974). The raw materials of the netting consist of fibres of which two main groups may be distinguished as natural and man – made fibres (Klust, 1982).

The search for means to increase the resistance against rotting is probably as old as the use of vegetable fibres for fishing nets and a great number of preservation methods have been developed by practical fishermen, by fishery research institutes or the chemical and textile industries (Klust, 1982). It was reported further that the use of practical fishermen mostly consist of the method of coal tar, wood – tar or carbolineum, either alone or combined with petroleum, benzene or in the treatment with tanning solutions as catechu (cutch) or other extracts of the bark or wood of certain trees. The use of *Rhizophora spp* bark to preserve netting material has been reported by Udolisa *et al* (1994). Klust (1982) stated that each of the synthetic fibre groups has well-defined characteristics which distinguish it from other groups. It was reported further that these characteristics may determine its suitability for certain type of fishing gear and the fishermen should therefore always know to which chemical group the material belongs. Also Klust (1982) outlined four methods of identifying netting material as water, visual inspection, burning and solubility tests. Klust (1982) noted that, of the natural fibres for fishing nets, vegetable fibres are utilized almost exclusively and particular cotton, manila, sisal, hemp, linen and ramie. It was further implicated that animal fibres, such as silk or hair are either not suitable or too expensive for fishing nets. It was added that, of the man-made fibres only the category of the synthetic fibres has particular advantages for fishing nets and that others such as those made of regenerated cellulose (rayon, cellulose wool) are not superior to natural fibres and therefore do not need to be considered.

Klust (1982) reported that man-made fibres synthetically made of such simple substances as phenol, benzene, acetylene, prussic acid, chlorine are, therefore called synthetic fibres. Klust (1982) reported that the development of synthetic fibres was started around 1920 by investigations of the famous chemist H. Staudinger (winner of the Nobel Prize for Chemistry in 1953). He found that all fibrous material consists of long chain molecules in which a great number of equal simple unit are linked together.

Klust (1982) explained the advantages of synthetic fibres over the natural ones where it was stated that vegetable fibres are parts of dead plants and consist mainly of cellulose. Therefore, when conditions are humid or when they are immersed in water they are attacked by cellulose digesting micro-organisms, especially bacteria. It was further stated that, unfortunately the side effect on fishing nets is a source of increased labour and financial loss and is the main reason for the advance of synthetic fibres. It was further reported that the activity of the cellulolytic bacteria depends to a great extent on the water temperature. Also the characteristics of the water, running waters generally have a greater decaying power than stagnant water.

Klust (1982) also noted that in fertile marine or freshwater which contains a high percentage of organic substances, lime and phosphorus (eutrophic) and consequently has a high yield of fish, unpreserved nets of vegetable fibres are more quickly destroyed than in unfertile, clear water. It is of equally great advantage to large scale deep-sea industrial fishing as it is to the small-scale artisanal fishery and one can only agree with the words of an expert that synthetic fibre "bring to one of man's oldest occupations the miracle of science and, in doing so, provides easier living for the fisherman".

The characteristics of synthetic fibres may determine its suitability for certain types of fishing gear and the fishermen should therefore always know to which chemical group his net material belongs (Klust, 1982). It was further reported that unfortunately there are less visual differences between the various kinds of synthetic fibres than there are in vegetable fibres and synthetic netting material can therefore rarely be determined by its appearance alone.

Klust (1982) outlined five different identification tests. These were: water test, visual inspection, burning test, solubility test and melting point test. Klust (1982) further advised to start the identification with water test. The water test serves to classify the netting material into two groups, that is, those synthetic fibres which float in water (Polyethylene and Polypropylene) and those which sink (all other kinds of synthetic fibres visual inspection was regarded by the same author as preliminary sorting test of the type of fibres).

For burning test only a clean flame and eventually two forceps are needed. The best source of flame is a Bunsen burner or if a gas supply is not available an alcohol lamp, but even a cigarette lighter may be used (Klust, 1982). It was further reported that the following should be observed: the reaction of the netting material near the flame, and after removal from the flame, the smell of the gaseous products (smoke) and the residue.

2.2.2 Artisanal Fishing crafts

Like fishing gear, crafts have passed the test of time, evolving from logs of wood, floating calabash and papyrus raft to wooden dugout canoes, planked canoes and fibre glass all in an attempt to complement changing sea condition and various fishing gear developed and employed (Ambrose *et al.*, 2001). They stated further that in the coastal artisanal fisheries, crafts are designed to suit the following: Surf crossing, beach landing, buoyancy and stability at sea and different types of artisanal fishing techniques. Gulbrandson (1974) and Haug (1974) outlined the construction and suitability of V-shaped and flat shaped bottom canoes respectively in different water bodies and stated the restrictive use of flat bottom cause in inland protected water ways. Udolisa and Solarin (1985) gave an account of the performance of a 13-metre (LOA) wooden shallow draft vessel designed to cross over the estuarine sand bars of Imo River. Ambrose *et al.*, (2001) recorded that the design and construction of an ideal fishing craft is an illusive idea, because the condition for an ideal crafts so varied and depends on an array of factors such as people's culture, fishing gear, water body and motorization. It is therefore easier to design a craft that will satisfy one condition at a time.

According to Kwei (1961) the attachment of outboard motors to the dugout canoes presents quite a problem. It was further recorded that in Ivory Coast the fishermen used outboard motor/engine in a well in the centre of the boat to enable them to get to and from the fishing grounds faster. The fitting of outboard engine was also reported by Udolisa, *et al* (1994) for most planked canoes in Nigeria. Kwei (1961) reported side fitting of outboard engine in Ghana. Solarin (1998) recorded the canoes types used in Lagos Lagoon where the three aforementioned types of canoes were identified.

Solarin (1998) stated that dugout canoes generally provided little space to accommodate the crew, gear and the fish caught during the fishing operation. It was further reported that the dugout canoes had relatively small free board and thereby displayed low reserved buoyancy and were less stable compared to any other canoe types. It was added that all the dugout canoes were propelled with paddles.

Solarin (1998) also stated that the planked canoe with flat bottom hull was completely built with planks fixed together with frames, u-shaped metal fasteners and nails. It was further implicated that the joints were generously sealed by caulking with natural fibres or yarns especially cotton often soaked in oil mixed with the lime to prevent leakage or seepage. In Lagos Lagoon less than half of the planked canoe actually used out board engine (8-15Hp) for the fishing operation (Solarin, 1998).

According to Udolisa *et al* (1994) dugout canoes are carved by skilled craftsmen scattered throughout the country from green logs of Opepe (*Nauchia diderrichii)*, Mahogany (*Khaya ivorensis)*, Afara *(Terminalia ivorensis)* White afara *(Terminalia superb)*, red iron (*Lophira alata)*, Silk cotton free *(Ceiba pentandra* and *Bombax buonopozense)*, Missada (*Erythrophleum suaveolens)*, Obeche *(Triplochiton scleroxylon* and *Alstonia sp.*).

2.2.3 Fish Aggregating devices (FADS) in Coastal lagoons

As the catch from the lagoon can hardly be improved, the development of other fisheries has gained importance. It is this context that a FAD – associated fishery was introduced by local fishermen to trap down the fish resources in the lagoons. The commonest FAD used is the 'acadja'. The term 'acadja' describes a family of installation of the fish parks type that is currently found in several of the West African coastal lagoons (Welcomme, 1972). Parks of branches that are artificially planted in the water to attract fish are widespread in West Africa, and are described particularly from the Niger river (Raimbault, 1960), from the Benue river Cameroon (Stauch, 1966), Nigeria (Reed *et. al*, 1967), in the coastal lagoon of Dahomey (Welcomme, 1972) and in Lagos lagoon (Solarin, 1998).

The methods of fishing acadja were extensively described by Welcomme (1972). It was reported that the smaller types of acadja was fished with a special castnet known as acadjado, although this has largely been abandoned recently and now the acadja is fished by surrounding it by a wall of netting held in place with stakes (Welcomme 1972, Solarin, 1998). According to Suresh (2000) fish aggregating devices (FADs) are natural or artificial objects or structures placed at the bottom, suspended in the water column or kept afloat on the surface of aquatic bodies to attract, aggregate and regenerate demersal, pelagic, resident and migratory fishes. Fish are attracted to these objects for the shade, shelter, food and breeding grounds they provide (Solarin, 1998; Suresh, 2000; Emmanuel and Kusemiju, 2005).

In Lekki lagoon, the type of FAD used is the floating island locally known as *Iken*. Little or no information was available on *Iken* fishery in Nigerian waters. Elsewhere, Suresh (2000) described floating island (Phoom) as a unique fish aggregating method. It was further reported that the major plant components of the phoom are *Zizinia latifolia, Lursia hexandra, Echinochloa crusgalli, Brachiaria mutica, sangitharia sagittifolia, Alternanthra philazeroidis, Pistia stratiotes, Eichhornia sp* and *Marsilia sp*. It was added that the dense network of roots and shoots of the weeds act as floating platforms, trapping layer upon layer of organic and inorganic debris on top of which the weeds keep growing. The floating islands are fished at intervals of 1 -2 months. Suresh (2000) reported that fishing was carried out by encircling the island with nets extending from the surface to the bottom on the ownership structure. It was further reported that although the lake is a common property resource and there is no restriction on fishing, there are certain territorial rules followed by the people and that the people communally own the phoom grounds in their territory.

The propable problems associated with floating island as reported by Suresh (2000) are the considerable pressure on untouched floating island grounds. It was reported further that the environmental consequences of the booming floating island fishery, the number of floating islands in the lake can sustain as well as stock; recruitment of fishes in the lake are yet unknown.

2.2.4 Fish species composition in lekki lagoon

It is understandable that a layman should sometimes accuse specialist fisheries workers of veiling their subject in obscure terms with long and complicated names in order to preserve their work from proletarian scrutiny. But these terms and description, though they might at first seem confusing, are really necessary if fisheries workers are to make a thorough investigation of their subject, create wise stock management policies, or to exchange information with colleagues who perhaps speak a different language (Reed *et al.*, 1967; Holden and Reed, 1991).

Reed *et al.*, (1967) reported that to know the correct name of a fish is of great importance if one is to take advantage of the work already done by others and thus save lot of unnecessary expenses and effort. They reported further that only the scientific names of fish will permit this, as they are the same in all languages, whether Japanese, Arabic or English. Holden and Reed (1991) reported that any group of fish, or of any other animal for that matter, whose members are similar in structure and appearance and are capable of breeding among themselves are said to belong to the same species. Holden and Reed (1991) and Reed *et al* (1967) jointly reported that if specimens from a certain locality show minor, differences from others found elsewhere, they are referred to as a sub-species or variety.

A group of species which closely resemble one another in structure but which do not interbreed are said to constitute a genus (Reed *et al.*, 1967; Holden and Reed 1991; Olaosebikan and Raji (1998). Holden and Reed (1991) reported that most fish can be identified correctly by examining their visible external features, but this is not always so and exact identification sometimes requires a detailed examination of such pasts as gill-rakers, air-bladder or the skeleton.According to Olaosebikan and Raji (1998) the freshwater food fishes found in Nigeria are about 268 different species. They inhabit over 34 well-known freshwater bodies (rivers, lakes, reservoirs and lagoons), which constitute about 12% of Nigerians total surface is put at 94,185,000ha (Ita, 1993). Oguzie (1997) produced a key to some of the freshwater fishes of Nigeria as adopted from Boulenger (1916) and Olaosebikan and Raji (1998). The key agreed with the identification method published by Leveque *et al* (1991) on the freshwater fishes of the NILO-Sudan river basin in Africa. These keys are commonly used to identify the families and species of fishes using the dichotomous identification method.

Welman (1948) produced a list of 181 species of fishes that could be found in Nigeria inland waters. It was further reported that there are about 145 species of fish in the areas of the Kainji Lake basin. The report also revealed that Anambra, Kaduna and Sokoto/Rima rivers have 23, 28 and 22 species respectively. Cross River, Ogun and Osun Rivers have 39, 23 and 23 fish species respectively. But Olaosebikan and Raji (1998) published a list of African freshwater fishes to include 976 species, referable to 185 genera and 43 families. Ita (1993) reported that an estimated 230 species of fish have been recorded from the rivers of Nigeria, but no record is available on the species present in Rivers like Benin and Calabar which all empty directly into the ocean. Reed *et al* (1967) and Holden and Reed (1991) reported that when identifying a fish, the fins are the first thing which should be examined, they also reported that the paired fins: the pectorals, pelvic and ventral, are not as important for identification purposes as the others, except regarding their positions on the body and in relation to each other.

Holden and Reed (1991) reported that the number of spines and or rays in the dorsal and anal fins is generally the most consistent character in a species and is seldom the same in two different species; hence these fins are very important for purposes of identification. They further reported that the fins are made up of a number of rays are given separately in a description. Reed *et al* (1967) and Holden and Reed (1991) jointly reported that in many fish, some or all of the rays, especially of the dorsal fin, are replaced by strong and sharp spines. They also reported that, it is customary to use Roman numerals for the spine count while the rays are represented with Arabic numeral. Holden and Reed (1991) reported that some species of fish have two dorsal fins, the second of which is often an adipose fin, composed only of soft, fleshy tissue and usually without rays of any kind.

The position of the mouth is usually given in fish description, months are said to be terminal when they are at the extreme tip of the snout. As the mouth is progressively posterior to this position on the ventral side, it is described as being subterminal, sub-inferior inferior or ventral. In a few cases the mouth is dorsal to the terminal position and it is then said to be upturned or oblique (Reed *et al* 1967; Holden and Reed, 1991; Gupta and Gupta, 2006).

Gupta and Gupta (2006) reported that the kinds of fishes are so numerous and their relationships so difficult to access that most Ichthyologists faced a lot of problems in devising a widely accepted system of classification of chordates in general and fishes in particular. They reported further that before World War II the classification of major groups of fishes, according to natural similarities and relationships, was a research field in which only a few workers were specialized to work.

As far as bony fishes (Teleostei) are concerned they have long been recognized as a natural monophyletic group but it is established today that in reality they had evolved as a number of distinct lineages from diverse Holostean ancestors in the Mesozoic (Gupta and Gupta, 2006). They also reported that the major approaches to classification discussed by Nelson (1994) are – the cladistic (=Phylogenetic) and the synthetic (= evolutionary). Both cladistic and synthetic have continued to undergo changes since the early 1970s, when cladistics became widely used in ichthyology, and especially in cladistics, new methods are continuing to be developed.

Nelson (1994) and Gupta and Gupta (2006) jointly reported that the taxonomist uses several characteristics or identification parameters. These can be divided into four main groups:

- Parameters that can be measured: Standard length, snout length, fin length and eye diameter

- Anatomical parts that can be counted: vertebrae, fin-rays, spines, teeth and scales.
- The appearance and position of the body structures; the lateral line, teeth, scales and the colouration (of live fish).
- Chromosome numbers and genetic parameters such as DNA sequences.

2.2.5 Fisheries Production and Management in Coastal lagoons

Fisheries and aquatic resources are economically, ecologically, culturally and aesthetically important to the nation. From the global perspectives, the main issues facing the international fishing community generally are over fishing, overcapacity, by-catch management as well as environmental degradation. The combined effect of these factors that have contributed 60-70% of the major world fisheries resources problems are in urgent need of management action; to restrict the increase in fishing capacity and to rehabilitate damaged resources (FAO, 1993).Coastal lagoons form an integral part of marine fisheries and provide important spawning and nursery grounds for many fish species. The economic contributions of lagoon fisheries have not been given adequate consideration by fisheries authorities (Entsua – Mensah *et al* 2000). The fisheries of the world are considered over fished. This over fishing has brought about change in the species composition that has important implications for the fisheries.

As pressures on lagoon fisheries in the tropic and subtropics have intensified, a number of authors have promulgated recently that greater involvement of the knowledge and institutions of local fishing communities could lead to more effective management. Panayotou (1988) reported that fishery management is the pursuit of certain objectives through the direct or indirect control of effective fishing effort or some of its components., It was reported further that selectivity of gear such as restriction on the size or spacing of meshes and hooks or the opening of pots aim at achieving and maintaining the most producing age structure of the stock. Scudder and Conelly (1985) recorded the management systems for riverine fisheries. Ssentongo *et al.*, (1986) stated that rational management of fishery resources in the Exclusive Economics Zone (EEZ) requires greater control of fisheries. Emmanuel (2004) recorded that the biodiversity has been directly affected by over fishing and that the use of active gear like cast net will manage (conserve) the juvenile fishes in the creek.

3.0 MATERIALS AND METHODS

3.1 DESCRIPTION OF STUDY AREA

The Lekki lagoon is one of the largest lagoons in West Africa and it supports a major fishery. The lagoon is located between Lagos and Ogun States of Nigeria and lies between longitude 4^0 00' and 4^0 15' E and between latitude 6^0 25' and 6^0 37'N (Figure 1). The lagoon has a surface area of about 247 square kilometers and it is mostly shallow (less than 3.0m deep) the maximum depth being 6.4 metres (Kusemiju, 1973). Lekki lagoon is a freshwater environment fed by the river Oni in the North eastern part and by Rivers Oshun and Saga in the north western parts of the lagoon. It opens into the sea via the Lagos lagoon and Lagos harbour. The lagoon is transitional in that it connects three south western states (Ondo, Ogun and Lagos). The lagoon is part of an intricate system of waterways made of lagoons and creeks that are found along the coast of South-western Nigeria from the Dahomey border to the Niger Delta.

The two distinct seasons (dry and rainy) are observable in the lagoon which is typical of the southern part of Nigeria. The fisheries techniques obtained in the lagoon are mostly small scale based. Thus little capital is required to set up fishing business. The lagoon serves as the fish basket of the protein source of the surrounding settlements.

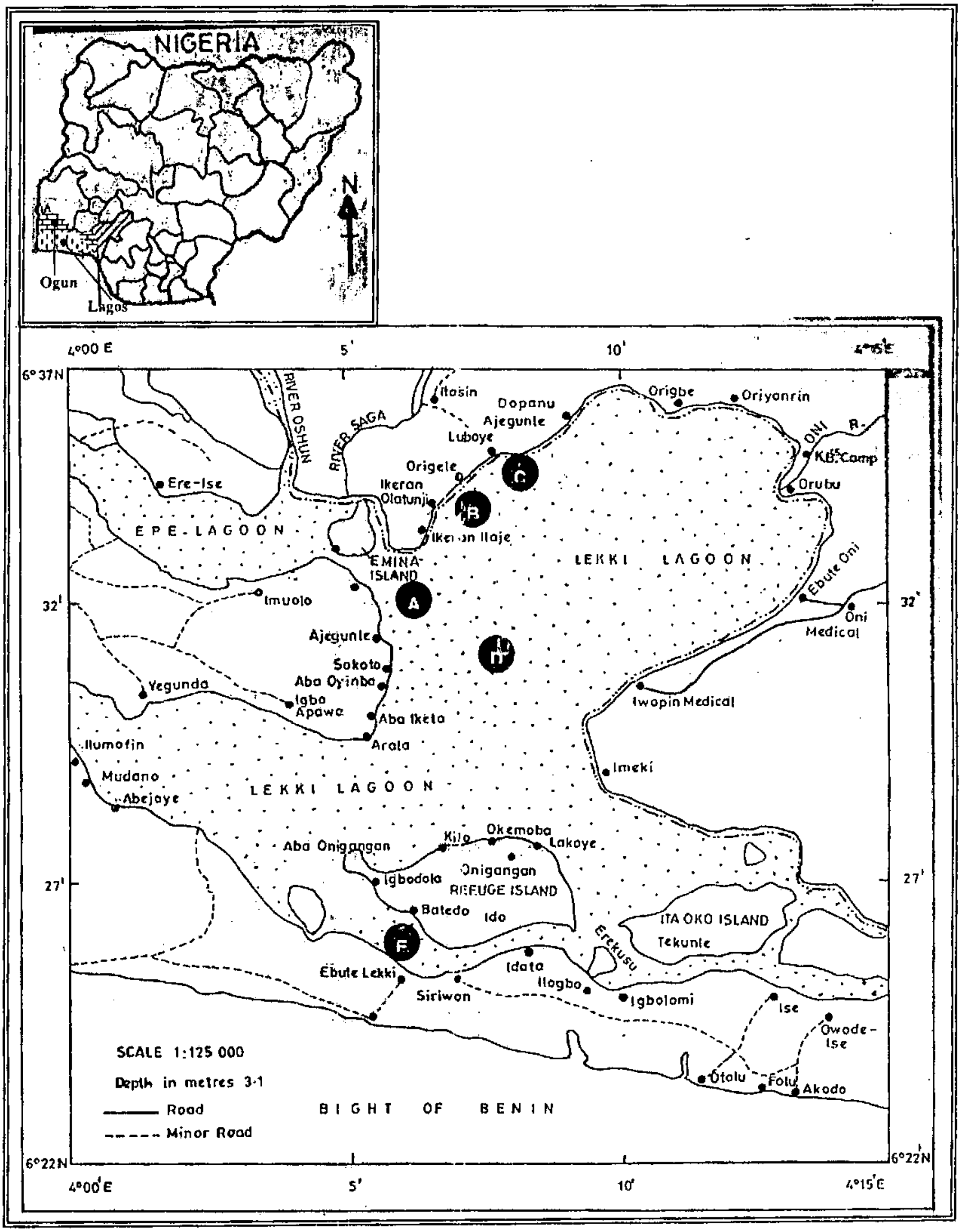


Fig. 1: Map of Lekki Lagoon and its environs

The vegetation around the Lekki lagoon consists mainly of stilt rooted trees, a dense undergrowth of shrub and raphia palms (*Raphia sudanica*) and oil palms (*Elaeis guineensis*). The floating grass (*Saccarum sp*) occurred on the periphery of the lagoon while coconut palms (*Cocos nucifera*) are widely distributed in the surrounding villages. Some parts of the lagoon are covered by floating plant like the water lettuce, *Pistia stratiotes*, duck weed, *Lemna* sp and the water hyacinth, *Eichhornia crassipes* are always found in the periphery and are distributed all over the lagoon during the dry season especially December, January, February and early March of the year.

3.2 SAMPLE COLLECTION

The study was conducted between March 2006 and February 2008. The fishing settlements in Lekki lagoon were identified through stakeholder mapping. The keyfishers were identified and discussions were held to know previous fishing activities in the lagoon. Monthly visits were carried out between March 2006 and February 2008 and data on the following were obtained: Water samples, fishing gears, fishing crafts and fishes.

3.3 FIELD AND LABORATORY PROCEDURES

3.3.1 Measurement of physical and chemical characteristics

Water sample (one litre) was collected using water sampler (non-metallic) monthly from each of the stations at about 0.5m depth between 0700hr and 1800hr at both low and high tides. Field procedures include the determination of the following parameters.

3.3.1.1 Air and Surface Water Temperature (^0C)

The air and surface water temperature was measured at the different stations by first drying the mercury – in - thermometer (calibrated from 0^0 – 100^0C) bulb with a dry cotton cloth. The thermometer was raised to eye level while shading the mercury bulb from direct sunlight. The reading was then taken after 1min of acclimatization. Readings was recorded in degrees Celsius (^0C).

3.3.1.2 Salinity (%o)

This was determined in the field with a portable refractometer (Model New 3 - 100). The probe was exposed and two drops of water sample were added to the probe to estimate salinity levels. In the laboratory, water sample was titrated against silver nitrate solution using 10% potassium dichromate as indicator. 10ml of the water sample was measured into 250ml conical flask and three drops of 10% potassium chromate was used. The solution was titrated against silver nitrate solution containing 27.0g of the salt per one litre of solution. The end point was marked by a faint brick red colour.

3.3.1.3 Dissolved Oxygen (mgl^{-1})

Water samples was fixed in the field and later analysed in the laboratory using Winkler's method (Strickland and Parsons 1972). Water samples was fixed by adding 0.5ml manganous sulphate solution ($MnS0_4$, $2H_2O$), with a concentration of 400g per litre and 0.5ml alkaline iodide solution. Care was taken to ensure that no air bubble was trapped. In the laboratory 10ml of the solution was titrated against M/40 standard sodium thiosulphate solution. Six drops of starch with a concentration of 0.5g per 300ml was added to serve as indicator (Solarin, 1998). This was observed for strong blue colour which disappeared when the end point was reached. Dissolved Oxygen meter was also used to confirm the results.

3.3.1.4 Hydrogen Ion Concentration (pH)

In the laboratory the pH meter was used. Standard buffer solution (pH 7.0 – 6.87) containing 0.025M potassium dihydrogen phosphate (KH_2PO_4) and 0.025M anhydrous disodium hydrogen phosphate (Na_2HPO_4) will be used as reference. 8.52g RH_2PO_4 and 8.875g Na_2HPO_4 was dissolved ir distilled water, making the volume to 250ml in a measuring flask. 25ml of the solution was then diluted to 250ml for use.

The temperature compensator of the pH meter was set to the same temperature of the buffer solution with pH value 6.87 and the meter reading was adjusted accordingly to read the same value. The meter was allowed to stabilize for about 5 minutes. The pH value of the water sample was then determined.

3.3.1.5 Nitrate – nitrogen (mg/l^{-1})

Determination of nitrate – nitrogen value was by a mixture of 20ml of water sample and 1ml of freshly prepared 0.5% sodium salicylate solution which was evaporated using a water bath. After cooling, 2ml of tetraoxosulphate (VI) acid (d=1.84) was added. Ten minutes later the solution was washed with 25ml distilled water in a cuvette and 7ml of alkali reagent (30% NaOH and 0.6% Rochelle salt) was added. After a further 10minute period the solution was made up to 50ml with prepared standards. The absorbance was read from a photometer at 420nm.

3.3.1.6 *Phosphate – phosphorus (mgl^{-1})*

This was determined by using the colorimetric method. 10ml of the water sample was acidified with dilute H_2SO_4. 1ml of ammonium molybdate reagent and 0.5ml stannous chloride reagent was added, mixed and allowed to stand for five minutes. The colour was determined at 650nm using HACH DR 2010 colorimeter which was previously calibrated with phosphate standards before use. The phosphate content was then recorded in mg/l.

3.3.1.7 *Sulphate (mgl^{-1})*

This was determined by using the Turbidmetric method. The conditioning reagent was prepared to contain the following mixture. 30ml HCl, 300ml water, 100ml 95% ethanol and 75g NaCl, 50ml glycerol was added. 10 drops of conditioning reagent was added to 10ml of water sample and mixed. A pinch of Barium Chloride crystals were then added to the solution and allowed to stand for five minutes and then determined at 420nm using a colorimeter previously calibrated with sulphate standard solution. The sulphate content was then recorded in mg/l.

3.3.1.8 *Conductivity (μS/cm)*

Surface water conductivity was determined using a conductivity meter (Philip Unicam Model PW 9405). Calibrations were performed, before each set of measurements, using standard solutions in the range 50 – 40,000μS/cm.

3.3.1.9 *Total Dissolved Solids (mgl^{-1})*

Total dissolved solids were determined gravimetrically by evaporating 100ml of a filtered portion of the sample at 105°C. The residue was cooled in a dessicator and then weighed. Total dissolved solids was determined as: TDS (mg/l) = weight of residue (g) X 10^6/100ml.

3.3.1.10 *Total Suspended Solids (mgl^{-1})*

The total suspended solids content was determined by filtrating 100ml of sample through a pre – weighed filter paperwhich was subsequently dried to constant weight, cooled and reweighed. The values were then recorded (in mg/l). The formular below was also applied. TSS (mg/l) = weight of residue (g) X 10^6/100ml

3.3.1.11 *Water Transparency (cm)*

Transparency was determined with weighed 20cm diameter secchi disc. The disc was lowered over the side of the canoe into the water and the length of rope when the disc disappeared as well as the length of the rope when the disc reappeared when pulled was noted and recorded. The average of the two lengths was recorded as the secchi disc reading.

3.3.1.12 *Water Depth (m)*

The water depth was measured with rope attached to weight secchi disc lowered into the depth and measured with a metric rule. When the water is too shallow, a calibrated paddle or a pole was used.

Rainfall

Data on rainfall for the study period (March 2006 – February, 2008) was obtained from the Federal Department of Meteorological Services Oshodi, Lagos.

The methods for physico – chemical analsysis are summarized in Table 1 below.

Table 1: Summary of environmental factors and method / device used for their estimation

	Parameter/Unit	Method / Device	Reference(s)
1	Air temperature (°C)	Mercury – in – glass thermometer	Nwankwo (1984)
2	Water temperature (°C)	Mercury – in – glass thermometer	Nwankwo (1984)
3	Transparency (cm)	Secchi disc	Nwankwo (1984)
4	Depth (cm)	Graduated pole	Brown (1998)
5	Rainfall (mm)	Acquired from NIMET, Oshodi, Lagos	
6	Total Dissolved Solids (mgl^{-1})	Cole Palmer TDS meter	
7	Total Suspended Solids (mgl^{-1})	Gravimetric	APHA (1998)
8	pH	Electrometric / Cole Parmer Testr3	
9	Conductivity (μS/cm)	Philip PW9505 Conductivity meter	
10	Salinity (‰)	Titration	APHA (1998)
13	Dissolved oxygen (mgl^{-1})	Titration	APHA (1998)
14	Nitrate – nitrogen (mgl^{-1})	Colorimetric	APHA (1998)
15	Phosphate – phosphorus (mgl^{-1})	Colorimetric	APHA (1998)
16	Sulphate (mgl^{-1})	Turbidimetric	APHA (1998)

3.3.2 The salt water incursion into Lekki lagoon

Preliminary findings from study indicated that salinity of the Lekki lagoon was higher than records from previous authors suggesting possible salt water intrusion. Therefore a detailed study of this phenomenon was undertaken.

The salt water incursion into Lekki lagoon was examined by collecting water samples from Ricket (Ebutte Meta) (Lagos) to Ori-oke Iwamimo (Ondo state) (Figure 2). Six trips were made from Lagos to Ondo state via the coastal road and the villagers along the coast were interviewed to acertain whether there was any link between the sea and the lagoon. Figure 2 and Table 2 show 18 sampling stations of water samples for salt water incursion studies from the two ends of the Lekki lagoon.

3.3.3 Fishing Gears, Design Details and Operational Methods

The fishing gear types used in the small – scale fisheries in the lagoon was inventoried and observed monthly. The gear types were classified according to International Standard Statistical Classification of Fishing Gear (ISSCFG) (Nedelec, 1982). The design details showing geographical configuration in three dimensional forms, the fishing operation, the catch composition, and the catch per unit effort (CPUE) equivalent was recorded. Experimental trials was carried out to complement the basic data that was collected in the field include the following.

3.3.3.1 Netting materials in Lekki lagoon

Each of the synthetic fibre group has well defined characteristics which distinguished it from other groups. This may determine its suitability for certain types of fishing gear and the fisherman should therefore always know to which chemical group his net material belongs. According to Klust (1982) there are less visual differences between the various kinds of synthetic fibres than there are in vegetables fibres and synthetic netting material can therefore rarely be determined by its appearance alone.

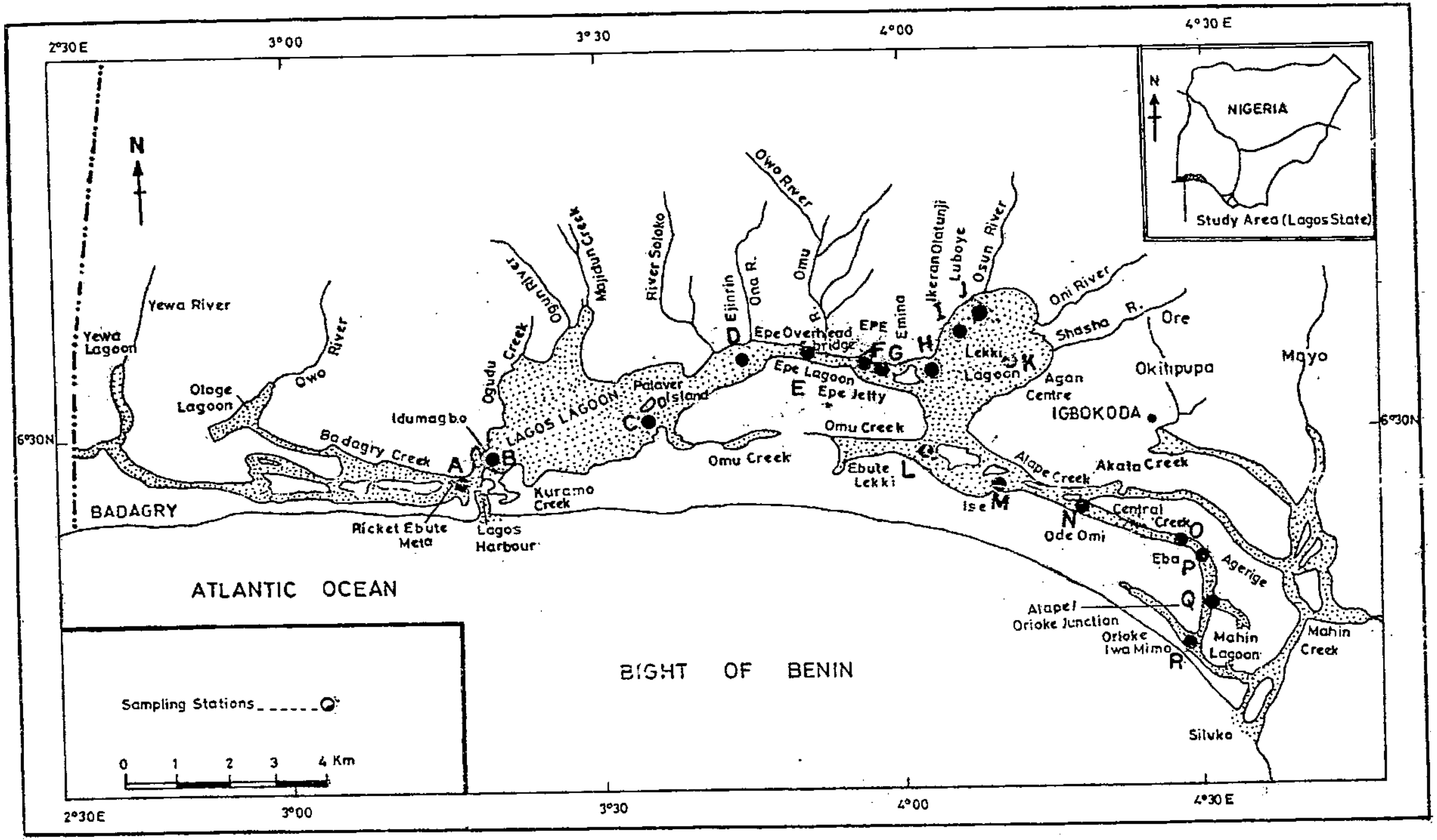


Fig. 2: Map of the lagoons of the south – western Nigeria showing water sampling stations (•)

Table 2: Water sampling stations along the south western lagoons (Ebute metta – Lagos state to Ori-oke Iwamimo – Ondo state)

Station code	Water sampling station	Coordinates
A	Ebute meta (Ricket)	06° 28.531N 003° 23.174E
B	Idumagbo	06° 27.920N 003° 23.910E
C	Palaver island (Ijede)	06° 31.484N 003° 33.218E
D	Ijede power house	06° 32.793N 003°36.450E
E	Ejirin	06° 32.594N 003°38.059E
F	Epe overhead bridge	06° 34.521N 003°57.292E
G	Epe jetty	06° 34.607N 003°58.571E
H	Emina	06° 32.741N 004°04.845E
I	Ikeran Olatunji	06° 32.232N 004° 05.386E
J	Luboye	06° 31.910N 004° 05.589E
K	Agan centre	06° 29.930N 004° 06.919E
L	Ebute Lekki	06° 26.952N 004° 09.390E
M	Ise	06° 25. 214N 004° 13.084E
N	Ode omi	06° 24. 540N 004° 20. 005E
O	Eba	06° 23. 483N 004° 29.204E
P	Agerige	06° 20. 476N 004° 37.345 E
Q	Alape/Ori-oke Iwamimo junction	06° 15. 980N 004 ° 44.176 E
R	Ori-oke Iwamimo beach	06 ° 15. 957 N 004 ° 44. 143E

3.3.3.2 Solubility Tests for netting materials in Lekki lagoon.

The test was conducted in the fishing gear laboratory of the Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria. One hundred and fifty samples (150) of netting material across the fishing villages in Lekki Lagoon were collected and sorted into seven groups using visual inspection as discussed by Klust (1982). Fourteen 25ml glass beaker were used for the test. The heat sources used was Nakai electric hot plate (Model HP - 103). The samples were shredded and the fibres cut into pieces of about 2mm in length with a sharp scissors. Twenty grams of samples of each material and 16ml of each solvent (Hydrochloric acid (HCL); tetraoxosulphate (VI) acid (H_2SO_4); Dimethylformamide ($HCON(CH_3)_2$; formic acid ($HCOOH$); glacial acetic acid (CH_3-$COOH$); Xylene, $C_6H_4(CH_3)_2$ and Pyridine) were put into the glass beakers.

3.3.4 Fishing Crafts Survey

Canoe types, specifications and woods, materials used in their construction and mode of propulsion was investigated. Monthly inventory of the operational fishing canoes was done in 25 villages, settlements and fish landing sites. The canoes used in the lagoon exclusively for fishing was distinguished from those used for transportation, sand digging and for buying fish. Biofouling organisms of wooden canoes were collected by scraping part of the affected canoes and identified in the laboratory using appropriate texts (Edmund, 1978).

3.3.5 Field Experiments of the fishing gears in Lekki lagoon

Field experiment of fishing trials were carried out in Lekki lagoon with prototype fishing gears.

3.3.5.1 Basket trap with two funnel entrances

These were constructed from palm leaves mid-rib spines with total length of 90cm and 12mm diameter. The spaces between the mid - ribs was 0.5mm while the trap entrances were 170mm (17cm). Some of the traps were baited with cassava tuber and were tied on a rope with suspended snood to suspend the trap. The traps were set overnight (18.00hr to 6.00hr). The catches were emptied into the basket shaded with fresh plant leaves. Prawns and the fish were counted and weighed. There were a total of 14 comparative fishing with and without baits. Baited traps were also operated for 16 days between 6.00 and 18.00 hr GMT.

3.3.5.2 Boat seine

A boat seine was hired at Igbodola village after thorough examination of the seine net. The boat seine was set from the bigger boat (LOA = 13m) to cover an expanse of water at station D. The net was 200m in length and 5 metres in depth. The net was hauled with a pair of rope (100 metres in length).This was done for six times and the species compositions of the catch were examined.

3.3.5.3 Floating island fisheries (Artificial floating Island (AFI)

The Artificial floating Islands 'Iken' were investigated as fishing enhancement techniques. The floating island consisted of floating aquatic weeds like luxuriant water hyacinth, *Eichhornia crassipes, Pistia stratiotes, Vossia spp., Cyperus sp.* and other aquatic plants staked into stationary position and prevented from drifting with the water movement.

Comparative harvesting of the floating island and the open water was done with traps (size range 70 – 90 cm length overall) and gill net (50mm mesh size). The weight (kg) of fish caught by selected traps in both the floating island and the open water were also inspected. The fishermen were also interviewed orally concerning the materials used in the floating island construction details, longevity and causes of the losses.

3.3.5.4 Long line selectivity experiment

A 600 hook long line was constructed (75 cm gangions, attached directly to the main line and spaced 1.5m apart) with 200 hooks of each size (hook number). After consultation with local fishermen it was decided to fish within a restricted area and depth range since species composition changes with depth. Eleven fishing trips were conducted and the catches were estimated in the laboratory.

3.3.5.5 Gill net experiment

Gill net made of 0.20mm twine thickness, multifilament 210D/9 and 50mm, 54mm mesh sizes were designed and constructed with hanging ratio 0.51 or 51.28%. Mesh selectivity study was carried out with gill nets to observe relationship between fish size (total length), fish growth and stretched mesh size of net. The monofilament and the multifilament catch variation were observed. The effect of *Callinectes amnicola* on the gill net was also observed.

3.3.6 Fish Fauna Assessment in Relation to the Fishing gear Types

Fish species caught with various gear types through the assistance of the fishermen were sampled monthly. In the field fish samples were preserved in ice chest and transferred to deep freezer in the laboratory. The fish species were identified with the aid of available literatures (Tobor and Ajayi, 1979; Fischer *et al.*, 1981; Schneider, 1990; Holden and Reed, 1991; Leveque *et al*, 1990, 1992; Olaosebikan and Raji, 1998; Pauly *et al*, 2004). Numerical abundance of the fish species was observed and noted. In the market, the catch abundance was recorded using these keys: 1 (very abundant), 2 (abundant), 3 (few) and 4 (rare).

3.3.7 Financial Investment Analysis of the Fishing Operations

The current market prices of fishing inputs, the running costs of the operational methods and retail prices of the fish species was collated to facilitate analysis of the financial investment.

3.3.8 Fishing Effort, Catch per Unit Effort and Production estimates of the fishing operation.

Monthly fishing effort was estimated as: **Effort** $= AverE \times A$

where: ***AverE:*** is the average fishing effort in boat-days over the sample days.

A: is a raising factor expressing total number of days of fishing activities during the month, i.e. it is calculated each month.

Catch per Unit of Effort (CPUE) is expressed as the average catch per day of a gear of a certain boat/gear type. Total fish production was estimated according to Suwarso and Wasilum (1991) and Solarin (1998) with the formula: T = h x n x c.p.u.e

Where T = total fish production

h* = average number of fishing days per month

n = estimated number of active or functional canoe units

c. p. u. e. = catch per unit effort (kilogram per canoe per day per trip) h* was influenced by the weather condition, lunar cycle, season, time required to mend nets or repair canoe/engine and period of religious and traditional festival.

Return on investment (ROI) was calculated using the formula:

ROI = End of the year investment value – Beginning of the year investment value/

Beginning of the year investment value.

3.4 STATISTICAL ANALYSIS

All fishing gears, fishing crafts, physico – chemical parameters and fishes data obtained were subjected to geometric mean and standard deviation. Pearson product – moment correlation coefficient was used to determine correlation between the physico – chemical parameters. Regression and correlation coefficient was used to find the relationship between the mesh sizes and the species caught to identify the best mesh size for the fish species.

4.0 RESULTS

4.1 PHYSICO-CHEMICAL PARAMETERS OF LEKKI LAGOON

The result of air and surface water temperature, transparency, depth, total dissolved solid, conductivity, salinity, hydrogen-ion concentration (pH) and dissolved oxygen between March, 2006 and February, 2008 are enumerated below.

4.1.1 Air and Surface Water Temperatures

The air and surface water temperature measurements for March, 2006 to February 2008 are presented in Table 3. The mean air temperature ranged between 24.0 and 34.0^{0}C during the period of study. The lowest air temperature for 2006 and 2007 was 17.76±2.44^{0}C and the highest was 32.10±0.96^{0}C (Table 4 and Figure 3). The mean air temperature in 2006 and 2007 ranged between 26.80±0.56^{0}C and 32.32±1.13^{0}C.

The mean standard deviation and range of the physico-chemical parameters of the sampled station between March 2006 and February 2008 are shown Tables 4 to 5. The corresponding range, mean and standard deviation of the water temperature between March 2006 and February 2007 is shown in Table 4. Table 5 shows the corresponding values for March 2007 to February 2008. Generally, there was no regular pattern in the temperature changes between the air and the water temperature in the sampled areas (Stations A – E).The lower temperature can be attributed to the cloud cover during the rainy season which reduces the heating effect of the sun. Kusemiju (1981) recorded the same seasonal variation in air and water temperature during the dry and rainy seasons for the same lagoon.

Air temperature values throughout the period of study showed a positive relationship with water temperature, transparency, depth, total dissolved solids, conductivity, salinity and pH. A negative relationship between air temperature values and dissolved oxygen was recorded (Table 8).

Water temperature values throughout the period of study showed a positive relationship with air temperature, transparency, depth, total dissolved solids, conductivity, salinity and pH. A negative relationship between water temperature and dissolved oxygen was also recorded (Table 8).

4.1.2 Water Transparency

The Lekki lagoon water transparency was comparatively high in the dry season than in the rainy season. Water transparency between March, 2006 and February 2008 is shown in Table 3 and Figures 5. In March 2006 to February 2007, the water transparency ranged between 0.81±0.15m and 1.83±0.38m. In March, 2007 to February 2008, the water transparency ranged between 0.80±0.15m and 2.13±0.58m.

The range, mean and standard deviation of the water transparency in Station A-E between March 2006 and February 2008 are shown in Table 4. Transparency values throughout the study period showed a positive relationship with air and water temperatures, depth, total dissolved solids, conductivity, salinity and pH. A negative relationship between transparency and dissolved oxygen was recorded (Table 8).

4.1.3 Total Dissolved Solid (TDS) in Lekki Lagoon

The total dissolved solid between March, 2006 and February 2008 are presented in Table 3 and it ranged between 60.04mg/l and 7346.00mg/l. The mean, standard deviation and range of total dissolved solid of the sampled station for March 2006 to February 2007 is presented in Table 4 and Figure 4. The mean, standard deviation and range of dissolved solid sampled Station (A-E) between March 2007 and February 2008 was presented in Table 5 and Figure 4.

Total suspended solids values throughout the study period showed a positive relationship with air and water temperatures, transparency, depth, total dissolved solids, conductivity, salinity and dissolved oxygen. A negative relationship between total dissolved solids and pH was recorded (Table 9).

4.1.4 Conductivity (μScm^{-1})

The conductivity for the sampled Stations (A-E) between March 2006 and February 2008 is presented in Table 3 and it ranged between 77.36 and 4600.20mg/l. The mean, standard deviation and range of conductivity data of the Station (A-E) between March 2006 and February 2007 is shown in Table 4 and Figure 6. $^{-1}$ with a mean and standard deviation of 988.30±1403.17 μScm^{-1}. The mean, standard deviation and range of conductivity for the sampled Station (A-E) for March 2007 to February 2008 presented in Table 5 and Figure 5.

Conductivity values throughout the period of study showed a positive relationship with air and water temperatures, transparency, depth, total dissolved solids, salinity, pH and dissolved oxygen (Table 9).

4.1.5 Water Depth in Lekki Lagoon

Water depth for Station A-E between March 2006 and February 2008 is summarized to show the range, mean and standard deviation as presented in Table 3 and Figures 5. The water depth between March 2006 and February 2008 ranged between 1.37 and 12.25m. The range, mean and standard deviation of water depth between March 2007 and February 2008 are given in Table 5.

Depth values throughout the study period showed a positive relationship with air and water temperatures, transparency, total dissolved solids, conductivity, salinity, pH and dissolved oxygen (Table 8).

4.1.6 Hydrogen-ion Concentration (pH)

The monthly mean and standard deviation of pH between March 2006 and February 2008 ranged between 6.22±0.20 and 8.86±0.49 (Table 3, Figure 5). The mean, standard deviation and range of pH between March 2006 and February 2008 is shown in Table 4. Tables 5 and 7 show the range, mean and standard deviation of pH in Stations A-E between March 2007 and February 2008. pH values throughout the the period of study showed a positive relationship with air and water temperature, transparency, depth, total dissolved solids, conductivity and salinity. A negative relationship between pH and dissolved oxygen was recorded (Table 8).

4.1.7 Dissolved Oxygen (mg/l)

The mean monthly dissolved oxygen between March 2006 and February 2007 ranged between 4.22±0.23mg/l^{-1} and 8.08±0.53mg/l^{-1} is shown in Table 3 and Figure 5. Also between March 2007 and February 2008, dissolved oxygen ranged between 4.38±0.33 mg/l^{-1} and 5.50±0.43 mg/l^{-1}. The range, mean and standard deviation of dissolved oxygen in Station A-E between March 2006 and February 2008 are shown in Tables 4 & 5. Table 5 shows the range, mean and standard deviation of the dissolved oxygen in Station A-E between March 2007 and February 2008.

Dissolved oxygen values throughout the study period showed a positive relationship with depth, total dissolved solids, conductivity and salinity. A negative relationship between dissolved oxygen values and air temperature, water temperature, transparency and pH estimates was also recorded (Table 8).

4.1.8 Salinity (‰)

Salinity varied between 0.007‰ and 4.70 ‰. The salinity mean, standard deviation and range for Station A-E between March 2006 and February 2008 are shown in Table 4, 5 and Figure 5. The mean, standard deviation and range of salinity for Stations A-E between March 2007 and February 2008 are shown in Table 5. Monthly variation in salinity in Stations A-E between March 2006 and February 2008 are shown in Tables 6 and 7.

Table 3: Summary of Physico-Chemical Features in Lekki lagoon between March 2006 and February 2008

Month	Air Temp. (^0C)	Water Temp. (^0C)	Transparency (cm)	Depth (m)	TDS (mg/l)	Conductivity (µScm-1)	Salinity (‰)	pH	DO
Mar-06	31.00±1.22	31.68±0.90	1.42±0.13	3.91±3.99	316.60±389.19	675.90±832.05	0.38±0.43	8.04±0.11	4.72±0.53
Apr-06	32.10±0.96	31.70±0.84	1.83±0.38	3.89±3.71	278.22±92.44	502.00±121.98	0.61±0.59	8.06±0.09	4.56±0.27
May-06	31.90±1.56	30.90±0.82	1.80±1.12	4.46±2.72	4416.00±2827.74	3777.80±3160.63	2.66±1.30	8.08±0.53	4.56±0.11
Jun-06	29.80±0.84	30.20±2.08	0.97±0.12	3.86±3.72	4132.00±766.11	1915.00±392.17	2.19±0.56	7.12±0.08	5.04±0.40
Jul-06	28.40±1.07	28.42±0.43	0.96±0.19	3.32±2.41	165.80±60.55	77.36±28.53	0.29±0.44	6.22±0.20	4.96±0.09
Aug-06	31.70±1.44	30.90±0.42	1.06±0.17	3.07±1.80	177.02±26.94	81.88±10.89	0.10±0.05	6.63±0.08	4.54±0.17
Sep-06	26.40±0.55	28.40±0.55	0.85±0.24	2.41±1.45	98.94±58.85	208.72±120.29	0.10±0.09	6.54±0.23	4.58±0.15
Oct-06	27.70±2.44	27.50±1.00	0.81±0.15	3.93±2.85	61.30±27.68	131.12±58.52	0.06±0.04	8.04±0.67	4.94±0.13
Nov-06	29.20±1.40	30.60±0.42	1.13±0.30	3.51±2.99	62.20±20.58	130.98±41.79	0.06±0.04	7.12±0.08	5.20±0.32
Dec-06	28.60±2.01	29.30±0.27	1.09±0.29	4.11±4.42	81.18±28.22	174.80±53.22	0.08±0.03	7.26±0.09	4.30±0.42
Jan-07	28.80±1.35	30.10±1.39	1.20±0.90	4.00±4.62	123.52±71.14	257.80±144.05	0.15±0.08	7.50±0.40	4.22±0.23
Feb-07	29.00±1.32	30.30±1.25	1.22±0.10	4.14±4.96	124.12±71.92	259.80±143.55	0.56±0.98	7.58±0.45	4.26±0.34
Mar-07	30.90±1.08	31.22±0.44	1.40±0.15	3.70±3.64	136.40±43.14	676.80±832.73	0.38±0.43	8.86±0.49	4.38±0.33
Apr-07	32.32±1.13	31.50±0.71	1.83±0.39	3.44±3.14	279.60±92.99	1201.40±1275.65	0.61±0.60	8.12±0.08	4.64±0.17
May-07	32.00±1.66	30.90±0.42	2.13±0.58	3.07±1.82	1033.40±697.50	2159.60±1426.08	2.70±1.38	8.36±0.58	4.54±0.36
Jun-07	29.80±0.84	30.32±2.13	0.91±0.17	4.04±4.02	7346.00±7489.27	4192.00±787.32	2.21±0.55	7.10±0.12	4.86±0.05
Jul-07	30.20±0.84	30.22±2.04	0.90±0.35	4.26±4.34	78.50±28.76	166.38±59.92	0.28±0.43	6.39±0.13	5.50±0.43
Aug-07	28.50±1.22	28.50±0.35	0.81±0.44	3.16±1.93	60.04±25.98	130.72±52.97	0.09±0.05	6.66±0.06	4.68±0.26
Sep-07	26.80±0.84	28.80±0.45	0.89±0.19	2.85±2.34	126.68±48.85	254.20±107.08	0.13±0.11	6.44±0.23	4.52±0.23
Oct-07	27.62±2.33	27.58±1.16	0.80±0.15	4.10±3.27	63.26±27.92	134.80±61.10	0.06±0.04	7.88±0.70	4.64±0.23
Nov-07	29.20±1.40	31.10±0.65	1.13±0.29	3.48±2.93	5642.00±1584.89	4600.20±4240.30	0.06±0.03	7.12±0.13	4.78±0.16
Dec-07	28.70±1.92	30.02±0.61	1.24±0.18	4.24±4.63	104.02±32.68	541.02±765.77	0.15±0.06	7.22±0.13	4.96±0.11
Jan-08	29.60±1.34	30.80±0.76	1.22±0.87	3.90±4.25	1661.60±2691.41	996.60±469.73	0.64±0.33	7.39±0.19	4.98±0.19
Feb-08	29.20±0.97	30.90±0.55	1.01±0.51	3.92±4.24	477.20±280.67	1020.40±458.51	0.67±0.31	7.78±0.11	4.92±0.13

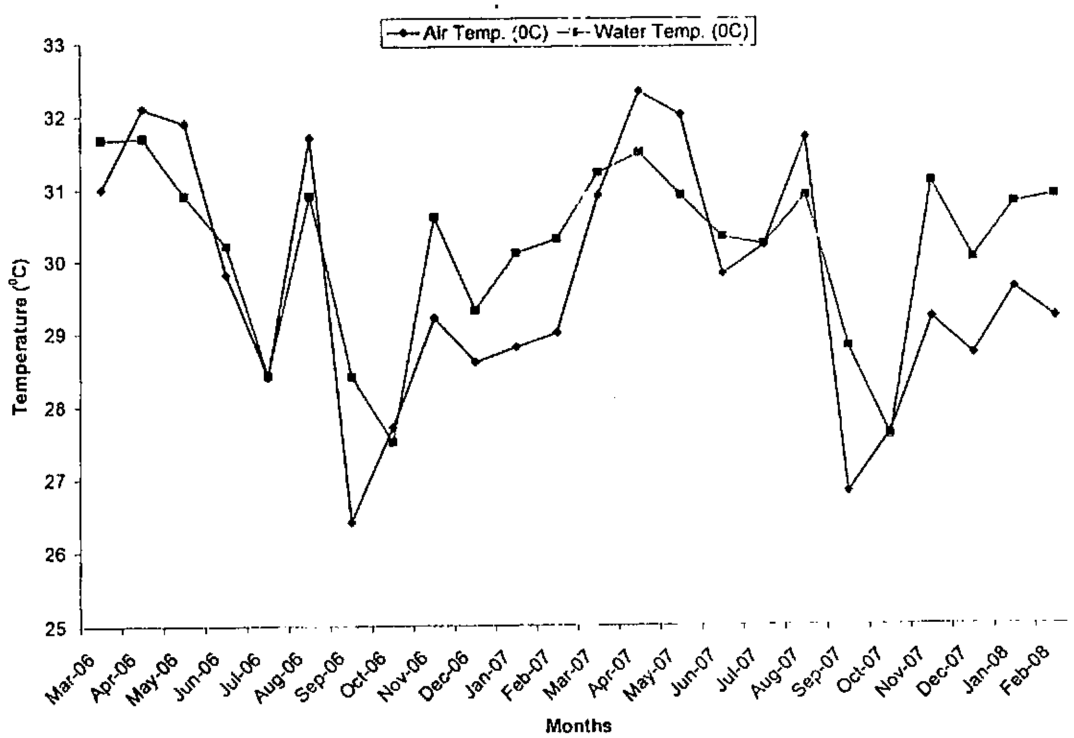


Fig. 3: Air and water temperatures in Lekki lagoon between March 2006 and February 2008

Table 4: Mean, Standard Deviation and range of physico-chemical parameters between March, 2006 and February, 2007

Sample Station	Air Temp. (^0C)	Water Temp. (^0C)	Transp. (m)	Depth (m)	TDS (mg/l)	Cond. (μScm^{-1})	Salinity (‰)	pH	DO Mg/l
A. EMINA	28.00±2.12 (24.0-31.0)	29.34±1.33 (26.5-30.5)	1.35±0.52 (1.00-2.80)	9.34±2.62 (4.88-12.25)	997.23±2175.71 (56.9-7070)	430.40±562.2 (78.2-1650.0)	0.46±0.65 (0.007-1.75)	7.53±0.75 (6.52-8.90)	4.68±0.42 (4.0-5.5)
B. IKERAN OLATUNJI	29.47±2.40 (26.0-34.0)	29.54±1.62 (26.5-32.5)	1.25±0.38 (0.61-1.78)	2.12±0.31 (1.37-2.50)	1020.47±2270.47 (34.4-7380.0)	417.47±604.30 (74.0-1770.0)	0.42±0.79 (0.02-2.10)	7.19±0.67 (6.00-3.00)	4.67±0.38 (4.0-5.4)
C. LUBOYE	29.46±2.35 (26.0-34.0)	29.38±1.54 (26.5-32.5)	1.23±0.40 (0.78-1.68)	2.18±0.26 (1.41-2.12)	1163.88±2568.52 (41.2-4360.0)	1082.54±1812.17 (33.2-8980.0)	0.49±0.77 (0.02-2.11)	7.50±0.98 (6.10-8.10)	4.69±0.39 (4.0-5.5)
D. AGAN CENTRE	29.78±1.67 (27.0-33.0)	30.33±1.50 (28.0-32.5)	1.24±0.65 (0.78-1.24)	2.73±0.81 (1.42-4.31)	543.74±1072.46 (82.0-3840.0)	522.35±690.85 (100.0-1785.0)	0.59±1.05 (0.095-3.52)	7.43±0.73 (6.21-8.40)	4.69±0.44 (4.0-5.6)
E. EBUTTE LEKKI	30.76±1.39 (27.0-32.5)	30.87±1.49 (28.5-32.5)	0.92±0.40 (0.61-1.48)	2.61±1.65 (1.87-7.80)	851.11±1589.36 (70.50-2610.0)	988.30±1403.17 (70.6-4580.0)	1.16±1.47 (0.084-4.49)	7.30±0.69 (6.25-8.30)	4.62±0.35 (4.0-5.0)

Table 5: Mean Standard Deviation of physico-chemical parameters between March, 2007 and February, 2008

Sample Station	Air Temp. (°C)	Water Temp. (°C)	Transparency (m)	Depth (m)	TDS (mg/l)	Conductivity (µScm⁻¹)	Salinity (‰)	pH	DO Mg/l
A. EMINA	28.04±1.96 (24.0-31.0)	29.37±1.40 (26.4-31.0)	1.34±0.52 (1.00-2.79)	9.65±2.23 (6.00-12.50)	1546.39±3570.88 (47.5-5680.0)	1064.87±1814.10 (102.0-3820.0)	0.54±0.64 (0.046-1.76)	7.53±0.91 (6.53-9.20)	4.86±0.29 (4.6-5.6)
B. IKERAN OLATUNJI	29.75±2.39 (26.0-34.0)	29.92±1.66 (26.5-31.5)	1.23±0.28 (0.61-1.87)	1.79±0.19 (1.69-2.68)	769.50±1548.90 (42.2-5690.0)	1055.30±2542.39 (74.0-9160.0)	0.38±0.67 (0.027-2.11)	7.29±0.67 (6.21-9.10)	4.63±0.51 (4.0-5.4)
C. LUBOYE	29.79±2.16 (27.0-33.5)	30.46±1.53 (27.5-31.5)	1.13±0.42 (0.71-1.61)	1.81±0.21 (1.31-2.12)	2515.84±5486.23 (33.0-4270.0)	940.05±1488.11 (72.9-9320.0)	0.44±0.65 (0.028-2.11)	7.44±0.80 (6.31-9.0)	4.85±0.46 (4.1-6.1)
D. AGAN CENTRE	29.76±1.45 (27.0-31.6)	30.68±1.33 (27.0-32.0)	1.29±0.65 (0.78-2.73)	2.70±0.75 (1.42-4.30)	721.56±654.00 (91.7-6460.0)	1620.34±2134.87 (196.0-3840.0)	0.68±1.03 (0.076-3.52)	7.47±0.77 (6.42-9.0)	4.76±0.34 (4.0-5.0)
E. EBUTE LEKKI	30.80±1.07 (28.0-32.0)	30.90±1.21 (29.0-32.1)	0.96±0.46 (0.30-1.55)	2.06±0.20 (1.65-2.30)	919.48±954.87 (84.1-8200)	2209.56±2684.40 (150.6-5600.0)	1.18±1.44 (0.105-4.70)	7.28±0.63 (6.49-8.30)	4.81±0.28 (4.6-5.5)

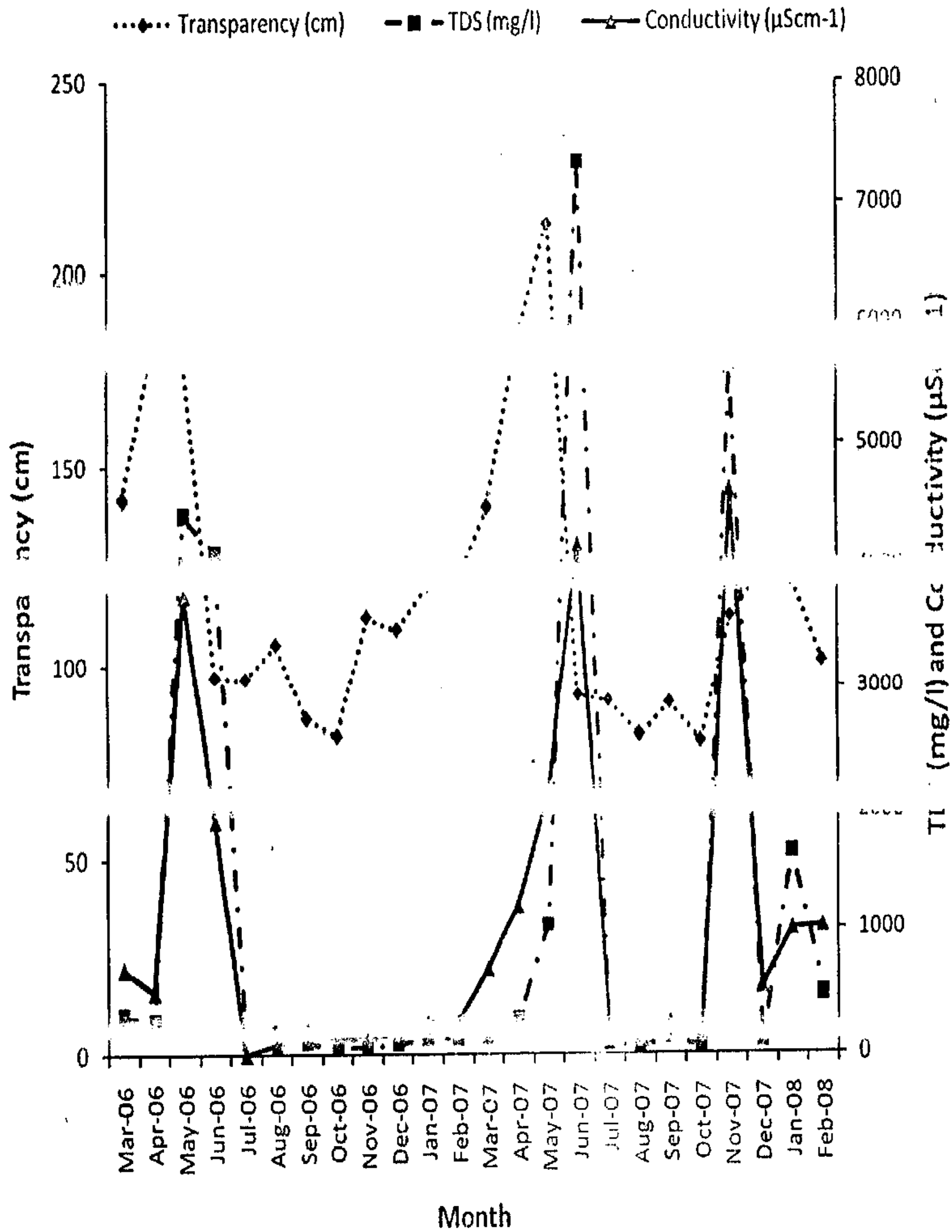


Fig. 4: Physico – chemical characteristics (Transparency, TDS and Conductivity) in Lekki lagoon between March 2006 and February 2008

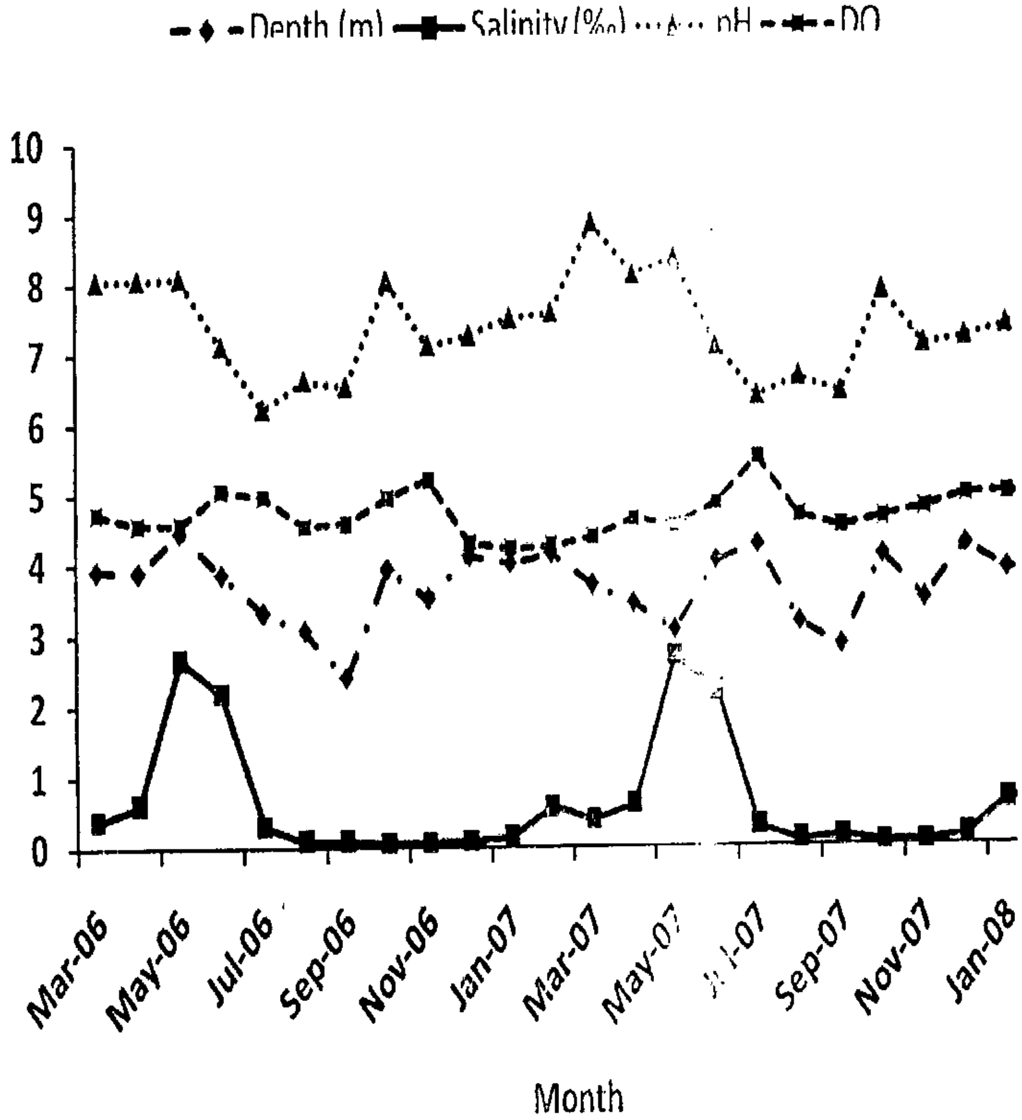


Fig. 5: Physico – chemical characteristics (depth, salinity, pH and DO) in Lekki lagoon between March 2006 and February 2008

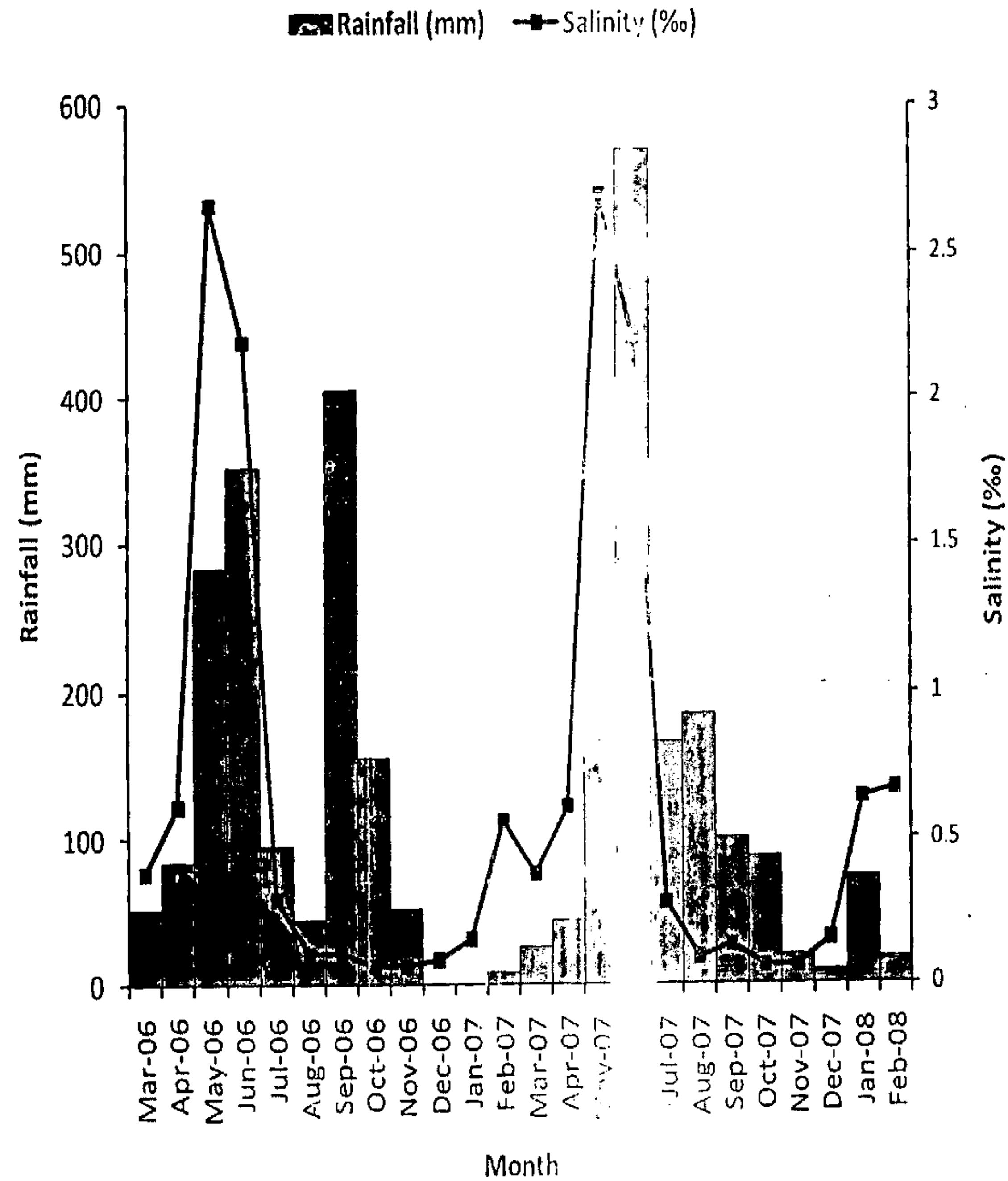


Fig. 6: Variation in salinity and rainfall in Lekki la; ı between March 2006 and February 2008

Table 6: Monthly salinity (%o) variation in Lekki lagoon between March 2006 and February, 2007

Station	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
A. Emina	0.212	0.30	1.75	1.67	1.07	0.06	0.0074	0.067	0.056	0.088	0.12	0.13
B. Ikeran Olatunji	0.132	0.26	2.10	2.10	0.04	0.07	0.063	0.021	0.028	0.056	0.10	0.11
C. Luboye	0.23	0.35	1.42	2.11	0.04	0.05	0.039	0.025	0.028	0.032	0.11	0.11
D. Agan centre	0.18	0.46	3.52	1.92	0.15	0.16	0.165	0.102	0.095	0.098	0.13	0.14
E. Ebute Lekki	1.14	1.66	4.49	3.14	0.16	0.15	0.207	0.084	0.105	0.116	0.30	2.31

Table 7: Monthly salinity (%o) variation in Lekki lagoon between March 2007 and February 2008

Station	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
A. Emina	0.21	0.31	1.76	1.76	1.05	0.06	0.072	0.061	0.046	0.12	0.50	0.50
B. Ikeran Olatunji	0.13	0.25	2.11	2.11	0.04	0.05	0.062	0.022	0.027	0.11	0.50	0.51
C. Luboye	0.23	0.36	1.41	2.11	0.03	0.05	0.049	0.025	0.028	0.10	0.40	0.52
D. Agan centre	0.19	0.46	3.52	1.93	0.15	0.14	0.164	0.103	0.076	0.21	0.61	0.62
E. Ebute Lekki	1.14	1.68	4.7	3.16	0.15	0.15	0.307	0.082	0.105	0.22	1.21	1.22

Table 8: Pearson correlation co-efficient matrix of physico - chemical characteristics in Lekki lagoon (March, 2006 – February, 2008)

	Air Temp. (°C)	Water Temp. (°C)	Transparency (cm)	Depth (m)	TDS (mg/l)	Conductivity (µScm^{-1})	Salinity (‰)	pH	DO
Air temp. (°C)	1.00								
Water temp. (°C)	0.82	1.00							
Transparency (cm)	0.79	0.68	1.00						
Depth (m)	0.23	0.20	0.09	1.00					
TDS (mg/l)	0.13	0.25	0.03	0.20	1.00				
Conductivity (µScm^{-1})	0.33	0.39	0.28	0.17	0.93	1.00			
Salinity (‰)	0.49	0.33	0.49	0.18	0.62	0.66	1.00		
pH	0.50	0.41	0.65	0.37	-0.02	0.18	0.30	1.00	
DO (mg/l)	-0.05	-0.04	-0.31	0.15	0.15	0.05	0.01	-0.35	1.00

Salinity gradient increase from Station A to E as the station E recorded the highest salinity overall.Figure 6 shows rainfall and salinity variations in the Lekki lagoon. Moore (1961) cited by kusemiju (1973) broadly classified water with salinity of 0.5 %o or less as fresh, between 0.5%o and 29.9%o as brackish and between 30%o and 35%o as marine.

Salinity values throughout the period of study showed a positive relationship with air and water temperatures, transparency, depth, total dissolved solids, conductivity, pH and dissolved oxygen was recorded (Table 8).

Salt water incursion into Lekki lagoon

The Physico – chemical characteristics in the lagoons of the South – western Nigeria between Ebute metta – Lagos state and Ori – oke Iwamimo – Ondo state is shown in Appendix I.

The Conductivity data for wet season ranged between 3025 (Station N) and 27500μScm^{-1} (Station A), while the dry season conductivity ranged between 466.0 (Station G) and 51400μScm^{-1} (Station B) (Figure 7). Conductivity values were distinctly higher at stations in the Lagos lagoon (A, B, C) and Mahin lagoon (R, Q, P) with proximity to the sea in the dry season but lower at stations P, Q, R (Mahin lagoon) during the wet season. Values for conductivity were higher in the dry season than wet season.

The total dissolved solids for wet season ranged between 905.0mg/L (Station T) and 12800.0mg/L in Station B while the dry season total dissolved solids ranged between

234.0mg/L (Station G) and 25800.0mg/L (Station B) (Figure 8). Total dissolved solid values were distinctly higher at stations in the Lagos lagoon (Stations A, B, C, D) and Mahin lagoon (R, Q, P) with proximity to the sea in the dry season but lower at statios P, Q, R (Mahin lagoon) with proximity to the atlantic ocean in wet season. Total dissolved solid values were higher in the dry season than wet season.

The pH data for wet season ranged between 6.60 (Station G) and 7.9 (Stations E and T) while the dry season pH ranged between 6.83 (Station R) and 9.33 (Station L) (Figure 9). There were no significant differences in pH values across the lagoons for both dry and wet season except in station L (Lekki lagoon) where a higher pH value (9.33) was recorded in the dry season.

The total suspended solids for wet season ranged between 1.0mg/L (Stations G, H and M) and 36.0 mg/L in (Station R) while the TSS for dry season ranged between 1.0mg/L in Station N and 28.0mg/L (Station A) (Figure 10). Total suspended solids values were distinctly higher at stations in the Lagos lagoon (A, B) for dry and Mahin lagoon (R, Q, P) for both dry and wet seasons with proximity to the atlantic ocean.

The salinity data for wet season ranged between 1.05‰ (Station Q) and 15.59‰ (Station S) while the dry season salinity ranged between 0.40‰ (Station F & J) and 35.6‰ (Station A and B). The characteristic feature of the lagoon is its high bioactivity and a distinctive regime of saline water mixing with fresh rivers water. The data showed that in general, the salinity decreased with the increase of the distance from Lagos lagoon (Station A) and Mahin lagoon (station R). This fact shows that during saline water intrusion from two main adjacent lagoons (Lagos via

Epe and Mahin Lagoon) might cause a substantial increase in water salinity of the Lekki lagoon. The salinity at extreme end station L (3.16‰) during the wet season was the highest in the lagoon followed by stations I and J (2.11‰) and the least was recorded in Station H (1.76‰) which is the extreme end of the lagoon towards Lagos lagoon. During the dry season the highest salinity 3.0‰ in Station L which is the extreme end of the lagoon to the Mahin lagoon side while the least salinity of 0.4 was noted in station J which is the centre of the lagoon skewed towards the Lagos lagoon end (Figures 11). Also seasonal salinity variations were noticed in the analysed area of the Lekki lagoon.

The dissolved oxygen for wet season ranged between 4.6mg/L (Stations F, Q, R and T) and 4.9mg/L (Stations A, I and L), the dry season DO ranged between 4.7mg/L (Stations A) and 5.6mg/L (Station E) (Figure 12). The dissolved oxygen level is good for better growth condition of aquatic organisms. There was no distinction in the dissolved oxygen values across the lagoon but the higher dissolved oxygen values were recorded in the dry season.

The sulphate content of the study area ranged between 13mg/L (Station G) and 51mg/L (Station A) for wet season and the dry season sulphate ranged between 3.0mg/L (Station L) and 19.0mg/L (Station B)(Figure 13). There was no distinction in the sulphate values across the lagoon but sulphate was higher in the dry than wet season.

The nitrate composition for wet season ranged between 4.9mg/L (Station P) and 80.4mg/L (Station B), dry season nitrate concentration ranged between 2.72mg/L (Station J) and 82.05mg/L (Station B) (Figure 14).Nitrate values were distinctly higher at stations in the Lagos lagoon (A, B) for both dry and wet seasons and Mahin lagoon (R, Q, P) for dry season with proximity to the sea in the dry season.

High salinity gradients were observed from the two ends of the lagoon. The salinity at the Lagos end tends to decrease toward Lekki lagoon and the same from Orioke Iwamimo end. In this study, two major sources of saline water incursion were identified which were Lagos lagoon and Mahin creek. The third source was, salt water intrusion by subsurface flow through the barrier beach from the ocean and leaching of ions through lagoon bottom sediments as reported by Waljeski and Williams (2004).

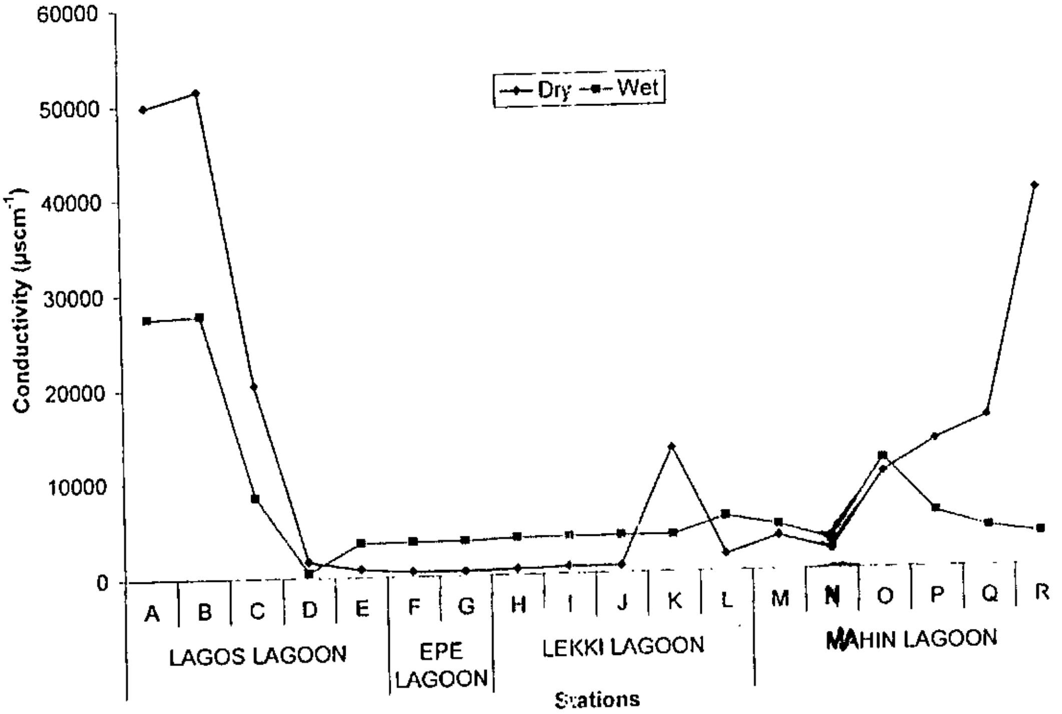


Fig. 7: Dry and wet season conductivity variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

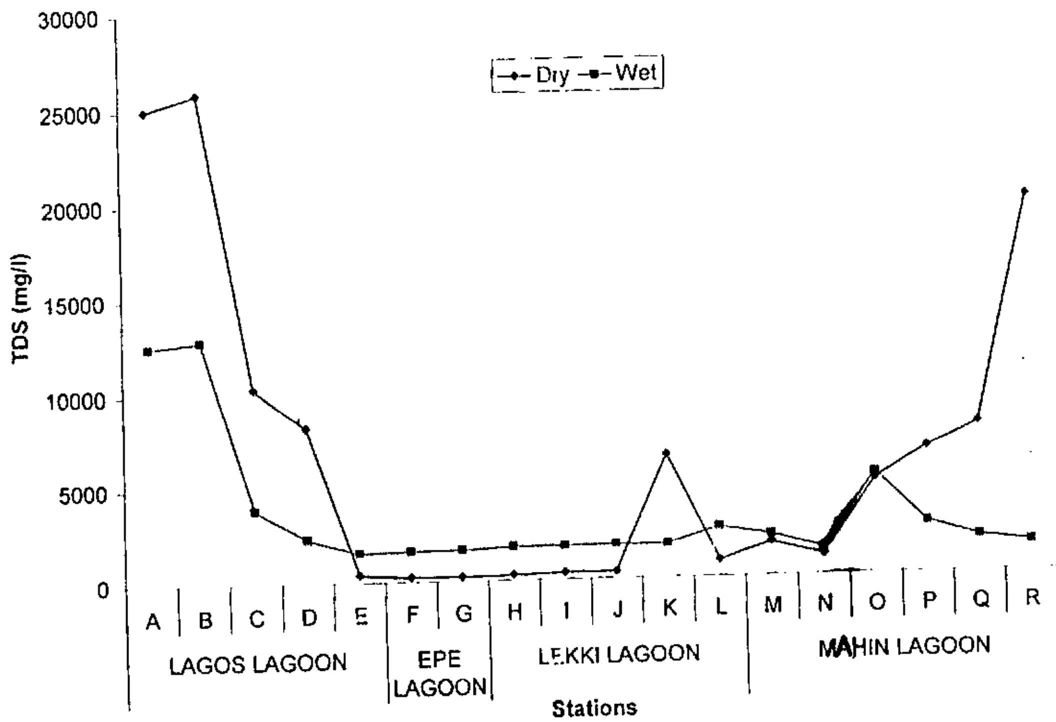


Fig. 8: Dry and wet season total dissolved solids variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

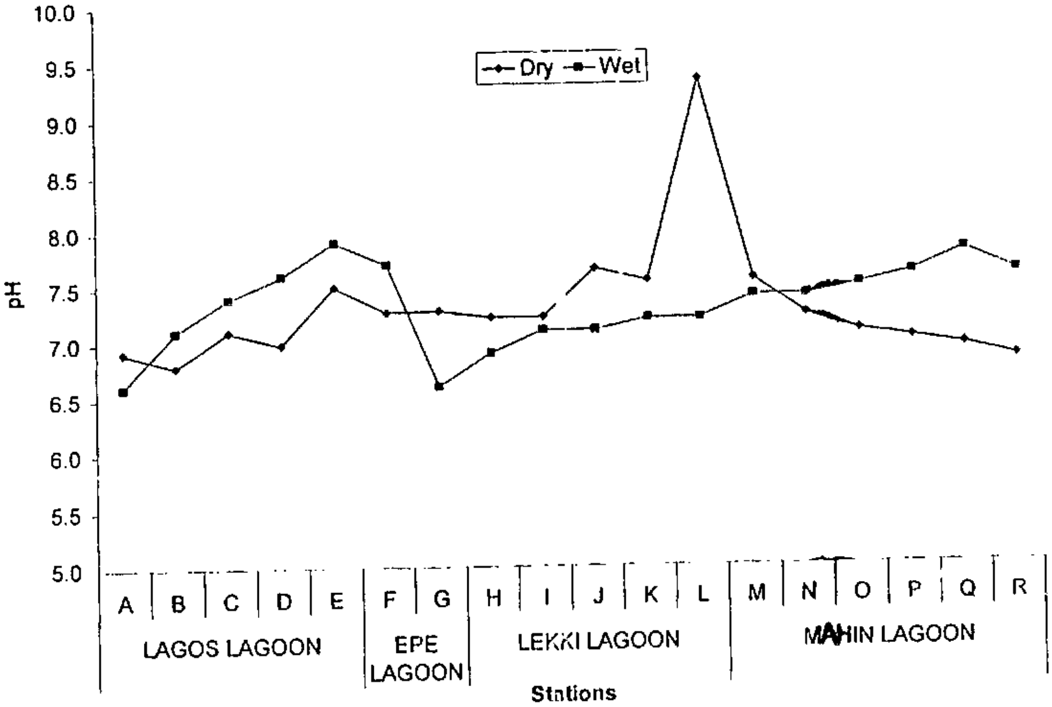


Fig. 9: Dry and wet season pH variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state.

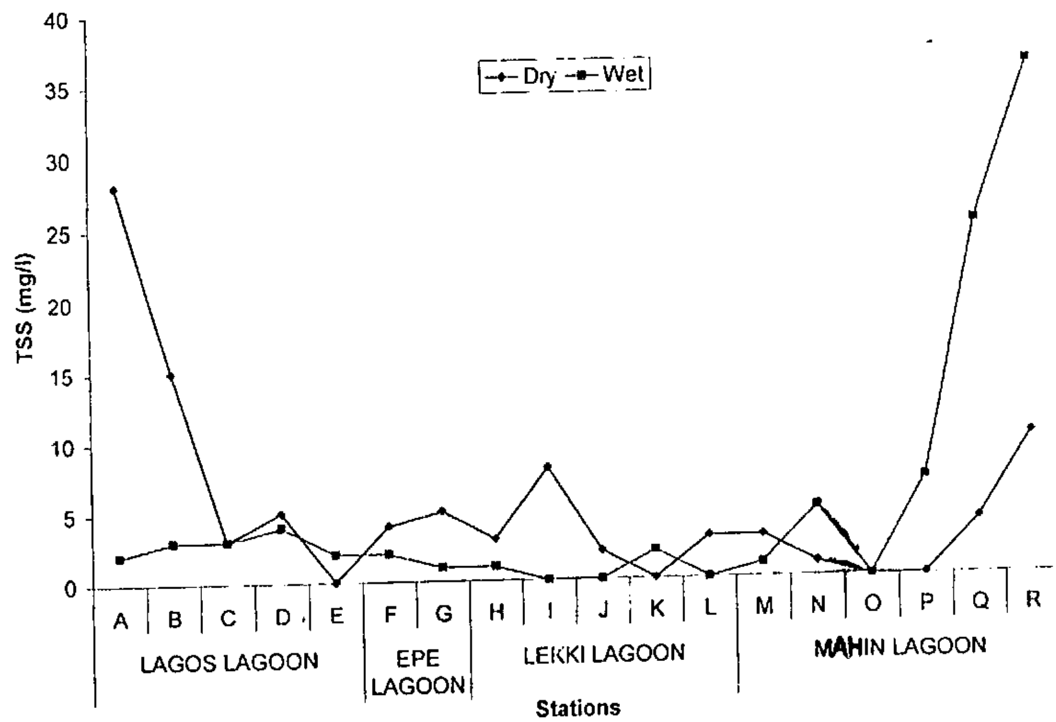


Fig. 10: Dry and wet season total suspended solids variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

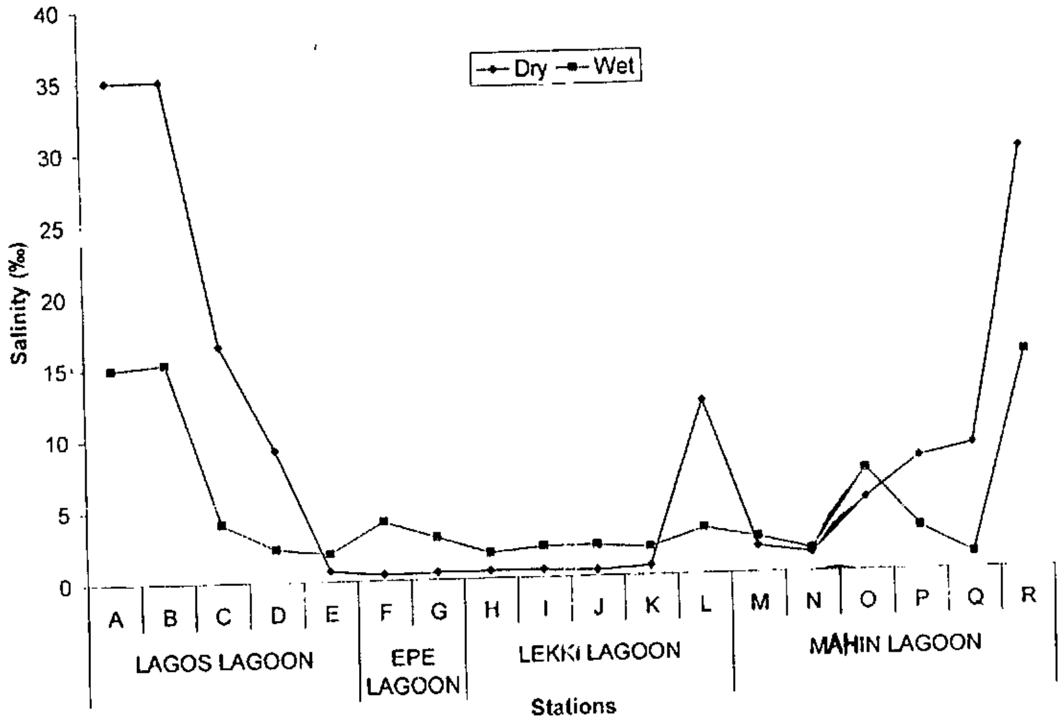


Fig. 11: Dry and wet season salinity variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

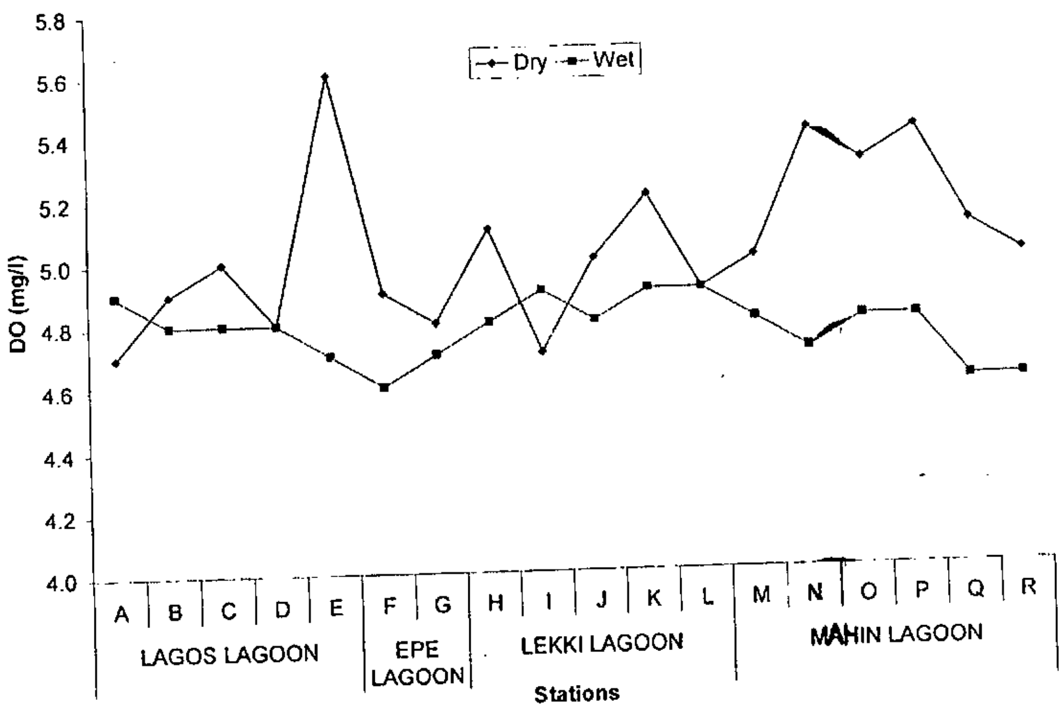


Fig. 12: Dry and wet season dissolved oxygen variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

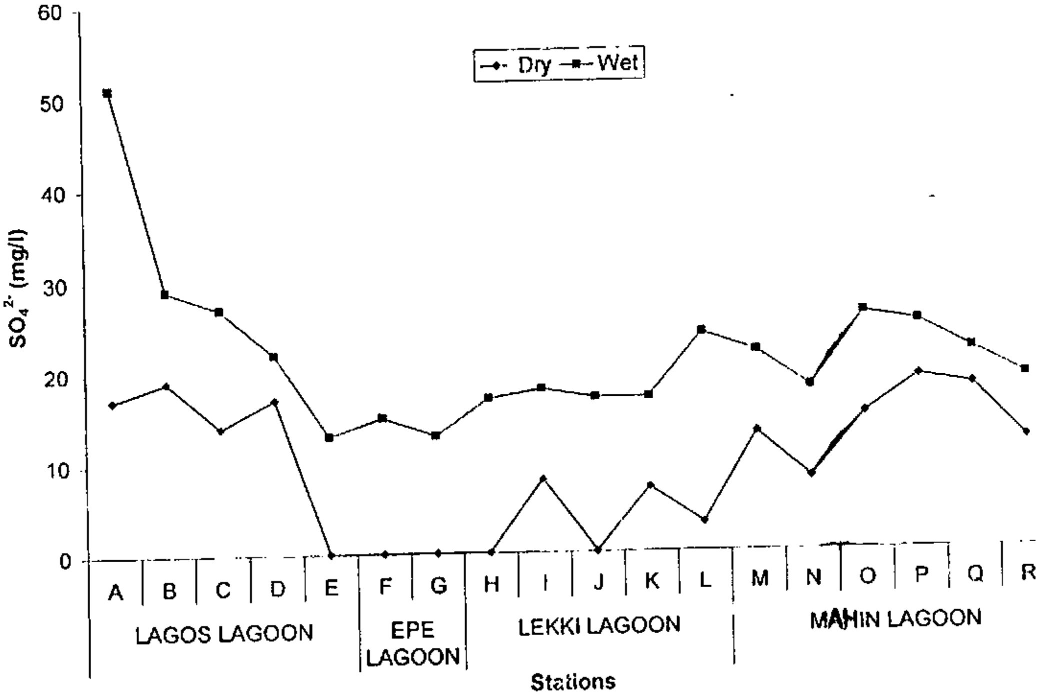


Fig. 13: Dry and wet season sulphate variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

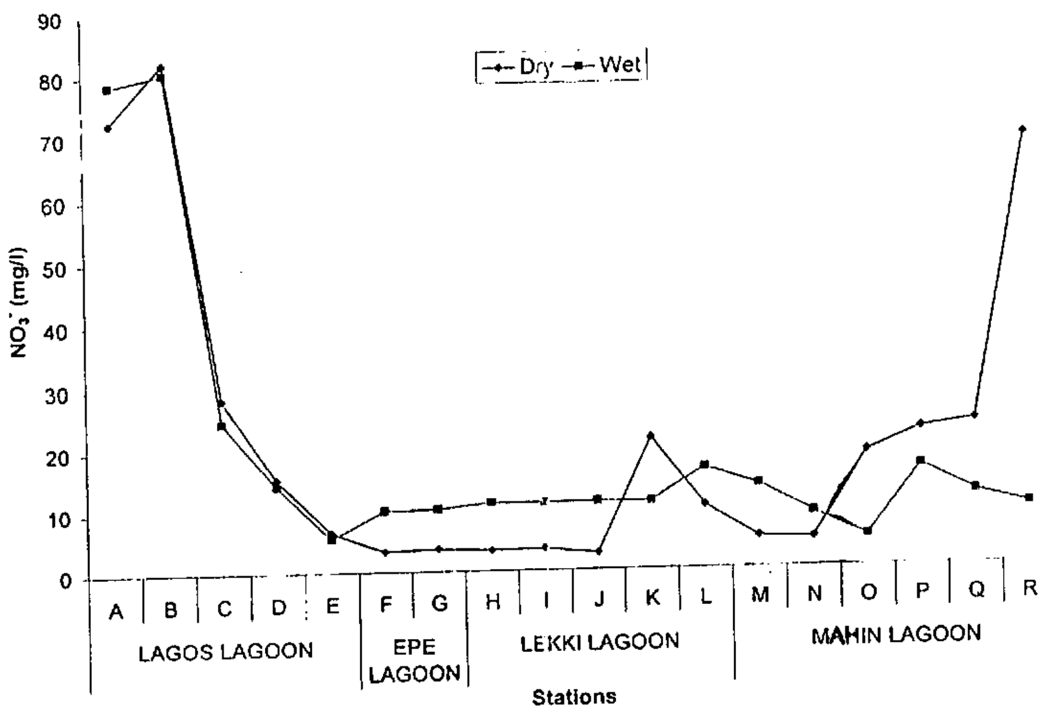


Fig. 14: Dry and wet season nitrate variation from Lagos lagoon via Epe and Lekki lagoons to Mahin lagoon in Ondo state

4.2 FISHING SETTLEMENTS IN LEKKI LAGOON

The fishing settlements in lekki lagoon were distinctively distributed with concentration of specific fishing gears in each area. The geographical locations of the fishing villages in Lekki lagoon is presented in Table 9.

Table 9: Geographical locations of each of the Fishing Villages in Lekki lagoon

Village	Coordinates	Population	Fishing gears	Number of Boats
Ebute Lekki	06° 28.94N 004° 09.166E	520	Gillnet, castnet, basket & bamboo trap	51
Arala	06° 27.296N 004 04.912E	100	Gillnet, castnet, basket & bamboo trap	22
Aba oyinbo	06° 30.547N 004 05.705E	100	Gillnet, castnet, basket & bamboo trap	24
Igbodola	06° 25.569N 004 06.046E	100	Gillnet, castnet, boat seine, basket & bamboo trap	25
Iwopin	06° 35.277N 004° 09.445E	2000	Gillnet, castnet, liftnet, boat seine, longline, basket & bamboo trap	123
Imeki	06° 29.075N 004° 09.527E	530	Gillnet, castnet, liftnet, boat seine, longline, basket & bamboo trap	45
Dopanu	06° 34.978N 004° 09.062E	360	Gillnet, castnet, longline, basket trap	32
Dopanu ajegunle	06° 34.594N 004° 08.552E	700	Gillnet, castnet, longline, basket trap	73
Abatitun	06° 34.637N 004° 08.532E	100	Gillnet, castnet, longline, basket trap	29
Luboye	06° 32.834N 004° 06.268E	100	Gillnet, castnet, longine, basket trap	19
Ikeran Olatunji	06° 32. 832N 004° 06. 269E	100	Gillnet, castnet, longline, basket trap	46
Ikeran Aba Ilaje	06° 32. 779N 004° 05. 839E	500	Gillnet, castnet, longline, basket trap	52
Emina	06° 25. 566N 004° 06.043E	200	Gillnet, castnet, longline, basket trap	43
Take	06° 32. 287N 004° 05.280 E	98	Gillnet, castnet, longline, basket trap	19
Abomiti Sokoto	06° 30. 546N 004 05.703 E	100	Gillnet, castnet, longline, basket trap	20
Abomiti Nla	06 31. 164 N 004 05. 725E	680	Gillnet, castnet, longline, basket trap	34
Ajegunle	06 31. 170 N 004 05. 720 E	270	Gillnet, castnet, longline, basket trap	17
Total		**6558**		**1027**

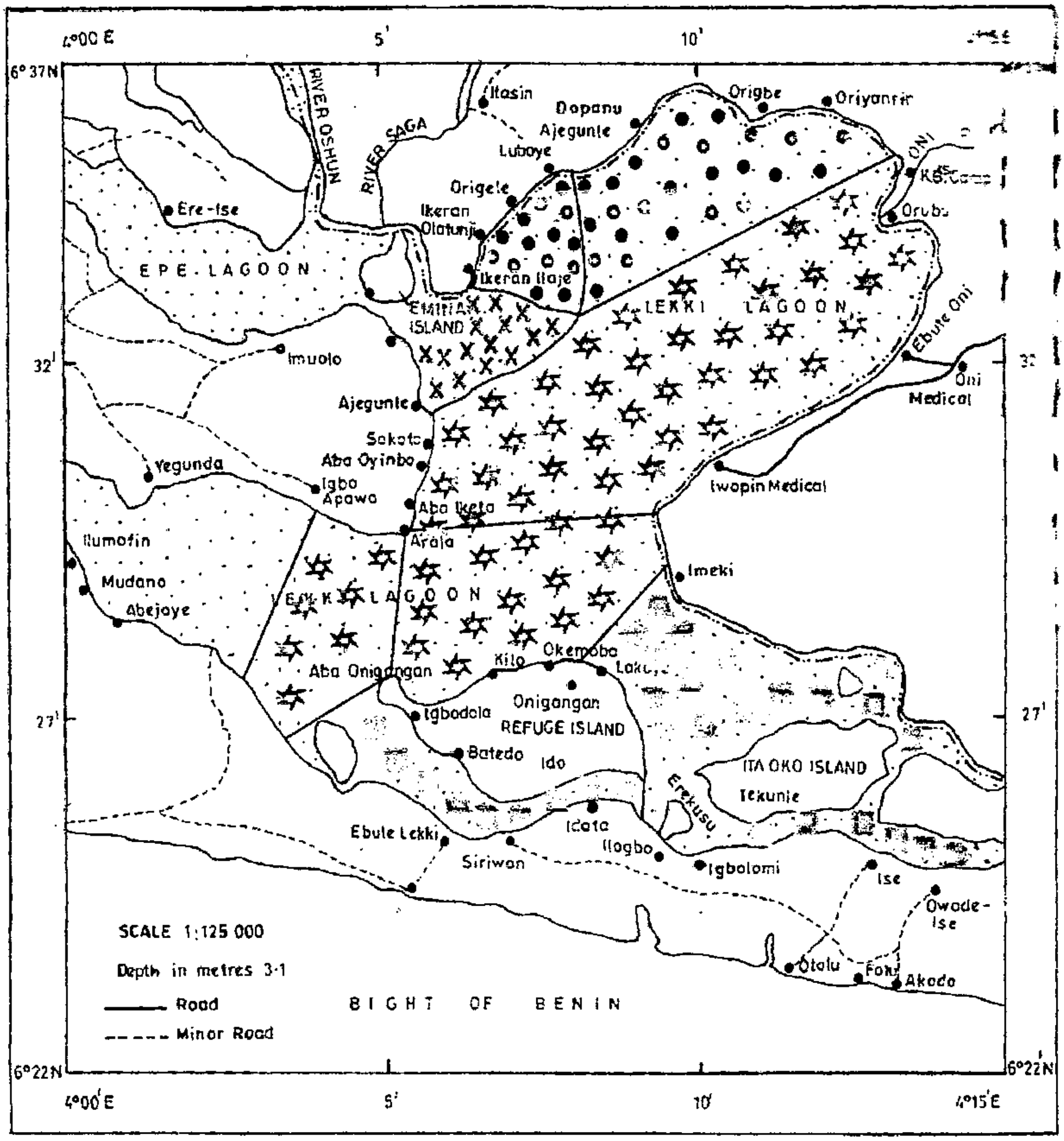
4.3 FISHING GEARS AND THEIR DESIGN DETAILS IN LEKKI LAGOON

4.3.1 Fishing Gear Distribution in Lekki lagoon

The fishing gear distribution mapping in Lekki Lagoon is presented in Fig 15. The use of basket traps gillnets and long line is common in the Emina axis of the lagoon. Ikeran Olatunji – oriyanrin axis had high concentration of floating island fishery, gill net and cast net operating in the area. The centre of the lagoon (Agan centre) was shallow and allowed the use of boat seine, cast net and floating island and covered about 50% of the entire lagoon. Ebute – Lekki – Ise axis comprised mainly the use of gillnet, liftnet, bamboo trap and cast net and this area covered about 20% of the lagoon.

4.3.2 Cast Net Design Detail in Lekki lagoon

The design details of small and big cast net used in Lekki lagoon are presented in Tables 10 and 11. The cast nets are conical in shape and panels varied from 3 to 4 panels. The sinkers are lead with weight ranging from 46.00 – 86.00g and are attached to the footropes at almost regular intervals. The numbers of the sinkers range between 71 and 100 depend on the net size. The net materials are multifilament polyamide (PA); all were white in colour when new but after use for some times it change colour to brown. The stapling distances ranged from 130mm – 250mm and the number of meshes in stapling length of footropes ranged between 10 and 12. The circumferences of the net mouths ranged between 7.92m and 55.53m. The lengths of the nets ranged between 5.86 and 9.35m. The areas of the net mouth ranged 12.99m^2 and 13.90m^2 the retrieving ropes ranged between 3.81m and 6.00m. The retrieving ropes were kuralon and polyethylene with diameter ranging from 2 – 3.5mm. The castnets mesh sizes ranged between 32 and 50mm. The mesh opening ranged between 31 and 4.9mm and the mesh circumferences ranged between 62m and 98mm.



KEY

- = Gillnet, liftnet, bamboo trap, cast net
- X = Basket trap, gillnet, longline
- O = Floating Island, gillnet, cast net
- ✡ = Boat Seine, cast net, floating island

Fig. 15: Fishing gear distribution mapping in Lekki Lagoon

Table 10: A Cast net (small) Design Detail

Panel	No. of Meshes		Mesh Size (mm)	Mesh Opening (mm)	Mesh Circumference (mm)	Material
	In Length	In Depth				
1	60	6	32	31	62	Polyamide
2	120	16	32	31	62	Polyamide
3	140	12	32	31	62	Polyamide
4	140	50	32	31	62	Polyamide

Other Design Characteristics	Measurements and Description
Gear colour	White (New); Brown (used)
Type of Mesh net	Knotted
Rope length; Material and diameter	3.81m; Polyethylene; 2mm
Footrope length; Material and Diameter	7.92m; Kuralon, 3mm
Number of Sinkers and distance between them	71; 130mm
Material of sinkers	Lead (Pb)
Weight of sinkers	46g
Stapling distances	130mm
Number of Meshes in the Stapling length of footrope	10
Circumference of Net mouth	7.92m
Area of Net mouth	2.99m^2
Length of Net	5.86m^2
Number of Pocket	71
Depth of the pocket	15cm (150mm)

Table 11: A Cast net (big) Design Detail

Panel	No. of Meshes		Mesh Size (mm)	Mesh Opening (mm)	Mesh Circumference (mm)	Materials
	In Length	In Depth				
1	80	14	50	49	98	Polyamide
2	160	11	50	49	98	Polyamide
3	320	90	50	49	98	Polyamide

Other Design Characteristics	**Measurements and Description**
Gear colour	White (New); Brown (used)
Type of Mesh net	Knotted
Rope length; Material and diameter	6.00m; Kuralon; 3.5mm
Footrope length; Material	55.3m; Kuralon; 3.5mm
Number of Sinkers and distance between them	100; 250mm
Material of sinkers	Lead (Pb)
Weight of sinkers	86g
Stapling distances	250mm
Number of Meshes in the Stapling length of footrope	12
Circumference of Net mouth	55.53m
Area of Net mouth	13.90m^2
Length of Net	9.35m^2
Number of Pocket	100
Depth of the pocket	19cm (190mm)

4.3.3 Gillnet Design Details

The two types of gillnets used in Lekki Lagoon surface drift and the anchored bottom gillnets. Both of them are walls of netting hanging vertically in water by the combined actions of the floats (Slipper, Raphia) attached to the headlines and the lead/stone sinkers were attached at intervals of (1.35 – 2.00) metre to the foot ropes to sink the nets to the lagoon bed while the floats were attached at intervals of (1.1 – 1.95) metres to the headlines which allow the heads of the nets to float thereby maintaining the vertical opening of the gillnets. The differences in the designs of a surface gillnets and an anchored bottom gillnet were that more weights (lead /stones) including the anchor were attached to the footrope of the anchored bottom gillnet than the surface gillnet while more float were attached to the headline of the surface gillnet than the anchored bottom gillnet.

The gillnet netting materials were white monofilament polyethylene and white multifilament polyamide. The headline materials were polyethylene and kuralon with diameters ranging between 2.5 and 3mm (210D/6 and 210D/9 respectively). The mesh sizes ranged between 39 and 160mm; the mesh openings ranged between 38 and 159mm with mesh circumferences ranged between 78 and 318mm. The rubber slipper floats had the following dimensions 6 x 4 x 4cm; 8 x 5 x 1.3cm and 7 x 5 x 4cm. The floats numbers on the headlines varied from 733 to 2001 and the headline lengths varied from 804.67m to 3,900m. The distances between floats varied from 1.1 to 2.0m.

Each of the lead sinkers weighed about 35g and the numbers of sinkers per foot rope ranged from 404 to 2,890. The foot rope lengths varied from 804.67m to 3,900m. The distances between sinkers varied from 1.35 to 2.2m.

Materials used to construct gillnets in Lekki Lagoon were rope, float for the float line, sinkers for the lead line twine to sew everything together. Floats and sinkers were improvised for in the lagoon. The floats were improvised with poles wood while the sinkers were improvised with concrete, stone and old bottles filled with sand concrete sinkers were produce with the following stages as indicated in the figure below (Fig. 16). The concrete was produced by mixing cement and sand in ratio 2 to 1 that is one bag of cement to 25kg of sand to prevent it from easily breaking.

In net making, the rope was stretched to get all the snarls and tangles out by tighting the rope between to pegged strong sticks. The netting material was measured and straight across the meshes. The netting was hung on the float line and the lead line with fishermen's needle (Fig. 17 - 19). The staples (loops of twine) that connected the netting with the rope were exactly the same distance apart so that all the meshes were of the same shape. The float line ends were tightened between two pillars. The floats were thread-on at regular interval. The twine was passed through the mesh on the corner of the piece a spot. The staples were as long as the stretched lengths of the one mesh.

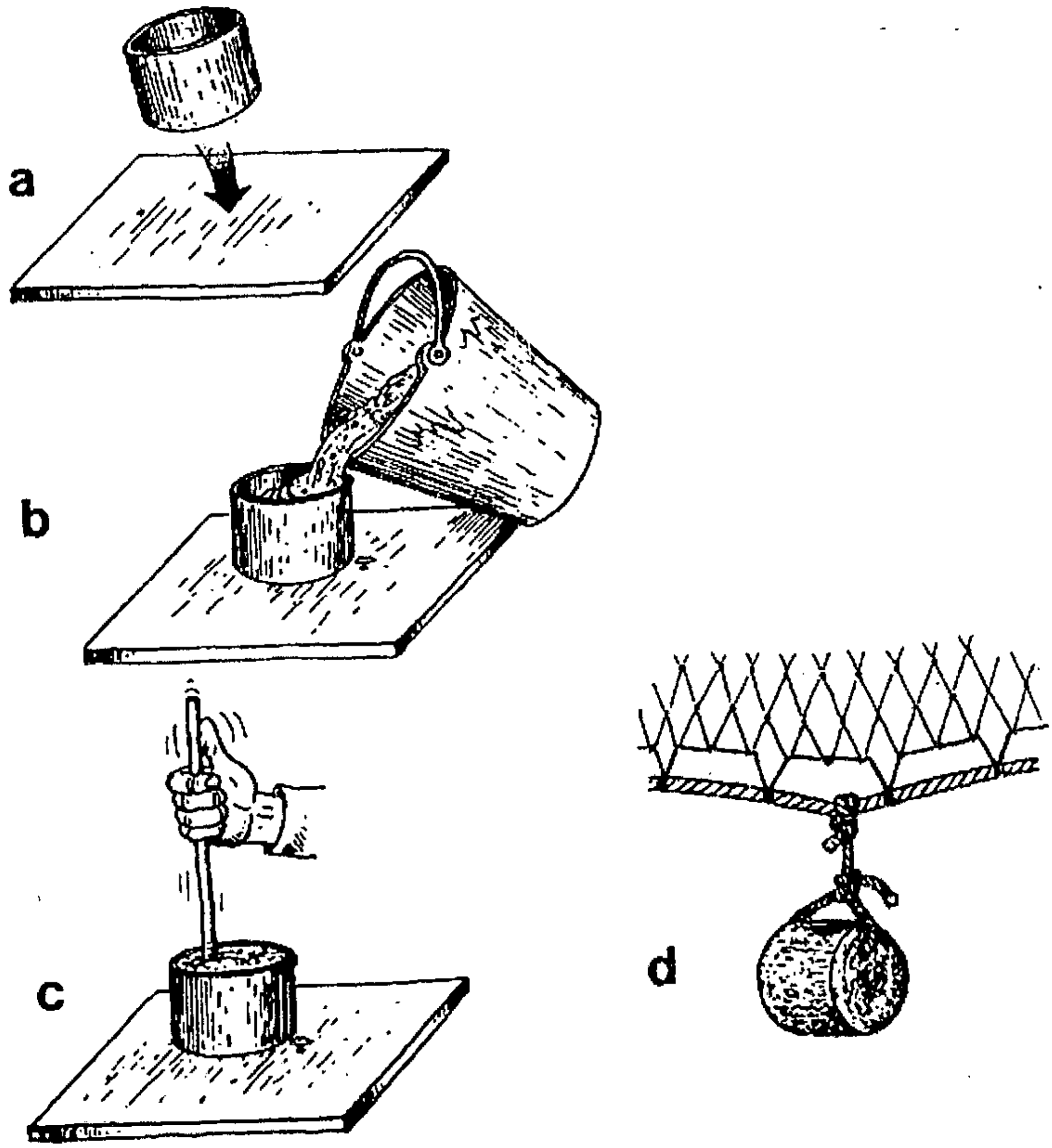


Fig. 16: Stages for the production of concrete sinker for gillnet legline and fixing

a – Placing the frame on the platform

b – Pouring of the mixed cement into the frame

c – Putting hole in the concrete sinker for easy attachment to leg line

d – An attached sinker to the leg line of a gillnet

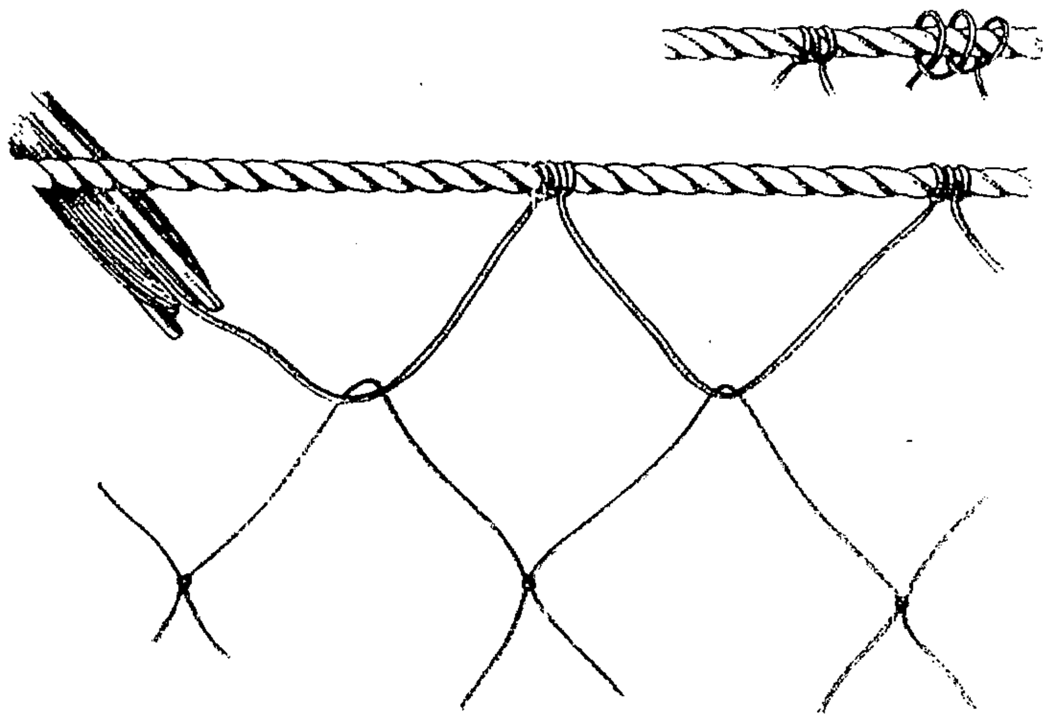


Fig. 17: Stapling method for single mesh using fishermen's needle (lead line)

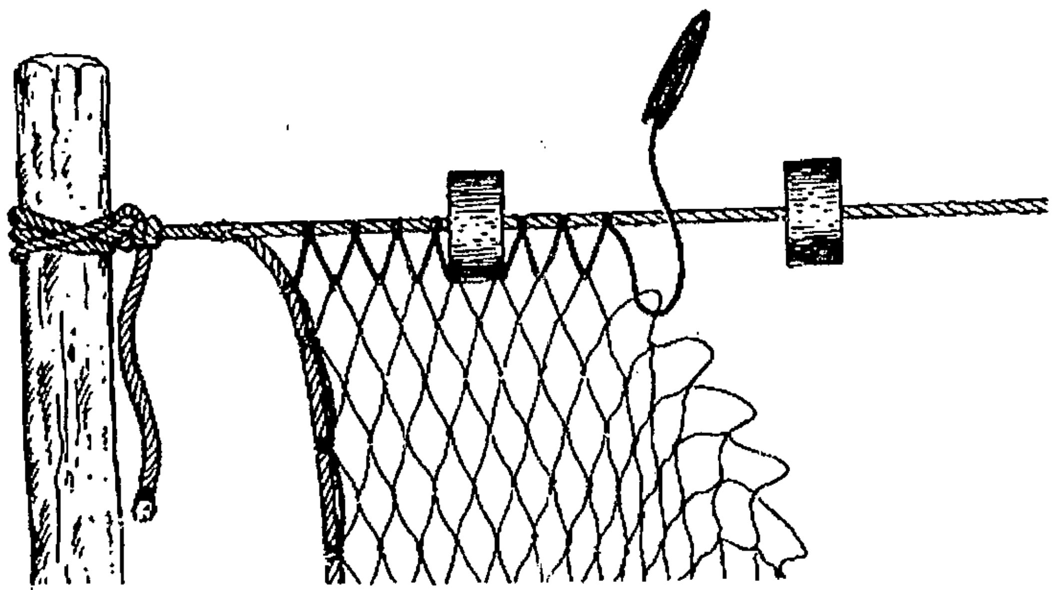


Fig. 18: Stapling method for single mesh using fishermen's needle (float line) in Lekki lagoon

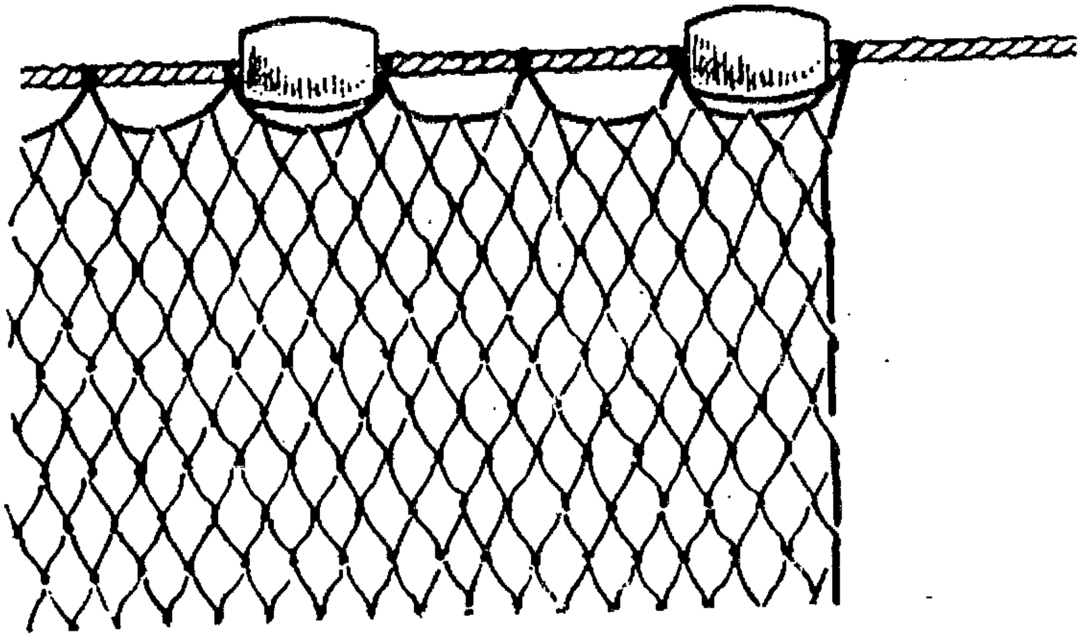


Fig. 19: Stapling method for three meshes for floatline in Lekki lagoon

The lead line was hung the same way the float line was hung (Fig. 20).

Two major types of gillnets were recorded in Lekki lagoon based on the set depth in the lagoon. These are surface and bottom gill nets (Figures 21 and 22). The surface gill net targets fishes that moves on the water column (pelagic species) while the bottom set gillnet targets fishes that move on the bottom (demersal species). Gillnets are also classified based on the mode of operation as motorized (operating using outboard engine) and non- motorized (operating without outboard engine or with pole or paddle). Improvised pole for float in gillnet fishery in Lekki lagoon is shown Plate 1. Gill net operation mostly involved two people and occasionally one person.

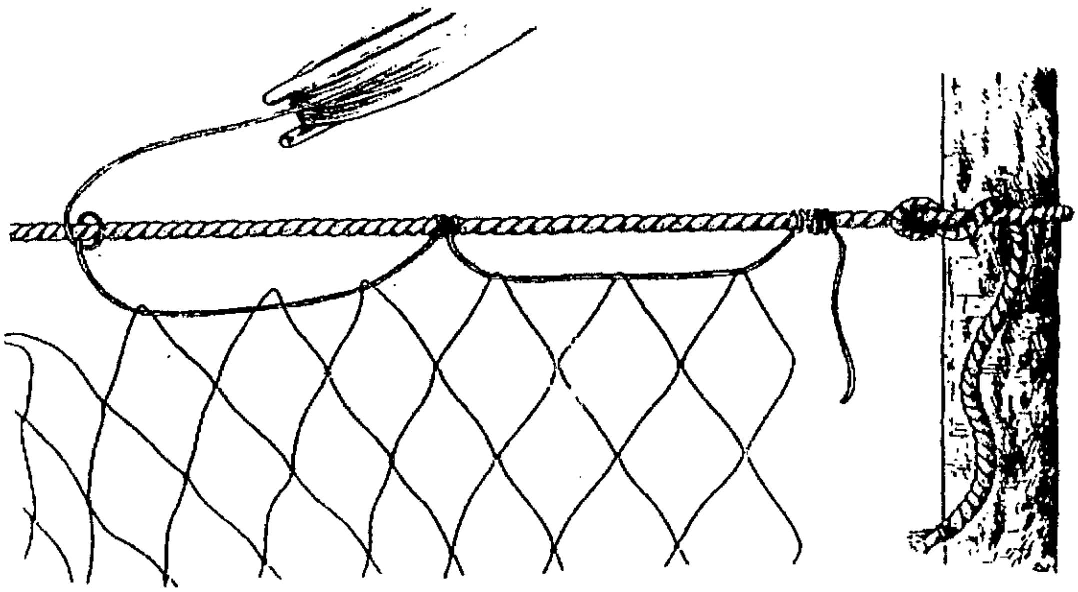


Fig. 20: Stapling techniques for lead line using fishermen's needle

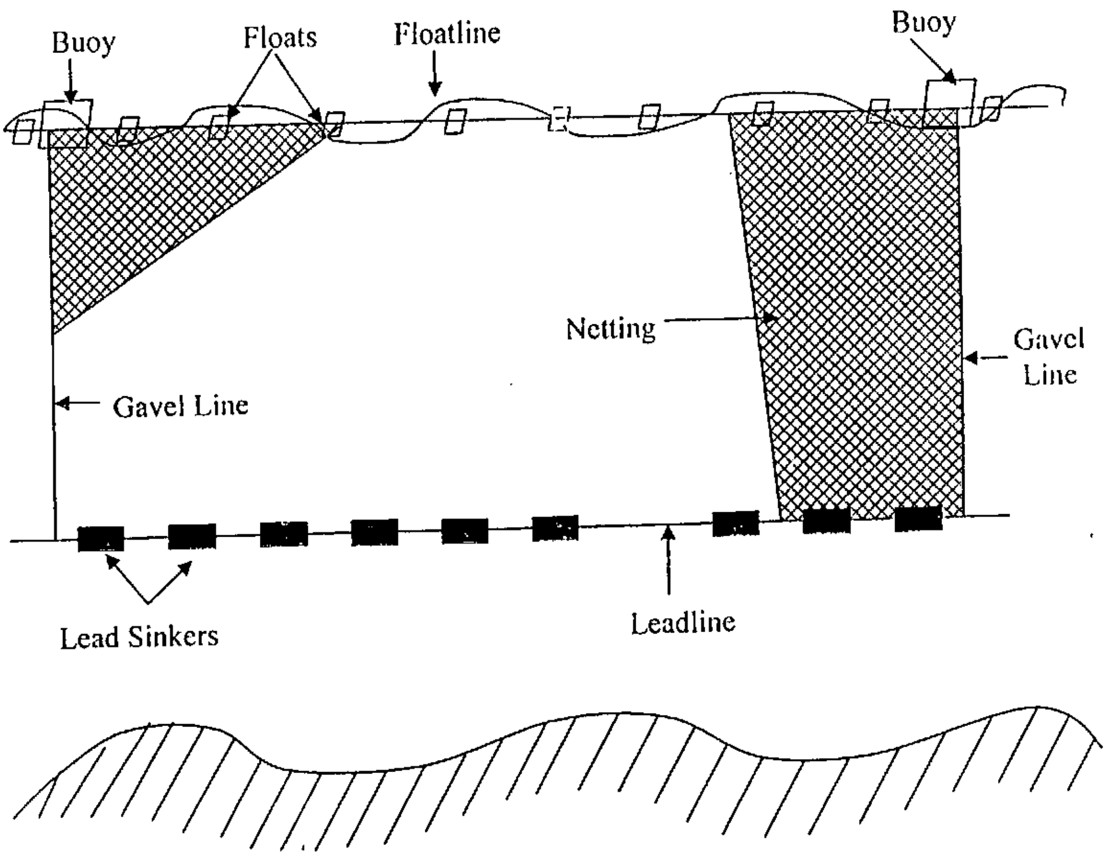


Fig. 21: A surface gillnet

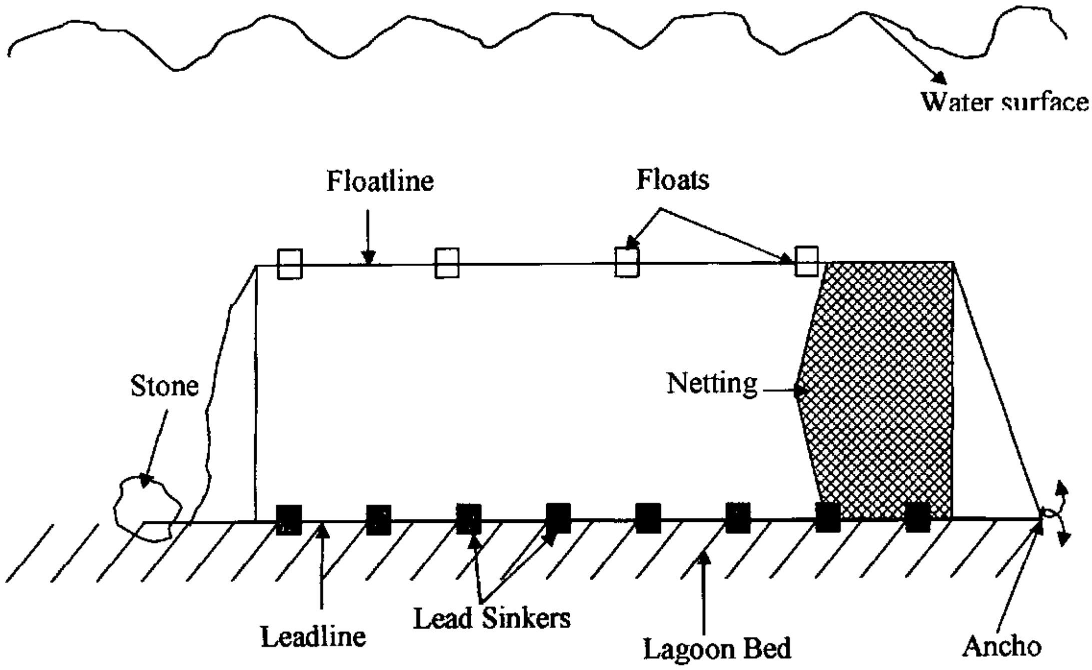


Fig. 22: A bottom set gill net

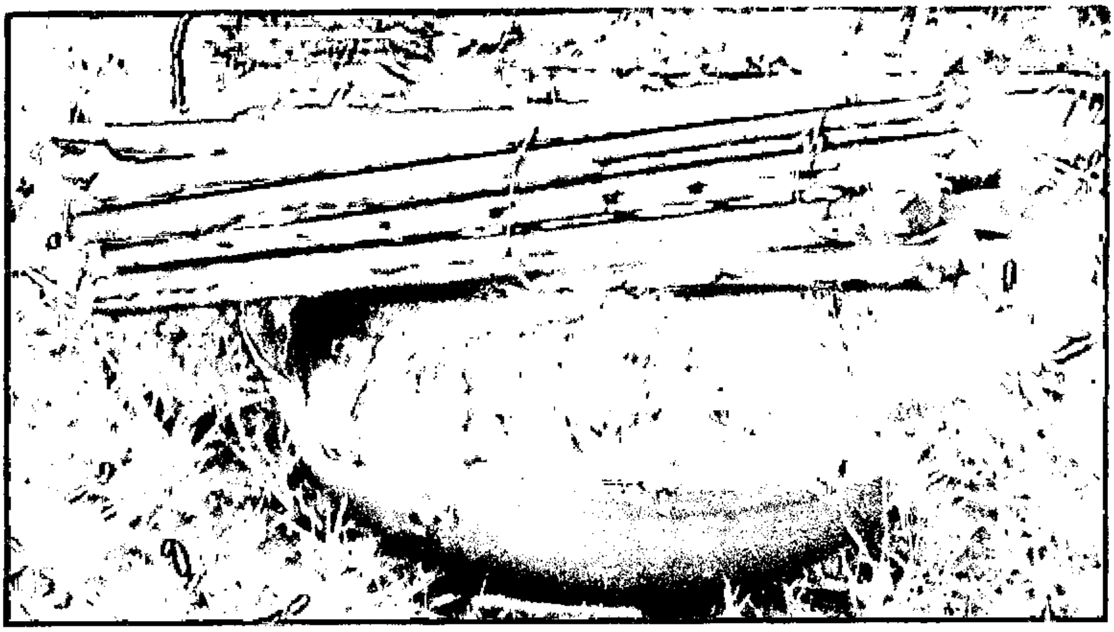


Plate 1: Improvised pole for float in gillnet fishery in Lekki lagoon.

4.3.4 Basket trap fishery in Lekki lagoon

These are cylindrical conical structures made from mid rib of palm fronds with two valves. It is locally referred to as 'Ogun'. The length ranges between 70 and 90cm. They are first sown together into a flat rectangular sheet which later sown into cylindrical shape. The two valves (entrance of no return) are then fixed into anterior end at interval of 35 to 40cm inward leaving only a narrow entrance. The other end is opened with a rope attached for closing and opening when in the water.

The traps are set in two ways: by pegging them singly in water with bamboo trees and by tying the traps to a leader rope at regular intervals between 2m and 2.5m. The traps are designed to catch prawns. The traps are set overnight baited with cassava tuber, canoe soap (soap tablet) and coconut (*Cocos nucifera*). It was noted that the longer the soak time the more the catch.

Though prawns were the main target of this trap, fishes and in rare cases crabs find their ways into them. The fishes observed in the trap are: *C. nigrodigitatus, C. filamentosus, C. walkeri, Eleotris vittata, C. isheriensis, T. guineensis, Erpetoichthys calabaricus* and *Polypterus senegalus senegalus.*

4.3.5 Boat seine design characteristics in Lekki lagoon

The mesh size and twine diameter of the net decrease from the wings to the cod-end. The mesh sizes of the cod-end were 24mm. The codend was constructed from singular-twisted polyamide twine and was of two-panel construction with between 600 to 800 meshes on their circumferences. The cod-end was separated into two sections. The forward section was 11-13m ano the section after about 2-3m in length.

4.3.5.1 Boat seine operation in Lekki lagoon

Boat seines with total length ranging from 400m to 450m were used in Lekki Lagoon. One end of the seine net was anchored with a strong wooden peg to set the net then returns its mooring and then hauls the gear in by the ropes by able men evenly divided into two groups (one group to one end of the net). Long warps were laid out to surround an area of the lagoon bed with a net similar to a trawl except for the long wings placed at mid length. At the end of the setting, the net wings were in shallow water (where the big boat was pegged with the able men inside) whereas the cod-end was in deep water. The two free ends of the warps were hauled in such a way that they move together hauling the fish inwards and into the path of the net to be scooped up and brought aboard the operating boat (canoe).

Due to the movement of the warps the fishing action was across the lagoon bed (bottom), which disturbs and guides the fish within the area to be worked. The lagoon depth around the area fished ranged between 2 to 5m at the Agan Centre (station D) of the lagoon. A boat seine operation was performed in 3 to 6 hours depending on the ropes shot, on the condition of the current, spirogyra bloom (that block the meshes of the net) and on the towing speed of the net. All tows were carried out during daylight hours.

The major operational problem for boat seine fishery in Lekki lagoon was algae impairment which prolongs the fishing operation with additional 2 to 4 hours depending on its thickness. Microscopic analysis of the green smear samples from fishing nets in the Lekki lagoon revealed *Spirogyra africana* as the sole organism constituting the fishing impairment through clogging of the net meshes. The smear of *Spirogyra africana* on boat seine net in the Lekki lagoon is shown in Plate 2.1. Numerous very long filaments forming thick mats (Plate 2.2) were observed. Each cell within each of the filament was between 40 – 90μm in length with at least more than 35 cells forming a single filament.

The boat seine operation in lekki lagoon, catch in the cod – end, capsized boat during boat seine operation and *Ethmalosa fimbriata* catch outcome of boat seine operation are shown in Plate 3.1 – 3.4 respectively.

Plate 2.1: Smears of *Spirogyra africanum* filaments on boat seine fishing net in the Lekki lagoon (March, 2007).

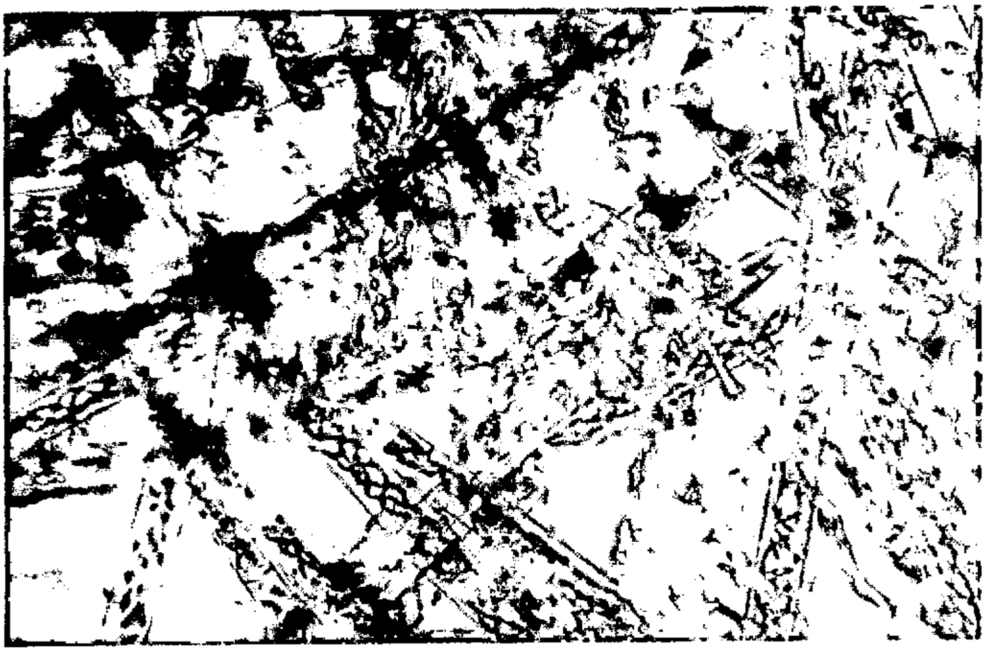


Plate 2.2: Examined smear on fishing nets reveals *Spirogyra africanum* (Fritsch) Crurda as causative organism.

Plate 3.1: Pulling of the boat seine in Lekki lagoon.

Plate 3.2: Boat seine cod-end filled with different fishes and *Spirogira africana* smear.

Plate 3.3: A capsized boat seine boat during operation on a stormy day

Plate 3.4: *Ethmalosa fimbriata* catch from a boat seine at Agan centre (Station D)

4.3.6 Longline design detail and operation in Lekki lagoon

A long-line consists of 210D/10 mainline with no. 9 twine ganglions of variable length (0.25 to 0.35m) spaced 1.5 – 3m apart. The long-line was coiled in round plastic tubs or basket with cork rims for fixing the hooks. Each tub contained between 300 and 500 hooks. The most commonly used hook design in the lagoon was "Mustard" round bent flattered hooks.

The long-line used to fish on the bottom and was weighed at both ends with a block or anchor attached to a buoys. In some cases, pegs (bamboo/stick/pole) were used to hold the line on both ends of the hooks. Depending on the length of the mainline, additional buoys and weights may be attached at intervals. Deployment of the gear involved raising the tub on a platform to avoid snagging the side of the boat. The long-line ends were attached to weight that was sent to the bottom and then used the momentum of the moving boat to pay out the long-line. The fisherman was limited to rotating the tub, occasionally untangling hooks, linking the end of a long-line to the next tub, added weights and buoys.

In this operation an artisanal fishing boat (planked or dugout) 5-7m without an outboard engine) with two fishermen fished a long-line with 100 to 1000 hooks with one man paddling or poling while the other sets the gear. Figure 23 shows the long line configuration in Lekki lagoon.

However, some fishermen fish alone and single handly set and retrieved their long-line (Plate 4). The long-line was retrieved manually as the boat moved between buoys, placed in the tubs, repaired and re-coiled properly on land. A hand net or scoopnet was used for the larger fish.

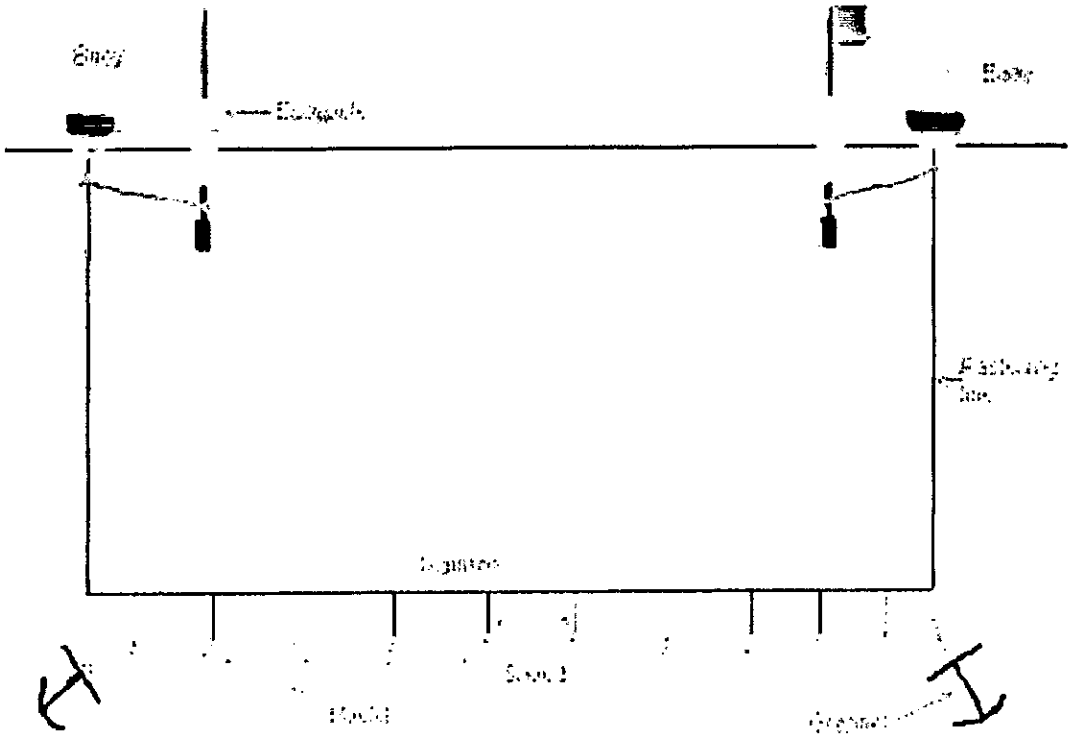


Fig. 23: Longline configuration in Lekki lagoon

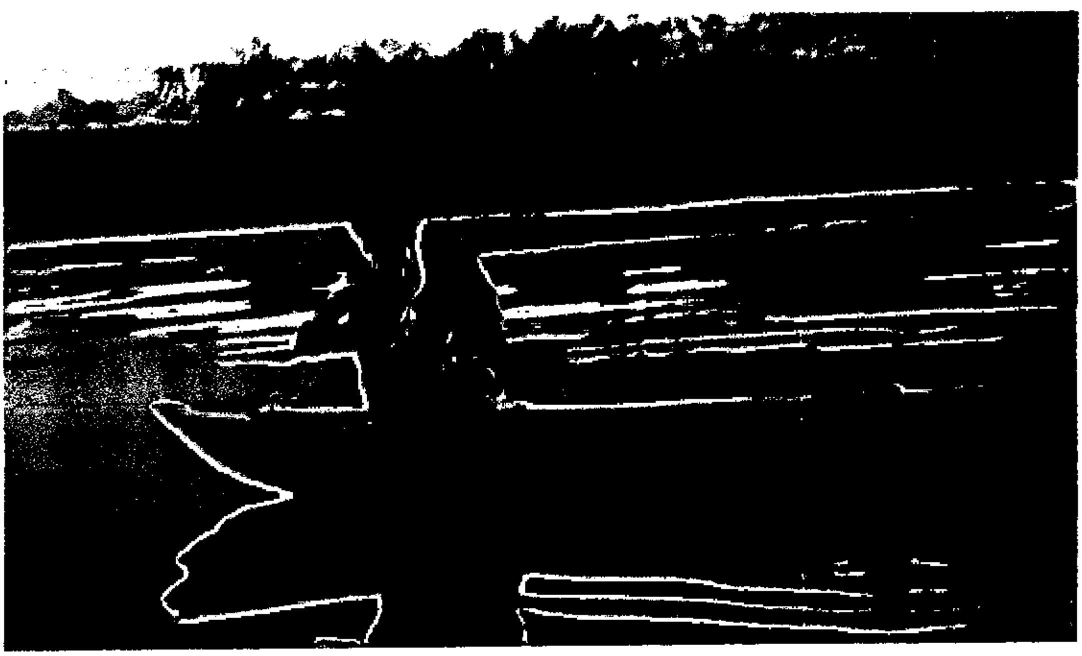


Plate 4: Long line fishery in Lekki lagoon

The long-line were set overnight (6pm – 5.30am) at varying depths. The hooks were baited with *Batanga sp* (bought from Obinehin Ilaje Local Government, Ondo State), *Anadara sp, Macrobrachium spp, Eleotris vittata, Mormyrus spp* (juvenile cut into bits), *Chrysichthys spp,* Periwinkle (*Tympanotonus spp*) and earthworm. Bait preferences in long line fishery in Lekki lagoon is shown Table 12.

Table 12: Bait preferences in long line fishery in Lekki lagoon.

Baits	Target fish species
Macrobrachium spp	*Clarias gariepinus, Chrysichthys nigrodigitatus*
Batanga lebretonis	*Cynoglossus senegalensis, Alestes spp*
Periwinkle, *Tympanotonus spp*	*Chrysichthys nigrodigitatus, C. filamentosus, C. walkeri*
Anadara senilis	*Chrysichthys nigrodigitatus, C. filamentosus, C. walkeri*
Chrysichthys nigrodigtatus	*Gymnarchus niloticus, Sphyreana barracuda*
Eleotris vittata	*Gymnarchus niloticus*
Mormyrus spp	*Gymnarchus niloticus*
Earthworm	*Tilapia guineensis, Sarotherodon melanotheron, Hepsetus odoe, Hemichromis fasciatus, Chrysichthys nigrodigitatus, C. filamentosus, C. walkeri, Clarias gariepinus, C. isheriensis.*

4.3.7 Floating Island traps design and operation in Lekki lagoon

The poles were purchased from Ejirin and were transported to the fishing villages where they were peeled (Plates 5.1 & 5.2) and dried under the sun. The peeled mid – ribs were measured and cut to specified size (1.2 – 2.5m in length). These were sown together with eflon or reed strips to form the conical shape. The traps were strengthened with stick to prevent the gear from operational damage. The valves were constructed separately and placed from inside out (i.e the inner valve was placed first before the outer valve).

The fence were design by sowing together the peeled pole mid – rib with eflon to form a mat. The construction was a communal operation that involved able young men with weaving skills (Plate 5.3). The height of the fence ranged between 2.5 and 3.2m; the width of each strip ranged between 1.1 and 2cm and the thickness ranged between 0.5 and 0.9mm depend on pole size.

Plate 5.4 shows the setting of fence in the boat for the operation.The fences were used to surround the floating island by 2-3 people. The owner of the island contributed 6 – 8 giant traps that were fixed the second day after fencing into the traps gates created (Plate 5.5 & 5.6). The remaining fishermen contributed one small trap each for the operation. The catch in the traps served as their labour or wage for the operation. The floating plants were then skillfully removed through a locally developed hydraulic (Plate 5.7 & 5.8). The fence were later readjusted to be sure there were no hole for the fish to escape before various acoustics were used to scare the fish into the traps.The catches were collected in the early morning of the next day (Plate 5.9). The giant traps were also constructed using wire guaze as shown in Plate5.10. The traps were preserved by hanging them horizontal under the shade (Plate 5.11).

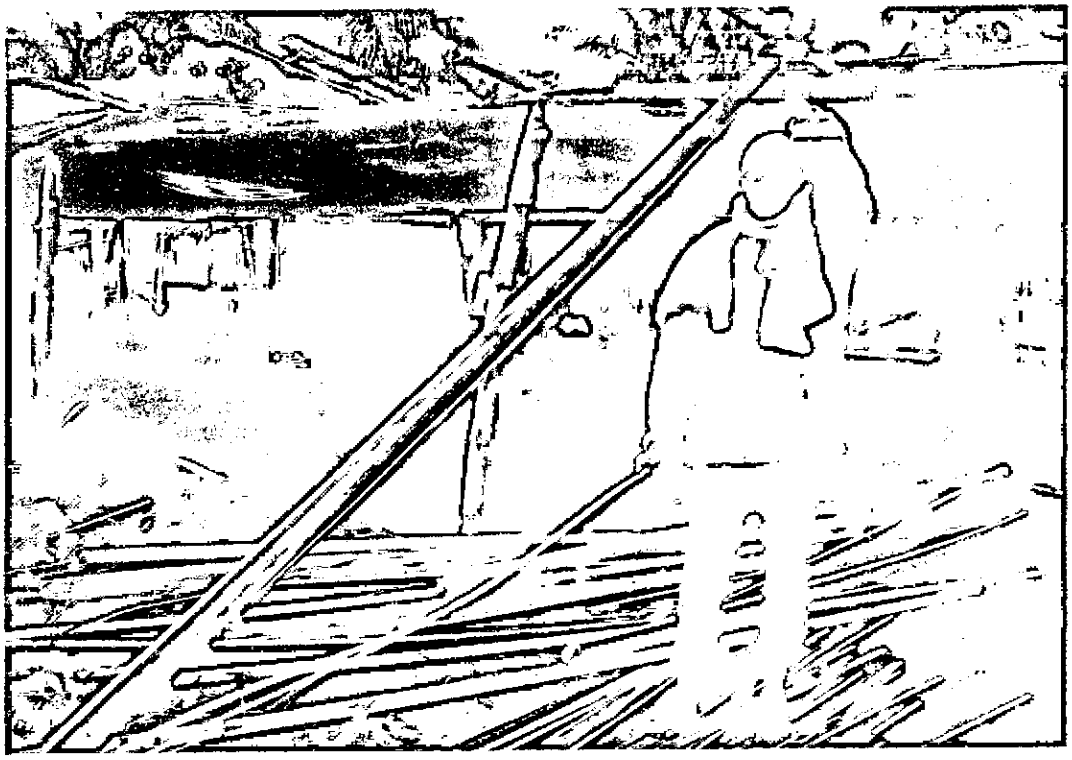


Plate 5.1: The peeling of the pole mid-ribs from the whole poles

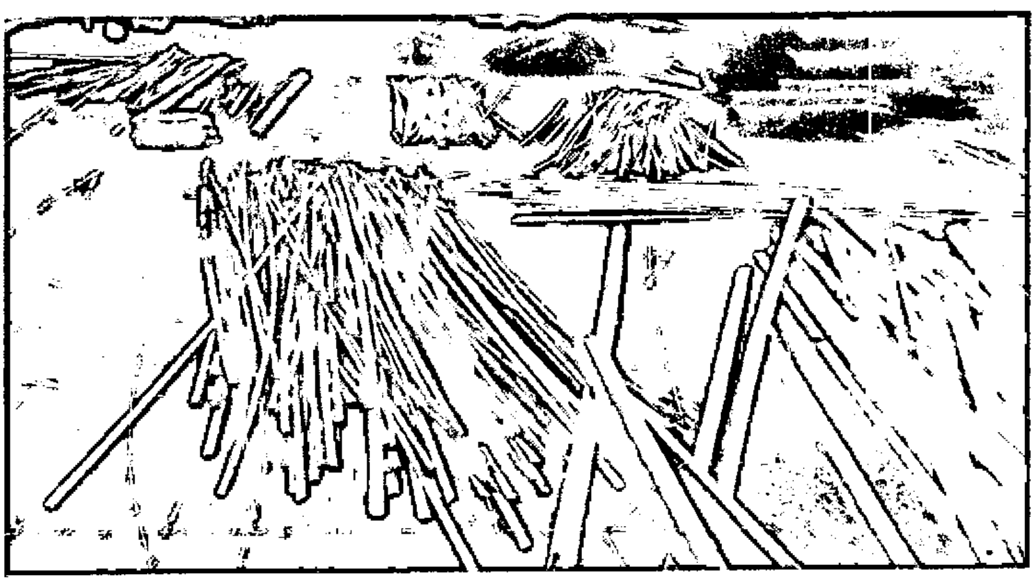


Plate 5.2: Pole midribs freshly prepared for the construction of the floating island fence

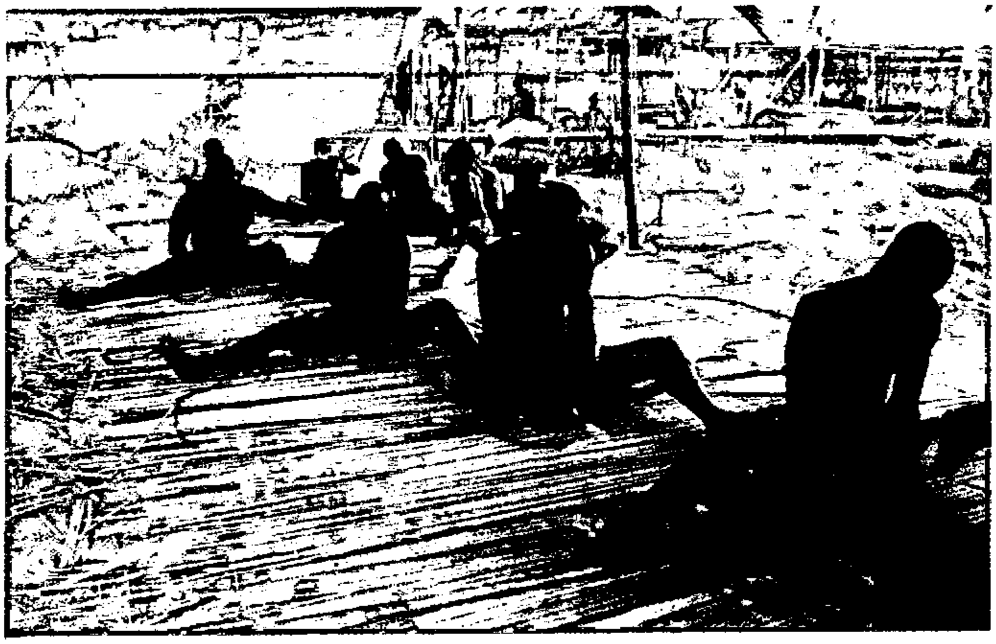


Plate 5.3: Construction of the floating island fence at Ikeran Olatunji village (station B)

Plate 5.4: Floating island fence ready for operation at Ikeran Olatunji beach

Plate 5.5: Fishmen preparing to place the giant trap into the fence gate before removing the floating plants

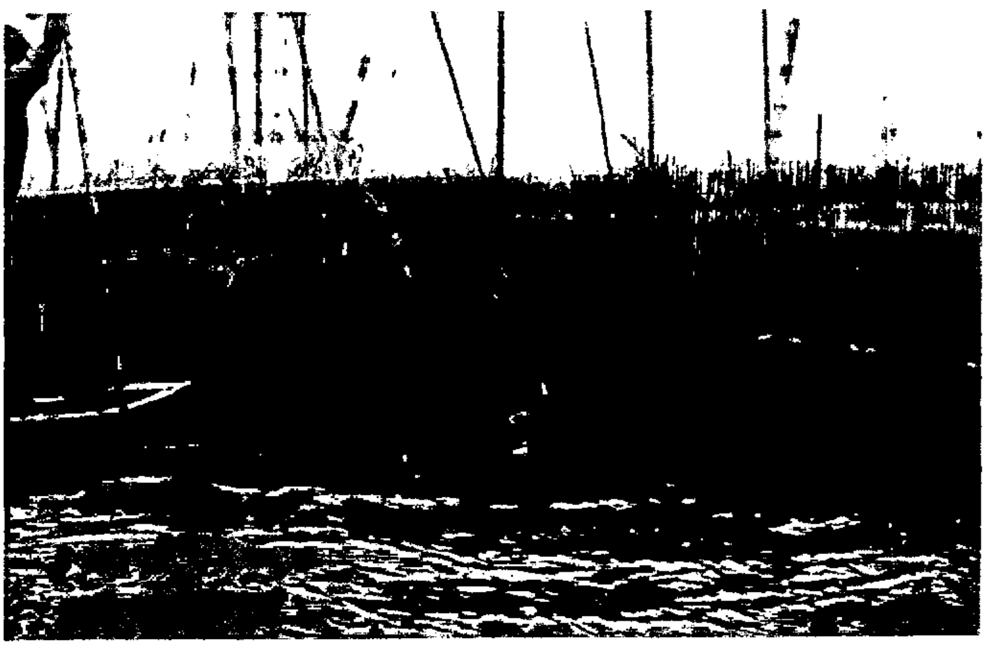


Plate 5.6: A fisherman fixing the giant trap into the fence gate

Plate 5.7: Mechanical way of cutting the sudd in Lekki lagoon.

Plate 5.8: The floating island fence and the encircling net after the macrophytes have been removed.

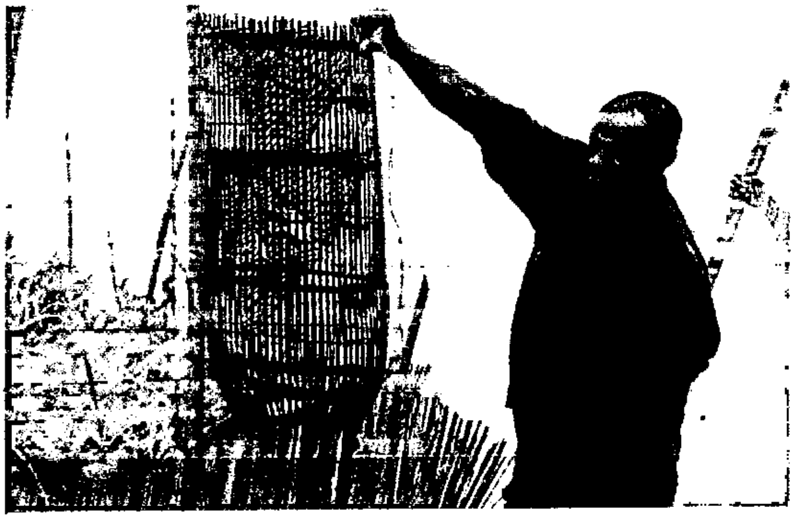


Plate 5.9: A floating island trap with crab and other catch.

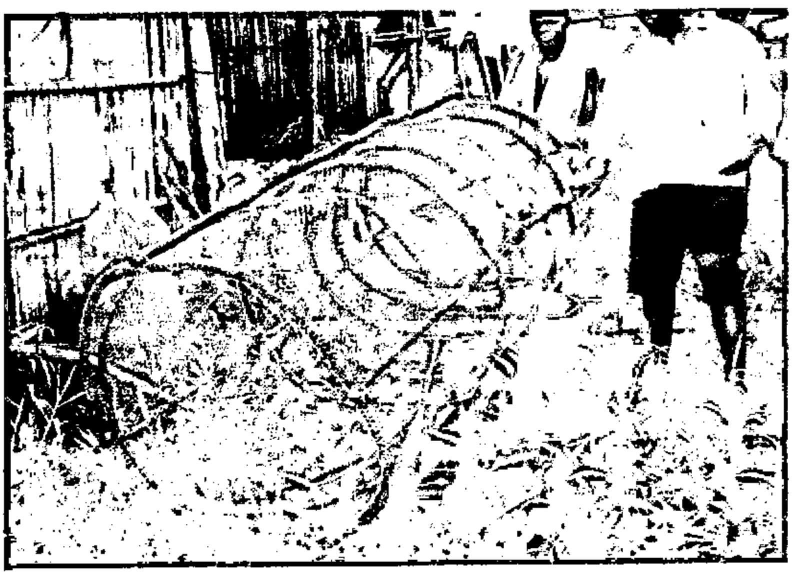


Plate 5.10: A big floating island trap constructed with wire guaze and sticks.

Plate 5.11: Traps hanging under the shade for preservation when not used.

4.4 SMALL-SCALE FISHING CRAFT SPECIFICATION IN LEKKI LAGOON

4.4.1 Canoe Type and Principal Dimensions in Lekki Lagoon

The fishing crafts in the lagoon were mainly the monohull (single hull) wooden dugout canoes, planked canoes and the planked dugout or half dugout canoes. The canoes used in Lekki lagoon had lesser length overall compared to those used in the other lagoon like Lagos lagoon. Constructional features of the canoes are elaborated in Table 13.

4.4.2 Hull Features of Canoes in the Lagoon

4.4.2.1 Dugout Canoes:

The dugout canoes were carved out from a log of red iron wood (*Lophira alata*) which predetermines its size. The thickness of the canoe hulls in Lekki lagoon ranges between 2 and 2.3cm. The length overall (LOA) ranged between 3.10 and 6.76m, the maximum breadth (moulded) ranged between 0.71 and 1.00m. Due to the nature of its construction, the hull is strong and rigid. Longitudinal re-enforcement of hull was not required while transverse strength was achieved by few number of thwarts (3-4) laid across the deck from one side of free board deck line to another. The dugout canoes had relatively small free board and thereby displayed low reserved buoyancy and were less stable compared to plank and half dugout types. The aft of the canoes terminated in a sterm piece which served as a platform for standing during fishing gear operations and for sitting while paddling. The shape was narrow, low curvature with long water line length. The log was excavated from inside to form the canoe shape. Excavation was completed by burning out the interior, using dry grass as fuel.

This was done to disinfect and preserve the fabric of the boat and to drive out insects and other parasites. During the burning, the wood tends to expand; then contraction on cooling was prevented by placing struts of wood across the canoe. The controlled burning with grass is to gives the canoe the characteristics black colour after carving. Paddles are made of wood, carved according to various patterns (pointed, rounded and blunted edges) and poles from bamboo or palm. Two types of paddles were observed in the lagoon (the arrow - like and the blunt end type). Plate 6 shows newly carved dugout canoe at Emina water front in Lekki lagoon.

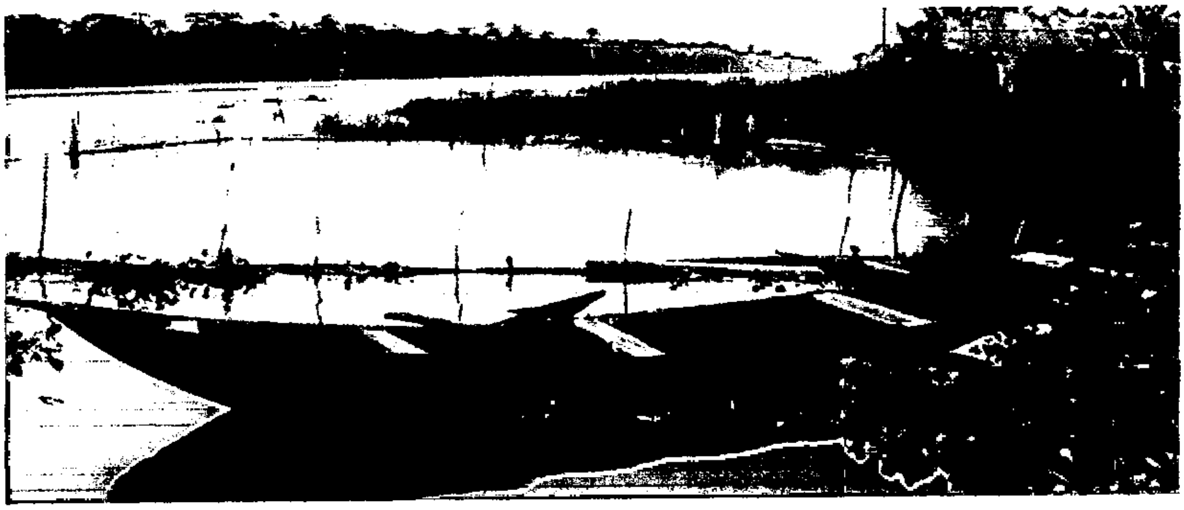


Plate 6: A newly carved dugout canoe at Emina water front in Lekki lagoon

4.4.2.2 Half-Dugout Canoes:

This is the combination of the dugout and the planked canoe features. The round bottom hull profile of the dugout canoe was built up with planks on each side to increase the size or cubic number of the canoe. The LOA of half dugout canoes ranged between 5.33 and 10.20m, the maximum breadth (moulded) ranged between 0.86 and 1.49m and the depth moulded ranged between 0.42 and 0.77m. The heavy hull reduced buoyancy of dug-out canoe was buffered by the addition of one or more planks made of soft wood like Opepe (*Nauclea diderrichi*), Mahogany (*Khaya* *ivorensis*) and black afara (*Terminalia ivorensis*), to both sides of the free board and deck line. The rigidity of the hull was maintained by more thwarts laid across the deck for transverse strength. The cubic number was relatively larger than dugout canoe and ranged between 1.93 and 11.70m^3 and provided enough space to carry a lot more crew and large fishing gear such as the seine net operated at Igbodola, Iwopin and Imeki also for floating Island fishery at Ikeran Olatunji. Gunwale is another hull feature that impacts longitudinal strength and stiffness to the canoe. This was nailed to the top side of the freeboard deck line and runs from the fore to after on both side of canoe. It had a long water line with low degree of curvature. Trim was equal at both stem and sterm. The canoe was propelled with paddle (85%) and outboard engine (15%).

4.4.2.3 Planked Canoe:

The canoe had flat bottom hull completely built with planks fixed together with frames, u-shaped metal fasteners and nailing a strip of galvanized iron aluminum pluck caulking over the plank seams (joints). The longitudinal and transverse reinforcement was by gunwale and the thwarts ranged between 4 and 6. The frames also provide transverse strength. The canoe had a flat keel about 5 – 9cm wide for upright sit on the roller or on the sand when being hauled on beach. Reserved buoyancy in high, at load waterline, a freeboard draft ratio of 1:2 was recorded. The canoes had a long narrow beam and equal trim. About 10% of them were provided with transom for installation of outboard engine to propel the canoe. The outboard used ranged between 8 and 40Hp from Yamaha, Suzuki, Tohatsu and Marina brand. Plates 7.1– 7.4 show the various stages in planked canoe construction at Epe.

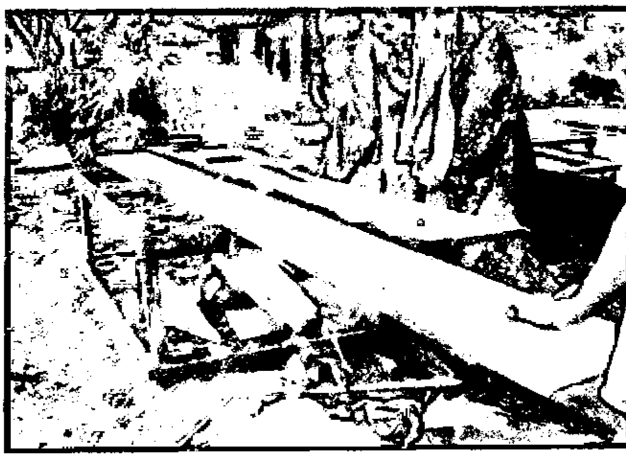


Plate 7.1: Planks placed on attender for framing before it is used in canoe *construction* at Epe.

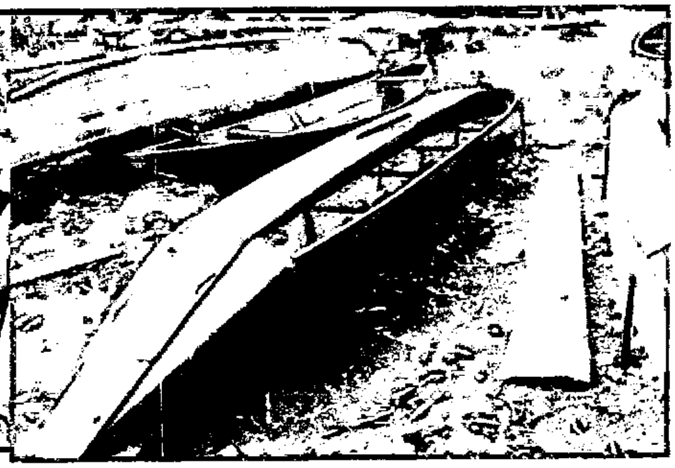


Plate 7.2: Planked canoe under construction at Epe.

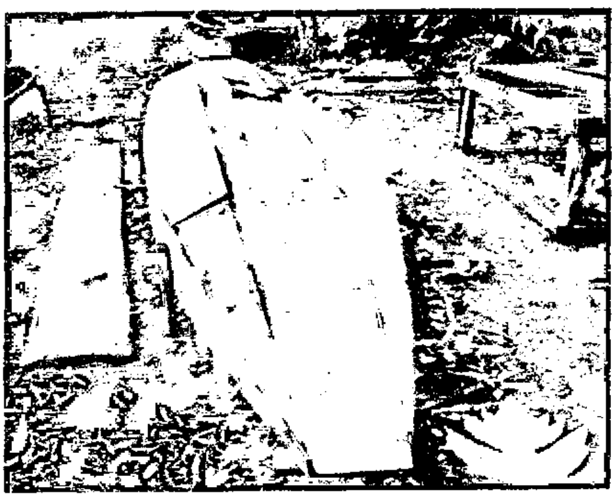


Plate 7.3: New constructed planked canoe at Epe (back hull)

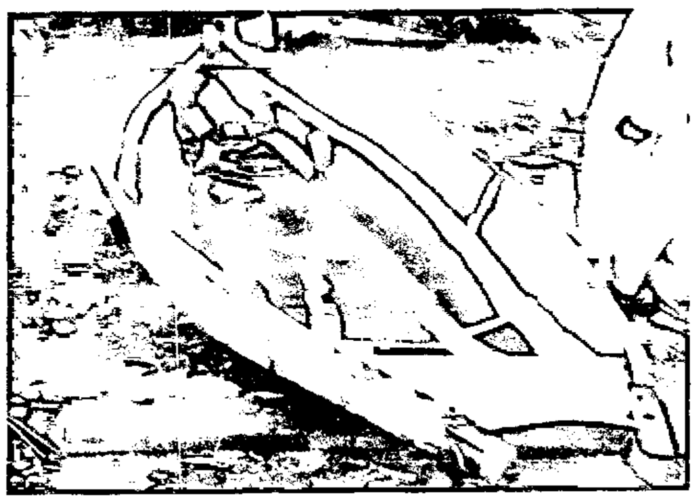


Plate 7.4: A newly constructed planked canoe with strips of galvanized iron aluminum

Table 13: Features of wooden canoes used in Lekki lagoon between March 2006 and February 2008

Characteristics	Dugout	Planked canoe	Half Dugout (planked dugout)
Length overall (LOA)(m)	3.10 – 5.86	5.20 – 11.00	5.33 – 10.20
Maximum width or moulded breadth (m)	0.71 – 1.00	0.93 – 1.80	0.86 – 1.49
Draft/ maximum Depth (moulded) (m)	0.18 – 0.40	0.27 – 0.60	0.42 – 0.77
Load water line (LWL) (m)	2.60 – 4.77	2.10 - 6.10	3.52 – 8.20
Number of Thwarts	3 – 4	4 – 6	4 - 7
Cubic Number / Size (m3)	0.42 – 2.70	1.31 – 11.88	1.93 – 11.70
Trim	More or less equal	By stern	More or less equal
Transom	Absent	Present in motorized canoe only	Present in motorized canoe only
Keel	Absent	Present	Absent
Frame	Absent	Present	Present
Gunwale	Absent	Present	Present
Bottom Profile	Round	Flat	Round
Free Board	Low	High	Medium
Breast hook	Absent	Present	Present
Stern piece	Absent	Present	Absent
Free board ratio	2:1	1:2	1:1
Bouyancy	Poor	Average	Good
Mode of Propulsion (Percentage in parenthesis)	Paddle (100) Outboard engine (0.0)	Paddle (90) Outboard engine (10)	Paddle (85) Outboard engine (15)

Most dugout canoes used in Lekki lagoon were carved at Saga village by the Ijaws while the planked canoes were constructed at Epe (Lagos state Government, Ministry of Agriculture Co-operative and Rural Development, United Nation Development Programme (UNDP), Support programme on Artisanal fisheries, fisheries development unit, Ebute Afuye, Epe Local Government), Iwopin and Ebute Lekki.

The most common canoe used in Lekki lagoon was planked canoe. The production of dugout canoes was restricted to Ijaw carvers at Saga village and was limited by the scarcity of timber which competed for some other uses like in furniture and building contruction. Most canoes used in the lagoon were generally tied to the planked jetties and left in water throughout the year.The wood absorbed a lot of water infested with algae such as *Spirogyra spp* which added more to the weight which eventually reduce the speed of the canoe when propelled.

4.4.3 Fisheries frame survey of Lekki lagoon

The numerical compositions as well as the percentages of the canoes types between 2006 and 2007 are shown in Table 14. In 2006 there were 1027 wooden canoes made up of 24.29% dugout, 54.29% planked and 21.43% planked dugout canoes. In 2007 the canoes number was reduced drastically with a total number of 995 wooden canoes made up of 248 (24.93%) dugout, 558 (56.08%) planked canoes and 189 (18.99%) planked dugout canoes. The details of the canoe units recorded in the fishing villages within the lagoon between 2006 and 2008 are presented in Table 15. The percentage decrease in the number of canoe was 3.12% between 2006 and 2007.

Table 14: Types of fishing canoes in Lekki lagoon (Percentage in parenthesis)

Year	Wooden canoe types			Total
	Dugout	Planked	Planked dugout	
2006- 2007	249 (24.29)	558 (54.29)	220 (21.43)	1027
2007- 2008	248 (24.93)	558 (56.08)	189 (18.99)	995

Table 15: Fishing villages and the canoe units in Lekki lagoon between 2006 and 2008

Fishing village	Number of functional fishing canoes	
	March, 2006 – Feb. 2007	March, 2007 – Feb. 2008
Emina	43	43
Abomiti – nla	34	33
Abomiti – Sokoto	20	19
Ajegunle	17	16
Ikeran Olatunji	46	45
Take	19	18
Luboye	19	18
Abatitun	29	28
Iwopin	123	119
Siriwon	39	38
Dopanu	32	31
Dopanu-Ajegunle	73	72
Idata	21	20
Igbolomi	42	42
Aba – oyinbo	24	23
Ikeran –Aba Ilaje	52	51
Origbe	48	47
Oriyanrin	46	45
Imeki	45	44
Lakoye	17	16
Ebute – Lekki	51	50
Arala	22	21
Igbodola	25	24
Aba – Onigangan	31	30
Ise	109	105
Total	**1027**	**995**

4.4.4 Fishing crafts preservation techniques

Most canoes used in the lagoon were generally tied to the planked jetties and left in water throughout the year. The wood absorbed a lot of water infested with algae such as *Spirogyra spp* which added more to the weight which eventually reduce the speed of the canoe when propelled. The attack of barnacles and annelid worm (*Mercierella enigmatica*) was not common in Lekki lagoon, it was only observed at Iwopin in only two canoes (planked) and one planked canoe at Ebute Lekki.

The canoe preservative used in the lagoon was by painting with bitumen, coating the back hull with cement and bitumen with ground pepper, although there has not been any scientific backing for the use of pepper against biofouling attack, the fisherfolks guaranteed its success. The pepper was used in ratio 1:2 to the bitumen, mixed thoroughly, rubbed on the outer canoe hull and dried under the sun for 3 to 5 days before use.

4.5 FISHING GEAR METHODS AND EXPERIMENTAL TRIAL IN LEKKI LAGOON

Small-scale fisheries in Lekki Lagoon supported fishing gears like gillnets, boat-seine, liftnets, castnets, traps (Basket), traps (bamboo), floating island fishery and longlines. The gears were classified according to the International Standard Statistical classification of fishing gear (Nedelec, 1982 and Solarin 1998).

The percentage composition of the inventoried fishing gear types based on canoe unit that were encountered between 2006 and 2008 is shown in Table 16. Gillnet was the most abundant fishing gear used in the lagoon, with 50.04% contribution in 2006/2007 and 48.74% in 2007/2008. Longline contributed 14.31% in 2006/2007 and 14.77% in 2007/2008. Castnet had 11.68% contribution in 2006/2007 and 12.06% in 2007/2008. Basket trap fishery contributed 10.61% in 2006/2007 and 10.65% in 2007/2008. All the above mentioned fishing gears suffered declines in 2007/2008. Floating island trap fishery contributed 8.18% in 2006/2007 and 8.44% in 2007/2008. Bamboo trap accounted for 3.41% 2006 and 3.52% in 2007. There was no change in the number of lift net and boat seine in the lagoon. They both accounted for 0.97 and 1.00% (liftnet), 0.78% and 0.80% (boat seine) in 2006/2007 and 2007/2008 respectively.

Table 16: Number and percentage composition of fishing gear types based on canoe unit in Lekki lagoon.

Fishing gear	March, 2006 – February, 2007		March, 2007 – February, 2008	
	Number	Percentage	Number	Percentage
Gill net	514	50.04	485	48.74
Long line	147	14.31	147	14.77
Cast net	120	11.68	120	12.06
Basket trap	109	10.61	106	10.65
Floating island fishery (trap)	84	8.18	84	8.44
Bamboo trap	35	3.41	35	3.52
Lift net	10	0.97	10	1.00
Boat seine	8	0.78	8	0.80
Total	**1027**	**100**	**995**	**100**

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Total	**1027**	**100**	**995**	**100**

4.5.1 Catch per Unit Effort of fishing gears in Lekki lagoon

The average weight of fish caught per canoe per day ranged between 3.2kg with Basket and bamboo traps to 47.1kg with boat seine net. The harvest from the floating island was 29.3kg of fish per 4 months installation. The gill nets caught fish that ranged between 6.0 to 13.0kg per canoe per day with mean weight of 8.60±2.91kg.

The castnet caught fish with weight range of 1.0 to 7.0kg with a mean weight of 4.3±2.49kg. Liftnet canoe yielded averagely 3.4kg of *Pellonulla afzeliuzi* per canoe per day. The average weight of fish caught per canoe per day was presented monthly from March 2006 to February, 2008 as shown in Table 17 (Figure 24). Table 18 showed the fishing methods, number of fishermen required, period of fishing and amount of fish caught in Lekki Lagoon (Figure 25). Boat seine fishery recorded the highest number of fisher folks (25-30) followed by floating island fishery (10-15). Castnet, basket trap, bamboo trap, gillnet and liftnet all recorded between 3 and 4 hours while cast net and boat seine operation lasted between 2 and 6 hours. Boat seine operation period depend on the purity of the lagoon water. During clear water it may not go beyond 3 hours but during the spirogyra bloom it may last for 6 hours.

Fishing villages/settlements, the fishing gear and method around Lekki lagoon was presented in Table 19. . The fishing gear indices in Lekki lagoon revealed gillnets (514) to be the most used fishing gear while boat seine (8) was the least used (Figure 26).

Table 17: Catch per unit effort of fishing gears in lekki lagoon from March, 2006 –February, 2008.

Fishing Gear Type	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Total	Mean ± SD
Gill net	18.0	20.2	21.1	23.0	22.8	20.6	18.8	17.5	17.1	16.2	17.2	14.2	226.7	18.9±2.91
Long line	5.6	9.6	8.2	8.5	7.6	10.2	9.2	8.0	9.8	6.0	5.6	4.2	92.5	7.7±1.94
Cast net	6.0	5.0	4.5	1.2	1.0	1.2	6.6	7.2	6.9	7.0	3.0	2.0	51.6	4.3±2.49
Traps (floating Island)	20.6	31.1	26.0	21.0	30.0	21.7	30.0	50.0	60.0	25.0	20.0	16.5	351.9	29.3±12.99
Bamboo trap	2.2	3.9	4.1	3.7	4.0	1.2	1.0	4.2	5.1	3.2	4.0	2.1	38.7	3.2±1.30
Boat Seine	70.1	68.9	78.0	98.0	100.0	150.0	105.1	100.0	25.0	2.0	36.0	56.0	889.1	74.1±40.54
Lift net	5.0	3.0	2.0	2.2	3.2	1.2	2.3	3.3	4.2	4.4	5.0	4.5	40.3	3.4±1.27
Basket trap	2.2	3.9	4.1	3.7	4.0	1.2	1.0	4.2	5.1	3.2	4.0	2.1	38.7	3.2±1.30

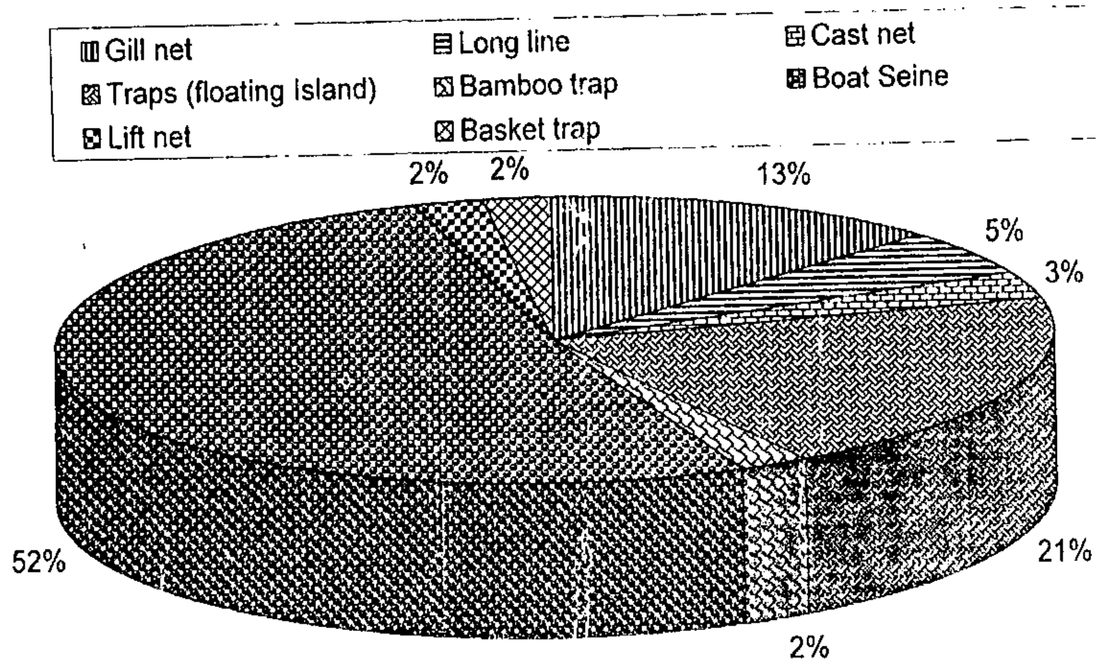

Fig. 24: Fishing Gear Type and mean weight of fish caught/kg/canoe/month

Table 18: Fishing Methods, Number of Fishermen, Period of Fishing and Amount of Catch in Lekki Lagoon

Fishing Methods	No. of Fisherfolks Required	Period of Fishing	Amount of Catch (mt)per annum
Gill net	2	Overnight	218.73
Cast net	2	2-6 hours	94.0
Basket traps	1 or 2	Overnight	83.23
Long line	1or 2	Overnight	117.71
Boat Seine	25-30	2-6 hours	174.04
Floating Island	10-15	5 – 6 hours	248.09
Bamboo trap	1 or 2	Overnight	83.20
Liftnet	1 – 3	3 – 4 hours	22.01

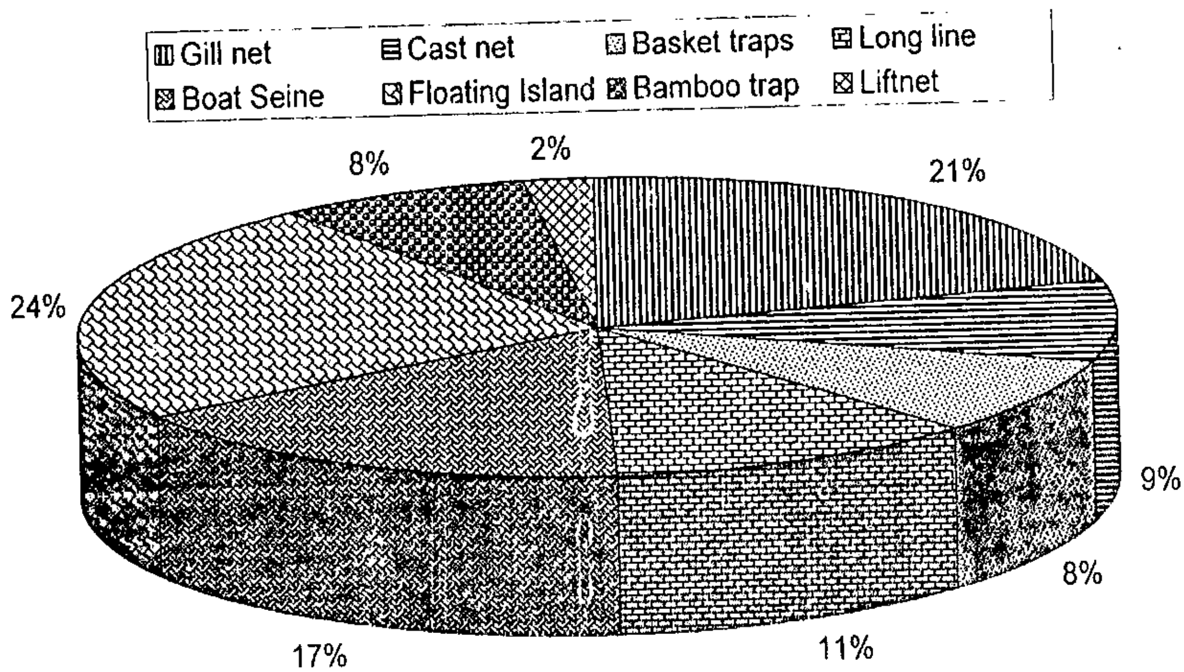

Fig. 25: Fishing method and amount of catch per annum

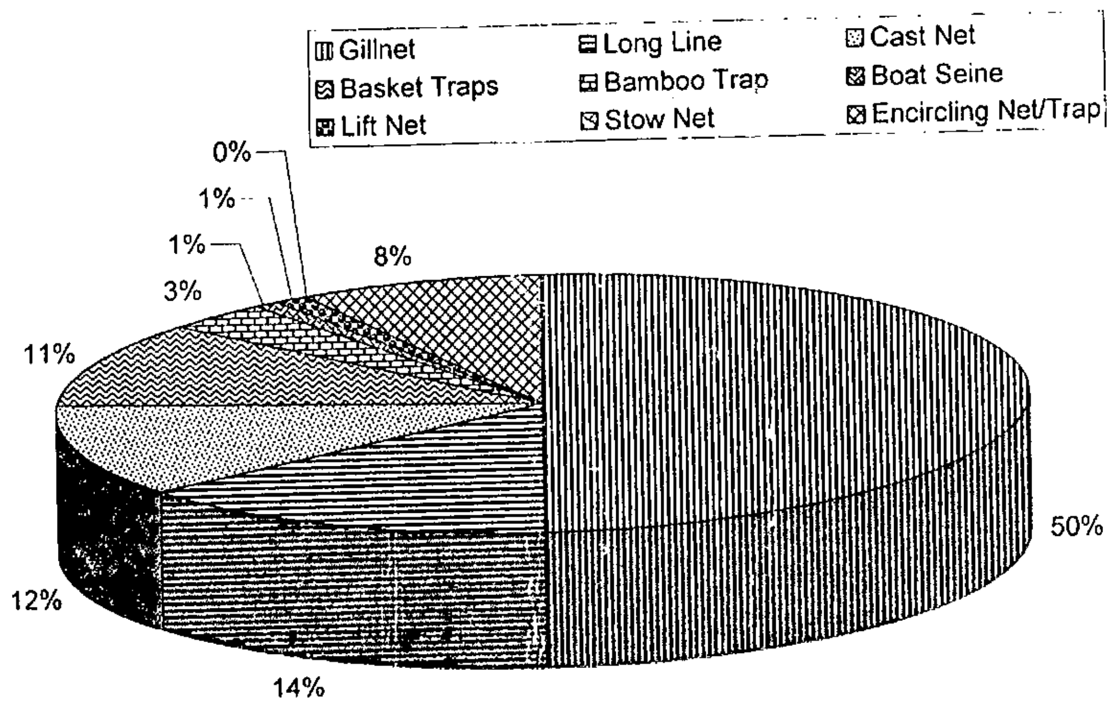

Fig. 26: Fishing gear indices in Lekki lagoon

Table 19: Fishing villages and gear indices in Lekki lagoon between March 2006 and February 2008.

VILLAGE	GILLNET	LONG LINE	CAST NET	BASKET TRAPS	BAMBOO TRAP	BOAT SEINE	LIFT NET	STOW NET	ENCIRCLING NET/TRAP
ARALA	13	5	3	-	1	-	-	-	-
ABA-OYINBO	15	5	4	-	-	-	-	-	-
IGBODOLA	10	-	7	6	-	2	-	-	-
ABOMUTI SOKOTO	11	4	2	-	3	-	-	-	-
ABOMUTI NLA	12	6	5	9	2	-	-	-	-
AJEGUNLE	6	3	4	4	-	-	-	-	-
TAKE	12	4	3	-	-	-	-	-	-
EMINA	28	11	4	-	-	-	-	-	-
IKERAN (ABA-ILAJE)	30	9	4	9	-	-	-	-	-
IKERAN OLATUNJI	-	1	3	6	-	-	-	-	36
LUBOYE	6	2	4	5	2	-	-	-	-
ABATITUN	4	11	5	7	2	-	-	-	-
DOPANU AJEGUNLE	36	9	2	6	-	-	-	-	20
DOPANU	20	2	4	6	-	-	-	-	-
ORIGBE	10	5	6	5	4	-	-	-	18
IMEKI	20	6	6	7	2	2	2	-	-
IWOPIN	86	15	8	-	-	4	-	-	10
LAKOYE	4	0	4	5	4	-	-	-	-
EBUTE LEKKI	26	6	8	6	4	-	-	-	-
SIRIWON	22	0	3	10	4	-	-	-	-
ISE	75	10	6	-	-	-	8	-	-
IGBOLOMI	19	7	3	8	5	-	-	-	-
IDATA	10	5	2	4	-	-	-	-	-
ABA ONIGANGAN	19	8	4	-	-	-	-	-	-
ORIYANRIN	21	13	4	6	2	-		-	-
TOTAL	514	147	120	109	35	8	10	0	84

4.5.2 Gill net selectivity and efficiency in Lekki lagoon

Out of 514 canoes, 110 canoes (21.40 %) operated gillnets with mesh size ranging between 30 and 45mm, 178 canoes (34.63%) operated gill nets with the mesh size ranging between 50mm and 70mm and the third group consisted of 226 canoes (43.97%) which operated gillnets with mesh size ranging between 75mm and180mm. Table 20 shows the frequency of gillnets by mesh size between 2006 and 2008.

The major fish species composition of the gill nets based on the mesh size categories in the lagoon is shown in Table 21. The gill nets with 30 – 45mm mesh size caught mostly *E. fimbriata, T. guineensis, C. nigrodigitatus, C. walkeri and C. filamentosus* which accounted for 64.2 % of the catch. *T. guineensis* and *S. barracuda* were two fish species which are predominant to gill nets with 50 -70mm mesh size. The gill nets with 75 – 180mm mesh size caught mostly *S. barracuda, C. hippos, T. teraia* and *C. senegalensis*. Gillnets with mesh sizes of 30 – 45mm, 50 – 70mm and 75 – 180mm harvested a total fish weight of 225.6kg, 386.4kg and 524.4kg *T. guineensis* respectively. A summary of the fish caught in the three gillnet categories is given in Table 23. 110 gillnet canoes operating 30 -- 45mm meshed net caught a total of 225.6kg (19.85%) fish with an average of 2.05kg per canoe. 178 gillnet canoes operating 50 – 70mm meshed net caught 386.4 kg (34.01%) fish with an average value of 2.19kg per canoe. 226 canoes using 75 – 180mm meshed nets caught 524.4kg (46.14%) fish with a mean of 2.34kg per canoe. The 75 – 180mm stretched mesh category of gillnets performed relatively better than the other two categories in terms of fish weight.

Mesh selectivity study of the prototype gillnets (the most used fishing gears in the lagoon) was undertaken as a conservation strategy for *T. guineensis*, one of the most abundant fish species that command high economic value in the lagoon. Table 24 shows the percentage length frequency distribution of *T. guineensis* caught by gillnets with 40mm, 50mm and 75mm stretched mesh sizes respectively. The highest caught fish length for 40mm mesh size was fish of total length 14cm while fish of total length 16cm was mostly caught by 50mm gillnet and 75mm gillnet mesh size caught mostly fish of 22cm total length. Figure 27 shows the selectivity curves of the fish caught by the three mesh sizes. The larger the mesh size the bigger the size of fish caught in the net. *T. guineensis* specimen with length ranges of 10.0 – 19.0cm, 12.0 – 22.0cm and 17.0 – 30.0cm were caught by 40mm, 50mm and 75mm mesh gillnets respectively. The corresponding mean retention lengths were 13.5cm, 17.0cm and 23.5cm respectively (Table 24 and Figure 28). The mean retention length increased with the increase in mesh size of gillnets.

The relationship between the mean retention length (Lm) and mesh size gave a regression equation:

$$Lm = 2.5577 + 2.8077\ M$$

The correlation coefficient (r) was 0.995 which indicated a high positive relationship between the mean retention lengths of fish and the mesh size of the net.

Table 20: Frequency of Different Meshes of Gillnet used by Fishermen in 2006 - 2008 in Lekki Lagoon

Stretches Mesh Size (mm)	Number of Gillnets Canoes	Percentages (%)
30	20	3.9
40	38	7.4
45	52	10.1
50	36	7.0
55	34	6.6
60	36	7.0
65	36	7.0
70	36	7.0
75	42	8.2
80	40	7.8
85	32	6.2
90	0	0
100	32	6.2
120	40	7.8
160	20	3.9
180	20	3.9
	514	**100**

Table 21: Fish species composition by weight (kg) caught by different mesh size ranges of gillnets in Lekki lagoon (Percentage in parenthesis)

Fish species	Mesh size of gillnet		
	30 - 45	50 – 70	75 – 180
Tilapia guineensis	37.8 (16.8)	64.9(16.8)	54.1 (10.3)
Ethmalosa fimbriata	50.6 (22.4)	20.2 (5.2)	0.0
Chrysichthys nigrodigitatus	20.7 (9.2)	30.2 (7.8)	54.9 (10.5)
Chrysichthys walkeri	20.1 (8.9)	29.2 (7.6)	52.5 (10.0)
Chrysichthys filamentosus	15.6 (6.9)	28.7 (7.4)	54.5 (10.4)
Caranx hippos	10.7 (4.5)	34.4 (8.9)	75.9 (14.5)
Sphyreana barracuda	10.1 (4.5)	40.7 (10.5)	90.5 (17.3)
Cynoglossus senegalensis	6.7 (3.0)	24.4 (6.3)	65.1 (12.4)
Trachinotus teraia	5.6 (2.5)	21.4 (5.5)	75.9 (14.5)
Hemichromis fasciatus	15.2 (6.7)	24.2 (6.3)	0.0
Schilbe mystus	12.1(5.4)	18.4 (4.8)	0.0
Alestes baremose	4.2 (1.9)	17.4 (4.5)	1.0 (0.2)
Mormyrus rume	6.1 (2.7)	16.4 (4.2)	0.0
Synodontis clarias	10.1 (4.5)	15.9 (4.1)	0.0
Total	225.6 (100)	386.4 (100)	524.4(100)

Table 22: Different mesh size ranges of gillnet category and weight (kg) of caught in Lekki lagoon (Percentage in parenthesis).

Gillnet category based on mesh size (mm)	Number of gillnet canoes	Weight (kg) of fish caught	Average catch/canoe (kg)
30 – 45	110 (21.40)	225.6 (19.85)	2.05
50 – 70	178 (34.63)	386.4 (34.01)	2.19
75 – 180	226 (43.97)	524.4 (46.14)	2.32

Table 23: Length frequency distribution of *Tilapia guineensis* caught by gillnets 40mm, 50mm and 75mm stretched mesh sizes.

Total length (cm)	Number of fish species (Percentage in parenthesis)		
	40mm	50mm	75mm
10	20 (2.0)	0	0
11	85 (8.5)	0	0
12	120 (12.0)	50 (4.3)	0
13	260 (25.9)	150 (12.9)	0
14	300 (29.9)	169 (14.5)	0
15	180 (17.9)	215 (18.4)	0
16	20 (2.0)	290 (24.9)	0
17	10 (1.0)	250 (21.4)	50 (4.2)
18	5 (0.5)	20 (2.0)	90 (7.6)
19	4 (0.4)	10 (0.9)	120 (10.10)
20	0	5 (0.4)	172 (14.5)
21	0	4 (0.3)	200 (16.8)
22	0	2 (0.2)	225 (18.9)
23	0	0	100 (8.4)
24	0	0	82 (6.9)
25	0	0	70 (5.9)
26	0	0	40 (3.4)
27	0	0	20 (1.7)
28	0	0	10 (0.8)
29	0	0	5 (0.4)
30	0	0	5 (0.4)
Total	**1004**	**1166**	**1189**

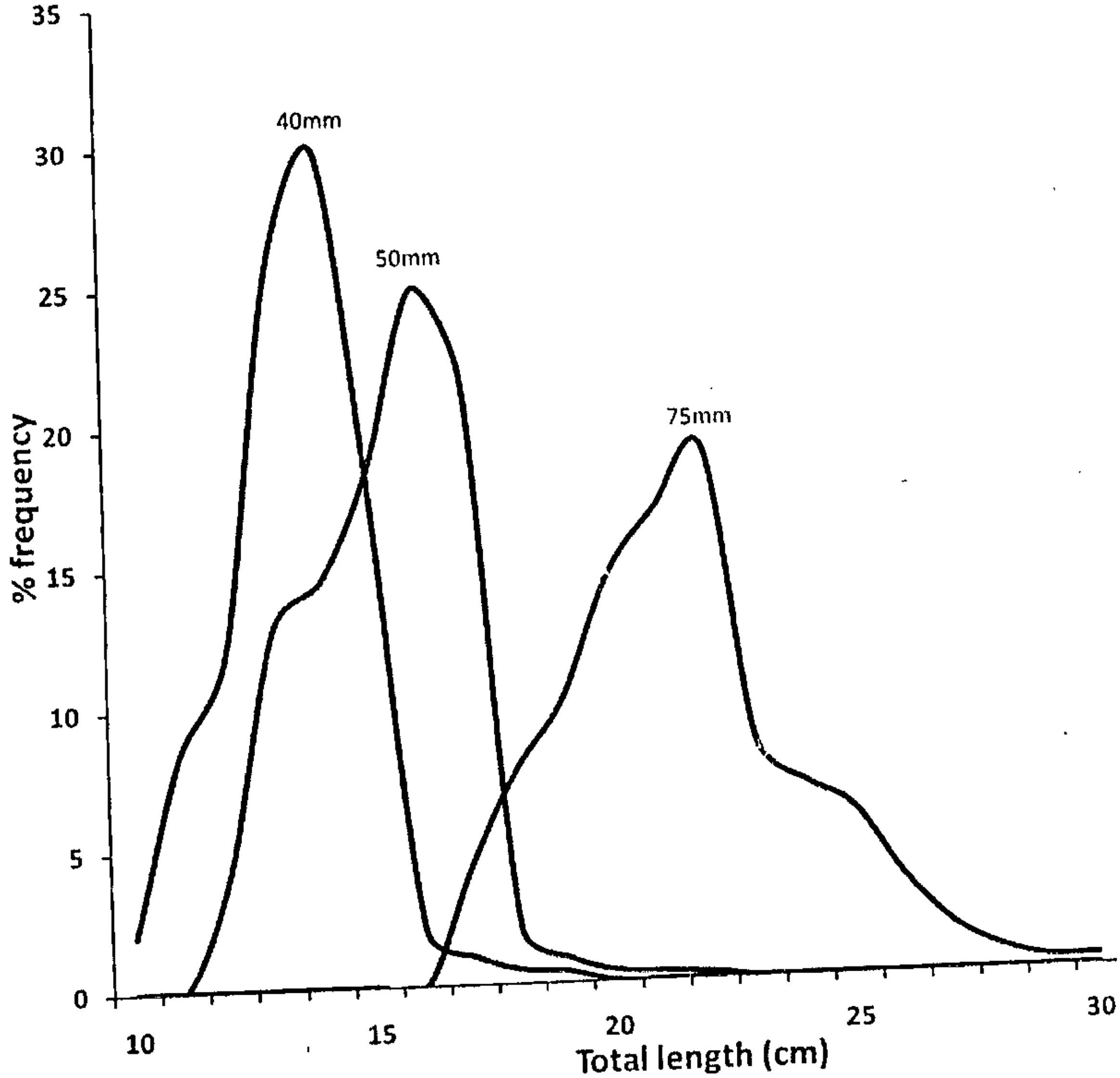

Fig. 27: Selection curve for T. guineensis caught by gillnets in Lekki lagoon.

Table 24: Length range, mean retention length and standard deviation of *T. guineensis* caught by gillnets in Lekki lagoon.

Mesh size(cm)	Total length range (cm)	Mean retention length (cm)
4	10.0 – 19.0	13.5
5	12.0 – 22.0	17.0
7.5	17.0 - 30.0	23.5

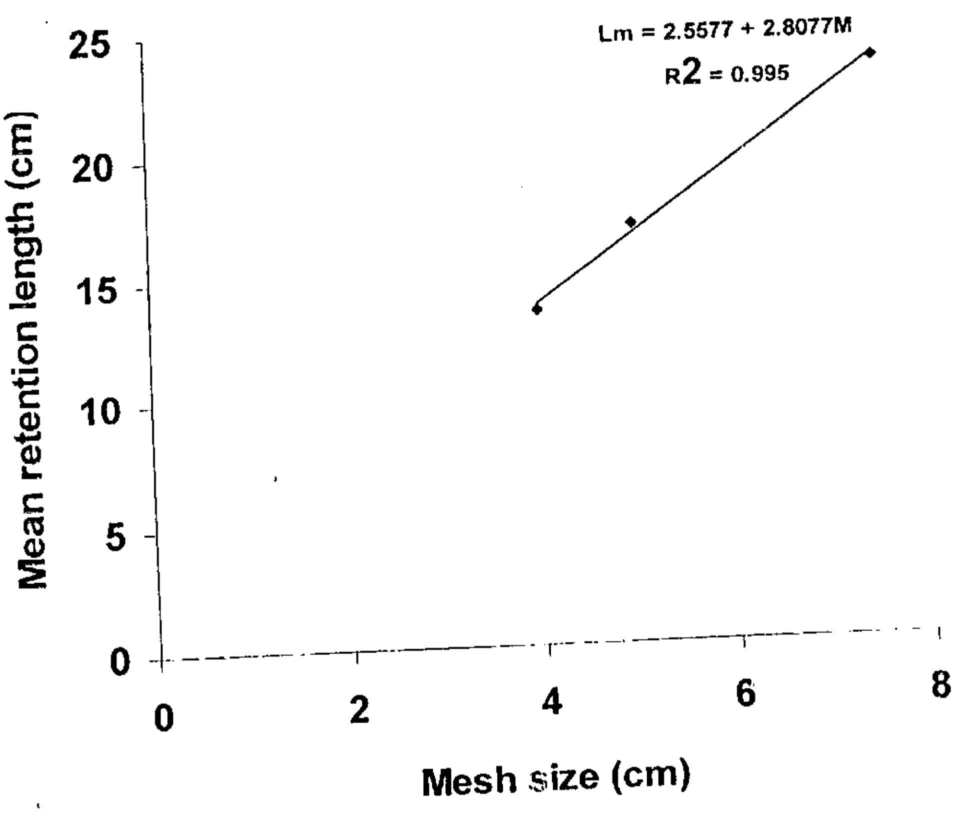

Fig. 28: The variation of mean retention length of *T. guineensis* with mesh size.

To further support the selectivity result of the gillnets, data were grouped by mesh size for the whole period of the test and number of fish caught according to mesh size, means and standard deviations of head girth and maximum girth are shown in Table 25 & Figure 29. The relationship between head girth and total length and maximum/body girth and total length from fitting the linear regression for *T. guineensis* were as follows for 50mm and 54mm mesh size:

$$Gmax = 1.2212 + 0.6951\ TL \qquad (n = 317) \qquad r = 1$$

$$Gh = -0.066 + 0.6443TL \qquad (n = 317) \qquad r = 1$$

Figure 30 shows that the optimum catch length of the 50mm net appears to be greater for fish in14.5cm length group, the same also was observed for 54mm mesh size but with lower number of fish. Plates 8 & 9 show gillnets operations in the Lekki lagoon using outboard engines. Plate 10 show gillnet kept on platform directly under the sun which results in net deterioration.

Table 25: Total length frequency distribution of fish caught according to mesh size, mean and standard deviations of head girth and maximum girth for *T. guineensis*.

Length Class (cm)	Stretched mesh size		Mean Head Girth	S.D Head Girth	Mean Max. Girth	S.D. Max. Girth
	50mm	54mm				
12.5	9	0	8.02	0.51	9.91	0.39
13.5	74	8	8.64	0.50	10.60	0.33
14.5	100	72	9.26	0.42	11.31	0.48
15.5	23	21	9.88	0.43	12.00	0.78
16.5	6	3	10.50	0.60	12.68	0.98
17.5		1	11.29		13.39	
Mean			9.60	0.49	11.65	0.59

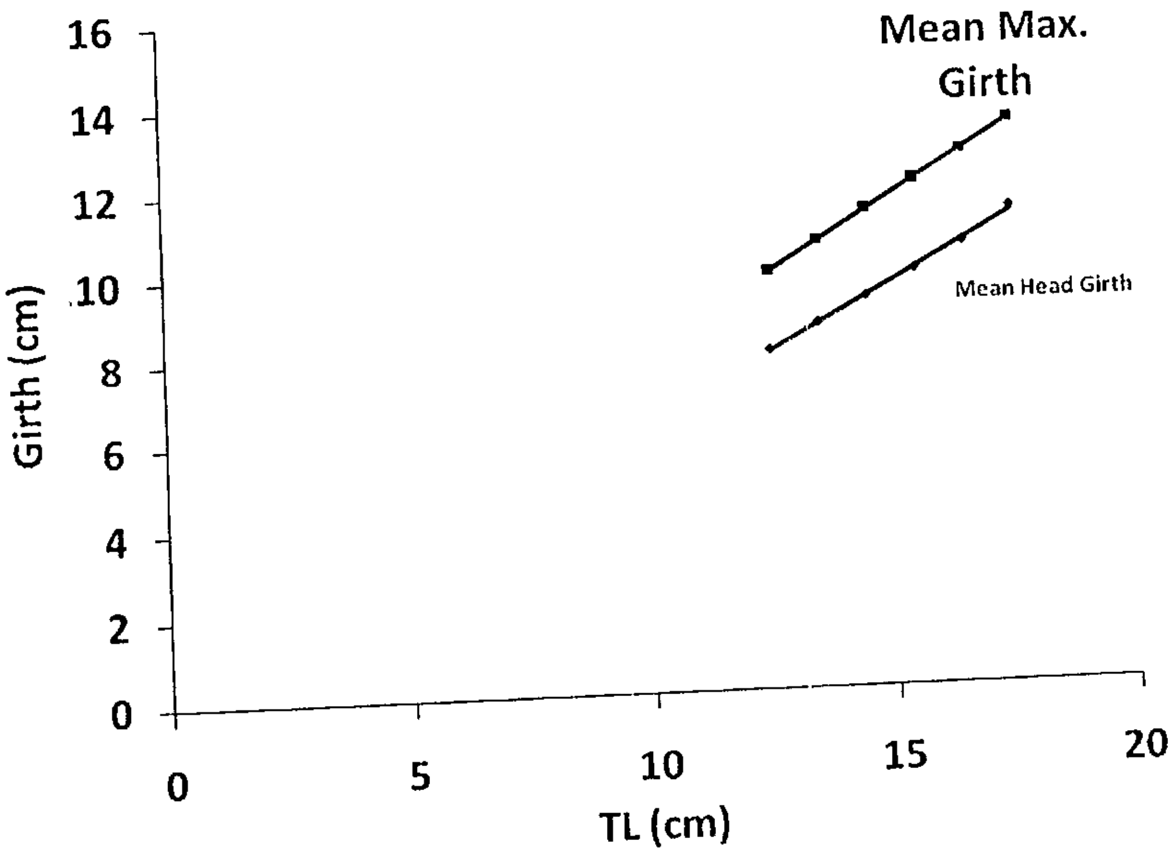

Fig. 29: Relationship between mean head girth and total length and mean body girth and total length of *T. guineensis*.

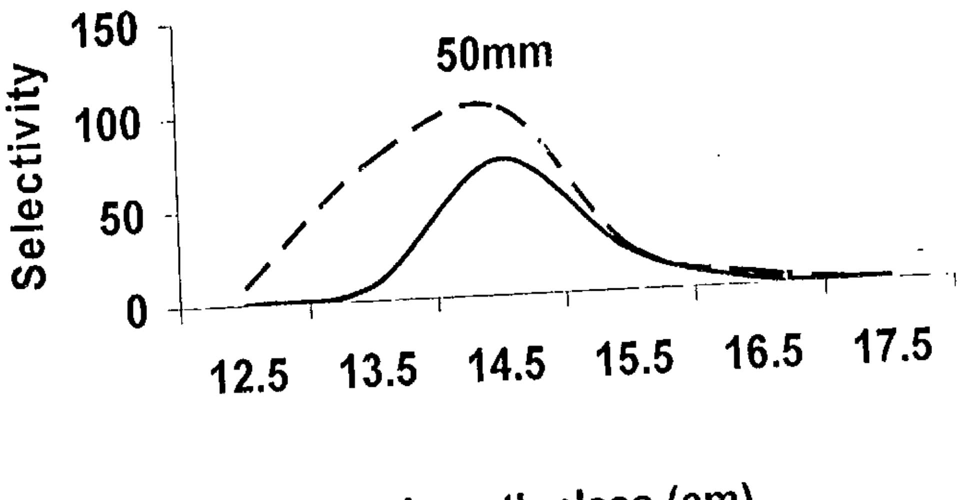

Fig. 30: Observed estimated gillnet selectivity curve for the 50mm and 54mm mesh sizes used in the Lekki lagoon.

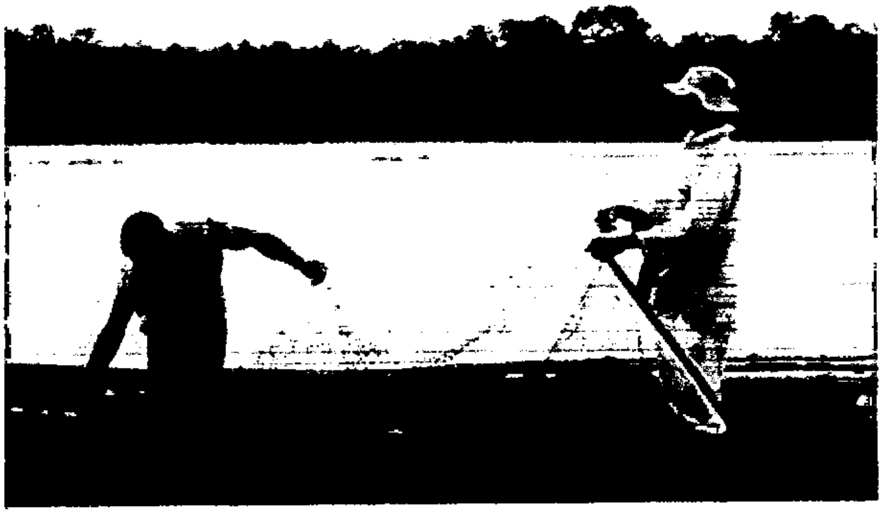

Plate 8: Gillnet operation in Lekki lagoon

Plate 9: The author and the engine boy during the gillnet operation in Lekki lagoon

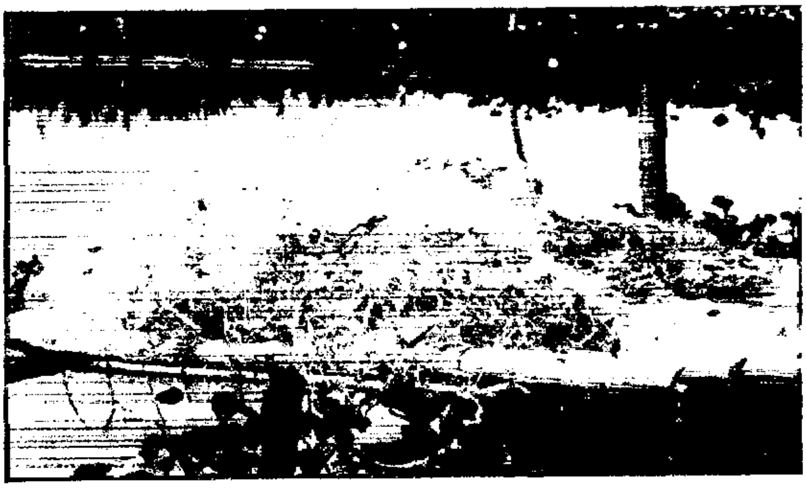

Plate 10: Gillnet on a platform made from bamboo exposed to the sun.

4.5.3 Variation in the Catches of the monofilament and multifilament gillnets in Lekki lagoon.

The weight of fish caught in monofilament gillnet were more than that of multifilament gillnet (Table 26). The Chi square test revealed that the weight of fishes caught with monofilament were not statistically significant to that of multifilament.This indicated that although the monofilament gillnet caught more fishes than the multifilament, it is not statistically proven.

Table 26: Monthly variation by weight (kg) of *Tilapia guineensis* caught from 50mm mono and multifilament gillnets in Lekki lagoon.

Month	Monofilament	Multifilament
January	5.51	4.90
February	8.20	5.00
March	10.10	7.28
April	9.22	6.94
May	11.26	8.26
June	7.82	6.27
July	7.26	5.22
August	8.21	4.20
September	6.21	5.22
October	8.61	7.12
November	10.10	9.11
December	12.12	8.97
Total	**104.62**	**78.49**

4.5.4 Boat seine fishery in Lekki lagoon

A total of 10784 individuals from eleven families and fourteen different species were caught in 6 hauls as shown in Table 27.*Ethmalosa fimbriata* had the highest percentage at 17.16 %, by number of individuals in the composition. Other species were as follows: 13.91% for *Tilapia guineensis*, 12.75% for *Caranx hippos*, 12.05% for *Chrysichthys nigrodigitatus*, 11.96% for C. walkeri, 11.95% for C. filamentosus, 10.02% for *Sphyreana barracuda* and 10.02% for other species like *Cynoglossus senegalensis, Callinectes amnicola, Macrobrachium vollenhovenii, M. macrobrachion, Hepsetus odoe, Polydactylus quadrifilis* and *Elops lacerta.*

Table 27: Catch composition of boat seine nets experiment by number of individual fish in Lekki lagoon (May, 2007)

Species	Number of individual	Percentage
Ethmalosa fimbriata	1850	17.16
Tilapia guineensis	1500	13.91
Caranx hippos	1375	12.75
Chrysichthys nigrodigitatus	1300	12.05
Chrysichthys walkeri	1290	11.96
Chrysichthys filamentosus	1289	11.95
Sphyreana barracuda	1100	10.20
Cynoglossus senegalensis	189	1.75
Callinectes amnicola	180	1.67
Macrobrachium vollenhovenii	170	1.58
Macrobrachium macrobrachion	168	1.56
Hepsetus odoe	125	1.16
Polydactylus quadrifilis	124	1.15
Elops lacerta	124	1.15
Total	**10,784**	

The covered cod end experiment revealed that most fish caught in the conventional cod end (24mm) were juvenile fishes with lesser weight compared to the catch in the covered cod end. The covered mesh size (50mm) retained only 4073 (37.77%) of the total catch while a total of 6711 (62.23%) swim through and was caught by the cod end (24mm). Although high numbers of fish was caught in the cod end, they only accounted for 209.66kg (35.71%) of the total catch while the covered cod end (50mm) catch accounted for 377.46 (64.29%).Table 28 shows a comparison of catches in covered cod end (50mm) and the conventional codend (24mm) in Lekki lagoon.

Table 28: Comparison of catches in covered cod end (50mm) and the conventional codend (24mm) in Lekki lagoon

Species	Covered mesh size (50mm)	Conventional codend (24mm)
Ethmalosa fimbriata	200 (10.00)	1650 (24.75)
Tilapia guineensis	700 (45.50)	800 (32.00)
Caranx hippos	375 (56.25)	1000 (50.00)
Chrysichthys nigrodigitatus	500 (37.50)	800 (32.00)
Chrysichthys walkeri	560 (41.44)	729 (29.16)
Chrysichthys filamentosus	580 (43.50)	709 (29.07)
Sphyreana barracuda	700 (105.0)	400 (30.00)
Cynoglossus senegalensis	100 (10.00)	89 (4.45)
Callinectes amnicola	80 (4.00)	100 (2.00)
Macrobrachium vollenhoevenii	40 (0.40)	130 (0.65)
Macrobrachium macrobrachion	38 (0.37)	131 (0.79)
Hepsetus odoe	50 (4.25)	75 (3.00)
Polydactylus quadrifilis	100 (16.00)	24 (1.56)
Elops lacerta	50 (3.25)	74 (2.59)
Total	**4073 (377.46)**	**6711 (209.66)**

NB: Weight in parenthesis

4.5.5 Long-line hook fishing trial in Lekki lagoon

The result of the experimental long line hook fishing is summarized in Table 29. Five hundred and forty – one fishes (14 species in total) were caught weighing a total of 253.71kg. The majority of the species and of the total catch consisted of commercially important species, with high value bagrid catfish (*Chrysichthys nigrodigitatus*) accounting for a significant part of the catch.

Catch rates (number of fish per 200 hooks) were generally low; rarely exceeding 5% for hook number 13 and less than 3% for the hook numbers 7 and 8. However, there was considerable variation in the catch rates and the percentage of hooks that were retrieved still with bait varied from 5 – 25% per set. The smallest hook (no. 13) caught the highest number of fish (192). The intermediate size (no.8) caught 177 fish and was the most successful in terms of total weight (39.2%). For most species there was a clear difference in terms of efficiency between the largest hook (no. 7) and the smallest (no. 13). Overall, the number 7 hook caught fewer fish (152) and accounted for only 28.9% of the total catch by weight.

As a group, the two species of bagrid catfish (Bagridae) *C. nigrodigitatus* and *C. filamentosus* was most abundant with 145 fish (27.41%) weighing 7.85kg. Two species of the clariids (*Clarias gariepinus* and *C. isheriensis*) contributed 15.12% of the total catch and 13.50kg of the weight. The commercially important *Gymnarchus niloticus* accounted for 13.04% of the total catch with 69 fish weighing 91.20kg. The cichlid, *Tilapia guineensis* contributed 6.62% of the total catch and 2.65kg of the total weight. The threadfin, *Polydactylus quadrifilis* contributed 33 (6.24%) weighing 48.87kg of the total weight. The sphyreanid, *Sphyreana barracuda* accounted for

7.00% of the catch, weighing 46.84kg of the total weight. *Mormyrus rume*, *Hepsetus odoe* and *Alestes baremose* all contributed 1.89% (1.72kg weight), 6.99% (1.89kg weight) and 2.27% (1.03 kg weight) respectively.

In general there was strong overlapping of the catch frequently distributions, with little evidence for an increase mean size with hook size for most species. Hook size also did not appear to significantly affect the minimum size of fish caught per species. Small increases in mean size as a function of overall hook size were found in all the fishes.

Table 29: Catch by hook number from long -line set.

Family and species	Hook no 13			Hook no 8			Hook no 7			Total
	N	ML (cm)	S.D	N	ML (cm)	S.D	N	ML (cm)	S.D	
Bagridae *Chrysichthys nigrodigitatus*	55	15.0	3.06	20	19.2	2.50	10	20.5	2.50	85
C. filamentosus	35	14.5	2.50	10	18.5	2.80	15	20.2	1.92	60
Gymnarchidae *Gymnarchus niloticus*	10	48.5	5.07	30	56.5	3.60	29	76.2	3.01	69
Cichlidae *Tilapia guineensis*	20	12.3	3.10	10	18.6	1.56	5	19.6	2.10	35
Cynoglossidae *Cynoglossus senegalensis*	5	30.5	2.40	10	45.6	2.62	7	48.6	2.60	22
Clariidae *Clarias gariepinus*	15	26.6	3.60	20	35.6	3.40	10	40.2	3.60	45
C. isheriensis	20	15.1	4.60	10	16.2	3.45	5	20.5	2.20	35
Characidae *Alestes baremose*	2	20.1	1.50	5	25.6	2.70	5	30.1	2.60	12
Carangidae *Trachiotonus teraia*	5	15.6	1.80	10	36.5	3.70	11	40.2	3.70	26
Caranx hippos	1	20.0		10	46.0	2.60	11	52.1	2.71	22
Mormyridae *Mormyrus rume*	5	18.84	2.15	2	25.6	1.60	3	42.0	2.11	10
Polynemidae *Polydactylus quadrifilis*	1	14.5		15	50.2	6.20	17	87.5	4.60	33
Sphyraenidae *Sphyraena barracuda*	3	34.80	2.00	15	76.0	4.60	19	86.1	3.60	37
Hepsetidae *Hepsetus odoe*	15	15.6	1.62	10	18.2	3.20	5	20.2	2.10	30
Total	192			177			152			521
Total catch weight (kg)	17.02			85.17			151.52			

N.B: (ML (cm) = mean total length, S.D = standard deviation).

4.5.6 Fishing Agregating Devices in Lekki lagoon

The beachline of Lekki Lagoon consists of two main types of habitat: Sandy beach and swamp. River mouths and parts of the lagoon beach are fringed with swamp vegetation, dominated by *Vossia* sp, *Pistia stratiotes*, *Cyperus sp*, water lilies and aquatic macrophytes *Echhornia crassipes* (water hycianth). The fish community of the river mouth (Saga and Osun Rivers) and lagoon beach swamps owes its distinctive character to no forms, including several mormyrids, characidis, Bagrids, cichlids and freshwater prawns. The shape of the boundaries between swamps and the lagoon is constantly changing. The combined actions of wind and waves can loosen open waters of the lagoon as floating Islands. The Lekki lagoon floating islands were purchased from Saga village along River Saga between N15, 000 and N20, 000 per island (between 20 and 30m^2). The floating Islands in Lekki lagoon regularly shelter several species of fishes. Three floating islands were used for the experiments.

Floating islands are composed of primarily of *Echhornia crassipes, Cyperus sp* or *Vossia* spp. The submerged parts of this vegetation comprise a complex framework of closely spaced densely tangled roots, providing many crevices in which small fishes can hide from larger, predatory fishes.

The roots also provide substrata or shelter for edible organisms. Epiphytic algae were noted, and dragonfly and dawnselfly larvae water scorpions and post larval fishes were collected beneath floating islands. The dimensions and dominant plant types for floating island for experimental trial are given in Table 30.

Table 30: Dimensions and Dominant Plant Types for Floating Islands in Lekki Lagoon

Dimensions	Floating Island		
	1	2	3
Length x width (m)	30 x 20	40 x 30	50 x 30
Circumference at waterline (m)	264.2	448.5	565.7
Maximum height above water (m)	2.7	3.1	3.7
Maximum depth below water (m)	2.10	2.50	1.78
Surface area (m^2)	600	1200	1500
Dominant Plant	Water hyacinth	*Vossia sp*	*Cyperus sp*

The performance of the floating island depends on the size and the thickness. Table 31 shows the fish species composition by weight in the floating island. *Chrysichthys nigrodigitatus* contributed 25.51%, 23.42% and 25.19% of the total weight of floating island 1, 2 and 3 respectively. *Tilapia guineensis* contributed 17.0%, 21.55% and 23.18% for floating island 1, 2 and 3 respectively.

Normally, giant basket trap with fence are used for floating island harness in Lekki lagoon but for this fishing trial, gillnet (50mm) was also used to sample one of the island (40 x 30m). Table 32 & Figure 31 show the comparison of fish caught with gillnet (50mm mesh size) in the floating island (installed for 12 weeks) and open water. The fishing operation with use of acoustic yielded the highest catch by weight of 47.22% followed by fishing without acoustic (33.33%) and the least catch was recorded in the open lagoon (19.44%). The use of the acoustics increases the catch due to the disturbances imposed on the environment which scared the fishes into the traps.

Table 31: Fishes collected beneath floating islands in Lekki Lagoon (Percentage Weight)

Species	Fish caught (kg) in the Floating Island		
	1 (kg)	2 (kg)	3 (kg)
Bagridae			
Chrysichthys nigrodigitatus	30(25.51)	40(23.42)	50.2(25.19)
C. walkeri	19(8.50)	25.2(14.75)	35.2(17.66)
C. filamentosus	10(8.50)	15.6(9.13)	
Cichlidae			
Tilapia guineensis	20(17.00)	36.8(21.55)	46.2(23.18)
Tilapia mariae	10(8.50)	15.0(8.78)	20(10.04)
Hemichromis fasciatus	6.2(5.27)	7.6(4.45)	8.2(4.11)
Elapidae			
Elops lacerta	2.1(1.79)	1.6(0.94)	3.2(1.61)
Hepsetidae			
Hepsetus odoe	3.1(2.64)	1.1(0.64)	3.2(1.61)
Palaemonidae			
Macrobrachium vollenhoevani	10.5(8.93)	10.2(5.97)	11.2(5.62)
Macrabrachium macrobrachion	5.6(4.76)	6.2(3.63)	8.70(4.37)
Portunidae			
Callinectes amnicola	10.1(8.59)	12.6(7.38)	13.2(6.62)
Total	**117.6**	**170.8**	**199.3**

Table 32: Comparison of Fish Caught with Gillnet (50mm mesh size) in the Floating Island (Installed for 12 weeks) (40 x 30m) and the open lagoon

Operational Type	Weight of Fish Caught (kg)	Percentage
Floating Island Fishing (without acoustic)	60.0	33.33
Floating Island Fishing with acoustic	85.0	47.22
Open Water	35.0	19.44
Total	**180.0**	**100.0**

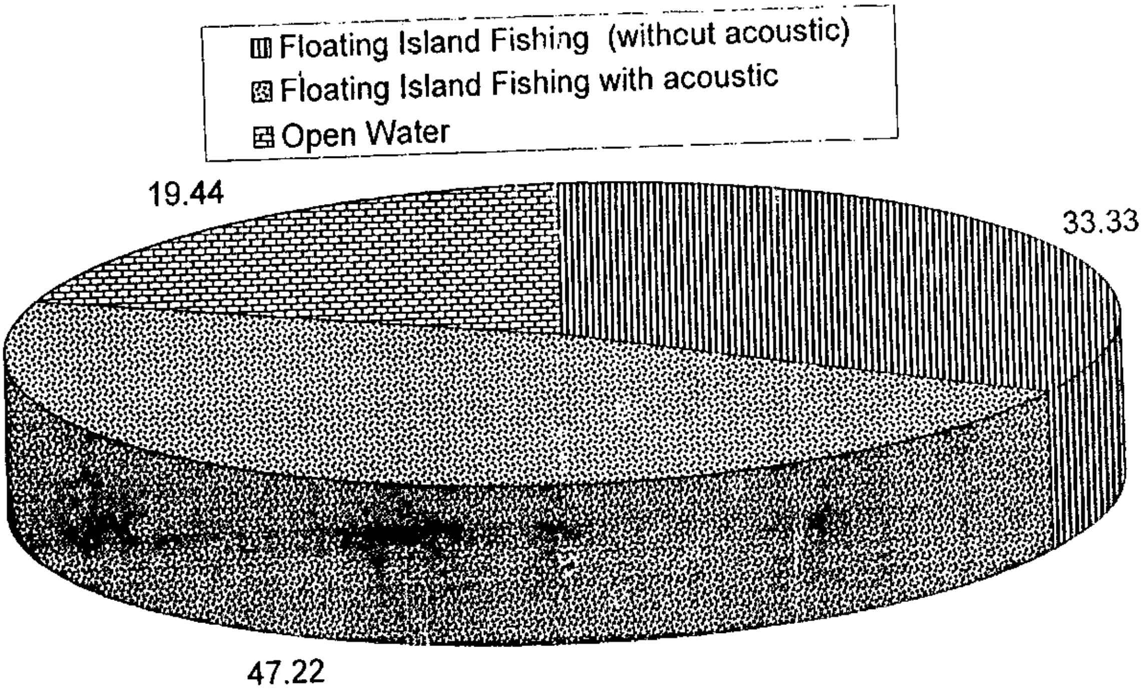

Fig. 31: Percentage by weight of fish caught in floating island and open lagoon

4.5.7 Basket trap in Lekki lagoon

The selectivity of bait for basket traps revealed that the fish species preferred canoe soap tablet to the other baits (cassava tuber, *Manihot sp* and coconut, *Cocos nucifera*) (Table 33).

Table 33: Baits selectivity in basket trap fishery in Lekki lagoon

Species	Bait types catches in kilogram		
	Cassava tuber	Coconut	Canoe tablet soap
M. vollenhoevenii	3.00	3.90	4.20
M. macrobrachion	4.00	4.90	5.20
C. jaensis	8.50	8.20	10.21
C. isheriensis	10.50	12.20	12.60
E. calabaricus	13.20	12.00	13.50
P. senegalus	13.29	9.00	10.99
H. fasciatus	8.00	9.25	11.14
Total	60.49	59.45	67.84

4.6 NETTING MATERIALS USED IN LEKKI LAGOON

Two major netting materials (fibre) (PA and PE) were identified in Lekki Lagoon. Polyamide (PA) fibre was soluble in hydrochloric acid and glacial acetic acid. Sample A, B, C, E and F were polyamide 6 (PA6) gillnet while samples in group E were boat seine and encircle nets. Table 34 shows the different netting materials used in Lekki lagoon.

The most common synthetic material used for gillnet was polyamide (PA) also called nylon. The advantage of nylon (PA), compared to materials made of other synthetic fibres is that it is more elastic. Polyethylene (PE) was a cheap material used for gillnet construction in Lekki Lagoon. Polyethylene showed equal efficiency with polyamide (PA) nets of the same size. However, the PE nets were easily torn and damaged thus; they were incomparable with PA nets in terms of longevity, although they were cheaper.

Table 34: Identification of synthentic fibre with solubility test

Reagent\Netting samples	A	B	C	D	E	F	G
(a) Hydrochloric acid/ HCl (37%) 30 minutes at room temperature	+	+	+	0	+	+	+
(b)Tetraoxosulphate (vi) acid H_2so_4 (97%) 30 minutes at room temperature	+	+	+	0	+	+	+
(c)Dimethyl formamide/$HCON(CH_3)_2$ 5 minutes boiling	+	+	+	0	+	+	0
(d) Formic acid/HCOOH (98 – 100%) 30 minutes at room temperature	+	+	+	0	+	+	+
(e) Glacial acetic acid/ CH_3-COOH 5 minutes boiling	+	+	+	+	+	+	+
(f) Xylene/ C_6H_4 $(CH_3)_2$ 5 minutes boiling (inflammable!)	0	0	0	+	+	+	+
(g) Pyridine 30 minutes at room temperature	0	0	0	0	0	0	0
Kind of fibre	PA6	PA6	PA6	PE	PA6	PA6	PA6.6

+ =soluble o = not soluble

4.7 SEASONALITY IN FISHING OPERATION IN LEKKI LAGOS

Three major fishing season were observed in Lekki lagoon. Gillnet season (January - May) Longline (June - October) and Cast net season (November - December) (Table 35). In gillnet season, other gears like longlines, castnets, boatseine, bamboo traps, traps and floating island fishery were operated but gillnets were majorly used likewise in the other two seasons (longline and castnet). According to the fisherfolks the essence of seasonality operation was to maximise their profits. Since they were aware of the fishes that were available in each season, there was a need to adjust their operation to match them. On the other hand, this also increases their cost of operation in the areas of gear procurement, design and construction. This also had led to borrowing of money which in some cases they may not be able to pay back before the other season set in. Although it makes all fishes to be available in the market, to the fisherfolks, it was not economical.

Table.35: Seasonal composition of fishing gears in Lekki lagoon

Gear	Gillnet season (Jan. - May) (%)	Longline season (June - October) (%)	Castnet season (Nov. – Dec.) (%)
Gillnet	50	20	20
Longline	11	50	10
Castnet	10	10	60
Trap	7.6	12	3.0
Bamboo trap	6.6	6.6	1.0
Liftnet	2.2	2.2	1.0
Boat seine	6.6	4.6	2.0
Floating island fishery	6.0	8.0	3.0

4.8 GENERAL SURVEY OF THE FISH FAUNA IN LEKKI LAGOON

A total of 16,960 specimens made up of juveniles and adults caught with different fishing gears types in the Lekki lagoon, were identified and classified. They comprised of eigty - one species belonging to 40 families, 56 genera and 14 orders. Decapod crustaceans comprised the freshwater prawns (*Macrobrachium vollenhovenii* (Herklots) and *Macrobrachium macrobrachion* (Herklots) and the swimming crab *Callinectes amnicola* (De Rocheburne). Table 36 shows a list of fish order, family and species, the size and weight ranges of the fish specimens. Anabantidae was represented by species (*Ctenopoma petherici*)). Currently the species was caught mainly with double funnel traps in and around the river mouth between station A and B. Dasyatidae was represented by only one species *Dasyatis garouaensis* (Stanch & Blanc) and being listed in the Lekki Lagoon for the first time. The species was caught with boat seine in the sandy area of the Agan station D. The length of 65.0cm and a weight of 400g were recorded for the species. The family mormyridae was represented with twelve species. This family had the highest species in the lagoon.Only two specimens of *H. longifilis* were recorded throughout this study.

Table 36: Fish Species Composition in Lekki Lagoon

Order/Family/Species	Total Length Range (cm)	Standard Length (cm)	Weight (g)
Perciformes			
Anabantidae			
Ctenopoma petherici (Gunther, 1864)	6.0 – 13.5	4.5 – 11.0	20.0 – 95
Centropomidae			
Lates niloticus (Linne, 1762)	10.5 – 60.0	8.2 – 55.0	40.0 – 4000
Carangidae			
Caranx hippos (Linnaeus, 1766)	5.5 – 59.5	4.0 – 53.5	9.0 – 3900
Trachinotus teraia (Cuvier, 1832)	9.5 – 45.0	7.0 – 40.5	20.0 – 3600
Cichlidae			
Tilapia guineensis (Bleeker, 1862)	4.0 – 21.0	3.0 – 19.5	2.81 – 700
Tilapia zilli (Gervais, 1848)	5.5 – 24.0	3.5 – 18.40	5.94 – 530
Tilapia mariae (Boulenger, 1899)	5.7 – 16.0	3.5 – 14.5	3.0 – 410
Chromidotilapia guntheriguntheri (Sauvage, 1882)	5.0 – 12.0	3.0 – 9.5	4.0 – 200
Sarotherodon melanotheron (Rupell, 1852)	4.4 – 16.0	3.0 – 14.0	3.70 – 375
Oreochromis niloticus (Linne, 1758)	6.8 – 26.0	4.5 – 23.0	13.0 – 857
Hemichromis fasciatus (Peters, 1852)	4.4 – 12.0	3.2 – 10.0	4.16 – 120
Hemichromis bimaculatus (Gill, 1862)	3.9 – 10.0	2.5 – 8.5	3.39 – 30.0
Eleotridae			
Eleotris vittata (Dumeril, 1858)	7.8 – 14.5	5.5 – 10.5	7.95 – 150.0
Kribia nana (Boulenger, 1961)	3.4 – 4.5	2.5 – 3.5	3.40 – 10.0
Channidae			
Parachanna obscura (Gunther, 1861)	14.1 – 30.8	11.5 – 28.5	89.5 – 400
Parachanna africana (Steindachner, 1879)	13.0 – 29.5	10.2 – 27.0	79.8 – 390
Pomadasysidae			
Pomadasys jubelini (Cuvier, 1830)	9.3 – 22.0	7.0 – 19.5	19.75 – 309
Lutjanidae			
Lutjanus dentatus (Dumeril, 1860)	9.3 – 22.0	7.0 – 18.0	20.20 – 311
Polynemidae			
Polydactylus quadrifilis (Cuvier, 1829)	18.0 – 105.0	16.0 – 85.0	20.70 – 6000
Gobiidae			
Bathygobius soporator (Valenciennes, 1873)	12.90 – 14.60 15.40 – 32.50	10.90 – 12.5 13.00 –30.10	24.8 – 40.0 25.0 – 65.0

Order/Family/Species	Total Length Range (cm)	Standard Length (cm)	Weight (g)
Goboides ansorgii (Boulenger, 1909)			
Spyracnidae			
Sphyraena barracuda (Walbaum, 1792)	30.9 – 103.0	27.5 – 87.0	98.5 – 4000
Monodactylidae			
Psettias sebae (Cuvier, 1931)	5.5 – 10.5	3.5 – 8.2	10.5 – 65.0
Distichodontidae			
Ichthyborus monodi (Pellegrin, 1929)	6.0 – 16.5	4.0 – 14.0	16.9 – 66.5
Rajiformes			
Dasyatidae			
Dasyatis garouaensis (Stauch & Blanc, 1962)	35.0		600
Polypteriformes			
Polypteridae			
Polypterus senegalus senegalus (Cuvier, 1829)	9.0 – 30.0	7.0 – 28.0	20.5 – 150.0
Erpetoichthys calabaricus (Smith, 1866)	20.2 – 35.5	18.0 – 33.5	19.5 – 50.2
Elopiformes			
Elopidae			
Elops lacerta (Valenciennes, 1846)	11.0 – 27.0	9.2 – 25.0	9.5 – 241
Osteoglossiformes			
Pantodontidae			
Pantodon buchholzi (Peters, 1876)	5.6 – 10.0	3.0 – 7.0	10.0 – 20.0
Notopteridae			
Papyrocranus afer (Gunther, 1868)	12.2 – 55.5	10.5 – 52.0	12.5 – 1069
Xenomystus nigri (Gunther, 1868)	12.0 – 45.0	10.0 – 42.0	13.0 – 1050
Osteoglossidae			
Heterotis niloticus (Cuvier, 1829)	14.5 – 54.5	12.0 – 50.5	20.0 - 2000
Mormyriformes			
Mormyridae			
Mormyrus rume (Valennciennes, 1846)	12.5 – 48.0	9.5 – 46.5	15.6 – 868
Mormyrus macrophthalmus (Gunther, 1866)	12.2 – 30.1	9.2 – 46.5	20.0 – 600
Hippopotamyrus pictus (Marcusen, 1864)	5.5 – 15.5	4.0 – 12.5	15.0 – 50.5
Hippopotamyrus psittasus	6.5 – 25.0	5.0 – 23.0	18.0 – 75.9
Hyperopisus bebe (Lacepede, 1803)	15.6 – 50.0	12.5 – 48.0	20.5 – 850
Mormyrops anguilloides (Linnaeus, 1758)	9.1 – 63.3	7.0 – 60.0	5.8 – 2453
Marcusenius senegalensis (Steindachner, 1870)	9.6 – 27.3	7.0 – 25.3	10.0 – 248
Pollimyrus adspersus (Gunther, 1866)	5.2 – 9.6	3.5 – 7.2	17.0 – 50.0
Marcusenius brucii (Boulenger, 1910)	6.3 – 30.8	5.0 – 28.5	12.1 – 515
Brienomyrus longianalis (Boulenger,	16.0 – 30.8	14.0 – 28.5	50 – 610

Order/Family/Species	Total Length Range (cm)	Standard Length (cm)	Weight (g)
1901)			
Gnathonemus petersii (Gunther, 1862)	15.0 – 35.0	13.5 – 33.0	48.5 – 590
Mormyrops caballus (Pelledrin, 1927)	9.1 – 46.0	7.1 – 44.2	15.8 – 850
Gymnarchidae *Gymnarchus niloticus* (Cuvier, 1829)	35.0 – 120.0	32.5 – 117	89.0 – 3000
Clupeiformes Clupeidae *Pellonula afzeliusi* (Johnels, 1954)	4.0 – 10.1	3.0 – 8.0	5.0 – 26.0
Ethmalosa fimbriata (Bowdich, 1825)	8.70-14.70	6.80-11.40	5.35-32.26
Characiformes Citharinidae *Citharinus latus* (Muller & Troschal, 1845)	7.0 – 46.0	5.0 – 43.5	25.5 – 1065
Cithranus citharus (Goeffrey Saint Hilane, 1809)	10.0 – 50.0	8.0 – 47.5	45.0 – 2010
Hepsetidae *Hepsetus odoe* (Bloch, 1794)	7.5 – 30.5	5.6 – 28.8	9.26 – 856
Characidae *Alestes macropthalmus* (Gunther, 1867)	20.5 – 30.6	18.2 – 29.0	45.0 – 150.0
Alestes baremose (de Joannis, 1835)	10.5 – 40.5	8.5 – 38.2	20.2 – 300
Brycinus nurse (Ruppell, 1832)	5.3 – 20.5	3.8 – 18.2	5.2 – 212
Brycinus longipinnus (Gunther, 1864)	4.8 – 10.7	3.0 – 8.8	3.6 – 41.6
Siluriformes Bagridae *Chrysichthys Walkeri*	5.5 – 36.5	3.5 – 33.6	4.36 – 724
Chrysichthys nigrodigitatus (Lacepede, 1803)	5.8 – 42.5	4.0 – 40.5	5.0 – 1500
Chrysichthys filamentosus (Boulenger, 1912)	5.6 – 38.5	3.8 – 36.8	4.0 – 798
Parauchenoglanis akiri (Risch, 1987)	10.0 – 12.5	8.0 – 10.0	15.9 – 45.6
Auchenoglanis occidentalis (Valenciennes, 1840)	15.0 – 20.0	13.0 - 18.0	24.0 – 50.1
Schilbeidae *Schilbe mystus* (Linne, 1758)	7.0 – 21.0	5.8 – 19.0	4.15 – 119.5
Schilbe uranoscopus (Ruppell, 1832)	6.2 – 28.5	5.0 – 26.5	7.61 – 360
Clariidae *Clarias gariepinus* (Burchell, 1822)	20.0 – 50.5	17.0 – 46.8	78.00 – 1920
Clarias jaensis (Boulenger, 1909)	10.2 – 20.0	7.5 – 17.9	22.8 – 64.25
Clarias agboyiensis (Sydenham, 1980)	11.2 – 21.0	8.5 – 18.7	21.9 – 72.96
Clarias anguillaries (Line, 1758)	9.0 – 34.5	7.2 – 31.5	17.0 – 65.0
Heterobranchus longifilis (Valenciennes, 1840)	40.5 – 50.0	37.8 – 48.5	1002 – 2100
Malapteruridae *Malapterurus electricus* (Gmelin,	13.0 – 16.5	11.5 – 14.0	60.6 – 89.8

Order/Family/Species	Total Length Range (cm)	Standard Length (cm)	Weight (g)
1789)			
Malapterurus minjiraya (Sagua, 1987)	14.0 – 17.5	12.2 – 15.0	64.7 – 92.0
Mochokidae *Synodontis eupterus*	4.5 – 22.0	3.0 – 20.0	9.2 – 218
Synodontis clarias (Linne, 1758)	5.5 – 22.5	3.8 – 21.0	10.2 – 316
Synodontis couterti (Pellergrin, 1906)	6.5 – 20.6	4.2 – 18.0	10.5 – 212
Synodontis filamentosus (Boulenger, 1901)	5.5 – 18.6	3.0 – 16.2	8.9 – 200
Mugiliformes Mugilidae *Liza falcipinnis* (Valenciennes, 1836)	13.0 – 26.5	10.5 – 19.2	41.6 – 200
Mugil cephalus (Linnaeus, 1758)	12.5 – 20.5	10.0 – 18.0	41.2 – 360
Synbranchiformes Mastacembelidae *Caecomastacembelus decorsei* (Pellegrin, 1919)	14.2 – 36.5	12.5 – 35.0	20.0 – 96.0
Pleuronectiformes Citharidae *Citharus linguatula* (Linnaeus, 1758)	10.30 – 15.0	8.0 – 13.2	9.0 – 15.9
Cynoglossidae *Cynoglossus senegalensis* (Kaup, 1858)	15.6 – 54.0	13.8 – 49.2	20.0 – 460.0
Gonorychiformes Phractolaemidae *Phractolaemus ansorgii* (Boulenger, 1901)	10.5 – 19.0	8.0 – 17.0	17.0 – 56.0
Decapoda Palaemonidae *Macrobrachium vollenhoveni*	6.4 – 13.0	3.00 – 600*	6.06 – 32.4
Macrobrachium macrobrachion	6.4 – 12.00	3.00 – 5.50*	6.04 – 28.29
Portunidae *Callinectes amnicola*	3.4 – 15.5**		19.5 – 115.5

*** Carapace length** **** Carapace width**

The fish species were of three ecological origin and seasonal occurrence in the Lekki Lagoon. There were eleven fishes of euryhaline origin which occurred mostly throughout the year, fifty-six fishes of freshwater origin and ten fishes of marine origin occurred in Lekki Lagoon during this study (Table 37).

Table 37: Fishes and their ecological origin in Lekki lagoon

Freshwater origin	Euryhaline origin	Marine origin
Ctenopoma petherici	*Chrysichthys nigrodigitatus*	*Caranx hippos*
Lates niloticus	*Ethmalosa fimoriata*	*Trachinotus teraia*
Tilapia zillii	*Tilapia guineensis*	*Pomadasys jubelini*
Tilapia marie	*Pellonula afzeluizi*	*Lutjanus dentatus*
Chromidotilapia guntheri guntheri	*Elops lacerta*	*Sphyraena barracuda*
Oreochromis niloticus	*Liza falcipinnis*	*Ethmalosa fimbriata,*
Hemichromis bimaculatus	*Sarotherodon melanotheron*	*Liza falcipinnis*
Eleotris vittata	*Polydactylus quadrifilis*	*Mugil cephalus*
Kribia nana	*Bathygobius soporator*	*Citharus linguatula*
Parachanna obscura	*Cynoglossus senegalensis*	*Cynoglossus senegalensis*
Parachanna africana	*Psettias sebae*	
Ichthyborus monodi		
Dasyatis garouaensis		
Polypterus senegalus senegalus		
Erpetoichthys calabaricus		
Pantodon buchholzi		
Papyrocranus afer		
Hippopotamyrus pictus		
Hyperopisus bebe		
Mormyrops anguilloides		
Marcusenius senegalensis		
Pollimyrus adspersus		
Marcusenius brucii		
Brienomyrus longianalis		
Gnathonemus petersii		
Mormyrops caballus		
Gymnarchus niloticus		
Citharinus latu		
Auchenoglanis occidentalis		
Hepsetus odoe		
Citharinus citharus		
Alestes macropthalmus		
Alestes baremose		
Brycinus nurse		
Brycinus longipinnus		
Chrysichthys walkeri		
Chrysichthys filamentosus		
Parauchenoglanis akiri		
Schilbe mystus		
Schilbe uranoscopus		
Clarias gariepinus		
Clarias jaensis		
Clarias agboyiensis		
Clarias anguillaries		
Heterobranchus longifilis		
Malapterurus electricus		
Malapterurus minjiraya		
Synodontis eupterus		
Synodontis clarias		
Synodontis courteti		
Synodontis filametosus		
Caecomastacembelus decorsei		
Phractolaemous ansorgii		

4.8.1 Fish species dominance in Lekki lagoon

The dominant fish species in the catches of the fisher folks during the year between March 2006 and February 2008 were *Chrysichthys nigrodigitatus, Chrysichthys filamentosus, Tilapia guineensis, T. zilli, Gymnarchus niloticus, Mormynus rume, Elops lacerta, Liza falapinnis, Clarias agboyiensis, Polydactylus quadrifilis* and *Synodontis clarias, Cynolossus senegalensis*. Others fish species observed in the fisher-folks catches during the rainy season period were *Ethmalosa fimbriata, Lates niloticus, Tilapia marie, Sarotherodon melanotheron, Chromidotilapia guntheri guntheri, Oreochromis niloticus, Pomadasys jubelini, Lutjanus agenes, Eleotris vitata, Caranx hippos, Hemichromis bimaculatus, Bathgobius soporator, Pantodon buchholzi, Papyrocranus afer, Sphyreana barracuda, Xenomystus nigri, Mormyrops anguilloides, marcusenius bruci, Pellonula afzeluisi, Citharinus latus, Trachinotus teraia, Cithanus cithanus, Alestes macrophthalmus, Brycinus nurse, Schilbe uranoscopus, Cithanus linguatula, Citharus linguatula, Macrobrachium vollenhoevenii* and *M. macrobrachion*. Few of the lagoon species were recorded for dry season; there were *Parachanna africana. Xenomystus nigri, Hippopotamyrus pictus, Hyperopisus bebe, Marcusenius senegalensis, Polymus adspersus, Brienomyrus longuanalis, Alestes baremose, Parauchenoglanis akiri, Hepsetus odoe, Clarias anguillaries, Malapterurus minijiraya, Synodontis filamentosus* and *Phractolaenus ansorgii*. Fish species dominance and seasonal variation is shown in Table 38.

Table 38: Fish dominance and abundance in Lekki lagoon

Order/Family/Species	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Perciformes												
Anabantidae												
Ctenopoma petherici (Gunther, 1864)	2	2	4	4	4	3	4	3	2	1	3	3
Centropomidae												
Lates niloticus (Linne, 1762)	4	4	4	4	4		3	3	3	4	4	3
Carangidae												
Caranx hippos (Linnaeus, 1766)	4	4	4	3	3	2	4	3	4	3	4	3
Trachinotus teraia (Cuvier, 1832)	3	3	3	3	3	2	2	3	2	2	2	3
Cichlidae												
Tilapia guineensis (Bleeker, 1862)	1	3	1	1	1		1	1	1	1	1	1
Tilapia zillii (Gervais, 1848)	2	3	2	3	1		1	1	4	1	4	2
Tilapia mariae (Boulenger, 1899)	4	2	3	4	4		4	3	2	3	1	3
Chromidotilapia guntheriguntheri (Sauvage, 1882)	3	3	4	4	4		2	4	1	1	2	4
Sarotherodon melanotheron (Rupell, 1852)	3	3	4	4	4		2	4	4	2	4	4
Oreochromis niloticus (Linne, 1758)	4	4	4	4	4		3	2	4	2	3	4
Hemichromis fasciatus (Peters, 1852)	3	3	3	4	4		4	4	3	3	2	2
Hemichromis bimaculatus (Gill, 1862)	3	3	3	4	4		3	4	4	4	4	4
Eleotridae												
Eleotris vittata (Dumeril, 1858)	4	3	3	4	4		2	3	2	-	4	4
Kribia nana (Boulenger, 1961)	4	4	4	4	4		4	4	4	-	4	4
Channidae												
Parachanna obscura (Gunther, 1861)	2	3	2	4	4	2	3	3	2	1	2	4
Parachanna africana (Steindachner, 1879)	2	3	4	4	4	4	4	4	4	4	4	4
Pomadasysidae												
Pomadasys jubelini (Cuvier, 1830)	3	3	4	3	3	3	3	3	3	3	3	3
Lutjanidae												
Lutjanus dentatus (Dumeril, 1860)	4	4	4	3	4	4	4	4	3	4	4	4
Polynemidae												
Polydactylus quadrifilis (Cuvier, 1829)	3	3	3	3	4	3	3	3	3	3	3	3
Gobiidae												
Bathygobius soporator (Valenciennes, 1873)	4	3	3	4	4	3	4	4	4	4	4	4
Goboides ansorgii (Boulenger, 1909)	4	4	3	4	4	3	4	4	3	3	4	4
Spyraenidae												
Sphyraena barracuda (Walbaum, 1792)	2	4	3	3	4	3	3	3	3	3	3	2
Monodactylidae	3	3	4	3	4	3	3	4	3	3	3	4

Order/Family/Species	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Psettias sebae (Cuvier, 1931)												
Distichodontidae	4	4	3	3	4	4	4	4	3	3	4	4
Ichthyborus monodi (Pellegrin,1929)												
Rajiformes												
Dasyatidae												
Dasyatis garouaensis (Stauch & Blanc, 1962)	4	4	4	4	4	4	4	4	3	4	4	4
Polypteriformes												
Polypteridae												
Polypterus senegalus senegalus (Cuvier, 1829)	3	3	3	4	4	2	3	4	2	2	3	3
Erpetoichthys calabaricus (Smith, 1866)	3	3	4	4	4	4	4	4	1	1	1	4
Elopiformes												
Elopidae												
Elops lacerta (Valenciennes, 1846)	3	2	2	3	3	2	3	3	1	4	2	1
Osteoglossiformes												
Osteoglossidae												
Heterotis niloticus	4	4	3	2	2	2	3	3	3	4	4	4
Pantodontidae												
Pantodon buchholzi (Peters, 1876)	4	4	3	3	3	3	3	3	3	4	4	4
Notopteridae												
Papyrocranus afer (Gunther, 1868)	3	2	3	2	4	3	3	3	3	1	3	3
Xenomystus nigri (Gunther, 1868)	7	3	3	3	4	4	4	4	2	3	4	3
Mormyriformes												
Mormyridae												
Mormyrus rume (Valennciennes, 1846)	2	2	2	2	2	2	4	4	2	2	1	3
Mormyrus macrophthalmus (Gunther,1866)	2	3	4	2	4	2	4	4	4	4	2	4
Hippopotamyrus pictus (Marcusen, 1864)	3	4	4	4	4	4	4	4	4	4	1	2
Hyperopisus bebe (Lacepede, 1803)	3	4	4	4	4	4	4	4	4	2	4	4
Mormyrops anguilloides (Linnaeus, 1758)	3	4	4	4	4	4	2	2	2	4	4	4
Marcusenius senegalensis (Steindachner, 1870)	3	4	4	4	4	4	4	4	4	4	4	4
Pollymus adspersus (Gunther, 1866)	3	4	4	4	4	4	4	4	4	4	4	4
Marcusenius brucii (Boulenger, 1910)	3	4	4	2	4	4	2	4	4	4	4	4
Brienomyrus longianalis (Boulenger, 1901)	3	4	4	4	4	4	4	4	4	3	3	3
Gnathonemus petersii (Gunther, 1862)	3	4	3	2	2	4	1	4	1	2	4	4
Mormyrops caballus (Pelledrin,1927)	3	3	4	3	3	3	2	2	2	3	3	4
Hippopotamyrus psittasus (Boulenger, 1897)	3	4	3	3	3	3	3	3	3	3	3	4
Gymnarchidae												
Gymnarchus niloticus (Cuvier, 1829)	3	3	3	2	2	3	2	2	1	1	1	4

Order/Family/Species	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Clupeiformes												
Clupeidae												
Pellonula afzeliusi (Johnels, 1954)	3	3	4	3	2	1	3	4	4	4	1	4
Ethmalosa fimbriata (Bowdich, 1825)	3	3	3	3	1	1	1	3	1	4	3	3
Characiformes												
Citharinidae												
Citharinus latus (Muller & Troschal, 1845)	4	4	4	4	3	3	3	3	3	4	4	4
Cithranus citharus (Goeffrey Saint Hilane, 1809)	4	4	4	4	4	4	4	4	3	3	4	4
Hepsetidae												
Hepsetus odoe (Bloch, 1794)	3	3	3	4	4	4	4	4	3	3	2	3
Characidae												
Alestes macrophthalmus(Gunther,1867)	3	3	3	3	3	3	3	3	4	3	4	1
Alestes baremose (de Joannis, 1835)	3	3	3	4	4	2	4	4	4	3	3	1
Brycinus nurse (Ruppell, 1832)	3	3	4	4	4	3	3	3	2	3	4	2
Brycinus longipinnus (Gunther, 1864)	3	4	4	4	4	4	4	4	1	4	3	3
Siluriformes												
Bagridae												
Chrysichthys Walkeri (Gunther, 1899)	2	3	4	4	4	1	4	2	4	1	1	1
Chrysichthys nigrodigitatus (Lacepede, 1803)	1	1	1	1	1	1	1	1	1	1	1	1
Chrysichthys filamentosus (Boulenger, 1912)	1	1	1	1	1	2	1	4	2	2	2	2
Parauchenoglanis akiri (Risch, 1987)	4	4	4	4	4	4	4	4	3	2	4	3
Auchenoglanis occidentalis (Valenciennes, 1840)	4	4	4	4	4	3	4	4	3	2	3	3
Schilbeidae												
Schilbe mystus (Linne, 1758)	3	2	2	2	2	2	1	1	3	2	3	3
Schilbe uranoscopus (Ruppell, 1832)	3	3	4	4	4	4	4	4	4	-	4	3
Clariidae												
Clarias gariepinus (Burchell, 1822)	2	2	2	4	2	1	4	3	3	1	1	1
Clarias jaensis (Boulenger, 1909)	3	3	4	4	2	4	4	1	1	1	3	2
Clarias agboyiensis (Sydenham, 1980)	3	3	4	4	4	2	1	4	4	1	4	2
Clarias anguillaries (Line 1758)	3	3	1	1	1	4	4	4	4	4	4	3
Heterobranchus longifilis (Valenciennes, 1840	4	4	2	4	4	4	4	4	3	4	4	4
Malapteruridae												
Malapterurus electricus (Gmelin, 1789)	3	3	3	2	2	2	3	4	2	2	2	3
Malapterurus minjiraya (Sagua, 1987)	3	3	4	4	4	4	4	4	4	4	4	3
Mochokidae	3	3	4	4	4	4	4	4	1	4	4	3
Synodontis eupterus	2	2	2	1	1	1	1	2	1	3	1	2
Synodontis clarias (Linne, 1758)	3	3	4	4	4	4	4	4	4	4	4	3

Order/Family/Species	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Synodontis couterti (Pellegrin, 1906)	3	3	4	4	4	1	4	4	4	4	1	3
Synodontis filamentosus (Boulenger, 1901)												
Mugiliformes												
Mugilidae												
Liza falcipinnis (Valenciennes, 1836)	2	2	3	2	2	2	2	3	4	4	1	2
Mugil cephalus (Linnaeus, 1758)	3	4	4	4	4	4	4	4	4	4	3	3
Synbranchiformes												
Mastacembelidae												
Caecomastacembelus decorsei (Pellegrin, 1919)	3	3	4	3	4	4	4	4	4	4	4	3
Pleuronectiformes												
Citharidae												
Citharus lingualata (Linnaeus, 1758)	3	4	4	4	3	3	2	4	3	4	4	3
Cynoglossidae												
Cynoglossus senegalensis (Kaup, 1858)	2	3	3	4	3	2	2	3	3	2	2	2
Gonorychiformes												
Phractolaemidae												
Phractolaemus ansorgii (Boulenger, 1901)	3	3	4	4	4	4	4	4	4	4	3	2
Decapoda												
Palaemonidae												
Macrobrachium vollenhoveni(Herkiots,1857)	3	3	2	2	1	2	1	1	1	3	3	3
Macrobrachium macrobrachion (Herklots,1857)	1	1	2	2	2	2	2	2	2	4	4	4
Portunidae												
Callinectes amnicola (DeRocheburne,1883)	3	3	2	1	1	2	1	1	1	3	3	3

NB: 1, 2, 3& 4 means very abundant, abundant, few and rare respectively

4.8.2 Weight – Length relationship of twenty commercially important fishes from Lekki lagoon

The results of the weight – length relationship analysis of 20 commercially important species belonging to 15 families are summarized in Table 39. Fish size variations were ranged from 4.00cm (*Pellonula afzeluisi* and *Tilapia guineensis*) to 120cm (*Gymnarchus niloticus*). Correlation coefficient (r^2) were ranged from 0.356 (*Gymnarchus niloticus*) to 0.972 (*Pomadasys jubelini)* and all regressions were highly significant ($p < 0.001$). The coefficient b ranged from 1.100 for *P. afzeluisi* to 3.664 for *Chrysichthys filamentosus*. Isometric growth was observed in *Mormyrus rume, G. niloticus and Parachanna obscura* while positive allometric growth was recorded in *C. filamentosus* and *H. odoe*. All other species examined undergo negative allometric growth in the lagoon. The exponent WLR (b) presented an inverse relationship with the logarithm of the intercept (log (a)) (Figure 32). This positive correlation curve is represented by the equation: $y = 0.8424 x + 2.5863$ ($r^2 = 0.30$). The tendency is that the lower *b* occurs with higher *a* value.

Table 39: Descriptive statistics, estimated parameters and type of growth of the weight- length relationship for 20 species caught from Lekki lagoon. I: isometric; - (A): negative allometric; + (A): positive allometric.

Species		Length (cm)		Weight (g)		Parameters of weight-length relationship		Type of growth	
	No.	Min	Max	Min	Max	a	B	r^2(b=3; p =0.05	
Bagridae *Chrysichthys filamentosus*	25	13.00	19.20	16.66	80.12	-2.874	3.664	0.779	+ (A)
Chrysichthys nigrodigitatus	25	13.90	27.40	28.26	116.97	-1.252	2.330	0.866	- (A)
Chrysichthys walker	25	12.20	20.9	12.42	73.74	-1.952	2.843	0.941	- (A)
Cynoglossidae *Cynoglossus senegalensis*	25	15.40	38.6	51.20	153.2	-0.295	1.527	0.753	- (A)
Pomadasyidae *Pomadasys jubelini*	25	11.50	21.80	25.10	132.7	-1.720	2.863	0.972	- (A)
Mugilidae *Liza falapinnis*	25	9.00	26.65	6.75	200.0	-1.692	2.669	0.955	- (A)
Mochokidae *Synodontis courteti*	25	10.5	17.40	24.76	96.35	-1.115	2.496	0.914	- (A)
Synodontis clarias	25	11.10	15.30	32.39	78.13	-1.692	2.294	0.712	- (A)
Mormyridae *Mormyrus rume*	25	16.2	68.00	37.00	995.0	-1.087	2.912	0.441	I
Clariidae *Clarias gariepinus*	25	20.00	50.50	64.41	1920	-0.990	2.172	0.809	- (A)

Species		Length (cm)		Weight (g)		Parameters of weight-length relationship		Type of growth	
	No.	Min	Max	Min	Max	a	B	r^2(b=3; p =0.05	
Clarias isheriensis	25	13.50	22.00	21.04	72.96	-1.742	2.700	0.973	- (A)
Cichlidae *Tilapia zillii*	25	5.50	23.70	5.94	286.10	-0.106	2.836	0.789	- (A)
Tilapia guineensis	25	4.00	21.50	2.81	139.86	-0.690	2.115	0.871	- (A)
Clupeidae *Pellonula afzeliuzi*	25	4.00	10.10	5.00	26.00	0.225	1.100	0.866	- (A)
Gymnarchidae *Gymnarchus niloticus*	25	20.0	120	100	6000	0.543	2.982	0.356	I
Osteoglossidae *Heterotis niloticus*	25	15.50	59.96	49.60	1932	-1.602	2.643	0.504	- (A)
Polynemidae *Polydactylus quadrifilis*	25	21.0	100	100	4000	-1.562	2.863	0.436	- (A)
Channidae *Parachanna obscura*	25	10.10	30.60	40.90	200.0	-2.156	3.021	0.671	I
Hepsetidae *Hepsetus odoe*	25	10.20	30.00	26.56	120.0	-1.680	3.061	0.761	+ (A)
Malapteruridae *Malapterurus electricus*	25	10.30	15.50	30.50	89.0	-0.634	2.668	0.891	- (A)

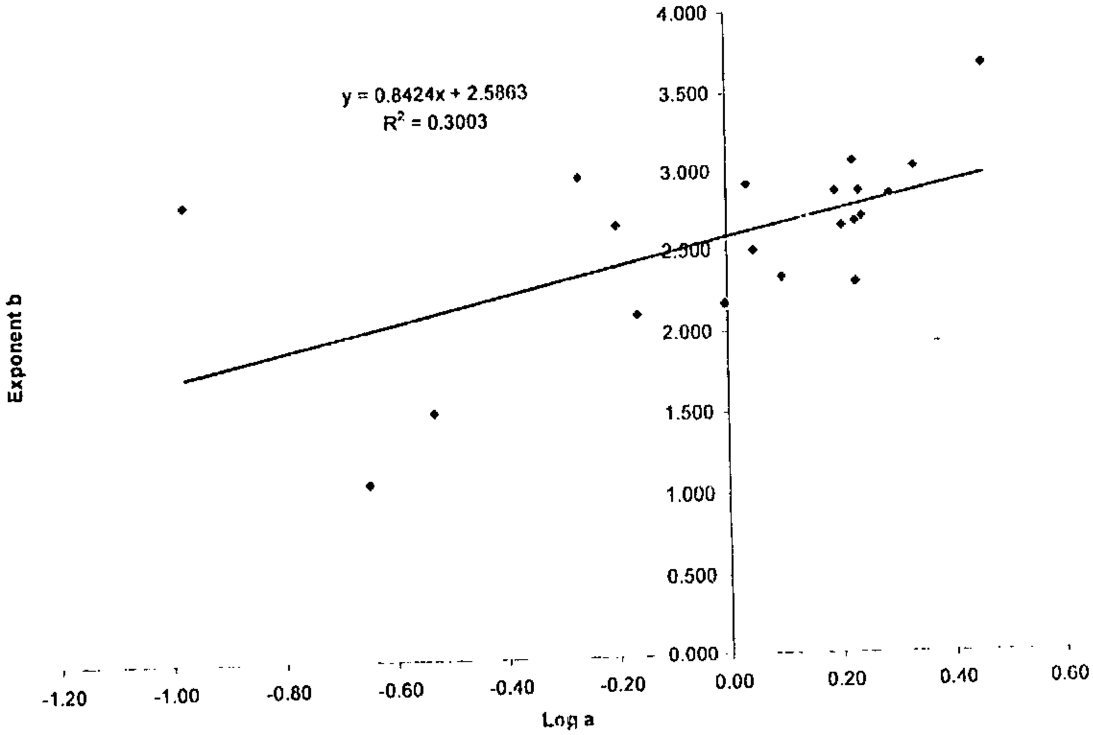

Fig. 32: Regression of parameters b and log (a) of the WLR for some commercially important species in Lekki lagoon

4.9 DESCRIPTION OF FISH SPECIES IN LEKKI LAGOON

***Ctenopoma petherici* (Gunther, 1864)**

It jaw is slightly protratile. It mouth is small with conical teeth; it is reported to be rarely found in brackish water (Shumway, *et al.*, 2003) (Plate 11).

***Parauchenoglanis akiri* (Risch, 1987)**

Mouth is much longer than the length of the snout; its eyes are small, situated superiorly, less than 10% of the head length with uniform or mottled dark brown in its flank (Plate 12).

***Chrysichtlys nigrodigitatus* (Lacepede, 1803)**

Its head and body is not depressed, head is not laterally swollen with fleshy. The snout is pointed, slightly longer than the width of the mouth. It has pectoral spines on the sides and dorsal spine. It has a forked tail. It has an adepose fin. It was reported to be widely distributed (Raji and Olaosebikan, 1998). Maximum length = 500m (Plate 13).

***Chrysichythys Filamentosus* (Boulenger, 1912)**

The eyes are burged out. The first soft dorsal fin ray is the longest often prolonged into a long filament. It has I dorsal spine with 6 dorsal rays, 10 to 12 anal fins and I pectoral spine with 8 rays. The base of the adipose fin is longer than the base of the dorsal fin. It had forked tait. The maximum observed was 300mm. It was reported to be widely distributed (Raji and Olaosebikan, 1998) (Plate 14).

Plate 11: Photograph of *Ctenopoma petherici*

Plate 12: Photograph of *Parauchenoglanis akiri*

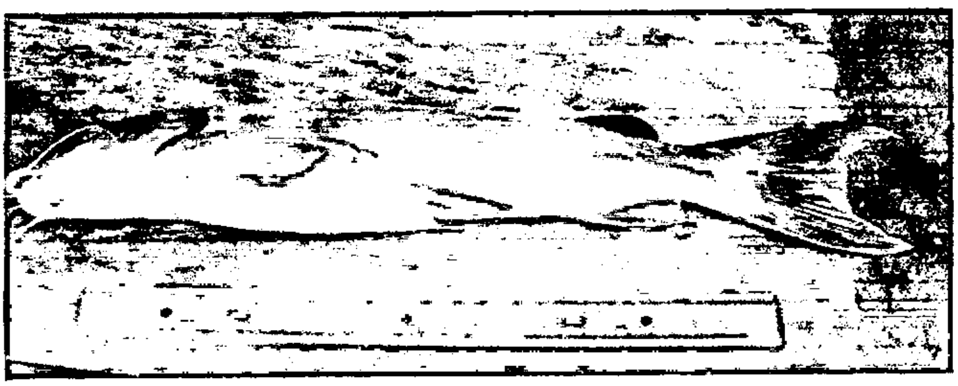

Plate 13: Photograph of *Chrysichythys nigrodigitatus*

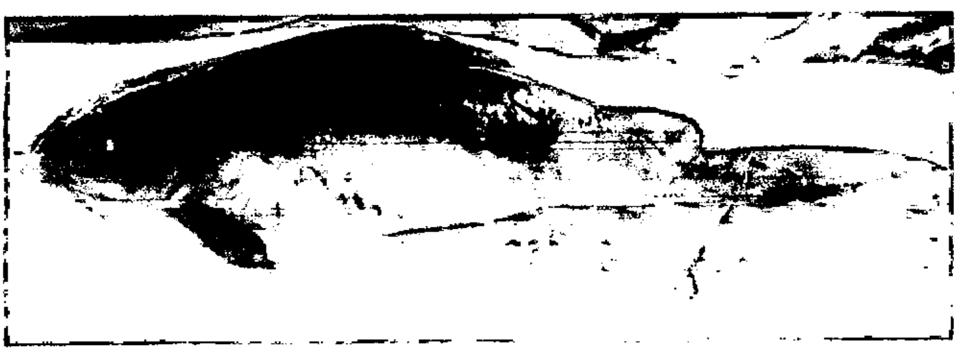

Plate 14: Photograph of *Chrysichythys Filamentosus*

Trachinotus teraia **(Cuvier, 1832)**

It has a deep and laterally compressed body. It has a widely forked with thin candal peduncle tail. The maximum length observed is 520mm. It is reported to be primarily marine but found in estuaries and occasionally far upstream (Shumway *et al*, 2003) (Plate 15).

Parachanna obscura **(Gunther, 1861)**

It has an elongaled body, the lower jaw is protruding. The bases of the dorsal and anal fins are long. It has 5 – 8 dark rounded blotches on the flanks. The maximum length observed was 270mm. It is reported to be widely distributed except Chad basin (Raji and Olaosebikan, 1998). It has 1 pair of short barbell on the upper jaw (Plate 16).

Parachanna Africana **(Steindachner, 1879)**

It has 8 – 11 dark bands on its flanks. It has 45 dorsal fin rays and 32 anal fin rays. The maximum length observed was 210mm (Plate 17).

Pellonula afzeliusi **(Johnels, 1954)**

It has no dorsal spine; 13 – 19 dorsal soft rays; no anal spine and 16 – 27 anal soft rays.It has a slender to moderately deep body.It has 17 – 22 scutes in its ventral side starting behind first pectoral fin ray.Its lower jaw is slightly projected further than the upper jaw. It has a forked tail. The maximum length observed was 88mm. It has 16 rays in the dorsal fin located just above or immediately behind the insertion point of pelvic fins (Plate 18).

Plate 15: Photograph of *Trachinotus teraia*

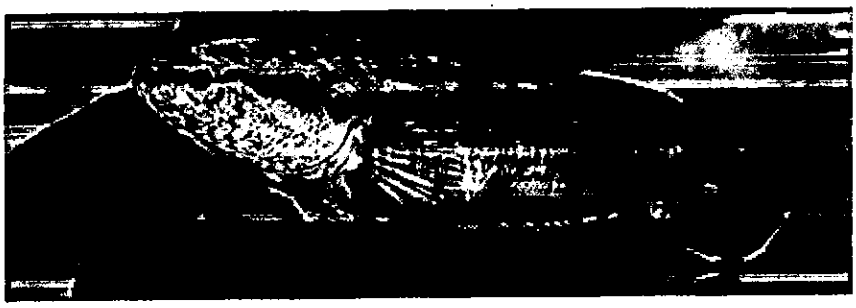

Plate 16: Photograph of *Parachanna obscura*

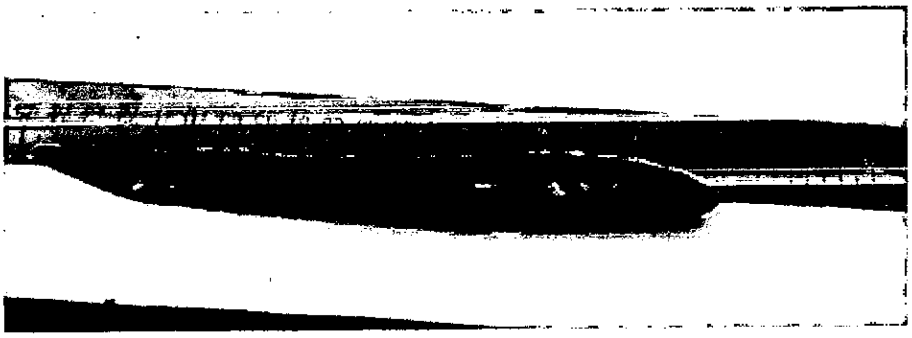

Plate 17: Photograph of *Parachanna africana*

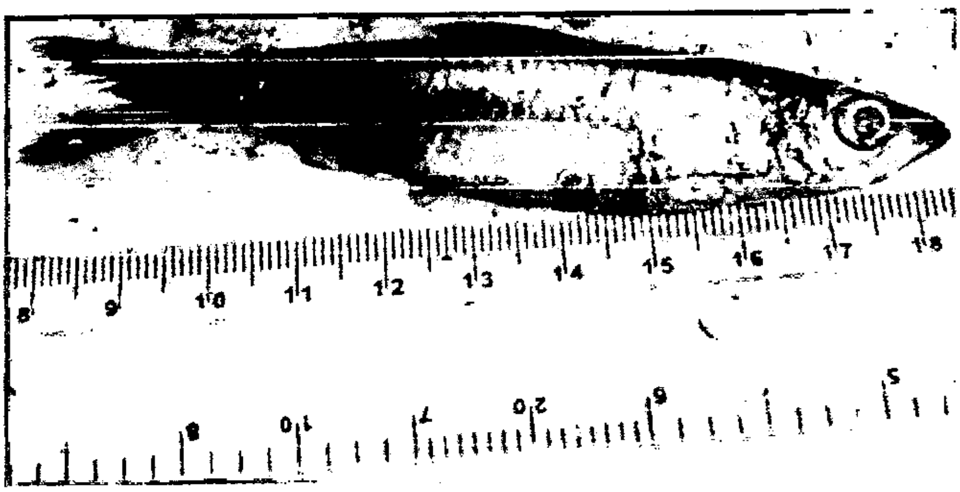

Plate 18: Photograph of *Pellonula afzeliusi*

Ethmalosa fimbriata **(Bowdich, 1825)**

It has a terminal mouth. It has ventral Scutes that extended from the base of the operculum base of the anal fin. It had a short anal fin. The tail was forked. The maximum length observed was 140mm.It has no dorsal spines; 16 -19 dorsal soft rays; no anal spines and 19 – 23 anal soft rays (Plate 19).

Alestes baremose **(de Joannis, 1835)**

Its adipose eyelid was well developed. It has a large fronto parietal fontanel. It has 2 dorsal spines 8 dorsal soft rays and 3 anal soft rays. It has silver colour with blue-gray back and white belly, grayish fins and it is entirely covered with scales. The maximum length observed was 300mm (Plate 20).

Alestes macrophthalmus **(Gunther, 1867)**

Its anal fin has 23 branched rays and its dorsal fin is situated slightly on the same level than pelvic fin. It has a small adipose fin. The tail is forked; the maximum length observed was 320mm.It has 2 dorsal spines; 8 dorsal soft rays; 3 anal spines and 18 – 23 anal soft rays (Plate 21).

Brycinus nurse **(Ruppell, 1832)**

It has a forked tail and a short adipose fin. Its mouth is terminal. It had 5 scales above the lateral line. The maximum length observed was 230mm (Plate 22).

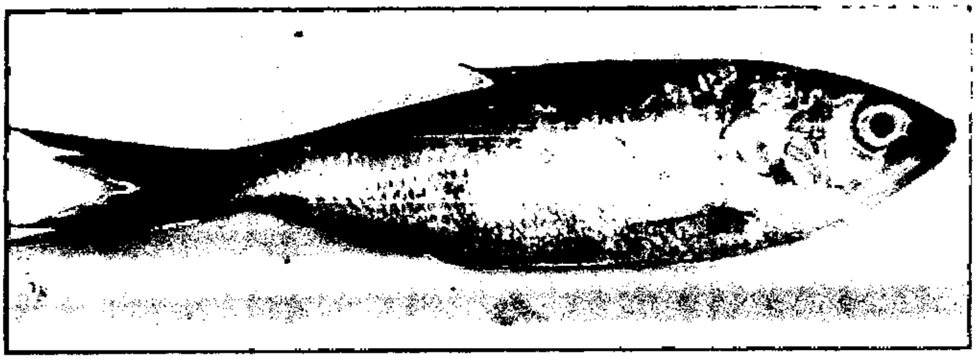

Plate 19: Photograph of *Ethmalosa fimbriata*

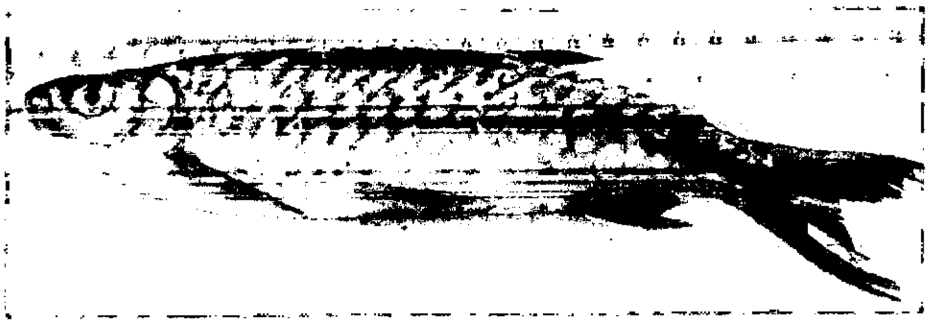

Plate 20: Photograph of *Alestes baremose*

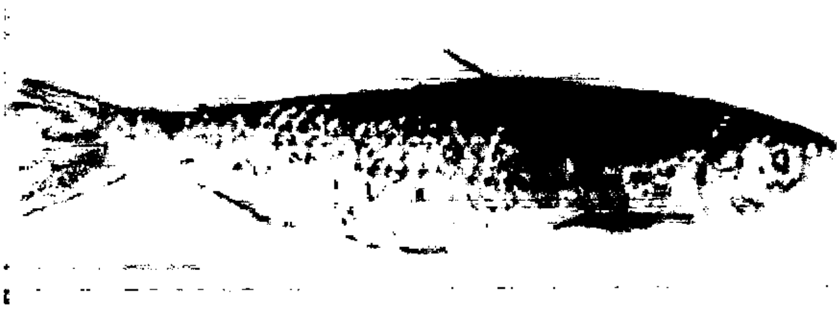

Plate 21: Photograph of *Alestes macrophthalmus*

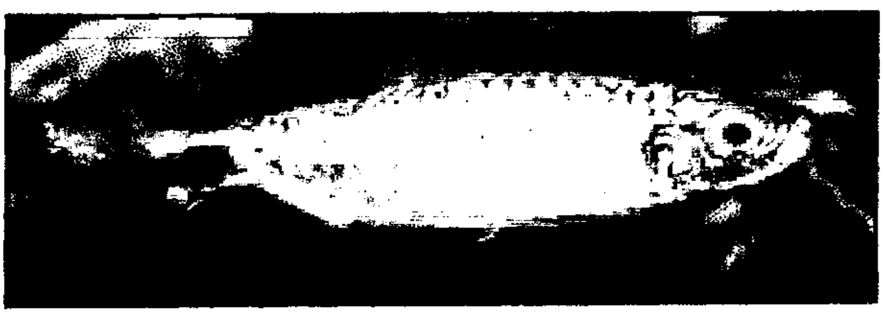

Plate 22: Photograph of *Brycinus nurse*

Brycinus longipinnis **(Gunther, 1864)**

It has III anal spines and 15 – 22 anal soft rays. It has striped caudal peduncle extending to middle rays of caudal. It has large dorsal fins which begin above front of the pelvic fin, and equidistant between that of the caudal and the tip of the snout. The precaudal spot elongated to the extreme of the candal fin. It has sivery body colour with greenish dorsal region and ventral part is whitish (Plate 23).

Ichthyborus monodi **(Pellegrin, 1929)**

It has 8 – 9 dorsal soft rays; 8-9 anal soft rays; no dorsal spine. It has a long, about the same length or shorter than the portion of the borders the mouth snout. The body tapers toward the tail. Its caudal peduncle is stripe and it has 3 -5 vertical black stripe on dorsal fin.It mouth is pointed and the tail is forked. The maximum length observed was 150mm (Plate 24).

Citharinus latus **(Muller & Troschal, 1845)**

It has 20 – 23 dorsal soft rays and 23 – 26 anal soft rays. Its body is silvery white and its adipose base is gray – black. The base of its adipose fin was longer than distance between adipose and dorsal fin. Its anal rays are 23 – 26. The maximum length observed was 300mm (Plate 25).

Citharinus citharus **(Goeffrey Saint Hilaire, 1809)**

The base of its adipose fin is shorter than the distance between adipose and dorsal fin. Its anal rays are 26 – 29. The maximum length observed was 440mm (Plate 26).

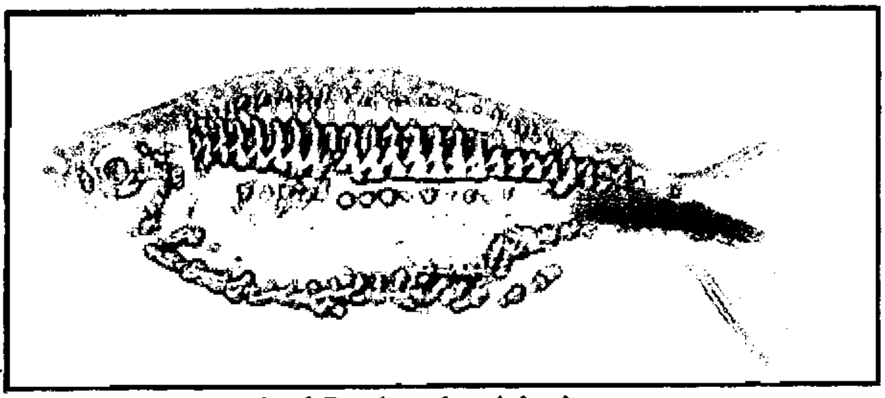

Plate 23: Photograph of *Brycinus longipinnis*

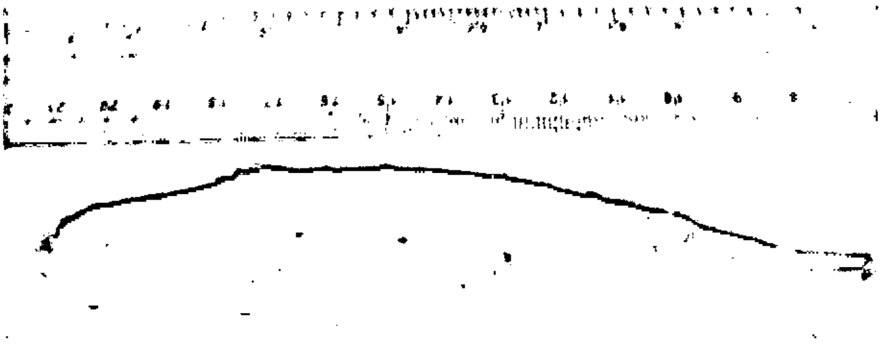

Plate 24: Photograph of *Ichthyborus monodi*

Plate 25: Photograph of *Citharinus latus*

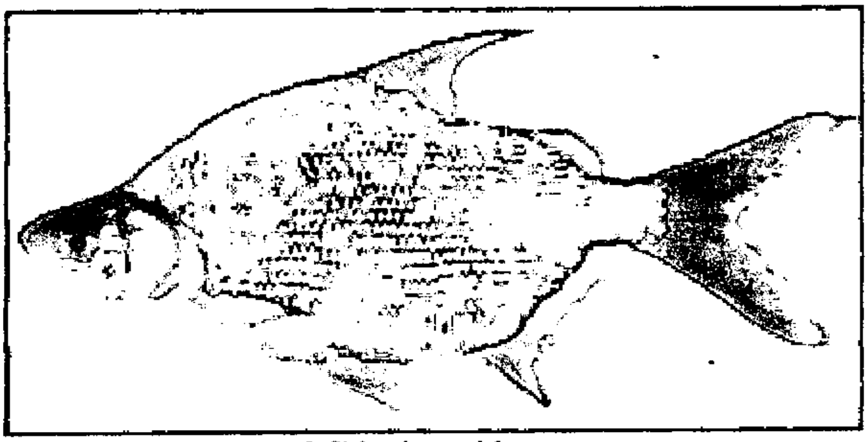

Plate 26: Photograph of *Citharinus citharus*

Hepsetus odoe **(Bloch, 1794)**

It has II dorsal spines; 7 – 9 dorsal soft rays; II – III anal spines and 9 anal soft rays. Its dorsal fin was located behind pelvic fins. Its jaws are elongated and teeth are conically arranged. Its head has dark bands radiating behind its eye (Plate 27).

Schilbe mystus **(Linne, 1758)**

Small adipose fin is present. Its anterior nostrils are closer to each other than the posterior ones. Its pectoral spines have their inner side strongly serrated posteriorly. It has a forked tail. The maximum length observed was 220mm (Plate 28).

Schilbe uranoscopus **(Ruppell, 1832)**

It has no adipose fin. It has 58 – 72 branched anal fin rays. Its eyes are supero – lateral positioned. The maximum length observed was 230mm (Plate 29).

Clarias gariepinus **(Burchell, 1822)**

Its dorsal fin is separated from the caudal fin by a noticeable space. It head length was 28 – 30% of the standard length. Its caudal peduncle is more than 50% of the standard length. Its superficial surface of cranium is granulated. The maximum length observed was 1000mm (Plate 30).

Plate 27: Photograph of *Hepsetus odoe*

Plate 28: Photograph of *S. mystus*

Plate 29: Photograph of *Schilbe uranoscopus*

Plate 30: Photograph of *Clarias gariepinus*

Tilapia guineensis **(Bleeker, 1862)**

It has XVI dorsal fin and 12 – 13 fin rays it has large vertical bands on flanks which is poorly marked and the base of the scales are flanked with dark line. Maximum size observed was 450mm (Plate 31).

Oreochromis niloticus **(Linne, 1758)**

It has XVI – XVIII dorsal spines; 12 -13 dorsal soft rays; III anal spines and 9- 11 anal soft rays. It has regular vertical stripes throughout the depth of caudal fin. Its caudal fin is decorated with regular vertical black stripes. It occurs most during the rainy season when the lagoon is fresh. The maximum size observed was 450mm (Plate 32).

Sarotherodon melanotheron **(Ruppell, 1852)**

It has XV – XVI dorsal spines; 10 – 12 dorsal soft rays and 8 – 10 anal soft rays.It has a black patch in its lower jaw, the length of the caudal fin is truncated or slightly sub truncate. No abrupt border between the small thoracic scales and the abdominal scales. The maximum size observed was 275mm (Plate 33).

Tilapia zilli **(Gervais, 1848)**

It had XV dorsal spines and 12 fin rays it had longitudinal bands that appeared on flanks when agitated. It has silver grey colour on the dorsal region. The maximum size observed was 200mm (Plate 34).

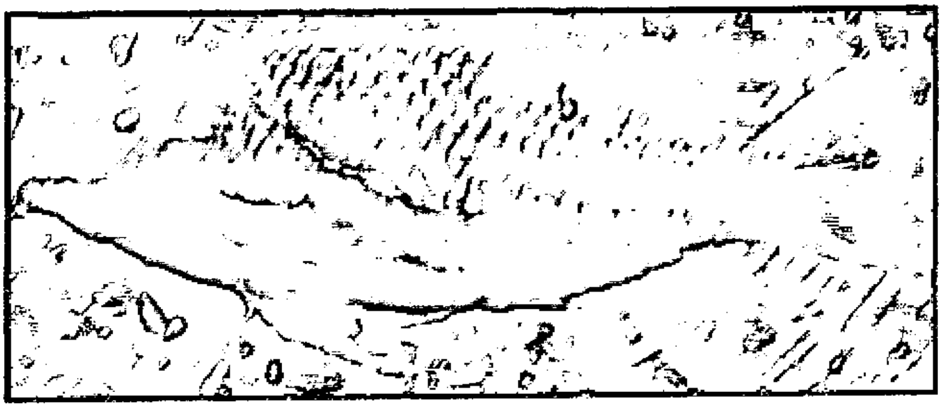

Plate 31: Photograph of *Tilapia guineensis*

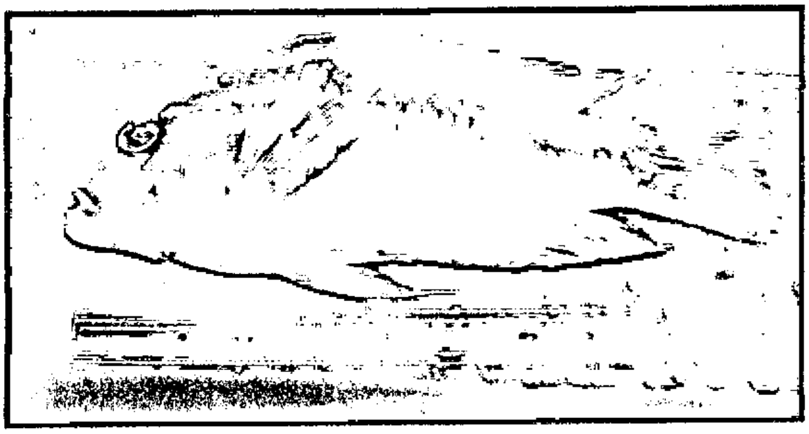

Plate 32: Photograph of *Oreochromis niloticus*

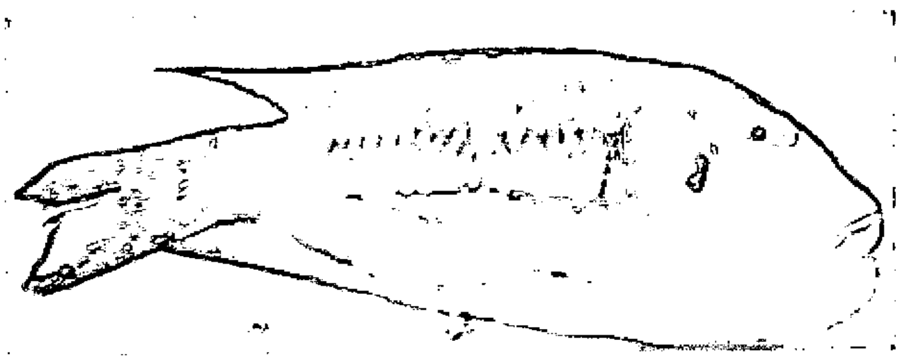

Plate 33: Photograph of *Sarotherodon melanotheron*

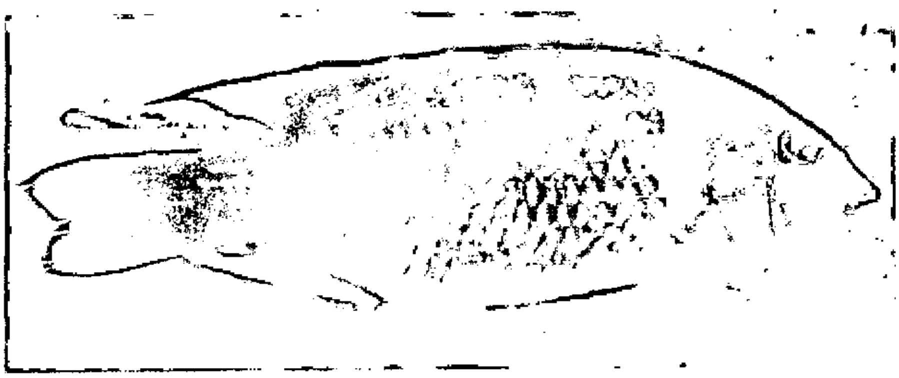

Plate 34: Photograph of *Tilapia zillii*

***Tilapia mariae* (Boulenger, 1899)**

Its body is rather elevated; the adult has a series of dark blotches in the middle of the flanks. The maximum size observed was 200mm. The dorsal fin of spotted tilapia has XVI spines (rarely 15), followed by 12-13 rays. Its anal fin has III spines and 10-11 rays. The lower part of its anterior gill arch has 13 to 15 short gill rakers. There are 29 to 31 scales in a lateral series (Plate 35).

***Chromidotilapia guntheri guntheri* (Sauvage, 1882)**

The upper lateral line is separated from the dorsal fin by 2 – 3 normal size scales in front and 1 normal sized and 1 small sized scale in the back. The maximum size observed was 147mm (Plate 36).

***Hemichromis fasciatus* (Peters, 1852)**

It has 5 blotches or vertical bands on its flanks with the first confluent with opercular spot, the last on the caudal peduncle. It also has smaller intercalary vertical bands. The upper profile of the snout was concave (Plate 37).

***Hemichromis bimaculatus* (Gill, 1862)**

It has 3 black blotches on flanks with the first on the operculum, the second in the middle of the flanks and the third on the caudal fin base. The upper profile of the snout is convex. The maximum size observed was 94mm (Plate 38).

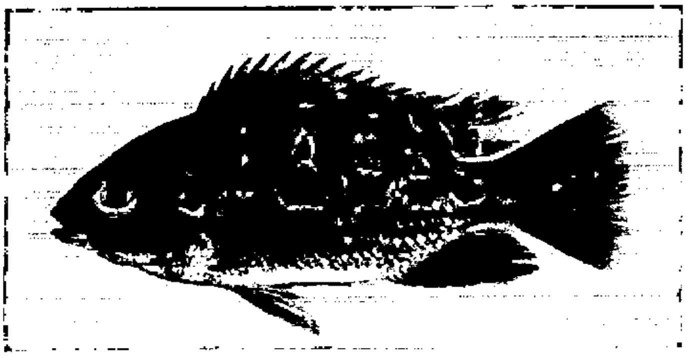

Plate 35: Photograph of *Tilapia mariae*

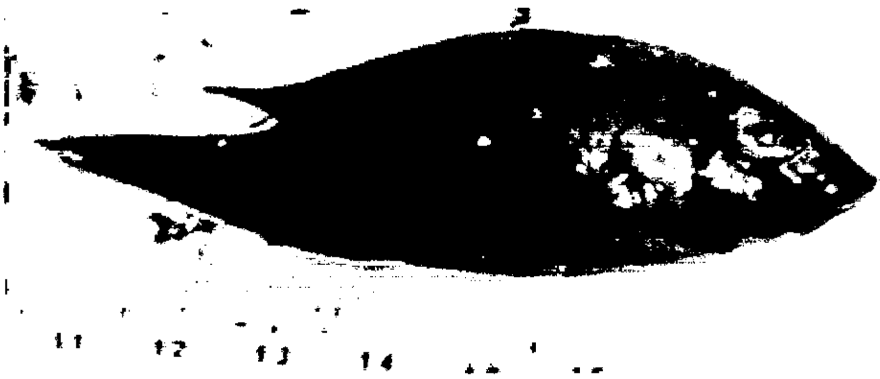

Plate 36: Photograph of *Chromidotilapia guntheri guntheri*

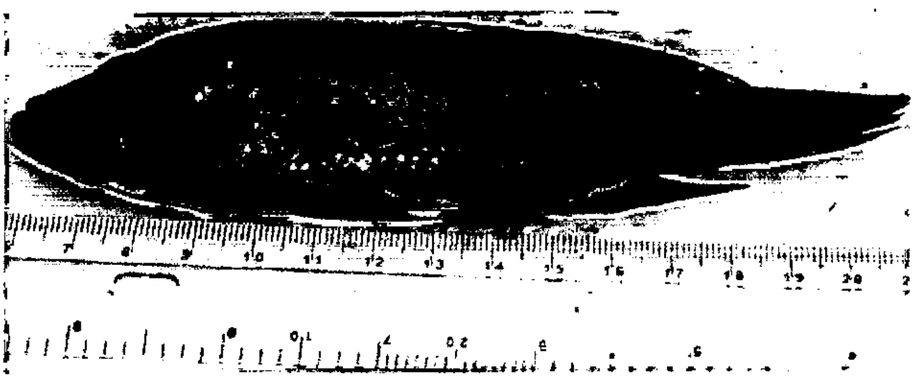

Plate 37: Photograph of *Hemichromis fasciatus*

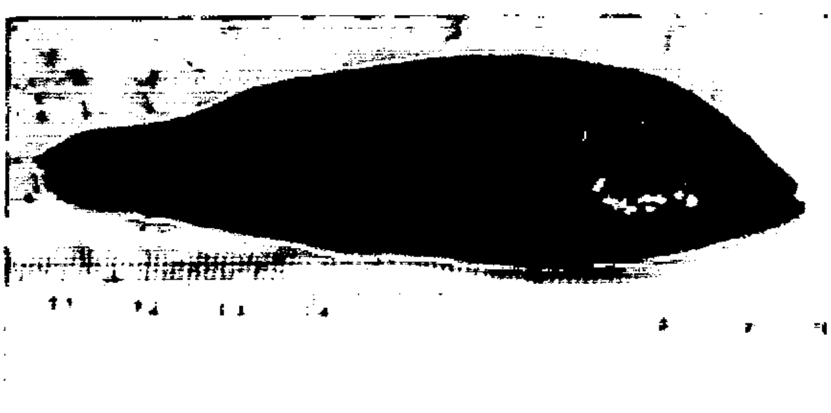

Plate 38: Photograph of *Hemichromis bimaculatus*

Goboides ansorgii **(Boulenger, 1909)**

It has very tiny eyes; the dorsal fin has 20 segmented rays and anal fin with 19 segmented rays. The maximum size observed was 495mm (Plate 39).

Eleotris vittata **(Dumeril, 1858)**

It had 2 dorsal fins, the anterior fin equipped with XI spines and the posterior equipped with 9 rays. It had a round tail, the mouth in upturned. It had 57 – 70 scales in longitudinal series or more scales in transverse series (Plate 40).

Kribia nana **(Boulenger, 1961)**

Predorsal scales were absent; it had 27 – 31 scales in longitudinal series and 9 – 11 scales in transverse series. It had a round tail, the pelvic fin were well separated. Anterior dorsal fin had XI spines and (flexible) fin rays the maximum size observed was 70mm.

Malapterurus electricus **(Gmelin, 1789)**

It has no anal spines but its anal fin have 9 – 11soft rays. It has a narrow patches tooth, its pectoral fin is placed near its body mid – depth; it has 7 – 8 branched caudal fin rays. Its adult and young are marked with large spots and blotches which are some up to 4-5 times an eye diameter. Its caudal fin is usually well – spotted in adults; caudal saddle and bar pattern are poorly developed in all ages. It also has a deep and cylindrical head with a slightly prominent lower jaw (Plate 41).

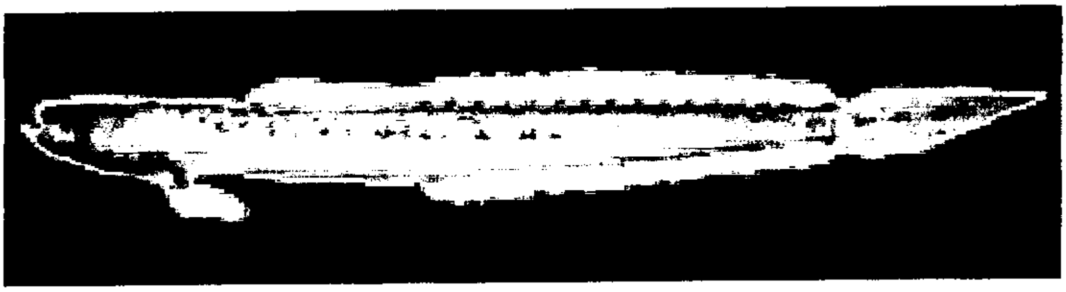

Plate 39: Photograph of *Goboides ansorgii*

Plate 40: Photograph of *Eleotris vittata*

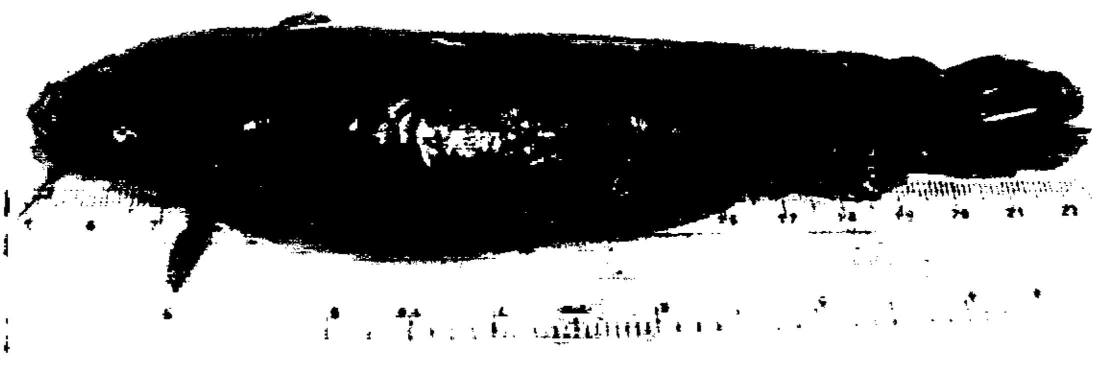

Plate 41: Photograph of *Malapterurus electricus*

Malapterurus minjiriya **(Sagua, 1987)**

It has no anal spines and 9 – 12 anal soft rays. Its pectoral fin is placed ventrally; 8 – 12 anal fin rays; 19 caudal – fin rays. It body and head are marked with large blotches. Its body and head are distinctly depressed; jaws are equal or the lower jaw is slightly prominent. It pigmentation is similar to *M. electricus* but more finely and sparsely spotted with its paired fins rarely spotted (Plate 42).

Gymnarchus niloticus **(Cuvier, 1829)**

It has no dorsal spine but has 183 – 230 dorsal soft rays. It has a prominent snout; no distinct caudal fin but its body terminates in thin point. Its head region has no scale and its body scales are small in size (Plate 43).

Marcusenius senegalensis **(Steindachner, 1870)**

It has no dorsal spines; no anal spines but has 28 – 38 anal soft rays. It dorsal fin originated behind its anal fin origin. Its lower jaw protrudes further than the upper jaw (Plate 44).

Lutjanus dentatus **(Dumeril, 1860)**

It has X dorsal spines; 13 – 14 dorsal soft rays; III anal spines and 8 anal soft rays. Its head is slightly rounded and its dorsal profile curving gently toward the tail (Plate 45).

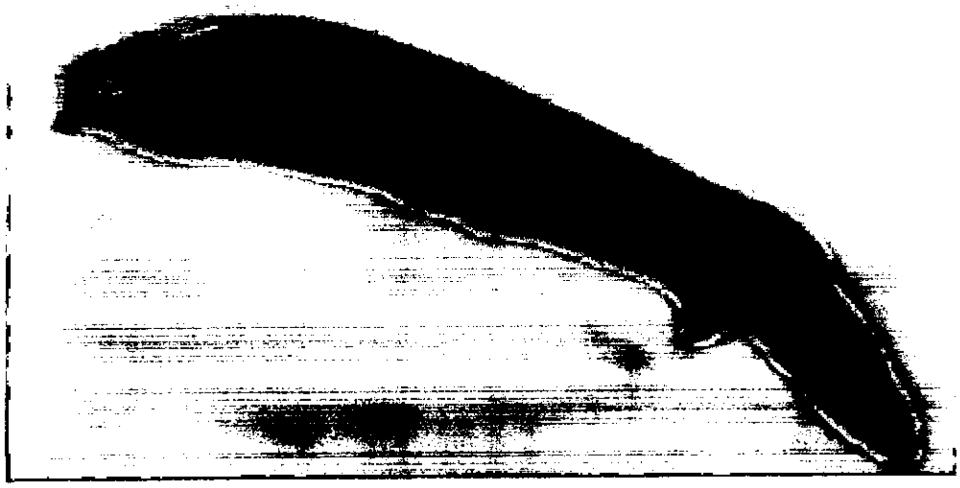

Plate 42: Photograph of *Malapterurus minjiriya*

Plate 43: Photograph of *Gymnarchus niloticus*

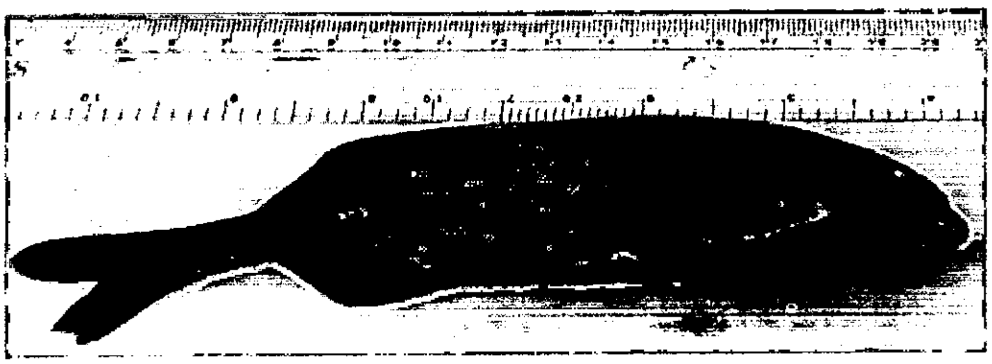

Plate 44: Photograph of *Marcusenius senegalensis*

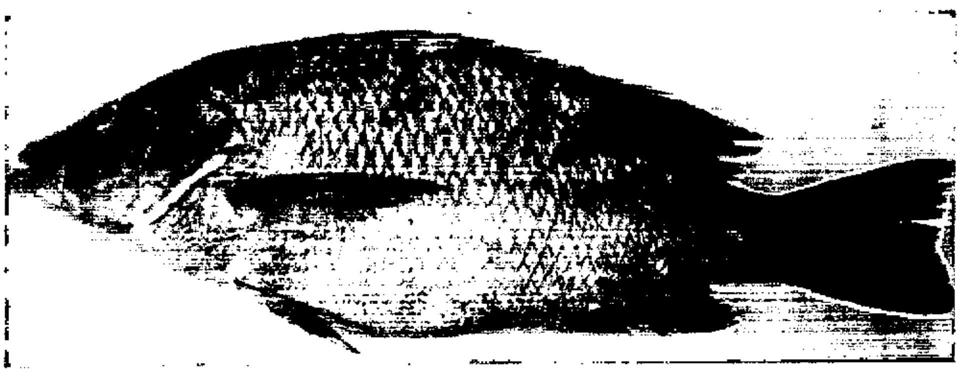

Plate 45: Photograph of *Lutjanus dentatus*

Caranx hippos **(Linnaeus, 1766)**

It has IX dorsal spines; 19 – 21 dorsal soft rays; III anal spines and 15 – 17 anal soft rays. It has 25 – 42 scutes at the base of the caudal peduncle. It has no scale on its chest except a small mid – ventral patch in front of the pelvic fins (Plate 46).

Synodontis clarias **(Linne, 1758)**

It has a side branches on the maxillary barbels. The front face of the dorsal spine is serrated. It has I dangerous spine in the dorsal and pectoral fins (Plate 47).

Brienomyrus longianalis **(Boulenger, 1901)**

It has no dorsal spine; 14 – 17 dorsal soft rays and no anal spine. It has 28 – 33 anal soft rays. It pectoral fins are at most as long as head with posterior end not extending beyond the origin of pelvic fins.It has thin caudal peduncle (Plate 48).

Citharus linguatula (Linnaeus, 1758)

It has its two eyes on one side of its body. Its dorsal fin originated from the front of the upper eye. It has black spots distributed on bases of the dorsal and anl soft fin rays. Lateral line is present on both sides.Its anus is on eyed side (Plate 49).

Plate 46: Photograph of *Caranx hippos*

Plate 47: Photograph of *Synodontis clarias*

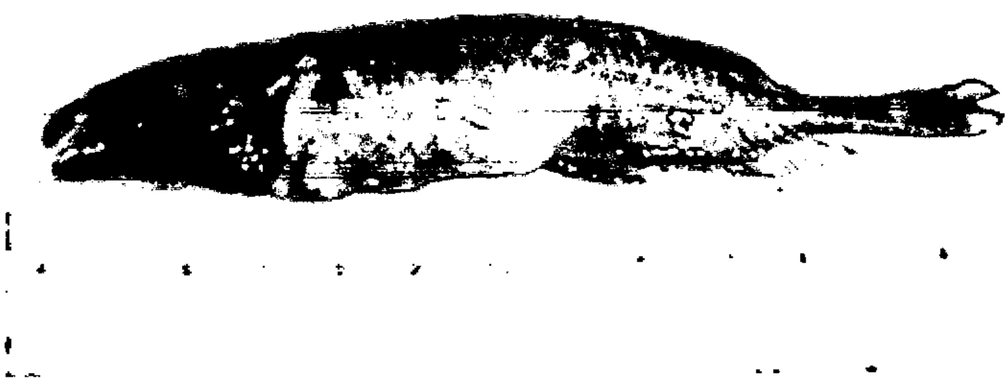

Plate 48: Photograph of *Brienomyrus longianalis*

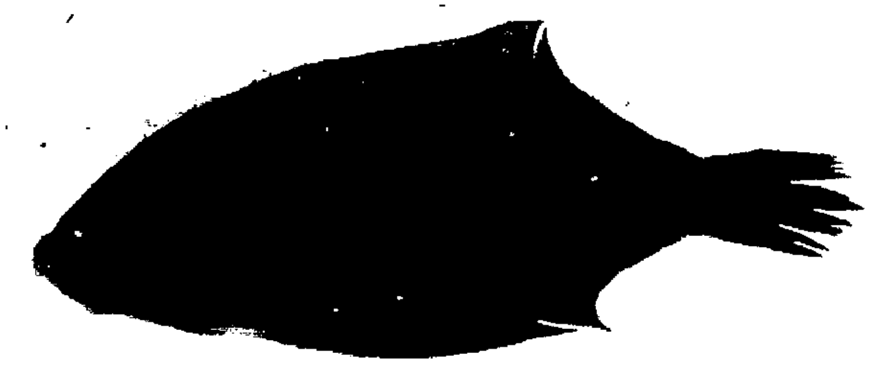

Plate 49: Photograph of *Citharus linguatula*

Gnathonemus petersii **(Gunther, 1862)**

It has no dorsal spine but has 25 – 31 dorsal soft rays.No anal spines but has 32 – 36 anal soft rays. Its lower lip protruded forward (Plate 50).

Pomadasys jubelini **(Cuvier, 1830)**

It has XI dorsal spines, 15 – 17 dorsal soft rays; III anal spines and 9 anal soft rays. It has 5 rows of scales above lateral line and round spots disperse around its back.Its maxilla is very broad (Plate 51).

Liza falcipinnis **(Valenciennes, 1836)**

It has IV dorsal spine in the first dorsal fin, I dorsal spine and 9 softrays in the second dorsal fin.It also has III spine and 10 soft rays in its anal fin (Plate 52).

Mugil cephalus **(Linnaeus, 1758)**

It has V dorsal spines, 7 – 9 dorsal soft rays, III anal spines and 8 – 9 anal soft rays. It has Olive – green dorsally (fresh), silvery shading sides to white ventrally; lateral stripes sometimes distinctive. Its pectoral fins are short and it has well developed adipose eyelids (Plate 53).

Plate 50: Photograph of *Gnathonemus petersii*

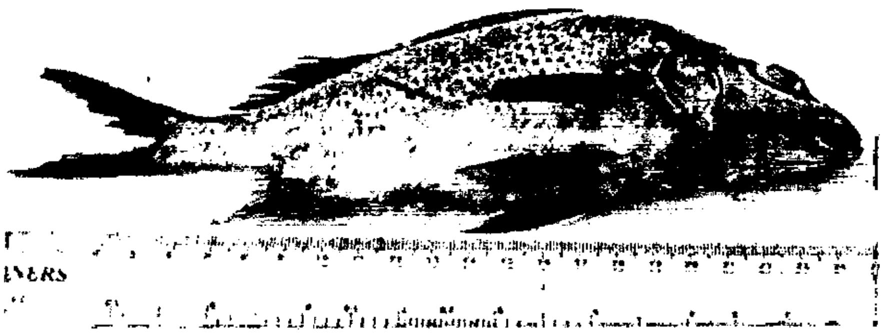

Plate 51: Photograph of *Pomadasys jubelini*

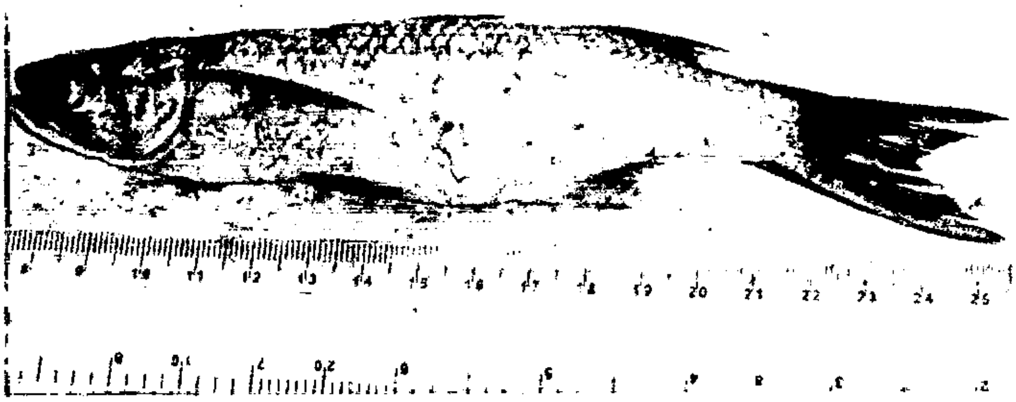

Plate 52: Photograph of *Liza falcipinnis*

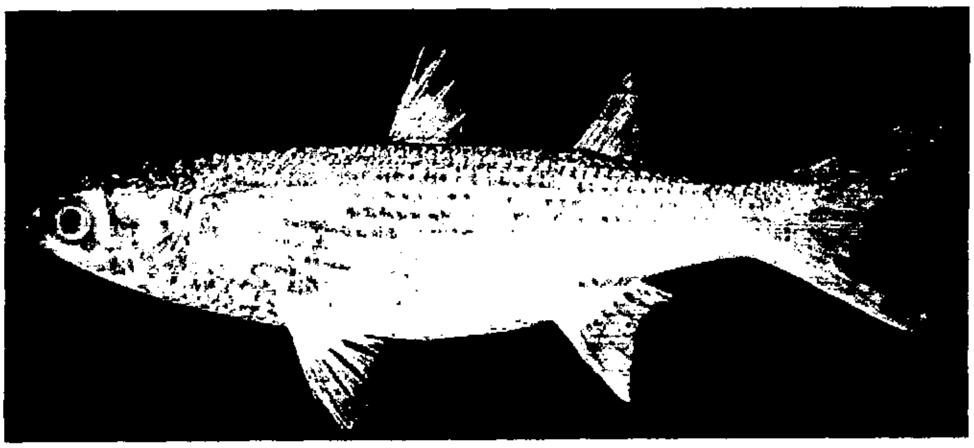

Plate 53: Photograph of *Mugil cephalus*

Polydactylus quadrifilis (Cuvier, 1829)

It has VIII dorsal spines in the first dorsal fin, I spine and 12 – 14 soft rays in the second dorsal fin. Its anal fin contain III spines and 10 -11 soft rays. It also has 4 or 5 rays, slightly longer than the upper rays of pectoral fin (Plate 54).

Clarias agboyiensis (Sydenham, 1980) = *(C. isheriensis)*

It has no dorsal spine; 72 – 73 dorsal soft rays and 55 – 56 anal soft rays. It head is oval – shaped in dorsal outline and its snout is rounded. It frontal fontanelle is usually short and squat.Its occipital fontanelle is small and oval – shaped. It pectoral spine is robust and slightly curved (Plate 55).

Cynoglossus senegalensis (Kaup, 1858)

It is a tongue – shaped flat fish with eyes on left side of its body which is highly compressed and tapers posteriorly. It mouth is asymmentrical; its teeth are minute and seen on the blind side only. Its dorsal and anal fins are joined to caudal fin, pectoral fins are absent and only left pelvic fin is present. It has no dorsal or anal spine. Its scales are small and it has 2 lateral lines on the eyed side (Plate 56).

Hyperopisus bebe (Lacepede, 1803)

It has no dorsal spine, 12 – 16 dorsal soft rays and 52 – 71 anal soft rays. It has a forked tail (Plate 57).

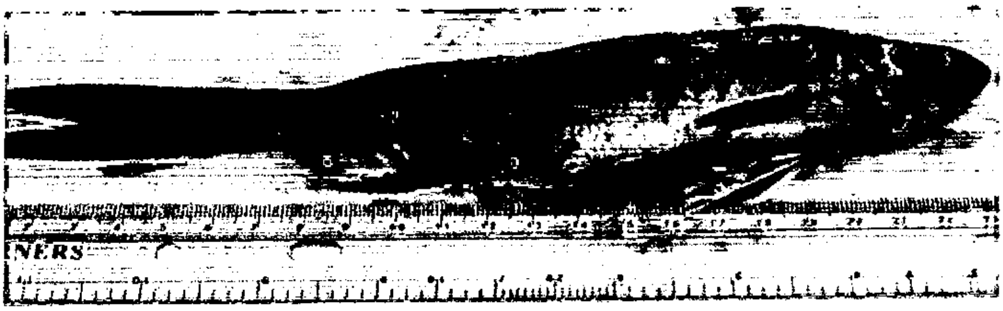

Plate 54: Photograph of *Polydactylus quadrifilis*

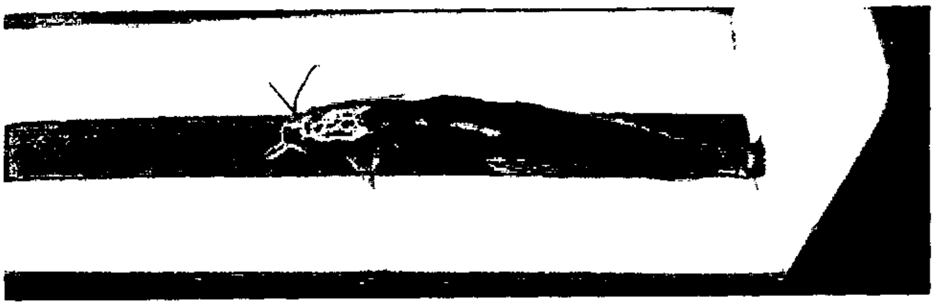

Plate 55: Photograph of *Clarias agboyiensis*

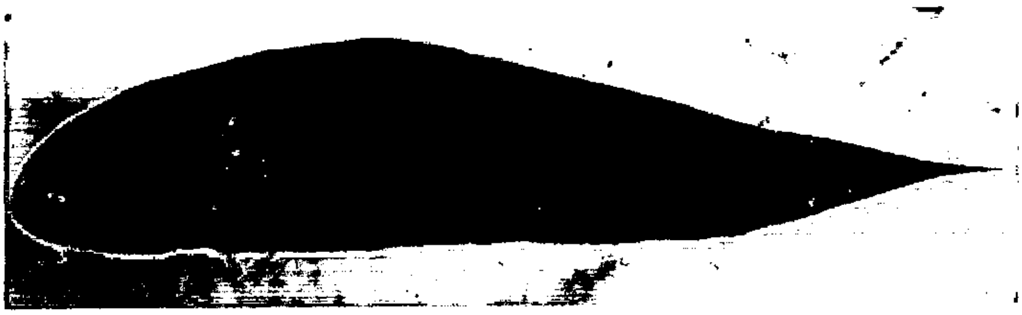

Plate 56: Photograph of *Cynoglossus senegalensis*

Plate 57: Photograph of *Hyperopisus bebe*

Papyrocranus afer (*Gunther, 1868*)

It has no dorsal spines; 2 dorsal soft rays; no anal spines and 113 -140 anal soft rays. Its flanks are spotted (Plate 58).

Xenomystus nigri **(Gunther, 1868)**

It has no dorsal spine, no anal spine but has 108 – 130 anal soft rays. Its snout is smaller than the eye (Plate 59).

Erpetoicthys calabaricus **(Smith, 1865)**

It has VII – XII dorsal spines; no dorsal soft rays and 9 – 14 anal soft rays.Its body is elongated and anguilliform. Its head has no sub – opercular, very slightly flattened, and two times longer than its width and its upper jaw is prominent. Its dorsal fin is composed of a series of well – separated spines each supporting one or several articulated rays and membranes. Its body is covered with rhombic ganoid scales (Plate 60).

Synodontis eupterus **(Boulenger, 1909)**

It has large eye, I short dangerous spines in dorsal and pectoral fin. Dark spots are all over its body even on the adipose. The tail (caudal fin) is serrated (Plate 61).

Plate 58: Photograph of *Papyrocranus afer*

Plate 59: Photograph of *Xenomystus nigri*

Plate 60: Photograph of *Erpetoichthys calabaricus*

Plate 61: Photograph of *Synodontis eupterus*

Synodontis courteti **(Pellegrin, 1906)**

It has 1 dorsal spine, 8 branched dorsal soft rays, its snout obtusely protruded, and maxillary barbels has no membrane. It has golden – yellow coloured body with large dark spots and on adipose fin (Plate 62).

Clarias angulliaries **(Line, 1758)**

Its body is elongate and has large, depressed head and bony with small eyes. Its mouth is terminal and large. Four pairs of barbells are present. It has long dorsal and anal fins; without dorsal spine and adipose fin. Anterior edge of pectoral spine is serrated and its caudal fin is rounded. Colour varies from sandy-yellow through gray to olive with dark greenish-brown markings and the belly is white.

Psettias sebae **(Cuvier, 1831)**

It has VIII dorsal spines and 31 – 34 soft doral rays. It anal fin contain III spines and 33 – 37 soft rays (Plate 63).

Chrysichthys walkeri **(Gunther, 1899)**

Its dorsal and pectoral fins are equipped with I dangerous spines. Its dorsal fin is made up of 16 rays and the anal fin contains 10 – 12 rays. Its body is scaleless; it has an adipose fin (Plate 64).

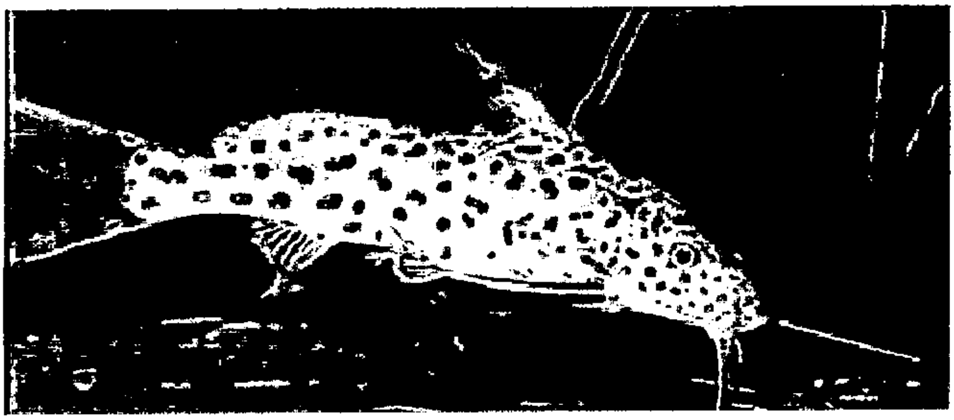

Plate 62: Photograph of *Synodontis courteti*

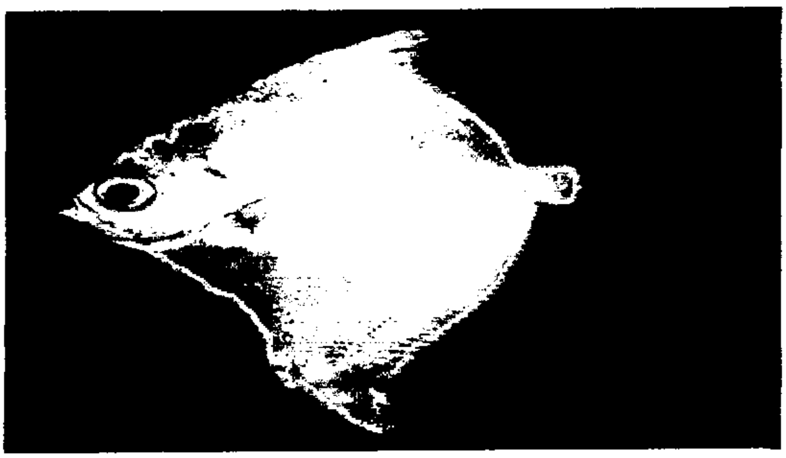

Plate 63: Photograph of *Psettias sebae*

Plate 64: Photograph of *Chrysichthys walkeri*

Heterotis niloticus **(Cuvier, 1829)**

It has no dorsal spines; 32 – 37 dorsal soft rays; no anal spine but has 34 - 39 anal soft rays. It has an elongated and robust body. It has a relatively short head. Its dorsal and anal fins, which are spineless, elongated and posteriorly positioned, ending close to the small, rounded caudal fin. Its caudal peduncle is very short. Its strong, large scales are oval with the exposed portion which is thick and corrugated. Its lateral – line is extending in a straight line from above the operculum to the middle of the caudal peduncle (Plate 65).

Phractolaemus ansorgii **(Boulenger, 1901)**

It has no dorsal spines; 6 dorsal soft rays; no anal spine but has 6 anal soft rays. Its dorsal and anal fins have 2 simple and 4 branched rays (Plate 66).

Hippopotamyrus psittacus (Boulenger, 1897)

Paired and vertical fins all present; narrow caudal peduncle and deeply forked caudal fin are also recorded .It has Dorsal fin rays of 12-91 and anal fin rays of 20-70. Dorsal and anal fins are usually opposite each other on posterior part of its body. Mouth of highly variable form, and often trunklike is recorded (Plate 67).

Elops lacerta **(Valenciennes, 1847)**

It has no dorsal spines and anal spines. It has 18 – 22 soft dorsal ray and 15 – 19 anal soft rays. Lateral line scales are ornamented with non-ramified small tubes. It has a gray back, silver glossy sides and the fins are tinted yellow (Plate 68).

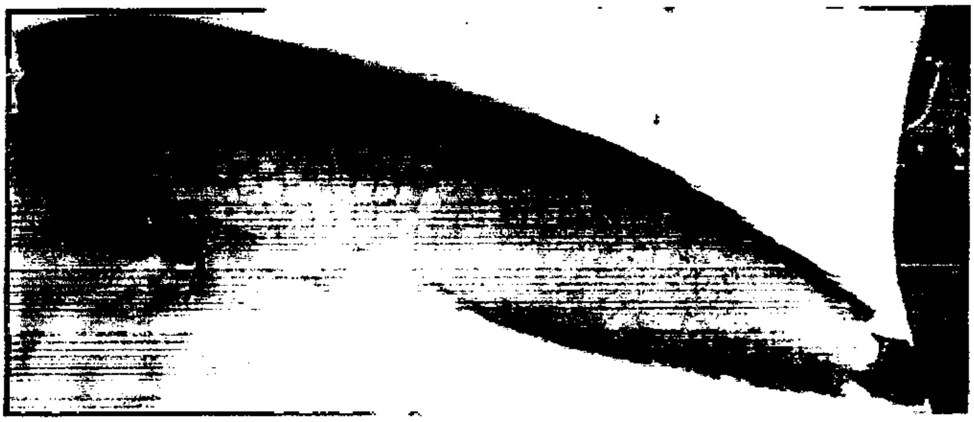

Plate 65: Photograph of *Heterotis niloticus*

Plate 66: Photograph of *Phractolaemus ansorgii*

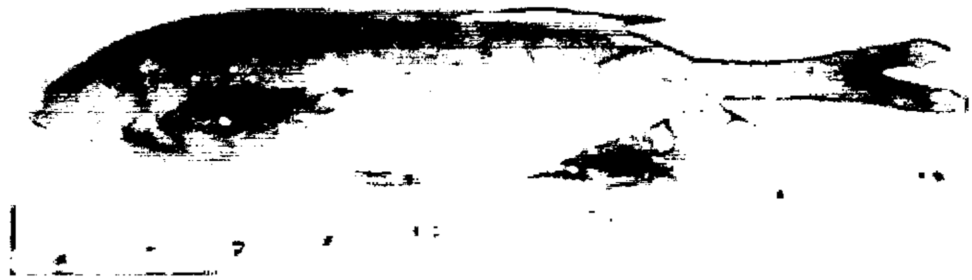

Plate 67: Photograph of *Hippopotamyrus psittacus*

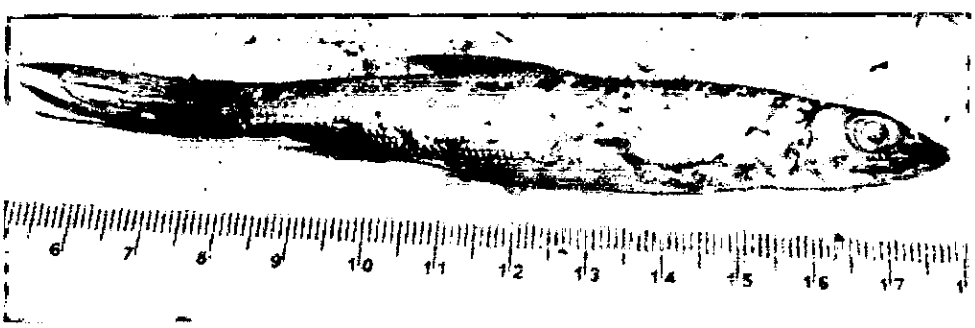

Plate 68: Photograph of ***Elops lacerta***

Sphyreana barracuda **(Walbaum, 1792)**

Sphyraena barracuda is a long silvery fish with two widely separated dorsal fins. It has large scales and a pointed head with a large mouth and long knife-like teeth.Great barracuda have a large gape. It has a lower jaw projecting which is helpful in biting. It is grayish brown above and silvery below which is quite universal throughout their geographic range. It often has dark ink-like spots that are arranged in no pattern on their sides. The young have dark crossbars on their backs and blotches on their sides. The young also have a soft dorsal fin and the anal and caudal fins can be blackish (Plate 69).

Auchenoglanis occidentalis (Valenciennes, 1840)

It has I dorsal spine; 7 – 8 dorsal soft rays; III – IV anal spines and 7 – 8 anal soft rays.Its body is marbled or spotted gray, with a few black spots arranged in rows (Plate 70).

Heterobranchus longifilis **(Valenciennes, 1840)**

It has no dorsal spine; 26 – 35 dorsal soft rays and 42 – 52 anal soft rays. It has long, broad and rectangular in dorsal outlined head. Its snout is broadly rounded and eyes with superolateral position. Its adipose fin is black posteriorly (Plate 71).

Hippopotamyrus pictus (Marcusen, 1864)

It has no dorsal spine; 29 – 39 dorsal soft rays; no anal soft rays and 30 – 36 anal soft rays. It has a cocave back profile. Its dorsal and anal fins are located at the same level (Plate 72).

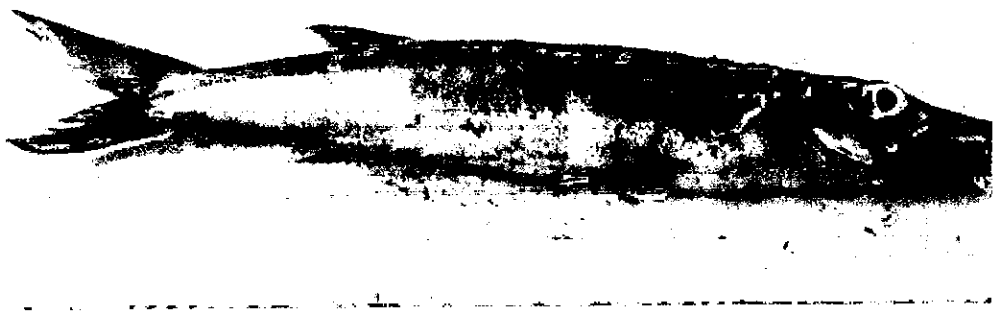

Plate 69: Photograph of *Sphyreana barracuda*

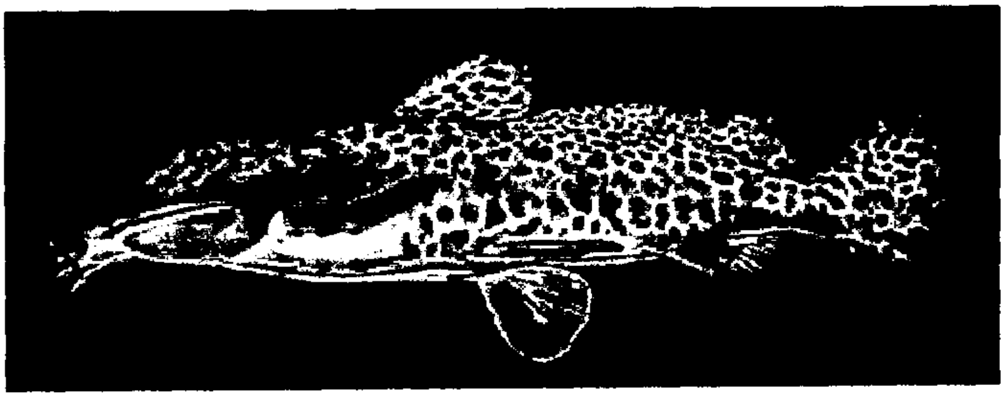

Plate 70: Photograph of *Auchenoglanis occidentalis*

Plate 71: Photograph of *Heterobranchus longifilis*

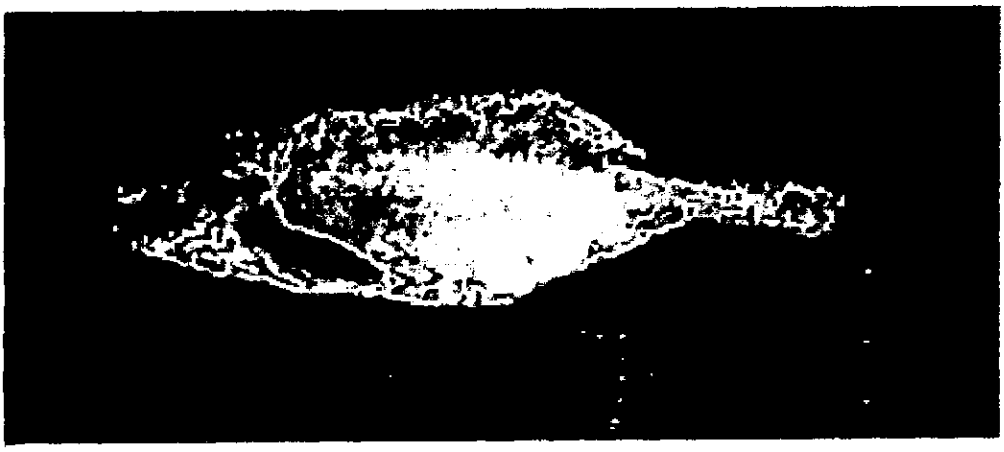

Plate 72: Photograph of *Hippopotamyrus pictus*

Polypterus senegalus **(Cuvier, 1829)**

It has VIII – XI dorsal spine; 11 – 7 anal spines and its upper jaw is slightly prominent. It dorsal fin has 8 – 11 fin lets (anterior separated from each other when folded). Its pectoral fin is not reaching the first dorsal spine (Plate 73).

Lates niloticus **(Linnaeus, 1758)**

It has VII – VIII dorsal spines and 10 – 14 dorsal soft rays.Its caudal fin is rounded, its preorbital and preopercular bones are armed with spines and a large spine is present on the free edge of the operculum. It dorsal region is dark grayish –blue grayish – silver on its flank and ventral side (Plate 74).

Marcusenius brucii **(Boulenger, 1910)**

It has no dorsal spine, 24 – 36 dorsal soft rays, no anal spine and it has 29 – 31 anal soft rays. Its dorsal and anal fin started directly opposite each other (Plate 75).

Mormyrops caballus **(Pelledrin, 1927)**

It has no dorsal spine; 26 – 35 dorsal soft rays; no anal spine but it has 39 – 45 anal soft rays.It is characterized by long narrow chin which looks like that of a horse. Its head narrows from the operculum to the snout. Its eyes are situated dorsally.

Mormyrus macrophthalmus **(Gunther, 1866)**

It has ano dorsl spine; 59 – 68 dorsal soft rays and 18 – 22 anal soft rays. It has a very short snout, rounded; its mouth opens before its eyes. It has 12 – 16 scales on the caudal peduncle.

Mormyrus rume **(Valenciennes, 1847)**

It has no dorsal spine; 72 – 94 dorsal soft rays; no anal spines; 16 – 20 anal soft rays and 20 – 26 scales on caudal peduncle. It mouth protrudes in rod–like form (Plate 76).

Plate 73: Photograph of *Polypterus senegalus*

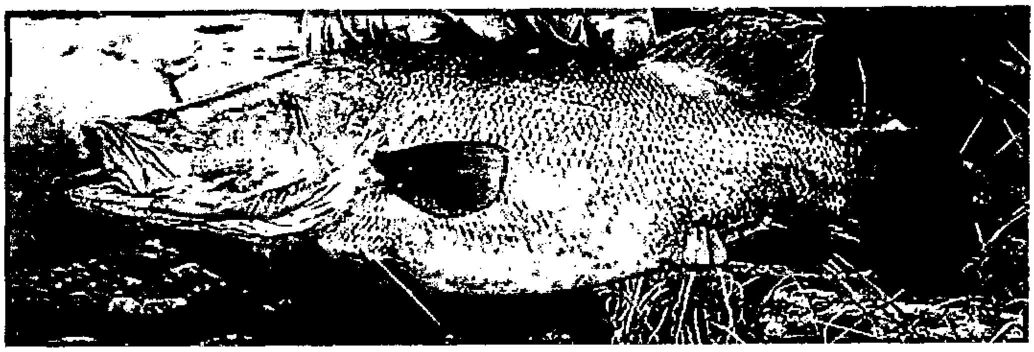

Plate 74: Photograph of *Lates niloticus*

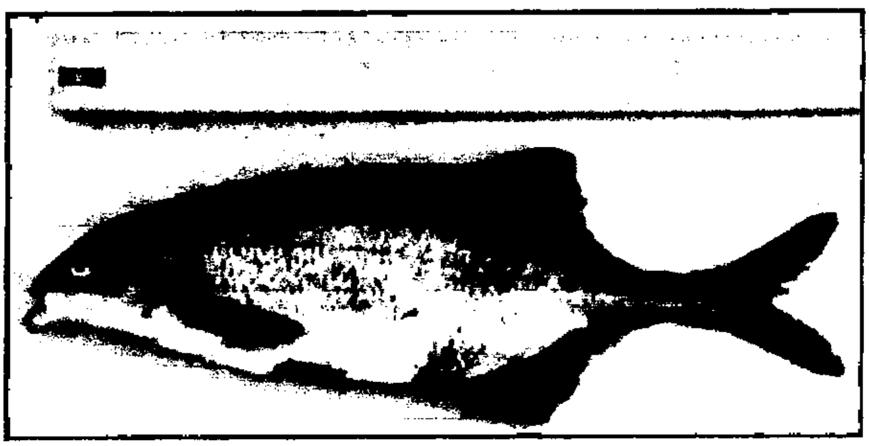

Plate 75: Photograph of *Marcusenius brucii*

Plate 76: Photograph of *Mormyrus rume*

Pantodon buchholzi **(Peters, 1876)**

The body is shaped like a boat with the top and bottom almost flat, so its profile almost seems rectangular. The sides are convex and the nostrils protrude like little tubes.The most distinctive feature of this fish are its fins; the long pectoral and ventral fins are extended like wings. The dorsal fin is small, rounded and set back on the body. Both the anal and caudal fins are elongated like flags. The anal fin of the male is notched, the females are rounded and their mouths are quite large (Plate 77).

Mormyrops anguilloides **(Linnaeus, 1758)**

It has no dorsal spine, no analspine but has 21 – 33 dorsal soft rays and 38 – 51 anal soft rays. Its head is depressed, mouth is terminal and the body is elongated. It snout is almost as wide as its head (Plate 78).

Pollimyrus adspersus **(Gunther, 1866)**

It has no dorsal spine, no anal spine but has 19 – 22 dorsal soft rays and 24 – 29 anal soft rays. The dorsal fin originated slightly behind anal fin origin. It is generally dark brown colour with first rays of dorsal and often of the anal fins is darkened (Plate 79).

Dasyatis garouaensis **(Stauch & Blanc, 1962)**

It has a moderately large and thin – body, disc oval and flatter shape than the other West African dasyatid. It has no pearl spine, the tip of its snout projecting as a small triangular process. It has a long tail with a dangerous spine (Plate 80).

Clarias jaensis **(Boulenger, 1909)**

It has no dorsal spine, no anal spine but has 70 – 86 dorsal soft rays and 54 – 70 anal soft rays. It has long, broad and pointed head in the dorsal outline.

Caecomastacembelus decorsei **(Pellegrin, 1919)**

It has 30 – 33 dorsal spines and 7 dorsal rays. Its upper lip protruded further than the lower lip (Plate 81).

Plate 77: Photograph of *Pantodon buchholzi*

Plate 78: Photograph of *Marcusenius senegalensis*

Plate 79: Photograph of *Pollimyrus adspersus*

Plate 80: Photograph of *Dasyatis garouaensis*

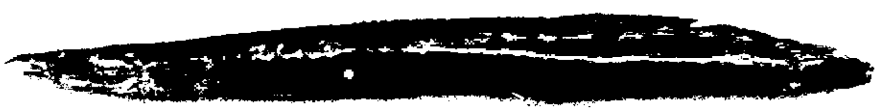

Plate 81: Photograph of *Caecomastacembelus decorsei*

4.10 FISH PRODUCTION COST AND REVENUES IN LEKKI LAGOON

Total fish production in Lekki Lagoon by Small Scale capture fisheries in 2007 was estimated at 1041.01 metric tons or 4.21 metric tonnes per square kilometer per year or 42.1 kg per hectare per year according to Suwarso and Wasilum (1991) and Solarin (1998).

The 514 (50.05% of the total fishing gear) gillnet canoes with an average catch of 6.10kg fish per day for approximately 20 days per month and eleven months in the year gave a production estimate of 218.73 metric tonnes. The 120 (11.68%) cast net canoes produced an average of 4.0kg, fish daily and for approximately 20 days per month and 9 months in the year gave a production estimate of 94.0 metric tonnes. Long line (147) produced an average of 5.10kg per day and 117.71 metric tonnes in a year. A total of 83.23 metric tonnes of fishes and prawns were produced by 109 basket trap canoes in the year. The 35 bamboo trap canoes produced 83.20 metric tonnes in the year. The eight boat seine produced 174.04 metric tonnes from average 10 days per month for eleven months. A total of 248.09 metric tonnes of fish was produced by 84 floating island fishery in the year. Table 40 & 41 shows the annual fish production by gear type in 2006/2007.

The current market values and cost of fish were used in the analysis of annual production costs and revenues from the small scale fisheries in Lekki Lagoon in 2007. The initial capital investment or fixed cost included the cost price of canoe, the fishing gear (net twine, rope, hooks and the accessories like the floats and sinkers as well as the cost price of outboard engine or paddle for canoe propulsion). The operational or variable costs covered fuel and lubrication oil, canoes maintenance estimated as 10% of the initial cost of the canoe, engine maintenance (15% of cost), net repair (10% of cost) and cost of labour (if the fisherman was hired) estimated as one third of the revenue from fish sale according to Solarin (1998). The total annual revenue from fish sale amounted to annual catch (kg) multiplied by the average price of fish per kilogram. The profit margin or loss amounted to the total revenue minus both capital and operational costs.

At the end of one year fishing operation, unmotorised canoes gillnet fishery gave 125.1% return on investment. In motorized gillnet fishery a loss of N31,322.00 (USD 261.02) or 10.0% was due to the high initial capital investment especially the cost of out board engine as well as the operational cost incurred in the buying of fuel and lubrication oil. The loss should be regained in the subsequent operational years. The useful life span of wooden canoe and out board engine ranged between six and fifteen years with good maintenance. The long-line fishery was highly profitable with 254.7% return on investment.

Table 40: Estimates of Annual Production Costs and Revenues in Small Scale Fisheries in Lekki Lagoon in 2006/2007

Cost and Revenue	Non-Motorised Gillnet (N)	Motorised Gillnet	Boat Seine	Basket tap	Hook and Line	Iken Fishery
A. CAPITAL INVESTMENT OR FIXED COST						
- Canoe	20,900.00 ($174.17)	35,200.00 ($293.33)	65,300.00 ($544.17)	20,900.00 ($174.17)	20,900.00 ($174.17)	65,300.00 ($544.17)
- Fishing gear/net and accessories	40,000.00 ($333.33)	40,000.00 ($333.33)	450,000.00 ($3,750)	20,000.00 ($166.67)	15,500.00 ($129.17)	40,000.00 ($333.33)
- Outboard engine or paddle	500.00 ($4.17)	85,000.00 ($708.33)	120,000.00 ($1,000)	500.00 ($4.17)	500.00 ($4.17)	1,000.00 ($8.33)
Sub-Total (A)	**N61,400.00 ($511.67)**	**N160,200.00 ($1,335)**	**N635,300.00 ($5,294.17)**	**N41,400.00 ($345.00)**	**N36,900.00 ($307.50)**	**N106,300.00 ($885.83)**
B. OPERATIONAL OR VARIABLE COSTS						
- Fuel and Lubrication	NIL	75,000.00 ($625.00)	100,000.00 ($833.33)	NIL	NIL	NIL
- Canoe Maintenance (10% of Cost)	2,090.00 ($17.42)	3,520.00 ($29.33)	6,530.00 ($54.42)	2,090.00 ($17.42)	2,090.00 ($17.42)	2,090.00 ($17.42)
- Engine maintenance (15% of Cost)	NIL	12,750.00 ($106.25)	22,500.00 ($187.50)	NIL	NIL	NIL
- Net Repairs (10% of Costs)	4,000.00($33.33)	4,000.00 ($33.33)	50,000.00 ($416.67)	2000.00 ($16.67)	1550.00 ($12.92)	4,000.00 ($33.33)
- Labour (1/3 of revenue)	57,672.99 ($480.61)	57,672.99 ($480.61)	458,940.95 ($3824.51)	32,963.00 ($274.69)	38,541.66 ($321.18)	81,078.33 ($675.65)
Sub-Total (B)	63,762.99 ($531.36)	152,942.99 ($1274.52)	637,970.95 ($5316.42)	37,053.00 ($308.78)	42,181.66 ($351.51)	87,168.33 ($726.40)
C. ANNUAL REVENUE						
- Average Catch (kg/Canoe /day)	6.10	6.10	74.09	3.23	5.10	31.83
- Annual Catch (kg) C_2	1342.0	1342.0	8149.9	387.6	1122	1834
- Average Price of fish/kg C_3	210 ($1.75)	210($1.75)	210 ($1.75)	250($2.08)	250 ($2.08)	250($2.08)
- Total Annual Revenue (N) C_4	281,820.00 ($2,348.50)	281,820.00 ($2,348.50)	1,711,479.00 ($14,262.33)	96900.00 ($807.50)	280,500.00 ($2,337.50)	458,500.00 ($3, 820.83)
- Profit (if any) or Loss (C_4 – A – B)	156,657.01 ($1305.48)	31,322.99 ($261.02)	438, 208.00 ($3651.73)	18444.00 ($153.70)	201,418.34 ($1678.49)	265,031.67 ($2208.60)
- **Return on Investment**	**125.1%**	**10.0% (loss)**	**34.42%**	**23.51%**	**254.7%**	**137.0%**

Table 41: Estimates of Annual Production Costs and Revenues in Small Scale Fisheries in Lekki Lagoon in 2006/2007

Cost and Revenue	Cast Net	Bamboo Trap	Lift Net
A. CAPITAL INVESTMENT OR FIXED COST			
- Canoe	20,900.00 ($174.17)	20,900.00 ($174.17)	20,900.00 ($174.17)
- Fishing gear/net and accessories	10,500.00($87.50)	8,500.00($70.83)	15,300.00 ($127.50)
- Outboard engine or paddle	500.00 ($4.17)	500.00 ($4.17)	500.00 ($4.17)
Sub-Total (A)	**N31,900.00 ($265.83)**	**N29,900.00 ($249.17)**	**N33,700.00 ($280.83)**
B. OPERATIONAL OR VARIABLE COSTS			
- Fuel and Lubrication	NIL	NIL	NIL
- Canoe Maintenance (10% of Cost)	2090.00 ($17.42)	2090.00 ($17.42)	2090.00 ($17.42)
- Engine maintenance (15% of Cost)	NIL	NIL	NIL
- Net Repairs (10% of Costs)	1,050.00 ($8.75)	850.00 ($7.08)	1,530 ($12.75)
- Labour 1/3 of revenue)	26,635.00 ($221.96)	25,214.00 ($210.12)	30,900.00 ($257.50)
Sub-Total (B)	**N29,775.00 ($248.13)**	**N28,154.00 ($234.62)**	**N34,520.00 ($287.67)**
C. ANNUAL REVENUE			
- Average Catch (kg/Canoe /day)	4.0	3.20	3.36
- Annual Catch (kg) C_2	720.0	307.2	403.2.8
- Average Price of fish/kg C_3	210 ($1.75)	210 ($1.75)	250 ($2.08)
- Total Annual Revenue (N) C_4	151,200.00 ($1,260)	64,512.00 ($537.6)	100,800.00 ($840.00)
- Profit (if any) or Loss ($C_4 - A - B$)	89,525.00 ($746.04)	6458.00 ($53.82)	32,580.00 ($271.50)
- **Return on Investment**	**145.2%**	**11.1%**	**47.8%**

4.11 WOMEN PARTICIPATION IN FISHERIES IN LEKKI LAGOON

Apart from the traditional roles as wives and mothers the involvement of women in the capture fisheries in the Lekki Lagoon covered many aspects with varying degree of participation. Women around Lekki lagoon especially in Dopamu village are excellent net fabricators.They participated in the construction as well as the repairs and mending of various fishing gear such as gillnet, cast net and traps. The cylindrical basket traps (with double non-return aperture local called Ighere or Igun), 10% of gillnet, cast net were constructed by the womenfolk who are excellent weavers.

Participation of women folk in the fishing operation was limited to small single and double non-return trap fishing, gillnet and castnet (Obiriki). Plate 82 shows a women operating narrow double valves basket trap 'Igun' around Emina village in Lekki Lagoon. Women were actively involved in boat seine operation in the lagoon (Plate 83). The sale of the catch from the fishery was done by the wives of the fishermen. The catches were transported in basket to Oluwo market in Epe market. Plate 84 showed the stacked fish baskets awaiting cargo boat to be transported to Oluwo market. Women in the fishing villages are not involved in fish processing; they transport their husbands catch to Epe (Oluwo market) for sale. The fish caught were taken off the fishermen at the landing jetty or beach by their wives who dispose them as deemed fit.

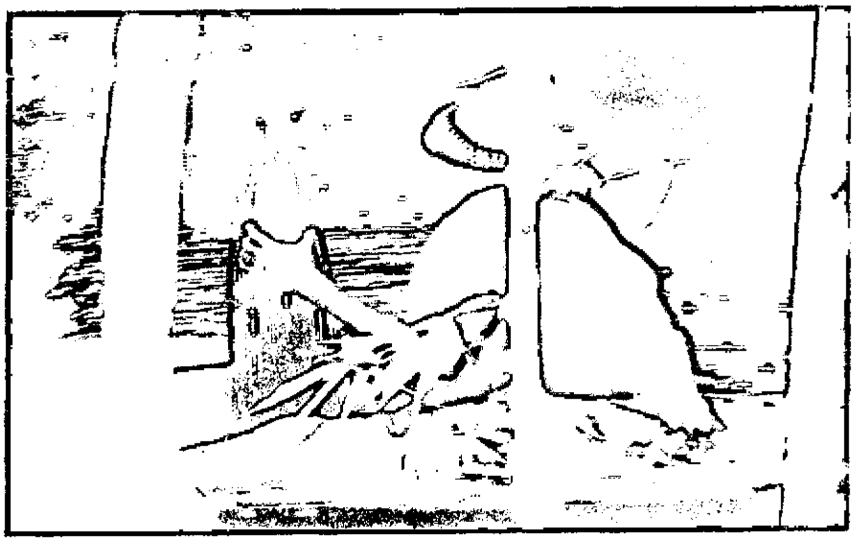

Plate 82: A woman operating basket trap in Lekki lagoon

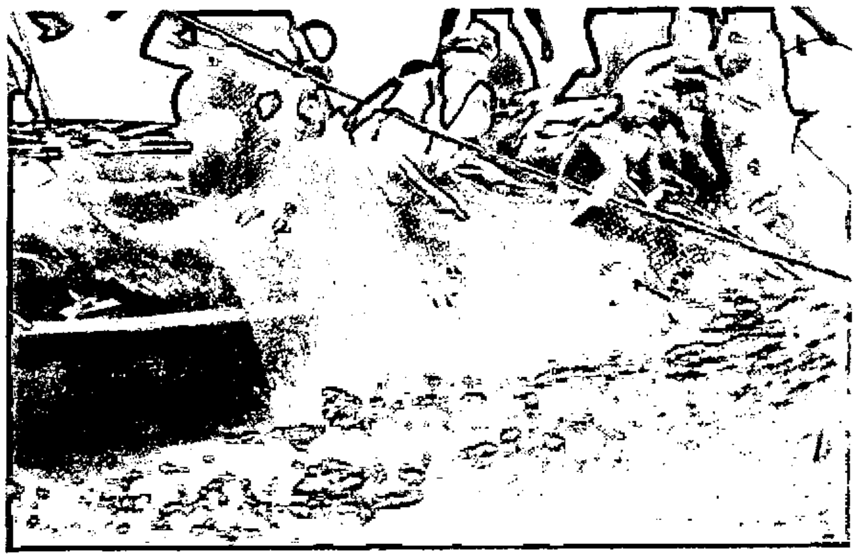

Plate 83: Woman in boat seine operation in Lekki lagoon

Plate 84: Fish catches in stacked baskets ready to be transported to Oluwo market at Epe

The live fish especially those caught by trap from floating island fishery, were kept in bigger traps or basket dipped in lagoon water before transporting to the market (Plate 85). The live fish e.g. catfish *Chrysichthys nigrodigitats* and *C. filamentosus* attracted high market value. Plate showed women selling live catfish at Oluwo market beach.

At Oluwo market, smoking was the most common preservation methods observed. The fish were dressed by the women before smoking (Plate 86). Plate 87 showed the dressing processes of fish before smoking and Plate 88 show *Malapterurus electricus* in horse shoe shape ready to be smoked. The dressing process involved gutting, scaling and in some cases cutting the fish into chunks.

All the smoking was done using the traditional drum oven (Plate 89) using woods as source of fire. The glittering effect was aided using dried cassava peels. Virtually everything is paid for in Post-harvest fish processing (like gutting and smoking). The fee varies depending on bargaining skills of the buyer. Plate 90 show dried *G. niloticus* arranged in small baskets for sale.

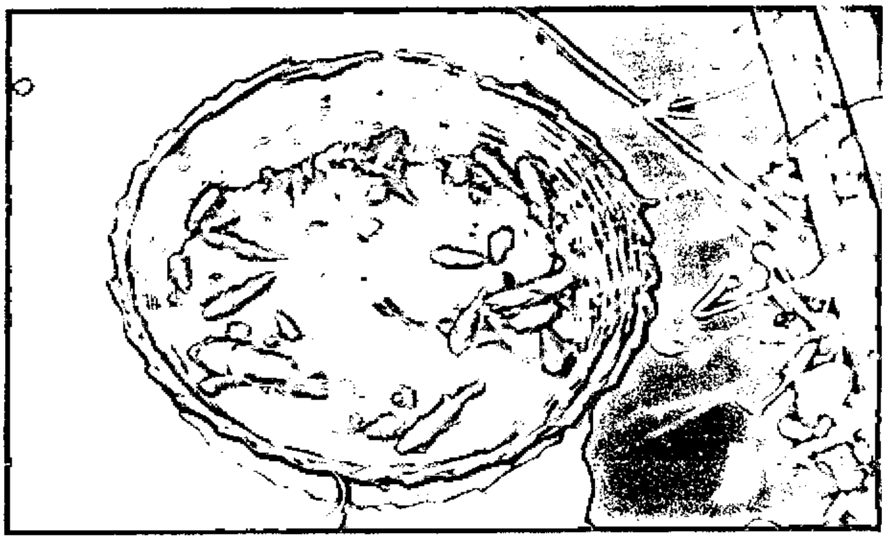

Plate 85: Live fish with few dead ones dipped in the lagoon

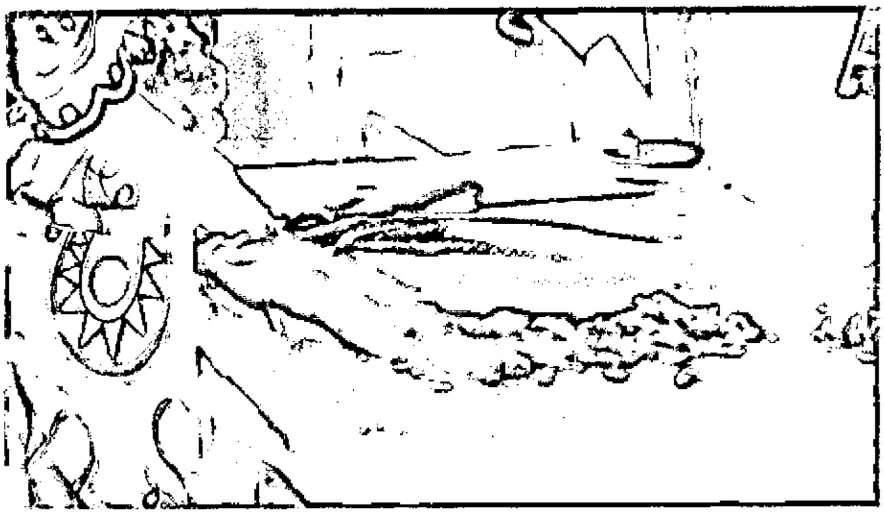

Plate 86: Scaling of *Heterotis niloticus* for smoking

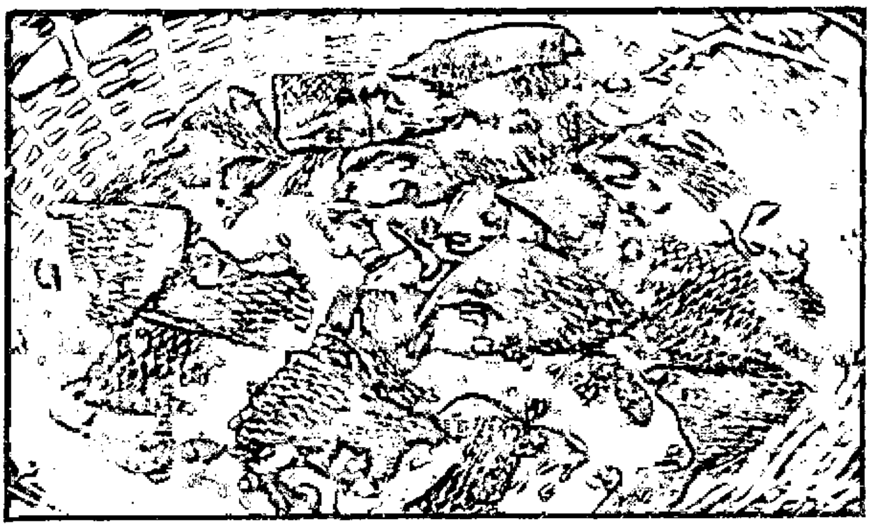

Plate 87: Dressed T. guineensis ready for smoking

Plate 88: ***Malapterurus electricus*** **in horse shoe shape ready to be smoked**

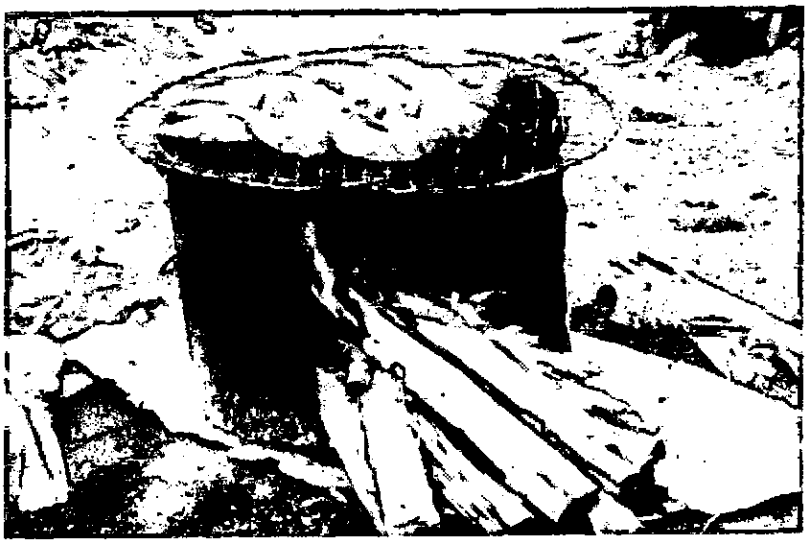

Plate 89: Traditional drum oven used in fish smoking and drying

Plate 90: Dried ***Gymnarchus niloticus*** **arranged in small basket for sale**

The woods used for smoking were transported from the fishing villages to the market and were tied in N50 and N100 depending on the size. The N50 fire was said to be use to make more than N500 gain by the fish smokers.

Other fish processing methods like sun drying and salting were less common practices for commercial purposes. Specifically they were jointly used for the fish prepared for frying for home consumption.

Fish marketing was solely women job, live fish like *Gymnarchus niloticus* (Plate 91), *Parachanna spp., Malapterurus electricus* (Plate 92), *Erpetoichthys calabaricus, Clarias gariepinus, Clarias agboyiensis* and *Clarias jaensis* were presented in iron tanks, plastic bowls and baskets (immersed in the lagoon); the smoked fish were displayed in the market for high amount of money in sets. Plate 93 shows the women selling live *chrysichthys spp* at Oluwo market beach, Epe.

The fresh and smoked fish were displayed openly on trays, basket, wooden tables or sacks spread on the ground. The fresh fish were set in fifteens (1 bundle) for sale (Plate 94& 95). The buying and selling of fish in Lekki and Epe market was peculiar in that after the fish has been paid for, extra amount of money ranging from N100 to N200 will be added as the sales girl's money locally known as "Owo Alarobo".

Plate 91: Live *G. niloticus* in fish hold for sale at Oluwo market in Epe

Plate 92: Live *Malapterurus electricus* stored in a bow for sale

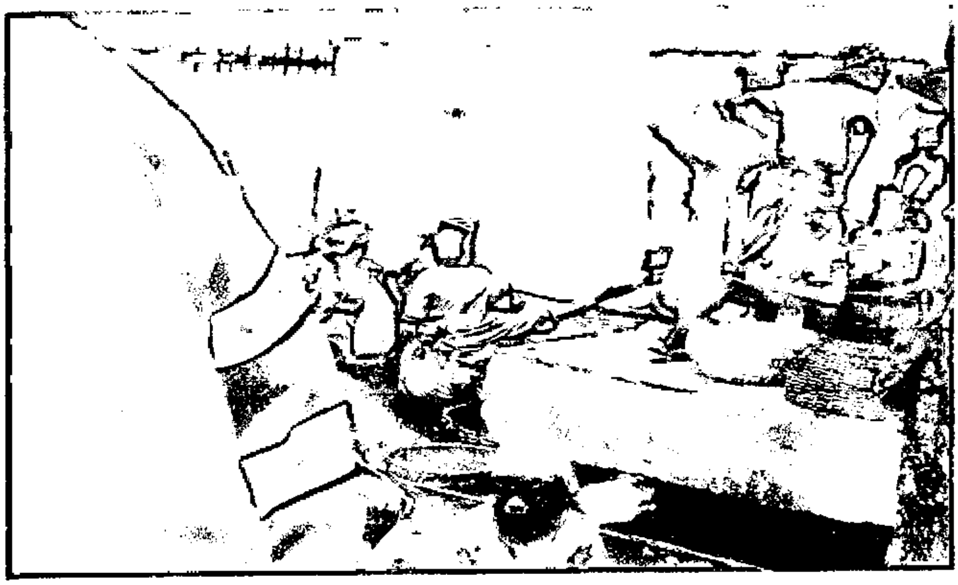

Plate 93: Women selling live *Chrysichthys spp* around Oluwo market jetty in Epe

Plate 94: Fresh *T. guineensis* display on a sack spread on the ground at Oluwo market

Plate 95: *T. guineensis* set in bundles for sale at Oluwo market in Epe

5.0 DISCUSSION

5.1 PHYSICO – CHEMICAL PARAMETERS OF THE LEKKI LAGOON

The physico – chemical data from this study shows clearly that the Lekki lagoon is open and low brackish lagoon.The air temperature ranged between 24.0 and 34.0°C and the water temperature ranged between 26.4 and 32.5°C during the two year period of March, 2006 to February, 2008. Ikusemiju (1981) recorded the air and water temperatures of 21.3 – 31.9°C and 22.7 – 31.0°C respectively over a period of two years in Lekki lagoon. Hayes *et. al.* (1984) recorded air temperature range of 27.0 - 28.2°C in the Lekki lagoon. Solarin (1998) recorded air and water temperatures of 25.0 – 33.2°C and 25.0 – 32.4°C over a period of three years in Lagos lagoon. Onyema *et. al.* (2007) recorded a temperature range of 27.0 – 31.0°C also in the Lagos lagoon.

The temperature range observed in this study agreed with the work of Vanden-Bossche and Bernacsek (1990) where ther recorded surface water temperature range of 27.5 – 34.0°C in Malonda lagoon in Congo, 25.0 -32.0°C in Ebrie lagoon, Cote d'ivoire and a range of 18.0 – 34.3°C in the brackish water lagoons in Ghana. If the present work was compared to the report of Fagade and Olaniyan (1974) in Lagos lagoon where temperature range of 24.5 – 31.5°C and Kusemiju (1981) in Lekki lagoon it could be concluded that the temperature had greatly increased. Though there was no regular pattern in the *in-situ* changes in temperature in the stations sampled (A-E), the monthly mean surface water temparture was slightly higher than the air temperature in most cases as observed by Kusemiju (1981) and Solarin (1998) in Lekki and Lagos lagoon respectively.

In general, dry season temperature values were slightly higher than those of the rainy season. The lower temperature during the rainy season could be attributed to the greater cloud cover during the seasom which reduced the heating effect of the sun.

Higher water transparency was recorded during the dry season than the rainy season, an indication of low and high water turbidity respectively. It is an optical property that expresses the degree to which light is scattered and absorbed by molecules and particles which during the rains was less due to influx of debris from rivers and run-off into the lagoon. The work of Kusemiju (1973) over three decades ago recorded a minimum of 0.52m in March and 1.04m in October and attributed the higher turbidity during the rains to discharge of rain water into the Lekki lagoon bringing debris, suspended particles and disturbance at the bottom. On the contrary, in this study, the minimum water transparency observed was 0.80m (October) and maximum transparency of 2.13m in May in the same lagoon. Solarin (1998) recorded minimum water temperature of 0.4m (June, July) and maximum transparency of 1.9m in April in Lagos lagoon and this was related to the influx from inland waters, sand extraction and filling of shallow areas in the lagoon and land reclamation for urban development as well as the construction of bridges increased water turbidity in those areas. The importance of water transparency in the lagoons was reported by Turner and Millward (2002) as a major determinant of the condition and productivity of an aquatic system and the tractability of water for human consumption, recreation and manufacturing. The high transparency water in the lagoon during the study supports the life of the fisher folk in the fishing village since the only means of drinking water in the area is the lagoon water.

The high transparency increases the light penetration for photosynthesis which gave rise to high phytoplankton production which serves as natural food for fishes and other aquatic organisms. This agreed with report of Turner and Millward (2002) who reported that the most obvious effect of increased turbidity is reduction in light availability for photosynthesis. Lekki lagoon is a shallow water body except in station A where a minimum depth of 4.88m was recorded. Dufour (1987) and Solarin (1998) jointly noted that shallow lagoons tend to be more productive than deep ones on the account of the presence of shallow littoral margins which serve as spawning and nursery ground for fish.

According to Brown and Kusemiju (2002) and Onyema (2008), rainfall pattern in the tropics creates the dry and wet season experienced in West Africa. The seasonal differences determine salinity in coastal waters and the distribution of aquatic biota (Brown and Oyenekan, 1998 and Onyema, 2008). The salinity in Lekki lagoon showed a peculiar trend in that rainy season salinity was higher than dry season. This may be as a result of daily intrusion of the ocean into under groundwater table which was transported by hydraulic gradients in the direction of the lagoon (Waljeski and Williams, 2004).

A period of significantly higher dissolved oxygen concentration was associated with the peak rainfall season when nutrients and debris are brought into the lagoon with the influx of fresh water from inland rivers. High dissolved oxygen concentrations also corresponded with the low temperature season indicating an inverse relationship (Ajao, 1990).

The hydrogen ion index ranged from 6.0 to 9.33. For most parts of each year the pH varied very little. The pH of the environment into which a pollutant is deposited may influence the chemical form, the solubility and its toxicity to exposed biota (Sheehan, 1984; Ajao, 1990). pH changes can drastically affect the structure and function of the ecosystem both directly and indirectly. The relatively small pH range in the study area would seem to depend largely on the salinity regime in the lagoon. This agreed with Ajao (1990) that the relatively small pH range in the study area would seem to depend largely on the salinity regime in the brackish environment.

The dry season was associated with the lowest values of nitrate while gradual increase occurred during the wet season. The levels obtained were possibly governed by the transport of suspended sediments with the influx of inland water into the study area during the wet seasons. Nitrate generally occurred in trace quantities in surface water (< 0.1mg/l) but was enriched by inputs from other sources (Ajao, 1990).

The dry season was associated with the lowest values of sulphate while gradual increase occurred during the wet season. The levels obtained were possibly governed by the transport of suspended sediments with the influx of inland water into the study area during the wet seasons. This agreed with Olaniyan (1969) and Ajao (1990) that during rainy season, and in particular from the early rains to the peak of the rains, mineral salts would be leached from the soil into the rivers and thence to the lagoons.

5.2 FISHING GEAR AND METHODS IN LEKKI LAGOON

The wide array of fishing gear used in the Lekki lagoon revealed various degrees of efficiency and selectivity in catching the fish resources. This study was conducted to provide information on the fishing gear in use in the lagoon, their effectiveness and their possible effect on the fish fauna.

In Lekki lagoon, there are over 3,000 active fisherfolks from 25 fishing villages covered in the study. Gillnet is the most used fishing gear in the lagoon and the use of monofilament nettings alone or in combination with multifilament materials should be encouraged to improve the efficiency of the net. This agreed with Solarin (1998) who stated that finest materials gave the best of catching result in Lagos lagoon. A minimum of 0.23mm twine thickness (instead of 0.16mm) is advised to reduce net wear and tear during fishing operation. The wide use of gillnets in the lagoon was because of its versatility, low cost and ease of operation. The efficiency of these net types is influenced by mesh size, exposed net area, flotation, mesh shape and hanging ratio, visibility and type of netting material in relation with stiffness and breaking strength. The knowledge of the efficiency of gillnets is important for the reconstruction of the population in fish stock. This agreed with the report of Machiels *et. al.* (1994) in the use of bottom gillnets for pike perch (*Stizostedion lucioperca*) and bream (*Abramis brama*).

In gill net operation care must be taken to prevent net wearing into the lagoon. Gears were noted to be lost for a variety of reasons including but not limited to: inclement weather (e.g. storms), macrophytes infestation, logging activities in the lagoon, bottom snags, and navigational collisions (e.g. with surface cargo boats and wrecks and entanglement with other gears), faulty fishing methods, abandonment, human error, and vandalising and gear failure. This was also reported by Laist (1995) in marine fisheries in Washington. The worn net if not retrieved in time will turn to ghost fishing gear. Smolowitz (1978) defined ghost fishing as the ability of fishing gear to continue fishing after all control of that gear is lost by fishermen.

Four different methods of catching fish by gillnets were observed during this study. These are:

(i) Fish kept by a mesh over the head (snagged);

(ii) Fish kept tightly by mesh behind the gill cover (gilled);

(iii) Fish kept tightly by a mesh around body or at base of dorsal fin (wedged); and

(iv) Fish hung up in the net by teeth, whisker (*Chrysichthys* sp.), fins or other projections (like the spines in *Chrysichthys* sp., *Schilbe mytus* and so on) or tangles in twisted or folded parts of the netting (entangled).

These gave clues to understand why the catching efficiency is so dependent on the ratio between mesh size and fish length. The efficient catching according to i, ii and iii above required a certain relationship between the mesh size and the width of different parts of the body as reported by Karlsen and Bjarnason (1987).

A fish that was smaller than mesh size will pass through it without being caught in a single mesh while a larger fish will not penetrate far enough into the net to get snagged or gilled. Consequently, it could be concluded that methods i to iii contributed mostly towards the narrow, high, efficient part of the selectivity curve and thereby the main reason for the importance of right mesh selection. This according to

Karlsen and Bjarnasson (1987) depends on several factors such as the shape of the fish, the softness of its skin and the elasticity of the twine in the net. The iv above was not dependent on the mesh size and the efficiency of entangling the fish depends on factors mainly related to type of fish sought, the twisting of the twine used, the hanging ratio of the net, the ballast and floats used.

The most common synthetic material used for gillnet was polyamide (PA) in Lekki lagoon. The least used synthetic material was polyethylene (PE). The advantage of polyamide compared to other synthetic materials according to Karlsen and Bjarnasson (1987) is that it is more elastic. This good elongation of PA twines was found to increase selection range; this also has positive effect on the efficiency in relation to the twine thickness and the swimming force of the fish. The elongation also supported the first three ways fish are caught in gillnets mentioned above (snagged, gilled or wedged).The tested netting materials observed showed majorly polyamide while only one group was polyethylene. In addition to the advantages of polyamide, the following disadvantages were noted: it was easily damaged when stuck by stump. This was also reported by Karlsen and Bjarnasson (1987) that when too many herrings were wedged in PA nylon nets, resulted in both increases release work and severe damage to the herring and the net.

The monofilament nylon caught more fish than the multifilament but the multifilament had longer life span than the monofilament.In the monofilament group the least netting twine diameter was 0.16mm and the largest twine diameter observed was 0.23mm. The 0.16mm caught more fish than 0.23mm but had shorter longetivity than 0.23mm. The thickness of the netting twine determines the price.

The special gillnet materials used in Lekki lagoon was multifilament polyamide twine ranging from 0.20mm to 0.36mm (mesh size 90mm – 180mm). They were used majorly for the big fishes (*Trachionotus teraia, Sphyraena barracuda, Caranx hippos* and *Polydactylus quadrifilis*).The netting materials were expensive to purchase, between N40,000 or USD333.33 (half bundle) to N80,000 or USD 666.66 (full bundle). This group of net can last for 5 to 7 years if properly managed, mended and preserved (bitumen and *Rhizophora* sp. bark extract).

There was no specific preservation technique for the monofilament gillnet in the study area unless the mending techniques used to prolong its life span. This agreed with Karlsen and Bjarnasson (1987) who reported that unlike the multifilament nets which can be coloured by dying, the colour of monofilament was determined during the production process.

One problem that was associated with the reduction of the twine thickness was that the meshes break more easily because of the struggle of large fish during hauling. In addition to this, problem with thinner twine was that it cuts into the skin of the fish more easily and thereby damages them.

The local fishermen set their nets between five and six o'clock in the evening and retrieve it at 6.30 – 7 o'clock the following morning. The long hours of setting (soak time) was believed to yield greater catch, but in most cases, a good percentage of the catch was not marketable because the fishes were already decomposing. This directly or indirectly attracts the swimming crab, *Callinectes amnicola* which caused great damage to both the fresh catch and the net itself. The crab's damage to gillnet was enormous. In one of the fishing trips, the damage caused by crab was estimated and small crab of carapace length 3cm tore a net size about $1.1m^2$. Then an estimation of $55m^2$ gap will be created if 50 crabs of this size were caught. Consequently if this net were not mended then, the whole net may be condemned. Solarin (1998) reported that, the longer the soak time the lower the catch rate. Fagade (1969) recorded that setting gillnet for a long time (e.g. 24 hours could lead to greater catch but 10 – 20% of the catch were not marketable because of deteriorating condition. Solarin (1998) suggested that to prevent fish deterioration and also prevent predators from devouring them, damaging the net and at the same time ensure optimal efficiency, gillnet should be checked at internal of 4 – 6 hours. This will result in sleepless night which may bring ill-health and addition expenses on the part of the fisher folks. In support of Solarin (1998), 4 – 6 hours is suggested as the best fishing period in the lagoon.

Due to the damage caused by the floating macrophytes, *Eichhornia crassipes* bottom set gillnet was recommended for this lagoon. Improvisation of fishing inputs, example the use of concrete sinkers and raffia to replace the more expensive lead weights and rubber slippers floats respectively should be encouraged in other to minimize cost of net construction to increase return on investment (ROI) for consequent fishing operation years.

The long lines are also widely used in Lekki Lagoon and the use in this study (experimental) cannot be considered to be highly species selective given the variety of species caught within a restricted depth range and area. Although hook gear can be highly species selective through hook size and bait type (Bjordal, 1989). The choice of longline in Lekki Lagoon as one of the major fishing gears was related to its fish size selectivity and it is environmental friendly. This agreed with Lokkeborg and Bjordal (1992) that hook does not damage fishing ground and it does not "ghost fish" when cast into the lagoon. These properties according to Jacobsen and Joensen (2004) make it a sensible type of gear for conservation and fisheries management purposes, combined with the fact that the catch is of good quality, because the fish was usually still alive when it was taken in.

Generally, longline in Lekki lagoon used many types of bait depending on targeted species. Peeled *Macrobrachium* spp target *Clarias gariepinus, C. ishenensis* and *C. nigrodigitatus*. This bait has a limitation since it was scanty during the dry season, so, its used will be restricted. *Batanga lebritonis* was used to catch *Cynoglossus senegalensis, Caranx hippos* and *Alestes baremose* but it was expensive to get, and fisher-folks had to travel to Obinehin, Ondo state to purchase it for use. This will relieve the fisher-folks up to three days of fishing which may affect their annual turnout. Different bait target different species, although there was overlapping of some like periwinkle and earthworm for *Chrysichthys* spp.

The size of the hook influences the efficiency of the longline. This was noted in mean length of the various fish caught in the longline trials. For most species the size distribution of the catches overlapped considerably with little or no significant increase in size with overall hook size. However, there were significant changes in catch-per unit effort, with the largest hook generally being much less efficient. It appears that there was a narrow range in terms of effective hook size for the majority of the species encountered in the long line fishery in the lagoon. This was largely due to the fact that these are mainly small species, which in most cases have maximum reported sizes of less than 50cm TL (Whitehead *et al*, 1984; Erzimi *et al.*, 1996). Since individuals at the upper end of the size range were rare, the most common sizes are considerably less than the reported maximum sizes. In general, this study had shown that efficiency decreases with increased hook size and all hook sizes catch a similar range of sizes. This agreed with the report of Erzini *et al.*, (1996) in Algarve waters south of Portugal. Some studies have concluded that there was no difference in selectivity (Ralston, 1982; Bertrand, 1988). Otway and Craig (1993) suggested that the observed lack of selectivity differences in the studies were due to the confounding effect of non-uniform bait sizes. King (1995) and Solarin (1998) both reported that the gap between the point and the shank of hook appeared to be the dimension which determined the size range of fish caught by a particular hook. The use of long line through the year in the Lekki lagoon is prevalent. This agreed with Solarin (1998) that baited hooks performed better in clear water with less turbidity while foul hooking in turbid water was more prevalent in the rainy season.

Intra- and inter-specific competition of baited hooks was observed in the lagoon for the various species encountered in the lagoon. Intra-and inter-specific competition for baited hooks has been reported in field studies of whiting (*Gadus merlangus* L) (Ferno *et al.*, 1986) and large cod chasing smaller ones away from baits has been observed by Lokkeborg and Bjordal (1992). Longline was size-selective in the lagoon, since one would expect larger fish to have wider foraging ranges, higher maximum swimming speed and to compete more successfully for the bait. This could partly explain the size-selectivity properties of the longline in the lagoon..

More than six different baits were observed for long lines in Lekki Lagoon. Kasumyan and Doving (2003) reported that interestingly there was apparently no correlation between what substances elicit an olfactory response, and those that provoke a gustatory response. This was probably the reason why longlines typically are baited with more than one type of bait in the lagoon. In respect of this, the decision making process of the fish which ultimately determines whether it was hooked or not was described in the following sequence.

Detect → Ignore

↓

Approach → Avoid

↓

Select → Reject

↓

Manipulate → Eject

↓

Ingest

It was only the bait that passed the "tests" that was assumed to have ingested and consequently hooked. Of course a fish could stumble over the bait without having been attracted to it, but attracted fish from a larger area was considered crucial if a decent catch rate was to be attained especially when fish density is low (Wooton, 1991; Jacobsen and Joensen, 2004). According to Nielsen (2003) the importance of smell and taste in feeding of fish are chemical and physical properties of water that make it an excellent solvent. Generally non-volatile compounds with low molecular weight (like amino acids) have the best potential for transport in the water masses.

Also Lokkeborg (1997) reported teleost fishes display a high sensitivity to different organic compounds via their olfactory system and that cod had been shown to detect and locate, through chemically medicated rheotaxis, a baited longline from up to several hundred metres away. Moreover, rheotactic odour search had also been reported in freshwater eels by Carton and Montgomery (2003).

During this study refrigerated fish used showed very low catch in all the bait tested. Kasumyan (1999) reported that after item has been located, the gustatory system, both oral and extra oral (barbell, pelvic fins, etc) was used to determined whether it was desirable food item or not. Brawn (1969) found that cod which had taken stale pieces of food, spat them back out again, this response was attributed to tastes and not texture. In addition to this, Lokkerborg (1991) reported that when handling the bait the texture of the bait was also important if ingestion was to follow.

The longer the time the less catch observed in the experiment. Soak time was associated with attractants that are released from the bait. This release decreases with time and catch rate were expected to decrease accordingly to a point when more fish were lost from the time than are caught (Lokkerborg, 1989). In the experiment conducted, however, all the bait was gone within 1-3 hours after setting, and the gear therefore was saturated. It simply cannot catch any more fish and therefore fish can only be lost from the line at that point. Also, the overnight setting of longline is not necessary.

Cast net was widely used in Lekki lagoon by both male and female fisher folks. As indicated by Fagade (1969) and Solarin (1998) the conical castnets were used extensively and were good for rapid sampling of the calm water and less cumbersome than some other gear types.The use of cassava tuber was observed to increase the catches of castnet in the lagoon. This supported the report of Udolisa and Solarin (1979) that the use of "garri" (processed cassava, *Manihot utilissima*) as bait to entice and concentrate fishes to marked fishing spots. Most castnet operation in Lekki Lagoon was done during the day. Udolisa and Solarin (1979) reported that castnet fishery was done throughout the year and that fishing during the day was more common than light fishing at night. Emmanuel and Kusemiju (2005) reports that more fish were caught using castnet in the dry season than rainy season because of a more conducive environment created for more euryhaline species in the creek.

With the conventional hanging ratios, the fishes having body girths smaller than the circumferences of the net meshes they contact can escape (Emmanuel *et al*, 2008). The depth of the area where castnet fishery was concentrated ranged between 2 and 3.5m. Emmanuel *et al*., (2008) reported that castnet was selective for shallow water fishes and that this was as a result of burst speed of escape of the fishes that was aggravated by the shallowness of the water in relation to the volume of water available for the fishes.

Basket traps were handled mainly by the women but at Luboye village it was solely the work of men. The entrance/valve of no return mouth aperture prevented fish escape and also determined the size of fish that would be caught. The bait types used in Lekki Lagoon were peeled fresh cassava tuber (*Manihot utilissima*) and coconut (*cocos nucifera*) but the latter was expensive to use though it attracted more catches. This was also reported by Solarin (1998) in Lagos Lagoon.In this study canoe tablet soap was tested and it yielded more catch although its effect on the palatability on catches was not known.

The floating Island is the only fish aggregating device; it was staked by bamboo tree. The shelters provided shade and hiding places as well as food for fish. Although modern FAD according to Suresh (2000) include huge structures made of concrete modules, vehicle tires etc, the artisanal fishers in Lekki Lagoon use this old fishing method they have evolved utilizing the natural weed mass as FAD in the form of floating islands. The organic matter releases by dead and decaying plant and animal materials in the *Jken* enrich the surrounding water, supporting a host of aquatic organisms. This fish aggregating device is peculiar to Lekki Lagoon due to its environmental factors like the salinity which allow the growth of the macrophytes.

Solarin (1998) reported on the use of brush park and other fish shelter in the Lagos lagoon were predominantly artificial reefs installed at the bottom. It was further reported that the floating weed acted more like the fish aggregating device (FAD) anchored (staked) or drifting at or near the water surface. Aquatic macrophytes contributed to an increase in fish abundance when compared with areas or water bodies devoid of macrophytes. This agreed with Borawa *at al.* (1979) who found that in the Currituck Sound (USA) fish density increased from approximately 1,000 to more than 15,000 fish ha^{-1} after *Myriophylum spicatum* became established. Killgore *et al.,* (1989) in their study of fish in the Potomac River (Virginia, USA) found densities of 17,000 – 98,000 fish ha^{-1} in areas with plants and the CPUE was two to seven times higher in areas with plants than without plant. They added that seasonal changes in density and species composition of aquatic plants cause a transition in the spatial and temporal distribution of fish. Egborge (1988) described the water hyacinth as a biological museum containing a wide array of organism like the algae, rotifers, nematodes, annelids, mollusks, cladocerans, copepods, isopods and amphipods which served as food for crabs and fishes.The mechanism of fish aggregation started with the colonization of the shelter with plankton and other micro – organisms which in turn promoted the growth of a large number of small planktophagus animals and fishes which fed on them (Solarin 1998). Macrophytes, as a substrate for epiphyton, and fish, are the major factors in the floating island fishery, which shows the importance of a vegetated littoral for the whole ecosystem of a water body. The need for biocontrol of aquatic macrophytes/weeds still remains high on the list of priorities, not only for fishery managers, but also for maintaining good quantity and quality water for drinking and home uses and transportation.

This study identified the use of giant basket trap and gillnet in floating island fish harvest in the lagoon. This had yielded value and has increased the living standard of the fisher folks. Dibble *et al.* (1996) gave the list of methods used in floating island harvest as electro-shocker, divers, seine, rotenone, gillnet, drop or throw-nets, pop-nets, light trap, explosives, belt transect, rotenone and block-net, modified traps. They categorically stated that pop-nets, drop-nets and throw-nets seem to be most effective in sampling fish in aquatic macrophytes.

As the demand and price of fish increased, the number of floating island multiplied and this causes considerable pressure on untouched fishing ground in the lagoon. The environmental consequences of the booming *Iken* fishery, the number of floating islands in the lagoon can sustain, as well as the stock and recruitment of fishes in the lagoon are not known. During the dry season the floating island caused great nuisance in the lagoon by hindering fishing activities and transportation in the lagoon by covering the lagoon expanse. This was also reported by Suresh (2000) in Loktak Lake (India).

5.3 FISHING CRAFT HANDLING AND MAINTENANCE

In Lekki lagoon the most common canoe was the planked canoe. The production of dugout canoes was restricted to Ijaw carvers at Saga village and was limited by the scarcity of timber which competed for some other uses like in furniture and building construction. This agreed with Solarin (1998) who reported that dugout canoes production was limited by the scarcity of timber which competed for some other uses like in furniture and building construction in Lagos lagoon.

Most canoes used in Lekki lagoon were generally tied to the jetties and left in water throughout the year. The wood absorbed a lot of water infested with algae such as *Spirogyra* sp. which added more to the weight to reduce speed of the canoes when propelled. The attack of barnacles was not common in the Lekki lagoon, it was observed at Iwopin in only two canoes (planked) and one planked canoe at Ebute-Lekki. The canoes were also left uncovered and water logged during the rainy season which could submerge or sink the canoe. In most cases, if the storm is too much this may result in permanent loss of dugout canoes carved from Opepe (*Nauclea diderrichi*). Exposure to the hot sun also results in cracks leading to water seepage. The preservative used for canoes in Lekki lagoon was by painting with bitumen, coating the back hull with cement and bitumen with grinded pepper. Although there has not been any scientific backing for the use of pepper in biofouling attack, the fisherfolk have accepted its success (per com).

The construction of more robust planked canoes to compensate for the shortage of large dugout canoe to non-availability of big timber, to increase the deck working space and to improve the lagoon worthiness. The technological status and development prospects of small scale fishing crafts in Nigerian coastal water were documented by Ambrose *et. al.* (2001) which supported the observation in this study.

Canoe maintenance should focus on:

(a) The prevention or reduction of water absorption by the wooden structure.

(b) The prevention of rot, decay as well as the control of boring and fouling organisms.

(c) Protection against splits or cracks as reported by Solarin (1998) in Lagos lagoon.

Wooden canoes have had a wide acceptance by the fishermen and will continue even if a new material for construction is introduced. Planked canoe can be improved by increase in hull size and stiffness, water tightness of deck by appropriate coating, caulking and fastening.

Safety measures in canoes should include adequate provision of life jackets. In Lekki lagoon the use of light indicator bouy for night fishing operation is highly important because of the tugging and cargo boat movement to prevent life and net losses.

5.4 FISH FAUNA COMPOSITION IN LEKKI LAGOON

Eighty - one species belonging to 40 families, 56 genera and 15 orders were recorded during this study period. Ikusemiju (1973) recorded only 28 species, Ekpo (1982) recorded 43 non-cichlid species in the same lagoon. Solarin (1998) reported that Lekki lagoon, Epe lagoon, Lagos lagoon, Badagry Lagoon and Badagry creek are connected by an intricate network of water ways that open to Gulf of guinea via the Lagos Harbour mouth. In addition to thus, this study identified two links to Gulf of Guinea, Lagos Harbour and Mahin Creek and two salinity peaks were identified at both ends.

William (1962) recorded the occurrence of 48 species in Lagos lagoon. Fagade and Olaniyan (1974) worked in the same lagoon area recorded 72 fish species. Also Solarin (1998) recorded 60 fish species belonging to 34 families in Lagos lagoon. Several workers have recognized the phenomena of an optimum salinity level associated with diversity of fishes about 34.7% and that any variation from that optimum level would cause variation in the number of species available (Hesse *et al.*, 1951; Hedgepeth, 1957). Grunter (1945) cited Ikusemiju (1973) found that a decrease in salinity from the optimum produced decline the number of species. For instance, it found that of 112 species commonly caught on the Texas coast 109 were taken at salinity greater than 30‰, 73 at 20‰ or less and only 39 at les than 5‰. Woolton (1992) noted that species richness was greatest in shallow tropical waters and would decrease as the abiotic condition become less favourable for life.

Macan (1963) cited Ikusemiju (1973) observed that where masses of fresh water and seawater adjoined, species from each invaded the brackish region between them, but few penetrated far and the number of species at a point midway between the two was small. So, the increase salinity from 0.05 – 0.30‰ (Ikusemiju 1973) to 0.02 – 4.70‰ in this study may likely be responsible for the increase in species diversity of the lagoon. Olaniyan (1968) cited by Solarin (1998) noted the variable fluctuation in abiotic factors in brackish water restricted number of species could exist under such condition and these few required particular adaptations to enable them to survive.

Motwani and Kanwai (1970) worked in the completely freshwater environment recorded 82 species of fish belonging to eighteen families at Kanji Lake, Nigeria. The high number of 73 species recorded for Lekki Lagoon in this study confirmed the fact that the lagoon is a transition area between brackish water (Lagos Lagoon and Mahin Creek) and freshwater (Rivers Saga and Oshun). The fact that there was variation in the salinity of Lekki Lagoon (0.007 – 4.70‰) further showed that the lagoon was not completely a freshwater system. Ikusemiju (1973) also confirmed that Lekki Lagoon with salinity range of 0.05 – 0.30‰ was not completely fresh.

5.5 WOMEN PARTICIPATION IN ARTISANAL FISHERIES IN LEKKI LAGOON

Women in Lekki lagoon has show an outstanding performance in the areas of fish processing, transportation and marketing. They have also shown some levels of competence in the area of basket trap, boat seine and gillnet operation. These agreed with Solarin (1998) in Lagos lagoon where it was reported that women were actively involved in the dragging of the seine net, post harvest handling and processing of fish. The restriction of women to some fishing operation was related to traditional gender role definitions and mystical beliefs (Kronen, 2002). The result of this study challenge a number of observation stated elsewhere. The involvement of women in the basket trap, boat seine and gillnet operations contrasts with the generally held beliefs that women are responsible for the collection of invertebrate only (Tonga et al., 2000) or that women only occasionally perform men's fishing (Matthews, 1991). This study agrees with the statements made by Schoeffel (1985), that women will use fishing gear if it available at home (e.g cast net, handline and lift net). Based on the fact that women's fishing activities stretch far beyond shell fish collection, it is argeed that little difference exists between men's and women's fishing in Lekki lagoon.

The fish sold to the public usually ought to be of good quality. Due to lack of cooling facilities fishes are sold within a few hours of being landed to achieve this. Otherwise, the high environmental temperature (24 – 34°C) accelerates the rate of post humous deterioration in quality of the fish.

5.6 FISHERY MANAGEMENT IN LEKKI LAGOON

The objective of fisheries management is to avoid over investment in fleet capacity and over exploitation of economically important fish stock. Kapesky (1984) noted that in the sense of regulation of entry, gear, fishermen numbers and fishing seasons, few coastal lagoon fisheries could be said to be well – managed. Fisheries may be regulated to some extent by traditional controls rather than by central government authority. The introduction of outboard engine and widespread use of gillnets allowed fishers to fish indiscriminately both on the small and big species in the lagoon. This gillnet fishery is unsustainable especially since the lagoon function as a nursery area. This study therefore recommend 50mm mesh size gillnet for sustainable fisheries resources in this major lagoon. This agreed with the report of Solarin (1998) who stated that bigger mesh sizes are good for sustainable fisheries resources in Lagos lagoon. Fishers in lekki lagoon maintained that the introduction and widespread adoption of boat seine and small mesh size gillnets imparted negatively on the fisheries resources in the lagoon because large proportion of fish species were caught before they reach adult stage. It also triggered an intensification of fishing in the lagoon to compensate for the decreasing yield of some of these species. The improvement of lagoon capture fishing potential through combination of enhancement of aquatic production and regulation of fishing is also advocated as indicatedby Kapetsky (1984) and Solarin (1998).

The artisanal fisheries management situation in the Lekki lagoon called for a cross – scale linkage between local institutions and government. This study demonstrated that fishers' knowledge can provide a valuable set of information about the relationship between fishers and the local environment and about the characteristics of practices, tools and techniques that led a more sustainable pattern of resource use in the past. Local knowledge can broaden the knowledge base needed for management and hence improve institutions that mediate the interaction between communities and their use of the resources. There are barriers to be overcome before fishers can play a significant role in management decisions. It is possible to identify 2 inter – related factors influencing the use of local knowledge in the co –management of lagoon resources as outlined by Reis and D'Incao (1998).

These are: (a) Illiteracy and socio – economic marginalization create low expectations of the management value of fishers' knowledge among scientists and decision makers. As put by Pauly (1997) the marginalization of fishers and their limited formal education have often blinded managers and scientists to their ecological knowledge which is used in many successful common property systems as basis for traditional community – based management. (b) Misfit between institutions and the characteristics of common property resources hinders fishers' stewardship of resources and the use of their knowledge to that effect. In a condition of scarcity and competition, fishers' stewardship of resource is an important yet difficult aim to achieve. The fishing gear type in Lekki lagoon showed varying degree of species selectivity and a few of them were species specific. The boat seine net was less selective and the fishing efficiency was relatively high.

6.0 SUMMARY OF FINDINGS

The present study investigated the artisanal fishing gears, crafts technology and their efficiency in the Lekki Lagoon, Nigerian. The salinity of the Lekki Lagoon has increased from freshwater (0.03‰) to low brackish (4.47‰) and this has affected the fish species distribution in the lagoon. Two major sources of salt water incursion were identified which were Lagos and Mahin Lagoon. The third source was assumed as salt water intrusion by subsurface flow through the barrier beach from the Atlantic Ocean and leaching of ions entrained in Lagoon bottom sediments.

Gillnets were noted to be most used fishing gear in the Lekki Lagoon.Two major types of gillnets were identified in the Lekki Lagoon: Surface drift and anchored bottom gillnets. Floats were improvised with slippers and *Raphia,* while the sinkers used were lead and stones. The differences in the designs of a surface gillnets and an anchored bottom gillnet were that more weights (lead/stone) in and was anchored were attached to the footrope; while more float were attached to float leadline of the surface gillnet than the anchored bottom gillnet.

The major operational problem for boat seine fishery was algae *Spirogyra africanum* impairment which prolongs the fishing operation with additional 2 to 4 hours depending on the thickness of the algae smear.The baits used for longline operation in Lekki Lagoon were: *Anadara selinis, Macrobrachium spp, Eleotris vittata, Mormyrus spp* (juveniles cut into bits), *Chrysichthys spp,* periwinkle *(Tympanotonus spp)* and earth worm.

The fishing craft in Lekki Lagoon were mainly the monohull wooden dugout canoes, planked canoes and planked dugout canoes. The attack of barnacles *(Mercieriella enigmatica)* was not common in Lekki Lagoon, it was only observed at Iwopin in only two canoes (planked) and one planked canoe at Ebute-Lekki. The canoe preservatives used in Lekki Lagoon was by painting with bitumen, coating the back hull with cement and bitumen with grounded pepper.

The fishing gear indices in Lekki Lagoon revealed gillnets (514) to be the most used fishing gear while boat seine (8) was the least used. Monofilament gillnets were more selective than multifilament gillnet in the Lagoon. The selectivity of bait for basket traps revealed that the fish species preferred canoe soap tablet to the other baits (cassava tuber, *Manihot* sp and coconut, *Cocos nucifera*).

There was considerable variation in the catch rates and the percentage of hooks that were retrieved with bait varied from 5 – 25% per set. The smallest hook (no. 13) caught the highest number of fish (192). The intermediate size (no 8) caught 177 (85.17kg) fish and the most successful in terms of total weight was no 7 with total fish weight of 151.52kg (59.72%).

Fishing aggregating devices used in Lekki Lagoon was *Iken* and it composed primarily of *Eichornia crassipes, Cyperus spp* and *Vossia* spp. The use of acoustics for floating island fishery yielded the highest catch by weight of 47.22% followed by fishing without acoustic (33.33%) and the least catch was recorded in the open lagoon (19.44%).

Two major netting materials, polyamide (PA) and polyethylene (PE) were identified in Lekki Lagoon. Eighty – one species of fish belonging to 40 families, 56 genera and 15 orders were identified in Lekki Lagoon. The fish species were of three ecological origin and seasonal occurrence in the Lekki Lagoon. There were twelve fishes of euryhaline origin which occur mostly throughout the year. There were fifty-six fishes of freshwater origin recorded in the lagoon. Ten fishes of marine origin occurred in Lekki Lagoon during this study.

The production costs and revenues in small scale fisheries in Lekki Lagoon showed that at the end of one year fishing operation, unmotorised canoes gillnet fishery gave 125.1% return on investment. In motorized gillnet fishery a loss of N31,322,00 or 10% was due to the high initial capital investment especially the cost of outboard engine as well as the operational cost incurred in the buy of fuel and lubrication oil. The longline fishery was highly profitable with 254.7% return on investment. The overall return on investment was high for all the fishing methods ranging between 10.0% (loss) (motorized gillnet) 254.7% (longline).

7.0 CONCLUSION AND RECOMMENDATION/IMPLICATION OF STUDY AND SUGGESTION FOR FURTHER STUDIES

7.1 CONCLUSION

1. The physical features of the study area were essentially stable with the exception of the salinity. The salinity in the lagoon had drastically increase from 0.30‰ (Ikusemiju, 1973) to 4.70‰ in this study.

2. The fishing settlements in Lekki lagoon were distinctively distributed with concentration of specific fishing gears in each area.

3. The small sized cast net in use in lagoon beach wading while the big sized are deployed mainly in the deeper parts of the lagoon using canoes. The two types of gillnets used in Lekki lagoon are surface drift and the anchored bottom gillnets.

4. The major operational problem for boat seine fishery in Lekki lagoon was algae impairment which prolongs the fishing operation with additional 2 to 4 hours depending on its thickness.

5. The fishing crafts in the lagoon were mainly the monohull wooden dugout canoes, planked canoes and the planked dugout or half dugout canoes. The dugout canoes are carved out from a log of wood (*Lophira alata*) which predetermined its size.

6. The canoe preservation used in the lagoon was by painting with bitumen, coating the back hull with cement and bitumen with ground pepper. The pepper was used in ratio 1:2 to the bitumen, mixed thoroughly, rubbed on the out canoe hull and dry under the sun for 3 to 5 days before use.

7. The fishing gear indices in Lekki lagoon revealed gillnet (514) to be the most used fishing gear while boat seine (8) was the least used. Two major netting materials, polyamide and polyethylene were observed in Lekki lagoon. The weight of fish caught in monofilament gillnet were more than those of the fish caught in multifilament. The selectivity of bait for basket traps revealed that the fish species preferred canoe soap tablet to the other baits (cassava tuber, *Manihot sp* and coconut, *Cocos nucifera*). Floating islands are composed of primarily of Echhornia crassipes, Cyperus sp or Vossia spp. The performance of the floating island depends on the size and the thickness. The fishing operation for floating islands with the use of acoustics yielded the highest catch by weight of 47.22% followed by fishing without acoustic (33.33%) and the least catch was recorded in the open lagoon (19.44%).

8. The fish species in the lagoon comprised of eighty –one species belonging to 40 families, 56 genera and 14orders. The species were of three ecological origin and seasonal occurrence in the lagoon. There were twelve fishes of euryhaline origin which occurred mostly throughout theyear. There were fifty – nine fishes of freshwater origin recorded in the lagoon. Ten fishes of marine origin occurred in Lekki lagoon during the study.

9. Total fish production in Lekki lagoon by artisanal capture fisheries in 2007 was estimated at 1041.01 metric tons or 4.21 tonnes per square kilometer per year or 42.1 kilogrammes per hectare per year. At the end of one year fishing operation, unmotorized canoes gillnet fishery gave 125.1% return on investment. In motorized gillnet fishery a loss of N31, 322.00 or 10.0% was due to the high initial capital investment especially the cost of outboard engine as well as the operational cost incurred in the buying of fuel and lubrication

oil. The longline fishery was highly profitable with 254.7% return on investment.

The study is important in serving as a comprehensive baseline for fishing crafts and gears design details and efficiency in relation to fish species composition of the lagoon. It provides, for the first time qualitative data on the salt water intrusion into Lekki lagoon. It also provides information on the selectivity of the fishing gears and their efficiency. The study is indicative of a need for fish resources mangement for ecological and economical sustainability.

7.2 RECOMMENDATION

Wooden canoes have had a wide acceptance by the fishermen and will continue even if a new material for construction is introduced. The continous availability of suitable quality and adequate size of timber for canoe construction is not certain because of danger posed by forest depletion. Gulbrandson (1985) and Ambrose etal (2001) reported the minimum size of tree for a long and big canoe to be 165cm diameter which could take over 100 years to grow. As a remedy, the Federal Government should mandate the Federal Department of Forestry to reserve certain species of trees like iron wood *Lophira alata*, obeche *Triplochiton scleroxylon* , black afara Terminalia ivorensis, white afara T. superb, mahogany *Khaya ivorensis* and opepe *Nauclea diderrichi* for Nigerian artisanal fishing industry.

The study shows that the larger the mesh sizes the bigger the fish. The larger mesh size should be encouraged to alow the small sized fish to reach adult stage before capture. The management measures should take into consideration both ecological and economic roles in order to optimize the fisheries resources of the lagoon.

High rate of inflation escalated prices of fishing inputs like fibre glass, canoes, netting materials, twines, ropes, plastic floats, lead weight and outboard engines beyond the reach of the small scale fishermen. The improvised materials like the used bottles, dried poles and wood for floats, cement, gravels for sinkers should be encouraged.

Small- scale fishermen found it almost impossible to procure loan directly from the banks because of collaterals and high interest rate which the loan attracted. Fishing inputs should be procured and supplied directly by Government agencies to the fishermen or fishermen cooperatives at subsidized rate and repayment should be instalmental. The fishermen should have access to credit facilities at very low interest rate to enable them purchase the necessary fishing inputs.

7.3 SUGGESTION FOR FUTURE WORK

The work described in this study conducted fishing gear crafts operational methods and the fish species composition this could be followed by fish tagging to know the movement of the fish in relation to salinity gradient. Also, the effect of boat seine on the lagoonal ecosystem and benthic micro and macro - - invertebrate fauna can be study in the future

The detailed hydrological analysis could be undertaken to acertain the salinity distribution in the lagoon. Also the environmental implication of the floating island could be studied.

8.0 CONTRIBUTIONS TO KNOWLEDGE

The study has contributed to science by:

- Established the current status of water quality of Lekki lagoon and its gradual transition from freshwater to low brackish lagoon with the attendant consequences on the lacustrine fish fauna.
- Documented the efficiency of artisanal fishing gears and crafts technology in Lekki lagoon which will serve as important tool in management of the fisheries resources.
- Established that boat seine is the most efficient fishing gear in terms of catch abundance while the long line fishery has the highest return on investment in the lagoon.
- Identified indigeneous cost effective methods fishing craft preservation techniques.
- Established that monofilament gillnet was more efficient than multifilament gillnet for fish catch but multifilament had higher longevity and resistance to environmental stressors.
- The efficiency of the floating island fishery was also documented to showcase its value in small scale fisheries in the lagoon.

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APPENDICES

Appendix I: Mean Standard Deviation of physico-chemical parameters between March, 2006 and February, 2008

Sample Station	Air Temp. (⁰C)	Water Temp. (⁰C)	Transparency (cm)	Depth (m)	TDS (mg/l)	Conductivity (μScm⁻¹)	Salinity (‰)	pH	DO Mg/l
A.EMINA	28.02±2.00	29.35±1.34	1.34±0.51	9.49±2.39	1271.81±2905.34	747.63±1352.82	0.50±0.63	7.53±0.81	4.77±0.36
B.IRERAN OLATUNJI	29.46±2.32	29.46±1.55	1.24±0.38	2.15±0.29	1092.18±2371.93	750.00±1364.05	0.46±0.76	7.34±0.84	4.680.38±
C.LUBOYE	29.77±2.23	30.19±1.59	1.18±0.35	1.80±0.20	1642.67±4042.03	997.68±2038.12	0.41±0.65	7.37±0.73	4.74±0.49
D.AGAN CENTRE	29.77±1.53	30.50±1.40	1.27±0.64	2.72±0.76	632.65±873.44	1071.35±1650.01	0.64±1.02	7.45±0.74	4.73±0.39
E. EBUTTE LEKKI	30.78±1.21	30.88±1.33	0.94±0.42	2.33±1.18	885.29±1282.73	1598.93±2185.65	1.17±1.42	7.29±0.65	4.71±0.33

Appendix II: Physico – chemical characteristics in the lagoons of the South – western Nigeria between Ebute metta – Lagos state and Ori – oke Iwamimo – Ondo State

Station	Parameter	pH	Cond (μscm^{-1})	Salinity (‰)	TSS (mg/l	TDS (mg/l)	SO_4^{2-} (mg/l)	NO_3^- (mg/l)	DO (mg/l)
A	Dry	6.92	49800.0	35.30	28.0	25000.0	17.0	72.33	4.7
	Wet	6.60	27500.0	14.94	2.0	12500.0	51.0	78.50	4.9
B	Dry	6.79	51400.0	35.50	15.0	25800.0	19.0	82.05	4.9
	Wet	7.10	27750.0	15.29	3.0	12800.0	29.0	80.40	4.8
C	Dry	7.10	20300.0	16.50	3.0	10300.0	14.0	28.14	5.0
	Wet	7.40	8350.0	4.04	3.0	3885.0	27.0	24.50	4.8
D	Dry	6.98	1648.0	9.10	5.0	8210.0	17.0	15.28	4.8
	Wet	7.60	500.0	2.28	4.0	2320.0	22.0	14.20	4.8
E	Dry	7.50	810.0	0.70	ND	404.0	ND	6.58	5.6
	Wet	7.90	3505.0	1.93	2.0	1565.0	13.0	5.60	4.7
F	Dry	7.27	498.0	0.40	4.0	247.0	ND	3.44	4.9
	Wet	7.70	3565.0	4.04	2.0	1600.0	15.0	10.10	4.6
G	Dry	7.28	466.0	0.50	5.0	234.0	ND	3.72	4.8
	Wet	6.60	3575.0	2.91	1.0	1640.0	13.0	10.30	4.7
H	Dry	7.22	563.0	0.50	3.0	283.0	ND	3.41	5.1
	Wet	6.90	3820.0	1.76	1.0	1775.0	17.0	11.20	4.8
I	Dry	7.22	741.0	0.50	8.0	369.0	8.0	3.62	4.7
	Wet	7.10	3830.0	2.11	ND	1770.0	18.0	11.10	4.9

Station	Parameter	pH	Cond (μscm^{-1})	Salinity (‰)	TSS (mg/l	TDS (mg/l)	SO_4^{2-} (mg/l)	NO_3^- (mg/l)	DO (mg/l)
J	Dry	7.65	712.0	0.40	2.0	357.0	ND	2.72	5.0
	Wet	7.10	3870.0	2.11	ND	1785.0	17.0	11.20	4.8
K	Dry	7.54	12910.0	0.60	ND	6460.0	7.0	21.31	5.2
	Wet	7.20	3840.0	1.93	2.0	1760.0	17.0	11.10	4.9
L	Dry	9.33	1676.0	12.00	3.0	839.0	3.0	10.21	4.9
	Wet	7.20	5600.0	3.16	ND	2600.0	24.0	16.40	4.9
M	Dry	7.55	3480.0	1.80	3.0	1730.0	13.0	4.98	5.0
	Wet	7.40	4625.0	2.46	1.0	2135.0	22.0	13.50	4.8
N	Dry	7.23	2040.0	1.30	1.0	1010.0	8.0	4.66	5.4
	Wet	7.40	3025.0	1.55	5.0	1405.0	18.0	8.90	4.7
O	Dry	7.08	9920.0	5.00	ND	4960.0	15.0	18.65	5.3
	Wet	7.50	11400.0	7.03	ND	5300.0	26.0	4.90	4.8
P	Dry	7.01	13310.0	7.80	ND	6610.0	19.0	22.14	5.4
	Wet	7.60	5700.0	2.91	7.0	2670.0	25.0	16.20	4.8
Q	Dry	6.94	15770.0	8.60	4.0	7870.0	18.0	23.31	5.1
	Wet	7.80	4040.0	1.05	25.0	1870.0	22.0	11.80	4.6
R	Dry	6.83	39500.0	29.20	10.0	19800.0	12.0	68.71	5.0
	Wet	7.60	3295.0	15.05	36.0	1530.0	19.0	9.60	4.6

Appendix III: Scientific, English and Local names of fish Species in Lekki Lagoon

Order/Family/Species	English name	Yoruba	Ilaje
Perciformes			
Anabantidae			
Ctenopoma petherici (Gunther, 1864)	Climbing perch	Ekiki	Ekiki
Centropomidae			
Lates niloticus (Linne, 1762)	Niger/Nile perch	Igbo	Obira omi tutu
Carangidae			
Caranx hippos (Linnaeus, 1766)	Crevalle jack	Agasa	Agasa onidi pupa
Trachinotus teraia (Cuvier, 1832)	Te ai pompano	Owere	Owere
Cichlidae			
Tilapia guineensis (Bleeker, 1862)	Tilapia	Epia	Ajikoro
Tilapia zilli (Gervais, 1848)	Tilapia	Epia	Ajikoro
Tilapia mariae (Boulenger, 1899)	Tilapia	Epia	Epiya elegwa
Chromidotilapia guntheriguntheri (Sauvage, 1882)	West African Devil		
Sarotherodon melanotheron (Rupell, 1852)	Black jaw tilapia	Epia	Epiya
Oreochromis niloticus (Linne, 1758)	Nile tilapia	Wesafun	Epiya
Hemichromis fasciatus (Peters, 1852)	Jewel fish	Koro	Akokoro
Hemichromis bimaculatus (Gill, 1862)	Jewel fish	Aleje	Akokoro elegwa
Eleotridae			
Eleotris vittata (Dumeril, 1858)	Sleeping goby	Orombo	Ikughun
Kribia nana (Boulenger, 1961)	Sleeping goby		
Channidae			
Parachanna obscura (Gunther, 1861)	Snake head	Korowo	Okodo
Parachanna africana (Steindachner, 1879)	Snakehead	Korowo	Okodo
Pomadasysidae			
Pomadasys jubelini (Cuvier, 1830)	Sompat grunt	Ikekere	Ikekere
Lutjanidae			
Lutjanus dentatus (Dumeril, 1860)	African brown snapper	Obira	Obira pupa
Polynemidae			
Polydactylus quadrifilis (Cuvier, 1829)	Giant African threadfin	Ofon	Ofon
Gobiidae			
Bathygobius soporator (Valenciennes, 1873)	Goby fish	Orombo	Ikughun
Goboides ansorgii (Boulenger, 1909)	Goby fish	Gbologbolo	
Spyraenidae			
Sphyraena barracuda (Walbaum, 1792)	Giant barracuda	Kuta	Ijakere okun
Monodactylidae			
Psettias sebae (Cuvier, 1931)	African moony	Akaraba	Akaraba

Order/Family/Species	English name	Yoruba	Ilaje
Distichodontidae *Ichthyborus monodi* (Pellegrin, 1929)	Lute fish/ grass - eater		
Rajiformes Dasyatidae *Dasyatis garouaensis* (Stauch & Blanc, 1962)	Ray fish	Alate	Late
Polypteriformes Polypteridae *Polypterus senegalus senegalus* (Cuvier, 1829)	Bichir	Adagba	Adagba
Erpetoichthys calabaricus (Smith, 1866)	Bichir	Weyi/Lakisa	Adagba
Elopiformes Elopidae *Elops lacerta* (Valenciennes, 1846)	West African ladyfish	Asugbon	Ajigban
Osteoglossiformes Pantodontidae *Pantodon buchholzi* (Peters, 1876)	Butterfly fish	Oloyan	Eleyan
Notopteridae *Papyrocranus afer* (Gunther, 1868)	Feather back	Lakoro	
Xenomystus nigri (Gunther, 1868)	African knife fish	Felefele	Belebele
Osteoglossidae *Heterotis niloticus* (Cuvier, 1829)	Bony tongue fish	Aika/ Afo	Agbadagiri
Mormyriformes Mormyridae *Mormyrus rume* (Valenncíennes, 1846)	Trunk fish	Lele	
Mormyrus macrophthalmus (Gunther, 1866)	Trunk fish	Lele	
Hippopotamyrus pictus (Marcusen, 1864)	Elephant fish	Lele	
Hippopotamyrus psittasus	Trunkfish	Lele	
Hyperopisus bebe (Lacepede, 1803)	Ngai		
Mormyrops anguilloides (Linnaeus, 1758)	Cornish jack	Lele/Ogodor obo	
Marcusenius senegalensis (Steindachner, 1870)	Trunkfish	Afinfin	
Pollimyrus adspersus (Gunther, 1866)	Elephant fish		
Marcusenius brucii (Boulenger, 1910)	Elephant fish	Afinfin	
Brienomyrus longianalis (Boulenger, 1901)	Elephant fish		
Gnathonemus petersii (Gunther, 1862)	Elephant fish		
Mormyrops caballus (Pelledrin, 1927)			
Gymnarchidae *Gymnarchus niloticus* (Cuvier, 1829)	Trunk fish	Osan	Ohanrin
Clupeiformes	Guinean sprat	Salapore	Salapore

Order/Family/Species	English name	Yoruba	Ilaje
Clupeidae *Pellonula afzeliusi* (Johnels, 1954)			
Ethmalosa fimbriata (Bowdich, 1825)	Bonga shad	Efolo	Folo
Characiformes Citharinidae *Citharinus latus* (Muller & Troschal, 1845)	Moonfish	Osu	
Cithranus citharus (Goeffrey Saint Hilane, 1809)	Moonfish	Osu	
Hepsetidae *Hepsetus odoe* (Bloch, 1794)	African pike	Ijakere	Ijakere
Characidae *Alestes macropthalmus* (Gunther, 1867)	Silversides	Arefe	
Alestes baremose (de Joannis, 1835)	Silversides	Arefe	
Brycinus nurse (Ruppell, 1832)	African tetras	Ajarapo	
Brycinus longipinnus (Gunther, 1864)	African tetras	Ajarapo	
Siluriformes Bagridae *Chrysichthys Walkeri*	Silver catfish	Obokun	Igangan
Chrysichthys nigrodigitatus (Lacepede, 1803)	Silver catfish	Obokun	Igangan
Chrysichthys filamentosus (Boulenger, 1912)	Silver catfish	Obokun	Igangan
Parauchenoglanis akiri (Risch, 1987) *Auchenoglanis occidentalis* (Valenciennes, 1840)	Catfish	Kankan	
Schilbeidae *Schilbe mystus* (Linne, 1758)	Butterfly fish	Asan	
Schilbe uranoscopus (Ruppell, 1832)	Butterfly fish	Asan	
Clariidae *Clarias gariepinus* (Burchell, 1822)	Sharp – toothed catfish	Aro	Aso
Clarias jaensis (Boulenger, 1909)	Catfish	Aso	Aro
Clarias agboyiensis (Sydenham, 1980)	Catfish	Aso	Aro
Clarias anguillaries (Line, 1758)	Catfish	Aro	
Heterobranchus longifilis (Valenciennes, 1840)	Catfish	Aso	
Malapteruridae *Malapterurus electricus* (Gmelin, 1789)	Electric catfish	Ojiji	Ojiji
Malapterurus minjiraya (Sagua, 1987)	Electric catfish	Ojiji	Ojiji
Mochokidae *Synodontis eupterus*	Catfish	Okokoniko	Akokoniko
Synodontis clarias (Linne, 1758)	Catfish	Okokoniko	Akokoniko
Synodontis couterti (Pellergrin, 1906)	Catfish	Okokoniko	Akokoniko
Synodontis filamentosus (Boulenger,	Catfish	Okokoniko	Akokoniko

Order/Family/Species	English name	Yoruba	Ilaje
1901)			
Mugiliformes Mugilidae *Liza falciptinnis* (Valenciennes, 1836)	mullet	Atoko	Itoko
Mugil cephalus (Linnaeus, 1758)	Mullet	Atoko	Agbokulu
Synbranchiformes Mastacembelidae *Caecomastacembelus decorsei* (Pellegrin, 1919)	Spiny eel	Doje	
Pleuronectiformes Citharidae *Citharus linguatula* (Linnaeus, 1758)	Sole	Iya abolibo	Abo
Cynoglossidae *Cynoglossus senegalensis* (Kaup, 1858)	Senegalese tongue sole	Abolibo	Abo
Gonorychiformes Phractolaemidae *Phractolaemus ansorgii* (Boulenger, 1901)	Bloodfish	Osigbi/ Ogidigbi	
Decapoda Palaemonidae *Macrobrachium vollenhoveni*	Fresh water prawn	Ede	Ipa/ Saghoro
Macrobrachium macrobrachion	Fresh water prawn	Ede	Ipa/Saghoro
Portunidae *Callinectes amnicola*	Swimming crab	Akon	Agharo

Appendix IV: Fishing villages/ settlements and the fishing gear and method around Lekki lagoon

Fishing village/ Settlement	Fishing gear, crafts, method and related activities
Emina	Gillnet, hook and line, cast net
Ikeran Aba Ilaje	Gillnets, traps, hook and line
Ikeran Olatunji	Cast net, traps, floating island fishery
Take	Cast net, gillnets, traps, hook and line
Luboye	Traps, gillnets, cast net, hook and line
Iwopin	Boat seine, giflnet, cast net, lift net
Siriwon	Gillnets, traps, castnet
Dopanu	Gillnets, traps, castnet
Aba onigbagbo	Gillnet, castnet, liftnet (Ita), hook and line
Idata	Gillnet, castnet, traps
Ilagbo	Gillnets, Castnet, trap
Igbolomi	Gillnet, cast net, trap, hook and line
Aba oyinbo	Gillnet, castnet, trap, floating island fishery
Origele	Traps, castnet, gillnet, hook and line
Origbe	Floating island fishery, gillnet, traps
Aba oriyanrin	Gillnet, hook and line, cast net, trap
Orubu	Gillnet, castnet, hook and line
Imeki	Liftnet (ita), gillnet, hook and line, Cast net ,boat seine
Lakoye	Gillnet, cast net, hook and line
Arala	Gillnet, cast net, hook and line
Ebute Lekki	Gillnet, hook and line, castnet, bamboo trap, boat construction and repair workshop
Igbodola	Boat seine, gillnet, cast net, trap
Aba onigangan	Gillnet, cast net, hook and line
Ise	Gillnet, liftnet, cast net, hook and line

Appendix V: The list of ornamental fishes exploited from Lekki lagoon, their common and local names

S/N	Scientific names	Common English Name	Local name (Yoruba)
1	*Alestes baremose*	Silversides/ Egyptian Robber	Agarapo
2	*Alestes nurse*	Tiger fish	Agarapo
3	*Erpetoichthys calabaricus*	Reed fish/ Rope fish	Adagda
4	*Chrysichthys nigrodigitatus*	Silver catfish	Obokun
5	*Ctenopoma petherici*	Climbing perch	Ekiki
6	*Gnathonemus petersii*	Elephant fish	Lele elenu doodoo
7	*Gymnarchus niloticus*	Aba Knife fish	Osan
8	*Hepsetus odoe*	African pike	Ijakere
9	*Heterotis niloticus*	Bony tongue	Agbadagiri
10	*Hyperopisus bebe*	Ngai	
11	*Malapterurus electricus*	Electric fish	Ojiji
12	*Caecomastacembelus decorsei*	Spiny eel	
13	*Mormyrus rume*	Trunkfish	Lele
14	*Pantodon buchholzi*	Butterfly fish	Oloyan
15	*Papyrocranus afer*	Featherback	Lakoro
16	*Phago loricatus*	African pike - characin	
17	*Polypterus senegalus*	Bichir	Adagba
18	*Schilbe mystus*	Butterfish	Ogan
19	*Synodontis clarias*	Red tail Syno	Akokoniko
20	*Synodontis eupterus*	Featherfin squeaker	Akokoniko
21	*Hemichromis fasciatus*	Banded jewel fish	Akokoro
22	*Hemichromis bimaculatus*	Jewel fish	Akokoro
23	*Chromidotilapia guntheri*	West African Devils	Ikorobo
24	*Xenomystus nigri*	African knife - fish	Felefele