FISHERIES SOCIETY OF NIGERIA

FISON

1985

CONFERENCE PROCEEDINGS

PRICE: ₦15.00

ISBN 978-2345-00-15

PROCEEDINGS OF THE 4TH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON) PORT-HARCOURT, 26TH - 29TH NOVEMBER, 1985

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PUBLISHED BY

FISHERIES SOCIETY OF NIGERIA
P. O. BOX 71228, VICTORIA ISLAND,
LAGOS — NIGERIA.

CONTENTS

CONSTRAINTS TO FISHERIES DEVELOPMENT OVER OUR 25 YEARS OF INDEPENDENCE

Concept

The major constraint to Fisheries Development in Nigeria derived from Nigeria's wrong concept of the status of Fisheries at independence. Fisheries was believed to be synonymous with zoology. Fisheries, in fact, is an economic terminology encompassing the state of commercially important aquatic resources, their exploitation and their utilization. Therefore, the emphasis in fisheries is quantitative with qualitiative undertone. By this definition, investors are not interested in the anatomy and physiology of fish species, neither are they interested in the biomaterial properties of fish. Investors would like to know of the quantities of fish harvestable, how to harvest them and how lucrative the fish market is. As far as they are concerned fish is like bags of rice or cement and, their major interest is the magnitude of return on their investment, relative to other competing products. Therefore, the pre-occupation of the fisheries workers should have been, to encourage capital formation and increase fish production in a bid to enhance fish consumption by Nigerians for proper growth and good health.

As in every economy, therefore, fisheries workers should consist of experts in all fields of human endeavour, excepting probably religious studies, all working in concert to bring about the fulfilment of this noble objective.

Staffing Policy

From this concept it is evident that another constraint to rapid fisheries development has been the national staffing policy. Although appreciable improvements have been made in this area since the last 10 years, a new staffing policy, relevant to the needs of the fisheries economy should be formulated. One would like to see more animal nutritionists, marine/mechanical engineers, electronic and radio engineers, shipbuilding engineers and fishermen to the levels of Skipp (fishing) Certificate of Competency (as in the Netherlands), occupying the positions of Research Officers in our Fisheries Research Institutes.

In the Fisheries Development Departments one would like to see more of pure agriculturists, aquaculturists, economists, civil engineers, occupying the positions of fisheries officers in aquaculture. So also should it be ideal to recruit to the Fisheries Officer positions such specailists as marine/mechanical engineers, shipbuilding engineers, refrigeration engineers and food processing engineers to man fishing terminals and fish utilization outfits throughout the country.

Funding

However, all the blame can not be ascribed to lopsided staffing policy only. Most planned projects slotted in the four National Development Plans suffered inadequate funding to the extent that most, if not all, were abandoned mid-way. Of course, inadequate funding of projects by Government might have been due to lack of proper articulation and lack of indepth knowledge of planned projects by schedule officers. Experience had shown that officers who were capable of defending their estimates of project costs always got what they wanted from Government without much difficulties

Another area which had always suffered from inadequate funding is Fisheries Education. Although financial provisions were made by Government to establish fisheries schools at Lagos, Kainji and Lake Chad, infrastructural facilities were inadequate. Besides, there is a dearth of specialists to teach the various aspects of fisheries required for the various courses. As a result of this, the curricula for various certificate courses leaned more to Fisheries Biology for which teachers were readily available.

On the other hand, the Universities were handicapped because of the meagre financial resources available to them for the implementation of fisheries training courses. Nigerian universities are not fully equipped to produce graduates in fisheries, let alone being able to help undertake meaningful investigations into problem areas of the fisheries economy.

The fact that previous Nigerian Governments were unable to appreciate the need for research might have accounted for their insensitivity to the needs of Research Institutes. Because of lack of funds our research programmes have not been as meaningful as they should have been. In spite of the good intentions of research workers, their efforts are stiffled by lack of funds.

Another very important aspect of fisheries which is badly affected by funds is fish preservation and utilization. Sufficient infrastructures are not available to fishermen for the preservation of their fish catches as a result of which, it is claimed, more than 50% of all local fish production is lost through spoilage.

NEW STRATEGY FOR ENHANCED FISHERIES DEVELOPMENT

Research

In a bid to foster appreciable growth of the fisheries economy, Government must change its attitude towards research. The need for research cannot be over-emphasised in view of the fact that the information available to us indicate that we might not be self-sufficient in fish production. This assumption derives from the limited research efforts brought to bear on Nigeria's fish resources identification.

I believe that we can attain self-sufficiency if sufficient funds were made available to Research Institutes and Universities to conduct comprehensive research into all aquacultural prospects, particularly cage and pen aquaculture systems. Besides, a lot of research is needed in identification of endemic cultivable species of fish whose culture histories are yet to be established.

As regards fish supply from capture fishery, Nigerian research efforts should extend to the territorial seas and exclusive economic zones (EEZ) of the countries with which she has bilateral fishing rights agreements. This would enable Research agencies develop a fish resources data bank from which prospective investors in diastant-water fisheries can procure economic information for their investment decisions. It is sad to note that inspite of Federal Government's efforts to avail Nigerians of the fisheries resources of countries like Guinea Bissau, Guinea Conakry, Mauritania, Senegal and Equitorial Guinea, few, if any, Nigeria-based fishing Companies have so far taken advantage of this opportunity.

The major reason for this seeming lack of interest is due to the fact that investors would like to be advised on the productivity of these waters with a view to determining whether or not the returns on investment might justify all their efforts in this respect.

Staffing

As mentioned earlier, the fisheries staffing policy in the public sector must be further reviewed to reflect our new understanding of the implications of fisheries. The aim of Government fisheries agencies should be, to put the right persons in the right positions.

The consequencies of this new approach are far-reaching. Not only will Fisheries Departments, Research Organisations be better able to advise Government more realistically and professionally, the private sector will restore the faith which has hitherto been lost in the ability of Government agencies to promote the growth of the economy.

Education

Being the bed-rock of all development processes fisheries education should receive Government's priority attention.

The staff positions of all Fisheries Schools should be strengthened so that specialists in the various disciplines included in the curricula are appointed, regardless of the number of students admitted at any given time. Emphasis should be placed on practical training in order to make graduates of such schools effective in the economy.

For high-level manpower development, faculties of fisheries should be established in selected Universities. All fisheries courses being run by the Biology Departments of our Universities are useful only to research organisation. While our Universities should be credited for their efforts in this regard, in the face of poor funding and inexistent National fisheries educational policy, their products are not effective in the private sector.

To be effective, such proposed fisheries faculties should have staff and facilities for courses in fish farm planning and aquacultural practices (freshwater, brackish and marine), fish capture techniques, fish preservation and utilization, fisheries economics including marketing and basic courses in aquatic biology, limnology and oceanography. The Nigerian fisheries economy needs more of jacks of all trade and less of specialists as of now.

In–Service–Training Programmes

Because of the poor concept of the fisheries development process, most in-service training programmes designed for fisheries officers had been academic. While those of reserach officers may be justified to some extent, it is counter-productive to send fisheries officers employed in Fisheries Development agencies for academic post-graduate courses. For fisheries officers to be effective, their post-graduate in-service training should be professional henceforth.

THE ROLE OF FISHERIES SOCIETY OF NIGERIA

The Fisheries Society of Nigeria has existed in name only and not indeed. It is time we woke up from our slumber. The private sector believes that FISON is a Federal Department of Fisheries affair, because the Society has made no impact on Nigeria's fisheries economy so far.

Other societies are making their existence felt in their sectors of Nigeria's economy. Some are organised to the level that they have established secretariats, some regulate the practice of their professions and influence Government policies. Although some of these professional societies are referred to as toothless bulldogs, the Fisheries Society of Nigeria is yet to develop to the level of a bull, let alone have dentition.

I appeal to the Society to redefine its objectives and brace up to the challenges of the future if it is our aim to secure Government's recognition.

In order to help the fisheries economy grow, the Fisheries Society of Nigeria (FISON) should do the following:–

(a) Increase the level of financial contributions by members so that the Society is able to establish a small secretariat.

(b) Encourage more private-sector participation through publicity.

(c) Organise more regular meetings of members during which Government policies affecting fisheries shall be discussed, and ex-rayed. The Society's decisions or positions on such policies shall be conveyed to Government, as and when the need arises.

(d) Constitute ourselves into a clearing house for National fisheries policies.

(e) Constitute ourselves into a formidable lobby capable of influencing Government programmes on National fisheries development.

(f) Organise fisheries shows once a year which will bring together all fisheries workers and fishermen to exchange ideas on how to foster the growth of the economy.

(g) Organise seminars or conference specifically to discuss new ideas, research findings and new techniques in fish resources exploitation and utilization.

(h) Organise annual social gatherings in a bid to keep alive the interest of all members and to encourage prospective members to join the Society.

It is my hope that this Conference shall deliberate on these suggestions and shall endeavour to draw our attention to other areas where the Society has failed and, that at the end of this session, we shall be in a position to make recommendations that shall make the Society more effective to the promotion of growth of Nigeria's Fisheries Economy.

Thank you.

SECTION 2 – RESOURCE EXPLOITATION, MANAGEMENT, DEVELOPMENT AND UTILIZATION

THE TRADITIONAL FISHERY OF IBU PROJECT AREA ON THE NORTHERN PORTION OF THE IMO RIVER, NIGERIA

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ABSTRACT

A survey carried out on the fishery of the Northern portion of Imo basin known as Ibu Project area for the purpose of this study, provided some information on the number and type of fishermen cropping this portion of the Imo River. The population was found to be very mobile with many itinerant or seasonal fishermen. The type of gear in use was studied and a high number of traditional dug-out canoes recorded which shows the ability of the people to make their own canoes. The presence of freshwater shrimps crayfish and clupeids at this upper region of the Imo River was observed.

INTRODUCTION

The Imo River rises from Umuaku in Isuochi near Okigwe and flows southwards where it is joined by its two major tributaries - the Otamiri and Aba rivers before it enters the sea through Akwete. The proposed Ibu Project area is named after the Ibu River which is one of the main tributaries of Imo River in the northern portion of the Basin at Ndimoko.

A proposed dam site at Ndimoko is situated south of the confluence of the Imo River and Ibu River about twelve kilometers west-northwest of Okigwe. The Ibu Project area extends south of this dam axis at Ndimoko through Ndionuoha Ndianiche to Amuro on the left bank. The river is covered with fallen logs of wood but the flow is known to be fast during heavy rains and this has some influence on the fishery of the area. There is a natural lake found on the right bank of the basin at Ndimoko.

For effective planning and management, data on the present status of the fishery of the area would be necessary. The area is rich in well known freshwater fish species and fish of about 8 - 15kg have been caught. Full-time as well as farmer/fishermen operate in the area. The presence of Clupeids in the Imo River system is worthy of mention. This fish has been known to be purely marine but have conquered the freshwater environment. Their presence has also been confirmed in the Niger, Anambra and Cross Rivers systems.

METHOD

A frame survey was produced. The frame survey was aimed at providing accurate information about the size and structure of the fishing industry under study. Area covered by the survey included the organic structures of the fishing site, type of fishermen, number and size of fishing crafts, composition of fish catch and general information about the methods used by the fishermen for processing and marketing their catch.

Study Area

For the purpose of the survey, the Ibu Project area was taken as a stratum and the area divided into four sub-strata on the basis of topography and size of river with contributing tributaries (Figure 1).

The four sub-strata are as follows :–

Sub-stratum 1 (Ndimoko/Obinetiti Ndianiche): This is located at the northern portion of the project further with a low lying valley on the left bank which extends further north. There are some tributaries. Notable among them is the Ibu River flowing into the Imo on the left bank and Ohi stream flowing into the Imo right bank. Immediately downstream, the confluence of Imo and Ibu rivers, the surrounding land is high and gradually slopes further downstream into a large extreme low lying land.

Sub-stratum 2 (Ndionuoha/Uwakonye, Ndinjoku): This is a low lying level land which stretches over a wide hectarage. The Iyiba stream joins the Uchu River in this zone and this in turn with Anamiri Rivers form the main contributing tributaries of Imo River on the right bank. The Imo River is moderately slow here. The Ozobara stream flows into the Imo from the left bank. These tributaries cause the over-flooding of the Imo River on the left bank, resulting in the formation of numerous flood ponds which are potential fishing grounds for basin residents. The Anambra Imo River Basin Development Authority has developed a 10-hectare fish farm project in this area which is operational.

Sub-stratum 3 (Ikpeze): This is another low lying area without any major contributing tributaries except for four small seasonal streams.

Sub--stratum 4 (Ndianiche/Amuro). The topography of the land is again gradual but it is broken by some small valleys created by the Iyiachara stream flowing into the Imo River. The river here is large because of some of the tributaries mentioned above. In all the sub-strata, fishing sites were identified and five fishermen interviewed. The fishermen were randomly selected.

RESULTS

In all, 14 fishing sites were recorded, out of which 3 were in substratum 1; 4 in substratum 2; 2 in substratum 3, and 5 in substratum 4 as shown in Table1.

Table 1 – Distribution of Permanent and Temporary fishing sites in all the 4 Substrata

Substratum	*Sampling Date*	*No. of Permanent Fishing Sites*	*No. of Temporary Fishing Sites.*	*Total No. of Fishing Sites*
Ndimoko/Obinetiti	8/8/80-5/6/81	1	2	3
Ndionuoha /Uwakonye/ Ndi Njoku.	9/8/80-10/6/81	1	3	4
Ikpeze	10/8/80-15/6/81	–	2	2
Ndianiche/Ezeana/ Amuro	11/8/80-10/7/83	2	3	5
Total		**4**	**10**	**14**

Substrata 1 and 3 had less fishing sites with 10 dug-out canoes, while substrata 2 and 4 had more fishing sites with 25 canoes. A seasonal variation in the size of fishing sites was found. With the number of canoes per site increasing during the low water periods, and a corresponding reduction in the number of fishing sites. At such periods the part-time fishermen engage in sand digging still using their canoes to land the sand.

It was interesting to note that most of the fishing sites were temporary. Table 1 shows a significant difference in the proportion of temporary fishing site found in each substratum. This indicated the mobility of the fishermen all through the project area especially in substratum 4.

Table 2 – Distribution of migrant and part-time fishermen

Substratum	*Date of Sampling*	*Nomber of Migrant Fishermen*	*Number of Part-Time Fishermen*	
S1 Ndimoko	8/8/80-5/6/81	2	13	
S2 Ndionuoha	9/8/80-10/6/81	–	20	
S3 Ikpeze	10/8/80-15/6/81	–	10	
S4 Ndianiche/Amuro	11/8/80-8/7/81	8	17	
Total		**10**	**60**	

Table 2 shows that of all the 70 fishermen interviewed, 10 were migrant, while 60 were part-time fishermen. Out of the 10 migrant fishermen, one came from Opobo in Rivers State, one from Ougta Egbema in Imo State, and eight from Udo along the Imo River in the Abor-Mbaise Local Government Area of Imo State-another lucrative fishing centre suffering from probable overfishing because of a great number of fishermen in the area. There is a significant difference in the proportion of migrant fishermen at substratum 4 (Ndianiche/Amuro) indicating a possible lucrative fishing in the area.

Fishing Gears in Use

Migrant as well as part-time fishermen used gillnet, castnet, long lines, set nets, triggered traps, hooks, clap net, funnel entrance basket traps, fish fences and making of embarkments across connecting channels is swamps when the flood is receding, thereby leaving some fish stranded as the water level falls. Poisonous chemicals like Gamalin were also in use especially during the dry season at low water level. Gillnets and castnets were made on nylon and locally constructed by fishermen. Many of the fishermen questioned used more than one gear. Little seasonal variations were found in the use of the four major gears, namely gillnet, castnet, hooks and longline, but clapnets, fish fences, traps and making of embarkments were used extensively mainly during the low water period of November – May.

The main fishing period was found to be from May to October with peaks in May – June – August. The abundance of fish in this area could be further strengthened by the existence of a big fish market at Eze Amuro on the Okigwe – Owerri road.

Of all the fish caught, the catfishes to which the families, Clariidae Schilbeidae, Mochokidae, Bagridae , and Malapteruridae belong and Cichlids ***(Tilapia, Sarotherodon, Hemichromis*** and ***Tylochronis)*** were found to be most abundant especially during the rainly season. Their spawns were more abundant during the dry season especially the family Clariidae. ***Clarias*** spp., ***Heterobranchus*** spp., ***Bagrus*** spp., ***Ophiocephalus*** spp., ***Lates*** spp. and ***Mormyrus*** spp. were all found to be big in size. Freshwater shrimps, crayfish and clupeids were also found.

Fish Processing, Marketing and Distribution

Half of the fish caught were sold fresh while the other half were smoked. Some of the sales were made at the landing sites to fish traders who resold them at the booming Eke Amuro market on the Okigwe – Owerri road. Other fishermen took their catch to the Eke Amuro market to sell themselves. Fresh fish were also sold to factory workers at the Kernel Crushing Industry (NIPROC) in Arondizuogu, Okigwe market and other local markets. There were permanent traditional smoking kilns made of clay and wire gauze erected at different shades in the Eke Amuro market for smoking the fresh fish not sold.

DISCUSSION

The fishery of the Ibu Project area may be said to be self-regulatory since the population of fishermen in the area is very mobile (as shown by the number of temporary fishing sites) and the fishermen usually return to their farms or take to sand digging when the returns from fishing is poor.

Many of the fish stocks may be said to be under-exploited by the use of the unspecified gears produced locally. This makes it difficult to catch fish in the middle of the main river channel which could ordinarily be caught with drifting gillnets. There is, however, the great need to introduce legislation to reduce possible over-exploitation of the fish stocks.

There is also the great need to increase the efficiency of preservation and marketing techniques. Spoilage of fish either by decomposition or insect infestation had however, been taken care of through the use of traditional smoking kilns. A lot more research into the modernisation of the existing smoking kilns or introduction of modern smoking kilns produced by Federal Institute of Industrial Research, Oshodi and other similar Institutions has to be undertaken. Furthermore, alternative methods of preservation has to be investigated. Communication in the area would have to be improved with the implementation of the Ibu Dam Irrigation Project. Already, a Federal Government highway passing from Okigwe through the project at Ndimoko to Onitsha is under construction. Finally, studies on the basic biology of the numerous economically important local fish stock which abound in the area need to be investigated and monitored.

An effective management of the 1-hectare River Basin Fish Farm at Nidonuocha in sub-stratum 2 has to be ensured to boost the production of table-size fish, fish fingerlings and as a centre for the dessemination of aquaculture technology to small scale fish farmers. The fish fingerlings produced should be distributed to intending fish farmers.

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A SUMMARY OF THE INVENTORY SURVEY OF NIGERIA INLAND WATERS AND PRELIMINARY ESTIMATES OF THEIR FISH YIELD POTENTIALS

By

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ABSTRACT

A summary of the inventory survey of Nigeria inland waters is presented. The survey reveals that Kano State tops the list in reservoir development with an existing water surface area of about 42,773 ha, while Anambra State has the least with about 38 hectares. No reservoir was recorded for Lagos and Rivers States. However, in aspects of existing fish ponds, a total of about 471 ha was recorded for Plateau State and about 5 ha for Niger State.

Preliminary estimates of Nigeria's fish yield potentials based on established production records of comparable water bodies in the tropics, at different levels of management, show that the available water mass in the country, estimated at about 12.5 million hectares, could yield a minimum of about 334,214 metric tonnes (m.t.) of fish per annum with little or no management and a maximum of about 511,703 metric tonnes per annum with adequate managment.

Comparison of the potential yields from inland sources with the projected fish production in Nigeria (1981 – 1985) based on supply and demand statistics shows that potential yield from inland sources even at a low level of management is relatively higher than the projected inland production and more than double the observed production.

The variation between the potential and the observed fish yields in the country has been attributed to the absolute lack of management strategies for our various inland waters.

The paper elaborates on possible management strategies for various categories of inland waters as a prelude towards increased fish production in the country.

INTRODUCTION

Fish provides the cheapest source of animal protein in the world. However, most valuable stocks in the wild are already fully exploited or overfished and relatively few new stocks are open to exploitation (Caton *et al*, 1974). In Nigeria, Ita (1982) proved beyond reasonable doubt that Kainji Lake has been overfished, using established biological indices of overfishing.

According to Abiagom (1980), the total demand projection for fish by 1985 will be 2.82 million metric tonnes as against the 687,446 metric tonnes expected from available resources as estimated by the Study Group on Fisheries (1981). Matton (1982) observed that Nigeria consumed about 1.5 million metric toones of fish in 1980 out of which about 900,000 metric tonnes of frozen fish were imported. By his projection, more than 2 million metric tonnes would be demanded by 1985 and out of this figure about 1.4 million metric tonnes would be imported. Events associated with the depletion of the country's foreign reserves have, however, overtaken this projection.

From the evidences shown so far, it is obvious that projected domestic demand for fish in Nigeria has never been met by dependence on yields from available aquatic resources. And the gap between fish supply and demand increases annually with progressive increase in population. The present trend in fish supply and demand stresses the need to explore ways of harnessing all available water resources in the country with the aim of optimizing their fisheries productivity. This could bring about the early realization of the much desired increased fish production to meet

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domestic demand, particularly in these days of dwindling national economy and restrictions on the importation of fish, fish products and other essential commodities in order to streamline the drain in the nation's external reserve.

As a step towards achieving our national target for fish production, it became necessary to collate a comprehensive statistics of the total water surface area, location and distribution of flood ponds, cattle ponds, stagnant pools of seasonal rivers, burrow pits, mining paddocks, major rivers, existing and proposed fish ponds, lakes and reservoirs including those under construction in the nineteen States of the Federation. The purpose of such statistics was to permit the estimation of the fish yield potentials of these inland water bodies as a prelude towards evolving proper management practices to improve our fisheries resources and their utilization. This paper, therefore, presents a summary of the inventory survey of Nigeria inland waters and attempts preliminary estimates of their fish yield potentials together with a brief on strategies for attaining the target.

METHODOLOGY

(i) Inventory Survey:

Data were collected by scheduled visits to Ministries of Agriculture (Fisheries Division), River Basin Development Authorities, Ministries of Water Resources and Electricity Supply, National Electric Power Authority, State Water Boards and Corporations, ancilliary fisheries establishments and by questionnaire method as outlined in Ita *et al* (1985).

Relevant data and information were also extracted from State Reports presented at the 18th National Fisheries Development Committee Conference held in Sokoto in August 1982 and other fisheries publications.

(ii) Computation of Yield Potentials.

Available water surface areas were obtained from results of the inventory survey of water bodies in the country. Estimates of potential yeilds per hectare in lakes, rivers and flood plains were obtained from literature sources based on comparative studies of different inland water bodies in Africa e.g. Welcomme (1973; 1975) and Henderson and Welcomme (1974). Pond production estimates were obtained from extensive literature review in Ita (1980).

RESULTS AND DISCUSSION

(i) Inventory Survey.

Table 1 shows that existing reservoirs and minor lakes cover a land area of about 137,802 ha, while about 23,698 ha of reservoirs are proposed and another 11,034 ha are under construction in the country. Cattle ponds provide about 638 ha of water surface area in Bauchi, Kaduna and Kano States.

With regards to fish pond development, a total water surface area of about 1,945 ha were recorded as existing, while about 2,694 ha are proposed apart from the 836 ha still under construction (Table 1). It is pertinent here to note that the burrow pits recorded in some States the mining paddocks in Plateau State and the flood ponds in Anambra State were considered along with the fish ponds for ease of computation. Most States had no records of available surface areas of the burrow pits in their States.

A cursory look at Table 1 reveals that the 137,802 ha of existing reservoirs and minor lakes together with the existing total water surface area of cattle ponds and fish ponds i.e. 638 ha and 1,945 ha respectively give a total water surface area of 140,385 ha which is more than the 127,000 ha of water mass in Kainji Lake but almost four times smaller than Lake Chad which has an estimated surface area of 550,000 ha during normal flood years. The survey revealed the existence of numerous small bodies of water such as reservoirs and minor lakes, which together give about 137,802 ha of water mass spread all over the country.

It is anticipated that with the implementation of the proposed water reservoir and fish pond projects and the completion of those under construction in addition to the existing harnessed water bodies, a projected estimate of about 283,298 ha of water surface area of man-made inland water bodies will be available for fish production in the country (Table 1).

As shown in Table 2, Lake Chad and Kainji Lake give a total water surface area of about 677,000 ha. Another 10,812,410 ha of water mass is provided by the major perennial rivers in Nigeria. Miscellaneous stagnant pools of seasonal rivers have been estimated to supply about 200,000 ha of water surface area (Table 2). Flood plains, burrow pits and mining paddocks supply about 515,108 ha of water mass. These water surface area estimates in addition to the 283,298 ha of water mass of inland water bodies give a total projected National estimate of about 12,487 ha of inland water resources.

The poor status of reservoir development in Anambra, Lagos and Rivers States could be attributed to much dependence on bore-holes, perennial streams and rivers for both domestic and industrial water supply in the three States. Information collected from the Borno State Water Board revealed that reservoir and fish pond development in the State is hampered by geological and climatic factors such as soil characteristics and high temperature for most part of the year. The extensive areas of sandy clay and sandy soil in Borno State favour water loss by seepage and infiltration (USDIBR, 1968). The few hectares of water bodies recorded in the State have possibly been retained by shallowness of the underlying bedrock in locations where a few fish ponds and reservoirs are found. Over 340 ha out of the 543 ha of reservoirs and lakes in Borno State are irrigation canals within the Lake Chad basin on the Nigerian sector of the lake. The Borno State Water Board therefore, relies solely on boreholes for both domestic and industrial water supply.

Although, Borno and Sokoto States lie in the extreme arid zone in the country, the predominantly clayey nature of the soil and the proximity of the basement complex to the surface soil layers in Sokoto State minimize water loss by seepage and infiltration in fish ponds and reservoirs i.e. water loss in Sokoto State is mainly by evapotranspiration. FAO (1969) confirms that reservoirs in Sokoto basement complex are confined by impermeable rocks. Jones (1948) reported that the few perennial streams in Sokoto Province (now State) lie on the main water-table and that seasonal pools known as "tabkuna" owe their existence to a bed of clay and silt (fine-grained alluvium) which prevents the downward percolation of the water.

USDIBR (1968) believes that while fish production is influenced by many biological and physico-chemical factors, there is a definite relationship between water surface area and fish production. A large water mass has a high holding capacity for varied fish fauna and also provides a wide area of breeding and feeding ground for resident fish populations.

The advantage of good soil type accounts for about 14,623 ha of reservoir and about 175 ha of fish ponds in Sokoto State as against the 543 ha of reservoir and about 25 ha fish ponds recorded in Borno State.

The fisheries productivity of most reservoirs in the country, has not been optimized because little or no attempt has been made to artificially stock these water bodies. As is the case in most of the Northern States, reservoirs are created mainly for irrigated agriculture. The outflow from these reservoirs is diverted by most local farmers to irrigate their vegetable plots as observed in Kano State. But generally, the poor status of fish farm development in the majority of the States (Table 1) is a manifestation of the low premium placed on fish culture particularly in States where abundant water resources and conducive topographic and climatic conditions exist

A substantial number of reservoir and fish pond projects have had little or no recorded information or data about them with the result that many gaps especially under the "Surface Area (ha) Column" are not adequately covered to afford a comprehensive and a very reliable water surface area estimates of all harnessed water resources.

Some State Fisheries Departments do not show sufficient interest in the numerous private fish farms that abound in their States, probably due to the operational constraints. Consequently only very few of the private fish farms have had information and data on them documented.

Even the fisheries utility of most of the reservoirs recorded during the survey was not optimized as no evident effort had been made recently to stock them with indigenous fish species. Fish production in such reservoirs therefore, rely heavily on endemic species which are exposed to indiscriminate exploitation with the resultant effect of overfishing because of lack of fishing laws and regulations in the country.

(ii) Potential Yield Estimates.

Table 3 shows the computation of yield potentials from different categories of inland water bodies. Reservoirs are separated into two categories. Those measuring above 10,000 ha are classified as large (e.g. Kainji) and those below 10,000 ha are classifed as small reservoirs. In principle, large reservoirs cannot be managed by stocking in the absence of control of fishing although, new species could be introduced to fill vacant niches. The estimate shows that in the absence of control, a minimum yield of 60 kg/ha could be obtained as observed in Kainji Lake. However, with a bit of control of number of fishermen and gear sizes, the optimum yield of 100 kg/ha could be attained.

Most small reservoirs (for irrigation and water supply) constructed across seasonal rivers with limited concentration of indigenous fish species may have extremely low standing crop ranging from 0–30 kg/ha (e.g. Bakolori Reservoir) and would require stocking right from the onset in order to attain the potential yield. Those contructed across perennial rivers with hiwher concentration of indigenous fish species may attain the minimum potential of 100 kg/ha without stocking. The yield could be increased to 500 kg/ha with stocking, with or without fertilization, if the morpho-edaphic characteristics are favourable.

The productivity of large natural lakes like Lake Chad are higher than those of large reservoirs because of their well established littoral zones and shallow mean depth. The observed potential fish yield of 100 kg/ha could be considerably increased with control of number of fishermen and fishing gears used.

Fish ponds and mini-reservoirs ranging from one to ten hectares must necessarily be stocked with fish since they are fed by small seasonal or perennial streams and sometimes by artificial water supply from boreholes. Yields of 500 kg/ha could be attained with or without fertilization if the stocking density is adequate. If selective cropping is practised, only the initial stocking will be necessary with adequate stocking, fertilization and supplementary feeding, even higher yields of 3,000 kg/ha and above can be obtained in the case of fish ponds. Similar yields could be obtained from cattle ponds and mining paddocks if adequately managed.

A summary of the estimates (Table 3) shows that potential yields from the above inland water sources could give a minimum yield of 88,051 metric tonnes (m.t.) of fish per annum and a maximum yield of about 135,606 metric tonnes per annum.

Fish yields from the main course of both perennial and seasonal rivers can be extremely low. Large perennial rivers have been observed to yield up to 20 kg/ha and above. Flood plains are natural breeding grounds for fish and therefore, have higher fish yields than the main river course. Yields of about 50 kg/ha and above are commonly observed in flood plains of major African rivers (Welcomme, 1975).

Flood ponds left behind by receding flood waters are known to be more productive than the flooded plains. This is partly due to the increased concentration of fish in reduced volume of water and also to increased period of growth for the fish. Yields ranging from 100 kg/ha to 500 kg/ha have been recorded in some flood ponds. Stagnant pools of seasonal rivers are usually overcropped during the drv season resulting in very low standing crop. Some shallow pools could be completely cropped with small meshed seine nets during the dry season. Both flood ponds and seasonal pools could be stocked for a limited period of time and cropped before the next flood season. Estimated total potential yields from rivers and their respective flood plains and ponds are about 264,163 m.t. per annum (minimum), and 376,097 m.t. per annum (maximum).

Table 4 shows the projected fish supply by Sector (1981 – 1985) with an average inland production of about 246,786 m.t. per annum. The relative contributions from inland sources to the total domestic production for the period is shown in Table 5. The mean percentage contribution from inland sources between 1981 and 1985 is 39%. The relative contribution form inland sources could be considerably increased with adequate management (Table 3) to over 70% of the domestic production.

Matton (1982) observed that in 1980, the total fish supply in country including import was about 1.5 million metric tonnes (m.t.) of which 900,000 m.t. were imported. This figure is far above the projected total supply for 1981 (Table 4). However, judging from the projected demand figure for 1981 of 2.2 million metric tonnes (Table 6), Matton's figure cannot be regarded as an over-estimate. The mean projected fish demand between 1981 and 1985 is about 2.3 million metric tonnes (m.t.) (Table 6), while the mean supply stands at 1.3 million m.t. giving a deficit of about 1.0 million m.t. per annum.

The import data from the Federal Department of Fisheries (Table 7) can be regarded as a gross under-estimate of the quantity of imported frozen fish into the country. This is partly caused by the unwillingness of our indigenous fishing companies to give accurate import records to Government Agencies needing such statistics. The reason for their secrecy cannot be far fetched and is not unconnected with the foreign exchange implications and tax evasion. This is why Matton's (1982) report under the auspices of the Food and Agriculture Organization (FAO) should be accepted as valid since it is supported with fish export figures from overseas agents to Nigeria.

(iii) Management Implications.

Evidences from this study point to the fact that the relative contributions from inland sources to the total domestic fish production can be considerably increased from its current position of about 39% to over 70% of the total domestic production, if a well outlined strategy for the management and development of the existing water bodies in the country could be worked out.

The first bold step in providing a State by State checklist of inland waters, their location and surface areas has been provided. The current study has provided in a nutshell the estimates of the hidden and untapped resources of our inland waters.

The next step which could be incorporated into the Fifth National Development Plan budgetting is for each State to undertake initial feasibility studies or invite Fisheries workers from various institutions in the country to carry out extensive study of their ongoing projects and make recommendations for improvement and increased development.

The Imo State Fisheries Department has taken this bold step by inviting workers from all over the country to constitute definite study groups on the following subjects:—

(i) Fishery statistics, fish stock assessment and restocking programme.

(ii) Potentials of Reservoirs, Lakes, and Flood ponds for fish production.

(iii) Accelerated fish seed production project.

(iv) Fish Feed Mill Project.

(v) Model Cooperative fishing programme and incentives to fish farmers/fishermen

(vi) Fish processing, storage and marketing programme and pollution monitoring.

The reports presented by the various Study Groups to the Imo State Government cannot be said to be comprehensive because of the relatively short duration of the study period and constraints in conducting extensive tours of the existing project areas. This notwithstanding, they can serve as guidelines in assisting the Government in her development programmes pending the full commissioning of detailed feasibility studies on these subjects.

The Kainji Lake Research Institute on her part, plans to collaborate with State Fisheries Departments in carrying out the next phase of her inventory survey involving the collection of fishery statistics and stock assessment of Lakes, Rivers and Reservoirs in the various States with the objective of designing strategies for their specific management and development. Since it has been highlighted that most reservoirs constructed by daming seasonal rivers are inadequately supplied with fish right from the onset, our management strategy is likely to rely heavily on extensive culture programme involving the introduction of large quantities of fish fingerlings into such reservoirs.

As a step towards facilitating this programme, the Institute is developing both indoor and outdoor hatcheries for intensive fingerling production and is also encouraging some States by helping to recondition their hatchery complexes for similar exercises.

In view of the fact that reservoir stocking requires a minimum of 1,000 fingerlings per hectare of water body (Ita *et al*, 1982), the magnitude of fingerlings production required to stock both ponds and reservoirs in each State cannot be over-emphasized. However, since it is not advisable to stock unmanaged water bodies because of the high cost of fingerling production, the need for established fisheries laws and regulations to enforce control over the exploitation of the stocked water bodies becomes meaningful. The Institute has assisted the Federal Department of Fisheries in her campaign towards the promulgation of the Federal Inland Fisheries Laws and Regulations for Nigeria by organizing a drafting committee meeting comprising of delegates from the States and other Fisheries establishments in the country as well as legal experts. The proceedings of this meeting comprising both technical and legal drafts as well as the verbatim report of the business session have been circulated to all the States in manuscript form, while a comprehensive proceedings is being published by the Institute. It is hoped that these efforts will yield some fruits in the nearest future in order to speed up the scientific process of our inland fisheries management and development.

SUMMARY AND CONCLUSIONS

Our investigation reveals that Nigeria is blessed with an estimated inland water mass of about 12.5 million hectares capable of producing about 512,000 metric tonnes of fish annually. However, available statistics shows that our inland water bodies are currently producing less than 50% of their estimated fishery potential.

The checklist of all identified water bodies in all the States in the country has been published as a technical report of Kainji Lake Research Institute. It is hoped that these publications will be a source of inspiration and competition among fisheries scientists in the country with the ultimate objective of striving to attain the expected potential fish production in the various water bodies as highlighted in this paper.

The greatest obstacle to increased inland fish production is the haphazard method of exploitation due to the complete absence of established inland fisheries laws and regulations in the country coupled with inadequate stocking of small man-made reservoirs. The first author in another paper entitled "Some guidelines for the drafting of the inland fisheries laws and regulations for Nigeria: A proposal" has highlighted the major issues requiring urgent attention for the effective management of our inland waters and with the final draft now submitted to the Federal Department of Fisheries, it is hoped that the processes for promulgating the law would be accelerated in order to render subsequent management attempts effective.

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Table 1 – Available hernessed Water Resources in the Nineteen States of Nigeria (From Ita et Al 1985)

State	Surface Area (ha) of Reservoirs and Lakes			Surface Area of Cattle Pond (ha)	Surface Area (ha) of Fish Ponds and Flood Ponds			Projected Total Water Surface Area (ha)
	Existing	proposed	Under Construction		Existing	Proposed	Under Construction	
Anambra	37.65	Nil	5000.0	Nil	1705.66	Nil	Nil	6743.31
Bauchi	298.50	Nil	52200.0	15.50	15.0	Nil	Nil	52529.0
Bendel	199.30	Nil	130.0	Nil	130.0	247.0	15.0	721.30
Benue	114.0	Nil	Nil	Nil	87.50	600.0	'200.0	1001.50
Borno	542.90	Nil	Nil	Nil	24.70	Nil	Nil	567.60
Cross River	1182.0	15084.20	80.0	Nil	51.40	9.30	30.0	16426.90
Gongola	17848.0	Nil	Nil	Nil	Nil	Nil	Nil	17848.0
Imo	354.50	3500.0	Nil	Nil	123.27	1.50	10.22	3989.49
Kaduna	8440.90	1580.0	4000.0	560.0	14.0	Nil	Nil	14594.90
Kano	42772.50	Nil	Nil	63.0	94.21	Nil	Nil	42929.71
Kwara	1968.60	Nil	4.0	Nil	22.09	8.50	3.50	2006.69
Lagos	Nil	Nil	Nil	Nil	13.43	10.0	Nil	23.43
Niger	36223.50	3500.0	32520.0	Nil	4.70	70.0	40.0	72358.20
Ogun	4028.50	Nil	100.0	Nil	48.15	39.0	46.0	4261.65
Ondo	2550.0	N.S.	Nil	Nil	84.19	549.96	2.06	3186.21
Oyo	3272.61	Nil	Nil	Nil	448.58	33.0	Nil	3754.19
Plateau	3345.0	Nil	Nil	Nil	471.0	Nil	Nil	3816.0
Rivers	Nil	Nil	Nil*	Nil	61.91	1026.25	499.58	1587.74
Sokoto	14623.25	34.0	20000.0	Nil	195.40	100.0	Nil	34952.65
TOTAL	**137801.71**	**23698.20**	**114034.0**	**638.50**	**1945.19**	**2694.51**	**836.36**	**283298.47**

Table 2. – Summary of Water Surface area of lakes, reservoirs, ponds and major rivers in Nigeria (From Ita et al, 1985)

Water Body	*Surface Area*
Lake Chad (Nigerian Sector)	550,000.0 ha
Kainji Lake	127,000.0 ha
Anambra River	1,401,000.0 ha
Benue River	129,000.0 ha
Cross River	3,900,000.0 ha
Imo River	910,000.0 ha
Kwa Iboe River	500,000.0 ha
Niger River (Less Kainji and Jebba Lakes)	169,810.18 ha
Ogun River	2,237,000.0 ha
Oshun River	1,565,400.0 ha
Fish Ponds	5,476.06 ha
Flood ponds	1,650.0 ha
Cattle ponds	638.50 ha
Miscellaneous stagnant pool of seasonal Rivers	200,000.0 ha
Reservoirs	275.534. 91.ha
Flood plains	515,000.0 ha
Burrow pits	2.0 ha
Mining paddocks	106.0 ha
Total	**12,487,817.65 ha**

Table 4 – Projected Fish Production in Nigeria – 1981–85 (in metric tonnes). Modified from Study Group on Fisheries (1981)

Year	*Lakes and Ponds*	*Rivers*	*Total Inland Production*	*Coastal and Brackish Water*	*Inshore Fisheries*	*Total Marine Production*	*Total Domestic Production*	*Import*	*Grand Total Fish Supply*
1981	73,596	159,872	233,468	334,150	13,857	348,007	581,475	397,744	979,219
1982	75,436	164,509	239,945	350,858	15,340	366,198	606,143	485,248	1,091,391
1983	77,322	169,279	246,601	368,400	16,981	385,381	631,982	592,002	1,223,984
1984	79,255	174,188	253,443	386,820	18,799	405,619	659,062	722,243	1,381,305
1985	81,236	179,239	260.475	406,161	20,810	426,971	687,446	881,136	1,568,582

Table 3 – Estimated Fish Yield Potential of Nigeria Inland Waters.

	Type of Water Body	Estimated Total Surface Area (ha)	Potential Yield per ha and Total Annual Yield (m.t.) (with little or no management)	Potential Yield per ha and Total Annual Yield (m.t.) (with adequate management).
1.	*Reservoirs, Lakes and Ponds.*			
	(i) Large reservoirs (e.g. Kainji)	250,387.0	60/kg/ha 15,023.2 mt.	100 kg/ha 25,038.7 m.t.
	(ii) Small reservoirs (e.g. for water supply).	25,148.0	100 kg/ha 2,514.8 m.t.	500 kg/ha 12,574.0 m.t.
	(iii) Major Lakes (e.g. Chad)	677,000.0	100 kg/ha 67,700.0 m.t.	120 kg/ha 81,240.0 m.t.
	(iv) Fish Ponds	5,476.0	500 kg/ha 2,738.0 m.t.	3000 kg/ha 16,428.0 m.t.
	(v) Cattle Ponds	639.0	100 kg/ha 63.9 m.t.	500 kg/ha 319.5 m.t.
	(vi) Mining Paddocks	106.0	100 kg/ha 10.6 m.t.	500 kg/ha 53.0 m.t.
	Total =	**958,756.0**	**88,050.5**	**135,605.5**
2.	*Rivers.*			
	(i) Flood Ponds	1,650.0	100 kg/ha 165.0 m.t.	500 kg/ha 825.0 m.t.
	(ii) Main River Course	10,812,410.0	20 kg/ha 216,248.3 my.	30 kg/ha 324,372.3 m.t.
	(iii) Flood Plain	515,000.0	50 kg/ha 25,750.0m.t.	60 kg/ha 30,900.0 m.t.
	(iv) Stagnant Pools of Seasonal Rivers	200,000.0	20 kg/ha 4,000.0 mt.	100 kg/ha 20,000.0 m.t.
	Total =	**11,529,060.0**	**246,163.2**	**376,097.3**
	GRAND TOTAL =	**12,487,816.0**	**334,213.7**	**511,702.8**

EDITORIAL COMMENTS

The year 1986 can be described as the most eventful year for the Fisheries Society of Nigeria (FISON). This could be attributed to the composition of the Executive Council. With the exception of the Editor and one Ex-officio member, all the other members were based in Lagos. Similarly, with the exception of the Editor-in-Chief, all other members of the newly constituted Editorial Committee were also based in Lagos. These new arrangements made it possible for a quorum to be formed at every meeting of the Executive Committee.

The new President, Mr. N. O. Fadayomi, deserves special commendation for being physically present in all Council meetings in spite of his tight official schedule as the Managing Director of his Company.

All members of the Editorial Committee participated in every meeting and also carried out their sectional editorial work promptly. Some of the papers presented during the Conference were not recommended for publication because of their poor quality, while others were not submitted for publication by the authors.

The publication of the Proceedings could be facilitated if members would endeavour to submit the originals of their papers including the figures. Duplicated copies of scripts often submitted are not adequate for editorial work, likewise photocopies of figures. A few of the papers had to be published without their relevant figures on account of the poor quality of the copies of the figures submitted to the Editorial Committee.

The host for the Conference and publisher of the Proceedings (the Nigerian Institute for Oceanography and Marine Research) also deserve commendation for its anxiety to get the edited scripts published.

It is hoped that this new enthusiasm to keep the Society alive and active will be maintained in subsequent years.

E. O. ITA
Editor–in–Chief
FISHERIES SOCIETY OF NIGERIA
(FISON)

Table 5. – Total Projected Domestic Fish Production and Supply including imports and the Corresponding percentage contributions from Inland sources and Import between 1981 and 1985, (Modified from Study Group on Fisheries 1981)

Year	*Total domestic Fish Production*	*% Contribution from Inland Waters*	*Total Fish Supply including imports*	*% Contribution for Imports*
1981	581,475	40.2	979,219	40.6
1982	606,143	39.6	1,091,391	44.5
1983	631,982	39.0	1,223,984	48.4
1984	659,062	38.5	1,381,305	52.3
1985	687,446	37.9	1,568,582	56.2

Table 6 – Supply and Demand Projections for 1981 – 1985 (From: Study Group on Fisheries 1981)

Year	*Projected Supply*	*Projected Demand*	*Projected Deficit*
1981	979,219	2,170,010	1,190,791
1982	1,091,391	2,235,100	1,143,709
1983	1,223,984	2,302,150	1,078,166
1984	1,381,305	2,371,200	989,895
1985	1,568,582	2,442,330	873,748

Table 7 -- Nigeria Fish Supply by Sectors 1979 -- 1983

Sectors	1979	1980	1981	1982	1983*
Total	753,435	713,596	741,221	760,195	675,977
1. *Artisanal*					
i. Costal and Brackish water	264,495	274,158	323,916	377,683	376,943
ii. Inland Rivers and Lakes	259,632	187,206	157,867	119,527	124,943
2. *Industrial*					
Commercial Trawlers					
i. Coastal Fish	9,406	16,342	12,435	15,052	11,213
ii. Coastal Shrimp	1,902	1,890	2,003	3,525	2,145
iii. Distant Water (Import)	218,000	234,000	245,000	244,408	160,728

Source: Federal Department of Fisheries Annual Report, 1983.

*Tentative.

THE DECLINE IN THE COMMERCIALLY IMPORTANT SPECIES OF FISH AND PREDOMINANCE OF CLARIAS LAZERA IN LAKE CHAD.

By

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ABSTRACT

About eightly six species of fish have been recorded in the Lake Chad. Most of the species occuring in the lake are widespread including most of the commercially important species. Fish distribution in the lake was adversely affected by the 1972/73 and 1983/84 droughts.

The commercially important species before the 1972/73 drought were; ***Lates, Labeo Distichodus, Heterotis, Gymnarchus, Hydrocynus, Citharinus*** and ***Bagrus.*** Other species which had less commercial value at that time include, ***Clarias, Gnathanemus, Polypterus, Protopterus, Tilapia*** and ***Synodontis. Lates niloticus*** was the most predominant species of commercial importance comprising 50–60% of the total catches of fishermen between 1962 and 1973.

This was followed by ***Citharinus*** sp, ***Bagrus*** sp, ***Labeo*** sp, and ***Heterotis niloticus*** comprising 10.4%, 4.2%, 3.5% and 3.4% of the total catches respectively.

Before the 1972/73 drought, occurrence of ***Clarias lazera*** was negligible and restricted to long line catches and had little commercial value. As a result of the drought of 1972/73 which resulted in near drying up of the northern sector of the lake, fish populations were confined to isolated pools and were completely scooped out.

The remaining fish populations retreated to the southern basin where enough water always remained to hold the surviving representatives of the population.

The effects of the drought resulted in occurrence of the little known ***Clarias lazera*** along with other hardy species like ***Tilapia*** and ***Protopterus*** to dominate the existing fish species composition. In 1976, ***Clarias lazera*** dominated the total catches of fishermen with 85.6%. It continued to dominate the catches fluctuating between 85.7% in 1977 to 38.8% in 1982 while other commercially important species recorded before the drought as mentioned earlier continued to disappear completely from the catches.

An over view of the fish population in the lake, their relative abundance, changes in species composition, the effects of drought on the fauna of the lake based on the available data are discussed in this paper.

INTRODUCTION

Lake Chad lies in the extreme north-eastern corner of Nigeria with a coast line of 288 kilometers extending southeast to northwest. It is one of the most productive inland waters in Africa. The lake has undergone significant ecological changes since the beginning of the eighteenth century and its surface area fluctuated between 6,000 km^2 and 25,000 km^2 since recording started. It lies in the arid region between latitude 12° and 14°N and longitude 13° and 15°E. The lake is shared by the Republics of T'Chad, Nigeria, Niger and the Cameroon in the proportion of 50%, 25%, 17% and 8% of the total surface area respectively. Its fishery contributes about 13% of the total annual fish production of Nigeria. It supports a fishing population estimated at over 10,000 full-time, part-time and occasional fishermen, and a large labour force market, transport owners etc (Sagua, 1982). From the estimated steady fish catch figure of 100,000 tonnes per annum (1974–82) estimated at ₦2,400.00 per tone (1980 price) Lake Chad contributes an estimated ₦240 million to our national economy each year.

The changes in depth and surface area also resulted in drastic change in fish population and diversity with clear indication of imbalance in the species composition. Fish population has been more widespread during high water level and increased surface area than during low water levels. During high water levels most species found in the lake are represented in many catches of fishermen, while reverse is the case during low water levels; when most hardy and species with accessory respiratory organs like *Clarias* and other mud fishes emerge in large numbers and dominate the fish population.

At high water levels, most species found with commercial value include ***Lates, Labeo, Distichodus, Heterotis, Gymnarchus, Hydrocynus, Citharinus*** and ***Bagrus*** just to mention a few. Their abundance and percentage composition also follows the similar order outlined. One of the most remarkable aspects of the species composition is that, highly valued and more sensitive species tend to disappear when the ecosystem becomes unfavourable. While hardy species like ***Clarias*** became predominant because the condition is more condusive to such species. Such species become widespread while the more sensitive ones retreat to the southern part of the lake where deep water always remains to habour them until the lake condition normalizes.

MATERIALS AND METHODS

The declining of the commercially important fish species and predominance of ***Clarias lazera*** was estimated by using the available data collected between 1963 to date, and they provide information on the estimated proportions over time. General appearance of fish species between 1963 to 1973 and 1985 was found after reviewing all the annual reports of 1963 to 1973 and observations of catch records from the local fishermen at various fish landing centres between late October to 15th November, 1985 respectively.

The Environment

Environmental conditions in the lake have been described by Bouchardeau and Lefevre (1957), Robinson (1969) and Hopson (1969 A and B). It is a closed lake with relatively unstable water balance. Variations in the annual inflow resulted in marked fluctuation in the surface area, depth and salinity. The early years of this century were marked by series of very dry periods in 1908, 1914 and 1940 – 1945, when the lake shrunk so much that it no longer extended beyond confluence of the River Robe.

After 1950, its water level and area increased, during 1962 – 1964, it reached a maximum of 25,000 km^2 the highest since record started with a total rise and fall of about 4 meters. This was followed by a period of continuous recession until it reached very low level of about 6,000 km^2 in 1974 and a similar situation was recorded in 1983. The change in water level is high considering the fact that the maximum depth of the lake rarely exceed 7–8 meters. In addition, to long term fluctuations over a period of years, regular seasonal variations occur with levels reaching the annual peak in December – January before falling approximately by one meter to a minium in July – August.

The water supply to the lake is derived from several sources which comprises the amount contributed by immediate rainfall on the lake itself, the local rainfall draining along the minor tributaries and the larger affluents of the Rivers Yobe, El–Beid and the Chari-logone.

During the second decade 1973 – 1982, the picture had completely changed which was greatly influenced by the 1972/73 drought when the northern portion of the lake was nearly dry. Species like ***Lates, Labeo, Citharinus, Hydrocynus*** and ***Distichodus*** completely disappeared from the catches of fishermen in the northern basin. Some of these species were caught in limited quantities with ***Lates*** only appearing at 1.3 – 1.4%. Abundance of most other species followed similar pattern to that displayed by ***Lates*** till the end of 1982. From 1982 to 1984 another drought hit the area and fishing activities was restricted to the southern basin located in T'Chad and Cameroon Republics. While fishing came to a stand-still on the Nigerian sector up to the end of 1984.

Owing to the significant ecological changes in the lake, most of the highly valued but sensitive species diminished, while more hardy species which could not complete with the rest before the drought became predominant. Notably, ***Clarias lazera*** which was rare between 1963 – 73 dominated the total landings in 1976 with 89.6% but it continued in declining order to 38.8% in 1982. At the peak of the drought, partly due to over population, most ***Clarias*** caught were stunted and locally called 'Dimka'. ***Clarias lazera***, continued to dominate the catches of fishermen with a range of 50–25% of the total annual landings (1976–1984) (Table 2). Figure 2 also shows clear picture of the fish landing statistics presented graphically, it clearly shows the sharp decline in the species composition with ***Lates*** giving way to ***Clarias.***

The rivers Yobe originating from an area with about 600 mm of rainfall per annum contributes less than 1% of the annual inflow, the El–Beid which is a deltalic branch of the Chari-Longone contributes about 4%. Other minor rivers and run-off from the area contribute 5– 10%. The remaining 85% is derived from the Chari-Logone River system which originates from the northern regions of the Cameroon Republic, Central African Republic and formed the boundary between T'Chad and Cameroon Republics.

RESULTS

Data on relative abundance of fish species composition recorded at various fish landing centres along the lake shore from (1962–1982) were analysed. A clear species composition of fish in Lake Chad is presented in Table 1 and Figure 1. This shows that in the first decade (1963–1973), among commercially important fish, ***Lates niloticus*** was the single most predominant species with high commercial value in Lake Chad, its percentage composition ranged from 52.7% in 1963–67 to 61.3% in 1973. This was followed by ***Citharinus*** spp with a range of 10.9 – 3.7%, ***Hydrocynus*** spp 17.9–3.4%, ***Labeo*** spp 13.1–1.9%, ***Distichodus*** spp 5.5–1.8% during the same period. Among the commercially less important species were ***Clarias lazera*** 0–0.1%, ***Alestes*** spp 0.3 to 0% and ***Clarotes leticeps*** 0.7–0%

The most interesting change noticed at the end of 1983/84 drought is the fast recovery of the lake itself. The year 1985 proved an optimistic year in terms of increase in the volume of the lake as well as abundance of many species of fish. There has been adequate rainfall in the catchment area of the lake this year which showed brighter prospect for recovery. The River Chari-Logone flowed into the lake at record volume for years which resulted in the fast expansion of the surface area. Even before the peak period (December–January) this year, the water had reached Baga Kauwa and flowed towards Malamfatori presently around Kangarwa.

The recovery of the lake also marked the re-emergence of many species that were not seen for 5–6 years. Most of the species obtainable in normal lake were recorded this year (October–November 1985). The newly emerged species which includes ***Lates, Hydrocynus, Labeo*** spp, ***Heterotis, Gymnarchus, Bagrus*** and ***Alestes*** spp., are shown in Table 3. All the emerging species are juveniles and immature. At least, the claim that enough water always remained in the southern basin to harbour representatives of many species of fish is clearly proved by the sizes and age groups of these fish species found this year. It is safe to assume that fish will not be totally depleted in Lake Chad.

Table 1 – Catch data of Commercially and Non-Commercially Important species of fish recorded in the Nigerian sector of Lake (1963–1982)

Species	*1963–1967*	*1972*	*1973*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*
Hydrocynus species	17.9	2.9	3.4	–	–	–	–	2.1	12.5	2.9
Lates niloticus	52.7	50.7	61.3	–	–	–	–	1.3	1.4	–
Labeo species	13.1	3.5	1.9	–	–	–	0.1	5.1	4.6	0.6
Distichodus species	5.5	2.9	1.5	0.5	–	–	–	0.7	0.9	0.5
Heterotis niloticus	1.9	3.4	1.6	1.8	2.2	2.0	6.9	9.5	0.3	4.6
Gymnarchus niloticus	–	0.8	3.4	0.3	0.1	–	–	0.1	–	20.0
Citharinus species	10.9	10.4	3.7	–	–	–	–	–	–	0.8
Bagrus bayad	1.4	4.2	1.9	0.2	–	–	–	1.1	1.6	0.5
Clarias lazera	–	–	0.1	89.6	85.7	84.0	76.0	50.6	26.6	38.8
Alestes species	0.3	–	–	–	–	–	–	–	–	–
Clarotes laticeps	0.7	–	–	–	–	–	–	–	–	–
Others	3.1	21.2	21.1	7.6	12.0	13.9	17.0	29.5	52.0	31.4

Table 2 – Abundance and Distribution of Commercially and Non–Commercially Important Species of Fish recorded in the Nigerian sector of Lake Chad (1963 – 1985)

Species	1963–1967	1972	1973	1976	1977	1978	1979	1980	1981	1982	1983	198.	1985
Hydrocynus species	+	+	–	–	–	–	–	+	+	+	–	–	–/
Lates niloticus	+++	+++	+++	–	–	–	–	+	+	–	–	–	–/
Labeo species	+	+	+	–	–	–	+	+	+	+	–	–	–/
Distichodus species	+	+	+	+	–	–	–	+	+	+	–	–	–/
Heterotis niloticus	+	+	+	+	+	+	+	+	+	+	+	+	–/
Gymnarchus niloticus	–	+	+	+	+	–	–	+	–	+	+	+	–/
Citharinus species	+	+	+	–	–	–	–	–	–	+	–	–	–/
Bagrus bayad	+	+	+	+	–	–	–	+	+	+	–	–	–/
Clarias lazera	–	–	+	+++	+++	+++	+++	+++	++	+++	++	++	–/
Alestes species	+	–	–	–	–	–	–	–	–	–	–	–	–/
Clarotes leticeps	+	–	–	–	–	–	–	–	–	–	–	–	–/
Others	+	+	+	+	+	+	+	++	+++	++	++	+++	–/

–/ = All appeared in the lake between October-November, 1985
+++ = Above 50% of the total catch
++ = Not less than 25% of total catch.
\+ = Less than 25% of total catch.

Table 3 – Fish species recorded in Lake Chad Between October and November 1985

Lates niloticus
Gymnarchus niloticus
Hydrocynus brevis
Distichodus brevipinis
Distichodus rostratus
Mormyrus rume
Clarias lazera
Protopterus annectens
Tilapia zillii
Tilapia nilotica
Tilapia galilae
Synodontis schall
Synodontis batensoda
Alestes nurse
Heterotis niloticus
Labeo senegalenses
Labeo coubie
Hyperopisus bene
Gnathonemus cyprinoides
Common Carp*

* Escaped from the CBRDA fish cage to Lake Chad.

Source: Fish landed at Baga Kauwa, Doro.

DISCUSSIONS

Fish population dynamics of Lake Chad was not studied in the past, as such not much work was done along this line except isolated studies on the biology of selected species such as ***Lates*** and ***Alestes.*** Most of the biological studies were undertaken before the severe drought of 1972/73 when normal lake conditions existed. With the onset of the drought, the ecosystem has completely changed beyond the imagination of the pre-drought investigators. Unlike the normal lake conditions, drought has completely separated the lake into two basins; northern and southern basins; while the former is more prone to complete drying.

It may be of interest to note that fish species such as ***Lates*** was not seen for 5–6 years and the little known ***Clarias*** abruptly dominated the catches. Unfortunately, human interference could not change the situation while natural course is awaited. The fish populations inter and intra-specific competition was not studied and it is high time such subject is considered for detailed study. Accidentally, an exotic species to this lake, ***Cyprinus carpio,*** Common carp was introduced to the lake last year. Common carps in holding cages of the Chad Basin and Rural Development Authority (CBRDA) at Baga intake canal escaped into the lake through the 13 kilometer canal. Surprinsingly, catches of fishermen observed between October and November 1985, contained some common carp. Although common carp is exotic to this lake, some members of Cyprinidae family such as the ***Labeo coubie*** and ***Labeo senegalensis*** closely related to the Indian major carp existed in Lake Chad.

Apart from the inter and intra-specific competition aspect, little work was done on the effects of the changing hydrology of the lake on its fisheries resources as well as the socio-economic impact on its beneficiaries. Anyone interestEd in the history of the lake and its fauna will wonder how the very rich Soudanian fish fauna has managed to survive the recessions that are known to have occured in the past.

Over-fishing in the lake has been on the increase tremendously. Smaller sized mesh nets (below 50.0mm) have been used indiscriminately. With the continuous encroachment of the desert, in the absence of any fish conservation law and with the recurrence of the Sahelian drought every ten years, fish species in the lake must resort to the concept of survival of the fittest. At this point, urgent conservational measures must be initiated by the authorities concerned. It is highly recommended that fingerlings of the commercially important species must be made available for restocking through carefully designed seed multiplication programme.

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A REVIEW OF THE CRAYFISH FISHERY OF NIGERIA WITH SPECIAL REFERENCE TO THE CROSS RIVER STATE

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ABSTRACT

The fishery for crayfish is of considerable importance in the maritime region of the Cross River State, where it forms an important occupation of a host of fishermen. Crayfish landings from this State contributed 11% to the national marine fish landings within the period 1980 to 1984 and also in the same period the volume of crayfish alone formed 26% of the marine fish landings within the State and was valued at ₦119 million. The species exploited as crayfish include *Palaemon hastatus; Hippolysmata hastatoides* and *Macrobrachium* sp. mixed with the larval, and juveniles of pink shrimp *Panaeus dourarum*. They are generally small in size ranging from 7 cm (maximum) to 2.5 cm. Crayfish are caught all year round along the Niger delta, but particularly along the river estuaries and littoral waters of the Cross River State with the highest production occurring in March to May. Crayfish are usually smoked, and occasionally sun-dried, and they form an indispensable food item in the diet of the people of the entire sourthern States in particular and Nigeria in general.

It appears that crayfish landings could be substantially increased without depleting the stock, if a proper exploratory survey is undertaken of the Niger delta, and the Cross River estuaries to chart potentially rich grounds of this resource.

INTRODUCTION

The crayfish Fishery has been an important occupation of a host of fishermen in the Cross River State from time immemorial, and presently more than 10,000 active fishermen are engaged in the production of crayfish in this State. The overall consideration of the crayfish fishery resources in this paper is based on the catch statistics of crayfish from the commercial landings by these local fishermen all over the scattered maritime fishing centres in the State. From all indications, it has become clear that crayfish form a very significant fishery in this part of the country. For instance, from 1980–1984, the National coastal and brackish water fish landings was 1.60 million tonnes and crayfish from this State alone contributed 164,658 tonnes thus, forming 11% of the national fish landings. In the Cross River State, and within that period, a total 628,849 tonnes of fish was landed, while crayfish contributed 164,658 tonnes, forming 26% of the marine fish landings in the State. The crayfish fishery has played a significant role in both the national and the Cross River State economy. In 1980, a total of 25,066 tonnes of crayfish was landed and valued at ₦17.5 million. For a period of 5 years, crayfish landed in Cross River State was 164,658 tonnes with an estimated value of ₦119 million. The upward trend in crayfish production in this State during the period has resulted from the pumping of modern fishing inputs into the industry by both the National and State Governments, at highly subsidized prices to the fishermen. This effort by the Federal and State governments in supporting this fishery should not be relaxed. From these data, it is true to say that the crayfish fishery is an important one and plays a major role in sustaining the economy of the Cross River State in particular and the Nation in general, but so far, information/data about this fishery is not included in the National Year Book of Fisheries Statistics. This situation has, therefore, necessitated a close look at the current status of this fishery from the data available from the Cross River State Fisheries Division. It is hoped that in future a proper study will be incorporated at the National level to appraise this fishery towards an integrated development in order to further enhance the economic role it offers to the people of this State and to Nigeria in general.

FOREWORD

The Fishery Society of Nigeria has a tremendous potential for making significant contribution to the scientific knowledge and development efforts of the Nigerian fisheries. The appointment of the third President of the Society, who is not a Civil Servant, will no doubt make the realisation of this potential possible. Unlike the Civil Servant, the incumbent President is not hampered by rules and regulations from expressing views on governmental policies, which he may consider to be disincentive to the promotion of fisheries development.

It is a matter of concern to the Society, that the total fish production from both inland and sea fisheries has shown a declining trend of recent and the gap between demand and supply is still wide. The production of less than 500,000 tonnes in 1986 represents less than 50 percent of an estimated demand of 1,200,000 tonnes.

The recent decline in production figures is believed to be a temporary phenomenon and is primarily due to several factors of production including acute scarcity and high costs of netting materials, gear accessories, and engine spare parts. Inadequate repair facilities keep many fishing vessels ashore for several weeks thereby causing colosal loss of fishing days.

Apart from low production figures, there is a wide gap between the size of fishermen catch and what finally reaches consumers. The difference is accounted for by heavy post harvest loss due to poor preservation and handling practices particularly by the artisanal and small scale fishermen, who account for over 80 percent of total production. It is estimated that the post harvest loss by weight is 45 percent.

There are three main sources for increasing fish production. The most promising source is aquaculture which, has a potential of an estimated 600,000 tonnes. But current aquaculture production of 21,000 tonnes represents an insignificant fraction of the potential.

A second promising source is tuna fishery which has an estimated potential of at least 10,000 tonnes a year. Nigerians are yet to benefit from the exploitation of this resource.

A third source is the expansion of inshore demersal trawl fishery to deeper waters where exist resources such as the drift fish ***(Ariomma bondi)*** and the Rose shrimp, ***(Parapenaeus longirostris)*** which appear to have potentials for economic exploitation.

Making harvested fish more available to consumers is attainable principally by:–

(a) giving incentive, financial or technical, to fishermen to land all low-value miscellaneous fish and

(b) converting the miscellaneous into fishery products for human and animal consumers.

The technology for the latter is already available at the Nigerian Institute for Oceanography and Marine Research, (NIOMR) Lagos.

FISON programme of activities embraces some of the issues raised above.

FISON recorded some achievements during the 4th Annual Conference. For the first time in the life of FISON, a Secretariat, though temporary, was established. The newly appointed President has offered to print the Draft Constitution, By–laws and Standing Orders free of charge to the Society. NIOMR has also offered to print the proceedings of the Conference free of charge. There were also numerous voluntary contributions by members towards the printing of proceedings of a previous Conference.

I wish the new Executive of the Society a successful tenure of office and acknowledge, on the behalf of all members, the excellent preparation made by the Local Organising Committee for a successful Conference.

J. G. Tobor
Ex–Officio Member
Fisheries Society of Nigeria.

Composition of Crayfish

In Nigeria, what is generally referred to as crayfish are mainly the small shrimps composed of three families: Palaemonidae, Hippolytidae, and Sergestidae. The species exploited include ***Palaemon hastatus, Hippolysmata hastatoides,*** and ***Macrobrachium*** sp., all mixed with the larval and junveniles of pink shrimp ***Penaeus duorarum*** which normally move into the coastal and estuarine areas to mature. The size composition of crayfish ranges from 2.5 cm to 7 cm (maximum without the long rostrum), though the most abundant and easily esploitable ones average in sizes from 3 cm to 4.5 cm. The bigger sizes are caught at estuaries open to the sea, while the smaller sizes are common in the littoral zones.

Distribution

Shrimp/crayfish fishing is practised in the Lagoon system east of Lagos, but significant fishery for crayfish extends from the eastern part of the Niger delta to the wider estuary of the Cross River up to and beyond Abana Ntuen in the Nigerian/Cameroun border in the Sea.

Catch Trend

For the period 1980 – 1984 the total catch of crayfish in the Cross River State and the national fish landings are given in Table 1.

Table 1 – National Fish Landings/Cross River State Crayfish Catch Data (in metric tonnes 1980–1984)

Year	*National Inshore and Brackish water Fish landings (A)*	*Crayfish Landings from Cross River State (B)*	*(B) as a Percentage of of (A)*
1980	274,158	25,066	9.14
1981	323,916	31,332	10.0
1982	377,683	40,896	11.0
1983	370,040	42,931	12.0
1984	227,659	24,433	11.0
Total	**1,573,456**	**164,658**	**10.5**

Source: (A) = Fisheries Statistics of Nigeria
(B) = Marine Fish Production by species/value in the Cross River State (1980–1984).

In 1980, crayfish contributed 9.0% to the national fish landings of 275,158 tonnes. In 1980 to 1984 the landings for crayfish established at 10.5%, that is around 32,932 tonnes. From 1980 to 1983, the crayfish fishery showed an increase from 25,006 to 42,931 tonnes which portrayed an annual growth of 3.25% in 4 years.

Cray fish alone contributed 164,658 tonnes, which represents 10.5% of the national marine fish landings of 1.60 million tonnes for 1980 to 1984.

The landings of crayfish, and the total marine fish caught within the period 1980 to 1984 in the Cross River State are presented in Table 2.

Table 2 – Cross River State marine fish/crayfish catch data (in metric tonnes) 1980–1984

Year	*Marine Fish (A)*	*Crayfish (B)*	*(B) as a Percentage of (A)*	*Value of Crayfish in Naira (₦)*
1980	122,544	25,066	20.45	17,546,200.00
1981	123,221	31,332	25.43	21,933,044.00
1982	146,148	40,896	28.00	29,199,744.00
1983	157,376	42,931	27.30	31,554,285.00
1984	79,560	24,433	30.71	81,813,410.00
Total	**628,849**	**164,658**	**26.20**	**₦119,046,683.00**

Source: As in Table 1.

The sharp drop in fish/crayfish production in 1984 has been attributed to the high cost of fishing inputs and the lack of government support in subsidizing these fisheries in the Cross River State. For the entire period of 1980 to 1984, the marine fish landed in the State was 628,849 tonnes and crayfish contributed 164,658 tonnes to the landings forming 26% of the catch and valued at ₦119.05 million. The increase observed up to 1983 in the fishery has been attributed to the mechanisation of the indigenous fishing crafts and the use of improved fishing gear made available through both the State and Federal Government subsidized fisheries schemes.

AREAS AND FISHING SEASON

Crayfish form a very important fishery in the estuarine fishing villages in the Cross River State particularly along Kwa–Iboe, and the wider Cross River Estuary. The big landing settlements for crayfish in the State include Oyorokoto, on the Bight of Bonny near Ikot Abasi (See Figure 1). Here, more than 3,000 crayfish fishermen from Ikot Abasi, Ete and the suburb assemble and engage in crayfish fishing. Ito, Okoroette, Nta Ikang, Itak Ibang, Okposo, and Inua Abasi all on the Bight of Bonny are the other big centres where more than 2,000 fishermen are engaged in this fishery.

In Ibeno/Eket, bonga fishing is the predominant occupation of the fishermen of the area, but even there about 1,500 fishermen are engaged in the crayfish fishery. The greatest volume of crayfish in the Cross River State comes from Efiat/Mbo (Oron). This region is on the wider estuary of the Cross River and extends up to the Nigerian/Cameroun border in the sea. The main crayfish fishing settlements in Efiat/Mbo include Esuk Enwang; James Town; Mkpang Utong, and Ine Okon Edu, all with a crayfish fishing population of about 2,500 fishermen. The largest crayfish fishing settlement in this area is Utan Brama with more than 5,000 fishermen engaged in the fishery alone. Other centres in this area include Mbe Ndoro (with 1,000 active crayfish fishermen) and Abana Ntuen (with 3,000) both located in the sea near the Nigerian/Cameroun border. Crayfish fishermen from Oron, Ebughu, and Nwaniba/Uyo migrate and stay at Utan Brama up to Abana Ntuen and participate in this fishery. Oron, and Nwaniba/Uyo form the ready land base for marketing of crayfish. These are about 2,000 crayfish fishermen engaged in this fishery in Ikang near Calabar.

Just as in Bonga fishing, Ikot Abasi crayfish fishermen at Oyorokoto, Iko, and Okoroette bring in their crayfish landings mostly from the estuaries of the Niger delta, while the Oron and Nwaniba/Uyo crayfish fishermen bring in their catches from Efiat Mbo on the wider estuary of Nigeria/Cameroun border.

Although crayfish are caught all-year -round, the real fishing season starts from October to June with the highest production occurring in March to May.

FISHING CRAFT AND GEAR

Crayfish fishing is carried out using the traditional craft and gear. In the Cross River State, two main sizes of these traditional dug-out canoes (large and small) are used. The large size measures about 9-12 meters in length; the width is about 0.9 meters with a depth of 0.8 meters and generally with a displacement of about 2.7 to 4.5 tonnes. This type of canoe is used by the fishermen who are based and operate from Efiat/Mbo in Oron sector (which include Esuk Enwang, James Town, Mkpang Uong, Ine Okon Edu, Utan Brama, Mbe Ndoro, and Abana Ntuen). These fishermen are operating at the wider estuary of the Cross River opening to the sea. The fishermen from Oyorokoto, Iko, and Okcroette near Ikot Abasi also use this type of canoe.

The other type of dug-out canoe is smaller in size and ranges inlength from about 8 meters to 9 meters. The width is about 0.9 meters with a depth of 0.8 meters and displacement of about 1.8 tonnes. This type of canoe is used by the crayfish fishermen who are fishing mostly in the Creeks and occasionally entering the wider estuary of the Crpss River mostly during the peak season. They operate at Ibeno/Eket; Nwaniba/Uyo; Uruan, and in the Creeks all over the fishing settlements. Some of these canoes have been motorized with outboard motor ranging from 18 - 40 Horse Power (HP). About 98% of these outboard motors have been supplied by both the national and State Governments at highly subsidized prices to aid these fishermen in increasing their landings, and make the catches available in the market for public consumption.

The type of gear used for crayfish fishing is a fixed bag net, and is usually fixed in the sea by either stakes or bouys. The largest size of these nets has a rectangualr mouth opening ranging from 2.4 m to 3 meters, by 1.8 meters - 2.4 m, with a net body measuring about 7m or 9 m, and extending from the mouth, and narrowing to a terminal point. Various sizes of these nets are prepared and used in waters where the current is strong and high enough to keep the nets in a horizontal and expanded position.

PROCESSING OF THE CATCH

Crayfish landings are usually sun-dried, especially during the dry season which corresponds to the peak period for this fishery. smoking is the alternative method used when sun-drying is impossible because of the freqent rains during the rainy season. Crayfish are usually spread on top of a mat for drying in the sun; or over an oven in a smoke house. During smoking, only heat and smoke are preferred (warm smoking) without the actual flame.

As they dry, crayfish are then packed in bags and marketed throughout the country.

DISCUSSION

As here presented, the crayfish fishery occupies an enviable position in the fishing industry of Nigeria generally, and contributes directly to the economy of the Cross River State. Huge amounts of crayfish are landed by artisanal fishermen from the inshore and various fishing grounds along the coast of the Cross River State. The enhanced trend in crayfish production has been attributed to Government participation over the last seven years by the provision of fishing inputs like outbaord motors, synthetic nets, fibreglass boats, et.c, at highly subsidized prices to the fishermen, fishermen cooperatives, and viable fishing communities.

This effort of the Government has been very remarkable, and should be continued. It seems obvious that with the availability of sufficient crafts and gear to venture to the inshore and offshore areas of the Cross River State, the uilization of crayfish fishery resources from this State could be substantially increased, without fear of depletion since the area fished at present is much smaller than the area available for fishing. Quite unlike other types of fisheries which have definite seasons, crayfish is abundant throughout the year. Theretore, any careful selection, and improvement on the fishing crafts which can withstand unfavourable weather conditions, and of efficient gear would prove very useful in ensuring a more regular supply of crayfish for our needs throughout the year

The crayfishery as practised in this State is relatively less labour intensive, and more income yielding than fishing for other types of fish. The present method of preserving crayfish by sun-drying and smoking appears to be satisfactory and inexpensive, and the fishermen have used this method for many decades, and should continue to do so unless better methods of preservation can be discovered.

Since the crayfish fishery offers considerable scope for further exploitation, this paper, therefore, calls for a proper survey and charting of the water areas extending from the Niger delta to the wider estuary of the Cross River, inorderto have an adequate knowledge of the distribution and abundance of this resource. It is also to be realized that the juveniles of ***Penaeus duorarum*** (our export prawn) are equally caught as crayfish. An attempt should be made with the survey to find out ways of regulating tbe crayfish fishery to allow maximum numbers of these juvenile prawns of ***P. duorarum*** to return to the sea to be caught at full and mature sizes so that our prawn resources in the country are not adversely affected, while the crayfish fishery continues.

ACKNOWLEDGEMENTS

I am grateful to B. S. Moses, Head of the Department of Zoology/Fisheries, University of Cross River State, Uyo for critically reading through the manuscript, and offering useful comments I also with to express my appreciation to the numerous authors of the different texts, journals and articles I referred to in the final presentation of the materials in this work.

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RELEVANCE OF THE PROGRAMMES OF THE FEDERAL FISHERIES SCHOOLS TO NIGERIA'S FISHING INDUSTRY

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ABSTRACT

Nigeria's three Federal Fisheries Schools are administered by three autonomous Research Institutes located in Lagos, New Bussa, and Maiduguri. The Schools were established at different periods to train the required manpower for Nigeria's fishing industry which has remained predominantly artisanal since its inception in 1942 as a Second World War exigency. Despite the establishment of the Schools, the industry's manpower is still being dominated by non-nationals especially in the capture fisheries sub-sector. The common features of the Schools include the apparent insensitivity of their programmes to the industry's dynamic manpower needs; the absence of coordination of their programmes by a National body which would have ensured that the Schools are able to communicate with one another and are willing to act and share a purpose. The need and the methodology for a change of emphasis from the on-going training of extension agents and officers to that of fishing operatives and technicians to enable Nigeria effectively harness her local fish resources towards self-sufficiency is highlighted.

INTRODUCTION

Although some in-service-training had started by 1965 at the Federal Department of Fisheries, formal institutionalized training did not commence until 1969 when the first Fisheries School the Federal Fisheries School, Lagos was established. The other Federal Fisheries Schools in New Bussa and Baga were subsequently established in 1980 and 1982 respectively. This was a late start when compared with the date of the establishment of manpower training institutions in the other agricultural sub-sectors.

For example, the first agricultural training school was established at Moor Plantation, Ibadan in 1921, a second school of agriculture was established at Samaru, Zaria in 1931 to cater for the training of junior technical workers for agricultural services in the northern parts of the country. The first forestry school was established also at Ibadan in 1941. These facts explain the main reasons for the quantitative pre-eminence of trained agricultural workers over fisheries in the country. Two main reason account for the delay in starting training in fisheries:—

(i) The relatively small size of the Department to support a national formal training scheme.

(ii) The fact that the Development Plan of the Regions as was contained in the first national plan (1962—68) were not sufficiently advanced to permit them to define their training needs.

The early limited requirements of the fishing industry in Nigeria were met by the recruits on the job. The Merchant Shipping (Fishing Boat Regulations) Act of 1963 precipitated the need to provide formal instruction in navigation to candidates for mates and skippers examinations.

Meanwhile, because the Federal Fisheries Service could not start a more purposeful training programme early enough, the then Government thought of setting up fisheries courses at Yaba College of Technology for Nautical Sciences; at Samaru, Zaria, for fisheries extension assistants for the North; at the School of Agriculture Umudike for the extension assistants in the Eastern Region, while a similar course was to be organized at the School of Agriculture in Ibadan for the West and Mid—Western Regions.

The meeting of the Fisheries Technical Committee (the predecessor of the present National Fisheries Development Committee – NFDC) held on July 28, 1966 agreed to establish a federal institute of fisheries education and training in Lagos. This was fulfilled in 1969.

A sub-committee of the NFDC on Manpower Development and Training at its meeting in February, 1972 recommended that:–

(i) The Federal Fisheries School, Lagos should continue to train Fishermen, Coxswains and Mates on a small scale until an anticipated UNDP/FAO assistance materialized.

(ii) Marine Engineers and Captains should be trained in Ghana until such time as need for them necessitated the provision of training facilities locally.

(iii) Graduate Fishery Officers and Research Officers should be trained in Universities. An expert study group with FAO and UNESCO backing would be needeo to work out details.

(iv) The Federal Fisheries School should also provide training for Fisheries Assistants and Superintendents for the marine fisheries, while a similar school would be established at Kainji (New Bussa) to train similar personnel for the freshwater fisheries.

Thus, the establishment and mandates of the two Federal Fisheries Schools in Lagos and New Bussa were well planned by a national body unlike the School in Baga which was apparently a mere administrative expansion of the Lake Chad Research Institute by its authorities. The Baga School, therefore, left its erstwhile laudable role of providing vocational training for fishermen and fish processor on the fringe of Lake Chad and started apeing the training programmes of the other two schools by running Diploma programmes in fisheries with aquaculture as its focus. The Baga School's programmes are therefore inadvertently out of the reach of the local fishermen because of the relatively high admission requirements.

It is mandatory that the programmes of the Fisheries Schools should be sensitive to changes in the manpower requirements of the industry. The Lagos and New Bussa Schools were created in response to the earlier technical middle-level manpower needs of the industry while the Baga School was to meet the vocational level needs of the local fishermen. All the Schools except the Lagos School to some extent, have not shifted from their original mandates and have equally become rigid as at now despite the obvious indicators for change of emphasis.

INDICATORS OF COMPELLING SHIFTS IN MANPOWER, DEVELOPMENT AND TRAINING FOR THE INDUSTRY

A vocational or technical School is relevant to its clientele's manpower needs if its programmes are sensitive to the dynamics of the clientele's demands. Thus the programmes of the School should regularly be subjected to sensitivity tests to be followed by a programme review at least every three years.

Nigeria's fishing industry has passed through three phases each of which indicated the compelling need for shifts in the contemporary manpower development efforts. These phases are:–

Phase I

Nigeria's signing of the Merchant Shipping Act of 1963 which stipulated the minimum manning regulations for fishing vessels necessitating the need to up-grade the knowledge of some of the already trained fishermen to satisfy the requirements for the Coxwain and Mate Competency Examinations.

Thus, a pilot Coxswain course for 10 candidates from the then Western Nigerian Fisheries Cooperative Union was conducted on request in 1965 by the Federal Fisheries Service in response to the above indicator. When the Federal Fisheries School, Lagos was formally established in 1969, it took up the regular training of fishermen, Coxswain, and mates. This phase lasted between 1970 and 1975.

Phase II

Between 1976 and 1980, the industry particularly in the public sector accumulated a large number of untrained staff recruited when the 12 new states were created in 1967 out of the former 4 Regions. These backlog of untrained staff were mainly composed of fisheries extension assistants and superintendents.

The Lagos School which was the only functional School was therefore, further mandated to introduce the two-year Oridinary and Higher Diploma Courses for the Assistants and Superintendents respectively. the thrust of the curriculum was on inland fisheries where many capitally intensive development projects had taken off.

Phase III

A lull was observed in the staff development efforts of State Governments. More qualified high school leavers were willing to come for training in fisheries as private students. The Government's indigenization decree was forcing more fishing companies to sponsor their staff for training. The private sector became more cooperative with the schools programmes by voluntarily requesting for graduates of the School for employment on board fishing vessels. Technical aids were being offered to the Schools by international and national agencies. These indicators were observed in 1981–1985 as shown in Table 1 where 223 private students enrolled out of 854 as compared to only 2 private students out of 857 between 1975–1980.

The response of the Lagos School was the restructuring of the former Mate and Motorman II Courses into two-year Ordinary Diploma programmes respectively. This shift permitted the admission of better qualified and much younger applicants to offer fishing and engineering courses An annual two-week Teaching Methodology Course was also introduced into the School programme. The objective of the course which was designed for fisheries instructors and extension officers is to produce personnel who would be able to communicate effectively, design relevant teaching aids, and be able to use them appropriately.

Figure 1 gives a pictorial summary of the three phases mentioned above as it affected the Lagos School. It will be observed that the most significant shift was from training at vocational level to technical. The gradual decline in the number of fishermen trained in the Lagos and the correspondingly gradual rise in the number of post-secondary based courses testified to this observation.

Phase IV

Indicators: There are already signals heralding a new phase in the industry's manpower demands. These signals are:–

(i) The access to 320 km Exclusive Economic Zone (EEZ) off Nigeria's coast which will attract the use of bigger vessels and highly trained professionals to exploit the resources and man the vessels. The training of senior level skippers and marine engineers will have to commence now for Nigeria to benefit from the EEZ.

(ii) There is already a backlog of intermediate level fishing officers, i.e. Mates, Motormen, Third Class Marine Engineers, Higher Diploma holders etc., who have already acquired requisite post training experience required for higher certification. This situation is reminiscent of the 1970–1975 new State creation boom in manpower recruitment for the public sector fisheries.

(ii) New Bussa (KLRI).

To conduct mainly courses for inland fisheries. These courses will produce experts in aquaculture and boat building.

(iii) Baga (LCRI).

To conduct courses to produce middle-level manpower in fish processing, and marketing mainly.

However, all the Schools should conduct any ancillary courses that will strengthen their main programmes. Such courses may include pre-diploma remedial, and extension education courses. All the Schools should also have outreach programmes with the industry in order to provide appropriate industrial experience for the trainees. The outreach programme will involve regular consultation with management of fishing companies and government fisheries development projects. Short-term ***ad hoc*** and vocational skill improvement training programmes are also included in the outreach.

Management of the Schools.

The attachment of the three schools to three autonomous Research Institutes without specific guidelines to the Directors on the extent of administrative control, gives an indication that the Schools should be administered as one of the Divisions of the Research Institutes. Only the Lagos School appears to have succeeded in being accorded some measure of administrative concessions over the Research Divisions.

The Schools cannot be effectively run if the Directors continue to administer them the same way as other Research Divisions. This is because school programmes are time limited, students are not staff members who can easily be subjected to the Institute's mode of operations. Furthermore, the criteria for promoting the School's teaching staff should be different from those of Research Officers. Their promotion should be based on dedication to duty, degree of readiness to accept extra responsibilities, innovative approach to work, students performance in their subject areas, documented contribution to knowledge in form of compilation of 'handbooks' for students' use.

The programmes of the School are not coordinated by any national body despite the fact that the programmes are expected to solve national manpower problems for the industry. The syllabuses being used by the New Bussa and Baga Schools are essentially those produced by the NFDC's sub-committee on Manpower Development and Training in 1975. The Lagos School has unilaterally modified its syllabuses, using its human resources and consultancy services, in response to the observed changes in the manpower need of the industry. In view of the existence of definite growth patterns of the industry as shown in Figure 1, the syllabuses of the Schools should be subjected to regular review at the end of each National Development Plan Period, i.e. every five years. This regular review will ensure that the manpower demand of the next plan is met.

RECOMMENDATIONS

1. The National Fisheries Development Committee (NFDC) should set up a permanent sub-committee on Manpower Training. The members will be made up of:–

   (a) The three Principals of the Federal Fisheries Schools,

   (b) The Manpower Development and Training Officer of the Federal Department of Fisheries.

   (c) Two State Chief Fisheries Officers, one from the Northern States and the other from the South,

(d) A member selected from the private sector of the fishing industry, and

(e) A member from one of the Universities offering fisheries sciences either at first or second degree levels.

The specific objectives of the sub-committee will be:—

– (i) To review and standardise courses and syllabuses for vocational and techical training programmes in the fisheries schools.

– (ii) To regularly assess the manpower needs of the fishing industry and identify the appropriate school or schools where the relevant training programme could be effectively conducted.

– (iii) To serve as the coordinating forum for the three Principals where management information on the Schools will be interchanged.

2. The Federal Department of Fisheries, the licensing authority for fishing vessels, should make the acceptance of trainees on board applicant's vessels mandatory. Even though, this recommendation has been made in other fora, the Department has not given any official backing to this important recommendation.

3. All fishing companies should be made to subscribe to the Industrial Training Fun (ITF), the national body in-charge of students industrial experience programmes. The Fisheries Schools will then transfer the arrangement for industrial attachment to the ITF which already has statutory powers on the programme from which all the 25 Polytechnics in Nigeria are benefiting.

4. The Federal Ministry of Science and Technology should provide specific guidelines to the Directors of the three Research Institutes on the extent of administrative control they should have on the schools. Sufficient powers should be delegated to the School Principals because of the peculiarities of their duties, vis-a-vis Research Division.

CONCLUSION

Nigeria's population and resources are the fundamental advantages she has over other African countries. Unfortunately, these advantages have not been effectively utilized to improve her economic and social status. The wealth of a country depends on its capacity to produce, and that also depends on its possessing a highly skilled and very flexible labour force.

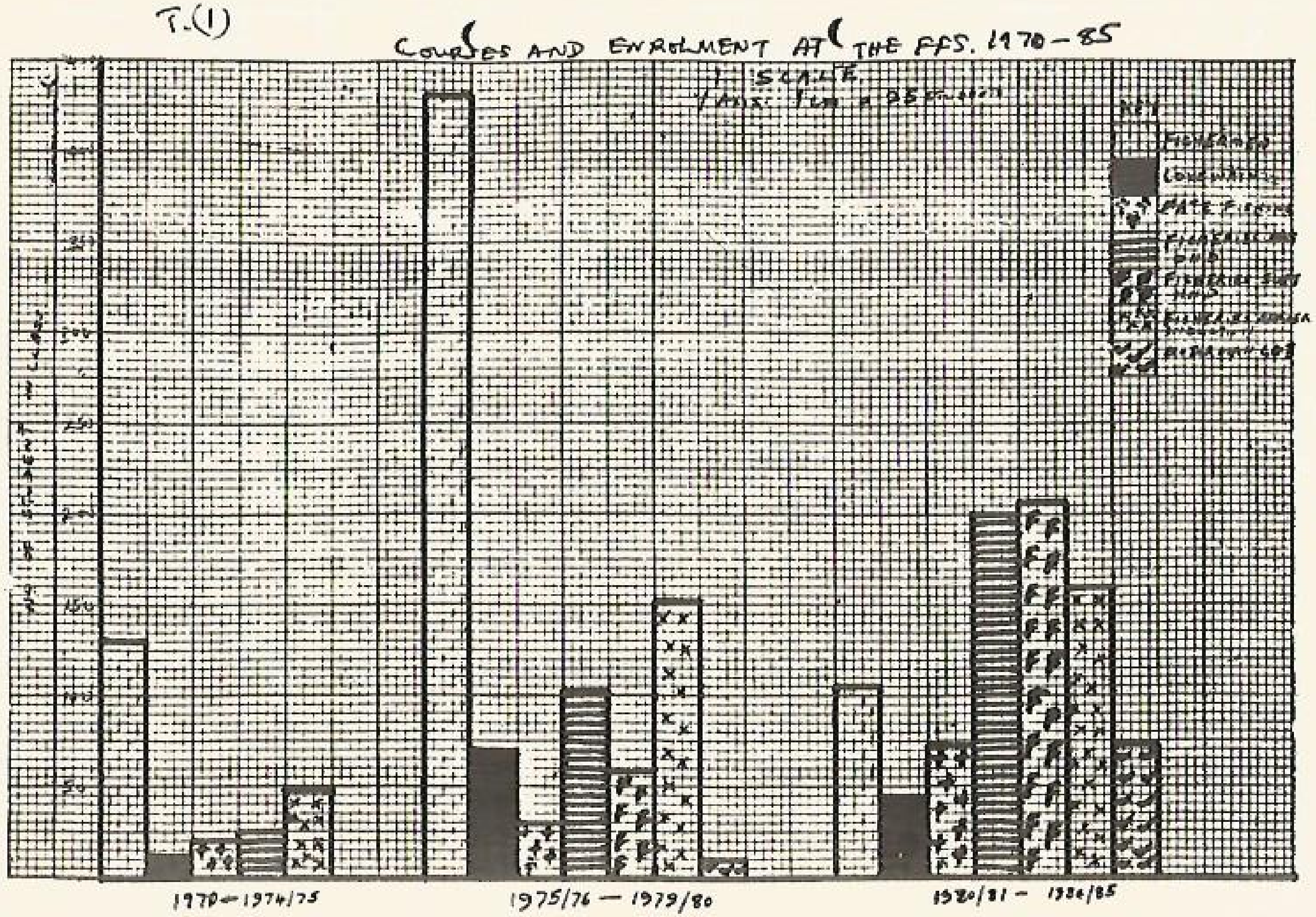
The training of the manpower for Nigeria's fishing industry is not being carried out by Federal Fisheries Schools only. At least five States agricultural schools have fisheries departments and each State Fisheries Division also has an extension and training unit. Thus, the basic administrative infrastructures are already there. What is absent is an objective co-ordinating force that will harness all the diverse structures and programmes to meet the country's target of self-sufficiency in fish production within this decade.

Table 1 – Students Enrolment at the Federal Fisheries School, Lagos, 1975 – 1984

Course	1975 – 1980					1981 – 1984				
	Sponsored	*Private*	*Total*	*% Sponsored*	*% Private*	*Sponsored*	*Private*	*Total*	*% Sponsored*	*% Private*
Fishermen	432	–	432	100	–	104	–	104	100	–
Coxswain	71	–	71	100	–	27	18	45	60	40
Mate Fishing	30	1	31	96.8	3.2	8	60	68	11.8	88.2
OND (Fisheries Assistants)	103	–	103	100	–	127	73	200	63.5	36.5
HND (Fisheries Suptd.)	56	1	57	96.3	1.7	187	20	207	90.3	9.7
Fisheries Officers (Induction)	152	–	152	100	–	161	–	161	100	–
OND (Motormen)	11	–	11	100	–	12	57	69	17.4	82.6
Total	**855**	**2**	**857**	**90.0**	**0.2**	**620**	**228**	**854**	**73.3**	**26.7**

– COURSES AND ENROLMENT AT THE FFS. 1970–1985

T.(1)



MARKET SURVEY OF THE PERIWINKLE TYMPANOTONUS FUSCATUS IN RIVERS STATE: SIZES, PRICES, TRADE ROUTES AND EXPLOITATION LEVELS

By

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ABSTRACT

Typmpanotonus fuscatus was collected from 23 markets through Rivers State, a few in neighbouring States, and from an unexploited population at Buguma. The size distribution of sheels was determined, and information on prices and trade routes was also obtained.

The mean shell length of specimens from the unexploited Buguma population was 46.4 mm, compared to 30.4 mm for the Buguma market samples. Mean sizes in other markets showed a geographic pattern: the smallest were from the Adoni-Ogoni–Opobo sector (28.1–30.9); the largest were from the Nembe-Brass sector (37.7–44.2) and Bendel State (35.7–45.6);

The results suggest the population structure of *Tympanotonus* in much of Rivers State has been strongly impacted by overharvesting. They show that local market as well as some in Cross River State, are increasingly being supplied by road with specimens from the Benin River area of Bendel State.

Differences between shell types, and relations between shell size, selling price and market distance from source, are also discussed.

INTRODUCTION

The mangrove snail, *Tympanotonus fuscatus* is a major food item in soups prepared by coastal peoples of south-eastern Nigeria. It is harvested from the swamps by women and retailed by petty market traders who remove the meat from the shells for sale. The snail is very hardy, and is able to survive many days out of water, so it is easily transported in quantity to inland markets.

The present survey was started to test our observations that excessive harvesting appears to be leading to a marked reduction in mean sizes in local populations: a simple and easily demonstrated case of over-exploitation. In the course of the sampling, a second point became evident: that a significant proportion of periwinkles now marketed through Rivers State (and also Cross River State) originate from the Sapele/Benin River area of Bendel State from where they are transported by road.

The paper thus, aims to identify the major trends in exploitation levels and marketing of the periwinkle; and to provide preliminary information for deciding on research priorities.

METHODS

Shell length was measured from the end of the outer lip to the tip of the spire, with vernier calipers. As normal, most of the medium and larger sized shells were decollate (tips of spires missing) thus the length measurements under-represent the true differences in sizes. Shells with extreme decollation were not measured.

Samples of about 200 shells if possible, were used from each source. Each shell was categorized as "smooth" (from *radula)* or "spiny" (form *fuscatus).* Shell length was measured to the nearest millimeter, but for the purpose of analysis, the data were reduced to size-classes of 3 mm.

During market visits, information was obtained from the traders on prices, and the source(s) of the periwinkles in each market. In many cases, the periwinkles being sold had been obtained from other markets, which in turn were visited if possible. Many were traced back to traders bringing large consignment from Sapele in Bendel State.

Other anecdotal information was obtained from local indigenes from various areas.

RESULTS AND DISCUSSION

Comparison of Market Sample with Sizes in an Unexploited Population

Figure 1 shows a comparison of the size-frequency distribution of shells from Buguma market (i.e. collected from wild, exploited populations), and from the Buguma station fish ponds. The difference in size is clear. The pond population had been subject to some limited harvesting by workers and except for this, the shell-size difference between the two samples would have been greater.

Similar differences between shell-sizes in exploited and unexploited populations were observed circa 1980 at the tributary of Elechi Creek supplying the fish ponds of the Rivers State University of Science and Technology, Port-Harcourt. The periwinkles of the peat flats subject to normal harvesting by local persons, were small; exceptionally large specimens occurred in two areas: the University's fish pond, and an isolated bend of the creek which was by-passed by the local gatherers.

Comparison of Market Samples and Geographic Sectors

Date for the market samples are shown in Table 1. Samples are arranged into four groups according to area of origin and market route. Each area has a surprisingly distinct range of mean sizes only a few exteme values in each group overlap the size range of other groups. Figure 1 compares graphically, the frequency distribution of shell sizes in samples from each of the four groups (Kono for the Andoni-Ogoni–Opobo sector; Okrika for Okrika-Bonny–Kalabari sector, Brass for the Brass–Nember sector; and Benin River for Bendel.

OGONI–ANDONI–OPOBO ZONE

This zone had consistently small specimens, with mean lengths of 28.1–31.4mm. Harvested specimens are marketed inland through the Bori area and up the Imo River to Azumini. Reports from the Kono . 'a indicate that extensive commercial harvesting began only around 1980, after which time there was a noticeable drop in sizes. Inland at Azumini, the small-sized periwinkles originating from the lower Imo River (Kono-Opobo) are now receiving competition in the market, from large specimens originating from Bendel.

OKRIKA–BONNY–KALABARI ZONE

The mean sizes in this zone are 30.4–34.7mm, excluding an additional, exceptional value of 36.5 (Choba market, purportedly from Kalabari but possibly from the Bendel market route). The sizes are intermediate between the previous zone, and those of the next two sones.

The zone can be subdivided into two, according to market routes. First is the Okrika-Bonny River area. Specimens from here are routed through Okrika to markets a few kilometers inland, mainly on the outskirts of Port-Harcourt (Eleme, Elelenwo etc).

Second is the Kalabari area extending from Bakana and Bille (New Calabar River) westwards to the Degema area. Specimens from these area are routed to (1), the Diobu-area markets of Port-Harcourt from where they are distributed to other markets of the city, and (2), local markets along the upper New Calabar River such as Ogbogoro and Choba. The major source area is the Soki region west of Degema, from where large quantities are sent directly to Port-Harcourt, and also inland to Abua and Ahoada.

BRASS–NEMBE ZONE

Only two samples were obtained. They had mean shell sizes (37.7 and 44.2mm length) larger than all other market samples of Rivers State origin. Several informants specifically noted that "Ijaws" (meaning Brass and Nembe *inter alia)* do not export their periwinkles, which suggests that their periwinkle populations are under less harvesting pressure.

BENDEL (BENIN RIVER)

These samples had large mean sizes (34.1–45.6mm), with most of the means larger than any from the Andoni–Ogoni-Opobo and Okrika-Bonny-Kalabari zones. The snails are transported from Sapele to Timber Waterside in Port Harcourt by traders who receive them from the lower Benin River. Timbe Waterside serves as a distribution center for markets in the Port-Harcourt area and further east: traders from Aba, Ikot Ekpene,Uyo and Calabar reportedly visit there to buy for re-sale. Some of these traders also buy directly from Sapele.

Evidently, none of the Bendel traders goes east of Port-Harcourt. Some stop at Ahoada.

According to the Bendel traders, there are also occasional shipments of periwinkles from the Forcados–River area via Warri to Port-Harcourt, but the shipments are infrequent and the periwinkles are smaller.

Relation Between Shell Size and Price of Removed Flesh

There is a general positive correlation between shell size and the selling price of removed flesh (Figure 2), even though the unit measure of flesh is the same.

The correleation is partly due to a strong consumer preference for large bodies periwinkles. However, it should be noted that the samples of large snails all came from inland markets, so their higher selling price may also be related to distance from source and middlemen. In all the main market sectors, there was evidence that larger shell sizes were sent to more distant markets, and the smaller ones kept for local consumption. This may be connected with differences in collecting efforts by persons gathering the snails full-time for sale to commercial transporters.

Differences Between Spiny and Smooth Forms

It is well documented that the spiny and smooth forms of the ***Tympanotonus*** belong to the same species ***(T. fuscatus)*** (Pilsbry and Bequaert, 1926; Brown, 1980). All individuals are of the smooth form early in life; the difference in forms is due to some individuals soon changing to the spiny pattern of shell growth. The occurrence of each form has been shown to be related to habitat factors (e.g. Binder, 1957) and changes in shell growth pattern from one form to the other has been accomplished experimentally by transplanting snails from one habitat to another (Routeillet, 1979; Gabriel, 1980, 1981).

Both forms reach large sizes (Table 1). Inspection of the data does not show any marked correlations of price or other factors with shell type, between samples (but see next paragraph). Within samples, there is a tendency for spiny forms to have a larger mean size than smooth forms (Figure 3) but significance of this is not clear. In two samples of small shells, the smooth forms had a larger mean size (Figure 3).

By some accounts, the smooth form is preferred by the petty traders because the flesh of this type is more easily removed in its entirety. In contrast, however, there is a general consumer preference for the spiny form, which is reputed to taste better.

Effects of Harvesting on Population Structure

The effect of harvesting on periwinkle population structure in the Port-Harcourt area was suggested earlier in a yet unpublished report (Powell, 1981).

From a different perspective, Nzewunwa (1985) reported archeeological evidence of reduction in shell size in the Okrika area, based on shells of specimens harvested there approximately 2,000 years ago. It is not possible, however, to say when in the intervening period the decrease occurred or was greatest.

Concerning the data at hand, it might be suspected that the larger size of the Buguma fish pond specimens, compared to the market sample, could be due to differences in habitat zones involved (permanently underwater vs intertidal) or trophic conditions. However, those arguments do not account for the size differences also observed at the Elechi Creek/University of Science and Technology site, between harvested and unharvested populations.' In that instance, one of the unharvested populations, with larger specimens, was in a natural intertidal site. Moreover, the only growth study available (Gabriel, 1980), showed that growth rates of a pond population (at the U.S.T. site) was if anything lower than a natural intertidal site (at Borokiri, Port-Harcourt).

ACKNOWLEDGEMENTS

We are grateful to the following for assistance in obtaining samples and/or information: E. S. Andrew-Essien, Promise Cookey, Dr. R. S. Konya, Mr. E. Nweke, Michael Oghuwu and F. A. Ojarikre.

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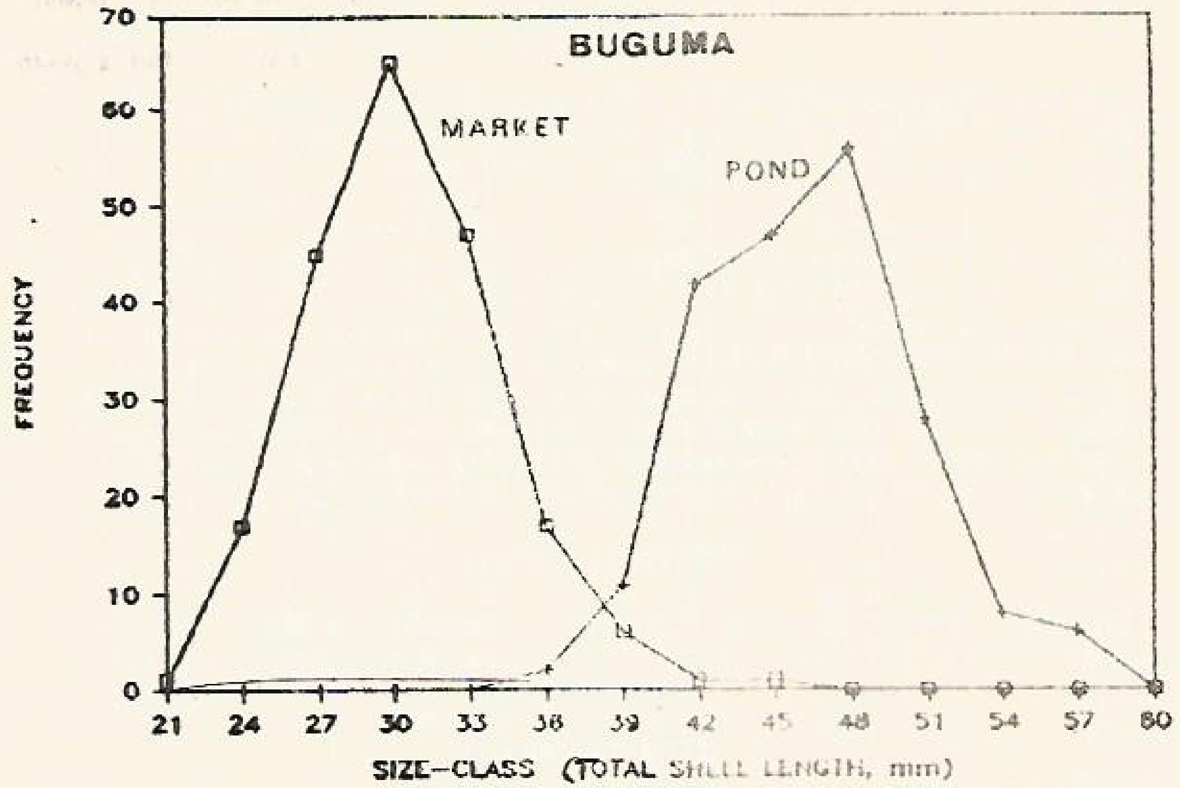
Table 1

Market	*Source*	*Mean Size*	*N=*	*% Spiny*	*Cost per Tomat*	*Cup (kobo) Milk*	*Cigarette*
ANDONI/OGONI/OPOBO ZONE							
Kono	Kono	28.1	200	42.5	–	25	–
Opobo	Opobo	29.5	200	3.0	–	–	–
Kaa	Andoni	30.7	200	33.0	–	50	–
Bodo	Bodo	30.9	201	1.5	20	–	–
Bori	Bodo & Maa	31.4	202	4.5	20	40	–
OKRIKA/BONNY/KALABARI ZONE							
Buguma	Buguma	30.4	200	8.0	–	–	50
Umuagbai	OilMill (Okrika)	30.8	201	.0	30	50	–
Onne	Onne & Bodo	31.7	201	12.4	–	50	–
Bonny	Bonny R.	31.8	200	11.5	–	40	–
Nchia Eleme	Okrika	31,9	201	33.3	20	50	–
Degema	Degema	32,4	201	37.3	–	50	–
Okrika	Okrika	32.5	200	7.5	20	–	–
Oil Mill Mkt	Okrika	33.3	202	10.9	30	80	–
Elelenwo	Okrika	33.7	201	48.8	25	50	–
Rumueme	Bakana	34.7	201	41.3	–	40	–
Choba	Kalabari	36.5	201	79.0	–	100	–
BRASS/NEMBE ZONE							
Brass	Brass	37.7	201	100.0	–	–	50
Nembe	Nembe	44.2	29	89.7	–	–	–
BENDEL (SAPELE/BENIN R. ZONE)							
Sapele		34.1	132	.0	30	50	–
Obigbo	CkRd(Bendel?)	35.7	201	30.3	30	50	–
PH Mi3 Mkt	TimberW/S Bendel)	36.9	206	96.1	30	–	–
Ahoada	Bendel	39.7	202	100.0	70	100	130
PH CreekRdMkt	Bendel	42.3	200	3.5	35	–	–
PH Timber W/S	Bendel -Benin R	45.6	156	.0	–	–	–
UNEXPLOITED							
	Buguma Pond	46.4	200	7.0	–	–	–
OTHER CALABAR							
Calabar	Local?	32.7	95	.0	–	–	–
Calabar	Bendel?	43.0	107	100.0	–	–	–

PERIWINKLE SIZE DISTRIBUTIONS



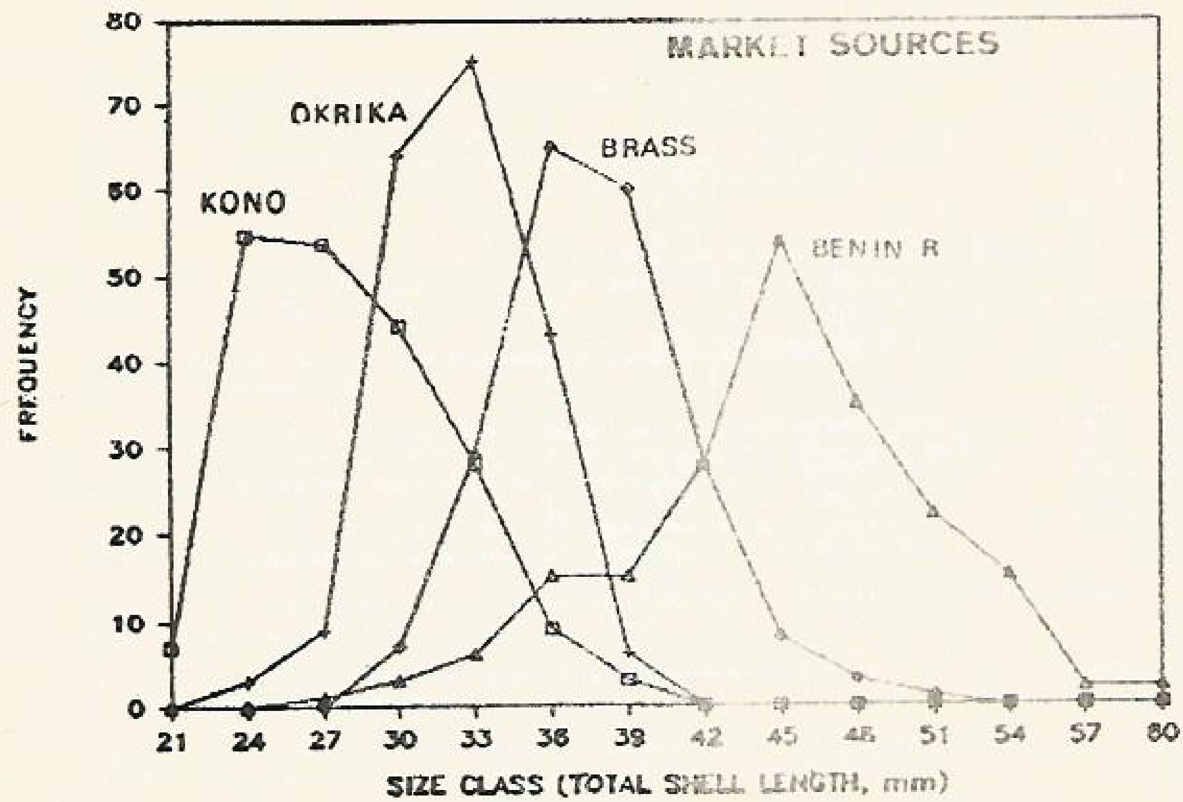
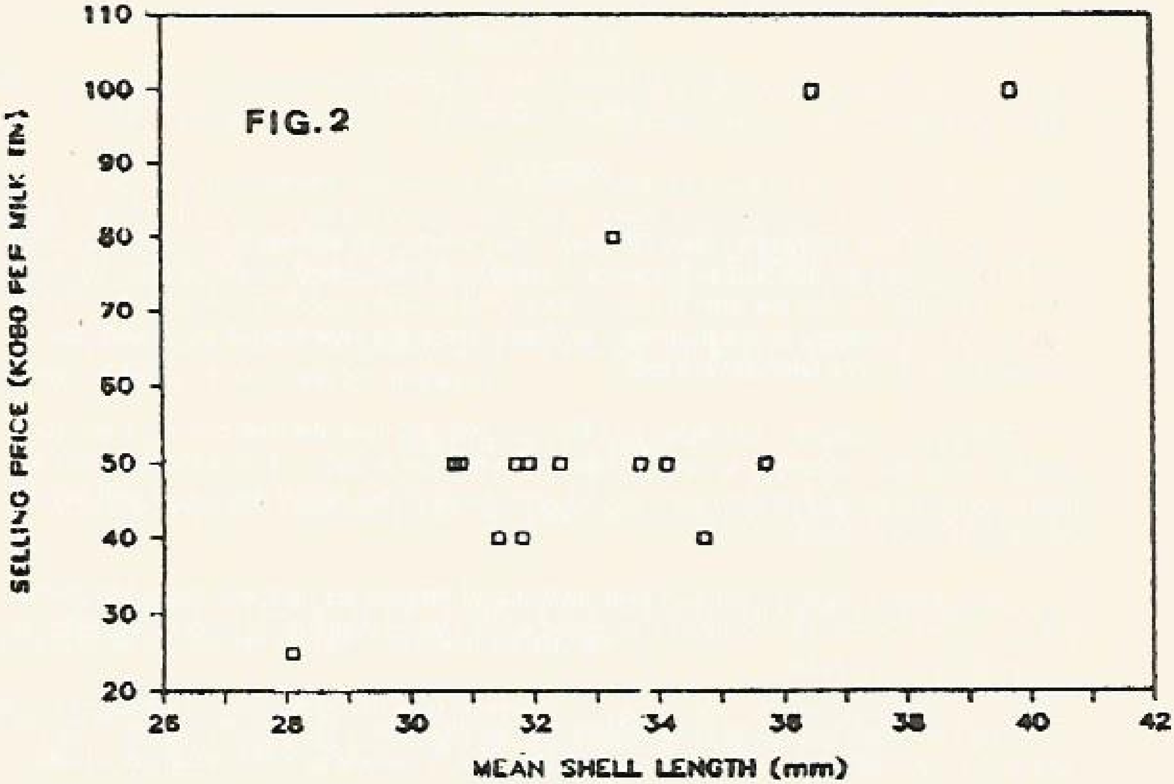


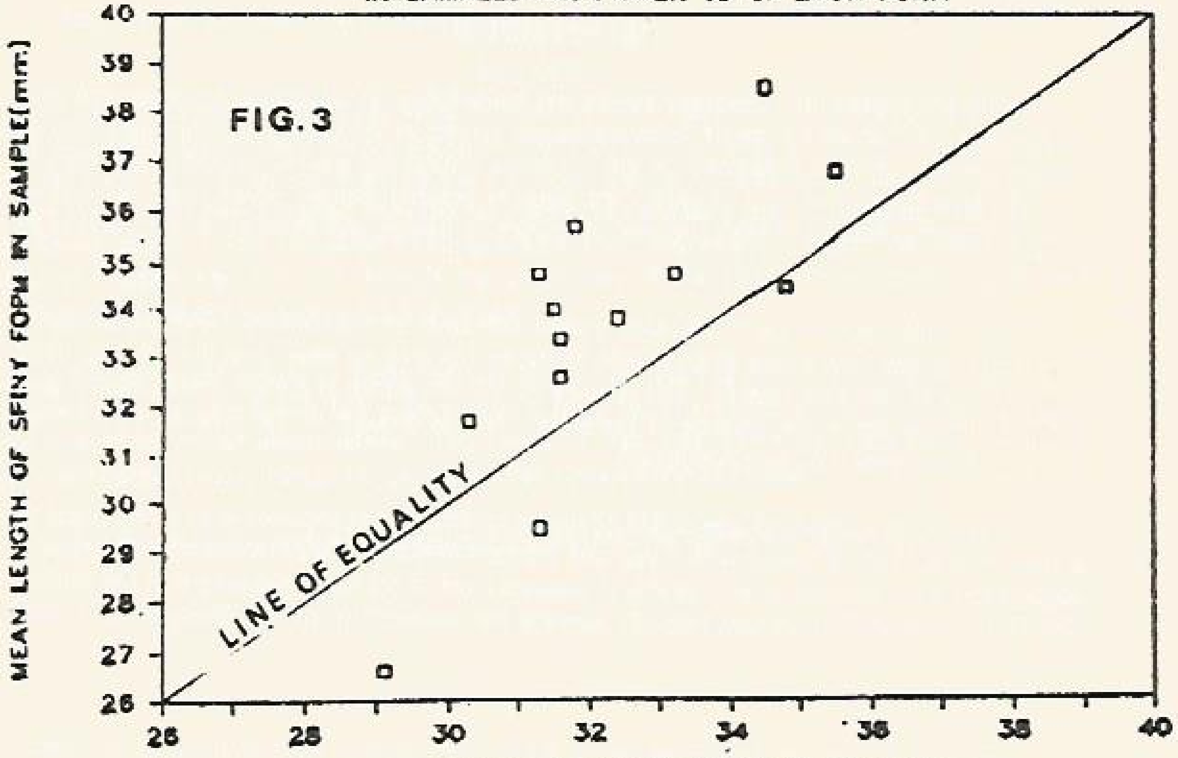
FIGURE 1.

PERIWINKLE SHELL SIZE vs FLESH PRICE



MEAN LENGTH OF EACH FORM WITHIN SAMPL

IN SAMPLES WITH OVER 15 OF EACH FORM



DEMAND FOR FISH IN CALABAR CROSS RIVER STATE, NIGERIA

By

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ABSTRACT

It is generally recognized from the food balance sheet prepared by experts (NADC, 1972, FAO, 1955; Oyenuga, 1967) that Nigeria is a protein deficient country. Not only is the daily intake of protein low but the contribution from animal sources is extremely low. Fish has been found to be the cheapest source of protein in Nigeria hence the consumption of fish will supply the needed protein at a relatively low cost.

The study, conducted in Calabar in 1981, was analysed using stepwise ordinary least square multiple regression technique as well as Pearson correlation analysis. The regression result was used to generate some demand curves for different levels of per capital income, as well as own price elasticity of demand.

The results show that both own price elasticity of demand for fresh and frozen fish decreased as the level of per capital income increased while income elasticity of demand increased as per capital income increased.

The calculated per capital consumption was found to be 5.18 kilograms and 4.31 kg per annum for fresh fish and frozen fish respectively. This is considered rather small since Calabar is a sea port where fish should be more readily available.

The values of own price and income elasticities indicate that more fish will be consumed at every increase in income if both production and marketing are improved.

INTRODUCTION

With the context of widespread hunger and malnutrition in developing countries, the greatest problem is that which results from inadequate protein in the diets of a large proportion of the population. Protein deficiency results in various clinical and sub-clinical conditions such as reduced growth rate and poor physical (and possibly reduced mental) development in children and adolescents, impaired health, reduced resistance to disease and lowered working ability in adults.

Fish holds the promise of reducing protein deficiency in the country. A casual survey in any market at any time shows that the cost of frozen fish is by far lower than that of other meat – and fish is of very high quality. The reliance on fish as a source of protein is even more accentuated following the recent episode of rinderpest and the drought in the Sahelian zone which considerably reduced the cattle population.

Nigeria with a total land area of 923.42 square kilometers and endowed with a long coastline – a good area of inshore waters with a vast and intricate network of water system which actually support fish (3) production should be able to produce most of the fish requirements of the citizens The Third National Development Plan (2), asserted the development of the fishery industry will:

(a) eliminate the present foreign exchange drain which is used to import fish for domestic consumption and release such funds for development needs;

(b) earn foreign exchange by exporting products like shrimps which are in high demand in the world market;

(c) encourage the local manufacture of fish products such as fish meal and dehydrated fish which are at present being imported;

(d) provide employment to more Nigerians either directly or indirectly through such activities as boat building, net making, thus boosting the economy through the multiplier process.

Demand is a multivariate relationship. Some of the most important determinants of the market demand for fish (or any other product) are its own price, consumers' income, prices of other commodities, consumers' taste and preferences, income distribution, total population, consumers' wealth, credit availability, government policy, past levels of demands and income.

However, only four of the determinants of demand-prices of the commodity, other prices, income and tastes are emphasized in this study.

Objectives of the Study

Fish competes with meat and poultry for consumers' income and a place in the consumers' meal.

The objectives of this study are to identify the effects of beef, goat, per capital income and prices on the demand for fish. Specific objectives are:—

(a) To identify the relationship (if any) between the quantity of fresh and frozen fish consumed and their prices, quantities of beef and goat consumed and consumers' income.

(b) Calculate own price elasticity of demand and income elasticity of demand for fresh and frozen fish and show their market implications, and

(c) Make suggestions for improving the marketing and distribution of fish to satisfy the existing demands and stimulate new demands for fish.

METHOD

The data used for this study were collected in 1981 from primary and secondary sources. The secondary sources were mainly the Department of Fisheries, Calabar, the Veterinary Division of the Ministry of Economic Planning and Statistics, Calabar. The estimated values of beef and goats slaughtered were obtained from the records of the Veterinary Division, Calabar. The monthly figures obtained were converted to kilograms by using dressing percentages. The 1981 population of Calabar was obtained through the projections of the 1963 national census figure for Calabar using the growth rate of 2.5% per annum.

The estimated values of fresh fish was that of the catches of fish in Calabar area. The primary data for the frozen fish were collected from the major cold stores in Calabar through the use of structured questionnaire. The values of fresh and frozen fish were divided by the estimated population to obtain the per capital fish consumption in Calabar.

The per capita disposable income was obtained from the 1980 World Bank Atlas.

RESULTS

The demand models used for the analysis are as follows: –

1. For fresh fish
   $Qff = f(pff, Qbf, Qgt, Y, ei)$ .. .. (1)

2. For frozen fish
   $Qf_z = f(Pf_z, Qbf, Qgt, Y, ei)$ .. .. (2)

Where: Qff = Quntity of fresh fish consumed

Qf_z = Quantity of frozen fish consumed

Pf_z = Retail price of frozen fish

Qbf = Quantity of beef

Qgt = Quantity of goat meat.

Y = per capita disposable income

ei = disturbance term

The disturbance term is assumed to be normally distributed. The independent variables are assumed to be non-serially correlated hence problem of multi-collinearity is assumed to be minimal.

Pearson Correlation

The initial analysis was done with the help of a Pearson correlation run. The correlation coefficients for fresh and frozen fish respectively are as shown in Tables 1 and 2. Table 1 shows the correlation matrix using the data collected for fresh fish while Table 2 shows that for frozen fish.

Table 1 – Correlation matrix using fresh fish data

	Qff	*Pff*	*Qbf*	*Y*	*Qgt*
Qff	+ 1.00000				
Pff	– 0.31204	+ 1.00000			
Qbf	– 0.16389	– 0.20120	+ 1.00000		
Y	+ 0.16583	– 0.01669	– 0.04093	+ 1.00000	
Qgt	– 0.40616	– 0.29331	– 0.16463	– 0.08018	+ 1.00000

Going through the correlation matrix, some inferences can be made: –

1. The sign exhibited between the per capita income (Y) and quantity of fresh fish (Qff) show that fresh fish is a normal good.

2. The relationship obtained between Quantity of fresh fish (Qff) and price of fresh fish (Pff) exhibited a ***priori*** expectation. As the price of fresh fish falls, the quantity consumed of fresh fish increases. The demand curve will have a negative slope conforming to the law of demand.

3. The relationship obtained between fresh fish and goat meat and between beef and goat meat also exhibited *a priori* expectations. The pairs are substitutes.

4. The coefficients also show that the degree of multicollinearity among the variables was low and negligible. As Johnston (1963)[7] explained, multicollinearity is the general problem which arises when some or all of the explanatory variables in a relation are so highly correlated one with another, that is becomes very difficult if not impossible, to disentagle their separate influences and obtain a reasonable precise estimate of their relative effect.

Table 2 – Correlation matrix using the frozen fish data

	Qf_z		Qf_z	Qbf		Y		Qgt
Qfz +	1.00000		–	–		–		–
Pf_z +	0.16916	+	1.00000	–		–		–
Qbf +	0.38317	+	0.20931 +	1.00000		–		–
Y +	0.22859	+	0.82234 +	0.17137	+	1.00000		–
Qgt +	0.38740	+	0.13534 +	0.09641	–	0.09641	+	1.00000

Most of the insights postulated from Table 1 still hold in Table 2. Degree of multicollinearity is low and negligible among the variables except between Pf_z and Y (i.e. price of fish and income).

Frozen fish and goat meat are substitutes; while goat meat and beef are normal goods.

Multiple Regression Result

There was further analysis of the data through the stepwise multiple regression, using the Ordinary Least Squares (OLS) method. The linear equation was derived from the fresh and frozen fishconsumed. In both equations the figures in parenthesis represent the estimated standard errors of respective regression coefficients.

3. $$Qff = 262935.77598 - \underset{(9.25365)}{25.45984}\ Qgt$$

$$14847.77192\ Pff - 0.07622\ Qbf + 15.2960\ Y$$
$$(6182.49483) \quad (0.99028) \quad (24.30273)$$

$R^2 = 0.61784$

$R^2 = 0.38173$

$F = 2.93271$

4. $$Qf_z = 57197.37660 - \underset{(2.27224)}{4.19193}\ Qgt - \underset{(3589.46412)}{2170.32681}\ Pf_z$$

$$+ 0.377798 + 10.31322\ Y$$
$$(0.21903) \quad (11.15332)$$

$R^2 = .30455$

$R^2 = 0.15814$

$F = 2.08015$

At 5 per cent level of significance in equation 3, quantity of goat meat (Qgt) demanded and price of fresh fish were significantly different from zero.

In equation 4, the only variable which was significantly different from zero at the chosen 5 per cent level of significance was Qgt i.e. quantity of goat meat demanded.

In equation 4, quantity of goat meat demanded and price of fresh fish have negative regression coefficients. This shows that, as the quantity of goat meat available in the market decreases, the quantity of frozen fish demanded increases. Quantity of beef demanded and per capita income show positive relationship with quantity of frozen fish consumed. However, the coefficients of the two variables turned out to be insignificant.

In equation 3, only per capita income show positive relationship with quantity of fresh fish consumed. All other variables have negative regression coefficient and therefore show negative relationship with quantity of fresh fish. Of the variables, only the coefficients of Qgt and Pff turned out to be significant as mentioned earlier.

The F value of equation 3 is significant while that of equation 4 is not significant at the 5 per cent level of significance.

The variables in equation 3 explain about 38 per cent of the variability in fresh fish consumption.

The variables in equation 4 explain about 16 per cent of the variability in frozen fish consumption.

Equation 3 (the fresh fish model) was used to generate a family demand curves shown in Figure 1. Each curve presents a level of per capita income. For this study, the level of per capita income used ranged between ₦150.00 and ₦900.00.

Demand curves would have been generated for frozen fish but for the fact that the F value was not significant.

The demand curve for the fresh fish was used to calculate own price elasticity of demand (PED).

Keeping other variables at their arithmetic mean, the elasticity was calculated for various levels of per capita income.

Table 3 shows the own price elasticity of demand (PED) for fresh fish.

Table 3 – Own price elasticities of demand for fresh fish at different per capita incomes

Income (₦)	*PED at P = ₦2.90/kg*
150.00	–0.9978
400.00	–0.9443
548.86	–0.8777
900.00	–0.7932.

Source: Computation from survey data.

Equation 3 was also used to calculate income elasticity of demand (IED) for fresh fish

Table 4 – Income elasticities of demand for fresh fish at different per capita income

Income (₦)	*IED at P = ₦2.90/kg*
150.00	0.0434
400.00	0.1268
548.86	0.1588
900.00	0.2463

Source: Computed from survey data.

DISCUSSION

Figure 1 shows the generated family of demand curves for fresh fish. Each curve represents a particular per capita income. The demand curve for any commodity shows the relation between the price of that commodity and the quantity the consumers wishes to purchase.

The demand curves generated in this work was drawn at the arithmetic mean of the explanatory variables (that is per capita income, quantity of beef and goat).

The fresh fish demand curves are downward sloping. This indicates that the lower the prices of fresh fish, the greater will be the quantity that the consumers are willing to purchase. From Figure 1, when the retail price of fresh fish is ₦2.00 per kilogram, per capital consumptions are 5.90 kilogram/annum, 6.25 kg/annum, 6.60 kg/annum, and 7.05 kg/ annum for per capita income levels of ₦150.00, ₦400.00, ₦548.86 and ₦900.0 respectively. When the prices rises to ₦2.90 per kilogram, per capita consumption falls to 4.49 kg/annum, 4.85 kg/annum, 5.14 kg/annum and 5.70 kg/annum at income levels of ₦150, ₦400, ₦548.86 and ₦900 per annum respectively. If the price of fresh fish falls, consumers will now purchase more of them and less of their substitutes (beef goat). The above results show that at any price level, as per capita income increases the per capita consumption of fresh fish increases. This is true of most low income countries. In high income countries, per capita income has comparatively less impact on food consumption levels than in low income countries. The physical quantity of all food consumed per person is relatively fixed in high income countries. In low income countries, with a rise in income, there is a marked increase in the demand for fish. Consumer substitute proteinous foods for starchy foods For low income groups in high income countries, the situation is similar.

The arithmetic mean price of fresh and frozen fish for the period covered by this study (1981) was ₦2.90 and ₦1.18 per kilogram respectively. Arithmetic mean per capita income was ₦548.86.

At the arithmetic mean of all the explanatory variables (i.e. price of fresh fish, quantity of goat, beef and income), the estimated per capita consumption was 5.18 kilogram and 4.31 kilogram per annum for fresh and frozen fish respectively. This is equivalent to 14.20 grams and 11.80 grams per day respectively. When this is seen from the point of view that Calabar lies in the zone infected by tsetse fly which causes sleeping sickness on cattle, and also that Calabar is a sea port and fish is very important as the main source of protein, the per capita consumption of fish is low and gives some concern.

The multiple regression results exhibited some ***a priori*** **expectations. The relation between** prices of fresh and frozen fish, and their per capital consumption turned out to be negative one. This can also be observed in the generated demand curves. As the price of fish falls, more of it will be purchased. Of the two prices, only the price of fresh fish was significant at 5 per cent level of significance.

As the price of fish falls, the budget line of the consumer shifts to the right. This is due to the increase in the purchasing power of the given money income of the consumer. More fish will be bought because of the increase in purchasing power. There is a negative price effect.

Both fresh and frozen fish are normal goods. This is because there is increase in demand as per capita income increases. The regression results also show this. Per capita consumption of fresh and frozen fish show a positive relation with income. At the 5 per cent level of significance, per capita income is not a significant explanatory variable.

The regression result for fresh fish shows that goat meat is substitute to fresh fish. Consumers can shift from goat meat to fish if the price of fish falls relatively to those of its substitutes. At the 5 per cent level of significance, the coefficient of goat meat is significantly different from zero.

The variable Qgt is significant at the 5 per cent level of significance in the frozen fish regression result. The result shows that goat meat and frozen fish are substitutes. Beef and frozen fish are not substitutes. The correlation matric table also shows a similar relationship between frozen fish with goat meat.

The correlation matrices in Table 1 and 2 confirms the findings exhibited by the regression result. Fresh and frozen fish are normal goods since per capita consumption of fresh and frozen fish were found to rise as their prices fall.

The estimated income elasticity of demand shown in Tables 3 are both positive and increasing with increase in per capita income level. Income elasticity of demand increases from 0.1268 to 0.2463 as per capital income increases from ₦400.00 to ₦900.00.

The estimated income elasticity was found to be greater than zero but less than one. That is, demand for fresh fish rises by a smaller proportion than does income.

Income elasticity of demand can be used to classify goods into 'luxuries' and "necessities" A commodity is considered to be a luxury if its income elasticity is greater than unity. A commodity is considered to be a necessity if its income elasticity is less than one. From this classification, fresh fishes are necessities in Calabar.

Own price elasticities of demand for fresh fish are shown in Table 3. Own price elasticities of demand for fresh fish decreases as per capita income increase. It is decreasing from 0.9978 to 0.7930 as income increases from ₦150.00 to ₦900.00 for fresh fish.

The price elasticity of demand is a measure of the responsiveness of demand to changes in the commodity's own price. In this work, demand is inelastic for fresh fish.

SUMMARY AND CONCLUSIONS

Both own price elasticity of demand for fresh and frozen fish were each a statistically significantly explanatory variable of per capita consumption of fresh fish.

Arithmetric mean price of fresh fish was ₦2.90 per kilogram. Arithment mean price of frozen fish was ₦1.18 per kilogram. Arithmetic mean per capita income was ₦548.86.

Estimated per capita consumption was 5.18 kilogram per annum (14.20 gram per day) and 4.31 kilogram per annum (11.80 gram per day) for fresh and frozen fish respectively. This is small since Calabar is a seaport and also infested by tsetse fly. Even the Northern Nigeria that has comparative advantage in cattle production, the outbreak of rinderpest is causing a lot of havoc to cattle production necessitating alternative protein sources.

The per capita fish consumption was found to be low. This calls for ways of improving the supply of fish to the market. Both the State Government and the Federal Government could do a lot here. Programmes like the National Accelerated Fish Production Programme presently sited at Uta Ewa, Ikot Abasi Local Government Area of Cross River State and some parts of the country could be used in Calabar to improve supply of fish.

Other ways of improving fish supply include the introduction of improved fishing equipment: and methods. Instead of mannually paddled canoe, all fishermen should be introduced to engine canoe or boat. Better handling of catches to reduce losses through spoilage could also improve fish supply.

The values of own price elasticities and income elasticities indicate that more fish would be consumed at every increase in income especially if both production and marketing are improved. The marketing system where prices are decided by merely looking at the fish or at times the mood of the fish seller, could bring distrust between buyers and sellers. Weighing could be introduced so that prices are fixed per weight but this would need to be extensively policed to beeffective.

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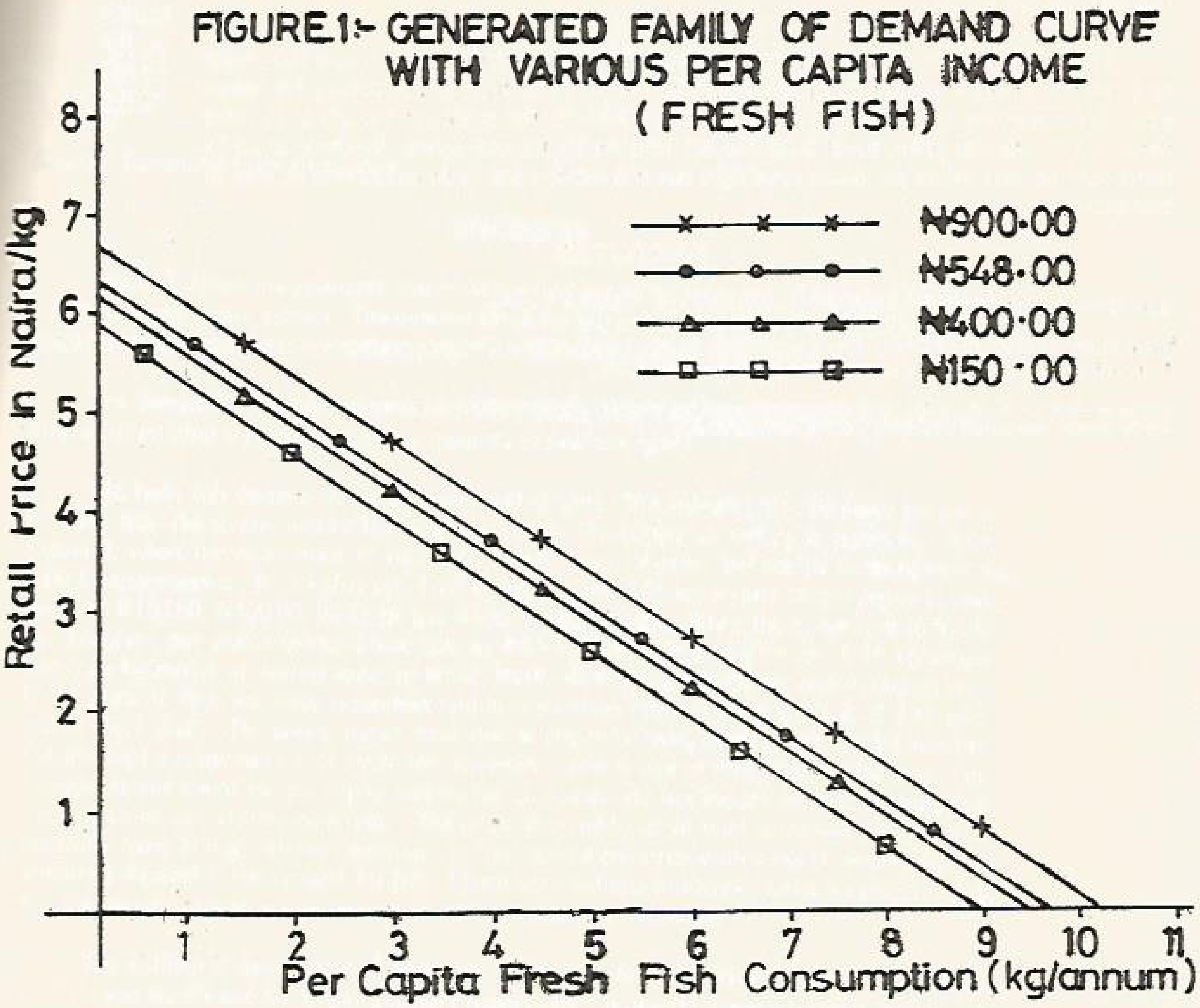
FIGURE.1:- GENERATED FAMILY OF DEMAND CURVE
WITH VARIOUS PER CAPITA INCOME
(FRESH FISH)
₦900·00
₦548·00
₦400·00
₦150·00
Retail Price in Naira/kg
Per Capita Fresh Fish Consumption (kg/annum)
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
11

THE ROLE OF OCEANOGRAPHY IN FISHERIES RESOURCES EXPLOITATIION.

By

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ABSTRACT

The 800 km coastline of Nigeria is a huge gateway to a supply of food and raw materials. But while the immense fishery recource is perceived by many, its full exploitation is obstructed by how little we understand of the ocean processes necessary for effective utilisation. Much basic oceanographic research is needed as a prerequisite to evolving successful strategies for full application of Nigeria's marine fisheries resources.

INTRODUCTION

Nigeria has an 800 km long coastline. This is a vast gateway to a supply of food, energy and mineral resources in Nigeria's Exclusive Economic Zone (EEZ) that will be critical to the economic development of the country (Bayagbona, 1979, Wise and Ajayi, 1981; Amadi, 1982 Ibe, 1982a; 1982b; Ibe *et al*, 1983; Tobor, 1984 among others).

The effective exploitation of these resources would depend largely on the understanding of the physical, chemical, geological and biological systems in our ocean. The study of these systems in the ocean is embodied in the science of oceanography. This paper, because of the theme of this Conference, would be limited to a discussion of the role of oceanography in bringing about the full utilization of Nigeria's marine fisheries resources.

For brevity, such contribution would be examined under the four broad divisions of Oceanography - viz, Physical - Biological - Chemical and Geological Oceanography; for clarity, examples would be drawn from work being done at the Nigeria Institute for Oceanography and Marine Research (NIOMR).

PHYSICAL OCEANOGRAPHY

A resolution of the physical oceanographic characteristics of Nigeria's EEZ is vital to improved fisheries resources exploitation.

Temperature which is one of the most studied physical parameters of the ocean is known to affect the abundance, availability and distribution of fish. Figure 1 summarises the pathways for such effects.

Salinity is not as regulatory as temperature but even then, it affects the osmoregulation and development of the eggs of fish; the quantity of future stocks therefore depends, at least in part, to the effects of salinity.

Temperature, salinity and pressure (depth) also affect marine fisheries exploitation through their effect on sonars used in finding fish. Because sonar speed in sea water depend on these physical parameters, a precise knowledge of their values and distribution aids in the accurate interpretation of echoes during fishing and fish resources survey.

Basic information on bathymetry and ocean dynamics such as the height, length, and frequency of waves. the nature of tides and the currents generated by these two phenomena, not only influence the movements and distribution of some fish but are necessary inputs to the design, construction and operation of fishing gear and vessels. A better understanding of these physical processes, would make fishing more efficient and therefore, enhance the effective exploitation of marine fisheries resources.

On ocean dynamics, currents are of particular significance because of their impact on fish stocks. Such impact is greatest in the egg and larval stages. As emphasised in Laevastu and Hayes (1978) currents have the ability to transport pelagic fish eggs and fry from spawning areas to nursery grounds and from there to feeding grounds. The implication is that any deviations from this transport pattern can cause diffferences in the survival of any given year brood. It is also known that migration of adult fish follows established ocean current circulation patterns (which also affect the regeneration and mobility of nutrients) and thus the knowledge of abundance and distribution of any given species could be inferred if the current circulation patterns in the area are known.

The programme in Physical Oceanography at NIOMR has been designed to provide information on the physical parameters and processes of the ocean including the nearshore region. Coincidentally, some of the physical processes are responsible, in part, for coastal erosion and are being investigated as a parrallel programme to that on coastal erosion. Some of these results for the nearshore area at Forcados offshore of which is a viable fishing ground, are presented Table 1. Also, a graphical summary of beach surface water temperatures and salinities at Victoria Island for 1978-1981 (after Oyewo et al, 1982) is presented in Figure 2 as an indication of NIOMR's effort in this direction. There would be great practical advantage if we are able to predict these variations from an understanding of previous records.

CHEMICAL OCEANOGRAPHY

The primary objective of this field of Oceanography is to assess the water chemistry of the ocean as an indication of marine environmental quality with a view to providing information for the intelligent management of the fisheries resources in the Nigerian Ocean.

The basic approach in this programme is to assess the level of pollutants in the marine environment that affect marine water quality and by implication influence the kinds, abundance and distribution of marine organisms including phytoplankton, zooplankton, fish and the benthic invertebrates.

The programme in Chemical Oceanography at NIOMR has as some of its objectives:–

(a) to sample and analyse brackish and marine waters, fish and shellfish and other aquatic organisms of commercial importance for the presence, concentration and organ distribution of such potential pollutants as petroleum hydrocarbons (including oil dispersants) industrial/trade wastes (including heavy metals), domestic wastes (including human wastes) and pesticides;

(b) to conduct both short term acute toxic tests and long term chronic tests on some marine fishes or shell fish of commercial importance in order to evaluate the impact of identified pollutants on the behaviour, reproduction and physiology or such commercially important organisms in the marine environment;

(c) to use the knowledge gained from the data obtained to provide important bench mark information to the Government for the purpose of enacting policies for the protection of the aquatic environment and its living resources.

Chemical Oceanography, in emphasing marine environmental quality through the identification of these elements and compounds that have deleterious effects on marine life, ensures the survival and flourishing of fish stocks and other marine organisms of commercial significance.

BIOLOGICAL OCEANOGRAPHY

The main thrust of this field of Oceanography is the determination of potential marine resources. The emphasis is therefore, on stock assessment through resources survey. Key aspect of this programme is the study of the physiology and ecology of marine organisms as a key to understanding the abudance and distribution of fish and other commercially important marine life. The study includes the determination of factors that control their survival, reproduction and growth. But successful fishing depends not so much on the size of fish stocks as on their concentration in space and time (Holt, 1977). Biological Oceanography therefore, seeks to define such concentrations - for example where fish gather, to feed or to reproduce, or where they are *on the move in streams or schools. In so doing catch rates as related to effort will be improved.*

At NIOMR, the programme on primary productivity is a very important aspect of Biological Oceanography. The "pastures of the ocean" must be understood because, through the food chain, they are indicators of availability of fish stocks. Large stocks of pelagic fish are associated with

the occurrence of primary production (upwelling); the resulting phytoplankton blooms are followed by herbivorous zooplankton that provides 'forage' for large schools of fish. It is therefore, important to understand the details of causes, timing and scope of upwelling in the Nigerian marine environment in order to take advantage of the large stocks of fish associated with this phenomenon (Ibe and Ajayi, in press).

An adjunct programme to the field of Biological Oceanography is that in Aquaculture/ Mariculture. The primary objective here is to try to improve on nature by breeding, rearing and managing fish, shellfish and other marine life of economic importance and cultivating their pasture. Although, it is recognised that fish farming on a large scale would certainly boost fish production in Nigeria, the main handicap in promoting this sector of fishery, is the inadequacy of fishseeds fry/fingerlings). Research at NIOMR in this field is directed at increasing the availability and supply of fish seeds of culturable species through controlled breeding on a large scale and collection from nursery beds identified along the coastal waters and major rivers emptying into the sea (Ezenwa, 1984).

The ultimate objective of Biological Oceanography is to ensure that marine fishery is efficiently exploited and also conserved.

GEOLOGICAL OCEANOGRAPY

Investigations in this field are of fundamental importance to the exploitation of marine fisheries. First the bathymetric information derived from this study is required in ship and gear design and construction.

Successful fishing operations depends in part on knowledge of the kind of ocean bottom frequented by specific fish and on the avoidance of hilly bottoms that can entagle and tear nets. Defining bottom topography and lithology therefore, aids the fishing industry in the accomplishment of its goals.

The study of the mineral dispositions in the marine environment also aids in descriminating between natural and authropogenic inputs of metal pollutants and by so doing provide basis for the formulation of appropriate clean up action when necessary.

Even a programme such as beach erosion has implications for fisheries because first, the sediments and, subsequently, turbidity generated greatly reduce light penetration in coastal waters which affect directly or indirectly the abundance and distribution of fish and other marine organisms in such waters.

CONCLUSION

A rational exploitation and full utilisation of Nigeria's marine fishries hold a lot of promise in meeting the nation's future food requirements. This, however, depends on how well we understand the complex and dynamic relationship between the living resources we seek to tap and their environment (the ocean). The science of oceanography holds the key to such an understanding.

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WATER TEMPERATURE

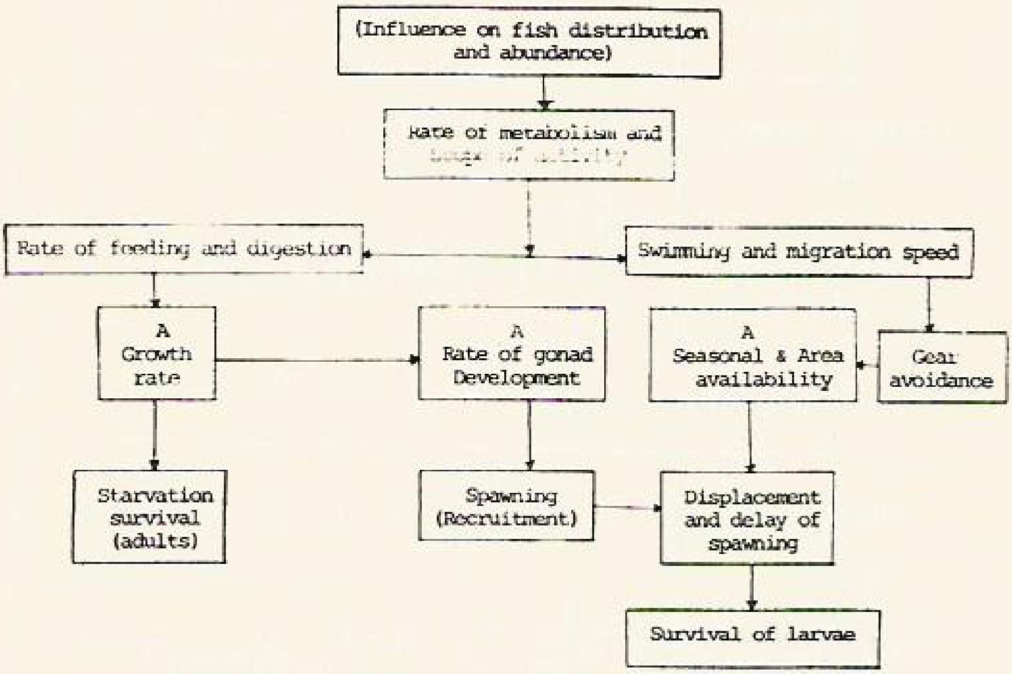

Figure 1 - Schematic presentation of the effect of water temperature on the abundance, availability, and distribution of fish. Subjects marked with A are those where year-toyear anomalies occur.

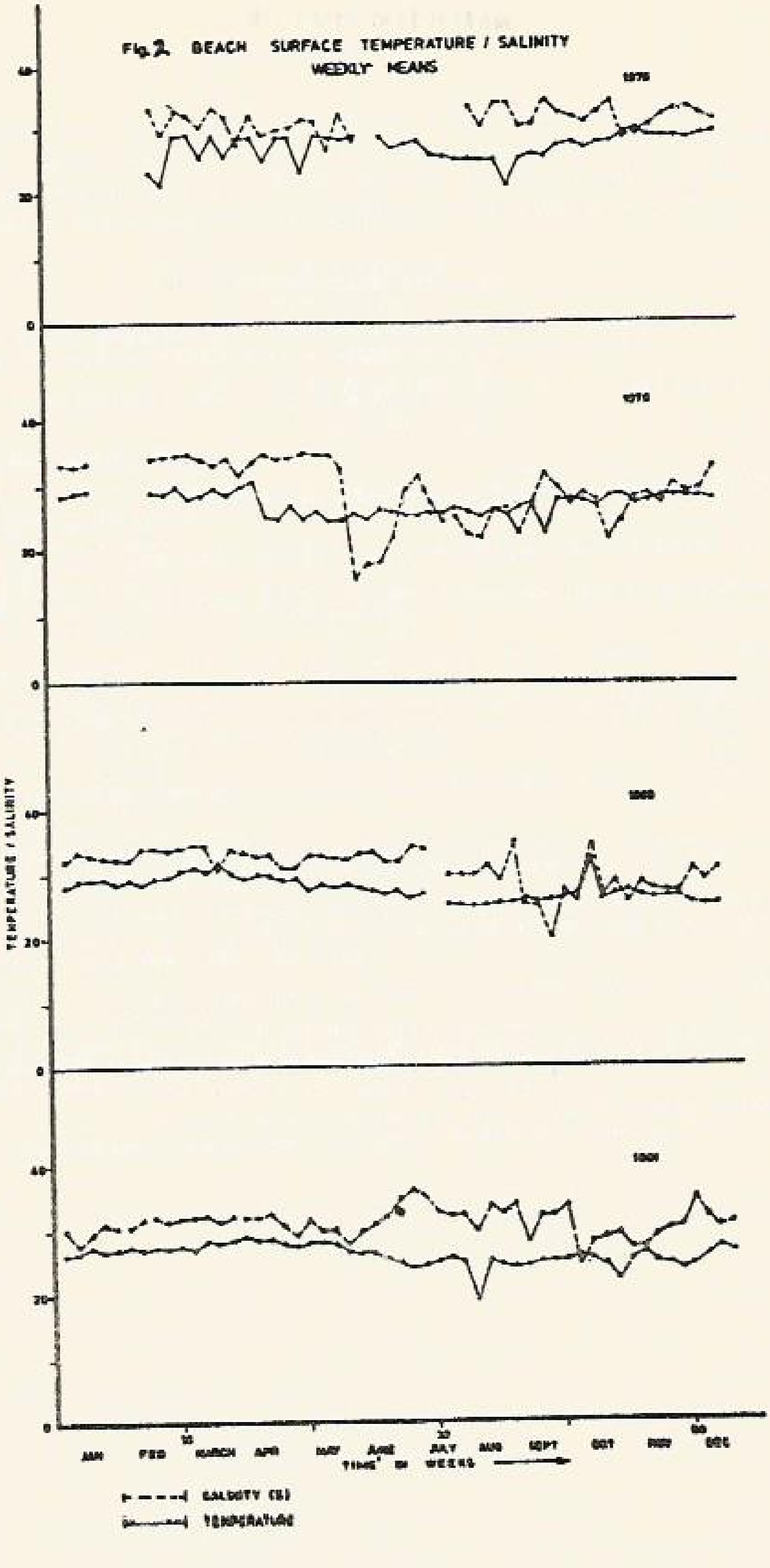
Fig. 2 BEACH SURFACE TEMPERATURE / SALINITY
WEEKLY MEANS
TEMPERATURE / SALINITY
JAN
FEB
MARCH
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
TIME IN WEEKS
SALINITY
TEMPERATURE

Table 1 – Littoral Environment Observations: Forcados Beach

Period	Breaker Type Spilling: Plunging %	Breaker Height Cm	Water Depth Cm	Period Secs	Wave Inclination X^o	Wind Speed (mph)	Wind Direction ^oX	Longshore Current m/s	Longshore current Direction.	Air temperature oC	Water temperature ^oC	Salinity.
February 1983	No Readings									No Readings		
April 1983	60/40	64	56	12	05	9.5	228	0.42	N	–	–	–
May 1983	90/10	66	56	10	7	10	210	0.61	N	–	–	–
July 1983	65/35	120	92	06	10	8	235	0.29	N	30.5	28.9	–
August 1983	80/20	109	87	08	09	9.0	250	0.54	N	27	26.7	31,2
September 1983	.70/30	90	82	6.5	13	9.5	230	0.57	NW	–	–	–
October 1983	95/5	84	102	9.5	08	9.5	220	0.63	N	29.4	28.5	32.1
November 1983	85/15	57	83	15	05	7.5	250	0.43	NW	30	28,3	33.2
January 1984	90/10	74	103	10	03	6.5	235	0.27	N	29.8	28.7	33.7

REVIEW AND APPRAISAL OF FISHERIES DEVELOPMENT EFFORTS IN NIGERIA.

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ABSTRACT

The paper reviews the various fisheries development plans from 1962 to 1985 and highlights major constraints in the development of the Nigerian fishing industry. The objectives of the plans are summarised together with policy measures formulated to achieve them. Major achievements of the plans, causes of failures to achieve plan objectives are given. Recommendations to improve formulation of future plans are summarised.

INTRODUCTION

The fishing industry in Nigeria before the second world war (1939–1945) was largely artisanal using indigenous crafts and gear particularly in inland waters creeks lagoons and brackish waters. The sea was unexploited for commercial fishing.

It was not until 1942 (because of dislocation of imports from Europe due to the war) before the Nigerian government made the first attempt to develop her fisheries Longhurst (1961). The first step in this direction was to make an institutional arrangement by establishing a Fisheries Development Division under a Department of the Ministry of Commerce and Industry. The division was charged with the responsibility for carrying out trawling surveys off Lagos and the Camerouns. The importance of the role of fish culture in fish production was recognised and a start made by stocking ponds and reservoirs at many places throughout Nigeria. At the same time an experimental Panyan fish farm was constructed between 1951–54

By 1953 under a new Constitution fisheries organisation in Nigeria was split between Federal and Regional governments. Fisheries development was made solely a regional responsibility while research was concurrent, implying that both the Federal and regional governments were equally competent to engage in it.

The above position which has not much changed has the disadvantage that research efforts are duplicated between the States and Federal governments as testified by Federal and States projects in the four development plans from 1962 to 1985. Summaries of each of the plans and major achievements will now be considered.

FIRST NATIONAL DEVELOPMENT PLAN

The first development plan placed emphasis on marine fisheries, fish farming, manpower development at lower levels fish preservation, Lake Chad, Kainji Lake and riverine fisheries as well as the establishment of inshore infrastructures.

Major projects in the above areas included a systematic hydrological and hydrobiological survey of Nigeria's coastal water, intensive training of fishermen by establishing a training school in Lagos, experiments with refrigerated road and river transport and storage of fish throughout Nigeria.

In connection with marine fisheries, the construction of an integrated fishing harbour at a cost of £700,000 was planned. For Lake Chad fisheries, the construction of an all season road from Maidugri to Baga was planned to facilitate transportation of fish from the Lake to heavy consumer centres. Modern fishing techniques using modern equipment and improved methods of fish curing were to be introduced in Lake Chad. By then the most prominent craft was the Kadei built of papyrus and had a short life span, 3–6 months. Nets were made of natural fibres.

The Panyan fish farm was to be used for experimental fish culture and breeding purposes.

ACHIEVEMENTS

A notable achievement in the First Plan was the establishment of the Federal Fisheries School in 1969. The school has grown from mere offering of vocational courses to fishermen to its present state of offering courses in a wide range of disciplines including engineering, nautical science and fisheries leading to the award of the Higher National Diploma.

A major achievement was the establishment of a Fisheries substation at Malamfatori and the development of Lake Chad fisheries.

Superior man-made netting materials e.g. nylon, replaced natural fibres. Effective hanging ratios for gillnets with high catching efficiency were introduced. The Kadei was replaced by well constructed fishing boats and motorisation of fishing boats was introduced to increase their range of operation in the Lake. The use of salt in fish curing was introduced in a package deal as incentive to fishermen. The package involved the provision of fishing boats, nets and accessories and out board engines to fishermen in groups of 4–6 members. Fishermen paid back the costs of their facilities in instalments from the proceeds of their catches. Complete repayment took 3–5 years after which the facilities became the property of the fishermen. Fishermen operated the loan scheme on the understanding that they would cure their fish by salting.

Various smoking kilns were designed and constructed by FAO experts and fishermen encouraged to use them.

The Malamfatori station which was an outstation of the Federal Department of Fisheries eventually became the present Lake Chad Research Institute.

Another achievement was made in the systematic survey of the shrimp resources in the inshore waters which resulted in the commencement of Commercial shrimp fishing before the Plan came to an end in 1966.

The failure to construct the integrated fishing harbour was a major set back to the early development of industrial fisheries in Nigeria. Nevertheless by 1968 major species of fish in the inshore waters (0 50m) had been identified and their bathymetric distribution in relation to the position of the thermocline determined. Knowledge of the extent of the continental shelf and the relatively low productivity of the inshore waters also became available.

SECOND NATIONAL DEVELOPMENT PLAN, 1970–1974

The main thrust of the second plan was to restrict the importation of fish and increase domestic production estimated then as 120,000 tonnes representing 12% of demand. Imports of fish totalled 150,000 tonnes (17% of demand), giving a total available fish of 270,000 tonnes against the demand of 1 million tonnes.

The Plan therefore had as its major objective the exploration of Nigeria's fishery resources rapidly for substantial increase in fish production. It Considered the construction of a fishing terminal in Lagos as a prerequisite for achieving this objective. Such a terminal was to provide facilities for the development of marine fisheries, foreign fish landings and the growth of a potential valuable export of fish and fishery products. The plan anticipated that a fishing terminal would encourage increased landing of fish by chartered distant water trawlers. By this, the Plan was indirectly discouraging local production of fish by Nigerians.

The Plan identified the following problems as being responsible for very poor yields in fish farming.

- little research into the best species combination ideal for particular environments.
- lack of optimum stocking rates.

- lack of knowledge in fertilizer and feeding combinations
- few training programmes for fish farmers.

There were no concrete plans to solve the above listed problems. The plan merely stated that efforts would be made to explore the possibility of increasing the yield of fish ponds in various states.

As in the first plan the need for fish preservation was recognised. There was therefore a proposal to introduce fish smoking and drying kilns to rural fishermen. This was to be achieved by organising rural fishing communities into cooperatives and encouraging them to build processing kilns. Not much achievement was made in this direction as fishermen still use traditional kilns to smoke their fish.

A major advance made by the second plan was in the direction of fishery administration in Nigeria. Fishery legislation was the responsibility of individual state governments and fishery research was and still is a concurrent subject in the Constitution. The former particularly created a number of problems including lack of policy coordination, duplication of research, and research interests not being necessarily related to visible development needs.

It was therefore decided in the plan to take steps to control policies relating to fishery research by making the Federal Government, through the Federal Department of Fisheries, administratively responsible for all fishery research and training. Little achievement was made as states still carry out their own fishery research and training. As of now some states have their own Fisheries Schools.

On fisheries development, the Federal Ministry of Agriculture and Natural Resources was to take appropriate steps to coordinate development of fisheries in the States. The success of this depended on the fact that the Federal Government made money available to states for development projects it approved.

ACHIEVEMENTS

Unlike the first plan, the second one produced no major achievements. The fishing harbour was not constructed, the major problems identified in fish farming remained largely unsolved at the end of the Plan, and fishery legislation remained the responsibility of individual states while fish preservation showed no marked improvement to reduce wastes. The highest fish production figure within the plan period was 473,220 tonnes in 1974 which represented only 47.32% of estimated demand of one million tonnes of fish.

THIRD NATIONAL DEVELOPMENT PLAN 1975–1980

The third plan which had a total national capital outlay of ₦101,554 million representing 4.6% of the total national investment in the agricultural sector was comprehensively written. It identified major constraints in the development of the fishing industry, identified development objectives and listed policy measures to ensure their effective implementation.

The constraints identified were as follows:–

- inadequacy of capital for fisheries development.
- lack of adequate fishing terminals and other infrastructural facilities.
- shortage of trained manpower at various levels.
- inadequate supply of inputs e.g. boats, outboard engines nets and accessories.

- poor communication network in the production areas and
- lack of effective fishermen organisations in the artisanal sector to assure success in obtaining government financial assitance.

The plan objectives were:–

(a) to increase domestic fish production with a target of 1.2 million tonnes by 1980.

(b) to earn foreign exchange by exporting products like shrimps.

(c) to encourage local manufacturing of fish products like fish meal and dehydrated fish.

(d) to provide employment to Nigerians especially young school leavers in the coastal areas and

(e) to increase the per capital income of indigenous fishermen.

Policy measures to implement the above objectives included:–

(a) grants and loans to fishermen cooperatives or individual fishermen to buy motorised boats.

(b) reducing or phasing out over a period of years fishing licences for chartering of trawlers.

(c) government participation in direct fish production through the Nigerian National Shrimp Company and the Nigerian National Fish Company. States were to be encouraged to participate in similar ventures.

(d) non establishment of fish farms built through excavation.

(e) concentration of efforts in applied research in the fields of fishery biology, fish processing, fishing technology and marine pollution.

PROGRAMMES

Programmes for the Third National Development Plan were designed to increase domestic fish production from 740,000 tonnes in 1975 to 1,190,000 tonnes in 1980. This was an increase of 60.81% over the 5-year period. There were also proposal to increase fish imports from 350,000 tonnes in 1975 to 450,000 tonnes in 1980. It was realised that self sufficiency in fish production was impossible during the life of the plan and the ever increasing deficit should be met by import.

The major areas of development were in:–

(a) artisanal fisheries composing coastal canoe fishery, brackish water canoe fishery, fresh water fishery in rivers and lakes.

(b) fish farming.
(c) fish processing and preservation
(d) fish marketing
(e) fish technology
(f) infrastructures
(g) research
(h) manpower training.

ARTISANAL FISHERIES

Under the development of artisanal fisheries, the Federal Government was to provide fishing boats and outboard engines, fishing nets and accessories and facilities for servicing engines to fishermen who were to be organised into 55 cooperative units each consisting of 60 fishermen. Each unit was to be provided 20 boats.

GRANTS, LOANS AND SUBSIDIES

There were special schemes designed to give grants, loans and subsidies to fishermen to enable them purchase modern fishing equipment (Federal Government, Benue Plateau, North East).

CONSTRUCTION OF COLD STORAGE COMPLEXES PROVISION OF INSULATED CONTAINERS AND REFRIGERATED VEHICLES

Governments involved in this included Federal, Benue Plateau, Lagos, South East, North-East and Mid West.

ESTABLISHMENT OF DEMONSTRATION FISH PONDS, ENCOURAGEMENT IN FISH FARMING, FISH FRY AND FINGERLING PRODUCTION IN HATCHERIES

Both the Federal and many States governments were involved in fish farming and its encouragement in rural areas. Hatcheries were to be constructed for production of seeds, and reservoirs were to be stocked with high quality fish seed (fry and fingerlings). (Federal, Benue Plateau, East Central, Kano, North Central, South East, Mid West).

MANPOWER TRAINING

The training of fishermen and the problem of acute shortage of trained personnel of the intermediate grade received the attention of the Federal and State governments. The Federal Government was to expand the facilities of the Federal Fisheries School in Lagos and establish a Fresh water Fisheries School in New Bussa. States involved in the training of fishermen were Benue Plateau, Lagos North West and Rivers.

DEVELOPMENT OF RIVERINE FISHERY INCLUDING INTRODUCTION OF TRAWL FISHING

Few states provided for riverine fishery development. They include East Central for the establishment of fishing gear demonstration units along selected rivers Kwara for the establishment of fisheries stations, along River Niger between Kainji and Jebba and development of trawl fishing down stream Lokoja to Idah.

MARINE FISHERIES

The projects of the Federal government included:–

– a scheme to introduce 50 medium - sized combination type commercial inshore vessels.

– commencement of deep sea operations by the Nigerian National Fishing Company.

The Mid-West State had a project to establish commercial fishing bases in Warri and Burutu and purchase trawlers to fish the inshore water resources especially shrimps. South East was also to undertake commercial coastal trawl fishery. The West was to build five trawlers for commercial trawl fishery.

PROVISION OF INFRASTRUCTURES FISHING TERMINALS

The Federal Government was to construct a distant water fishing terminal on Tin can Island in Lagos and undertake feasibility studies for coastal fishery terminals at Oron, Port-Harcourt, Koko, Aiyetoro Igbokoda.

The Lagos State proposed the construction of a fishing terminal in Badagry to provide facilities for landing 10,000 – 20,000 tonnes of fish and 1,300 tonnes of shrimps.

The Rivers State also proposed to establish a fishing terminal complex in Bonny for mooring and servicing of fishing vessels. There were to be seven sub terminals to facilitate the distribution of fish in the hinterland.

RESEARCH

The projects of the Federal Government for fishery research included:–

- purchase of a research vessel for long range investigations in deeper and more distant waters.
- development of a shallow water mechanized boat capable of beach landing.
- fish products developments based on low grade fish.
- construction of a live fish laboratory marine pollution.

States which had research projects included, East–Central, Kano and South–East. The projects of East–Central were:–

- investigations to develop riverine fisheries and fish culture.
- involving the establishment of investigation stations and fishing gear design and trial units along main river systems.
- development of improved processing and preservation methods.

Kano State had a project on the productivity of the Tiga Lake to be carried out with the collaboration of the Federal Department of Fisheries and the Ife University. There was also to be a research into fish culture.

South–East was to conduct a fishery inventory survey into fish and shrimp resources of the State as well as research into methods of fish processing.

ACHIEVEMENTS

Plan achievements will be considered against plan objectives one of which was to achieve domestic production of 1.2 million tonnes by 1980. The plan did not achieve 50 per cent of the target. Production rose from 466,236 tonnes in 1975 to 504,014 tonnes in 1980 peaked at 535,435 tonnes in 1979 and declined to 430,751 tonnes in 1980. Production at the end of the Plan fell short of 1975 figure by 35,485 tonnes (7.61%) represented 35.89% of the target.

A second objective of the plan was to earn foreign exchange by exporting fishery products. The measure of achievement in this direction was low and disappointing. Total earnings from fishery exports at the beginning of the plan in 1975 was ₦2,514,430 rising to ₦2,632,521 in 1970 but declined to ₦1,754,762 in 1979 and hit the rock bottom at ₦476,455 in 1980 according to figures compiled from the Federal Office of Statistics and the Nigerian Trade Summary Data. (Tobor, 1985).

The objective of local manufacturing of fish products e.g. fish meal and dehydrated fish was not achieved. Through research at the Nigerian Institute for Oceanography and Marine Research, Lagos, several fishery products were developed from miscellaneous fish. They include fish meal, frozen fish fillets, fish cakes and fish sausages. These products were produced on a pilot scale but their production on a commercial scale is yet to be taken up by the private sector.

The fourth objective of providing employment to Young School leavers in the coastal areas, cannot be said to have been realised. Young Nigerians even from the traditional fishing communities will hardly make fishing a career after leaving school as long as rural areas lack social amenities e.g. good roads, electricity and pipe borne water.

The fifth objective of increasing Per capital income of fishermen cannot be objectively assessed for lack of statistics on the earnings of fishermen. It may however be guessed that the decline in domestic fish production meant decline in the earnings of Fishermen.

REASONS FOR LOW ACHIEVEMENT LEVEL

Poor performance in the Third Plan could be attributed to the policy measures adopted to achieve objectives. Successful direct public sector involvement in fish production is difficult to achieve as shown by the experience of the private sector to produce fish.

The giving of grants and loans to Fishermen cooperatives or individuals to buy motorised boats can be a successful measure only when strong fishermen cooperatives combining production with marketing activities exist to ensure repayment of loans. Most individuals given loans often direct the loans to uses other than fish production.

It is difficult to reconcile the policy of phasing out fishing licenses for chartering of trawlers with the plan to increase fish imports by 28.57% over the Plan period. Equally difficult to understand was the policy of discouraging fish farming in the Plan until its viability was established.

The review of achievements of the Fourth Plan noted that only about 50% of Federal programmes was completed by the end of 1978/79 and that States achieved between 19% in Lagos and 57% in Imo State.

THE FOURTH NATIONAL DEVELOPMENT PLAN 1981–1985

Problems of shortage of trained manpower, inadequate supply of nets and accessories, boats and engines, lack of effective fishermen organizations and of fishing terminal facilities and infrastructures persisted into the fourth plan. The plan also identified a new problem; that of inadequate fisheries extension services.

The objectives and policies were little different from those of the third Plan. There were however two new policy measures:–

(a) the establishment of an appropriate marine fisheries development agency for the promotion of industrial fishery. This was not implemented.

(b) the second policy measure was the introduction and enforcement of fishery Regulations both for sea and inland waters. The limited success in the implementation of this policy measure particularly for inland waters could be attributed to the efforts of the Kainji Lake Research Institute.

The other policy measures revolved round the encouragement of cooperative societies, provision of inputs, subsidies and infrastructures.

PROGRAMMES

The total plan allocation for fisheries programmes was ₦170,989 million almost double the Plan allocation in the Third Plan. Projects were essentially the extension of those in the previous Plan except that they were given ponderous titles like the National Accelerated Fish Production Programme, "Integrated Rural Fisheries Development Project" the "Mechanized Fishing Extension and Training Project and the Integrated Federal Fisheries Extension Services"

ARTISANAL FISHERY

The National Accelerated Fish Production Programme was designed to modernize artisanal fishing while the Intergrated Fisheries Extension Services was to serve all the maritime States and provide fishing crafts and gear and improved maintenance workshops in Lagos, Benin and Ikot Abasi. The Integrated Rural Fisheries Development Project was aimed at linking the economic, social and infrastructural needs of the fishing communities to increase their productive efforts and supply of fish. It involved the provision of cold stores, i.e. plants, workshops, together with equipment fishing boats and nets, schools, health and community centres water and power supply to fishing communities. There is no doubt that its scope was ambitious.

The mechanized fishing extension and training project was designed to establish three coastal centres to train technicians and fishermen, the maintenance of fishing gear, outboard and inboard engines to support mechanized fishing operations.

AQUACULTURE

The importance of aquaculture was realised in the Fourth Plan and a plan allocation of ₦12,500 million representing 14% of the total Federal Government allocation to the Fisheries Sub sector was made. The main thrust of the aquaculture project was the construction of breading /hatchery centre to produce 5 million fingerlings annually for stocking dams and reservoirs. It was also proposed that 50 ha. pilot fish farms would be built in eleven states for demonstration purposes. States proposed similar projects to build demonstration farms and produce fish fingerlings.

FISH PROCESSING, STORAGE AND MARKETING

Projects on fish processing, storage and marketing in both Federal and States government were concerned with construction of cold stores ice-making plants, dehydration plants, smoking kilns and provision of refrigerated badges, insulated fish boxes and refrigerated fish trucks and vans.

FISHERY INFRASTRUCTURES

A total of as much as ₦41.500 million representing 45% of the total Federal Government capital allocation to the fishery sub sector was earmarked for provision of a fishery harbour complex for vessels up to 5,000 GT in Lagos and fisheries terminals for vessels up to 200 GT in the Rivers, Ondo Bendel, Cross River and Ogun States.

The States, on the other hand proposed the establishment of fishery workshops for servicing fishery equipment boats and engines. There were proposals to establish a training centre to train various cadres of fishery personnel and a fish mill plant to serve both government and private fish farms.

MANPOWER TRAINING AND RESEARCH

There was a project to establish 200 ha farm in Eriwe Ijebu for Research, training and production of 250 tonnes of fish annually.

ACHIEVEMENTS

The fourth Plan was crippled with dwindling funds after 1982 creating a situation which seriously incapacitated plan execution and achievement of targets. Two fishing terminals one at Igbokoda and the other in Port Harcourt were however completed and commissioned. The choice of Igbokoda was unfortunate for its seasonal accesibility and long distance from the sea. Increase in fish production was minimal or negative. It rose from 496,211 tonnes in 1981 to a maximum of 515,249 in 1983 and then declined to 344,618 tonnes in 1984. Generally none of the objectives set for the Fourth Plan were realised as actual production fell, earnings from shrimp exports sharply declined and no fishery based industries were established.

MAJOR REASONS FOR FAILURE OF EFFORTS TO ACHIEVE DESIRED RESULTS

Most of the plans for over two decades focussed attention on the following areas of fisheries development resources survey, fish farming, fish preservation and processing, development of infrastructures, modernization of fishing crafts and gear, man power training and development. Development in each of these areas has been slow and short of planned targets as already highlighted under each plan. The following reasons are considered responsible for the failure of development efforts to achieve plan objectives.

WEAK AND INEFFECTIVE FISHERMEN COOPERATIVES

Without well organized cooperatives, financial assistance and other forms of assistance to fishermen become ineffective in ensuring the realisation of the objectives for such assistance. Fishermen derive little benefit from their labour becuuse of the activities of middle men and therefore lose the incentives to produce more fish. Productions achieved in all the plans were thus not justified by the quantity and quality of facilities provided fishermen at highly subsidized rates.

LACK OF RELIABLE DATA ON WHICH TO FORMULATE PROJECTS

There seems to be no effective mechanism for nation wide collection of fisheries statistical data. No one for instance can give, with confidence the number of Nigerians engaged in the fishing industry, the number and type of fishing canoes and gear, or the production figures from inland fisheries by sectors. It was not until 1983 that the Nigerian Insitute for Oceanography and Marine Research, Lagos was able to design and implement a statistical method for the collection of production figures for fish farming. Production figure for that year was 20,500 tonnes and for 1984, 22,012 tonnes. Before then, production from fish farming was often quoted as "negligible"

DEVELOPMENT PLANS WERE NOT BASED ON THE POTENTIAL YIELD OF THE VARIOUS BODIES OF WATER

Ajayi (1984 per. comm) put the potential yields of the major fisheries as follows:–

Inshore fisheries	201,000 tonnes
Offshore fisheries	33,900 tonnes
Inland fisheries	288,500 tonnes

Tobor, (1985) unpublished put potential yield from fish farming at 656,815 tonnes, a figure which exceeds the total for the above three sub sectors. Emphasis placed on some sub sectors of the fisheries was therefore unrelated to their potential yields. An example is fish farming which has greater potential than artisanal fisheries for increasing production, yet emphasis on it in all the plans has been lower than that on artisanal fisheries. Development priority was thus on areas least capable of promoting increase in fish production.

COMMUNICATION GAP BETWEEN DEVELOPMENT GOVERNMENT INSTITUTIONS AND RESEARCHERS

Development Institutions rarely consult researchers during the formulation of development plans. Most projects are therefore formulated without adequate research inputs and reasonable data base.

POLICY MEASURES FORMULATED FOR THE REALISATION OF PLAN OBJECTIVES ARE OFTEN UNREALISTIC, VAGUE OR AT WORST UTOPIAN

Involvement of the public sector in direct fish production has already been given as an exercise in the ineffective use of scarce resources. Another example is the establishment of a development agency to promote industrial fisheries, which appears unrealistic.

LEVEL OF FUNDING TOTALLY UNRELATED TO PLAN ALLOCATION

The size of capital fund release for development projects always show progressive decline with years within the plan period. This has the effect of disrupting planned targets of completion and failure to achieve set objectives.

INADEQUATE SUPPLY OF TRAINED PERSONNEL TO SUPERVISE THE EXECUTION OF PROJECTS EFFECTIVELY

The area in which acute shortage of trained personnel is most felt is in industrial inshore fisheries. Nigerian capable captains and marine engineers to man trawler vessels are few and the industry still depends on expartriates to operate and maintain the fishing fleet.

THE FISHING INDUSTRY IS HEAVILY DEPENDENT ON IMPORTS FOR NEARLY ALL FISH MATERIALS AND EQUIPMENT AND ENGINE SPARE PARTS

Nets and accessories, trawlers, hooks and lines, inboard and out board engines, are few examples. Imports result in heavy outflow of foreign exchange. Orders placed for engine spare parts or netting materials take long time to materialise and result in the loss of many fishing days. This is turn affects the completion period of projects.

MANAGEMENT PROBLEMS AND INADEQUATE CAPACITY TO COPE EFFECTIVELY WITH PROJECTS

Shortage of experienced fisheries managers and field officers contribute immensely to failure to cope effectively with many projects

Monitoring of projects was lacking in many cases resulting in reports of achievements which could not be authenticated.

UNPREDITABLE CHANGES IN POLICIES AFFECTING INCREASE IN FISH PRODUCTION

A typical case is the duty of 20k/kg paid on crabs, lobsters, oysters, caught and landed by vessels owned or charteered by Nigerian companies or citizens. This duty was once removed and then reimposed. Duty on fish landed by Nigerian generates revenue to the government but increases the cost of the above items to consumers and creates disincentive in the promotion of the fishing industry. One wonders why agricultural products are exempted from such duties.

RECOMMENDATIONS

(1) Development of national capability in fisheries data collection for effective plan formulation

(2) Development of effective extension services and adequate monitoring of projects to ensure their proper execution.

(3) Establishment of proper mechanism for consultations between development government agencies and research institutions at the early stages of plan formulations.

(4) Adequate incentives to trained and experienced fishery personnel to ensure their retention in the fishery sub sector.

(5) Recognition of traditional technologies, social and cultural practices of fishermen communities in formulating projects for artisanal fisheries.

(6) Upgrading the capacity of the Federal Fisheries School, Lagos to train skippers for industrial fishing.

(7) Introduction of short term projects capable of being completed in 2–3 years at minimum costs.

(8) Improvement in the funding of projects to prevent interruption in their execution.

(9) Establishment of objective criterial for assessing level of achievements in capital projects.

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POTENTIALS FOR FISHERIES DEVELOPMENT IN THE NIGER DELTA: ANOTHER GREEN–LIGHT FOR SELF SUFFICIENCY IN REGIONAL FOOD PRODUCTION

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INTRODUDTION

General

The Niger Delta has vast potential for agricultural development and production but these potentials remain largely undeveloped because of the difficult nature of the terrain. The whole area is a maze of creeks and shallow estuaries interspersed with swamps and sandy ridges, reminiscent of a vast netting spread out on a flat ground (Figure 1). The creeks and estuaries are the many outlets through which the vast waters of the Niger, Benin, Orashi and Sombreiro Rivers drain into the Gulf of Guinea. The fresh water output by these rivers is so enormous that in the region of the Niger Delta west of the Brass River, the fresh water comes almost to the mouths of the estuaries at the peaks of the rainy seasons (July and September). Infact, the discoloured water occasioned by the floodal flux is seen several kilometers into the Bight of Benin, especially off the Nun, Escravos; Forcados and Benin-River entrances. Inspite of these numerous outlets, the floods coming down the hinterlands are so much that until recently, they could not be effectively discharged with dispatch into the sea. The result was the flooding of the banks at the upper Niger Delta and middle reaches of most of the main rivers which resulted in prolonged inundation of arable agricultural lands and a menance of severe erosion. Economic development, especially in the areas of agriculture and infrastructure were held in check to the agony of the inhabitants of the region. South of the freshwater flood-plains are the brackish water mangrove swamps which are inundated twice daily by tidal action (figure 2). Here the floods are not annual and even the brief but colourful short season cropping possible during the receding floods in the upper reaches of the delta is not possible here.

But developments related to engineering activities throughout the region now hold a hope not only for a profitable agriculture in the region but also that the region could evolve into a veritable bread basket of the Nigerian nation. The hydrography, geology, vegetation and related studies of the Niger Delta, and surveys of the agricultural and fisheries practices and potential of the region have been elaborately covered in the works of Anderson, (1967); Scott, (1960); Hartoungh (1960); and FAO (1969). These studies outline vast potentials for agriculture and Fisheries in the region, but all of them were conducted anterior to the trends in evidence today that a thorough up-to-date study has become due as a necessary complement to these earlier efforts. This paper advocates this stance on the basis of sound scientific premise deducted from unforeseen developments resulting from several engineering activities in the region aforesaid.

Since these trends are in their infancy and still unfolding, no attempts at scientific analysis and conclusions have been made. This paper serves to draw the attention of interested scientists to the issue raised, for a more professional approach and close study of the observed phenomena.

Agriculture and Fisheries in the Region

Agriculture in the Niger Delta whether animal husbandry or crop production is essentially a small-holders affair. Vast hectarages of land can not be put under crops because of the difficulty in employing farm machinery and staggering loss following the annual floods that submerge and devastate the farms. Over the years, a pattern has emerged in the fresh water flood plains of the region. A variety of short season crops including cocoyam, water yam, sweet-potato, groundnut, maize, sugar-cane and assorted vegetables are grown during the receding floods, when the land is exposed for a brief period of five months (November – March). The brief and colourful farming has demonstrated the vast agricultural potentials of the region, in terms of variety of crops and livestock, fertility and natural soil conservation. The annual flooding and its attendant erosion also demonstrates the seriousness of the regions agricultural and other economic predicament. The cycle of annual losses to farmers has reduced the inhabitants of the region to marginal existence where the bulk of the population, until recently was largely illitrate, and the economy subsistent.

With political autonomy more relevant to the region under the state instead of the estwhile regional administrations, the construction of roads, dredging of water ways and the provision of water borne transport systems has immensely altered the economy of the Niger Delta. Farmers have evolved from subsistence to peasant operations Quite a surplus over family requirements are recorded in crops and animal production. This surplus is channelled to population centres such as Yenagoa, Ahoada, Port Harcourt, Brass, Nembe, Warri and Patani for disposa But the hydrography of the region still takes its heavy yearly tolls on agricultural production. Only this year (1985) an estimated 95.5 million naira worth of crops was destroyed by flood. This is inspite of all precautions taken, in putting vast arable land under crops. The magnitude of the loss is a suitable index in estimating the vast potentials that could be opened up for agricultural development in the Niger Delta.

The nature of the annual floods and the level of the flood plains have made fish culture near impossible. Fish-ponds and pens in the true sense are virtually nonexistent in the fresh waterflood plains of the Niger Delta. The water is all too high when it is high and too low when it is low for a meaningful fish culture or fishery development programme. But the potentials for a sound fisheries development exist by way of remarkable strains of culturable fish fauna some of which include the hard clam--***Egeria spp, Alestes spp., Sarotherodon spp., Channa obscura, Heterobranchus spp., Clarias spp., Chrysichthys nigrodigitatus*** and some African carps. These species could be cultured for significant returns to the farmer, or properly managed to make the extractive fishery more worthwhile for the fishermen. But the reasources necessary for harnessing these potentials are beyond the inhabitants of these plains.

Further south, in the fresh water/Brackish water transition zone, are vast swamps suitable for intensive rice culture. Various government agencies have made efforts at establishing rice farms at Abobiri, Otuaka, Imbiakapaba, Yenagoa, Peremambiri and Igbematoru over the years (SCOTT, 1966; Hartoungh, 1966). But the difficult nature of the terrain, especially the difficulty of employing heavy agricultural machinery and implements in land preparation has held agricultural development in check. .Here the effect of annual floods is considerably lesser but the soil is perpetually wet that the tubers of otherwise promissing crops like cassava, and sweet potatoes do not keep long in the soil. In this zone fish-culture has vast potentials for development - fish ponds, fish pens, race ways, fish tanks and cage culture are all possible at a considerably smaller capital outlay. But the check on the use of heavy earth moving machines imposed by the very soft and sodden soil has limited development severely.

Still farther south, are the brackish water mangrove forest. The soils are principally of three types – (Anderson, 1967):–

- Recent Aluvium (very soft and purulent)
- Chikoko (firm and fibrous)
- Saline sands (sandy-silt soils in the eastern Niger Delta).

The agricultural potentials of this zone were virtually unknown two decades ago. Some skeletal subsistent farming took place on the reminant of the coastal plain terraces of the eastern Niger Delta and the sandy-beach ridges from Opobo to Escravos. Plantain, cassava and sugar-cane were among the crops grown (Anderson, 1967; Hatoungh, 1966). Today, the hidden potentials are being unlocked but they still go unnoticed by a vast majority of the people. The zone is written down essentially as a fishery zone with artisanal fishery as its principal industry. Fin fish and shell-fishes are exploited in large quantities by migrant fishermen. The competion for the catch is keen and often, the unscrupulous fishermen resort to unpopular and often clandestine methods such as poisoning and explosives. The catch here is supplemented with that from the inshore fisheries that the fish market is virually in glut in the immediate vicinity of the fishing ground. This makes aquaculture development not popular in the zone inspite of the vast potenttials for fish pond, fish-pens and mariculture development.

It is clear then that the Niger Delta region has vast potentials for food production that could be harnessed with the aid of the right Technologies and resources. A clue to this fact is especially demonstrated in certain side occurrences resulting from oil exploitation, canalisation, reclamation and road consturction throughout the Niger Delta.

Properly studied, the trends manifesting from these activities hold a key to developing the Niger Delta region into Nigeria's bread basket as a necessary complement and a fitting finish to the laudable school-to-land programme that is gaining currency now.

ENGINEERING ACTIVITIES AND FOOD PRODUCTION POTENTIALS

The Freshwater Zone and the Immediate Hinterland

The relevant major engineering activities in this zone are the construction of new roads and oil exploration and exploitation. In the hinterland from Ogoni to Ahoada and parts of Omoku are new roads with a significant feature - they are lined all along with burrow pits from which the earth for building the roads was removed. Often these pits become receptacles for water (ground water or surface run-off). In the freshwater flood plains, the roads are raised several meters high to keep above the highest flood when they occur, and the first picture this engineering feat,conjures up is that of a gigantic dam. The road (dam) effectively keeps the water under check allowing it passage only at predetermined points. Side-by-side with the roads, are the water ways which are deepened by canalisation or dredging to make for easy evacuation of flood water or for easy navigation. All along, one thing is clear - to a certain degree the water is controlled. The increase in these developments has made it possible in recent years to farm most of the flood plains with losses due to flooding, significantly reduced except during unusually wet years such as that of 1985.

The Brackish–Water Mangrove Swamps

The principal engineering activities in this zone are oil exploration and exploitation, canalisation and land reclamation. The drilling of oil wells and construction of canals to facilitate oil exploitation and navigation results in dredging-up a lot of organic materials deep down to the surface. In most cases, the materials moved forms a vast land mass a few meters above the surrounding creeks or canal. Three major soil types are identifiable from such formations.

- Sand
- Chikoko
- Sna Recent Aluvium.

Some times, it is a mixture of two or all three types combined in different proportions. With time, vegetation of various types develop on these new land formations. Various grasses and ferns are common to sandy formations. Pure Chikolo formation are either entirely barren or covered with a poor vegetation of grass. The most interesting is where the formation is entirely recent alluvium or has this materials mixed in large quantities with others. In such places. the vegetation grows very fast. A succession of plants that give way to a lush, evergreen rain forest with a large array of plants soon emerges. Where these artificial land formations occur near suitable fishing grounds or other human habitation, the fishermen or other natives have been quick to appropriate them for agricultural use. Particularly suitable for these soils and very important in this new area of agricultural awareness are coconuts, pineapples, oil palms, and plantain Some of the farms are in the region of mini estates and the crop performance is excellent Inquiry showed that no fertilizers were used.

In the same zone, canalisation gives rise to vast mud flats being smoothered with sharp sand. Where such sand is subject to tidal action, the area soon gets colonized by shell fishes including the Razo Clams, *Cultellus tenuis and Targelus andansonii.* These grow to about 7 cm in less than six months and constitute a lucrative fishery for the gatherers. The Clams yield excellent meat and are used in soups.

The Estuaries

At the estuaries, engineering activities take another form. Man dredges the river mouths to facilitate navigation such as are the cases of the Bonny and Brass Rivers. On the other hand, nature transports sand, creating banks and bars that obstruct the free flow of water. This is most noticeable in non-navigable estuaries* such as the Sombreioro, Santa Barbara, San Bartholomeo, and St. Nicholas Rivers. These engineering activities run counter to each other producing two significant effects. Here a comparison of the Bonny and Sombreiro should surfice. It is based on observations made on an on-going aquacultural study on spatfall in the two rivers. Five pairs of stations were set up equidistant from the river mouth in north-south transects. It was assumed that the hydrographic condition should be same for corresponding station, being in the same natural region and latitude. But the assumption proved unreliable from evidence obtain from transparency, and salinity cheks (Table 1). Of the five stations established up the Sombriero, in no station was transparency above 0.50 m and salinity was 15% at the mouth and oto just 1 kilometer upstream. On the Bonny River, transparency ranged between 0.85 m to 2 m and salinity from 25% to 12% in the 4th station and 0%o in the 5th station (about 50 and 60 km) upstream. Whereas spatfall of the mangrove oyster *(Crassostrea gasar)* was recorded in all but the 5th station upstream on the Bonny River, spatfall occurred only at station 1 at the mouth of the Sombreiro River. Under such differences in salinity and transparency regimes between corresponding stations of what should be two similar rivers, the basis for comparison of the animal population processes (spatfall and growth) was lost. On average the Sombreiro River is more turbid than the Bonny River, a situation that is likely to result in reduced phytoplankton abundance and hence reduced food for the oyster population on the Sombreiro River as compared to the somewhat healthier population on the Bonny River. Implicated is the difference in hydrography and topography of the river beds. The Bonny River has a central deep channel right up to station 5 (Iwofe). The depth averaging 15–20 m is maintained by constant dredging to facilitate navigation to and from the many ports spanning the river.

Table 1 – Transparency and salinity at 5 stations on (a) the Bonny and (b) the Sombreiro River (July – September 1985)

(a) Bonny River

Station	*Transparency (m)*	*Salinity (‰)*
1	–	–
2	1.35	18
3	1.30	14
4	1.04	12
5	0.85	0

(b) Sombreiro River

Station	*Transparency (m)*	*Salinity (‰)*
1	0.23	15
2	0.24	10
3	0.22	0
4	0.50	0
5	0.47	0

Besides, the Bonny River has no principal freshwater body draining into it.

The Sombreiro River on the other hand is comparatively very shallow especially at its mouth where it is virtually obstructed by a sand bar that is exposed at ebb tides. This bar, in effect, keeps off the influx of saline water at flow tide and thereby, enhances the sea-ward distribution of the ample freshwater through-put from the upper reaches of the river and the hinterland. Thus, the translational power of the flowing river is very effective for a considerable distance down-stream, resulting in the uncharacteristics turbidity and fresh water so near the estuary.

This basic difference resulting from the bottom structure of the estuaries of the two rivers is not likely to change so long as it is not found necessary to dredge the Sombreiro River as is done with the Bonny River. And so long will be oyster resources of the former remain stunted and their exploitation unimaginable, except something drastic is done.

DISCUSSION

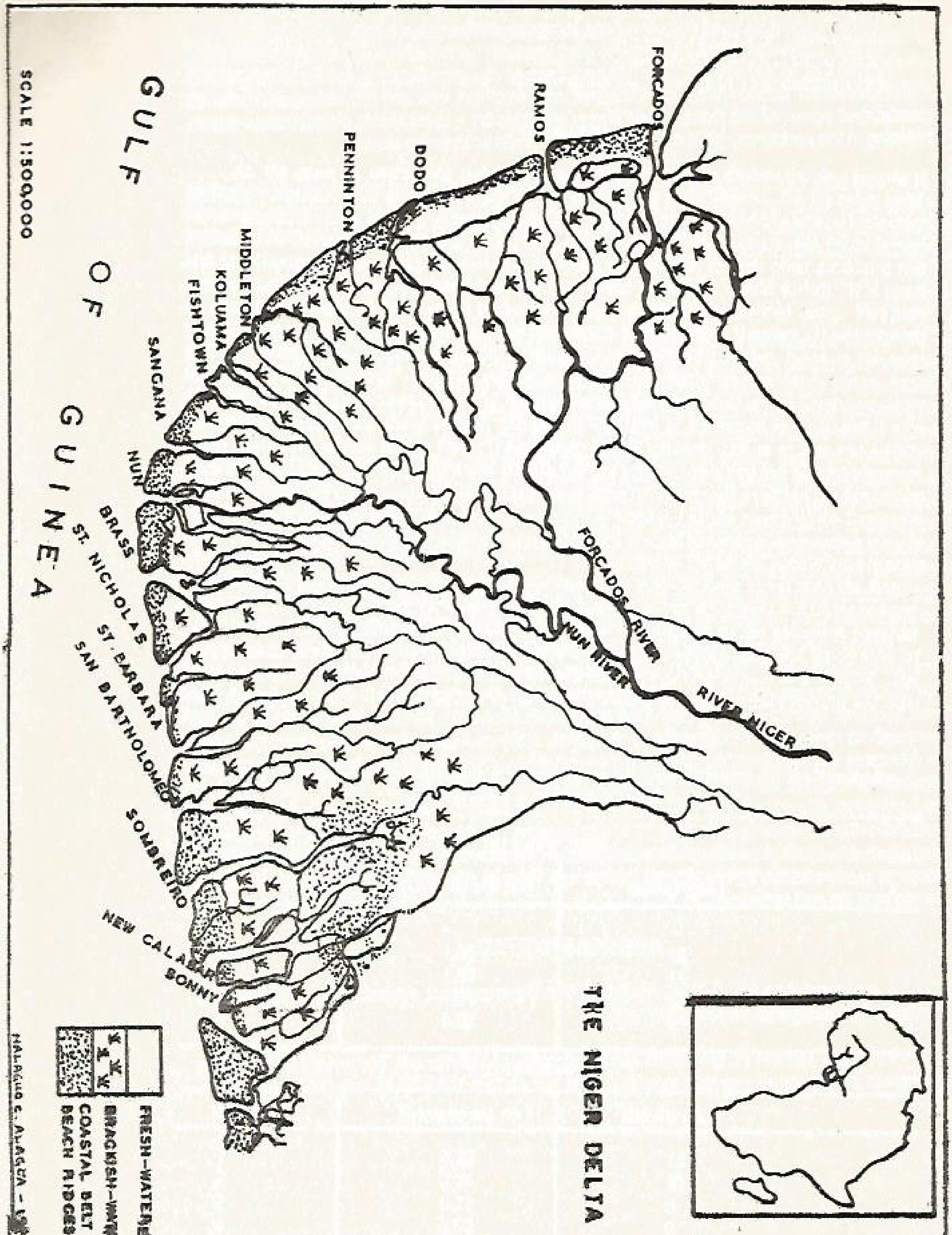
From an overview of the current trends in the environment of the Niger Delta resulting from various engineering activities, both natural and artificial, a pattern emerges for the meaningful harnessing of the enormous but latent food production potentials. The answer is in hydraulic engineering, the manipulation of environmental conditions through varying fresh-water and sea-water inputs so as to increase aquactic and weland productity. Dams reminiscent of the roads traversing the flood plains from Port Harcourt with inlets, outlets, by-passes, and controls to subjugate the vast arable farmland made unusable by floods. Similarly, wider and deeper canals would make for easier evacuation of excessive freshwater and curtail flooding to manageable magnitudes. The same arrangement wo ld while establishing suitable grounds for the farming of clams and oysters also extend the area of salt-water influence and restore natural oyster populations in rivers such as the Sombreiro and St. Nicholas. Carefully planned and executed, the deposition of dredged up materials would be effected through a careful soil management technique to create vast opportunities for crop farming as is being discovered in the mangrove swamp belt.

Finally, the experiences of Mexico, Venezuela, Egypt, Romania, Tunisia, Morocco, India, and Sri-Lanka are invaluable to the Niger Delta region in the adoption of hydraulic engineering for the development of the numerous estuaries, creeks and wet lands into vast pens, ponds and well managed lagoons for increased food production (Kapetski, 1981). One advantage of this approach to agricultural development in the region, is the multi-use of same and adjacent facilities in altrernate and integrated practices in food production. Properly engineering reservoirs could be drained for crops in one season and filled up for aquaculture in another. With adequate control and planning, the same facility could be developed for irrigating crop land, watering live-stock and fish-culture in a scale yet unknown in this country. In the same vein, broad dams and ancilliary structures developed through interdisciplinary approach that involves the skills and competence of transportation/civil engineers, farmers and fisheries scientists and technologists is the key to realising the goal envisaged.

ACKNOWLEDGEMENT

I am grateful to Mr. S. P. C. Phillip of the Department of Agricultural Engineering and Fisheries Technology for preparing the map.

I am also grateful to the Rivers State University of Science and Technology under whose sponsored programmes I was able to collect data and observe the bulk of material for this paper.


THE NIGER DELTA
FORCADOS
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KOLUAMA
FISHTOWN
SANGANA
NUN
BRASS
ST. NICHOLAS
ST. BARBARA
SAN BARTHOLOMEO
SOMBREIRO
NEW CALABAR
BONNY
FORCADOS RIVER
NUN RIVER
RIVER NIGER
GULF OF GUINEA
SCALE 1:500,000
FRESH-WATER BELT
BRACKISH-WATER BELT
COASTAL BELT
BEACH RIDGES
N

SECTION 3 – AQUACULTURE

FISH POND MANAGEMENT AT THE ONIBONOJE AGRICULTURAL INDUSTRIES (NIGERIA) LIMITED, FISH FARM AT ESA OKE ROAD' IJEBU JESA OYO STATE, NIGERIA

By
G. O. Onibonoje
(Chairman and Farmer)
Onibonoje Agricultural Industries (Nigeria) Limited

INTRODUCTION

I must thank the National Executive Council of Fisheries Society of Nigeria (FISON) who "in pursuance of their decision", and according to them "in view of the management success of (our) private fish farm", invited me to present this paper. This is a very big encouragement indeed and a big challenge as well.

Secondly, I must thank the entire staff past and present, of the Oyo State Ministry of Agriculture and Natural Resources, Fisheries Division, who are my teachers in the open University of Fish Farming. Our association dates back to 1964 during which entire period they have proved very helpful with advice, suggestions and encouragement.

Location and Size of the Fish Farm

The O.A.I. Fish Farm is situated along Esa Oke, Ijebu Jesa, Obokun Local Government, Oyo State. The firm is two hours' drive from Ibadan on a very good asphalt tarred road linking Oyo, Ondo, Kwara, Abuja, Niger and serveral other Northern States. The establishment of which the Fish Farm is a section covers some 200 hectares, featuring poultry, food crops like yam, maize, rice and cowpea farming as well as oil palm plantation, palm oil processing and dry season vegetable farm.

The perennial River Oni bounds the site at the southern end. On the eastern side is the Esa Oke Road, while on the western side is the Esa Odo Road. Between the Esa Oke and the Esa Odo Roads is a 4–km stretch of low lying valley of the River Oni with its two tributaries which run diagonally through our site. It is this wide expanse of valley which is the stie of our Fish Farm. When fully developed, it will be about 150 hectares of fish farm, that is 3/4 of the entire 200 hectares will be under water.

The functioning/completed Ponds to date are 34 hectares as follows:–

	Description	*Area (ha)*
1	Pond D.1	1.16 ha
2.	Pond D.2	3.72 ha
3.	Pond D.3	1.94 ha
4	Pond D.4	2.37 ha
5.	Pond D.5	1.72 ha
6.	Pond D.6	2.10 ha
7.	Barrage I	3.65 ha
8.	Barrage II	3.01 ha
9.	Barrage III	2.33 ha
10.	2nd Reservoir	12.00 ha
	Total	34.00 ha

** Published as experience paper.*

The types of fish cultured are as follows:–

(i) *Tilapia nilotica*
(ii) *Tilapia galilaeus*
(iii) *Clarias lazera*
(iv) *Heterotis niloticus*
(v) *Cyprinus carpio (Common Carp).*

The Stocking Pattern

Stocking usually starts in April and ends about September. Before we let in water, we condition the ponds by ploughing it, removing any debris and liming it. Lime controls the acid and helps the fertilizer to work. After this, we let in the water. The main source of water is the rainstorm. During the dry season we pump water from the River Oni. A third reservoir which is under construction will be fed directly by River Oni, the reservoir in turn will be made to feed the other ponds by gravity. The first reservoir, however, is fed by a tributary of River Oni.

Description of Pond	*Area of Pond*		*Type of Fish*			
		Clarias	*Heterotis*	*Tilapia*	*Carp*	*Densit*
Pond D.1	1.16 ha	3,500	50	–	–	3,550
Pond D.2	2.72 ha	10,881	–	600	–	11,481
Pond D.3	1.94 ha	12.082	100	–	–	12,182
Pond D.4	2.37 ha	3,000	–	1,200	–	4,200
Pond D.5A	1.72 ha	–	90	–	1,545	1,635
Pond D.5B		–	30	2,000	–	2,030
Pond D.6	2.10 ha	2,500	20	2,000	–	4,520
Barrage Pond I	3.65 ha	–	8*	580	–	588
Barrage Pond II	3.01 ha	–	20	750	–	770
Barrage Pond III	2.33 ha	–	27*+192	1,200	–	1,419
2nd Reservoir	12.00 ha	–	28*	1,500	–	1,528
TOTAL	34.00 ha	31,963	565	9,830	1,545	43,90

The following types of fish are cultured:–

The average weight of each of the *Clarias* is between 60 to 90 g when stocked into the pond. They are then reared for six to nine months by which time they have attained an average weight of 1.5 to 2.5 kg.

It should be observed that as a matter of policy we have tried to confine *Heterotis* and *Tilapia* to Barrage Ponds I, II and III as well as the second reservoir. At the next cropping season, all the *Heterotis* in ponds D.1, D.3, D.5 and D.6 will be moved and stocked into the barrage ponds I–III as well as second reservoir, thus leaving *Clarias* in Ponds D.1, D.2, D.3, D.4 and D.6 where they will be restocked according to their age and size into the respective ponds. One of the *adult ponds, however, will be specially reserved for Carp and be multiplied over a period of time until a desirable and maximum density is achieved.

Feeding of the Fish

The fish are fed 5% body weight with pelleted groundnuts cake and rice or brewery waste. They are fed in the morning between 7.00 and 9.00 a.m. from Mondays to Saturdays. The feeding ratio is 1 kg rice bran to 1 kg brewery waste and 1 kg of groundnut cake or alternatively, 2 kg of rice bran to 1 kg of groundnut cake. The feed is soaked in water overnight. The soaking is for proper digestion of the feed by the fish. Also, kitchen wastes like beans chaff from moinmoin as well as chiken Intesture and liver plus the blood are cooked separately to feed the fish. These supplementary feed is increased every month when the fish are viewed at the feeding spots.

Fertilization of the Ponds

The fertilization of the pond is done weekly. We use poultry droppings at the rate of 250 kg per hectare per week or 13 tonnes per hectare per year. This fertilizer helps to increase the plankton contents in the water. The maggot in the poultry droppings act as direct proteins to the fish and gives it a gradual development. The fertilization with poultry droppings as organic manure usually starts in April and ends in October to avoid algae bloom due to hot wheather.

TABULATION OF FERTILIZATION (ORGANIC MANURE)

S/No.	*Pond*	*Area (Ha)*	*Quantity*
1.	D.1	1.16 ha	300 kg
2.	D.2	3.72 ha	930 kg
3.	D.3	1.94 ha	485 kg
4.	D.4	2.37 ha	593 kg
5.	D.5A	0.69 ha	219 kg
6.	D.5B	1.03 ha	259 kg
7.	D.6	2.10 ha	525 kg
8*.	2nd Reservoir	12.00 ha	3,000 kg

*Once monthly.

250 kg/ha/week organic manure.

POND MANAGEMENT

1. Clearing of pond surroundings to scare predators.

2. Clearing of monks and spiliway screens for effective flow of excess water from the pond.

3. Filling of burrows made by rodents and crabs to prevent any damage to the dyke.

4. Manual clearing of water weeds to prevent water pollution or deficient oxygen at night.

5. Scaring of predator birds to avoid preying on young fish.

Cropping and Harvesting

We crop an average of two times a week, usually Thursdays and Fridays using the set nets and sometimes the cast nets to fish out the larger sizes of the *Clarias* which otherwise would feed on younger ones. The harvest is then made available to the people in the Ijesa area as well as to the travellers who ply the major road which links Oyo State to the far North through Ondo and Kwara States. We make available to the market an average of 80 to 100 kg a week. During the festivals, particularly Christmas/New Year and Easter, we usually undertake the total cropping of one, two or three ponds. We drain the water to reduce the level to a manageable proportion and use the draw-net to fish out the crop. The bigger ones are offered for sale not only in Ijesa area but as far afield as Ibadan and Lagos where they are sold live. The smaller sizes are, however, distributed to other less heavily stocked ponds.

Immediate Future Plans

There is a plan to accelerate the development of the remaining site as soon as funds are available. We also have a plan to establish our spawning and breeding section. Hopefully, when the 4 km stretch of the fish pond site is fully developed and fully stocked, it is expected that we would be in a position to supply daily some of 2 toones of live/fresh fish.

The Role of the Government Vis–a–Vis that of the Organised Private Sector

Fish farming in Nigeria is still in its infancy and may likely remain so for sometime to come. The reasons for this are many. First, it is capital intensive and necessarily involves the use of heavy machinery and equipment. Secondly, the terrain for a suitable fish pond site especially in the Southern parts of Nigeria is usually very difficult to penetrate and develop. Thirdly, the gestation period is usually much longer than most other aspects of Agriculture and therefore, necessitates a rather patient investor usually one who has a natural taste for water and aquacultures. Further, the national economy is facing plenty of difficulties and is therefore, inhospitable especially to ventures such as fish pond or fish farming. In view of the above, one would expect that government intervention as pioneers would be the obvious necessity. But the paradox is that government would be less likely to be forthcoming in these matters. However, it must be emphasized that fish farming apart from the initial heavy capital investments requires very little, if any foreign input that would require expenditure of scare foreign exchange earnings. Whereas the importation of fish from abroad is not so. Government would, therefore, be advised to consider a deliberate encouragement of fish farming as one of the ways to solve the protein deficiency and the food shortage in the country. One of the most effective ways of encouraging private fish farmers is the provision of technical assistance by way of making available well-trained fisheries staff to identified and serious minded fish farmers. After a period of initial attachment of technical assistant to a private fish farmer, such a technical man could be encouraged deliberately to seek a career within the establishment to which he had hitherto been attached. I understand that most of the now famous Japanese multi-nationals started in this way. Another way in which Government could assist the development of fish farming is to make readily available to identified and serious minded or proven fish farmers at least 50% or more of the cost of heavy equipment and machinery; and/or the cost of maintenance and repairs of such heavy equipment and machinery. This will go a long way to encourage proven fish farmers to continue and expand the scope of their activities. It may be added that the Central Bank guaranteed loan scheme to Agriculture which many farmers usually avail themselves of would not appear to me to be an adequate incentive to Fish Farmers.

CULTURABLE FISH SEEDS IN NIGERIAN WATERS: A RESEARCH SURVEY (1978–1985)

By

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ABSTRACT

The desired species identified in this survey include mullets, catfishes, fast growing fish predators, species for control of weeds and grass in ponds, cichlids and shrimps. Five coastal State: Lagos, Ondo, Bendel, Rivers, and Cross River State were covered in the studies. Investigations were also carried into the major rivers and their tributaries. A combination of the estimation methods of Le Cren (1962) and Pitcher and Mac Donald (1973) was employed in the analysis of data. From the detailed data collected from (1978–1985), the survey indicated that about 100 million fish seeds can be collected annually from Nigerian waters using appropriate gears - seine nets, cast nets, and fish traps. Of this number, 60% is available along the coastal belt of the country while 40% is in the major rivers, their tributaries and swamps. At the present level of fish culture development in Nigeria, this is more than enough, even after allowing for 50% mortality due to handling and transportation stress.

INTRODUCTION

A key priority area that is often neglected in fish farming in developing countries is the under exploitation of the abundant culturable fish seeds in their natural environment. Rather, emphasis seems concentrated on the establishment of indoor hatcheries that have never functioned

This is a misplaced priority because of the capital intensive nature of hatcheries and highly skilled personnel to make them functional. In order, therefore, to accelerate fish culture development in Nigeria, and some countries of Africa, a detailed research work is needed to map out nursery beds of the most desired species, their breeding habits, and breeding seasons with a view to collection of their seeds at the peak period for stocking of fish farms. The success on the establishment of both pond and indoor hatcheries also depends on the knowledge gained from the study of each individual breeding characteristics.

This research survey (1978–1985) presents a fairly detailed information on quantity of culturable fish seeds available in Nigerian coastal and inland waters, periods of peak abundance, factors effecting their natural abundance and suitable gears for collection of the seeds from the wild with minimum stress.

METHODOLOGY

During the period January 1978 – October 1985, research trips were made to fish landing sites of each state and to established fish markets. Areas (Figures 1–2) which hitherto were inaccessible water-logged terrain, especially in Rivers and Bendel States were covered with speed boats made available by Federal and State Departments of fisheries. Data on total length and weight of each culturable species were collected for the fry, fingerlings and adults. Floating fertilized eggs, where located, were collected, and preserved in *Gilson's fluid.* Soil samples were collected from areas identified as nursery beds and salinity measurement taken from such areas. Fecundity studies of adult specimens were carried out from samples collected directly from fishermen and some from fish markets.

Landing statistics of spawning adults were also taken. Using LeCren (1962) and Pitcher and Madonald (1973) estimation methods (Table 1) the number of fish eggs laid in our waters was estimated. The final figures of fingerling survival and abundance in our waters were arrived at by calculating 20% of the total number of eggs laid as corrected by the study group. The variables against successful spawning of the species in their natural environment were properly taken care of.

The identification of fry and fingerlings of the desired species was made easier by the Taxonomic keys provided by FAO and other workers.

RESULTS

The most desired fish species for culture in Nigeria, their peak periods for the collection of their seeds from the natural environment are listed in tables 2–6.

1. Mullets.

Liza falcipinnis, Liza grandisquamis, Mugil cephalus. For centries, growing of mullets in ponds or confined environment has been the common practice in South-East Asia, India, the Pacific basins, the mediterranean East European countries and many parts of Central America. From available literature, Irvine (1947) listed seven species of Mullets for Ghana, Daget and Utis (1965) listed five for Ivory Coast, Pillay (FAO/UN, 1965) identified four species for the coast of West Afican between 20^{o}N and 15^{o}S, while Fagade and Olaniyan (1973) listed six species for Lagos lagoon and also indicated *Liza falcipinnis* as the most abundant.

Since the technology of growing and spawning of mullets in ponds and indoor hatcheries has been well developed in other regions, the species offers a very good prospect for commercial farming in West African sub-region. From the work of Sivalingam (1975), Ezenwa, (1973 and 1977), mullets have been found to grow very well in polyculture systems with the common carp, *Cyprinus carpio;* the catfish, *Chrysichthys nigrodigitatus* and the cichlids, *Tilapia* spp.

With a view to accelerating the culture of mullets in Nigeria, the research study identified three major species namely ***Liza falcipinnis*, *Liza grandisquamis*** and ***Mugil cephalus***. A total number of *12.5 million* mullets fingerlings of the three species could be collected annually from the Nigerian coastal waters; 3 million for Lagos State 2 million for Ondo State; 2 million for Bendel State; 3.5 million for Rivers and 2 million for Cross-Rivers State. These figures were grossly under estimated if one looks at the number of eggs per mature female mullet. As many as one million eggs are released by one adult female mullet and in established hatcheries, three males are needed to accomplish a successful fertilization of the eggs, (Rober and Walter, 1975).

In the Lagos area, along the shorelines of the lagoon and the isolated pools at the harbour mouth, ***Liza falcipinnis*** was very abundant all year round but more in June and July. The other two species, ***Liza grandisquamis*** and ***Mugil cephalus*** are found more at the mouth of the major rivers that flow into the sea and shore lines of creeks, estuaries and lagoon systems. They are dominant during the high Salinities 20% of the year; March–May and October to December. ***Liza grandisquamis*** also tolerates low salinities (1%0–5%0).

Appropriate gears for collection of mullet fingerlings during their peak periods with minimum stress are shore seines, drift nets, and cast nets.

2. *The Catfishes*
   (1) Chry. nigrodigitatus
   (2) Clarias lazera (Mud catfish)
   (3) Heterobranchus bidorsalis
   (4) Heterobranchus Longifilis

There is the possibility of a mono-culture catfish industry in Nigeria because of the rapid growth and diverse species available in the country. The detailed biology of the most desired species *Chrysichthys nigrodigitatus* (Lacepede) has been given by Ezenwa (1978 and 1981). The fingerlings are found to be more aboundant in fresh water and in the low salinity brackish water lagoons and esturies of the Country, during the period May–September of each year. Eight million fingerlings could be collected annually from the natural environment by use of fish traps and hook and line. The species keeps to the bottom of the ponds, feeding on the surface layers of the soil. It therefore grows well in poly-culture systems with either ***Liza falcipinnis*** or with ***Tilapia guinensis*** which are surface feeders.

Table 1. Population estimation of number of eggs laid by the Catfish *Chrysichthys nigrodigitatus in Warri/Burutu (Creeks) Estuaries (July – August 1982)*

Age group	*Mean Length (cm)*	*Mean Number eggs*	*No. of spawning females sampled*	*Estimation of total eggs laid*		
				**lecren (1962) simple multiplications methods*	**Pitcher and Mac Donald (1973) correct integral*	**Ezenwa et al (1985) 50% reduction method*
1	34	10,000	1560	15,600,000	20,280,000	7,800,000
2	45	20,000	850	17,000,000	22,100,000	8,500,000
3	55	25,000	620	15,500,000	20,150,000	7,750,000
	TOTAL			48,100,000	62,530,000	24,050,000

N.B. *Lecren (1962) estimated total number of eggs laid, by multiplying mean number of eggs by number of spawning females.

*Pitcher and MacDonald, (1973) used 30% under-estimation errors of Lecren (1962).

*Ezenwa et al (1985) used 50% reduction values of Lecren (1962) due to ecological problems against natural spawning.

*In tables 2–6,figures of fish seeds obtained were based on assumption that 20% of total eggs laid survived as fingerlings for collection.

Table 2 — Culturable fish seeds in Lagos State

Species	*Locality*	*Time of year*	*Estimated Population (million)*
Mullets *Liza falcipinnis* *Mugil bananensis* *Liza grandisquamis*	Shore lines of Lagos lagoon and Tarkwa bar	April–July	3
Chry. nigrodigitatus	Badagry, Lagos and Epe Lagoons	May–August	1
Clarias lazera	Badagry and environs.	June–September	1.0
Heterotis niloticus	Badagry, Epe and Lekki and Environs	July and August	1.0
Tilapia guineensis *Sarotherodon galiliae* *Tilapia zilli*	Shore lines of Lagos, Ojo, Lekki Epe lagoon system	March–July	3
Tarpon (megalops) atlanticus	Shore lines of Lagos Lagoon	April–May	0.1
Lutjanus goreenis (red snapper)	Tarkwa bay and Shore lines of Lagos Lagoon	March–June	0.05
Pomadasys jubelini (grunter)	Tarkwa bay and shore line of Lagos Lagoon	January–March	0.01
Elops lacerta	Tarkwa Bay and shore lines of Lagos Lagoon	June–July	0.15
Penaeus notialis (Shrimps)	Tarkwa bay and shore lines of Lagos Lagoon	April–July	2

Of recent, doubts have been raised by fisheries taxonomists as to the correct identity of three other species of *Chrysichthys* reported in Nigerian fresh and brackish waters,

(a) *Chrysichthys auratus longifilis?*
(b) *Chrysichthys walkeri?*
(c) *Chrysichthys furcatus?*

Examination of the gonads by Sivalingam (1972); Ezenwa, (1974, 1978, 1981) gave an indication that *C. auratus longifilis* and *C. walkeri* are probably one species. The external characteristics of the head of what is though to be *C. walkeri* may be the breeding characteristics of the male of *C. longifilis.*

Specimens with these characteristics are present throughout the year and more abundant in low brackish water areas of the lagoons and estuaries (1%–3%). During the fry and fingerlings stages, they are often confused with those of *C nigrodigitatus.*

A similar question, again, on taxonomy, is raised about *C. furcatus.* Ezenwa (1981) reported that during the breeding season, the sides of the adult male of *C. nigrodigitatus* become extended laterally forming a pouch-like structure, and as a result the snout assumes a semi-circular "C" broad shape. Specimens called *C. furcatus* could possibly be the adult mature male of *C. nigrodigitatus* since they are often very rare in catches of fishermen.

Another group of more desired catfishes belong to the family claridae. The most important specis are:–

(i) *Clarias lazera* (mud - catfish)
(ii) *Heterobranchus bidorsalis*
(iii) *Heterobranchus longifilis.*

To a casual observer, *Clarias lazera* has identical external features with *Heterobranchus* spp. They are now widely cultured in fresh water fish farms. Growth rate has been reported to be very rapid at Enwazor's Fish Farm, Onitsha Anambra State. *Heterobranchus longifilis,* cultured with *Tilapia zilli,* has recorded a growth rate of 2kg. in 12 months, much faster than the mud catfish, *Clarias lazera.*

Similar results have been noted at Nigerian fish farms limited, Patani, in Bendel State. (Ezenwa, 1982/83, personal observation).

Clarias lazera and *Heterobranchus* spp. are found to live in swamps and Rivers. They are very common in swampy areas of the major Rivers of the country. The gonads are well developed between June and September for *Heterobranchus* spp. Fry and fingerlings are most abundant during the receding floods (November, –January).

The fingerlings of *Clarias lazera* (Mud–catfish) are available all year round but most abundant in June, July, and August in the tributaries and swamps of the major rivers of the country

(3) Selected Predators.

(i) *Tarpon atlanticus*
(ii) *Elops lacerta*
(iii) *Lutjanus goreensis* (snappers)
(iv) *Pomadasys jubelini* (grunter)
(v) *Gymnarchus niloticus*

Table 3 – Culturable fish seeds in Ondo–State

Species	*Locality*	*Time of year*	*Estimated Population (million)*
Tarpon (megalops) *atlanticus*	Shore lines of coastal areas: (Aiyetoro)	February-May	1
Liza falcipinnis *Liza grandisquamis*	Shore lines of *coastal areas*	March–June	2
Chry. nigrodigitatus	Rivers lagoons estuaries.	June–August	2
Tilapia zilli *Tilapia guineenis* *Sarotherodon* galiliae	Rivers and shore lines of coastal areas	April–October	3
Clarias lazera *Heterobranchus spp*	Tributaries of River & swamps	June–September	1.5
Gymnarchus niloticus	Shore lines of Rivers and Tributaries.	August–October	1
Heterotis niloticus	Shore lines and swamps of Rivers	June–August	.1

At the present level of fish culture development in Nigeria, the best culture system suitable for Nigerian fish farms is the stocking of fast growing predators with the fast-reproducing cichlids *Tilapia* spp. in the appropriate ratio. For the past five years, the Institute carried out trials on the best predator for brackish water fish farms. *Tarpon* (megalops) *atlanticus* has been found to grow up to 1kg. in three months when grown with *Sarotherodon galiliae* (Ebietomiyeand Ajana 1982); 1.6kg in six months (Ezenwa and Alegbeleye, 1984) incorrect stocking ratios of 1:16 i.e. fingerling (12–16cm T.L.) together with 8 breeding females and 8 males. The fingerlings of *Tarpon atlanticus* are very abundant in the coastal waters of Ondo State around Aiyetoro in the months of April, May and June. They come into Lagos lagoon areas during the peak rainy season. Its distribution seems restricted to the Western part of the coastal waters including Bendel State. It was not identified in the eastern zone of the country throughout the period of study. Since it tolerates fresh water conditions, plans are at hand to transport their fingerlings to fresh water ponds.

In the Eastern and Western parts of the coastal waters, the other equally fast growing predators – *Elops lacerta; Lutjanus goreensis* (snapper) and *Pomadasys jubelini* (grunter) are very abundant, January – March, at the shorelines of coastal waters at Bodo, in Rivers State and Ikot Abasi, and Oron, in Cross River State, Burutu/Warri estuaries in Bendel, Aiyetoro and environs in Ondo State and Tarkwa bay and Lagoon systems in Lagos State. The species, Gymnarchus niloticus, is very popular in fresh water ponds in Nigeria and grows very rapidly in *Tilapia* ponds. The species lives mainly in swamps, where during the floods, build spawning nests of grass. Fingerlings are very abundant in the major rivers and their tributaries by October, November and December annually.

(4) Cichlids.

- *(i) Tilapia guineensis*
- *(ii) Tilapia (Sarotherodon) galiliae*
- *(iii) Tilapia zilli.*

The three cultivable species of *Tilapia* studied in this survey are abundant in fresh and low brackish waters of Nigeria, *Tilapia guineensis* is less prolific than *Sarotherodon (Tilapia) galiliae* and is common in areas where vegetation is abundant. The former grows better in ponds and in the wild attains a growth range of 1kg – 1.5kg.

Both species have been recorded in waters where salinities are up to 30%.

Tilapia zilli, is predominantly found in fresh water but is reported to be abundant in very low brackish water (0.5% – 1.5%) areas of the country from Badagry lagoon, Epe lagoon, Warri creeks and estuaries; and parts of Rivers and Cross River States with such low salinities. *Tilapia* generally are plankton and detritus feeders and readily accept all locally available food materials like groundnut cake, palm kernel cake, rice bran etc.

Fingerling collection from the wild is by means of traps and shore seines.

Table 5 – Culturable fish seeds in Rivers State

Species	*Locality*	*Time of year*	*Estimated Population (million)*
Mugil cephalus *Liza grandisquamis* *Liza bananesis*	Shore lines of the coastal areas, lagoons, esturies, creeks.	March–July	3.5
Chry. nigrodigitatus	Major Rivers and tributaries.	May–September	1.5
Elops lacerta	Shore lines of coastal areas	June–July	0.5
Lutjanus spp (snapper)	Bodo, Opobo Baguma, etc.	May–June	
Pomadasys (grunter)	Shore lines of coastal areas	January–March	0.5
Clarias Lazera *Heterobranchus* spp	tributaries and swamps of major Rivers	June–September October–December	1.0
T. zilli *T. guineensis* *S. galiliae*	Shore lines of coastal areas & major Rivers	April–October	3.5
Heterotis niloticus	Major Rivers	June–July	
Distichodus spp	Major Rivers	June–July	1.5
Penaeus notialis (shrimps)	Shore lines of coastal areas	March–May	1.5

Table 6 – Culturable fish seeds in Cross River State

Species	*Locality*	*Time of Year*	*Estimated Population (million)*
Mugil cephalus *Liza grandisquamis* *Liza bananensis*	shore lines of the coastal areas e.g. Ikot Abasi Oron, Itu etc.	March–July	2.0
Chry. nigrodigitaus	Shore lines of Cross Rivers and tributuaries (Itu & Oron)	June–September	1.5
Tilapia zilli *Tilapia guineensis*	Shore lines of the coastal area	April–September	3.5
Sarotherodon galiliae	Rivers and tributaries		
Pomadasys spp. (grunter)	Shore lines of the coastal areas	February-April	0.5
Lutjanua spp (snapper)	Shore lines of the coastal areas	June	0.5
Gymnarchus niloticus	Shore lines of Cross River at Itu and Tributaries	July–October	1.5
Heterotis niloticus	–do–	June–August	1.05
Distichodus spp	–do–	July–August	1.0
Clarias lazera *Heterobranchus spp*	Major Rivers tributaries and swamps	October–December	1.5
Penaeus notialis (shrimps)	Shore lines of coastal areas	April–July	1.5

(5) Fish species for weeds and grass control in ponds.

(i) Heterotis niloticus
(ii) Distichodus brevipinnis
(iii) Distichodus rostratus

Many ponds in Nigeria are often covered with weeds and grass during the rainy season. Some pond owners have for the past ten years expressed interest on the exotic grass carp. It has been stocked in Nigerian Fish Farms Limited, Patani and recommended for all pond owners with problem of too much weeds and grass. Specimens caught during the survey were dissected and the long intestine were found to be filled with grass. In natural environment, *Distichodus brevipinnis D. rostratus* generally live along the grassy shores of rivers, their tributaries and swamps. During the floods (June, July end August) fingerlings are abundant in the catches of fishermen especially arbund Forcados River, River Niger, Excarvos and Calabar River and Cross River. Few dissected specimens from Forcados Rivers, indicated very large ovaries that contained many eggs.

The fingerlings of *Heterotis niloticus* are abundant in major rivers, tributaries, and swamps in June, July and August. The species grows very well in ponds and reservoirs with problem weeds. It spawns very easily insuch environment. Spawning was recorded in 1982, 1983 by the survey team at Nigerian Fish Farms Limited, Patani.

Penaeus notialis (shrimps).

Interest in shrimp culture has increased among Nigerians for the past five years. Request for shirmp culture have come mianly from residents of the coastal belt where the larvae of the shrimps come into the creeks with the tide. Although technology in shrimp culture is non-existent in the country, efforts have been made by the Institute to culture the incoming larvae with mullets and Tilapia. Results obtained have been encouraging (Sivalingam and Ezenwa, 1973). Data from this survey indicated an abundance of shrimp larvae to sustain any commercial culture pending the establishment of shrimp hatchery in the country. Peak period of abundance of juveniles in lagoons, creeks and estuaries in Nigeria falls between May and July. During this season, they are generally caught in traps by fishermen. The juveniles are more abundant in the lagoons during high tidal periods. An estimated seven million juveniles could be collected annually from the coastal waters.

DISCUSSION

Fish production through Aquaculture in some countries has contributed to a considerable extent towards meeting national demand. In United States of America, it is 11% of the overall fish production, in China 50%, and Isreal, 25%. The figure in Nigeria is 0.4%. If Nigeria is to raise her present production level of 20,000 tons (Okpanefe et al 1984) to 100,000 tons of fish through aquaculture by the year 2,000 certain key priority areas have to be developed. Top on the list is the full exploitation of seeds of desired species from their natural environment.

To raise two tons per hectare of table sized fish from ponds in Nigeria needs about seven thousand fingerlings at our present level of fish culture development. To meet the projected figure of 100,000 tons of fish through Aquaculture in the next fifteen years, the country needs an established pool of 350, million fingerlings annually. How can we meet this figure. Over 50% of this requirement must come from the wild while 10% from indoor and pond hatcheries. Data from the present survey have proved that 100 million fish seeds can be collected annually from both fresh, brackish and marine waters of the country.

The major highlights of the research survey include fish seed migration along the various ecological zones as shown in figure 3 isolation of fish species, and overlapping of feeding habits.

The Nigerian water environment is classified according to salinity level from the works of Olaniyan (1957), Moore (1963), Ikusemiju (1973) Ezenwa, (1978, 1981). What is regarded as Marine environment has a salinity of above 30%; High brackish water (20–29.9%), mid-brackish water 0.5–9.9%, fresh water (0.0–0.5%). Certain cultured fish species are euryhaline e.g. mullets, *Liza falcipinnis; Tarpon* atlanticus (predator); the catfish, *Chry. nigrodigitatus* (up to 30%); and *Tilapia guineensis* and *Sarotherodon Tilapia galiliae* (up to 30%). The fish seeds of the mentioned species are most abundant in the low brackish and fresh water conditions. They could easily be conditioned to live in fresh water ponds. The seeds of *Mugil cephalus* and *Liza grandisquamis* prefer the high salinity zones (25% – 32%). Such seeds are more abundant at the mouth of harbours, estuaries, lagoons, and shore lines of the coastal belt.

It was also observed by the research team that there is an incidence of over-lapping of feeding habits of the desired species. The seeds of mullets, *Tilapia* spp. and shrimps are essentially plankton and detritus feeders. There is therefore serious competition for food. In the Lagos area, the fingerlings of the more desired and fast growing *Tilapia guineensis* are gradually phasing out and being replaced by the more prolific *Sarotherodon galiliae.* The ratio of abundance of the two speices a decade ago was 10:1 (Sivalingam and Ezenwa, 1973) in favour of *S. galiliae.* The ratio was found to be 20:1 (Ezenwa and Alegbeleye, 1984). Similar competition was observed in the three species of mullets but not to a very serious extent.

Certain ecological restriction of the cultured species were also observed. The fast growing predator, *Tarpon (megalops) atlanticus* seems restricted to the Western zone of Nigeria while *Elops lacerta, Lutjanus* and *Pomadasys* are more abundant in the Eastern zone of the coast. This type of distribution reduces the incidence of severe competition for food.

Certain key factors affecting population abundance of desired fish seeds were identified. Use of explosives and over-fishing, destruction of juvenile schooling areas by modern coastal development as happened in Lagos areas (1974–1980) have Significantly reduced the members available for collection by farmers. Oil pollution is very common in Bendel, Rivers, and Cross River areas. Industrial and human wastes are dumped in lagoons, estuaries, creeks and the major rivers. The nursery grounds of most of the cultured species are destroyed and the nation loses considerably in terms of fish production. The nature of the bottom sediments along the coast is identified as a factor which affect population abundance of fish seeds. The coastal area is made up of sand, silt clay, and very rocky portions. Some nutrients available in the soil are utilized for plankton formation. If absent in the soil, abundance of seeds will be reduced. Tilapia and mullet fingerlings pick up detritus from the muddy areas, hence their large numbers in Lagos and Delta areas of the coast. Some demersal species like *Lutjanus* spp. (snappers) tend to keep close to rocks when such shelter is available (Sivalingam, 1974). Their fingerlings can be collected from small bays and crevices along estuaries.

The key areas of future research will include the development of gears for collection of the seeds and transportation facilities, since over 80% are located in most inaccessible water-logged areas of the coastal waters.

ACKNOWLEDGEMENT

The Research team appreciates the support and interest of the Director (NIOMR) Mr. J. Tobor, in the research survey. We are also very grateful to field officers of Federal Department of Fisheries, and State Fisheries for their assistance and co-operation.

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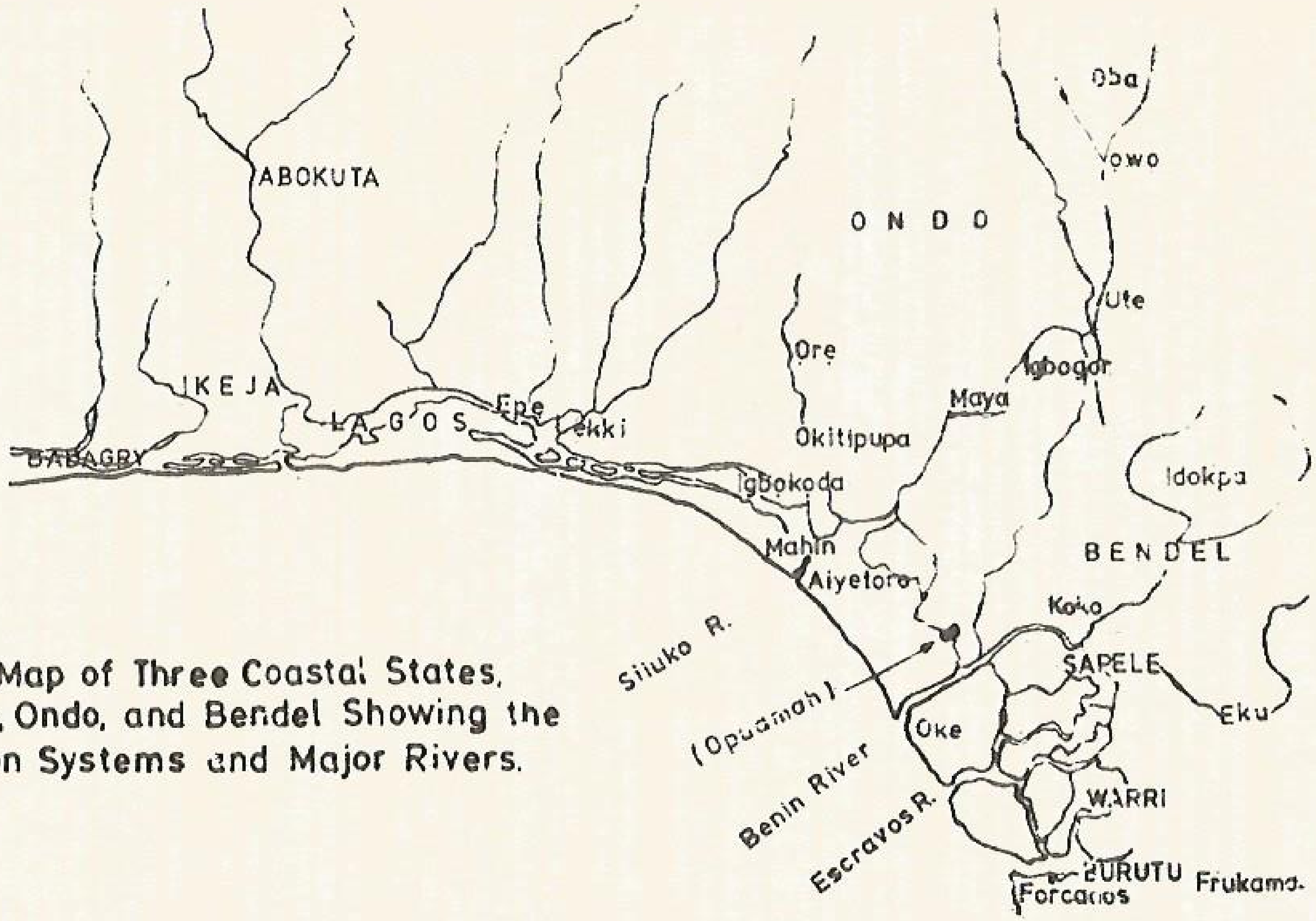

Fig. I Map of Three Coastal States, Lagos, Ondo, and Bendel Showing the Lagoon Systems and Major Rivers.

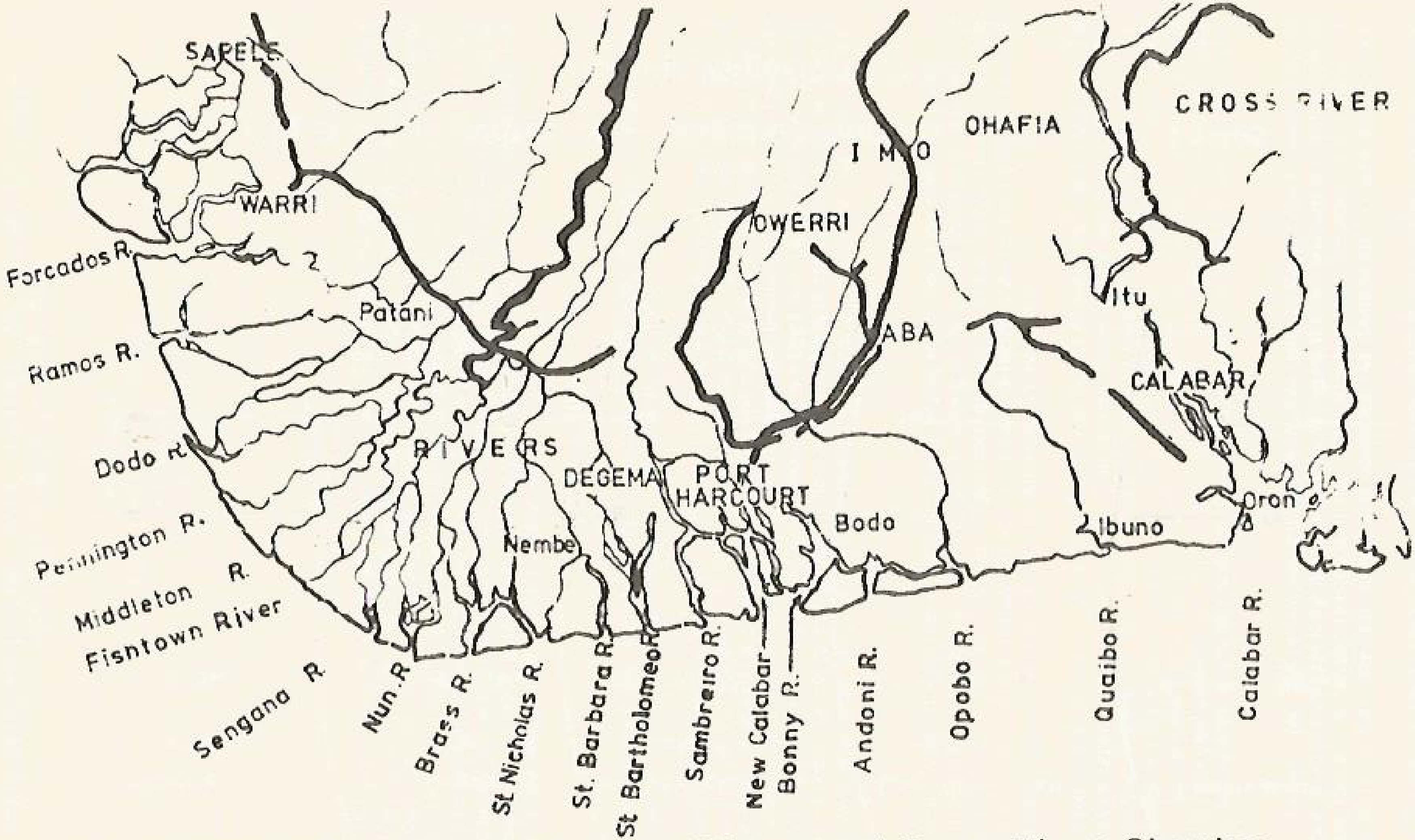

Fig. 2: Map of Two Coastal States, Rivers and Cross River Showing Lagoon, estuaries, and Major Rivers.

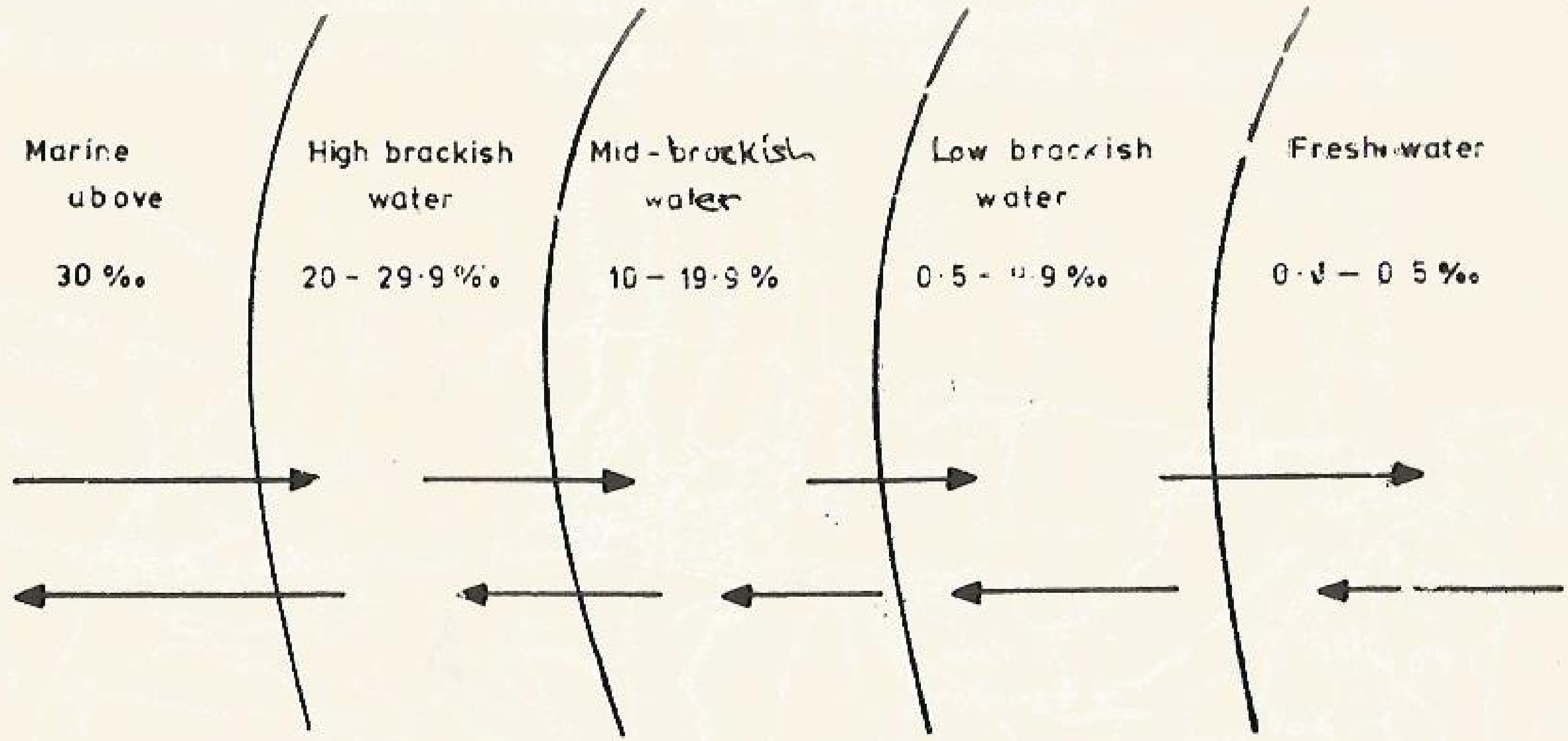

Fig. 3 Fish migration — Showing various ecological zones along Nigerian Coast.

PRELIMINARY STUDIES ON BAMBOO FLOATING CAGE AND NET ENCLOSURE FISH CULTURE IN KAINJI LAKE BASIN

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ABSTRACT

The main objective of this paper is to introduce this new technology aimed at producing fish from almost all available inland bodies of water in Nigeria. The experimental approach embarked upon at Kainji Lake Research Institute is discussed. Results obtained from these experiments would help in identifying the inherent problems of this culture system and in determining the urgently needed information that will serve as management and production guidelines for adapting the technology to local conditions of varying ecological characteristics in Nigeria. Ultimately, the project is aimed at increasing the productivity of fishermen/fish farmers and hastening the development of rural communities.

INTRODUCTION

Amongst the known modern aquaculture systems for increased fish production, cage and net enclosure culture are about the cheapest to operate (Otubusin, 1983).

Unlike pond culture which is one of the earliest and widely practised aquaculture systems cage culture does not compete with other land use for urbanization, agriculture and other industrial development. This culture system is preferred to pond culture because it requires limited investment, allows higher stocking density of fish, ensures complete control of the harvest and generally provides high returns on investment when effectively managed and the fish species and site are suitably selected for the culture system. Fish yield from this system could be as high as 10 to 20 times more than from pond culture considering the surface area/space and the inputs (Anon, 1979).

This system of aquaculture has undoubtedly proved to be one of the main alternatives for fish production in many countries – the catfish farming in the United States of America; trouts raising in Norway and Great Britain; Tilapia/milkfish culture in the Philippines; the serranids culture in Hong Kong and yellow tail and red seabreams raising in Japan are but few examples of the centres of greatest activity utilizing this innovation in aquaculture.

Even though Nigeria is well-endowed with vast bodies of water and resources suitable for this culture system, the potentials are yet to be tapped. Some success have been reported in fish cage culture in some African countries like Tanzania in Lake Victoria (Ibrahim *et al*, 1975), Ivory Coast at Lake Kossou (Coche, 1975; 1977; Shehadeh, 1974). and recently in Egypt (Ishak, 1979). In the Lake Kainji, Nigeria, Konikoff (1975) studied the possibilities for cage culture and noted the great potential for fish culture in the lake area. Ita (1981) also attempted some cage culture experiments in the lake and noted some major constraints to viable cage culture experiments.

The cage, pen and net enclosure project embarked upon at Kainji Lake Research Institute is aimed at maximally exploiting the water bodies of Nigeria through production oriented research on cage, pen and net enclosure culture of fish. The ultimate goal of this project is to increase the productivity of fishermen/fish farmers and accelerate the development of rural communities.

This paper presents some findings from the on-going preliminary studies of bamboo floating cage and net enclosure fish culture in Kainji Lake basin.

MATERIALS AND METHOD CAGE CULTURE

The Site

Two culture sites, namely Kigera III drinking water reservoir located within the Kainji Lake Research Institute Estate at New Bussa and Shagunu Bay on the western side, of the central basin of Lake Kainji (Figure 1) are used for this culture system. Kigera Reservoir, a drinking water reservoir about 0.5 hectare surface area and 2m average depth was constructed by damming a seasonal stream. The reservoir was filled with water just before this study by pumping water from Lake Kainji through a distance of about 1 km. Subsequent water replenishment was from the annual rainfall. The physico-chemical and biological characteristics of Lake Kainji (about 1275 km2 surface area) have been reported by several workers (El–Zarka, 1973; Henderson, 1973; ımevbore and Adegoke, 1975, Adeniyi, 1978).

Cage Construction.

Two types of modules of cages were used in these series of experiments. The first type was a module 9x6m bamboo raft of 6 units fitted with 1x1x1.5m floating net cages (210/9, 10mm mesh size), while the second module was of 9x9m bamboo raft with sixteen 2x2m compartments to which were fitted 1x1x1.5m floating net cages (210/9, 12.7mm mesh size) or 1x1m floating net hapas (for breeding and fry nursery) (Figure 2). Empty oil drums served as floatation devices and 0.3x0.3x0.3m concrete blocks were used for mooring the bamboo raft and cast concrete sinkers (of empty tomato and milk tins) were used for rigging the net hapas and cages respectively. Other construction procedures are as described in Otubusin and Opeloye (1983).

The Culture Studies.

Three grow-out phase studies and two hatchery/nursery studies were conducted.

Study 1: The effect of varying levels of blood meal feeds on fish (Oreochromis niloticus) Production

Three diets of varying amounts of blood meal and corn bran mixed with layer's concentrate in the ratio 3:1 and 1% vitamin mix were tested. The composition and proximate analysis of the feeds are shown in Tables 1 and 2.

Table 1 – Composition of three feed formulations fed to Oreochromis *niloticus* in cages for 120 days

Ingredient	*Feed*		
	I	*II*	*III*
Blood meal	50	25	10
Corn bran/layer's concentrate	49	74	89
Vitamin mix	1	1	1

Note: Figures are expressed in percentages (%).

Table 2 – Proximate analysis of three feeds used in Study 1

Feed	*Crude Protein*	*Crude Fat*	*Crude Fibre*	*Ash*	*NFE*	*Ca*	*P*
I	49.07	0.61	3.60	5.31	41.41	1.14	0.07
II	46,87	0.25	3.71	6.81	42.36	1.36	0.11
III	31.34	1.26	4.14	5.90	57.36	1.30	0.10

Note: Figures are expressed in percentages.

The treatments I, II and III corresponding to feeds I, II and III were assigned to cages using a completely reandomized design. *Oreochromis niloticus* fingerlings (3.1–4.0g) were stocked at the rate of 100/m3 into the cages.early morning on April 10, 1984. Each treatment (diet) was replicated twice. The fish were fed with the pelleted feeds corresponding to their treatments at the rate of 10%, 5% and 3% of the fish biomass during the 1st, 2nd, 3rd and 4th months of the experiment respectively. Feed allowances were adjusted every two weeks based on the estimated fish weight by sampling or by using a feed conversion value of 2.57 (Guerrero, 1980). 10% of the fish stocked were sampled for growth at 30 days interval. Physico-Chemical parameters of the water within the cage module and outside were monitored by the Limnology Division of the Institute (KLRI). The fish were harvested on August 6, 1984.

Study 2: Growth performance and cage-culturability of some fish species endemic in Kainji Lake

Mixed fish species viz: *Citharinus citharus, Clarias* sp, *Oreochromis niloticus, Sarotherodon galilaeus, Alestes dentex, Heterobranchus bidorsalis, Lates niloticus* and *Distichodus* sp., were stocked randomly in cages (2x2x2m and 2x2x3m) between April 16, 1984 and July 4, 1985 at Shagunu Bay to observe their growth performance and cage-culturability. The fish were fed sparingly with feed II as in study 1 about once a week but they were made to subsist mainly on the natural food present in the Lake water. The fish were sampled about monthly for growth rate.

Study 3: The effect of stocking density on tilapia production in floating bamboo net cages in Kigera III Reservoir

The experiment consisted of four treatments (I, 25 fish/m3; II, 50/m3; III, 75/m3 and IV, 100/m3) each replicated in three cages (1x1x1.5m) in a completely randomized design. The fingerlings (4.6–6.7g) were randomly stocked into the net-cages in the early morning of March 16, 1985. The fish were fed with pelleted feed (See Table 3 for the nutrients composition) at 6% of thrie biomass per day. The fish daily ration was adjusted bi-weekly by sampling 20% of the fish for body weight changes.

Study 4: The effect of male: female ratio of Oreochromis niloticus breeders on fry production in floating net-hapas

The breeders were sexed and stocked randomly in net hapas (1x1x1m) in the evening on April 2, 1985 based on the following treatments:–

I	1 Male	1	Female	(10/m3)
II	1 Male:	3	Females	(12/m3)
III	1 Male:	5	Females	(12/m3)

Table 3 — Nutrients composition(%) of ingredients in the diet formulated for study 3

Ingredients	*Amount*	*Protein*	*Fat*	*Carbohydrate*	*Fibre*
Starch (binder)	2.0	—	—	2.0	—
Brewer's waste	40.0	7.32	—	18.36	—
Corn bran	43.5	5.31	3.74	28.01	1.22
Layers' concentrate	14.5	4.71	0.15	—	—
	100.0	17.34	3.89	48.37	1.22

The breeders were fed with pelleted feed I as in study 1, twice daily at 5% of the fish biomass. Sampling for the number of hatchlings (fry) per hapa was carried out immediately the fry were observed to be schooling within the hapa. The breeders were also sampled for growth at about 30 days intervals and the feed ration adjusted accordingly. Some physico-chemical parameters of the water were monitored. The experiment was terminated on June 8, 1985.

Section 5: The effect of different feedstuffs on Tilapia Fingerlings production in floating hapas in Kigera III Reservoir

The diets used in this study were single ingredient feeds: rice bran, corn bran and brewer's waster (Table 4). They were ground singly into powder form and then sieved.

Table 4 — Nutrients composition (%) of the feedstuffs

Feedstuffs	*Crude Protein*	*Carbohydrate*	*Fat*
Brewer's waste	18.8	45.9	—
Rice bran	8.7	56.0	8.7
Corn bran	12.2	65.4	8.6

The experiment consisted of four treatments — I, Brewer's waste; II, Rice bran; III, Corn bran and IV, Control, No feeding, each replicated in three net hapas in a completely randomized design. The fry (0.28 — 0.40 g) were stocked at the rate of 100/m3 in all the hapas on March 15, 1985 early morning. The fish fry were fed twice daily (09.00 hrs and 16.00 hrs), seven days per week at the rate of 20% of their biomass per day. Feed rations were adjusted every week based on the estimated new weight by sampling 40% of the biomass. Some aspects of the physico-chemical parameters of the water were monitored. The fish were harvested on April 26, 1985.

RESULTS AND DISCUSSION

Table 5 shows a summary of the results obtained in study 1. The average growth rate (g per day) for treatments I, II and III were 0.27, 0.31 and 0.39 respectively. There was significant difference in the relative weight gain in treatment II compared with the values in treatments I and III. The high survival rates were partly attributed to proper management of the stock and the physico-chemical conditions of the water in the reservoir during the culture period.

Table 5 – Summary of results for *Oreochromis niloticus* receiving different levels of blood meal feeding in floating cages for 120 days

Items	*Treatments*		
	I	*II*	*III*
Average initial wt. (g)	3.4	3.3	3.8
Average final wt. (g)	20.0	35.0	39.1
Average wt. gain (g)	16.6	31.8	35.4 ns
Relative wt. gain (%)*	497.8	972.5**	956.8
Survival (%)	99.5	99.0	100.0
Total fish production (kg/m3)	1.993	3.465	3.910 ns
Feed Conversion ratio	2.17	1.36	1.67

* Relative wt. gain (%) = $\frac{\textit{Final wt.} - \textit{Initial wt.}}{\text{Initial wt.}} \times 100$

ns Not significantly different (P = 0.05) compared with the values of other treatments.

** Significantly different (P=0.05) compared with the values of treatments I and III.

Note: Figures are means of two replicates.

Table 6 – Means and ranges of physico-chemical parameters in Kigera III Reservoir site for the Floating cages

Parameters	*Means*	*Ranges*
Temperature (oC)	29.4	25.8 – 31.6
Water pH	7.1	6.9 – 7.6
Conductivity (umho/cm)	124	63 – 160
Dissolved Oxygen (mg/L)	3.6	2.8 – 4.8
Suspended solids (mg/L)	21	0 – 40
Turbidity (FTU)	53	15 – 220
No_3 (mg/L)	2.0	1.5 – 2.5
PO_4 (mg/L)	0.47	0.11 – 1.22
Chlorophyll (kg/L)	20.4	14.7 – 32.0

Note: Water samples taken at 1m depth from surface.

The total fish production in this study is comparable to the value 2kg per m3 obtained by Delmendo and Baguilat (1974). Treatment III (10% blood meal feed) recorded the best average gain, survival and total fish production. Performance of this feed could be related to the crude protein level (31.34%) ad the energy/protein ratio of the feed.

The feed with 25% blood meal had the lowest conversion ratio (1.36) which was even better than the ratio (1.7) obtained with 25% fish meal feed by Guerrero (1980). Blood meal aside from having a higher protein content (80%) than fish meal was compensated for its lower arginine, tyrosine, methionine and isoleucine contents by the cereals by-products incorporated in the feed. This result confirmed the observation that 27% protein was suitable for intensive culture of tilapia (ADCP, 1983).

The growth performances of the fish species stocked in Shagunu cages are shown in Table 7. *Citharinus citharus* recorded the highest average growth rate, followed by *Clarias lazera, Oreochromis niloticus, Sarotherodon galilaeus, Distichodus rostratus* and least in *Alestes dentex*. The cage culture method used in this study was more or less the extensive or semi-intensive type because the tocked fish were made to subsist almost entirely on the natural food in the lake.

Table 7 – Growth performances of fish species stocked in floating cages at Shagunu Bay

Species	*Rearing period (days)*	*Mean Size of Fish*		*Average growth rate (g/fish/day)*
		Initial (g)	*At Harvest*	
Citharinus citharus	150	54.0	550.0	3.31
Oreochromis niloticus	150	50.0	475.0	2.83
Clarias lazera	177	135,9	715,0	3,28
Sarotherodon galilaeus	150	30.0	225.0	2.03
Heterobranchus bidorsalis	147	41.8	110.0	0.46
Tilapia zilli	150	14.3	77.3	0.42
Alestes dentex	240	60.0	120.3	0.25
Distichodus rostratus	200	20.0	225.0	1.02
*Lates niloticus**	14	30.0	–	–

**All died before the scheduled sampling period (Stomachs observed empty).*

The planktivorous fish species which often have low protein requirements were mostly favoured. It was therefore, not surprising that the microphagous/planktivorous *Citharinus citharus, Oreochromis niloticus*

The planktivorous fish species which often have low protein requirements were mostly favoured. It was therefore, not surprising that the microphagous/planktivorous *Citharinus citharus, Oreochromis niloticus* and *Sarotherodon galilaeus* recorded high growth rates. Algal growth was observed on the side walls and top covers of the cages. In addition some schools of clupeids were found inside the cages during sampling periods. *Clarias lazera* (an omnivore) could have subsisted on these little sardines in addition to other food sources for growth. The macrophagous *Tilapia zilli*, however, did not grow as fast as the other tilapias cultured. The good performance of *Citharinus citharus* in this study has therefore confirmed the observation of Arawomo (1972) that *Citharinus* sp were no longer bottom dwellers in Lake Kainji. In fact, all the *Citharinus* sp used in stocking the cages were caught by cast-netting around the Shagunu bay. The fish were observed to be browsing on the periphyton that grew on the cage walls.

The summary of the results obtained in study 3 is shown in Table 8. It was observed that the growth rate of the fish generally decreased with the increase in stocking, but the trend was broken by fish in treatment III which had a better average final weight (55.8g) and growth rate (0.23g/day) than treatment II. However, at final harvest it would be possible to state the best stcoking density based on survival rate total fish production and the final mean size of fish.

Table 8 – Summary of results for *Tilapia* sp stocked at different densities as at October 22, 1985

Treatment	*Mean size of fish (g)*		*Average growth rate (g/fish/day)*
	Initial	*Final*	
I, 25/m3	5.3	70.6	0.30
II, 50/m3	6.7	52.3	0.21
III, 57/m3	5.2	55.8	0.23
IV, 100/m3	4.6	36.1	0.14

Table 9 – Shows the Summary of results of the effect of male: female ratio of *Oreochromis niloticus* breeders on fry production in floatig net-hapas.

Table 9 – Summary of fry production of *Orechromis niloticus* in floating net hapas

Treatment	*Mean Wt. (g)* M	F	*No. of frys produced*	*Average No. of fry/spawn*	*Average No. of fry/female*	*Average No. of fry/Prod./Month*	*Average Wt. gain/breeder (g/day)* M	F
I M:F 1:1	106.0 (5)*	72.0 (5)*	1500(1)**	1500	300	750	0.81	0.27
II M: F 1:3	116.7 (3)	66.7	2001(4)	500	222	1000	0.75	0.08
III M: f 1.5	150.0(2)	60.0(10)	670(2)	335	67	335	0.33	0.07

**No. of breeders in parenthesis*
***Total No. of spawninin parenthesis.*

School of fry was first observed 18 days after stocking in treatment II; day 38 in treatment III and day 61 in treatment I. Likewise, spawning frequency in 61 days was highest in treatment II, 4 times; followed by III, 2 times; and least in treatment I, only once. The highest spawning frequency observed in treatment II (1:3) corresponds to the results of Uchida and King (1962) and Guerrero (1976). The delayed spawning and least spawning frequency observed in treatment I (1:1) could be related to the competition among the males for the female breeders.

The high fry production per female breeder in treatment I could be attributed to the high chances of successful fertilization of the female eggs by the numerous number of males in that treatment compared with the low number of males in treatment III. Madu and Ita (1984) on the other hand observed a total number of fry/spawn of 228 and 226 for ratios 1:3 and 1: 1 respectively feeding the breeders with a diet of about 30% crude protein. Their figures are indeed lower than the range 225 to 1500 observed in this study. The highest values obtained in this study may be as a result of the richer pellected feed (approximate 50% crude protein) fed to the breeders coupled with the favourable physico-chemical parameters observed throughout the experimental period (Table 10).

Table 10 – Means and ranges of Physico-Chemical parameters in Kigera II reservoir during the period of study 4

Parameters	*Ranges*	*Means*
Water Temperature (°C) A.M.	25–30	27.5
Water Temperature P.M.	26–34	30.0
Air Temperature (°C) A.M.	26–32	29.0
Air Temperature P.M.	28–39	35.5
pH	7.8–8.3	8.05
D. O. (ppm)	3.02–5.68	4.35
Primary productivity (mg/L/day)	0.33–2.34	1.34
Transparency (m)	0.45–0.75	0.54

The floating hapas in the reservoir were regularly flushed by the flow of water through them as if it was a flow-through system. The flow of water also brought along plank onicfood. Comparing the results of ratio 1:1 in this study with those of similar ratio by Madu and Ita (1984) producing 1,281 fry in 5 months (256/month) in indoor concrete tanks and Sado (1984) producing 1,918 fry in 8 months (240/month) in outdoor raceways. The floating hapa method of fry production is more productive.

Table 11 shows the summary of results of Tilapia fry receiving different feedstuffs under study 5.

Table 11 – Summary (means 1/of results of Tilapia fry receiving different feedstuffs for a period of 42 days in floating hapas

Treatment	*Average Wt (g)*		*Average daily Wt. gain 2/ (g/day)*	*FCR*	*Survival*
	Initial	*Final*			
I. Brewer's waste	0.34	1.19	0.0203 b	7.14 b	94 a
II. Rice Bran	0.40	1.10	0.0167 b	9.12 a	84 b
III. Corn bran	0.33	1.60	0.0302 a	6.53 b	90 a
IV. Control (No feeding)	0.28	1.05	0.0183 b	–	78 b

1/. *Means in a column with the same supercript are not significantly different at 5% Duncan Mean Range Test (DMRT)*

2/. *Average daily weight gain =* $\frac{\text{(Final Wt. – Initial Wt.)}}{\text{No. of days}}$

The growth performance of the fish on these feedstuffs could be related to the crude protein, fat and carbohydrate levels of the feed ingredients used. The best growth observed in fish fed with corn bran (64.4% carbohydrate) was similar to that of Coche (1977) who noted that Tilapia *(Sarotherodon niloticus)* could accept very high levels of carbohydrate diet. In addition, the stability of the three feedstuffs could have contributed to the growth performances of the fish. The corn bran was observed to float almost indefinitely on the water surface in the hapas, thus, allowing the fry to feed on it and utilizing it for growth.

Similarly, treatment III (corn bran) had the best feed conversion ratio of 6.53. The FCR range, 6.53 – 9.12, for the three feedstuffs in this study was similar to the FCR values 5.0 and 8.0 obtained for cereals and rice hulls respectively fed to tilapia (FAO, 1976). The digestibility, stability in water and nutrient contents of these feedstuffs could be attributable to these varying FCT. Corn bran was observed to perform best, based on the FCR, average final weight and the growth rate.

ENCLOSURE CULTURE

Enclosure culture of fish in an unstocked seasonally flooded bay of Lake Kainji at Dogongari, New Bussa.

The Site

This culture system is sited at Dogongari bay, a seasonally flooed enclosed bay located at the south-western side of Lake Kainji (Figure 1).

Enclosure Construction and Inputs

The first trial of this fish culture system was made during the 1983/84 culture season Otubusin and Opeloye, 1983 and 1984). During that trial the cleared bay (total area, 7.9 ha) flooded by the black flood starting November 28, 1983 was blocked shore-to-shore using a mounted nylon net (210/9, 25mm mesh size and length about 150m) on March 5, 1984. Bamboo poles *Bambusa vulgaris* Schrad-ex–Wendel, each about 9m long, served as frame work for the block net (Figure 3). Other construction details are as reported in Otubusin and Opeloye (1983). The serious gale during the early rains contributed to the failure of the first trial (Otubusin and Opeloye, 1984). Based on the experience gained during the first trail, some modifications on the culture system were recommended for implementation in the next trial (Otubusin and Opeloye, 1984).

The modifications implemented were (Figure 4):–

(a) partial bunding of the bay in addition to blocking with the net used in the first trial

(b) blocking of the unbunded part i.e., the channel along which flood water flows in from the lake, using 2" – meshed fencing wire, with G.I. pipes (2" diameter, 20ft length) as frame work.

(c) rip-rapping of the water channel inlets into the enclosure (from the upper zone) with bamboo poles and fencing wire to control influxt of debris.

The fourth modification i.e. the excavation of about 2 ha of the total surface area of the enclosure for increased water retention and all-year round fish culture was only partially implemented due to non-availability of an excavator.

For the second trial culture, the enclosure was flooded by the black flood starting October 29, 1984 and the water level peaked on January 2, 1985 with a total water surface area of about 4 ha. The G. I. pipes were installed and the fencing wire affixed on January 20, 1985. The enclosure water inlet from the lake was finally blocked with the blocknet on February 14, 1985 in the early evening. The enclosed fish (brought in by the lake flood) were fed at the rate of 7 bags of brewers waste per week as from February 18, till the first harvest on 28 March, 1985

RESULTS AND DISCUSSION

Table 12 shows the summary of the fish harvest from the enclosure. Harvesting started when the water surface area was about 0.2 ha and the fish were already concentrated in the small water volume.

The total fish harvest was about 58 kg. The table size fish constituted 22.3% and 54.8% of the total harvest by number and by weight respectively while the fingerlings constituted 77.7% and 45.2% by number and weight respectively. Of the table size fish, *Tilapia* sp were the most abundant in terms of number and weight – 63.0% and 72.0% respectively. The other abundant fish species in the harvest in terms of number and/or weight are *Bagrus* sp and *Chrysichthys* sp. The abundance of these fish species (Families Cichlidae and Bagridae) was not surprising because Ita (1978) observed that the cichlids have restricted distribution and are confined to the shallow inshore waters while Ajayi (1972) noted that *Bagrus* sp. and *Auchenoglanis* sp., frequent inshore and offshore shallow waters. Since about 4 ha of the enclosure was impounded by the black flood at the peak water level, the total harvest of about 58 kg is undoubtedly less thatn the estimated average productivity of the flood plains in Africa which is about 40 kg/ha/year (FAO, 1978).

This culture trial was successful in that the modifications made at the enclosure withstood all hazards and fish harvest was possible; even though thousands of fingerlings (average wt 5g) escaped through the 1" (25 mm) meshed net used in blocking the enclosure, leaving only the bigger fingerlings as recorded in Table 12.

Table 12 – Shows the summary of the fish harvest from the enclosure

Fish species	*No.*	*%*	*Wt*	*%*	*Mean Wt. (g)*	*Wt. range (g)*
Tilapia sp.	360	63.0	22,825	72.0	63	33–567
Bagrus sp	9	1.6	3,950	12.5	439	310–950
Clarias	2	0.4	300	0.9	150	120–180
Auchenoglanis sp	2	0.4	1,000	3.2	500	450–550
Alestes sp	2	0.4	110	0.3	55	50–60
Chrysichthys sp	194	34.0	3,187	10.0	16	12–17
Heterobranchus sp	2	0.4	350	1.1	175	125–225
Sub–Total	571	100.2	31,722	100.0		
Tilapia fingerlings	1,890	94.9	24,570	–	13	10.4–18.5
Auchenoglanis "	100	5.0	1,500	–	15	10.0–23.0
Bagrus "	2	0.1	47	–	24	15.0–27.0
Sub–Total	1,992	100.0	26,117			
Grand Total	2,563	57,839.				

PROSPECTS AND PROBLEMS

Even though floating bamboo net-cage and net-enclosure fish culture systems are still very new in Nigeria, they undoubtedly have great potentials in augumenting fish production from the country's vast inland (and even marine) bodies of water including mining paddocks.

The cage culture module system when perfected is transferrable to fishermen families for operation at family unit basis. An advantage of this technology is that it is relatively simple and can be operated at small and large scale production levels. Several modules of cages can be linked together depending on the level and target of operation. More so a "vertically" integrated system can be operated wherein there are modules for broodstock development, hatchery, sursery, and finally the grow-out phase. The cage culture system is useful not only for production high quality protein cheaply but also in cleaning up eutrophic waters e.g. sewage lagoons through the culture and harvesting of caged planktivorous species. Tropical water bodies offer better opportunities for extensive and semi-intensive cage and pen culture systems since many of the commercially important species such as the tilapias, carps and even citharinids feed readily on natural macrophyte, plankton and detrital production. Lake Kainji (surface area 1,275 km2) the largest man-made reservoir in Nigeria offers great opportunities for cage, pen and enclosure culture of fish at extensive and semi-intensive levels but its potentials are yet to be harnessed. An estimated annual fish production of 765,000 metric tonnes is possible from these culture systems utilizing only 10% of the lake total surface area at a production rate of 6 kg/m3/year.

Considering the ecological variabilities in these culture systems, there are plans to establish cage culture out-stations for research, demonstration and training in certain zones of the country viz: Tiga Lake in Kano; Oguta Lake in Imo State; Ero Reservoir in Ondo State and Shiroro Lake in Niger State, while Lake Kainji serves as the national headquarters (at Shagunu Bay). More research into absolute dependence on locally available material inputs for this culture system will be intensified in order to considerably reduce the total cost of production.

The potentials of the enclosure culture system for increased fish production when fully developed are immense. Integration of this culture system with poultry, cattle rearing and paddy rice cultivation is also feasible. When perfected, the enclosure culture system is anticipated for introduction to fishermen/farmers communities along the lake. Incidentally, Lake Kainji is blessed with numerous bays suitable for enclosure culture. A good example of this type of enclosures is at the Soochow State Fish Farm, Lake Chinging in China where duck manure from the duch house built at the shore provides nutrients for the adjacent fish enclosures. Approximately 10,000 ducks and 1,000 pigs are housed along 8 to 10m wide embarkment, extending roughly 2 km into the lake (de la Cruz, 1980).

The major problems confronting this project are inadequate funding for research inputs, handy field kits for monitoring of physico-chemical and biological parameters of the water bodies and shortage of trained oersonnel for the proposed outstations. Private fishery-oriented organizations and aquacultural consulting firms like Ibru Organization; Almarine Nigeria Limited; Ritsever (Nigeria) Limited; Midland Industrial Fisheries (Nigeria) Limited and many others could be partners-in-research by generously funding this type of project, the great potentials of which are yet to be harnessed in Nigeria.

ACKNOWLEDGEMENT

The author is grateful to Mr. E. O. Ita, Head of Fisheries Division, and the Acting Director of Kainji Lake Research Institute, Dr. J.S.O. Ayeni for their encouragement and support for this on-going project. The assistance of the Fisheries Division staff especially Mr. G. Opeloye, Mallam Salihu Mohammed, Mallam Nuhu Mohammed and Mr. Lawrence Aboh Unogwu, and the Higher National Diploma (HND) Students (1984/85 set) especially Mallam S. Kotorkoshi, Messrs P. Ikyari and S. A. Shehu is highly appreciated. Mrs. Rhoda Mukoro is acknowledged for carefully typing the manuscript.

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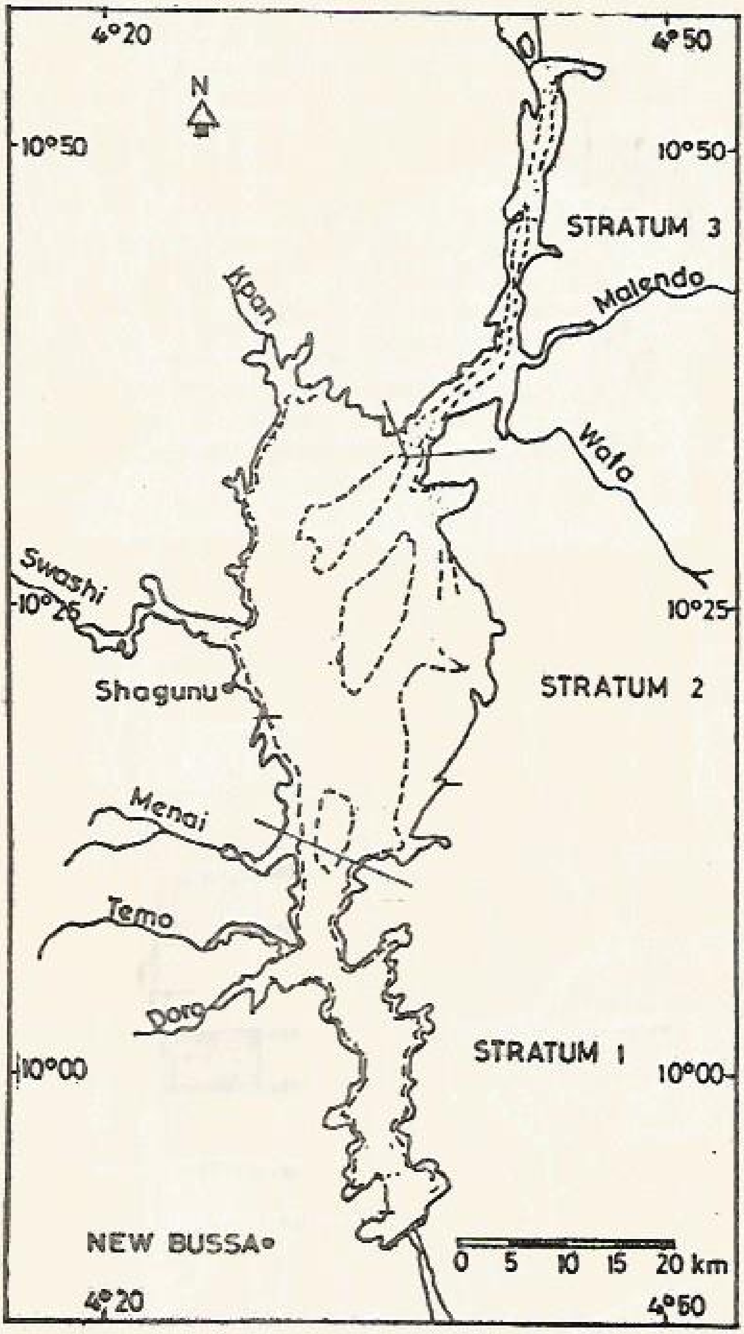

Fig. 1. Map of Kainji Lake

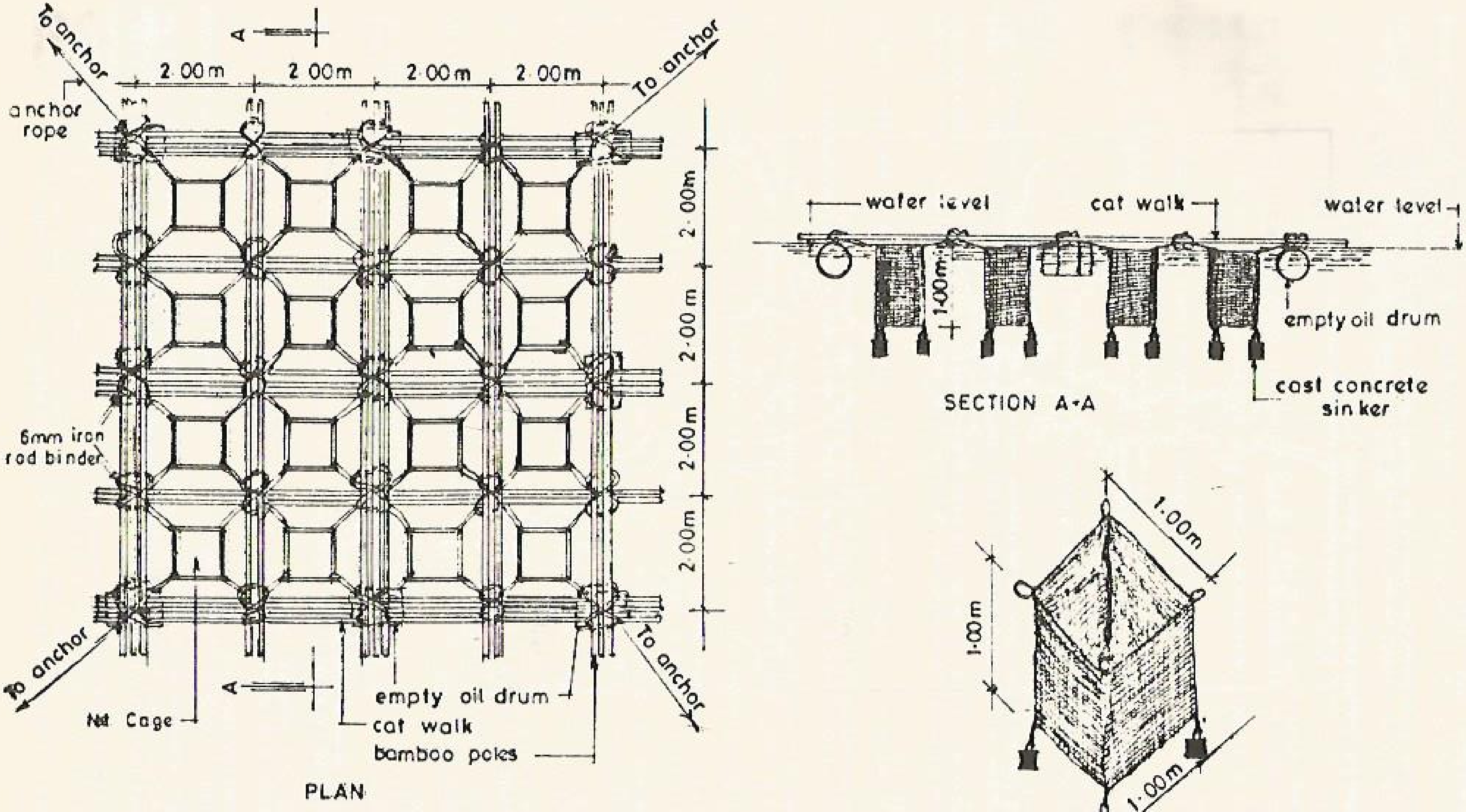

Fig 2 16 Units Bamboo Floating Cages

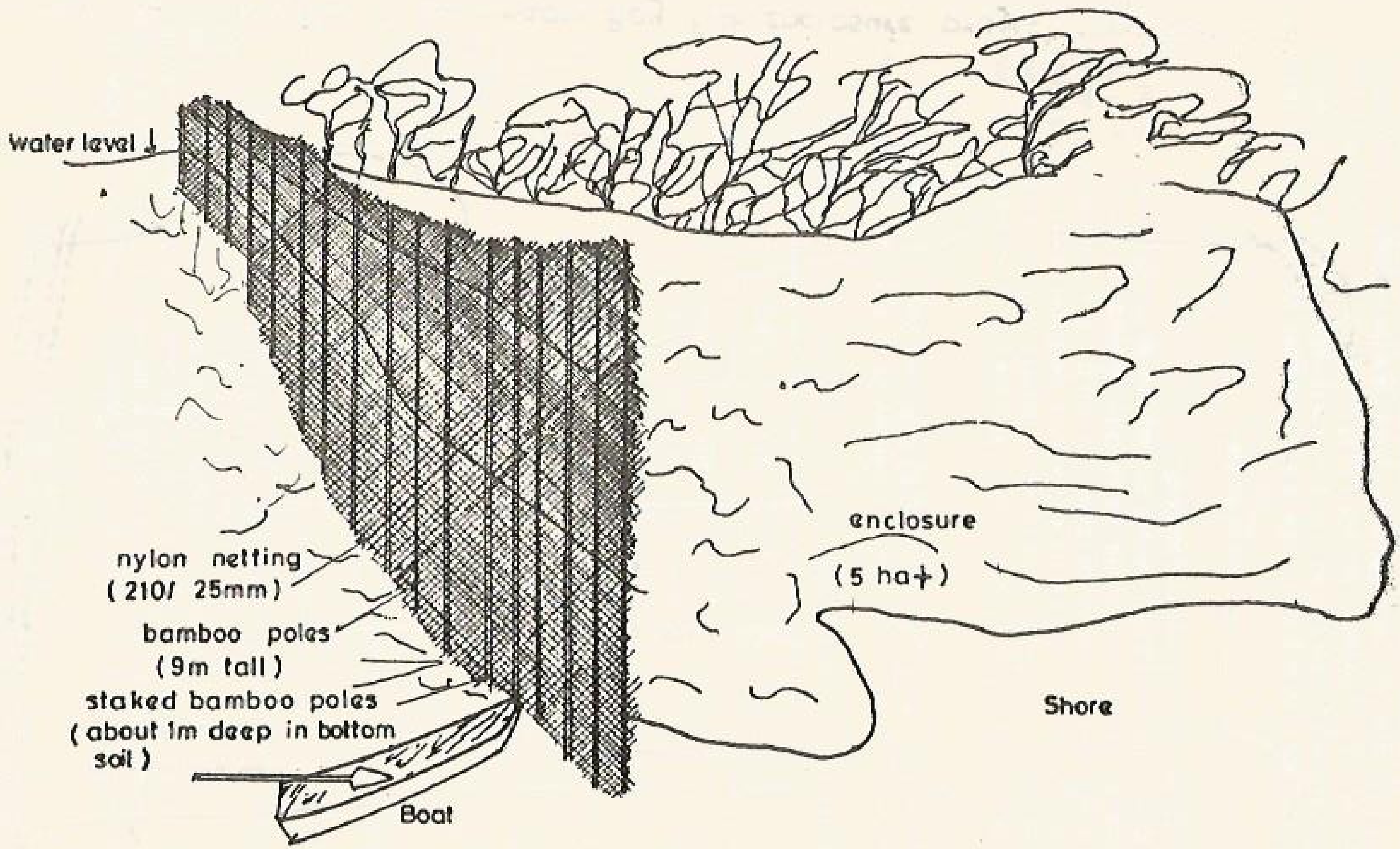

Fig. 3. Bamboo Net Enclosure Fish Culture. Dogongari Bay Lake Kainji

(not to scale

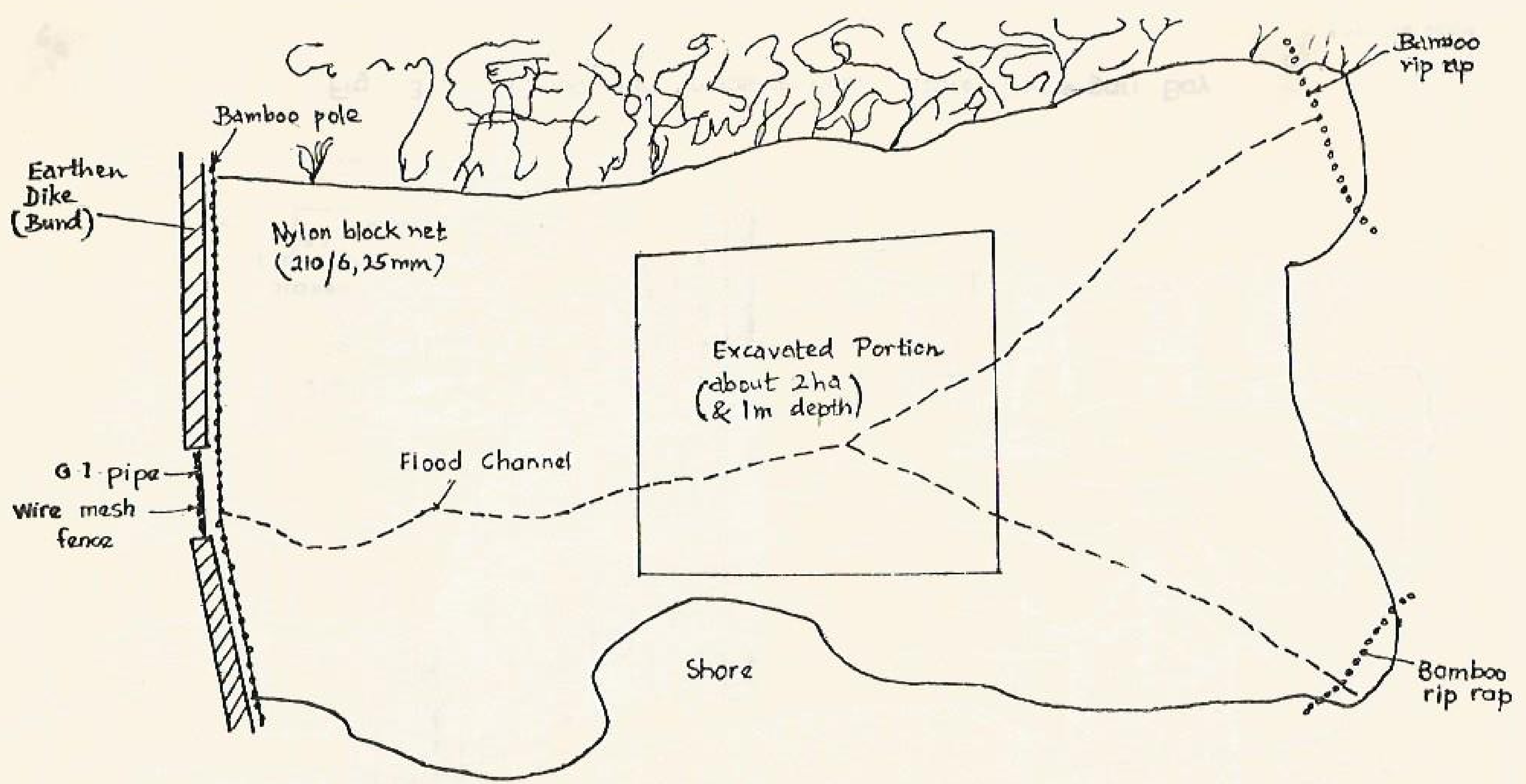

Fig 4. Profile of Dogongari Bay Fish enclosure project modifications (approx Total area: 7.9ha)

EFFECTS OF HUMAN CHORIONIC GONADOTROPIN (HCG), TOAD AND *Clarias* PITUITARY HORMOGENATES ON SPAWNING IN THE CATFHISH: *Clarias lazera* (C&V) AND *Clarias anguillaris* (LINNE)

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ABSTRACT

Experiment on induced spawning of *Clarias lazera* and *Clarias anguillaris* using human chorionic gonadotropin (HCG), freshly prepared toad and *Clarias* pituitary hormogenates were carried out.

Clarias pituitary hormogenates induced spawning in *C. lazera* and *C. anguillaris* at dosage levels of 0.27–0.46 mg/150 g body weight or 2 glands/fish of equivalent weights. HCG induced spawning in *C. anguillaris* at 500 i.u/500 g body weight but failed in *C. lazera*. Toad pituitary was not successful at even a higher dosage level of 0.60 mg/150g body weight. The implications of these results are discussed.

Spawning occurred in the HCG (and *Clarias* pituitary treated females in less than 12 hours after injection and subsequent examination of ovaries of the spawned fish showed incomplete spawning. Furthermore, fertilization occurred, following spawning in the piscine pituitary hormone treated male and female fish but failed in the HCG (treated pair. A mean fertilization rate of 50–90% was recorded. Possible explanations of these observations are advanced.

The hatching time of 24–48 hours and a mean hatching rate of 75–90% were recorded. A high larval mortality of up to 95% was observed in the post yolk-sac stage after 8 days. The need for the development of appropriate larval food for *Clarias* species in culture practice is stressed.

INTRODUCTION

Hormonally induced ovulation and spawning have been carried out in different parts of the world. Experiments with the channel catfish, *Ictalurus punctatus* have shown tht spawning was induced by the injection of pituitary materials from carp, buffalo fish, flat head catfish, channel catfish or gar into the females (Gray, 1976). Ramaswani and Sundararaj (1956) have induced ovulation in gravid *Heteropneustes fossilis* by injecting hormogenate of the catfish pituitary glands. Success was also obtained with pituitary hormogenate and some mammalian hormones (Ramaswami, 1962; Sundararaj and Goswami, 1977). Partially purified salmon gonadotropin (SG–100) brought about ovulation in the hypophysectomized *Heteropneustes fossilis* (Sundararaj *et al*, 1972). Similarly, de Kimpe and Micha (1974) have suggested that the rise of water level as stimulus for *Clarias lazera* to spawn can be replaced by a hormonal injection. Tests with pituitary suspensions and DOCA (Deoxycorticosterone acetate) have been successful, whereas human chorionic gonadotropin (HCG) and luterinizing hormone (LH) gave negative results in inducing spawning in *Clarias lazera* (de Kimpe and Micha, 1974; Nwoko, 1983, Adigun *et al*, 1984).

In the present study, HCG, Toad and *Clarias* pituitary hormogenates were comparatively used on *C. lazera* and *C. anguillaris* so as to determine their relative potency in inducing spawning in the two fish species.

MATERIALS AND METHODS

Collection and Care of Fish

Specimen of *C. lazera* and *C. anguillaris* were collected from fishermen in the Anambra River Basin in mid-February. The fish were captured by bailing out of water from family ponds – a dry season (February/March fishing method in the basin (Awachie, 1975; Awachie and Ezenwaji, 1981; Ezenwaji, 1982). This method guarantees fish capture with minima? injuries to the fish. The fish were transported a distance of about 130 kilometers in FAO type standard fish carrying tanks, to the experimental station (Zoological Garden, University of Nigeria, Naukka) The catfish were kept in concrete tanks and fed on domestic waste for a period of four months.

Preparation of Pituitary Hormogenates

Pituitary glands were removed from mature fish and toad respectively. The fish or toad was weighed on a torsion balance to the nearest gramme and immediately killed by a blow on the head. Careful removal of the roof of the buccal cavity exposed the rounded whitish mass – pituitary gland, located ventrally at the base of the cerebrum. This was then excised with fine forceps weighed on a mettler balance and stored prior to use in saline-alcohol (10% absolute alcohol in 0.6% Nacl). The glands were later ground in groups of 4, 8 and 12 respectively in pyrex test-tubes using glass pistle, hormogenized in 2 ml Saline-alcohol and then centrifuzed using Sanetzki (T30) centrifuge. Each hormone concentrate (the supernatant) was then collected in 2 ml stringe for use.

Female Treatment

Gravid females (mean body weight 130g) were chosen for this study. Each femal was weighed and placed in separate (80x40x40cm) aquarium tank containing 70 litres of water and palm fronds at the bottom as substrate for the attachment of spwaned eggs. The fish was allowed to acclamatise for one day. Ovarian development was determined by in vivo siphoning of intra-ovarian eggs using cannula according to Shedadeh *et al* (1973 b) and females with mean egg diameters in excess of 800 u were selected for use. Fish weights and initial mean egg diameters are shown in Tables 1 and 2. In the absence of established guidelines, dose rates were chosen arbitrarily at the beginning of the study and subsequently modified according to initial results. Injections were given in the evening (17:00 to 18:00 hours) and at the base of the caudal peduncle of each fish.

In order to determine the effect of single dose injection in each female, in vivo egg samples were taken before each injection. Egg diameters were measured and the dose rates (Unit/150 g body weight) and injection schedules are listed in Tables 1 and 2.

Male Treatment

The males used in this study were taken from the same captive populations as the females. The body weights of both males and females were equally matched and were injected with equal dosage of hormones.

The male was placed with each injected female when the latter began to exhibit abdominal distension (ovulation) (Shehadeh et al, 1973b). At this time, aeration was increased in the tank to help in mixing of eggs and sperm. Spawning and fertilization of released eggs were permitted to proceed naturally in the tanks. Each experiment was in three replicates. The female and male catfish were removed from the spawning tanks after spawning and natural fertilization was allowed.

Table 1 – Spawning by exogenous hormone treatment in *Clarias lazera* (C&V)

Group	Mean Body Wt. (g)	Hormone Treatment	Dose Inject. Unit/150 g Body (Wt.)	No. of Inject-ions.	Initial Mean Egg Dia-meter (u)	Latency Period (Mean)	Fecundity (Estimated After Spaw-ning (mean)	Fertilization Rate (% Range)	Hatching Range	Mortality After 8 days	
										Egg Yolk	Natural Food
1	130	HCG	20 i.u	1	900						
2	135	HOG	300 i.u	1	960						
3	150	HOG	500 i.u	1	880						
4	122.5	Toad Pituitary (3 glands)	0.26 mg	1	890						
5.	131.6	Toad Pituitary (5 glands)	0.44 mg	1	936						
6.	134	Toad Pituitary (7 glands)	0.61 mg	1	1050						
7.	135	*Clarias* Pituitary (1 gland)	0.12 mg	1	985						
8.	130	*Clarias* Pituitary (2 glands)	0.29 mg	1	950	11 hrs 10 mins	3,120	80–95	90–95	90–93	40–70
9.	142	*Clarias* Pituitary (3 glands)	0.46 mg	1	1120	10 hrs 30 mins	3,566	90–95	85–100	90–95	40–70

Table 2 – Spawning by Exogenous hormone treatment in *C. anguillaris* (Linne)

Group	Mean Body Wt.(g)	Hormone Treatment	Dose Inject. Unit/150 g Body (Wt.)	No. of Inject-ions.	Initial Mean Egg Diameter (u)	Latency Period (Mean)	Fecundity (Estimated after Spawning (mean)	Fertilization Rate (% Range	Hatching Range	Mortality After 8 days: Egg Yolk	Mortality After 8 days: Natural Food
1	125.5	HCG	200 i.u	1	999						
2	120	HCG	300 i.u	1	842						
3	132	HCG	500 i.u	1	947	10 hrs 45 mins	5,800	None			
4	126.5	Toad Pituitary (3 glands)	0.23 mg	1	894						
5	128	Toad Pituitary (5 glands)	0.41 mg	1	1030						
6	138	Toad Pituitary (7 glands)	0.60 mg	1	999						
7	128.6	*Clarias* Pituitary (1 gland)	0.13 mg	1	1105						
8	126.5	*Clarias* Pituitary (2 glands)	0.27 mg	1	947	11 hrs 26 mins	2,150	55–80	75–100	80–90	40–55
9	130.8	*Clarias* Pituitary (3 glands)	0.40 mg	1	894	11 hrs 32 mins	2,600	75–96	80–100	85–95	45–60

Determination of the Number of Eggs Spawned

The weight of the females were taken before the injection and after spawning. The drop in weight was used to calculate the numher of eggs spawned using the equation for estimating the fecundity of *Clarias lazera* by Hogendoorn (1977). Total number of eggs = 66.6xfemale body weight(s).

Estimation of Percentage Fertilization

The number of unfertilized and fertilized eggs were estimated by counting 10 to 12 hours after fertilization. The unfertilized eggs were white while the fertilized eggs were transparent (de Kimpe and Miche, 1974). The percentage fertilization was estimated from the number of unfertilized eggs by the equation:

$$\% \quad \text{fertilization} = \frac{N - n}{N} \times 100$$

N = Total No. of eggs

n = No. of unfertilized eggs.

RESULTS

The results of the effects of various dosage levels of human chorionic gonadotropin (HCG) and pituitary materials on spawning are summarized in Tables 1 and 2. Both HCG and *Clarias* pituitary homogenates proved to be potent spawning agents for *C. anguillaris.*

With a high dose of 500 i.u of HCG/150g body weight; *Clarias anguillaris* spawning naturally producing a mixture of mature and immature eggs. Similar dosage and even more failed to elicit spawning in *C. lazera.* There was no fertilization as the eggs degenerated after 4 days.

All the females injected with different dosages of toad pituitary homogenates neither ovulated nor spawned throughout the period. However, spawning occurred in females treated with *Clarias* pituitary at a minimum 0.27 mg/150g body weight dosage level. Examination of the ovaries confirmed that spawning was incomplete even at a higher dosage levels. Spawned fertilized eggs measured 1313 + 10 u.

The "latency period" (i.e. the time before spawning after injection of the effective dose) varied between 10 hours 30 minutes and 11 hours 30 minutes. During this time, the females exhibited gradual abdominal distension and protrusion of the cloacal region. This distension was apparently due to egg hydration (ovulation) (Shehadeh *et al,* 1973a).

Observations on the Spawning Behaviour, Hatching and the Early Larval Stages

During the latency period, and as each female began to exhibit abdominal distension, the male became more active and tended to remain in close contact with the female. Occasionally, the male would spin around the female or nudge her cloacal region. When female eventually shed her eggs the male was always closely applied to her sides with the caudal fin near the femals's cloaca. As spawning commenced, the bodies of the males vibrated rapidly and the caudal fin tended to disperse the eggs. Sperm was not visible during natural spwaning. Fertilization rates ranged between 50% and 90%.

Most of the sheded eggs due to their adhersive outer covering were attached to palm fronds provided as substrate. The unattached eggs at the bottom of each aquarium seldom hatched. Hatching occurred from 24–48 hours after spawning at temperatures of 26–27oC and pH of 6.9–7.1. Hatching success was estimated to be 75 to 80%.

The hatchings on emergence wriggle downwards into the gravel bottom only to re-emerge after two days, swimming vigorously in the water column. The larvae at this stage is transparent and yolk ladden.

Larvae were fed on two separate diets - ground boiled egg yolk and natural food (plankton) filtered out of the concrete pond. Initial larval feeding started just before final yolk resorption on the third day when larvae were seen clustering around egg-yolk deposits or darting around for food in the plankton feed tanks. The darting behaviour of larvae for planktonic food seems a predatory habit and suggests a preference for zooplankton which incidentally was in short supply.

Larval mortality as high as 95% was recorded after 8 days in the egg-yolk feed tanks. Most dead larvae were seen entangled in the mesh produced by mucor that had grown around each egg yolk deposit.

DISCUSSION

The efficacy of HCG in the induction of spawning in *C. anguillaris* in this study confirms similar findings in the catfish, *Clarias batrachus* (Ramaswami and Sundararaj, 1956) and Indian catfish, *Heteropneustes fossilis* (Sundararaj and Goswami, 1966) and in the channel catfish, *Ictalurus punctatus* (Sneeds and Clemens, 1969). On the other hand, the failure of HCG to induce spawning in *C. lazera*, a closely related species to *C. anguillaris*, collaborates the findings of De-Kimpe and Micha (1974) and Adigun *et al* (1984). The reason for this is not known. In the present study also, a comparatively high dose (500 i.u./150g body weight) of HCG was required to induce spawning, compared to 700 i.u/450g body weight in the case of *Ictalurus punctatus* (Sneeds and Clemens, 1969), 100 i.u for *Heteropneustes fossilis* (Sundararaj and Goswami, 1966) and 250–300 i.u. for *C. batrachus* (Ramaswami and Sundararaj, 1956). Thus the spawning response of different catfish species to HCG may be dose-related as well as species specific.

Of interest is the non-occurrence of fertilization in the HCG spawned eggs and the reason for such a phenomenon remain unclear. It is however, tempting to speculate that HCG may have caused only spawning (abortion) in *C. anguillaris* (Nwoko, 1983), without bringing about final maturational changes preceding spawning in both the male and female fishes. In such a case, the action of HCG in *C. anguillaris* is similar to that of Deoxycorticosterone acetate (DOCA) in *C. lazera* which only induced spawning without affecting eocyte maturation (De Kimpe and Micha, 1974).

Toad pituitary hormogenate failed to induce spawning in *C. lazera* and *C. anguillaris* at even 0.6 mg or 7 pituitary glands/150g body weight. The reasons for this failure are not clear and further investigation is deserable. The successful spawning runs achieved in *C. lazera* and *C. anguillaris* when injected with freshly prepared pituitary homogenates confirm earlier reports on the use of exogenous fish pituitary material to induce spawning in catfishes (Ramaswami and Sundararaj, 1956; Sundararaj and Goswami, 1966; De Kimpe and Micha,, 1974; Gray, 1976; Nwoko, 1983 and Adigun *et al*, 1984). The spawning time of less than 12 hours, in all the treatment after injection, in this study is in agreement with the 10–16 hours range reported by De Kimpe and Micha (1974) for *C. lazera*.

Of significance however, is the fact that a higher dose of 0.40mg or 3 pituitary glands/150g body weight yielded partial spawning in both *C. lazera* and *C. anguillaris*. Two possible reasons can be adduced for this phenomenon. Firstly, it is possible that the "captivity syndrome" aided by the limited space provided in the aquarium may have hampered the vigorous movement of the catfish during spawning resulting in partial spawning. A second possibility which can be verified may be that *Clarias* sp. do not shed all the eggs in one spawning-run which presupposes that the species spawn intermittently and probably at definite intervals over a period of time. The later argument is butressed by the examination of ovaries of female *C. anguillaris* and *C. lazera* from the wild during the late spawning season (August–September), which varied from deflated sacs forming amorphous mass to fully turgid sacs from which fewer or no eggs had apparently been shed. Similar observations for *C. gareipinus* (Bruton, 1979) and *C. albopunctatus* (Ezenwaji, 1982) after the spawning season lends credence to this possibility.

The observed hatching time for eggs of between 24 to 48 hours after fertilization was within the range (minimum of 24 hours) recorded for *C. lazera* (De Kimpe and Micha, 1974). The high larval mortality recorded in 8 days after hatching may have resulted from mal-transformation from the yolk-sac stage to the internal feeding runs after the resorption of the yolk sac. This situation in the present circumstances could be attributed to the use of inappropriate or poor food quality for initial larval feeding (Jones et al, 1974). This highlights the importance of adequate food for catfish larval rearing. Alternatively, a detailed investigation on the development of appropriate techniques for the production of plankton preferred by *Clarias* larvae is thus recommended.

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DUCKWEED *(Lemna paucicostata* HEGLEM EX ENGLE) IN THE DIET OF TILAPIA *(Sarotherodon galilaeus)*

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ABSTRACT

The growth of *Sarotherodon galilaeus* fingerlings fed with test diet of 33% crude protein and containing 10% duckweed was compared with standard KLRI/40/6 feed of 40% crude protein. From an initial mean weight of 1.18gm and 1.17gm, the fingerlings in the test diet and control respectively grew to a final mean weight of 2.17gm and 1.98gm after seven weeks. With mean growth rate of 2.02% and 1.65% of their body weight per day respectively for the test diet and the control, it was obvious that the test diet was better and had a higher food conversion than the control. The duckweed must have therefore, supplied some essential amino acids to the test diet thereby making it a higher quality feed.

INTRODUCTION

The potential of ducweeds as an easy and cheap source of high quality protein (Rusoff, 1980; Culley *et al*, 1981) makes it an ideal plant for use in animal feed. This group of floating aquatic plants from the family lemnacea exhibit a great efficiency in the removal of nutrients from waste waters which are converted into edible tissues of high protein content (Harvey and Fox, 1973; Culley and Epps, 1973; Sulton and Oraes, 1975; Culley *et al*, 1978).

The plants have been shown to be relished by a variety of livestock (Rusoff, 1978; Sutton, 1981; Gulley *et al*, 1978), and fish especially the grass carp *(Ctenopharygodon idella)* Verigin, (1962); Galkina *et al* (1965); Nikolski and Verigin (1966); Dattu and Kilgen, 1975; Van Dyke and Sutton, 1977; Bam and Back, 1980). A replacement with 20% dry duckweed in the diet of channel catfish produced the same weight gain, food conversion and energy use as standard catfish feed when fed to *Ictalurus punctatus* (Robinette *et al*, 1980).

Mbagwu and Okoye (1984) showed that Tilapia *(Sarotherodon galilaeus)* accepted the duckweed *(Lemna pancicostata)* as food and digested 77% to 87% of the dry matter although it grew very little, while feeding at 3% body weight on the plant. This may be possibly because of the large quatity of water (95%) in the plant which could result in the intake of excess water and less food matter. Another reason may be the low content of protein in the duckweed used in the experiment (16% crude protein). When Pullin and Almazan (1983) fed Tilapia *(Oreochromis niloticus)* with *Azolla* a floating aquatic macrophyte, containing 27% crude protein, the fish gained very little weight and this they attributed to the high water content of the plant (92–95%) which must add significantly to water excretory load for a freshwater fish like tilapia – one of the energy consumming features of osmoregulation.

To evaluate the dry duckweed as an ingredient in tilapia feed this study was conducted to compare the growth performances of *S. galilaeus* fingerlings fed with prepared feed of 33% crude protein containing 10% duckweed and a standard 40% crude protein feed.

MATERIALS AND METHODS

This study was carried out between 23rd April and 12th June, 1985 – a period of seven weeks in the hatchery complex of Kainji Lake Research Institute (KLRI). The two feeds compared were a 33%-crude protein test diet containing 10% duckweed and a standard 40% crude protein feed (KLRI/40/6) used as control and prepared in the manner of Ita and Orobor (1983).

The duckweed was sun-dried, ground into fine powder and analysed (as per cent dry matter) using standard methods (AOAC, 1978) for crude protein (16.13), crude fibre (25.83), fat (0.27), nitrogen-free extract (37.17) and ash (14.30). This analysis was utilised in the formulation of the test diet. The nutrient analyses of the two feeds are presented in Table 1

Table 1 – Nutrient analysis of the feeds

Feed Ingredient	*Amount*	*Crude Protein*	*Carbohydrate % (NPE)*	*Fat*	*Fibre*
Test Diet Mixed flour Blood meal Duckweed Polfamix	 65.19% 23.81% 10.00% 1.00%	33.01%	34.13%	2.73%	1.41%
KLRI/40/6. Mixed flour Blood meal Polfamix	 65.19% 33.81% 1.00%	40.13%	31.92%	4.02%	1.22%

The fingerlings used in this study were collected from the integrated poultry-cum-fish reservoir in the Kainji Lake Housing Estate and weighed between 1.0 and 1.5gm. Ten fingerlings were placed in each of the six 55-litre indoor glas aquaria containing 10 litres of water under continuous aeration. The fingerlings in the first three aquaria were fed the test diet at 5% body weight 5 days a week (treatment 1), while those in the other three aquaria were fed KLRI/40/6 diet (treatment 2). The fingerlings were weighed every week to monitor growth and adjust the feeding rate.

Indoor conditions consist of a well-ventilated and illuminated environment of normal day length photoperiod. Water temperature was maintained at 29.6oC + 1.2oC and water in each aquarium was changed every two days.

RESULTS AND DISCUSSIONS

The mean weight gain and food conversion ratio of the fingerlings fed with the two diets are shown in Table 2, while Figure 1 shows the growth curves. From the mean initial weights of 1.10 gm and 1.17gm. the fingerlings fed on test diet and KLRI/40/6 grew to mean final weights of 2.17gm and 1.98gm respectively. Mean weight gain was higher (P 0.05) in fingerlings fed with the test diet thatn those fed with the control. This may be as a result of the presence of duckweed in the test diet which has supplied some essential amino acids like methionine and Isoleucine above the level in the cow blood (Table 3) thereby making it a higher quality feed than the control. Some essential amino acids which are usually in dificient levels in plant protein are generally in standard or even surplus levels in duckweed (Rusoff *et al*, 1980; Robinettei *et al*, 1980) reported that catfish showed reduced weight gain when fed with diets containing low levels of essential amino acids. Fish powder and blood meal are the other protein source ingredients used in diet formulations in KLRI that can provide adequate levels of essential amino acids in a fish diet but these are more expensive to obtain than duckweeds.

Mean growth rates were 2.02% and 1.65% of body weight per day respectively for the test diet and the control. This shows that the fingerlings grew better on the test diet than on the control and food conversion was higher in the test diet than in the control. Analysis of variance showed a significant difference (P 0.05) between these parameters.

There was no case of disease infection during the study period and mortality was only 3.3%.

Table 2 – Mean weight gain and food conversion ratio per *S. galilaeus* fingerling per diet

Replication	*Test Diet*	*KLRI/40/6*
1	0.93gm (76.33%)	0.81gm (68.56%)
2	1.09gm (90.41%)	0.88gm (75.83%)
3	0.96gm (84.51%)	0.75gm (63.58)
Mean weight gain	0.99gm (83.75%)	0.81gm (69.[illegible]2%)
Mean weight of feed consumed	2.69gm	2.86gm
Food conversion Ratio	2.99	3.53

Table 3 – Comparison of the amino acid composition of the blood meal and duckweed with FAO Standard

Amino Acid	*FAO*	*Bloodmeal*	*Dockweed*
Lysine	4.2	9.08	5.39
Threonine	2.8	4.31	5.53
Valine	4.2	6.31	5.62
Methionine	2.2	1.19	1.35
Isoleucine	4.2	1.13	4.48
Leucine	4.8	10.05	8.67
Tryptophan	1.4	–	–
Phenolalanine	2.8	6.51	4.62

SUMMARY

The growth response of *S. galilaeus* fingerlings fed with an artificially prepared 33% protein diet containing 10% duckweed protein (treatment 1) was compared with those fed a standard 40% protein feed, KLRI/40/6 without duckweed (treatment 2).

Feeding at 5% body weight, each fingerling in treatment 1 gained an average weight of 0.99gm over a seven-week period growing at an average rate of 2.02% of their body weight per day, while those in treatment 2 gained an average of 0.81gm growing at 1.55% of their body weight per day over the same period. Food conversion ratio were 2.99 in treatment 1 and 3.53 in treatment 2.

The results show that fingerlings fed with a diet supplemented with duckweed protein exhibited significantly higher weight gain, growth rate, and food conversion than those fed with an isoproteinous diet but containing no duckweed. This significant difference could be due to boosting of the essential amino acids levels in the supplemented diet by duckweed protein which contains standard or even surplus quantities of essential amino acids unlike other plant matter.

CONCLUSION

Since the two diets were formulated to provide approximately the same levels of nutrients there is evidence that duckweed is a suitable source of protein for tilapia feeds and that addition of duckweed to diets of *Sarotherodon galilaeus* will significantly enhance feed quality. Considering other attributes of duckweed, it is a potential feedstuff and should be further studied.

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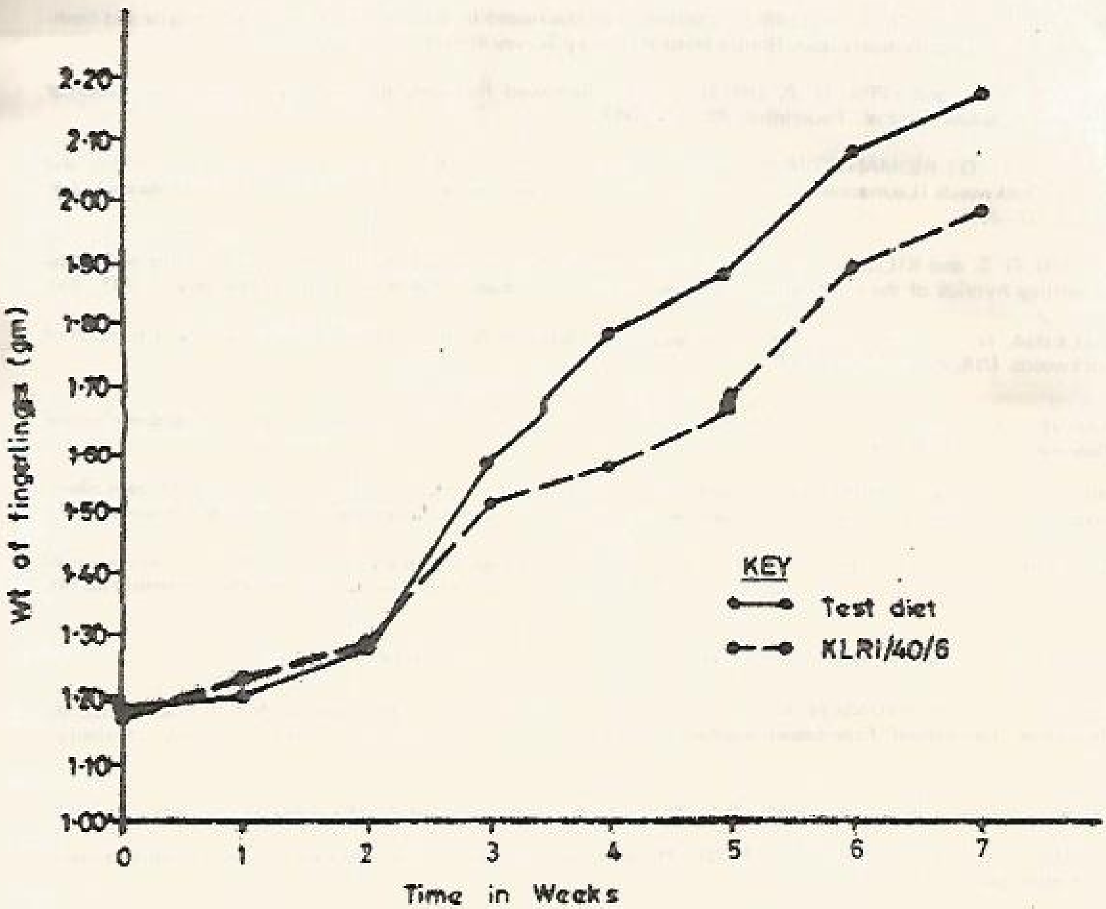

Fig. 1. Growth curves of S galilaeus fingerlings fed with protein diet, supplemented with duckweed and diet containing 40% crude protein (KLRI/40/6)

THE USE OF LOCALLY AVAILABLE MATERIALS IN FISH FEED PRODUCTION

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ABSTRACT

In Nigeria, the culture of fish is gaining importance, but local fish farmers face a set back because of the stoppage on importation of fish feed.

Locally available raw materials such as yam, plantain, banana, cowpeas, macuna, maize, cassava, millet, sorghum, groundnut, sunnhemp seed and brewery wastes are considered as potential materials for fish feed. These have been examined on their minimum protein contributions since this is the most expensive part of the fish feed.

Alternative sources to animal proteins are also examined. Plant protein from groundnut, melon, mucuna and others compare favourably with bloodmeal mixture and thus can be used to replace the more expensive animal proteins.

Fish feed can be produced on a small scale or commercial basis from the locally available raw materials and the fish farmer is advised to seek assistance from qualified fisheries personnel.

INTRODUCTION

In Nigeria, the artisanal fishing is decreasing in importance and the trend is towards intensive fish culture. This has its advantages in that useful man hours are not spent searching for fish in the wild. But the problem is that an intensive fish culture demands extra feeding in order for the fish to attain table size within a short time. To a large extent, fish seeds are still imported. With the constraints on importation currently being experienced all over the Federation, the fish farmer is facing a major setback in his business. This paper emanated from the demand of local fish farmers (some intending fish farmers) who are now facing problems with restriction on importation of fish feed. This paper therefore, intends to highlight those raw materials locally available that can be used in making pellets as fish feed.

Fish Basic Requirement

Like other animals, fish need protein, carhohydrate, lipids, minerals and vitamins for growth and maintenance of physiological activities. These they get from the organisms they feed on in the wild. With intensive culture where there is competition for food, extra food, in form of pellets or mash has to be added to the system for fish to attain table size within a short time.

Some of the locally available raw materials in Nigeria include maize, cowpeas, groundnut, melon, potato, cassava, yam, banana, plantain, pawpaw, soyabean, millet, guinea corn, rice, palm oil, brewery wastes and fish. These have been analysed for their chemical composition (Table 1) An examination of this list shows that there are more carbonhydrate than protein foodstuffs and therefore, the energy requirement of fish would be adequately met. However, the most expensive part of feed is the protein and this is the more important because it is used for body building. Experience has shown that one source of protein is not adequate, a combination of various sources such as animal and plant sources, is best (Bryant *et al*, 1980). The reason is that the essential amino acid composition of each protein source varies from source to source (Table 2). Thus, the addition of three to four different sources of protein should complement each other and hence improve the essential amino acid composition of the feed, making it adequate for the fish.

Locally Available Raw Materials Brewery Wastes

There are a lot of breweries in Nigeria, perhaps on the average of one brewery per State. These daily turn out several tonnes of brewery wastes such as spent beer plus solids, spent beer, brewery grain waste that hitherto have not been put into any use. They can be incorporated into fish feed. Ezenwa (1979) has reported beer waste to contain 46.4, 22.8, 7.8 and 18.8% carbohydrate, protein, fat, and fibre respectively.

In Peurto Rico, Kohler and Pagan–Font (1978) evaluated various waste products such as rum distiller's yeast; pharmaceutical wastes, rum distiller's solubles; spent beer plus solids, inorganic fertilizer of N–P–K (8–8–2); commercial fish feed containing 36–5–and 7% crude protein, fat and fibre respectively; and a locally manufactured chicken feed containing 18, 2.5 and 4.0% crude protein, fat and fibre respectively. Water quality criteria such as pH, dissolved oxygen and temperature were used as guideline for applying the rum and pharmaceutical wastes to the pools. They found that survival at harvest ranged from 80.0% for commercial chicken feed to 96.7% for commercial fish feed. The highest mean standing crop was got from the fish fed, the commercial fish feed and this was closely followed by the spent beer treatment. However, the weight of offspring from the spent beer treatment was higher than that from the fish feed treatment. The fish from the unmanaged system yielded the lowest mean standing crop while the other treatments gave moderate yields but the yield from the inorganic fertilizer was greater. There was more than three fold increase of fish weight over that of the unmanaged system in the rum distriller's yeast treatment, though poor water quality conditions were observed in the water of the pools. They concluded that "some potentials" exists for the utilization of the rum and pharmaceutical wastes for rearing *Tilapia aurea* in Puerto Rico" and the "dried forms of the by-products should be evaluated for their possible incorporation as part of a local feed". They also suggested that the application of the commercial chicken feed be limited to supplemental feed in conjuction with some intensive fertilization in view of the fact that the bits of hard corn in the chicken feed were not assimilated by the fish.

Rice, Maize, Sorghum

Uchida and King (1960) in Hawaii tested the acceptability of various feeds using Javatilapia *(Sarotherodon mossambicus).* Finely ground rice bran and chicken mash were suitable for the adults as they could not strain small particles from the water, and thus much of the feed was wasted and tended to foul the tanks. The pelletized pond fish and trout feeds were consumed by the adult fish with little wastage, while the rabbit feed, which has a high percentage of crude fibre, passed through the fish undigested and left much residue in the tank. Alfalfa pellets were less acceptable due to their large size and their high fibre content.

In Brazil, Castagnolli (1975) found that carp fingerlings fed on either opague-2-maize or hybrid maize gave the same conversion rate and performance. In another test, he showed that sorghum can be substituted for maize at 70% level in the diet for mirror carp *(Cyprinus carpio)* and tilapia *(Tilapia rendalli).* Under the same environmental conditions, mirror carp grew twice as fast and gained three times as much weight as the tilapia. Similar feeding studies carried out on fishes at Ellah Lakes at Obrikom in Rivers State showed species of *Clarias, Gymnarchus* and *Heterotis* to accept pelleted diets made from maize and other local materials In this case, the maize and other ingredients were milled together. These studies are still in progress.

Kitchen Garbage

There are many kitchen wastes such as bean testa, plantain, cocoyam, potato, banana, pineapple, orange, pawpaw, yam and cassava peels which are thrown away daily. Most of these could be included in fish feeds Even though they have low protein contents (From 7.87–11.21%), they can still supply some amount of it in addition to their normal contribution of minerals and vitamins to the feed. It is interesting to note that the protein contents of these peels are higher than those of the actual edible portions of the same foostuff (Table 1). These have their own attraction in that they are readily available and very much within the reach of small scale fish farmers who can easily throw them into the ponds for fish to nibble on.

Given the mineral and vitamin composition of these foodstuffs, it would be necessary to find out what percentage of these are in the peels.

Leaf Concentrates

Naturally, some local species of fish such as *Distichodus engrycephalus, D. brevipinis* and *D. rostratus* are *herbivorous* in their feeding habits. Thus, other raw materials worth including in fish feed are the leaves such as water leaf, green (tete), pawpaw, sweet potato, garden egg, yam, banana, plantain, okro, groundnut, maize, cassava and cocoyam. These leaves are daily consumed by ruminants without any pathological effect on them. Hence the leaves can be used as both fibre and filler in fish feed.

For instance, the sweet potato leaves have successfully been included in fish diet by the author to act as both filler, fibre and most importantly as colourant. Some of their mineral contents would be made available to the fish through processing.

Apart from the herbivores, the omnivorous species such as *Clarias, Heterobranchus* and *Cyprinus carpio* would feed on this type of pellet too.

Alternative Protein Sources

Since protein is the limiting item in feeds in terms of its cost as well as its body building properties, consideration of alternative sources is hereby attempted. Traditionally, fish and bloodmeals are the usual sources of protein in fish feed. These are becoming very expensive (about ₦1,000/metric tonne of fishmeal) and scarce, thus making fish feed exorbitant or out of reach of the average fish farmer.

A critical examination of the protein contents (Table 1) of some of our plant feeding stuffs such as water melon, sunnhemp seed, greengram seed, groundnuts seed and cake, cowpea, mucuna and cotton seeds, show that they compare favourably with bloodmeal mixture. Although these may not have the same amount of amino acid contents as either fishmeal or bloodmeal, they can still be used to supplement the blood or fish meals in order to reduce the quality and cost of the latter without necessarily reducing the biological quanlity of the feed. Igbinosun et al (in NIOMR Technical Paper No.7) found that soyabean meal can be used to replace fishmeal partially or completely, however, the growth of the Nigerian catfish on this meal was poorer than in the fishmeal. Research is needed on the optimum protein requirement of the warmwater fishes.

CONCLUSION

From the foregoing, it is realized that enough raw materials are available locally to produce fish feed in commerical quantity. Perhaps the majo, problem is the technical know-how. This can be referred to qualified fishery personnels who are prepared to render such services with minimum charges.

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Table 1 – Chemical composition of some Nigerian feeding stuffs (per cent of dry matter*)

Common Name	*Scientific Name*	*Dry Matter*	*Crude Protein*	*Oil*	*Calories per 100g*	*Total Ash*
Maize	Zea mays Lin	90.38	10.65	4.09	409.65	3.68
Cowpea seed	Vigna unguiculata Walp	91.36	24.67	2.46	389.94	3.78
Cowpea testa	Vigna unguiculata Walp	–	–	–	–	–
Groundnut	Arachis hypogaea Linn	95.10	27.20	50.92	605.00	2.79
Groundnut cake	Arachis hypogaea Linn	90.36	51.41	10.16	–	5.51
Water melon	Citullus vulgari Schrad	91.92	34.48	46.74	576.06	4.37
Soya bean	Glycine max Merr	93.23	44.08	19.10	452.42	5.06
Millet	Pennisetum typhoides Stapf and Hubbard	88.76	9.02	4.99	413.79	2.13
Rice	Oryza sativa Linn	90.10	9.10	0.14	397.14	0.58
Guinea corn	Grain sorghum pers	88.40	15.03	3.25	394.09	2.60
Banana	Musa sapientum Linn	27.43	4.49	1.45	384.10	7.60
Banana Peels	Musa sapientum Linn	14.08	7.87	11.60	–	13.44
Plantain	Musa sapientum var. paradisiaca Linn	27.43	4.59	1.63	377.22	7.97
Plantain peels	Musa sapientum var. paradisisaca Linn	18.35	9.14	5.62	–	17.18
Pawpaw leaves	Carica papaya Linn	24.60	32.6	0.8	–	11.47
Pawpaw fruit	Carica papaya Linn	15.00	4.1	0.6	–	3.9
Cassava	Manihot utilissima pohl	31.94	2.38	–	375.93	2.89
Cassava leaves	Manihot utilissima pohl	25.60	14.69	8.39	–	16.07
Cocoyam	Xanthosoma sagittifolium schott	24.89	7.85	–	382.63	5.22
Cocoyam	" " "	33.18	9.40	0.75	–	8.81
Cocoyam peels	" " "	9.43	20.62	11.74	–	12.18
Sweet potato	Ipomea batatas poir	28.08	5.36	0.54	391.06	3.15
Sweet Potato peels	Ipomea batatas poir	11.73	6.33	1.34	–	4.55
Sweet Potato leaves	Ipomea batatas poir	12.45	24.65	3.58	–	11.47
Yam white	Dioscorea rotundata poir	26.17	5.87	0.46	381.18	4.30
Sunn hemp seed	Crotalaria juncea Linn	95.99	40.27	1.41	344.65	5.61
Mucuna	Mucuna spp Adams	94.15	28.59	0.67	–	4.01
Palm kernel cake	Elaeis guineensis Dacq.	91.60	20.40	8.32	–	5.67
Cotton seed	Gossypium sp Linn	94.56	28.47	14.05	–	4.75
Prickly Amaranthus (Tete Elegun)	Amaranthus spinosus	19.4	31.9	3.7	–	15.1
Water L .f	Talinum triagulare Wild	9.68	21.09	1.47	–	34.56

**Table adapted from Oyenuga (1968).*

Table 2 – Essential Amino Acid Composition of some Nigerian Foodstuffs (mg/gN)*

	Arginine	*Histidine*	*Isoleucine*	*Leucine*	*Lysine*	*Phenyl alanine*	*Terosine*	*Cystine*	*Methionine*	*Threonine*	*Tryptophan*	*Valine*
Cassava flour (gari)	931	106	113	181	244	131	100	–	63	175	–	163
Cocoyam (Tania)	525	106	206	425	235	325	188	175	81	225	–	413
Sweet Potato	181	88	225	300	269	269	–	–	106	238	113	350
Yam (white trifoliate)	344	113	256	450	263	275	300	–	63	269	–	350
Cowpeas	444	194	256	456	394	325	190	106	119	239	60	325
Groundnut whole	775	150	250	438	319	325	220	81	88	244	70	312
Soyabean meal	519	175	306	488	406	306	200	94	94	244	81	319
Coconut seed protein (globulin)	1046	151	277	449	273	319	–	–	126	254	41	370
Cotton seed	706	169	250	375	219	375	200	138	106	188	81	300
Palm kernel cake	1075	113	313	519	294	300	–	–	144	250	50	400
Guinea corn grain	293	110	324	827	162	325	260	58	29	197	64	295
Maize grain whole	300	156	400	938	144	313	375	94	194	231	38	331
Mullet, bulrush	–	119	369	606	244	256	–	–	106	–	119	400
Rice polish	495	233	322	406	370	286	418	89	256	233	203	376

*. *Table adapted from Oyenuga (1968).*

THE EFFECTS OF SUPPLEMENTAL FEEDS CONTAINING DIFFERENT PROTEIN: *ENERGY RATIOS ON THE GROWTH AND SURVIVAL OF Tilapia nilotica (Oreochromis niloticus)* IN BRACKISHWATER PONDS*

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ABSTRACT

A research was conducted in thirty approximately 100 sq.m earthern ponds of the Brackishwater Aquaculture Centre (BAC), College of Fisheries, University of the Philippines, Leganes Iloilo from November 7, 1982 to March 7, 1983 to evaluate the effects of nine supplemental feeds containing different protein: energy ratios on the growth and survival of *Tilapia nilotica* in brackishwater ponds. Nine supplemental feeds formulated were with protein levels of 20%, 25%, and 30% each at three energy levels of 3,000 kcals; 3,500 kcals; and 4,000 kcals.

There was a control treatment with no feeding so that mean weight gain growth rate, feed conversion rate, and survival were determined. Fish fingerlings were acclimated from 0–29 ppt. salinity before the experiment and 20% of fish in each treatment were sampled after every 30 days.

Mean weight gain were significantly different as follows:– 30%:4,000 kcals (102.21g); 30%:3,000 kcals (93.24g); 25%:3,000 kcals (89.79g) 30%:3,500 kcals (83.42g); 25%:4,000 kcals (78.80g); 25%:3,300 kcals (78.13g); 20%:3,000 kcals (76.50g); 20:4,000 kcals (71.05g); 20%:-3,000 kcals (69.68g); and control (59.11g).

Growth rates were significantly different and increased with increasing energy level at the 30% protein feeds but decreased at high energy levels in the 20% and 25% protein feeds. Feed conversion was significantly different due to interraction between protein and energy levels in the feeds, and was better at the 30:3,500 kcals feeds having a feed conversion of 1.55g. Survival was not significantly different.

INTRODUCTION

Members of the genus tilapia (Family Cichlidae) are a major protein source in many of the developing countries (Pullin and McConnell, 1982). Of all other species cultured *T. nilotica* appears to have gained a wider acceptablity from fish farmers and consumers alike following some improved culture technology in the 1970s. It is a plankton feeder, hardy, prolific, exhibits rapid growth and above all appears to thrive well on artificial supplemental feed.

To date there are no studies on the suitable protein: energy ratios in supplemental feeds for the culture of Nile tilapia in brackishwater ponds. There is a need therefore, to come up with a reliable protein energy combination as basic data for improved feeding programmes which for practical purposes could be adopted for growing marketable size *Tilapia nilotica* at high stocking densities with minimum time and cost, hence this experiment.

**Extract from M.Sc. Thesis (Major in Aquaculture) University of the Philippines, Iloilo City, Philipinnes, 1983*

MATERIALS AND METHODS

Experimental Ponds and Fish

Thirty approximately 100sq m brackishwater ponds were drained, and dried to level the pond and repair leakages. 10cm diameter, 75cm long adjustable standpipes were each installed centrally on the canal dike of each pond to regulate water supply. A 0.5mm mesh nylon screen bag (50x10cm) was tied around the mouth of each standpipe to prevent entry of unwanted fish and escape of stocked fish.

Ponds were prepared according to the schedule of activities in Table 1. Juvenile *Tilapia nilotica* fingerlings with an average weight of 2.85g and average total length of 3.20cm were procured from a freshwater hatchery. These were acclimated to pond salinity and trained to accept supplemental feed in ten wooden troughs of dimesnions (90x80x40cm) each containing 500 fingerlings, during a 3-week period before stocking in ponds. Each pond was stocked with 150 fish each with an average weight of 2.90g, 20% of which were sampled by seeing after every 30 days to monitor growth changes. At the end of the experiment, fish were weighed en masse and data for mean weight gain, growth rate, feed conversion, and survival rate were taken. A temperature range of 15.4oC–32.1oC was observed during the experiment. Ranges of other physico-chemical parameters are shown in Table 2.

Experimental Design

The various treatments: No feeding (control–I); 20:3,000 kcals (II); 20:3,500 kcals (III); 20:4,000 kcals (IV); 25:3,000 kcals (V); 25:3,500 kcals (VI); 25:4,000 kcals (VII); 30:3,000 kcals (VIII); 30:3,500 kcals (IX); 30:4,000 kcals (X) were replicated three times each using a 3x3 factorial arrangement in a completely randomised design.

Results obtained from the study were analysed statistically using a two-way Analysis of Variance (ANOVA) with equal replication and significance testing for mean and interraction effects as described by Sokal and Rholf (1969). Duncan's Multiple Range Test (DMRT) as described by Walpole (1974) was used to detect differences between treatment means. All statistical analysis were done at the 5% probability level.

Diets and Feeding Regime

Nine (9) diets were prepared based on proximate analysis of the feed ingredients (Table 3). The composition and proximate analysis of the experimental diets are shown in Tables 4 and 5. The coarse feed ingredients were ground and passed through an 850 micron laboratory multipurpose sieve. Two thirds of the protein in the diets came from plant sources i.e. mainly from ipil-ipil leaf meal and copra meal at a ratio of 1:1 while the remaining one-third came from animal protein sources-fish meal and shrimp head meal. Rice bran and copra oil served as additional energy source while rice hull served as filler. Metabolizable energy was based on mammalian values: protein-4.0 kcals/g; fat–9.0 kcals/g; and carbohydrate-4.0 kcals/g (Maynard et al, 1979). The average cost of feed was ₱2.26 or approximately US $0.16 per kilo (using the Philippine peso to dollar conversion as at March 1983).

For the proximate analysis, moisture was determined using the method decribed by Lovell, (1974); crude protein by the semimicro Kejldahl digestion and distillation, Mitchell (1972; crude fat by the soxhler ether extraction method, Maynard (1970); crude fibre by successive digestion with dilute acid and alkali, AOAC (1945); ash by using an ashing furnace, Maynard (1970); calcium and phosphorus as described by Lovel (1974), while nitrogen free extract (NFE) was computed by taking the sum of values for crude protein, crude fat, ash and crude fibre and substracting this from 100, Maynard *et al* (1979).

The diets were prepared by thoroughly mixing the dry ingredients with oil and then adding cold water until a stiff dough resulted. This was then passed through a meat grinder using a 2mm die. The extrussions were cut into approximately 5mm pellets by hand and dried in a 50kg capacity locally made feed dryer. After drying the diets were stored at room temperature in plastic bags. Samples of the diets were subjected to proximate analysis as previously described.

A constant feeding regime of 5% of the body weight per day divided into two halves, fed one part in the morning and the other in the afternoon, was adopted throughout the culture period. At monthly intervals of 30 days 20% of fish were sampled to monitor growth.

RESULTS

Growth curves (Figure 1) of *Tilapia nilotica (Oreochromis niloticus)* fed diets containing different protein: energy ratios in comparison with unfed fish in treatment I (control) show that the best growth occurred in treatment X while the least occurred in treatment I (control). The highest final mean weight of 104.60g occurred in treatment X while a low 61.80g was recorded in control treatment I. There were significant differences in growth as revealed by final mean weights and growth rates in various treatments (Table 5).

Feed Conversion

Treatment IX gave significantly better feed conversion of 1.55 followed by treatments II, V, X, VII, VIII, IV and IV and VI (Table 6). At the 20% and 25% protein levels feed conversion ratio was better at the lowest energy level of 3,00 kcals while at the 30% protein level combinations with higher energy levels of 3,500 kcals proved better.

Survival

The highest survival rate of 95.33% was recorded in treatment V although this was not significantly different from those of other treatments (Table 6).

DISCUSSION

The results of this study suggest that for maximum growth of this species, a diet having 30% protein in combination with 4,000 kcals of energy is required as shown by the growth rate, final mean weight, survival and growth curves.

Growth curves in Figure 1 and data in Table 6 shows that treatment X (30:4,000 kcals) maintained the best performance throughout the period of the experiment. This may be due to the higher amount of protein in the diet, which observation agrees with the general principle that increase in protein content of diets improves growth of animals as this will enable animals meet their protein requirements. The amount of fish meal also increased proportionately with the increase in the protein level which probably brought the amino acid profile of the feed closer to that of the fish. Lovell (1979) cited by Yamada (1983) reported that protein levels of 30–36% will probably be adequate for most warmwater fish diets while NAS (1977) reported that fish meal in the diet generally satisfies the demand for indispensable aminoacids necessary for growth. The use of vegetable oil as energy source is another possible factor that influenced the observed growth Oil increased proportionately at various energy levels within each dietary protein level. Viola and Rappaport (1979) reported that oil improved protein retention from 13% to 20% and energy retention from 23.35% to 30% while testing the "extra caloric effect" of oil in the nutrition of carp. The low crude fibre content of 2.5% in this diet probably enchanced digestibility of the feed NAS (1977) stated that high crude fibre level of 21% reduce nutrient intake and impairs digestibility in practical diets for channel catfish. Rumsey (1978) citing Poston (1978), reported that fibre is indigestible and thus high amounts add to the biochemical oxygen demand of the rearing system and interferes with digestion and absorption of other nutrients and retards growth.

Protein-energy relationships in the various treatments undoubtedly affected the growth of fish during the 120-day culture period. Growth increased with increase in energy at the 30% crude protein diets while the reverse was observed at the 20% and 25% crude protein diets. This finding is in agreement with that of Prather and Lovell (1973). At high energy level the 20% and 25% protein diets adversely affected growth of fish. Lovell (1979a) reported that when fish are fed with diets containing too much energy in relation to protein, they will not meet their daily protein needs for optimum growth even if they are fed to satiation. These findings are similar to those of Adron et al (1975), Harper (1967), Russel–Hunter (1970) cited by Bowen (1982); and Sadao *et al* (1980)

Growth rate was better in treatment X (30:3,000 kcals) with 0.84g/day. High stocking density of 15,000/ha, lower temperatures of 16.7oC to 16.45oC observed during the months of January and February 1983 retarded growth due to reduced feeding activity. Growth rate ranged between 0.67g/day to 1.0g/day and o.32g/day to o.69g/day during the first and second 60 days of the experiment respectively. Denzer (1968) reported that the lower and upper lethal limits recorded for *Tilapia nilotica* were temperatures of 11oC and 42oC respectively while Chervinski (1982) found that the activity and feeding of Tilapias were observed to be reduced below 20oC and were stopped completely around 16oC.

Feed conversion ratio decreased with increasing energy levels at the 20% and 25% protein levels while the reverse occurred at the 30% protein level. Winefree and Stickney (1981) reported that apparent feed conversion was superior on diets having lower protein energy ratios and was between the 34%:3,200 kcals diet fed to *T. aurea.* Poor feed conversion value in treatment IV (20:4,000 kcals) suggests that energy was in excess. Rickly (9180) observed the same effects for diets low in protein and high in carhohydrate (energy) fed to trout.

A relatively high survival rate of 92.80% was obstained in this experiment (Table 6). This could be attributed to larger size fish which were stocked (2.90g) initially. Biona (pers comm.) earlier attributed low survival to smaller size (1.5g) used in a similar experiment. Adaptability to a wide range of salinity (15–50ppt), good water management, tolerable limits of dissolved oxygen levels (1.2–5.48ppm) and desirable water pH range (6.8–8.2) are possible factors that could enhance survival.

CONCLUSION

The results of this study confirm earlier studies that *T. nilotica* thrives well on supplemental feed. The highest growth rate of 0.84g/ day is slightly higher than 0.80/day reported by Dadzie (1982) in monoculture of *T. nilotica* suggesting that a diet having 30% protein in combination with 4,000 kcals of energy has better protein: energy ratio in the diet for intensive culture of *Tilapia nilotica* in brackishwater ponds.

ACKNOWLEDGEMENT

We thankfully acknowledge the financial support given to this study by the Rivers State University of Science and Technology, Port–Harcourt, Nigeria through the Vice Chancellor Professor T. T. Isoun. Out gratitude also goes to Mr. Christian Kuzor who did the typing of the manuscript.

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Table 1 – Summary of standard pond preparation for growth of natural food "lab–lab"

Date/Interval	*Activities*
28/8/82–15/9/82	Partitioning of four (4) 1,000 sq. m. ponds into 32 100 sq.m ponds.
15/9/82–30/9/82	Flushing and drying of ponds to reduce acidity. Installation of standpipes with flexible elbow joints for filling and draining individual ponds.
24/9/82–30/9/82	Laboratory soil analysis for pH and organic matter.
13/10/82	Admit water into ponds to a level of 2–3 cm. Application of tobacco dust at the rate of 300kg per hectare.
16/10/82	Application of agricultural lime by broadcasting at the rate of 2 tons per hectare to condition the pond and keep pH between 6.5–9.
18/10/82	Application of chicken manure at the rate of 2 tons per hectare mixed with Urea at 50 kg/ha to speed up decomposition. Raise water level to 5cm.
20/10/82	Application of inorganic fertilizer 16–20–0 (NPK) at the rate of 50 kg/ha.
21/10/82–4/11/82	Raised water level to 10 cm and growing of "lab–lab".

Table 2 – Means of some physico-chemical parameters observed in different treatments during experimental period

Item	Time (hr)	Treatment I	II	III	IV	V	VI	VII	VIII	IX	X
Water Temperature Range (oC)	0530–0630	16.00–24.40	16.10–24.50	15.80–24.40	15.70–2430	16:20–24.60	15.90–25.00	15.40–24.20	16.20–24.40	15.50–24.50	16.00–24.40
	1530–0630	22.90–31.40	22.90–32.10	22.80 31:10	22.80–30.40	22.80–30.40	22.90–31.00	22.70–32.00	23.20–31.90	22.90–31.60	23.20–31.20
Dissolved oxygen (D. O. ppm)	0530–0630	1.72–5.38	1.22–5.48	1.80–4.87	1.40–5.43	1.27–4.79	1.40–4.80	1.17–5.40	1.33–5.03	1.10–4.90	1.50–5.19
	1530–1630	8.23–14.01	8.28–13.60	7.24–13.30	7.31–14.10	8.61–13.10	7.93–12.91	8.20–14.20	8.11–14.20	8.40–14.36	7.73–14.00
Salinity (ppt)	1530–1630	18.39–48.00	17.11–49.00	19.61–50.00	19.50–49.00	18.22–48.00	18.61–49.00	17.89–49.00	18.83–49.00	18.39–50.00	18.17–48.00
pH	0900	6.80–7.80	6.80–8.00	6.90–8.10	6.80–8.20	6.90–7.80	7.00–8.00	6.70–7.90	7.10–8.00	6.90–8.00	7.00–8.00
Ammonia nitrogen (ppm)	0900 0.46	0.84–0.43	0.05–1.81	0.05–0.67	0.05–0.86	0.11–1.39	0.05–1.27	0.02–1.27	0.08–0.67	0.05–0.41	0.07–1.43

Table 3 – Proximate analysis of feed ingredients used in the supplemental diets

Ingredients	*Moisture %*	*Dry Matter %*	*Crude Protein %*	*Crude Fat %*	*Crude Fibre %*	*Ash %*	*Nitrogen Free extract %*	*Calcium %*	*Phosphorus %*
Fish meal (local)	20.43	79.57	36.06	1.17	1.70	28.78	9.86	4.44	1.45
Shrimphead meal	12.32	87.68	44.80	4.38	1.80	31.40	5.30	5.20	1.48
Ipil-ipil leaf meal	8.12	91.58	35.06	4.49	4.61	10.28	37.14	2.56	0.23
Copra meal	7.96	92.04	26.96	4.02	5.33	8.26	47.47	0.22	0.11
Rice Bran	5.78	94.22	13.57	14.18	2.37	8.42	55.68	1.1	0.19

Table 4 – Composition of Experimental diets (%)

Ingredients	*Diet I*	*Diet II*	*Diet III*	*Diet IV*	*Diet V*	*Diet VI*	*Diet VII*	*Diet VIII*	*Diet IX*
Fish meal (Local)	12.31	12.31	12.31	15.42	15.42	15.42	18.50	18.50	18.50
Shrimphead meal	4.98	4.98	4.98	6.18	6.18	6.18	7.43	7.43	7.43
Ipil-ipil leaf meal	18.97	18.97	18.97	23.76	23.76	23.76	28.49	28.49	28.49
Copra meal	24.67	24.67	24.67	30.90	30.90	30.90	37.05	37.05	37.05
Rice bran	0.22	0.22	0.22	0.08	0.08	0.08	0.25	0.25	0.25.
Refined coconu oil	12.92	18.48	24.04	7.87	13.42	18.98	2.76	8.31	13.87
Fine Rice Hull (filler)	25.93	20.37	14.81	15.79	10.24	4.68	5.62	0.07	–
TOTAL	100	100	100	100	100	100	100	100	105.49
Protein level %	20	20	20	25	25	25	30	30	30
Metabolizable energy level (kcals)	3,000	3,500	4,000	3,000	3,500	4,000	3,000	3,500	4,000
Price per kilo	₱1.91	₱2.24	₱2.57	₱1.89	₱2.23	₱2.55	₱1.98	₱2.31	₱2.64

Protein. 4.0 kcals/g; Fat, 9.0 kcals/g; Carbohydrate, 4.0 kcals/g (Maynard et al, 1979).

1/. Metabolizable energy (ME) values were based on mammalian physiological fuel values: Protein. 4.0 kcals/g; Fat, 9.0 kcals/g; Carbonhydrate, 4.0 kcals/g. (Maynard et al, 1979).

Table 5 – Proximate analysis data of experimental diets (%)

Ingredients	*Diet I*	*Diet II*	*Diet III*	*Diet IV*	*Diet V*	*Diet VI*	*Diet VII*	*Diet VIII*	*Diet IX*
Moisture	9.93	9.03	8.32	9.60	9.22	9.33	8.83	8.85	9.60
Dry matter	90.07	90.97	91.68	90.40	90.78	90.67	91.17	91.15	90.40
Crude Protein	20.93	21.32	21.19	25.45	25.56	25.81	30.62	30.68	30.67
Crude Fat	16.09	21.00	27.09	10.98	16.86	23.35	6.75	12.47	18.05
Crude Fibre	26.41	26.05	17.02	18.89	13.28	7.24	10.81	3.48	2.50
NFE	20.41	20.38	20.40	25.39	25.41	25.40	30.53	30.48	30.50
Ash	16.16	11.25	14.30	19.29	18.89	18.20	21.29	22.89	18.28
Calcium	3.30	3.47	3.47	3.49	4.21	4.81	4.49	6.63	6.68
Phosphorus	2.71	2.80	2.71	2.80	2.73	2.80	2.80	2.90	2.77
Calculated M.E. (kcal/kg)	3,100	3,550	4,100	3,020	3,550	4,100	3,050	3,500	4,100

Table 6 – Summary of results for fish receiving different feeds having different protein: energy ratios

Item	*Treatment*									
	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*
Average initial weight (g)	2.70	2.88^{a}	2.72^{a}	2.98^{a}	2.98^{a}	2.98^{a}	2.52^{a}	3.49^{a}	2.54^{a}	3.39^{a}
Average Final Weight (g)	61.60	79.38^{cd}	74.40^{d}	74.03^{cd}	92.77^{be}	81.32^{c}	81.32^{c}	96.73^{b}	85.96^{ce}	104.60^{a}
Average weight gain (g)	59.11	76.50^{cd}	69.68^{d}	71.05^{cd}	89.79^{be}	78.80^{c}	78.80^{c}	93.24^{b}	83.42^{ce}	101.21^{a}
Growth Rate (g)	0.49	0.64^{cd}	0.58^{d}	0.59^{d}	1.59^{de}	0.75^{be}	0.65^{c}	0.66^{c}	0.78^{b}	
	0.49	0.64^{cd}	0.58^{d}	0.59^{d}	0.75^{be}	0.65^{c}	0.66^{c}	0.78^{b}	0.69^{ce}	0.84^{a}
Feed Conversion	–	1.57^{de}	1.76^{cd}	1.96^{ab}	1.59^{de}	2.04^{a}	1.75^{cde}	$1,83^{bc}$	1.55^{e}	1.68^{ce}
Survival	93.78	91.11^{a}	95.11^{a}	91.11^{a}	95.33^{a}	94.89^{a}	87.56^{a}	93.11^{a}	91.56^{a}	94.45^{a}
Average Total Production	1,292.88	1,963.43	1,480.31	1,585.98	2,151.42	1,508.69	1,952.54	2,017.56	2,124.26	2,538.01

Means in a row with the same superscript are not significantly different (p 0.05).

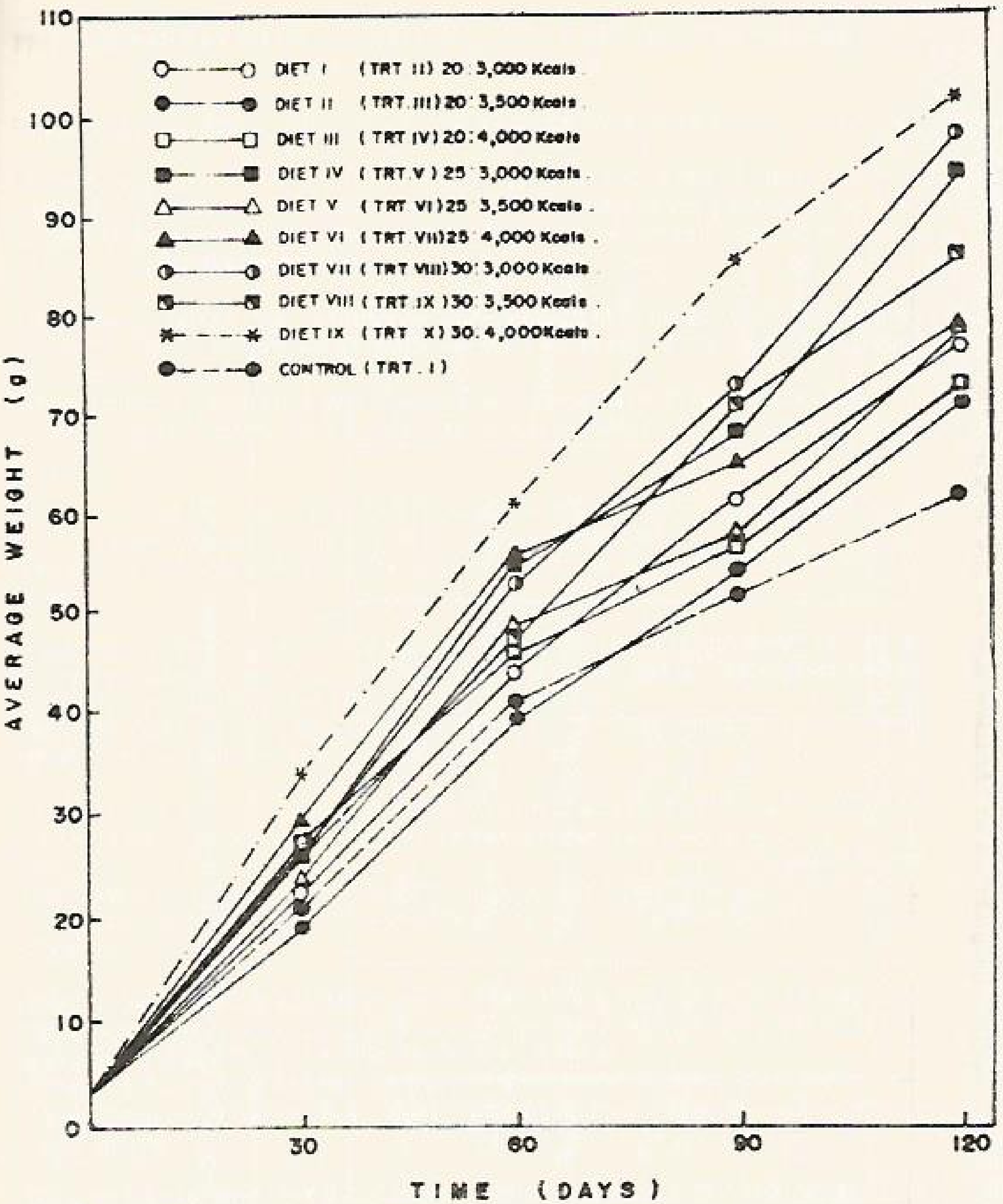

Fig. 1. Growth curves of Tilapia nilotica fed diets containing different protein energy ratios for 120 days in brackishwater ponds.

THE SHAPE OF FISHERIES TO COME
SOME THOUGHTS ON FISHERIES DEVELOPMENT AND EDUCATION WITH SPECIAL REFERENCE TO AQUACULTURE

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INTRODUCTION

The world fisheries is still mainly (90% of the total production) capture-oriented, which is just the reverse of plant-based and animal-based food production systems. In spite of the fact that the surface area of waters in the world is over 3–times that of the land and is also less accessible, given time, aquaculture would clearly point to this development. Leaving out the aqua-food (rice excluded), cultivated crops are the main source of human food. Man's unfamiliarity of the watery environment might only delay the process of development of aquaculture. But now with the global awareness of population explosion and food/protein shortage and limitations of terrestrial and aquatic production and also with the advances of science and technology, capable of penetrating millions of miles into the starry world, man would certainly 'plough' the waters as successfully as he does with the land.

EVOLUTION OF WORLD FISHERIES

I have suggested in Figure 1 three stages in the evolution of world fisheries (aquaculture) in the future. Stage I depicts the present position. The relative areas for capture (cp) and culture (Cl) fisheries approximate the contributions to overall fisheries production. The present global culture fisheries production is about 10% of the total, but in the 'near' future (Stage II), it (Cl) would increase and in the farther future (Stage III), it (Cl) would be over 50% of the total production. "Capture" would still be about half of the total production, but inroads of 'culture' into 'culture' will be much more for the capture operations will be based greatly on contributions from culture (Stocking and artificial recruitment), as the world's wild stocks would be overfished and man's intrusions (industrialization/ pullution) would reduce the wild stocks considerably. Thus in the real sense, the major portion of production (hatched area in the stages in Figure 1) would be strictly aquaculture-based but due to the nomenclature (accepted as 'capture') and indeed the major need for capture of the stocked fishes, 'captured fisheries' would continue to be about half or diminished half of the total.

Unbroken and broken horizontal arrows in the figure indicate greater and lesser influences (Cp or C1) on each other - the trend being a greater influence of capture (wild) fisheries on culture fisheries in the beginning, as now, which changes with time, as human control over the total fisheries increases.

The element of time involved is not specified, because of, as it appears, the telescoping effect of time on human progress or at any rate the telescoping of the progress in scientific achievements of man with time. Therefore, events conceived to take place in 50–100 years now could take place in 5–10 years from a fixed point in time in future. However, one might guess that in the next 50 years aquaculture production would be equal to capture fisheriee sproduction.

Disciplines in Fisheries

The various components involved in fisheries are indicated in Figure 2 as affecting all the changes in fisheries through time. The four major components, which may be treated as disciplines inside fisheries, are depicted as biology of the species involved., environment, technology/ engineering and socio-economics. Thed sub-components concerned are also indicated. A moment's reflection would make it obvious that the component with some modifications are also more or less common for not only the capture and culture fisheries, but also for most of the living resources - would's plant and animal crops.

An overall viewing of this type of obvious help to planners and educators as is recognized, but not often realized, especially in curricular planning and development.

The various sub-components in Figure 2 are the various subjects, courses or topics, depending on the stress needed to be covered, under the broad component/discipline headings in the figure. These are not complete but do suggest most of the interests. In long-established systems as for agriculture and animal husbandry these are well-formulated but for disciplines such as fisheries, the systems are relatively new, in spite of the fact that fisheries and allied subjects are taught for some years in various biology departments in the universities and also in a few fisheries colleges and universities - the latter especially in certain advanced countries such as Japan and U.S. are exceptions. Again, here the total approach is for fisheries, with aquaculture getting a subsidiary role if any at all.

It is of interest to view the role or importance of the various components sub-components depicted in the figure on the type of fisheries either capture. The approaches of the two subdivision of fisheries would be entirely different. For example, we can look up the interplay of the environment on the capture fisheries and explain the past and also future performances in a detached sense,-with much less control. But, as is obvious, with the culture systems, we would look at the environment e.g. a fish-pond environment as soil conditions of a farm as controllable. The technology/engineering for aquaculture will often be much profound and meaningful.

As indeed is well recognized aquaculture is this more akin to agriculture for study of most scientific disciplines than it is to fisheries (capture fisheries). It is the water and biological materials which are the common links of capture fisheries and aquaculture, but if one looks at pond culture, areas such as soil-water interaction and regulation of the chemical environment are as important for aquaculture as they are for agriculture.

While, the technology of high yielding varieties of crops might reduce the compatibility of fish-crop-livestock growing advancement of science and the need for integration of such systems (also need for recycling and pollution control and adoption of biological control methods, evolution of resistant varieties etc), would bring aquaculture and agriculture to real proxity universally, if not immediately, in the future, as is indeed realized and practised in certain ancient parts of the world.

From the point of view of the educator, it is convenient to teach many aquaculture subjects with specialists in the field so close to agriculture. Both these will fit-in together in the rural scene of developing countries also. The situation in most areas connected with capture fisheries is somewhat different.

Again, as recognized, in one area, especially post-harvest technology and marketing of the product, capture and culture fisheries are identical. Species biology and environment also have many common grounds in capture and culture, but here again one's approach is to manipulate the populations in an uncontrolled environment while the other's is to manipulate the environ for controlled populations. Indeed as is suggested, the two systems would drift towards each other but may remain separate considering the space involved.

In academic programme as indicated, it would be convenient to have aquaculture programmes going in proximity to agriculture programmes, but an obvious common groups for capture and culture fisheries should be maintained wherever the two programmes can coexist. Much of the basic aspects often included in the first degree in the university can be offered together.

In as much as fisheries and aquaculture programmes are developed new in several universities all over the world, aquaculture training programmes are actively planned and organised by

ADCP global network of FAO (this Centre) is a part, it is useful as indeed had been done, in some cases to view proximity and interdependence of the various components or disciplines of fisheries and agriculture and formulate teaching programmes accordingly.

For a general programme in fisheries, as a first degree or bachelor's degree of a university, it would be pertinent to offer together all the disciplines (biology, environment, technology/engineering and socio-economics complexes), cutting across the two divisions, capture fisheries and aquaculture.

Explanations for Figures

Figure 1

Likely changes in capture (Cp) and culture (Cl) fisheries contributions to overall fisheries production (harvested biomass) with time. The present global culture fisheries production is less than 10% of the total (Stage I, Figure 1), but in the 'near' future (Stage II) it (Cl) would increase and in the 'far' future (Stage III) it would be over 50% of the total production – capture would still be about half of the total production but inroads of 'culture' into 'capture will be much more, for the capture operations will be based on contributions from culture (stocking and artificial recruitment) as the world's wild stocks would be over-fished and man's intrusions (industrialization/pollution) would reduce the wild stocks considerably – thus in the real sense the major portion of production (hatched areas in the 'stages' in figure) would be strickly aquaculture based, but due to the nomenclature accepted as 'capture') and indeed the major need for 'capture' of the stocked fishes. 'Capture' fisheries would continue to be about half the total. Unbroken arrosw and broken horizontal arrows indicate the influence of one type of culture or the other ('Cp' vs 'Cl') – the trend being a greater influence of capture (wild fisheries) to culture fisheries in the beginning as now (Stage I) which changes with time (Stage II and III), as human control over the total fisheries increases.

At higher levels of specialization, say for the second or third degree programmes, it would be useful to branch off into capture fisheries or aquaculture and to individual disciplines affecting each division, as the subject of interest needing deeper study. Indeed, the accent of course programming contents for capture fisheries and aquaculture, as has been pointed out, will be more different as also are the expertise and facilities required. Having both these broad divisions under the same roof especially in higher level academic programmes will be highly expensive, though helpful, as is indeed experienced in a few such centres existing.

The ideas presented here have been collected/developed (1–5) in the course of my association with fisheries teaching, organising a fisheries programme (Fisheries College, Tuticorin) of the Tamil Nadu Agricultural University and also my involvement as Aquaculturist (Training) with the Post–graduate course for senior aquaculturists offered at the African Region Aquaculture Centre, Port Harcourt, Nigeria, which is part of the global network of the Aquaculture Development and Coordination Programme (ADCP) of the F.A.O.

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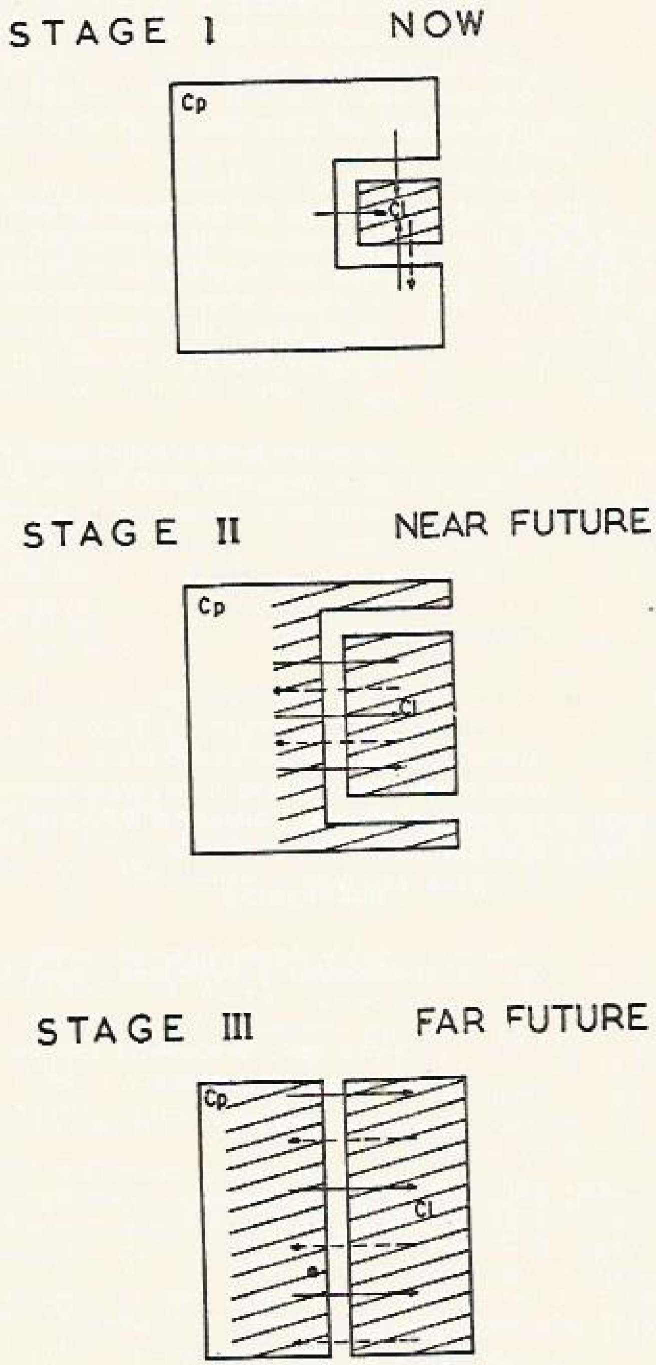
STAGE I
NOW
Cp
Cl
STAGE II
NEAR FUTURE
Cp
Cl
STAGE III
FAR FUTURE
Cp
Cl

FIGURE 1.

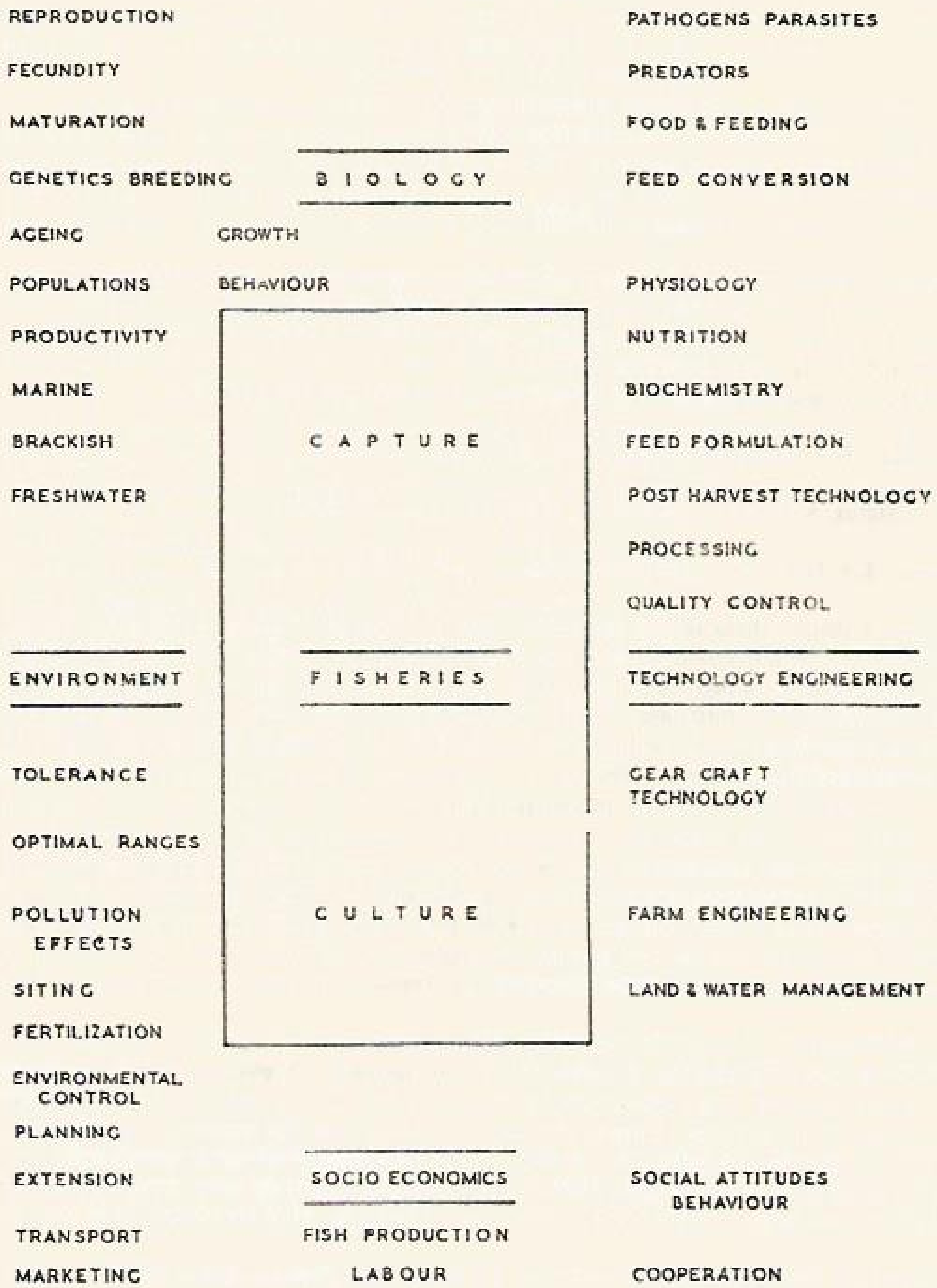
REPRODUCTION
FECUNDITY
MATURATION
GENETICS BREEDING
AGEING
GROWTH
POPULATIONS
BEHAVIOUR
PRODUCTIVITY
MARINE
BRACKISH
FRESHWATER
BIOLOGY
PATHOGENS PARASITES
PREDATORS
FOOD & FEEDING
FEED CONVERSION
PHYSIOLOGY
NUTRITION
BIOCHEMISTRY
FEED FORMULATION
POST HARVEST TECHNOLOGY
PROCESSING
QUALITY CONTROL
CAPTURE
ENVIRONMENT
FISHERIES
TECHNOLOGY ENGINEERING
TOLERANCE
OPTIMAL RANGES
POLLUTION EFFECTS
SITING
FERTILIZATION
ENVIRONMENTAL CONTROL
PLANNING
CULTURE
GEAR CRAFT TECHNOLOGY
FARM ENGINEERING
LAND & WATER MANAGEMENT
EXTENSION
TRANSPORT
MARKETING
SOCIO ECONOMICS
FISH PRODUCTION
LABOUR
SOCIAL ATTITUDES BEHAVIOUR
COOPERATION

FIGURE 2.

SECTION 4 – FISH BIOLOGY, TAXONOMY AND ECOLOGY

A STUDY ON THE GROWTH OF *Pseudotolithus elongatus*, *Chrysichthys nigrodigitatus* AND *Cynoglossus goreensis* OCCURRING IN THE CROSS RIVER ESTUARY

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ABSTRACT

Samples of *Pseudotolithus elongatus, Chrysichthys nigrodigitatus* and *Cynoglosus goreensis* obtained from the Cross River Estuary (which is most probably the largest estuary water system along the coast of West Africa) between January 1980 and May 1981 were evaluated on basis of population dynamic analytical method postulated by Pauly (1980) for tropical fish stocks. The following growth parameters were obtained for the three fish species:–

P. elongatus: K = 0.28, L = 48.04cm, to = –0.04, L_{max} = 45.6cm

C. nigrodigitatus: K = 2.39, L = 68.38cm, to = –0.29, L_{max} = 82.0cm

C. goreenis: K = 0.097, L = 82.1cm, to = 0.01, L_{max} = 78.0cm

Wherever possible, these results were compared to those obtained by Longhurst (1964d) and LeGuen (1971) in other West African waters. On the whole, results obtained in this study tend to indicate that the growth of the croaker, bagrid catfish and the sole in the Cross River Estuary is allometric, the third and fourth year-classes of *P. elongatus* the second and third class-year of *C. nigrodigitatus* and the fourth, fifth and sixth year classes of *C. goreensis* dominated in the age distribution of these fish species.

INTRODUCTION

Growth studies on tropical fish species have so far proven difficult owing to problems associated with the age determination of these fish species. Studies carried out by Longhurst (1964d), Troadec *et al* (1966), Bayagbona (1969), Le–Guen (1971), Pauly (1979; 1980), and Nawa (1982) on various tropical fish species have definitely made useful contributions, but a better understanding of this important phenomenon demands increased research work in this field.

Growth is a very appropriate property for system analysis. A study of growth in fishes therefore, offers ecologist many opportunities to inquire into the dynamic balance and stages of change in aquatic ecosystems. Growth studies are important for the assessment of fish stocks (i.e. the biomass of standing stocks and predictions on the strength of future stocks) and they also create a basis for making suggestions for optimal exploitation, so as to avoid overfishing and its attendant problems.

Chrysichthys nigrodigitatus, Cynoglossus goreensis and *Pseudotolithus elongatus* form the bulk of the commercially important fishes in the Cross River Estuary. These three fish species constitute about 39.6% and 82.6% of the annual catches in the artisanal and trawl fishes of the estuary respectively (Nawa, 1982). This study was necessitated by the absence of growth data of these fish species in the Cross River water system.

MATERIALS AND METHODS

Samples for this study were collected from various parts of the Cross River estuary between January 1980 and May 1981. The Cross River estuary is most probably the largest estuary in West Africa and belongs to the drowned-river-mouth type of estuary (Nawa, 1982). It has a total area of about 580km2 and consists of several islands distributed over a large expanse of land most especially in the upper reaches of the esturay. The estuary, located in the rain forest belt of the south-eastern corner of Nigeria, lies between latitudes 4^0 30'N and 4^0 58'N, and 8^0 09'E and 8^0 30'E. A distinctive feature of the surrounding vegetation is the dominance of mangroves (genera: *Avicennia* and *Rhizophora).* During the sampling period, both the artisanal and trawl fisheries were covered. The total length of individual specimens of these fish species was measured immediately during each sampling exercise, and the otoliths and scales were preserved for subsequent analysis in the laboratory. The surface temperature of each sampling area was also measured In the trawl fisheries, fish species investigated in this study were caught with the aid of a bottom trawl net with a mesh size of 60–70mm (stretched) in the cod end, while set gill nets with a mesh size ranging between 50–60mm (stretched) were used in the artisanal fisheries.

The length frequency distributions of *Chrysichthys nigrodigitatus* (bagrid catchfish), *Cynoglossus goreensis* (sole) and *Pseudotolithus elongatus* (croaker) covering a sampling period of one year were used for the computation of the age of these fish species. The method employed is a combination of the Ford-Walford Plot and a modified version of the Von Bertalianfy growth function (VBGH) developed by Paul (1980) specifically for tropical fish species

RESULTS

Otoliths and Scales

The scales of these fish species with a wide range of length distribution were obtained during the sampling period and examined under a high-power microscope. These were no clear boundaries on the annuli that would have facilitated the recognition of year-classes and thereupon confirm results obtained by other methods. An attempt made to relate the number of rings on the scales to the length of the fish proved futile. In all scales examined, the number of rings seemed to be distributed randomly in time. Furthermore, there was no indication of spawning marks on them. The use of fish scales for the separation of the age groups was, therefore, not given further consideration. Unlike temperature fishes, an examination of the otoliths of the fish species obtained from the Cross River Estuary for possible occurrence of annual growth rings did not yield favourable results. The use of daily growth rings in the determination of the age of fishes was given due consideration. The work of Panelia (1971) who worked on several tropical fish species, and that of Worthmann (1980) which dealt with the early growth stages of the pescada *(Plagioscion monti*, Soares) obtained from the Amazon Basin have shown that the daily growth rings could successfully be used in determining the age of tropical fishes. Otoliths of soles, sciaenids and catfish obtained from the Cross River estuary indicated that this is possible. The laboriously prepared otoliths of *Pseudotolithus elongatus, C. goreensis* and *Chrysichthys nigrodigitatus* showed daily-laid rings, some of which could not be separated from each other; an exact count proved difficult. Results obtained from this attempt are, therefore, not incorporated into this study. This aspect needs further investigation.

Length Frequency Analysis

Length frequency polygons, based on the relative abundance of *C. nigrodigitatus, C. goreensis* and *P. elongatus* obtained from the Cross River estuary, were plotted to examine the modal distribution.

The resultant wave-like mode of distribution was an indication of the presence of year-classes but these were blurred. In order to facilitate the separation of the year-classes, the relative values of abundance were "smoothed" according to the formula:–

$$a = \frac{2b + C}{n}$$

whereby,

a = Relative abundance of the preceeding length group,
b = Relative abundance of the length group being "smoothed",
c = Relative abundance of the succeeding length group,
n = The number of length groups (in this case n = 4).

Thereafter, the length frequency polygons gave more favourable modes of distribution (Figure 2a, b, c), with clearer boundaries between the various peaks. For further analysis, these peaks were assumed to represent the mean modal lengths of the various year-classes.

The evaluated growth parameters of the three main fish species occurring in the Cross River Estuary, *Pseudotolithus elongatus, Chrysichthys nigrodigitatus* and *Cynoglossus goreensis*, are depicited on Table 1 (a,b, and c).

The symbols used on the table represent the following:—

LT_m = Modal total length (cm) of each age group

G_L = Annual increment in length (cm)

X = Relative abundance of each age-group in the sample (5)

WT_m = Modal wet weight of each age-group (gm).

The asymtotic length ($L\infty$) and von Bertalanffy growth coefficient (K) were obtained with the aid of the For Walford plot. The evaluated data of both parameters was subsquently used to compute the length-at-birth (to) according to the empirical relationship postulated by Pauly (1980a):

$$Log_{10}(-t_0) = 0.3922 - 0.2752 \log_{10} L\infty - 1.038 \log_{10} K.$$

On Table 1 (a,b,c) L_{max1} denotes the maximum length of each species obtained in the Cross River Estuary, while L_{max2} is the maximum length of each species calculated according to the forumal suggested by Taylor

$$L_{max} = L\infty \quad .095.$$

The asymtotic length ($L\infty$) of *Pseudotolithus elongatus* is slightly higher, but compares favourably with results earlier obtained. In the Sierra Leone River Estuary, Longhurst (1964d) and Le Guen (1971) obtained an asymototic length of $L\infty$= 46.7cm for *P. elongatus* in the Congo River Estuary. The evaluated growth coefficient (K) for specimens from the Cross River Estuary was 0.28; this is good agreement with the result obtained by Le Guen (K = 0.274), but much longer than that of Longhurst (K = 0.61) in the afore-mentioned areas. The elngth-at-birth (to) recorded in the estuary is lower than that obtained by the above-mentioned workers, but lies closer to the value obtained by Le Guen (1971) in the Congo River Estuary. As shown on Table 1, it is evident that the second, third, and fourth age-groups with modal lengths ranging between 18cm and 32cm make up the bulk.

Table 1 – Evaluated growth parameters for *P. elongatus* (a); *C. nigrodigitatus* (b); and (c). *goreensis (c) in the Cross River Estuary*

Year Class	LT_m *(cm)*	*X %)*	G_L *(cm)*	WT_m *(g)*
(a) I	13.5	3.4		21.0K = 0.28
II	18.0	13.2	3.5	97.0 L_∞ = 48.04cm
III	25.0	39.7	7.0	120.0 t_0 = 0.04cm
IV	31.5	21.1	6.0	230.0 L_{max1} = 58.0cm
V	36.0	8.3	4.5	340.0 L_{max2} = 45.6cm
VI	39.0	7.8	3.0	440.0
(b) 0	9.0	4.7	6.0	50.0 K = 2.39
I	15.0	5.5		91.0 L_∞ = 68.38cm
II	20.0	16.8	5.0	128.0 t_0 = –0.293
III	25.0	35.5	5.0	150.0 L_{max1} = 90.0cm
IV	33.0	10.5	8.0	220.0 L_{max2} = 82.1cm
V	36.0	14.8	3.4	300.0
VI	40.0	12.0	4.0	346.0
(c) I	17.0	5.0		85.0 K = 0.097
II	22.0	12.4	5.0	96.0 L_∞ = 82.1cm
III	27.0	7.1	5.0	115.0 t_0 = –0.01
IV	34.0	20.7	7.0	163.0 L_{max1} = 88.0cm
V	37.0	17.7	3.0	270.0 L_{max2} = 78.0cm
VI	42.0	22.4	5.0	310.0
VII	45.0	13.6	3.0	340

18cm and 32cm make the bulk of *P. elongatus* caught in the Cross River Estuary. The maximum length sampled (L_{max1}) was higher than that evaluated (L_{max2}) according to the method suggested by Taylor (1962). Growth parameters obtained for *Chrysichthys nigrodigitatus* are shown in Table 1 (b). An asymtotic size of L = 86.38cm and a growth coefficient of K = 2.39 was evaluated for this fish species. The size during the first birthday t) was in the magnitude of –0.293. A maximum length of 90.0cm was recorded in the catch, but L_{max2} (82.1), was much lower. It seems most probable that a year-class, which would otherwise lie between the third and fourth year-classes, was not sampled because the length increment between both year-classes is considered to be abnormally high, as contrasted with the others, modal lengths of 20cm and 25cm respectively, were the dominant age-groups obtained (Table 1b). The various modal length-at-age for this fish species are shown in Figure 2 (b). The tongue sole, *Cynoglossu goreensis* had an asymtotic length of 82.1cm and a growth coefficient of K = 0.097 Table 1, c). The evaluated size-at-birth (t_0) was –0.01. The maximum size recorded in the estuary during the sampling period (L_{max1}) was 88.0cm and much higher than L_{max2} (78.0cm). A relatively high length increament was also recorded between the third and fourth year-classes. The most abundant year-classes were the IV–VI age groups whose modal lengths ranged between 34–42cm. Figure 3 (c) depicts the modal length-at-age of the various age-groups sampled.

DISCUSSION

The slight differences between the asymtotic size (L_∞) and the growth coefficient (K) of *Pseudotolithus elongatus* in the Cross River estuary and those obtained by Longhurst (1964d) and Le Guen (1971 in the Sierra Leone River and Congo River Estuaries, respectively, are not unexpected and may result from differing environmental conditions (though of a low magniture) in these water systems Unfortunately, corresponding growth parameters from the Cross River Estuary or similar water systems are not available for a comparative analysis of results obtained for *Chrysichthys nigrodigitatus* and *Cynoglossus gorennsis.* The significant differences recorded between L_∞ and Lmax2 for the three fish species are most probably related to the fact that several large specimens were included in the samples analysed. A scrutiny of the evaluated length frequency data and the conclusions derived from the work done on some otoliths reveals that the growth of the three fish species is allometric.

A limitation of this study is related to the fact that the fish samples collected over a period of one year were combined together for the final computation of data. Consequently, the assessment of the growth of the various year-classes in time (i.e. time intervals of less than one year) is not considered here. However, this limitation is partially offset by the fact that most tropical fish species have a comparatively slow rate of growth; small time unit intervals may therefore, yield insignificant size increament. From the modal length-at-age distribution, it would seem that *Chrysichthys nigrodigitatus* enters the fisheries in the Cross River Estuary much earlier than *Pseudotolithus elongatus* and *Cynoglossus goreensis.* The empirical observations made during this study tend to infer that the growth of the last two species is slower than that of the bagrid catfish. This may explain the delayed period of recruitment of *P elongatus* and *C. goreensis.*

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to Professor D. W. Nellen of the Institute of Marine Science, Kiel, West Germany whose support and advice made this study possible. I should also thank Dr. T. S. Matuszek, Mr. A. A. Nawa and Mr. N. C. Alagoa who in one way or the other have contributed to the successful completion of this study.

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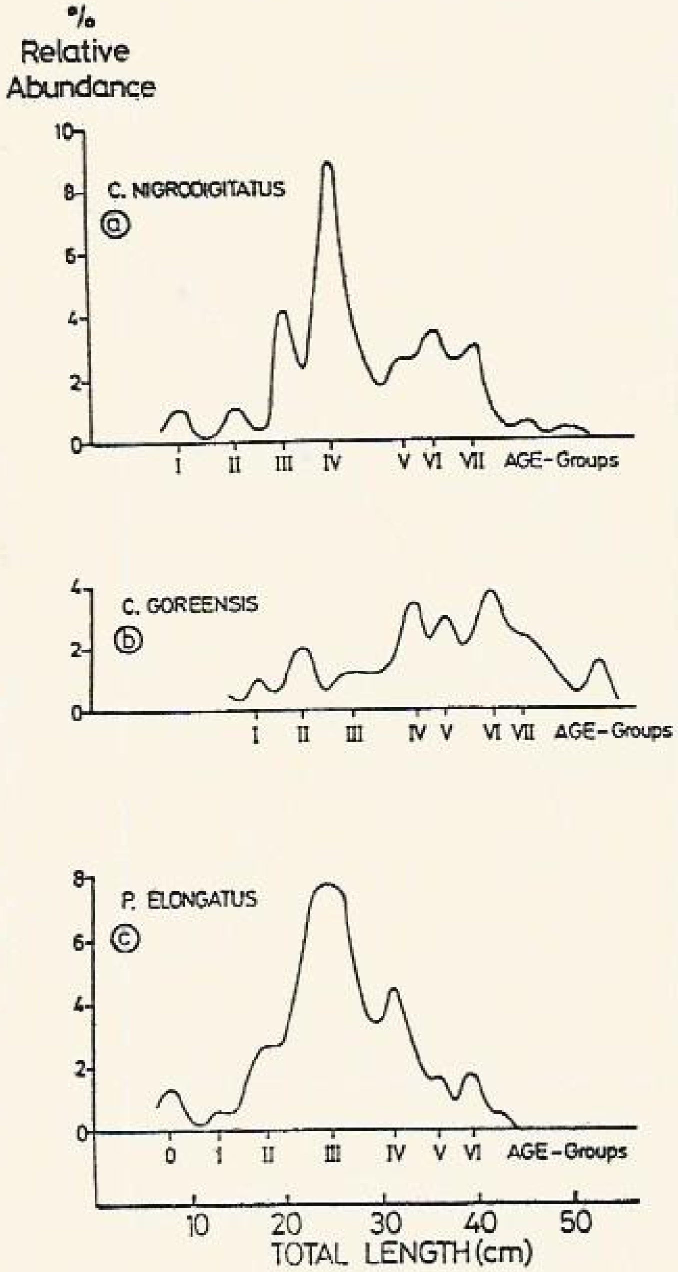

Fig. 3 a, b, c,: Growth curves of C. nigrodigitatus C. goreensis and P. elongatus showing mean modal lengths of the age-groups.

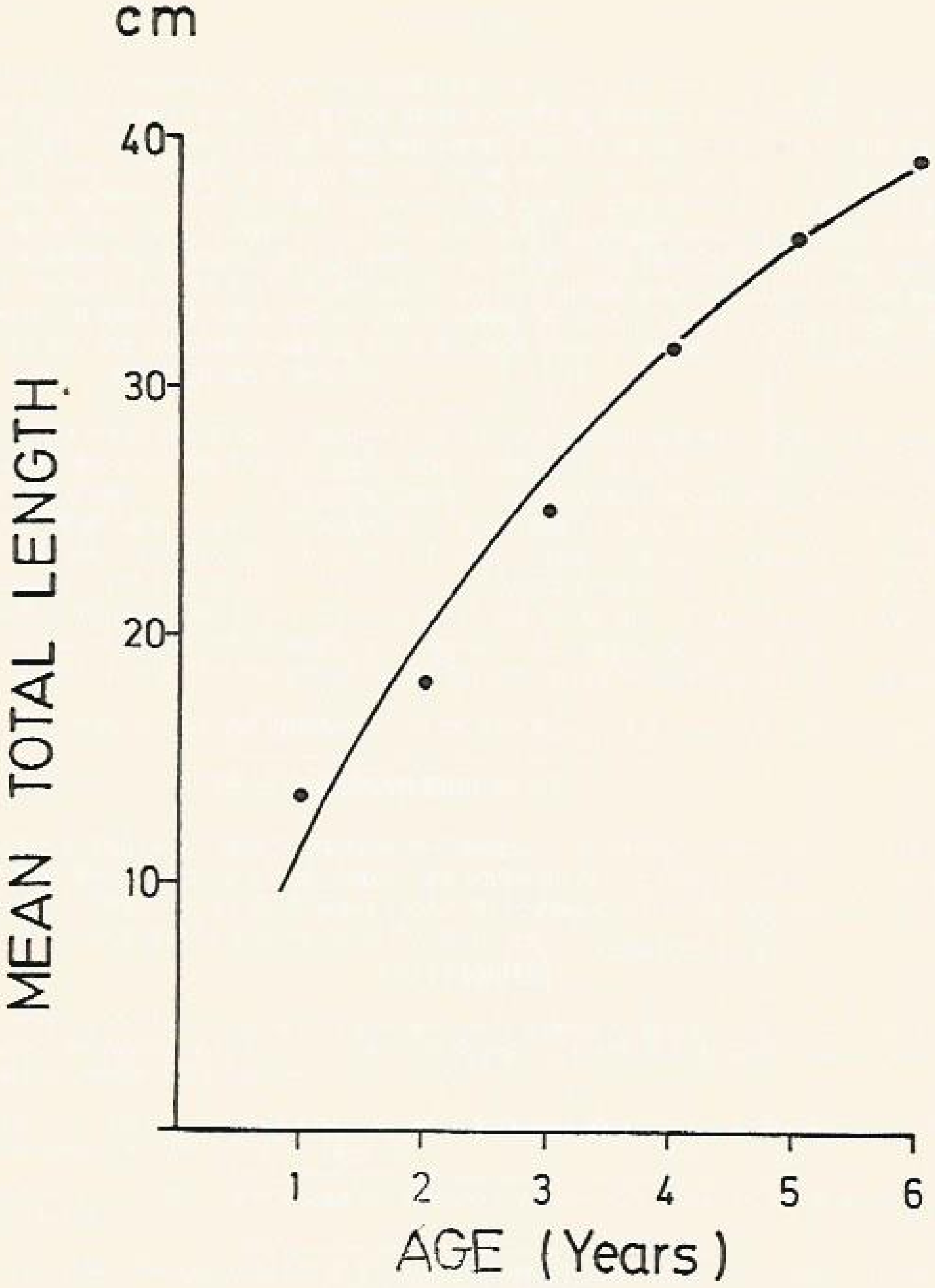

Figure 2 : Growth Curve of *P. elongatus* showing Mean Modal Lengths of the Age-groups.

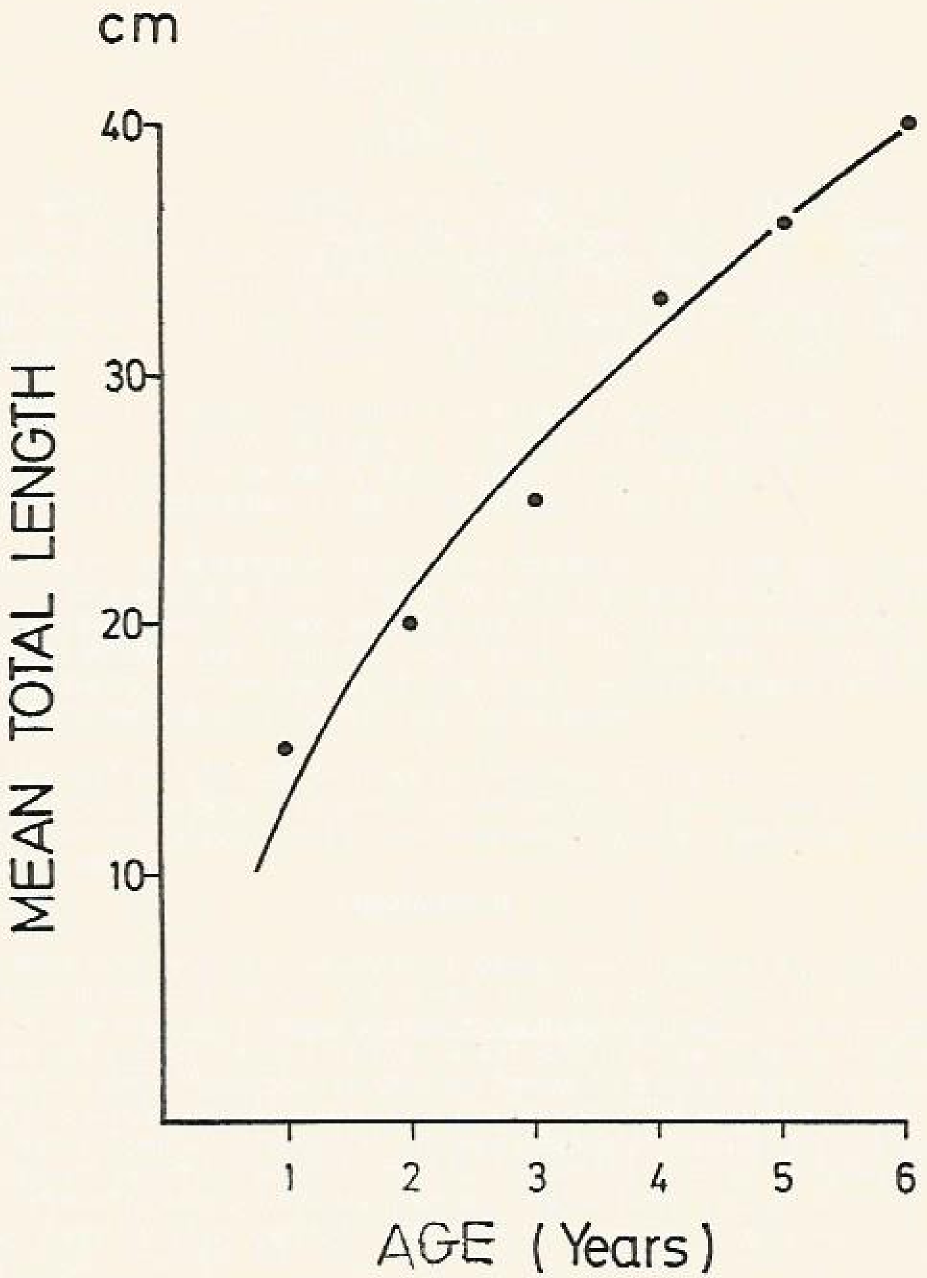

Figure 3 : Growth Curve of *C. nigrodigitatus* showing Mean Modal Lengths of the Age-groups.

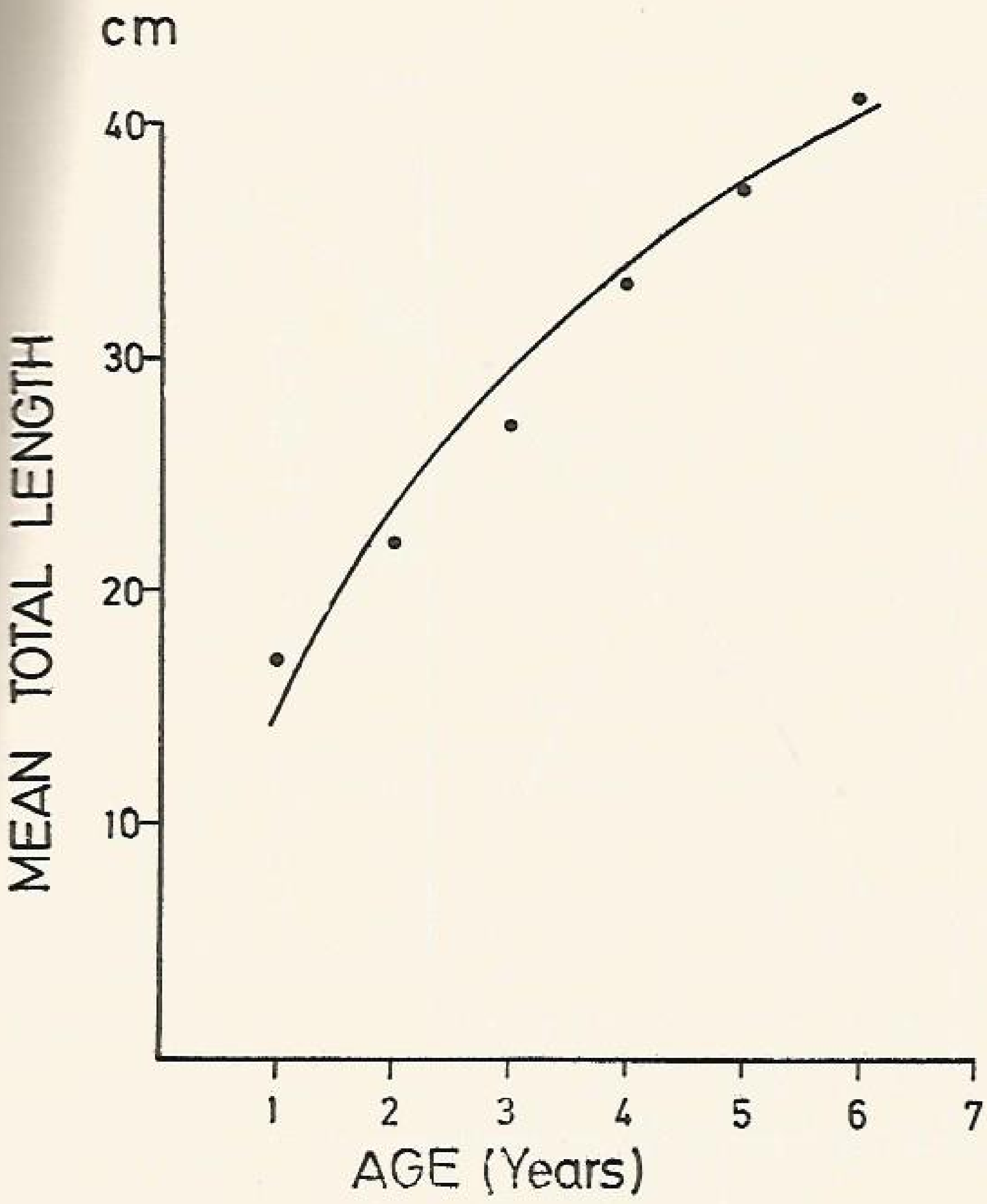

Figure 4 : Growth Curve of *C. goreensis* showing Mean Modal Lengths of the Age-groups.

A REVIEW OF BONGA FISHERIES OF THE CROSS RIVER STATE NIGERIA

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ABSTRACT

The Nigerian pelagic fishery contributes about two-thirds of the total marine fishery resources of the country. The main components of this fishery are the Clupeid *(Ethmalosa,* and *Sardinella* spp) and the Scombroid (jacks, barracuda, and tuna) fisheries. In 1979 to 1983, fish production from the national inshore and brackish water zones was 1,702,685 tonnes. Bonga *(Ethmalosa fimbriata)* which dominates the pelagic fishery in the Cross River State of Nigeria, contributed about 158,612 tonnes (i.e. 9.3%) of this national marine fish catch.

Although bonga is caught along the entire Nigerian coast, a significant fishery exists mostly in the wider estuary of the Cross River State, which borders on the Cameroon Republic. In the Cross River State, and within the period, Bonga contributed 24% to the marine fish landings. The highest volume of Bonga in the State tends to be localised in Ibeno/Eket.

Bonga is supported by a single species *(Ethmalosa fimbriata).* It is a phytoplankton feeder, occuring in estuaries, lagoons, and shallow seas at the rarther high temperatures of 25oC where dense diatom blooms appear. The peak season is in the dry season (November to March) within the estuaries of the Niger Delta to the Cameroun Republic. The species forms an important fishery all the year-round in the open sea off these estuaries, whenever the canoes venture to sea, but these open sea fisheries are affected by wheather conditions.

The best, and most suitable gear for Bonga are the gill nets, cast nets, boat seines, and shore seines. Dried and smoked Bonga are a common market commodity in the southern parts of the country generally, but particularly in the Cross River State where it is a readily available and acceptable food item.

INTRODUCTION

The Bonga fishery consists exclusively of one species, namely *Ethmalosa fimbriata* (Bowdich), *Ethmalosa dorsalis* (Cuvier and Velenciennes); and in Nigeria the fishery is more or less localised along the coast, and numerous estuaries of the Niger Delta Region. It is extensively fished in the wider estuary of the Cross River, which borders with the Cameroun Republic. In the western States of Nigeria, there are important fisheries for Bonga during the dry season (December to March) within the estuaries of the principal rivers of the delta (Benin, Escravos, Forcados, Ramos, Dodo and Pennington). The species also forms the main fishery all year round in the open sea off this section of the delta coastline, but these open sea fisheries are very much effected by weather conditions (Oslen and Lafevere, 1969). Presently in the Cross River State, Bonga forms very important fishery along the estuarome fishing villages notably Ibeno/Eket, Oron, Effiat/Mbo, Ikot Abasi, and Ifiayong/Uyo. The fishing season normally extends from November to May with a peak period of three months from January to March.

With the role of both the national, and State Governments in subsidizing fishery development in the Cross River State particularly in the mechanization of fishing crafts, the fishing activity of the Cross River State fishermen along the coast has considerably increased in recent years. As a result, the area of exploitation of the fishery has increased tremendously and the landings of Bonga in the Cross River State have gone up from 8% of the annual fish landings from the national inshore and brackish water in 1979 to 11% in 1980, and almost stabilized at 9% in 1982 and 1983. More than 9% of the total Bonga fish landings of Nigeria came from the Cross River State.

Within the State, Bonga contributed 24% of the marine fish landings. It is true to say that the success or failure of this fishery determines to a large extent the well-being of some fishing communities in the Cross River. There has always been great demand for dried and smoked Bonga fish from the Cross River State by neighbouring Nigerian States.

DISTRIBUTION

In distribution, Bonga is seen along the West African coastline extending from Villa Cisneros, Rio de Oro to Lobito, Angola (Bainbridge, 1963). This range of distribution (24oN to 12oS) corresponds roughly to the extreme northerly, and southerly limits of the 25oC isotherms throughout the year as shown by various surface temperature charts (Longhurst, 1962); suggesting that temperature is possibly the basic limiting factor to the longitudinal distribution range of the species (Bainbridge, 1963). According to Zei (1969), Ethmalosa has two main areas of concentration, i.e.

- From the River Senegal to Sierra-Leone;
- Along the Coasts of Nigeria, Cameroun, and east-wards to the mouth of the Congo.

These areas (including the more isolated Abidjan Region) are characterized by extensive estuarine regions enriched bv river affluents. Although a significant fishery for Bonga exists in the Niger Delta, and the wider estuary of the Cross River, which borders with the Cameroun Republic, a small fishery occurs in the lagoon system open to the sea at Lagos (Bainbridge, 1963)

CATCH TRENDS

The national fish landings form the inshore and brackish water during the period 1979 to 1983 ranged from 356,888 to 370,040 tonnes with a total of 1,702,685 tonnes. The Cross River State Bonga constributed to 158,612 tonnes or 9.30% of this national marine fish landings.

In the Cross River State, the marine fish landings for the five year period ranged from 110,603 tonnes to 157,376 tonnes with a total of 659,892 tonnes. The catch for Bonga fish ranged from 27,367 to 34,871 tonnes and with a total of 158,612 tonnes thus, contributing 24% to the Marine fish landings there.

Bonga is generally classified among the most easily available and acceptable table fish in the Southern States of Nigeria; and it constitutes one of the important commercial fishes in the Cross River State. The quantity of Bonga fish landed within the five year period was valued at ₦213 million.

At the national level, Bonga from the Cross River State contributed 8% in 1979; 11% in 1980; 10% in 1981; and 9% in 1982 and 1983 to the marine fish production in the country. In the Cross River State, 25% of the marine fish landed in 1979 was Bonga which was estimated at ₦26.8 million and in 1981; Bonga also contributed 26% to the marine fish production in that State, and was valued at ₦38.7 million (Table 3). At this point, it seems true to say, that the Cross River State is the main producer of Bonga fish to the rest of the country.

Ibeno/Eket in the Cross River State is the centre of greatest concentraion of Bonga fishery activities. Oron fishermen staying along Utan Brama, Mbe Ndoro, and Abana Ntuen near the Cameroun/Nigerian border also specialise, and land bonga the whole year-round. The Bonga fishermen in Nwaniba/Uyo migrate and join the Oron fishermen to fish along the Cameroun/Nigerian border. Oyorokoto near Ikot Abasi is a large fishing settlement for bonga fishermen. The Ibeno/Eket and Ikot Abasi bonga fishermen bring in their catches mostly from the estuaries of the Niger Delta, while the Oron, Nwaniba&Uyo bonga fishermen bring in their catches from the wide estuaries of the Cameroun/Nigerian border where Bonga fishing is intensively carried out throughout the year.

Large scale shoals of *Ethmalosa* is common along these areas, and the fishing by the fishermen is normally restricted to these estuarine coastal belt of about 10 to 16km from the shoreline, due on the one hand to the limitations of their dugout canoes, other types of fishing crafts and on the other during the tikes of good harvest when bonga is seen nearer to the estuaries shore. The shoals are usually caught at a depth of about 15 metres.

SIZE COMPOSITION OF THE CATCH

The minimum size at maturity, and the various length distribution usually represented in the catches landed by the fishermen in Nigeria have been recorded by Fagade and Olaniyan (1972) to exhibit three modes of 40, 120, and 270mm. Solzen (1958) working on the size composition of this species inthe Sierra Leone river estuary, had observed a modal length distribution pattern of 120, 150, and 280mm, and again 330 and 360mm. The mean length of the species had been measured to be 23.62–34.61cm for the males and 23.90–24.84cm for the females in the Niger Delta according to Oslen and Lefevere (1969) as quoted by Fagade and Olaniyan (1972). In March to May, specimens with total length of 70mm are most frequent in the catch while larger ones ranging from 70mm – 170mm are obtained throughout the entire year. But in the peak season for Bonga fishing in November to May, larger sizes ranging from 170–310mm are caught (Fagade and Olaniyan, 1972). In the Cross River State, especially in Ibeno/Eket, the common size ranges usually landed by the fishermen fall between 150 to 310mm during the peak season.

SPAWNING GROUNDS AND SEASONS

The bonga *(Ethmalosa fimbriata)* spawns in the sea at the beginning of the dry season. The planktonic eggs hatch and in the high temperatures of the tropics metamorphose quickly, and immature stages move up the estuary into the brackish water creeks where they grow to 11–17mm (TL) before they migrate back to the sea (Bainbridge, 1961; Salzen, 1958; Longhurst, 1961) as quote by Moses (1980). After collecting the eggs of Ethmalosa fimbriata from the Lagos Lagoon between January and May with higher figures in February and March, Fagade and Olaniyan (1972) inferred that the species spawned between January and May with peak spawning in February and March. Watt (1957) studied the seasonal variations in the chemical composition of bonga, and found that the average fat content increased from less than 10% of the dry weight in January to more than 20% during June and July after which it declined to below 10% by September. Salzen (1958) has shown that fluctuations of the condition factor follow a similar pattern. According to Bainbridge (1961), there appeared to be no appreciable spawning of the species within the estuary, and concluded that the aggregation of Ethmalosa within the estuary during the dry season is a feeding aggregation associated with the high standing crop of diatoms. Bainbridge (1963) further observed that since neither the eggs or larvae of Ethmalosa are present in the plankton of the estuary, spawning therefore, takes place at sea.

Table 1 – National Fish landings/Cross River State Bonga fish catch data in tonnes 1979–1983

Year	*National Inshore and Brachkish water fish Landings (A)*	*Cross River State Bonga Fish Landings (B)*	*(B) as a Percentage of (A)*
1979	356,888	27,367	8.0
1980	274,158	29,895	11.0
1981	323,916	32,481	10.0
1982	377,683	33,998	9.0
1983	370,040	34,871	9.0
Total	1,702,685	158,612	9.3

Source: (A) – *Fisheries Statistics of Nigeria, 1983.*
(B) – *Marine Fish Production by Species in the Cross River State 1978–1984.*

(B)

Table 2 – Marine Fish/Bonga fish Landings in the Cross River State 1978–1983

Year	*Marine Fish (A)*	*Bonga Fish (B)*	*as a % of (A)*	*Value in Naira (₦)*
1979	110,603	27,367	25.0	26,819,600.00
1980	122,544	29,895	24.4	34,482,500.00
1981	123,221	32,481	26.4	38,721,550.00
1982	146,148	33,998	23.3	47,996,000.00
1983	157,376	34,871	22.2	65,177,870.00
Total	659,892	158,612	24.0	213,197,580.00

Source: As in Table 1.

Table 3 – Percentage Contribution of Cross River State Bonga Fish to the National/Cross River State Marine fish landings

Year	*National*	*Cross River State*
1979	8.0	25.0
1980	11.0	24.4
1981	10.0	26.4
1982	9.0	23.3
1983	9.4	22.2
Total	9.3	24.0

Source: Compiled from Tables 1 and 2.

FECUNDITY

Fagade and Olaniyan (1972) had estimated the number of eggs in the mature ovary of *Ethmalosa* by gravimetric method and found that the number of eggs in the ovary ranges between 2.38×10^4 for a 175 mm fish to 1.87×10^5 for a 305mm specimen. Bonga with total length above 25.5cm according to them, exhibited wide variation in their fecundity, while the less variable fecundity of 17.5 to 25.5cm size class, being first spawners showed little variation in total number of eggs in the ovary.

FOOD AND FEEDING HABIT

Quite intensive studies have been made on the food, and feeding habits of Bonga *(Ethmalosa fimbriata)* by Bainbridge (1963) and other authors. It has been established that Bonga is a planktonic feeder feeding to a much greater extent on phytoplankton viz., Dinoflagellata *Dinophysis* spp), diatoms including the main *Pleurosigma* spp, *Nitzhia* spp, *Paralia sulcata, Cymatodiscus* and *Cymatotheca* spp, *Coscinodiscus radiata, C. lineatus* etc., and to a lesser extent on zooplankton including lamellibranch larvae, copepod, nauplii and a few other zooplankton as recorded by (Bainbridge *loc. cit.)*. Bonga occurs in highest concentration in estuaries and lagoon, as well as in the shallow sea at the rather high temperatures of over 25oC, where any when dense phytoplankton diatomblooms appear. These are most frequent during the dry season, engendering the main estuarine canoe fishery (Oslen and Lafevere, 1969).

The ability of *Ethmalosa* to feed on phytoplnlankton is associated with the extremely fine filtering mechanism of the gill rakers. Thiemann (1934), as quoted by Bainbridge (1963) made brief exploratory surveys of the estuaries of some West African Rivers – the Bonny River in Nigeria, the Bimbia and Cameroun Rivers both in the Cameroun Republic. The survey further emphasized the huge number of phytoplankton with large species of *Coscinodaceae* predominant as food for Bonga. According to Wilson (1979), *Ethmalosa* inhabits estuarine lagoons and the inshore waters feeding on zoo-and phytoplankton. The fish is highly adapted to its mode of feeding.

From January to July, there is a high standing crop of phytoplankton in the estuaries which coincides with the main fishing season for *Ethmalosa*. From August to October, with sparse phytoplankton within the estuaries few Bonga are caught, and their stomachs contain very little food material. It seems possible, therefore, that the association of *Ethmalosa* fisheries with estuaries, and lagoons open to the sea may be related to the availability of food (Bainbridge, 1963).

AGE AND GROWTH

The size distribution of Bonga fish caught with gill-nets varies little within the season and total size range is rather small. No success was achieved in aging the fish. Scales show some sort of growth zones, but they are too numerous to represent annuli (FAO, 1969). There is a size variation in age one ranging from 14cm to 15cm (FL) and in age two from 21cm to 24cm (FL). Spawning fish arrive in the lagoon, and estuarine spawning grounds as from November onwards. The first group of spawners include first year and second year old fish 14cm to 15cm (FL), and 21cm to 14cm (FL) respectively. Most late spawners of February to May are first year old Bongas. The period of November to May represents maturation in the advanced stage and spawning (Wilson, 1979).

The adult Bonga fish according to Bainbridge (1963), has a length range of 26cm to 30cm (TL). Landings of Bonga fish reach a maximum about the middle of the dry season, and fall off to negligible quantities at the height of the wet season. About 28cm represents the modal length of adult bonga fish taken by cast nets, and which did not change during the year.

As the scales and operculum of bonga do not reveal any growth rring, then the determination of the age of bonga by the use of these two conventional materials could not be feasible. Fagade and Olaniyan (1972) applied length distribution method in determining the age of this fish. Bonga having total length below 170mm belong to the one year old class and the ones ranging in length from 170 to 310mm belong to the two year old class. If spawning is restricted to a definite age groups, this then means that Bonga exhibits a growth of 170mm in the first year, and a growth of 140mm in the second year. The male Bonga attains sexual maturity at a total length of 120mm, while the females have mature gonads at a total length of 170mm. It could be inferred that the normal life span of Bonga is 2½ years, as they attain sexual maturity and almost full adult size at the age of one year, within which time they can only spawn once in their life time.

SHOALING BEHAVIOUR

Bonga are always found in huge shoals in the estuaries, and inshore waters. There are differenct kinds of shoals each having its own characteristics features. Bainbridge (1963) observed the shoal of bonga in the estuary remaining for about 40 minutes moving slowly and apparently rising and falling in depth. Among the shoals, pattering, leaping, rippling and flipping types are recognised based on the physical movement of the fish. The shoaling behaviour of Bonga as narrated by the Bonga fishermen in Ibeno/Eket, tends to tally with what has already been described by Balan (1962) and Nair (1972) for *Sardinella longiceps*, an Indian oil sardine. It has been reported that the surface shoals of bonga are observed to be luminiscent during the nights of the dark phase of the moon. They are easily caught when the luminiscence is moderate while bright luminiscence is unfavourable for bonga fishing since the light enables the fish to see and avoid the nets. The shoals of bonga occasionally descend to the deeper level of the estuaries, or even the sea, but their occurrence in depths could be known for the nature of bubbles, which ascend to the surface or from the characteristic odour. The local fishermen always search for this sign while trying to locate a bottom shoal, and according to them these bubbles are released by Bonga from the bottom, while feeding within the region. At times, a very strong fishy odour emantes from the fishing grounds indicating the presence of bonga concentration at the bottom, and within which time, the fishermen usually make very heavey catches from such shoals. This fishy odour is probably caused by the discharge of mucous form large concentration of Bonga.

The occurrence of Bonga shoals near the shore at the beginning of the fishing season is clearly linked with the salinity of the water. When brakish water of low salinity prevailed, no bonga shoals were caught, but as soon as the estuarine water was replaced by clear, salt seawater good catches were obtained (FAO, 1969).

MIGRATION

Regarding the migrational pattern of Bonga, not much is understood. Longhurst (1960) had conducted some tagging experiments which strongly indicates that there is a considerable exchange of individuals of shoals between the inshore/estuary/offshore, and vice-versa, which appear to suggest more of a local migration. Bonga exhibits a complex behaviour in relation to hydrographic conditions because the breeding does not occur in the estuarine area, and the adults exercise a frequent inshore-offshore movement (Longhurst, 1961, Bainbridge, 1961; 1963).

FISHING SEASON

Bonga fishery in the Cross River State usually commences in November and terminates in May, with the January to March portion representing the peak period of the fishery. After May, no appreciable quantity of bonga may be caught in the estuaries, and none at all in August to October.

Longhurst and Bainbridge (1963) observed that it is only in the dry season and that of certain parts of the open coast and in particular the open sea off the Niger Delta, the fish are caught all-year-round whenever the canoes venture to sea.

FISHING CRAFT AND GEAR

The fishing for Bonga is carried out mainly with the traditional fishing craft, and gear The traditional dug-out canoes employed for Bonga fishery along the coast of Nigeria are of two main sizes. The bigger size ranges from about 9 metres to 12 metres long, 0.9m wide and about 0.8m deep with a two-tonne capacity. In both types, the fishermen use big paddles for propulsion as well as for control of the canoes when in operation. Some of these dug-out canoes have been fitted with outboard motors ranging from 18–40 Horse Power (HP). Most of these outboard motors are supplied at highly subsidized prices by both the State and the Federal Governments to the fishermen in order to increase fish production for public consumption.

The best and most suitable gear for Bonga are the gill-nets, cast nets, set nets and drift nets. Currently, some Bonga fishermen in the State are also employing boat seines, and shore seine nets in catching Bonga especially in Ibeno/Eket. These seine nets are basically a wall-net of enormous length. Plastic floats, stone sinkers, and wooden floats are attached to the head and foot ropes respectively to keep the nets in position. One end of the net is tightly secured to the shore, while the canoe either mechanised, or non-mechanised takes the other arm into the sea in a semi-circle, forming a large loop and assisted by a large group of fishermen to draw the net back to the shore. Large shoals of Bonga mixed with other fishes are trapped.

Gill nets, sets, and drift nets are all wall-like nets of various sizes and meshes. The traditional ones, until recently with the introduction of the imported synthetic types, were made of cotton twines provided with lead sinkers, and floats to keep them vertical. The operation of the nets consist in spreading the nets in the fishing ground with one of the ends either secured to the dug-out canoe or just allowed to drift with heavy plastic floats without the canoe. The nets drift in the direction of the current, and tide. Shoals of Bonga while moving about are gilled or entagled in the nets. After some few hours, the fishermen haul up the nets, and collect the fish.

Cast nets are conically shaped nets with large mouth tampering to a tiny end which is tied. At the mouths, are strong ropes with lead sinkers. Pouches are formed along the whole length of the mouths. The tiny ends of the nets are provided with hard ropes which fishermen use in hauling the nets after throwing them (Saphe, Nigeria, Consortium, 1980). The method of operating cast net consists in throwing the net fully spread over a shoal of Bonga which are trapped as the circumstance of the net closes as result of the lead weights attached to the net. Cast netting is mostly operated along the creeks and in the estuaries.

PROCESSING OF THE CATCH

In the Cross River State, and in Nigeria as a whole, dried and smoked Bonga is the most widely accepted food item in the market. The artisanal Bonga fishermen are still using the traditional method of smoking their catches, eventhough in some places, for instance in Esuk Enwang (Effiat/Mbo Local Government Area) and Queenstown near Ikot Abasi Local Government Area, the State Government had built model smoking kilns at these production centres for the smoking of Bonga. The fishermen have not found the need to make use of these smoking kilns. These smoking kilns, are at present therefore, existing as monuments in these fishing settlements. Presently, it has not been possible to evaluate the acceptance of Bonga in the fresh and frozen form by the upland consumers due mostly on the one hand to the non-availability of roads linking up the production centres and the upland markets. What really happens under the situation is that since bonga has not undergone any or massive icing or freezing in the fresh condition, no one is yet familiar with what problems could be associated with the handling of bonga in the frozen conditions in Nigeria.

It may be suggested in this paper that block ice could be conveyed to the landing centres for preservation of bonga in the fresh condition for the upland market. In the Cross River State of Nigeria and during the peak season for Bonga, huge quantities are landed and because of lack of facility for icing and freezing, spoilage sets in, and the fishermen are left with no alternative than to empty their canoe loads of the catches back to sea. Such spilage forms about 30% daily wastage on the fishermen's Bonga landings during the season.

Ethmalosa fimbriata being a clupeoid fish as *Sardinalla longiceps* - and Indian oil sardine of high economic importance, though not of the same species as bonga, has been studied in detail in terms of handling it in the fresh and frozen condition. In India, under a similar condition when *Sardinella longiceps* are caught in such unmanageable quantities during the peak season, the fish is rather utilized as manure for lack of facility for preservation by freezing or some other economic way of processing. In trying to reduce this economic waste on this commercial Indian sardine, a research had to be conducted by the Central Institute of Fisheries Technology, Cochin, India, and was discovered that one of the major difficulty encountered in preserving *Sardinella longiceps* in ice, or even in the frozen state was the phenomenon of belly bursting. The belly walls of this sardine normally broke up exposing the visceral portion thus reducing the consumer acceptability of the fish. A successful method of icing and freezing that sardine had since been worked out and implemented – thus, reducing the economic wastage (Anon, C.I.F.T.).

Currently, ice is being manufactured in Uta Ewa – Ikot Abasi, and the modern fishing terminal with facilities for ice production in Ebughu–Oron had been completed, and commissioned. Ice is no more a scarce commodity in this State. It's my opinion, that before ice, not to mention freezing, could be introduced to the Bonga fishermen for preservation of the fish at the landing centres, a detailed investigation should be carried out to indicate what problems could be encountered with the fish in ice, and the economic aspects of such a venture on the part of the fishermen, the government and the consumer.

DISCUSSION

Data in respect of Bonga Fishery based on annual fish landings from the national inshore and brackish water with particular reference to the Cross River of Nigeria have been presented. It is clear that Bonga from the Cross River State forms 9% of the National Marine Fish landings; and within the State as a major pelagic fish of high economic importance, Bong forms 24% of the marine fish landings.

The effort of both the State and Federal Government canoe mechanization and fishing inputs subsidy schemes have made tremendous impact in enhancing Bonga production in the State. Government efforts should not be relaxed in this direction.

The problem seriously posed in this fishery is that of preservation of the catch in the fresh condition. It becomes a matter of mere common sense that in order to get Bonga to the upland market, and to preserve the catch, efforts have to be made to increase the shelve life. The only practical answer on the part of the fishermen is to smoke the catch, in the absence of any other method. The fishermen are already used to their traditional method of smoking bonga, but smoking kilns could facilitate larger quantities of bonga to be smoked at a stretch. It calls for more smoking kilns to be built at the landing centres, and intensive extension work to demonstrate the usefulness of the smoking-kilns to the fishermen. Good communication road system – where feasible, should be constructed to link the fishing bases with the hinterland.

About the most ideal thing to do, would be to provide ice, freezers cold room facilities, freezing and chilling at such populous Bonga fishermen centres as Utan Brama with more than 6,000 fishermen, and in Ibeno with about same number of fishermen, but the provision of such infrastructure should be handled with care until it could be ascertained that the fishermen would only buy the idea in terms of profit and loss of the venture.

Since Bonga is a fish of great economic importance in the Cross River State, the Nigerian Institute for Oceanography and Marine Research should incorporate a proper research into the Bonga fishery of this State in terms of preservation of the catch; spawning survey for bonga; identity of stock/stocks of bongas; and environmental studies that affect bonga fishery in whatever way in the Cross River State of Nigeria.

ACKNOWLEDGEMENTS

I wish to express my gratefulness to B. S. Moses, Esq., Head, Department of Zoology/ Fisheries, University of Cross River State, Uyo for critically reading through the manuscript, and making useful comments.

My appreciation also goes to the numerous authors whose work I have read through, and cited in the text to bring this paper to its present form.

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STUDIES ON THE BIOLOGY OF *Gymnarchus niloticus* IN LAKE CHAD: AGE DETERMINATION AND GROWTH; MERISTIC AND MORPHOMETRIC CHARACTERS

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ABSTRACT

The meristic and morphometric characteristics of *Gymnarchus niloticus* are described and linear regression equations relating various parts of the body to the head length or total length are given.

The age of *Gymnarchus niloticus* in Lake Chad was determined from growth marks on the opercular bones. The mean lengths for age, and mean weights for age obtained for the first five years of life are given. The assymptotic length and the von Betarlanffy growth parameters for the males and females combined were as follows:

L oo = 211.32cm; K = 0.1215; = 2.05224.

INTRODUCTION

Gymnarchus niloticus, "dan sarki" in hausa, meaning "prince", is an electrical fish emitting continuous weak electrical signals generated from an electric organ located in its rat - like tail (Lissman, 1951). It has been shown that *Gymnarchus niloticus* has the ability to locate objects in the water by means of the electric signals it emits (Lissman and Machin, 1958). This fish is of bilogical interest because of its peculiar shape and habits; but it is also economically important in Lake Chad for it is a very much relished edible fish species which during the drought era (1972 to 1984) became the dominant piscivore in the lake.

The body of *Gymnarchus* is elongated, round in section and tapers to end in its rat-like black tail. A long rayed dorsal fin extends from just behind the head to a short distance from the tip of the tail. No pelvic, anal or caudal fins are present. The mouth is large and bears large and sharp incisiform teeth in both jaws. Its colour is blue-grey becoming progressively darker towards the tail. The diet of the adults is alsmost exclusively fish (Sagua, 1983); but the juveniles also feed upon insect larvae and nymphs.

Gymnarchus is common though not abundant in River Nile, River Niger in the riverine areas around the Niger Delta and in some east African lakes such as Lake Turkana. It is however, absent from Lake Victoria.

The breeding habits of *Gymnarchus* were discussed by Budgett (1900) and the origin of its electric tissues determined by Dahlgren (1914). Information on the general biology and growth patterns of *Gymnarchus* is however scanty. The scientist at ORSTOM Laboratory in Lake Chad made only cursory observations on its length-weight relationships (Durrand and Loubens, 1967). Paucity of biological knowledge of this economically important fish could be due to its relative scarcity where it is found.

The study of the detailed biology of *Gymnarchus niloticus* in Lake Chad was initiated in August 1982 and this paper is part of the results of the study.

MATERIALS AND METHODS

Freshly caught specimens of *Gymnarchus niloticus* obtained from hook and line or gill net fishing at Baga and the neerby fishing islands in Lake Chad were used for this study. The underlisted detailed body measurements were made on a standard one-metre measuring board also with the aid of a 3 metre plastic measuring tape graduated in mm. The weight of the whole fish was taken with a top loading salter balance to the nearest gramme. The opercular bones were dissected and cleaned in fresh water from all flesh, and skin. The length of the opercular bones was measured in an antero-posterior plane from its insertion to the free posterior border. The meristic characters recorded included the numbers of gill-rakers; dorsal fin rays; lateral line scales; numbers of teeth in the upper and lower jaws; and numbers of preanal and postanal vertebrae. There was difficulty in enumerating the vertebrae in the tail.

Body Measurement

Total length: The length of the fish from the tip of the snout to the posterior extremity of the tail.

Head length: The distance from the tip of the snout to the posterior border of the operculum.

Eye diameter: The distance from the anterior to the posterior margin of the eye measured across the pupil.

Snouth-Dorsal fin: The direct distance from the snout to the anterior insertion of the dorsal fin.

Length of Dorsal fin: The direct distance from the anterior insertion to the posterior insertion of the dorsal fin measured at its base.

Length of tail: The distance from beginning to the posterior end of the tail.

The age of the fish was determined by examining the opercular bone through incident light in the fresh state. Light passing through the bone reveals alternating bands of opaque and transluscent growth markings and the distance from the anterior insertion of the operculum to each transluscent marking was recorded. The growth band on the edge of the operculum bone was noted as well as the date the fish was caught. Over an annual period the incidence of occurrence of transluscent and opaque growth markings was determined. The relationships between the length of the operculum bone and the total length of each fish was determined from a linear regression equation.

Scales were also collected from each fish and examined for growth markings.

RESULTS

Age and Grwoth Rate of Gymnarchus niloticus

The scales of *G. niloticus* were found unsuitable for age determination. There were no clear growth checks on the tiny scales. The opercular bones were therefore, used. Figure 1 shows the relationship between the length of the operculum and total length of *G. nil otcus.*

The linear regression equation relating the two is $LP = 0.0242L + 0.0272$, $(r = 0.947)$.

(LP = Length of the operculum in cm and L = Total length of the fish in cm). The highly positive correlation coefficient and the fact that th. intercept of the line on the y axis is nearly sero are worthy of note. The operculum grows proportionally with the length of the fish and is thus a valid object for use in direct back calculation for age-length data.

The translucent narrow bands on the operculum were formed from December to January when the lake's water level was highest and the water temperatures were at their lowest (Figure 2).

The mark represents a period of reduced biological activity and reduced growth. The opaque and broader growth band on the opercular bones were found during the remaining months of the year. They represent periods of increased growth and increased biological activity.

A fish which has an opaque band plus one transluscent growth mark was classed as one year old, while those having an additional opaque band, not a second narrow transluscent band was classed one year plus, i.e. aged between one and two years old.

In finding the mean value of the length for each year class, fishes of one year and one year plus were grouped togethr as one year olds etc.

By measuring the distances of the transluscent bands from the point of insertion of the operculum and using the regression equation relating the length of operculum to the total length of the fish, back calculations of the length of the fish at each year mark on the operculum were made.

Table 1 shows the comparison between age-length age-weight data for *Gymnarchus niloticus* obtained by direct observation and from back calculations, which reveals a very close fit in the figures.

Table 1 — Mean age-length, age-weight data for Gymnarchus niloticus from direct observations and back calculations (Males and Females combined)

Age (years)	1	2	3	4	5	6	7
Mean length (cm) (Back calculation (N)	68.94 42	83.88 23	100.12 10	114.17 10	125.61 3	129.04 2	137.31 2
Mean length (cm) (Direct observation (N)	68.88 22	85.50 15	99.25 8	114.42 6	124.00 2	– –	140.00 3
Mean weight (gm) (computed)	1212	2083	3528	5217	6933	7512	9038
Mean Weight (gm) (Direct observation)	1150	2500	3850	5460	7600	–	10420

Table 2 shows the age-length, age-weight data for male and female *G. niloticus* for data directly observed. At each age the males are slightly heavier and longer than the females. The males therefore, have faster growth rate than the females during the first five years.

The Walform growth transformation plot of Lt+1 (Ordinate) against Lt (abscissa) gave a linear relationship represented by the equation:—

$$Lt + 1 = 0.886\ Lt + 24.09\ (r = 0.9951).$$

for the combined female and male data from which the asymptotic length (Loo) was found to be 211.32cm. The von Bertalanffy growth parameters were obtained from plotting Ln (Loo — Lt) (ordinate) against t (abscissa)

Table 2 – Mean age-length and mean age-weight for females and and males G. Niloticus from Lake Chad (direct observation)

Age (Year)	1	2	3	4	5	6	7
Females Only							
Mean length (cm)	71.5	83.88	96.14	110.86	–	–	140.5
Annual increment (cm)		12.88	12.26	14.72	–	–	10380
Mean weight (gm)	1320	2050	3550	5080	–	–	10380
Number observed (N)	13	8	5	4			2
Males Only							
Mean length (cm)	72.75	87.36	104.43	121.50	124.00	–	141.00
Annual increment (cm)		14.61	17.07	17.07	2.50	–	
Mean weight (gm)	1140	2470	4170	6230	7600	–	10500
Annual increment (gm)		1330	1700	2060	1370	–	
Number observed	4	7	3	2	2	–	1

the resultant slope (–K) being – 0.1215 and t_0 = –2.0524.

By repeating the calculatins using the data for the males only the following results were obtained:–

L_{t+1} = 34.9009 + 0.7711 Lt (r = 0.9554)
L_∞ = 152.4723 cm
K = 0.2599
t_0 = – 1.2298.

Insufficient data made calculation of the von Bertalanffy growth parameters for the females alone unreliable as there were insuffient points.

Figure 3 shows the graphs relating to the calculations for the growth parameters given above.

Meristic Characters of G. niloticus

The values obtained for the meristic characters investigated are shown in Table 3.

Table 3 – Some meristic characteristics of G. niloticus from Lake Chad

Meristic Character	Number Examined	Means, modes, frequencies, of occurrence
Dorsal fin rays	43	Range 168 to 215. 73% were from 201 to 210. Mean: 205 Std. 8.05
Number of pre-anal vertebrae	5	47 constant in all specimens.
Post-anal vertebrae	5	51–87. Mean number to the end of dorsal fin is 70 vertebrae.
Pre-anal lateral line scales	18	Range: 82 to 100: Mean number 88.
Number of gill rakers on lower limb of 1st gill arch.	51	5–9; mean, 6.75 mode, 7. Frequency 5 (f2); 6 (f18), 7 (f24); 8(5); 9 (f11).
Teeth in lower jaw	48	24–28.24 (f6 26(f21) 28(f21)
Teeth in upper jaw	48	14 constant in all specimens

Morphometric Characters of G. niloticus

Relationships between lengths of parts of the body and the head length or total length were as follows:

Body part as percentage of total length (TL)

Body Part	Arithmetic means, standard deviation
Head length	17.00% TL Std = 1.09, N = 47
Tail length	9.55% TL Std = 1.66, N = 44
Dorsal fin length	74.09% TL Std = 2.50, N = 44
Snout to Anus length	47.46% TL Std = 2.37, N = 45

Body part as percentage of head length (HL)

Body Part	Arithmetic means, standard deviation
(ED) Eye diameter	3.09% HL Std = 0.97, N = 46
(LP) Length of pectoral fin	26.29% HL Std = 2.89, N = 42
(MW) Mouth width	31.65% HL Std = 2.26, N = 15

Linear Regression Equations Relating Lengths of Body Parts to the Total Lengths (TL) or Head Lengths (HL)

(i) Length of Pectoral fin (Lp) and Head Length (HP) Lp = 0.9413 + 0.1919 HL (r = 0.9196) N = 58

(ii) Diameter of eye (ED) and Head Length (HL) ED = 0.3537 + 0.0734 HL (r = 0.2147) N = 58.

(iii) Length of dorsal fin (LDF) and Total length (TL) LDF = –2.2247 + 0.7647 TL (r = 0.99220) N = 56.

(iv) Snout to Anus Length (LSA) and Total Length (TL) LSA = –2.7832 + 0.5048 TL (r = 0.9877) N = 57.

(v) Length of operculum Lop and Total length (TL) Lop = 0.0269 + 0.0242 TL (r = 0 0.9467) N = 60.

(vi) Head Length (HL) and Total Length (TL) HL = 1.2565 + 0.1834 TL (r = 0.9807) N = 58.

(vii) Weight (W) and Total Length (TL) relationship. Log W = 2.978 Log TL – 2.41 (r = 0.9852) N = 58;

It is note-worthy that the positive correlation coefficients obtained for the linear regression lines given above are highly significant for the number of degrees of freedom at 1% level. However, the correlation coefficient (r = 0.2417) obtained for the linear regression of the eye diameter and head length was not significant. The eyes may have a subordinate function in vision in *G. nil otcus* which is able to navigate and locate objects in its environment by use of its electric organ discharge activity.

DISCUSSION

Knowledge of the age composition of a fish population is essential to good resource management. Correct age information is necessary for longevity prediction, establishing growth rate records, the age at maturity and determining the assymptotic length and weight of fishes. Concerning *Gymnarchus niloticus*, there is no previous scientific work known to the author on its age and growth rate in Lake Chad or elsewhere. This study therefore, provides the first attempt at determining the age of this highly prized fish which is also being cultivated in water reservoirs in the southern part of Nigeria. Due to the insufficiency of specimens, it has not been possible to cross check the age data by the length-frequency technique.

The use of bony parts in the determination of the age of Nigerian fishes has, however, been done by Bayagbona (1968) using the Otoliths of croakers; Fagade (1974) using opercular bones of *Tilapia melanotheron;* Ezenwa and Ikusemiju (1981) using the first dorsal spine of *Chrisichthys nigrodigitatus* and Willoughby (1979) using veterbae for Lake Kainji's *Synodontic* species. In Lake Chad, Hopson (1972) used scales of *Lates niloticus*, on which he found "winter rings" formed during the coldest months of January and February to determine age.

The problem usually encountered in determining the ages of tropical fishes by use of growth marks or checks formed seasonally on skeletal parts, arises from little environmental changes, especially of temperature This is particularly true of low latitudes. But the further one goes (north or south) from the equator or the higher one goes in latitude, the greater the seasonal temperature changes. Lake Chad located in a semi-arid area between latitudes 12o 30'N and 14o 30'N experiences well marked seasonal changes in water temperature with a drop of about 10oC between the warmest months (May/June 28oC) and the coldest months, (December/January, 17.08oC). The cold period also coincides with high water level. This seasonal drop in temperature has also been associated with reduction in feeding intensity (Sagua, 1983) and hence results in a reduced growth rate reflected on the operculum as transluscent band. The validity of the transluscent growth band for age determination arises from its formation only once in a year. Fagade (1974) has shown that other seasonal changes such as salinity could also cause formation of growth marks on operculum of *Tilapia mealnotheron* in Lagos Lagoon.

The biggest specimen of G. niloticus seen during this study in Lake Chad was a female of 157 cm TL weighing 14.25kg. Durand and Loubens (1969) found, as their largest specimen in Lake Chad, a fish of 151 cm TL, weighing 15.50 kg but its sex was not stated.

The observed largest size is 74.4% of the calculated assymptotic length (211 cm) for the combined data for females and males. This value appears a good estimate since the high fishing pressure in Lake Chad makes larger and older fishes to be rare.

The value of Loo (152 cm) obtained for the males would, therefore, appear to be an under estimate. This is, however, the best information that is obtainable from the observed data.

A certain amount of variability in the meristic and morphometric characters will be expected in G. niloticus over its wide geographic distribution range in Africa in which the species is endemic. The results in this paper for Lake Chad, should therefore, form basis for useful comparison with those of workers in other parts of the continent and the water bodies in Nigeria.

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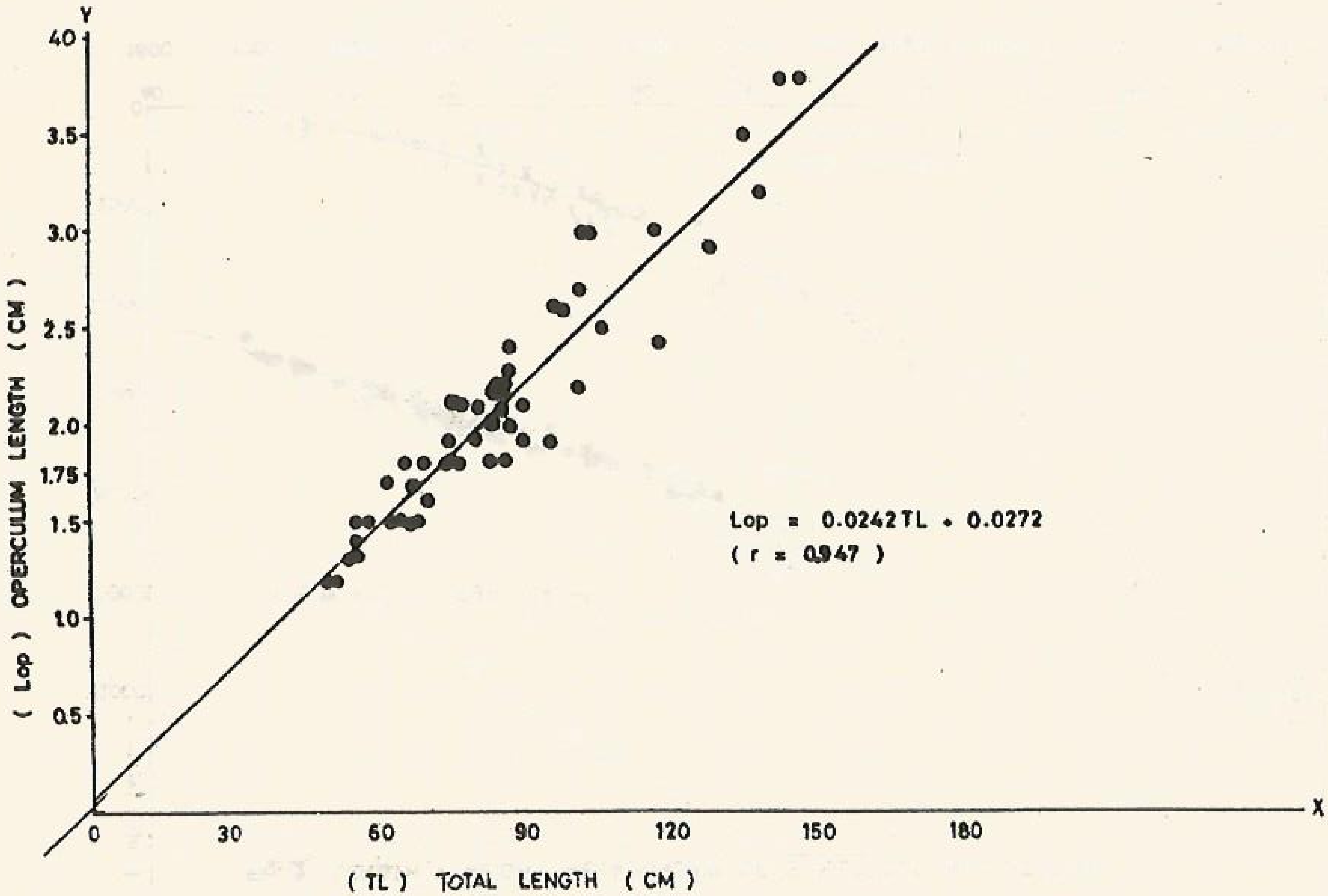


Fig. 1. RELATIONSHIP OF TOTAL LENGTH AND OPERCULUM LENGTH IN G. NILOTICUS

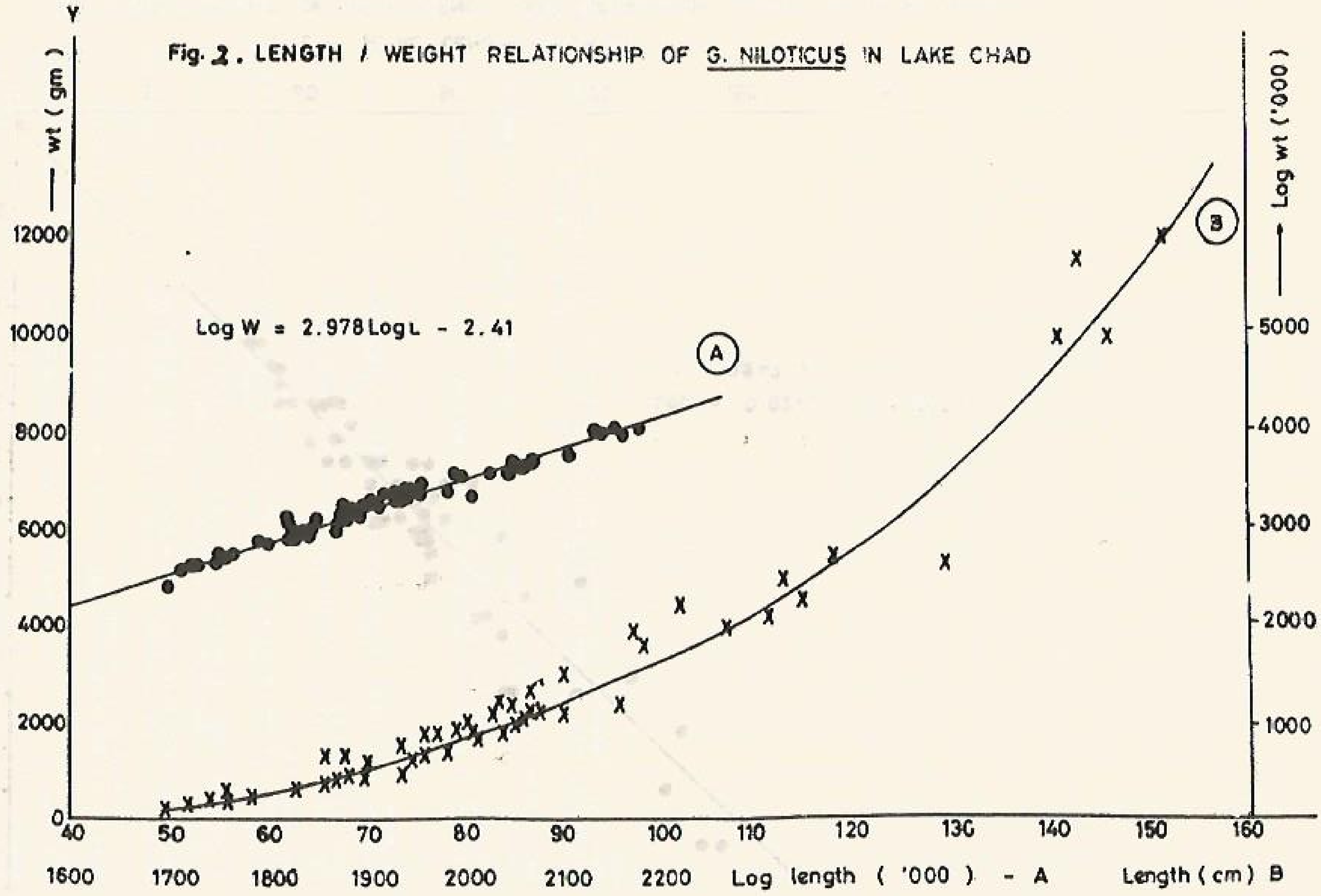


Fig. 2. LENGTH / WEIGHT RELATIONSHIP OF G. NILOTICUS IN LAKE CHAD

Fig. 3a GRAPH OF ln (L∞ - Lt) AGAINST t (YEARS) FOR G. NILOTICUS FROM LAKE CHAD (Males and Females)

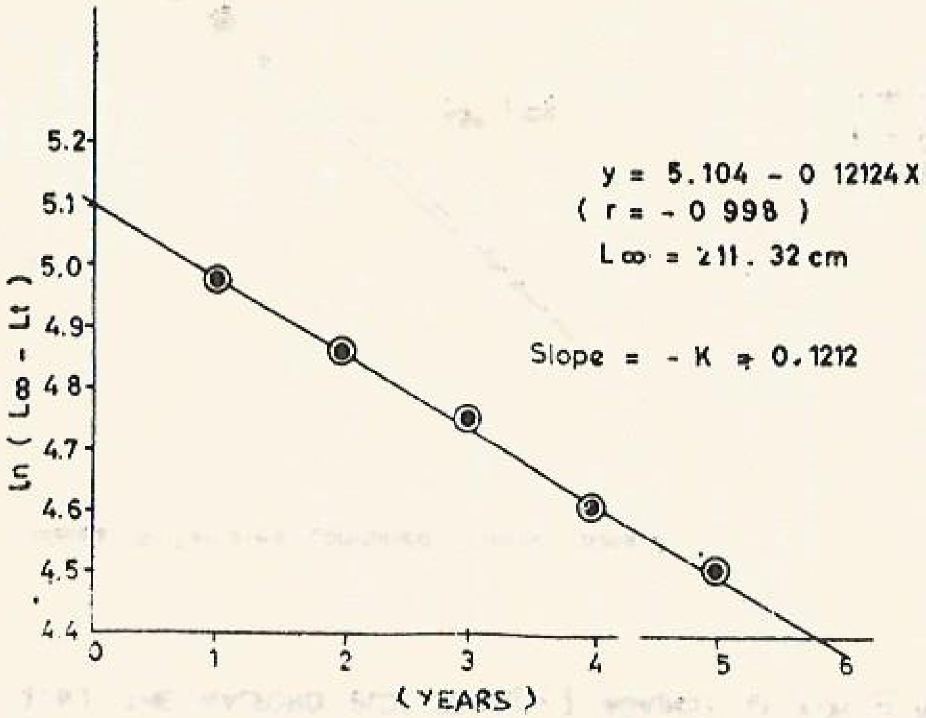
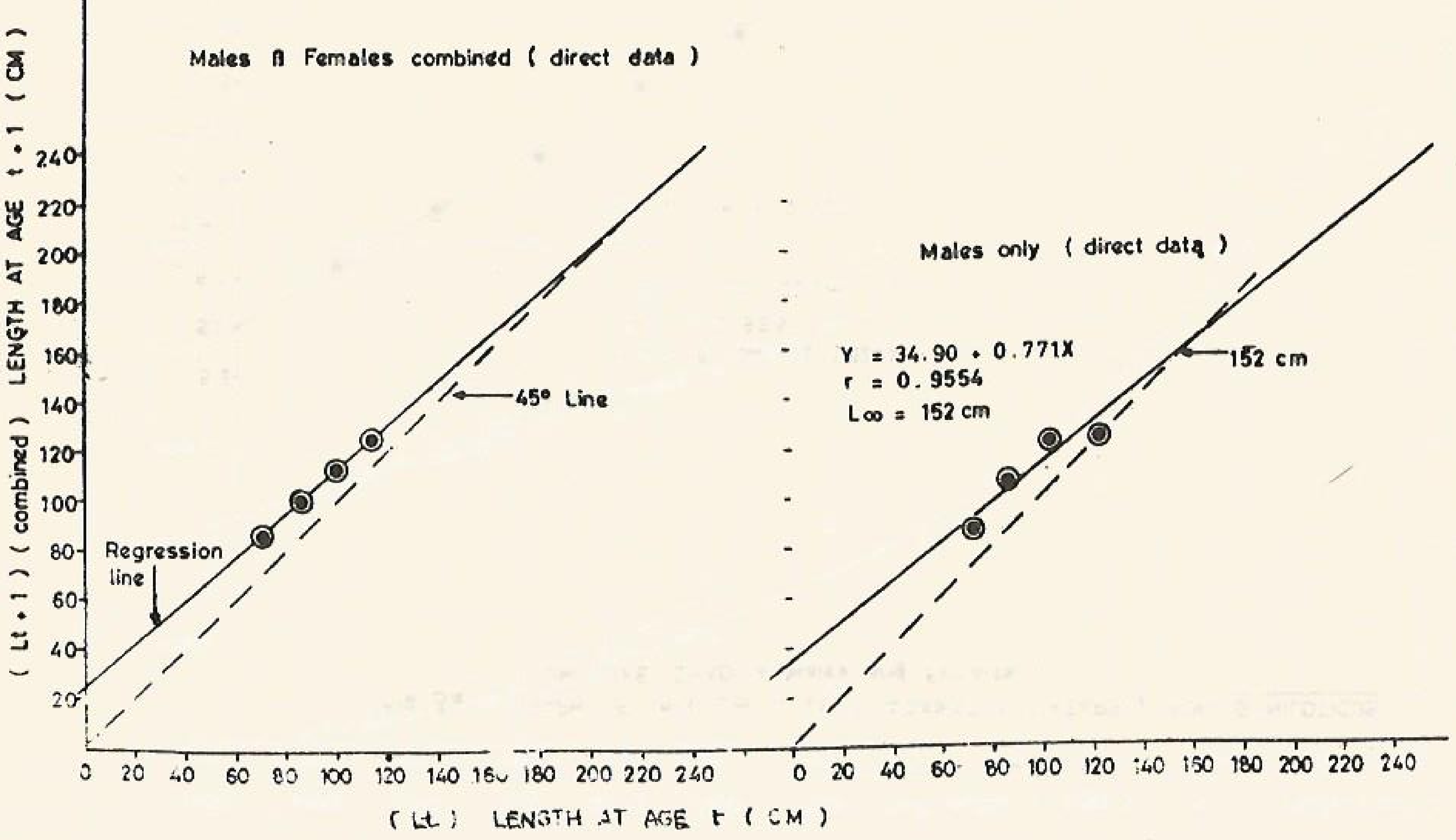


Fig. 3(b) THE WALFORD PLOT OF L_{t+1} AGAINST Lt FOR G. NILOTICUS FROM LAKE CHAD



AFRICAN *Clarias* Taxonomy: IMPLICATIONS FOR THE FIELD WORKER

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ABSTRACT

The taxonomy of African *Clarias* was reviewed. It was emphasized that much confusion still exists in this taxonomy. The major sources of this confusion were outlined. The recent division of the genus into six sub-genera:

C.	(Dinotopteroides),		C.	(Clarias),
C.	(Platycephaloides),		C.	(Clarioides),
C.	(Anguilloclarias),	and	C.	(Brevicephaloides).

in a recent revision and the establishment of synonyms, however, helped to clarify some of the taxonomic problems. There are now only about 33 valid species of the 122 original species so far described in Africa.

The implications of the present state of African Clarias taxonomy for the field worker were highlighted. In particular the need for the field worker to be an informed amateur taxonomist in addition to the possession of a good knowledge of the biology of his fish was emphasized. The connection between this and a successful Clarias culture was pointed out.

INTRODUCTION

Clarias is widely distributed in tropical Asia and Africa. In these areas, the fish is extremely popular on account of its tasty flesh, its unparalleled hardiness, its cultivability and rapid growth, and the high revenue which it earns. Furthermore, Clarias fishery constitutes one of the major fisheries in many river basins in Africa; in the Anambra River Basin, Awachie and Ezenwaji (1981) estimated that it contributes about 17% of the over 6,000 tonnes of annual fish production from all fisheries sectors. A good understanding of the taxonomy of such an important fishery resource is desirable. But unfortunately, unlike the Asian Clarias, the taxonomy of African Clarias is rather confused. Much of this confusion is perpetuated by the non-taxonomist field worker. As a result data on the biology of Clarias, particularly the biology of members of the sub-genus Clarias (Clarioides) (David and Poll, 1937) remain barely reliable. To stem this tide, a systematical revision of the genus Clarias on a Pan-African scale is being undertaken (Teugels, 1980; 1981; 1982). The field worker should be aware of the shortcomings of this revision and make conscious effort to rectify them so as to be able to produce more reliable results.

THE STATE OF CLARIAS TAXONOMY

Very few non-taxonomists recognize that many animal groups are poorly known taxonomically. For example, it is often observed that, while accurately recognizing some species of Clarias, the local fisherman and fishery scientist alike, sometimes assign a species status to complexes of rather good Clarias species. The Clarias taxonomist avoids this by making use of various taxonomic characters but primarily relying on precise measurements and meristic counts and supplements with other data from genetics, behaviour, ecology, particularly biogeography, etc. All these help him especially to delimit taxa of species rank with a fair degree of certainty.

Criteria for Identification

Except in a few cases, descriptions of Clarias species have relied heavily on morphological and anatomical characters and on biogeographical distribution. This is especially so in the on-going systematic revision of the genus, Clarias in various museums. The measurements normally employed are shown in Figure 1 and the counts normally include fin ray (dorsal and anal) counts as well as counts of the vertebrae and gill rakers. Taken in various combinations, these are usually enough to identify any Clarias species. But the non-taxonomist field worker is often only interested in recognizing his fish, so live colour descriptions become very important for him. For example, this writer's experience shows that many Fisheries Officers/Fisheries Biologists involved in the culture of Clarias in the various river basins are unable to distinguish between 'large' and 'small' Clarias species. They, therefore, proceed to introduce Clarias fingerlings into their ponds and waste valuable time, money and labour in feeding them and maintaining the ponds only to discover at harvest time that most of or all the Clarias has refused to grow. Those which have 'refused' to grow are 'small' Clarias spp. Yet this can be avoided if descriptions are clear enough to distinguish them.

Based on these criteria (morphological, anatomical and colour descriptions) as well as on ecological data, the following Clarias species have been identified in the Anambra Basin:—

(i) Clarias gariepinus (Burchell, 1822) (Synonym: Clarias lazera Cuvier and Valenciennnes 1840).

(ii) Clarias anguillaris (Linnaeus, 1758).

(iii) Clarias macronystax (Günther, 1864).

(iv) Clarias buthupogon (Sauvage, 1879).

(v) Clarias albopunctatus (Nichols and LaMonte, 1953).

(vi) Clarias agboyiensis (Sydenham, 1980) (Synonym: Clarias ishriensis (Sydenham, 1980).

(vii) Clarias ebriensis (Pellegrin, 1920) (Synonym: Clarias dahomeyensis (Guntert, 1938).

Current Position of the Systematics of Clarias

Prior to 1911, there were numerous original descriptions of African Clarias species but these are not collected in volume. In a monumental work, Boulenger (1911) prepared the Catalogue of the Freshwater Fishes of African (Vol. 2). In this catalogue, serious mistakes were made in sorting the African Clarias collections of the British Museum (Natural History), BM (NH). A re-description of some of these species by Boulenger aggravated these mistakes. Many latter workers including David (1935) and Daget (1954) relied heavily on the sorting and descriptions of Clarias species made by Boulenger (1911). Based on osteologic studies (as well as the work of Boulenger (1911), David (1935) revised the genus, Clarias and proposed three sub-genera namely: Clarias (Heterobranchoides), Clarias (Clarias) and Clarias (Allabenchelys) (Boulenger, 1902). This work worsened the errors of Boulenger (1911) because the type species of the genus Clarias is a Heterobranchoides sensu David so that this subgenetic name was replaced by Clarias. Therefore, in a subsequent revision by David and Poll (1937), C. (Heterobranchoides) was replaced by C. (Clarias) and C. (Clarias) sensu David became C. (Clarioides) C. (Allabenchelys) was not altered. Even after this revision, Sydenham (1978) noted that David and Poll (1937) sorted the 'smaller' West African Clarias species into one or the other of the subgenera C. (Clarioides) and C. (Allabenchelys). Based on the form of the dermosphenotic and suprapreopercular bones and other data Sydenham (1978) redescribed these West African Clarias species as well as those original wrongly identified and placed them in their appropriate subgenera. This work, however, merely upgraded the revision of David and Poll (1937). But it further highlighted the need for a thorough revision of the genus Clarias and with the frequent call by Clarias workers such as Richter (1976) and Bruton (1979), Teugels (1982) made a monumental attempt in this direction. Based on morphological, anatomical and biogeographical studies, Teugels divided the genus Clarias into six subgenera four of which are new. The subgenera are:—

(i) Clarias (Dinotopteroides) Fowler, 1930

(ii) C. (Clarias) Gronovious, 1781

(iii) Clarias (Platycephaloides) Teugels, 1982

(iv) C. (Claroides) David and Poll, 1937

(v) Clarias (Anguilloclarias) Teugels, 1982

(vi) Clarias (Brevicephaloides) Teugels, 1982.

A field worker finds the key to the six subgenera of the genus Clarias less confusing than what emerged from the revision of David and Poll (1937), but some overlaps in the distinguishing characters are evident. This, and the fact that so many synonyms are now being established (Teugels, 1980; 1981; 1982; Teugels and Van den Audenaerde, 1981) point to the fact that it may yet be some time before the final resolution of the taxonomy of the genus Clarias.

Biogeographical Distribution

As much as 122 nominal species of African Clarias have been described but Teugels (1982) is of the opinion that there are only about 33 valid species because many of the species have been synonymised. In Nigeria, eight valid species are recognized namely, Clarias anguillaris (= C. senegalensis Cuvier and Valenciennes, 1840), C. garienpinus (C. lazera C. albopunctatus, C. Agboyiensis (= C. isheriensis), Clarias walkeri, Guntert, 1896 (= C. nigeriae, Popta, 1919). The list of these and the other valid African Clarias species is presented in Table 1 and their geographical distribution in Figure 2.

The distribution pattern of the 33 valid species of Clarias indicates that most of the species inhabit the waters of forested regions of Africa. Four main distribution zones can be delimited:

(i) the western forests of Sierra Leone, Liberia and the Ivory Coast;

(ii) the central forests of Nigeria;

(iii) the eastern forests of Cameroon, Gabon, Zaire, and down to Angola; and

(iv) the predominatly savanna areas of the great east African lakes down to Lake Malawi and the Zambezi system.

SOURCES OF CONFUSION IN THE IDENTIFICATION OF CLARIAS SPP

Unquestioning Acceptance of Authority

One of the major problems, which has bedevilled the systematics of Clarias, is the unquestioning acceptance of authority.

Welman (1948) listed four species of Clarias, including Clarias angolensis Steindachner, 1866 and Clarias dumerilli Steindachner, 1866 as occurring in Nigeria; Again, Reed et al (1967) and Holden and Reed (1972) erronenously emphasized the existence of Clarias submarginatus Peters, 1882 in Nigeria (other Clarias spp. listed by these workers as occurring in Nigeria are C. anguillaris and C. lazera). Based on these listings, many field workers have misidentified some Nigerian Clarias spp. This author was also a victim: the most abundant Clarias species in the Anambra River Basin, C. albopunctatus, was misidentified as C. submarginatus. It tookSydenham (1978; 1980) a detailed work in the BM (NH) and elsewhere to establish that C. submarginatus does not exists in Nigeria, and that the existence of C. dumerilli and C. angolensis have mainly been reported from the Zaire system and C. submarginatus from Kribi and Libi Rivers, Cameroun. Following this work by Sydenham (1978; 1980), extensive collection of Clarias spp. was undertaken by this author in the Anambra flood river system. The various species so far identified and confirmed mainly by BM (N H) and Koninklijik Museum Voor Midden-Afrika, Tervuren, Belgium, have been given in earlier paragraphs. A field worker must be sure of the identity of his fish and have it confirmed, where doubt exists, by a specialist. This is particularly compelling for workers in Nigeria where there is a dearth of fishery taxonomists and where the ichthyofauna of our various river systems is poorly documented

Sorting Into 'Large' and 'Small' Clarias Species

Another problem in the precise identification of Clarias spp is to sort them into 'large' and 'small' Clarias species. This problem can be resolved easily. It is a major characteristics of the 'large' Clarias species to posses a dark horizontal stripe on either sides of the undersurface of the head. Alevins, fingerlings and adults alike possess the mark. Only one 'small' Clarias species, C. buthupogon is known to possess the dark horizontal stripes but the marks are not as dark and clear as those of the 'large' Clarias. As pointed out above, this distinction is of extreme importance to the field worker who is interested in culture fisheries. Of the African Clarias species, only members of two subgenera Clarias (Dinotopteroides) and C. (Clarias) grow to very large size but members of C. (Clarias) are often larger.

Inadequate Original Description

Allied to the above source of confusion in the precise identification of Clarias species is the problem of inadequate original description. Sometimes only one (or two) specimen is used in such descriptions. For example, Gill (1962) using only one specimen described Clarias laeviceps as follows: "Height at anus a tenth of length; head (laterally) a sixth; its breadth an eighth; the surface smooth; maxillary barbels twice as long as head; dorsal 86 fin rays, anal 61 fin rays"; Clearly, it would be almost impoosible to identify this Clarias on the basis of this description. Realizing this, many workers including Boulenger (1911) redecribed this species but it was only recently that Sydenham (1978) made an accurate redescription of the holotype, which other redecribers did not use. Furthermore, it has been demonstrated that the taxonomic value of the dorsal and anal fin rays and barbel is doubtful (Pers. obs.; Sydenham, 1978; Tengels, 1982). Nevertheless, Boulenger (1911) considered the length of the nasal barbel as well as the spacing between the median and caudal fins of high taxonomic value. While these characters some of which overlap, are still used today to sort out the various Clarias species, much more reliance is now placed on other morphometric measurements and meristic counts.

Individual Variation and Clarias Speciation

A fourth source of confusion in the taxonomy of Clarias species is the high individual variation particularly those which, according to Mayr (1960) result from differences in ecology (ecological variation) and genetic inheritance (non-sex-associated variation). Many workers, no doubt, have neglected or are unaware of the considerable amount of intraspecific variation shown by fishes in general and so have described species based on their locality or on slight differences in morphology. It may well be some time before this source of error is eliminated in the taxonomy of Clarias. The recent demonstrations of synonym (Tengels, 1982), therefore, is a step in the right direction. The field worker must keep the possibility of variation constantly in mind but it is gratifying to note that with experience the error resulting from variation may be minimized.

Sometimes, however, the variations are sufficiently pronounced as to suggest the emergence of a species. Such speciation appears to occur more in forested regions than in the savanna. According to Sydenham (1980), "there is a marked tendency for increased speciation of the smaller species or Clarias in the waters of forested areas, as for example, there has been such a remarkable diversification of the genus Synodontis in the waters of savanna areas". Thus, in a preliminary sample of Clarias on a Nigerian scale, only two, C. albopunctatus and C. agboyiensis, of the six 'small' Clarias species were recorded in the Sudanean zone although both also occur in the Guinean zone. Sydeham (1980) has in addition recorded C. macromystax in the Soudanean zone.

IMPLICATIONS FOR THE FIELD WORKER

The field worker must always bear in mind that the taxonomy of Clarias as already pointed out, is still in state of flux. He must especially take note of the following:—

(i) Your field work, particularly when accompanied with museum research, can go a long way in clarifying the problem of Clarias taxonomy.

(ii) Off all the taxonomic characters used in the study of Clarias species, the taxonomic value of fin rays and barbel length is the most doubtful. In fact, overlap exists in these characters. Meristic counts and other measurements must be employed but these measurements must be accurate and used with caution.

(iii) Measurements and counts should be taken by the field worker himself in order to identify his fish unequivocally. Also, use live colours. Always remember that there are enormous intraspecific variations in Clarias (and indeed, other fish). Where in doubt, contact a specialist Clarias taxonomist even though specialists often disagree.

(iv) Endeavour to know the other species of Clarias in your immediate locality (in our own case, Nigeria), and note variations, if any, in specimens from different areas.

(v) Always remember the source of confusion in the taxonomy of Clarias outlined above. In particular, the distinction between 'large' and 'small' Clarias species must be clearly made and avoid heavy reliance on authority.

(vi) To sum the above, the field worker in addition to a sound knowledge of the biology, including physiology, genetics ecology and behaviour of his fish, should also be an informed amateur taxonomist if he is to undertake a reliable and productive research.

(vii) Much of what has been said here also applies to other fish species.

CONCLUSION

Although it has been emphasized that African Clarias taxonomy is in a confused state, the confusion is primarily brought about by little knowledge of the smaller species. The 'large' Clarias spp are fairly well known and their biology adequately documented. At present, no major work has been done on the biology of the 'small' Clarias spp except C. albopunctatus (Ezenwaji, 1982; Ezenwaji and Awachie, 1983 a and b). However, a detailed study of the other 'small' Clarias spp. of the Anambra River Basin is underway in the Hydrobiology/Fisheries Unit of the Department of Zoology, University of Nigeria, Nsukka. Other Clarias field workers are called upon to intensify research in this area. But in doing so, you must take care to identify your fish accurately so that a reliable result may be produced. If you fail to do so, you will only agravate the already bad state of African Clarias taxonomy.

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Table 1 - List of Valid African *Clarias* Species

1. *Clarias agbajieinsis* Syndeham, 1980.
2. Clarias albopunctatus Nichols and LaMonte, 1953
3. Clarias alluaudi Boulenger, 1906
4. Clarias angolensis Steindachner, 1866
5. Clarias anguillaris Linnaeus, 1758
6. Clarias buettikoferi Steindachner, 1894
7. Clarias buthupogon Sauvage, 1879
8. Clarias cavernicola Trewavas, 1936
9. Clarias dialonensis Daget, 1962
10. Clarias dumerilli Steindachner, 1866
11. Clarias ebriensis Pellegrin, 1920
12. Clarias gariepinus (Burchell, 1922)
13. Clarias hilli Fowler, 1936
14. Clarias jaensis Boulenger, 1909
15. Clarias laeviceps Gill, 1862
16. Clarias lamottei Dage and Planquette, 1967
17. Clarias liocephalus Boulenger, 1898
18. Clarias Longior Boulenger, 1907
19. Clarias maclareni Trewavas, 1962
20. Clarias macromystax Gunther, 1864
21. Clarias ngamensis Castelnau, 1861
22. Clarias nigromarmoratus Poll, 1967
23. Clarias pachynemna Boulenger, 1903
24. Clarias Platycephalus Boulenger, 1902
25. Clarias salae Hubrecht, 1881
26. Clarias stappersii Boulenger, 1915
27. Clarias submarginatus Peters, 1882
28. Clarias theodorae Weber, 1897
29. Clarias werneri Boulenger, 1906
30. Clarias gabonensis Gunther, 1867
31. Clarias carerunensis Lonnberg, 1895
32. Clarias dhonti (Boulenger, 1919)
33. Clarias engelseni (Johnsen, 1926)

IDENTIFICATION OF WEST AFRICAN ESTUARINE SHRIMP AND CRAB LARVAE

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ABSTRACT

The paper deals with the decapod crustacean larvae likely to be found in fresh and brackish waters in tropical West African. It summarizes results from an ongoing program of describing larvae hatched directly from adults of known species, to provide the identification keys necessary for applied research on nursery grounds, plankton ecology and pollution effects.

A preliminary key to Stage – 1 larvae is given for approximately 40 species. It includes all the genera, and nearly all the species, known to produce larvae in fresh and low-salinity waters. The common species of higher salinity waters are also included.

INTRODUCTION

The larvae of decapod crustaceans (shrimps, crabs etc) form an important element in the zooplankton in inshore waters. Even in rivers they may constitute an appreciable proportion of the zooplankton (pers. observations), although their very occurrence in such habitat generally goes unnoticed by freshwater biologists.

The importance of identification of larvae, for fisheries research, is self-evident. A knowledge of them is required for working out life-histories and more so, for determining the location of nursery areas. Their larval development frequently takes place in areas other than the habitat of the adult or exploited populations but the exact location is unknown (Powell, 1985).

The present paper is part of an effort to provide quick identification of the decapod larvae of West African rivers and estuaries. It is intended to facilitate ecological and pollution as well as fisheries studies. The strategy has been to start with the descriptions of Stage 1 larvae hatched from adult females of species known to occur in fresh and brackish waters. Gradually a progressively more refined key may be built up.

The key provided here has been constructed from moredetailed information in Ambrose-Hart (1983) and Jonathan (1984). It has been tested during the identification of numerous zooplankton samples from fresh and estuarine waters through southern Nigeria. Although the key omits the larvae (yet to be described) of many small and uncommon species, it allowed the identification of the vast majority of larvae encountered in such samples.

MATERIALS AND METHODS

Ovigerous (berried) female specimens of each species were kept alive until their eggs hatched. Descriptions and drawings were based on at least 6 larvae. Where possible, larvae from 3 or more females were examined. The larvae were preserved in 10% formalin. Whole specimens or isolated appendages were examined on slides with a few drops of the preservative. Drawings were made free-hand using dissecting and compound microscopes (magnifications 10–100x). For descriptions of pigment patterns, the specimens used were freshly killed with 1 drop of 5% formalin in a few drops of water.

Detailed descriptions of the larvae of each species are given in Ambrose-Hart (1983) and Jonathan (1984).

Information on the adults of most of the species treated are given in one or another of the following references: Monod, 1956; Manning and Holthuis, 1981; Manning, 1982; Powell 1979; 1983a; 1983b, 1985 and in press.

PRELIMINARY KEY TO FRESHWATER AND ESTUARINE DECAPOD LARVAE (STAGE 1 ZOEAE) OF NIGERIA

1. Rostrum short or absent. Carapace with a single dorsal spine, or no spines (figure 1a, b) 2
Rostrum long, about 3 times carapace length. Carapace with a pair of posterior spines. Family Porcellanidae (a single medium-salinity species: Rostrum and posterior spines with spinules on both ventral and dorsal margins (figure 5a). Antennule 1-segmented (figure 14a)...............*Petrolisthes armatum.*

2. Telson sharply forked, with : 3 pairs of setal processes on inner margin of the furcal prongs (figure 2). Second and sometimes 3rd abdominal somites with dorsolateral knobs (figure 9). Infraorder Brachyura 6
Telson triangular, with 14-15 setal processes, and sometimes with deep median notch on posterior border. Second and 3rd abdominal somites without dorsolateral knobs (figure 8) 3

3. Telson with 2nd outermost pair of setal processes normal (figure 4). Peduncle of antennule bearing a single flagellar segment (figure 13). Infraorder Caridea 20
Telson with 2nd outermost pair of setal processes hair-like (figure 3). Infraorder Thalassinidea. 4

4. Telson with 14 processes and a long median process (figure 3a). Ventral margin of rostrum and anteroventral margin of carapace bearing minute spines. 2nd – 5th abdominal somites each with a large posterodorsal spine. Family Callinassidae. . . . .
Callichirus balsii Telson with median cleft (figure 3b, c). Rostrum and carapace without spines. Families Upogebiidae and Diogenidae...........5

5. Innermost pair of telson processes about half as long as adjacent pair (figure 3c). Antennal scale with the outermost seta smooth and spine-like (figure 17a) . . . .
. . . . *Upogebia furcata*
Innermost pair of telson process more than 2/3 as long as adjacent pair (figure 3b). Antennal scale with all the setae plumose (figure 17b)................*Clibanarius spp cooki and africanus.*

6. Third to 5th abdominal somites each with a pair of long lateral sharp spines (figure 9a). Telson furcal prong with a long spine on outer margin (2 extra smaller spines sometimes also present) (figure 2b, c). Families Majidae and xanthidae .7
Third to 5th abdominal somites with a pair of short lateral obtuse projections (figure 9b) Telson furcal prong without outer spines (figure 2a). Families Gecarcinidae, Ocypodiadae and Grapsidae. 9

7. Carapace bearing rostral and lateral spines. Telson furcal prong with 3 outer spines (figure 2c) Xanthidae. 8
Carapace lacking rostral and lateral spines. Telson furcal prongs with a single outer spine (figure 2b) . . . . *Achaeus powelli*

8. Rostrum projecting beyond end of antennular aesthetascs (figure 6b). Antennal exopod reaching less than 1/5 of distance to protopod tip (figure 18a). . . . .
Panopeus africanus Rostrum not reaching tip of antennular aesthetascs (figure 6a) Antenna exopod reaching tip of protopod (figure 18b) . . . . *Pilumnopeus* sp.

9. Carapace with well-developed lateral spines. Gecarcinidae and ocypodid subfamily Ocypodinae. 10
Carapace with lateral spine absent, or very short (less than half the length of any abdominal somite). Grapsidae and ocypodid subfamily Camptandriinae. 11

10. Rostrum projecting beyond end of antenna and antennular aesthetascs. Rostrum longer than dorsal spine (figure 6c). Ocypodid subfamily Ocypodinae:. . . . . *Uca tangeri*
Rostrum not reaching tip of antenna or antennular aesthetascs. Rostrum shorter than dorsal spine (Figure 6d). Gecarcinidae. . . . . *Cardisoma armatum*

11. Antennule with 2 terminal aesthetascs (figure 15a). Fourth or 5th (sometimes both) abdominal somites laterally expanded. Telson with furcal prong less than half total telson length. Camptandriinae and grapsid subfamily Grapsinae 12
Antennule with 3 terminal aesthetascs (figure 15b). Abdominal somites normal. Telson with furcal prong more than 2/3 total telson length. Grapsid subfamily Sesarminae. . . . 18

12. Antennal exopod long, reaching tip of protopod, with a median seta (figure 20). Abdomen (excluding telson) equal or shorter than carapace length.
Camptandriinae. 13
Antennal exopod reduced, reaching less than 1/5 distance to tip of protopod (figure 19). Abdomen (exclusing telson) longer than carapace length. Grapsinae. 16

13. Dorsal spine absent (figure 6g). Rostral spine equal or shorter than 2nd abdominal somite *Ecphantor modestus* Dorsal spine longer than 2nd abdominal somite. 14

14. Dorsal spine more than half the length of the rostrum. Fourth and 5th abdominal somites with large lateral flaps reaching base of telson (figure 11b) 15
Dorsal spine about 1/3 length of rostrum. Fourth and 5th abdominal somites without lateral flaps (figure 11a) . . . . *Telmatothrix powelli*

15. Dorsal spine shorter than total telson length. Antennular aesthetascs reach or extend beyond tip of rostrum (figure 6f) . . . . *Lillyanella plumipes*
Dorsal spine equal or longer than total telson length. Antennular aesthetascs shorter than rostrum (figure 6e). . . . . *Calabarium crinodytes.*

16. Fourth abdominal somite with lateral knobs or flaps near midlength (figure 10b, c). Genus *Pachygrapsus* 17
Fourth abdominal somite broadly expanded laterally but lacking knobs or flaps near midlength (figure 10a . . . . *Goniopsis pelii.*

17, Antennal protopod with a large subterminal spine (figure 19a). Sides of 4th abdominal somites evenly rounded with short flaps at midlength (figure 10c) . . . . *Pachygrapsus transversus* Antennal protopod lacking a prominent subterminal spine (figure 19b). Sides of 4th abdominal somites angled (figure 10b) . . . . *Pachygrapsus gracilis.*

18. Carapace with a short lateral spine. *Sesarma angolense* Carapace without lateral spine 19

19. Tip of antennal exopod smooth around base of terminal setae (figure 21a). . . . . *Sesarma buettikoferi*. Tip of antennal exopod toothed around base of terminal setae (figure 21b) . . . . *Metagrapsus curvatus, Sesarma huzardi, Sesarma alberti and Sesarma elegans.*

20. Rostrum spine-like, extending beyond eyes (figure 7b). Families Palaemonidae, Atyidae and Hippolytidae. 21
Rostrum absent (figure 7a). Family Alpheidae 33

21. Sixth abdominal somite continuous with telson Palaemonidae and Atyidae 22
Sixth abdominal somite not continuous with telson Hippolytidae. 32

22. Telson bilobed (figure 4a). Atyidae . . . . *Atya*
Telson spatulate, not bilobed (figure 4b, c). . . . . Palaemonidae 23

23. Antennal scale with 4 distal segments (figure 16a) 26
Antennal scale with 5 distal segments (figure 16b). 24

24. Antennal scale with 11 setae. Chromatophores present on 1st – 5th abdominal somites and telson . . . . *Periclimenes* sp.
Antennal scale with 9 or 12 setae. Chromatophores present only on 2nd and/or 3rd abdominal somites and telson 25

25. Antennal scale with 12 setae. Chromatophores present on 2nd – 3rd abdominal somites and telson . . . . *Palaemonetes africanus*
Antennal scale with 9 setae. Chromatophores present on 3rd abdominal somites and telson . . . . *Macrobrachium vollenhovenii.*

26. Fifth abdominal somite with a pair of short lateral spines (figure 12a). Innermost pair of telson processes more than half the length of the adjacent pair (figure 4c). Genus *Palaemon* 27
Fifty abdominal somite without spine. Innermost pair of telson processes less than half the length of the adjacent pair (figure 4b) 29

27. Antennal scale with 10 setae . . . . *Palaemon maculatus*
Antennal scale with 9 setae 28

28. Fourth abdominal somite with a posterodorsal lobe (figure 12b). Chromatophores present on telson . . . .*Palaemon* sp.
A Fourth abdominal somite normal. Chromatophores absent from telson . . . . *Palaemon elegans.*

29. Antennal scale with marking of segmentation at apex; and with 9 plumose setae and 1 spine-like seta on either side . . . . *Nematopalaemon hastatus*
Antennal scale with no marking of segmentation at apex, and without spine-like setae. Genus *Macrobrachium*. 30

30. Antennal scale with 4 distal segments and 10 setae. . . . . *Macrobrachium equidens* Antennal scale with 4 distal segments and 11 or 12 setae 31

31. Antennal scale with 12 setae. Chromatophores on proximal end of antennule. *Macrobrachium macrobrachion* Antennal scale with 11 setae. Chromatophores absent on antennule. . . . . *Macrobrachium felicinum.*

32. Exopod of maxillipeds each bearing 1–2 segments. Outermost telson process placed in normal position (figure 4c) . . . .*Lysmata* sp.
Expode of maxillipeds each bearing 4–5 segments. Outermost telson process placed at midlength of lateral border (figure 4d). . . . . *Latreutes parvulus.*

33. Sixth abdominal somite distinct from telson. Chromatophore absent from antenna and antennule. . . . . *Leptalpheus* sp
A Sixth abdominal somite not distinct from telson. Chromatophores present on antenna and/or antennule. 34

34. Eyes angular. Antennal scale with 4 distal segments and 10 setae . . . . *Alpheus pontederiae* Eyes rounded. Genus Potamalpheops . . . . 35.

35. Posterior border of telson with minute spinules in between the 4 innermost pairs of processes 36
Posterior boroer of telson without spinules in between the processes. Antennal scale with 2 segments and 10 setae.. . . . . Potamalpheops haugi.

36. Antennal scale with 4 distal segments and 11 setae. Chromatophores absent from 4th abdominal somite . . . .*Potamalpheops monodi*
Antennal scale with 2–3 segments. Chromatophore present on 4th abdominal somite . . . . 37.

37. Antennal scale with 3 segments and 11 setae. Two chromatophores present on the 2nd abdominal somite. One Chromatophore directly under each eye. No chromatophore at tip of rostrum. *Potamalphops pylorus* Antennal scale with 2nd abdominal somite. One chromatophore on 2nd abdominal somite. No chromatophore under eyes. One chromatophore at tip of rostrum............Potamalphops sp. A.

DISCUSSION

General Features

Though the present work is based on Stage 1 zoeae, it will assit in the identification of later larval stages especially for crab larvae, which tend to retain the basic features of the early larvae. Moreover Stage I is generally the dominant larval stage in most plankton in samples (Warner, 1977; Ngoc-Ho, 1981; and McConaugha et. al., 1983.

In Nigerian estuararine samples Stage 1 zoeae account for over 80% of decapod larvae (pers. obser., GEJ).

The first task in larval identification is to separate brachyurans, anomurans and carideans. Brachuran (true crab) larvae have a distinct telson type: sharply forked with 3 spine-like processes on the inner margin of each turcal prong. In anomurans and carideans, the telson is usually simple in shape; it may be bilobed but always bas 7 (not 3) pairs of setal processes on the posterior border. Seven normal pairs occur in Carideans. In local Anomurans the second outer-most pair is always reduced to a small hair so the apparent number of setae is 6 pairs also the telson is more often bilobed than simple.

Although pigment patterns are often useful at species level (e.g. Fryderyk, 1965) they can only be relied on with freshly preservered material.

Important species lacking Estuarine/Freshwater Larvae

Some spcies of commercial interest do not have estuarine larvae. The well known ***Penauss* and *Callinectes*** species spawn outside the estuary, and their larvae are not estuarine. Freshwater crabs (family Potamidae) have no larvae, but hatch as fully formed juveniles.

Estuarine Larvae Not Treated in the Key

In the more saline waters of estuaries there occur many small species of Hippolytidae and Alpheidae, and some species of Ogyrididae and Crangonidae. The larvae of these families show much diversity hence lack definition for the families as a whole. Stage 1 carideans lacking a rostral spine are likely to be alpheids.

The large calliannassid ***Callichirus turneranus*** is seasonally abundant in tidal fresh water. Its larva should resemble that of ***C. balssi***, described in the key. The family characters include long ventrally-toothed rostral spine, toothed anterior carapace margin, dorsal spines on abdominal somites 2–4 (sometimes only on the 3rd), and a single medial telson spine which may be either longer or shorter than the paired processes (Gurney, 1942).

There are several species of small anomurans ***(Pachycheles*** and ***Pagurids)***, and crabs (xanthids, pinnotherids and hexapodids) not treated in the key, but known to occur in high salinity zones of estuaries and probably having estuarine larvae.

Species–Specific Comments

There is a problem concerning the identity of ***Macrobrachium vollenhovenii*** larvae. The characters used in the present key are based on the description and figures given by Ville (1971). Ville noted a pair of spines projecting laterally on the 5th abdominal somite. However this has not been detectable on the larvae of the other West African species of ***Macrobrachium*** examined by us, nor has it been recorded for species from other areas e.g. ***Macrobrachium acanthurus*** (in Choudhury, 1970), ***Macrobrachium*** rosenbergii (in Ling, 1969). Macrobrachium australiense (in Fielder, 1970) ***Macrobrachium lar*** (in Atkinson, 1977), ***M. idella*** (in Pillai and Mohammed, 1973), and ***Macrobrachium*** sp. (in Willimsan, 1972). Ville's drawings closely resemble the larvae of the genus ***Palaemon*** and it is not impossible that a misidentification is involved. The characters of ***Nematopalaemon hastatus*** have been taken from Marioghae (1980), and also need to be confirmed.

The large land crab *Cardisoma armatum* has a larvae closely resembling that of the fiddle crab *Uca tangeri.* Besides the characters used in the key, a further distinguishing feature concerns the innermost pair of telson processes, In *C. armatum* the outer side of each process has only two conspicuously prominent spinules; in *U. tangeri* there are four or more. (The inner margins are more similiar; both margins also have a number of shorter, thinner spinules).

Some species lack larval features useful for species -level identifications: the two hermit crabs *Clibanarius africanus* and *C. cooki* can not be distinguished, nor could the four sesarmine crabs *Metagrapsus curvatus, Sesarma huzardi, S. alberti, S. elegans and S. buettikoferi.*

A few species have aberrant larvae. *Sesarma angolense* has a lateral spine, which has not been recorded for other species of the genus (Wilson, 1980). The larvae of *Ecphantor modestus* lack a dorsal spine

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LEGENDS TO FIGURES

Figure 1 Stage 1 larvae of (a) caridean shrimp and (b) brachyuran crab. Al, antennule; A2, antenna; exA2, antenna exopod scA2, antennal scale; aeA1, antennule aesthetascs; ds, dorsal spine; kn, dorsolateral knob; 1s, lateral spine; mxp, maxilliped; rs, rostral spine; T. telson. Tp, telson process.

Figure 2 Brachyuran telson types. (a) Type A; (b) Type B *(Clibanarius);* and (c) Type C (xanthids).

Figure 3 Anomuran telson types. (a) Type A *(Callichirus);* (b) Type B *(Clibanarius);* and (c) Type C *(upogebia).*

Figure 4 Caridean telson types. (a) Type A (Atyidae) (b) Type B; (c) Type (C); (d) Type (D) *(Latreutes).*

Figure 5 Porcellanid carapaces. (a) *Petrolisthes; (b) Pachycheles.*

Figure 6 Brachyuran carapaces. (a) *Pilumnopeus; (b) Panopeus; (c) Uca; (d) Cardisoma; (e) Calabarium; (f) Lillyanella; (g) Ecphantor.*

Figure 7 Caridean carapaces. (a) Type A., (b) Type B.

Figure 8 Caridean and anomuran abdomen.

Figure 9 Brachyuran abdomes (a) Type A; (b) Type B.

Figure 10. Grapsinae abdomens. (a) Goniopsis peli; (b) 4th abdominal somite in *Pachygrapsus gracilis and (c) P. transversus.*

Figure 11 Camptandriinae abdomens. (a) *Telmatothrix powelli* showing 5th abd. somite laterally expanded; (b) Other genera.

Figure 12 4th and 5th abdominal somites of carideans with (a) lateral spines on 5th somite; and (b) short posterdorsal lobe on 4th somite.

Figure 13 Antennule of cardiean.

Figure 14 Antennule of porcellanids (a) *Petrolisthes* and (b) *Pachycheles.*

Figure 15. Brachyuran antennules (a) Type A and (b) Type B.

Figure 16. Caridean antennal scales with (a) 4 distal segments and (b) 5 distal segments.

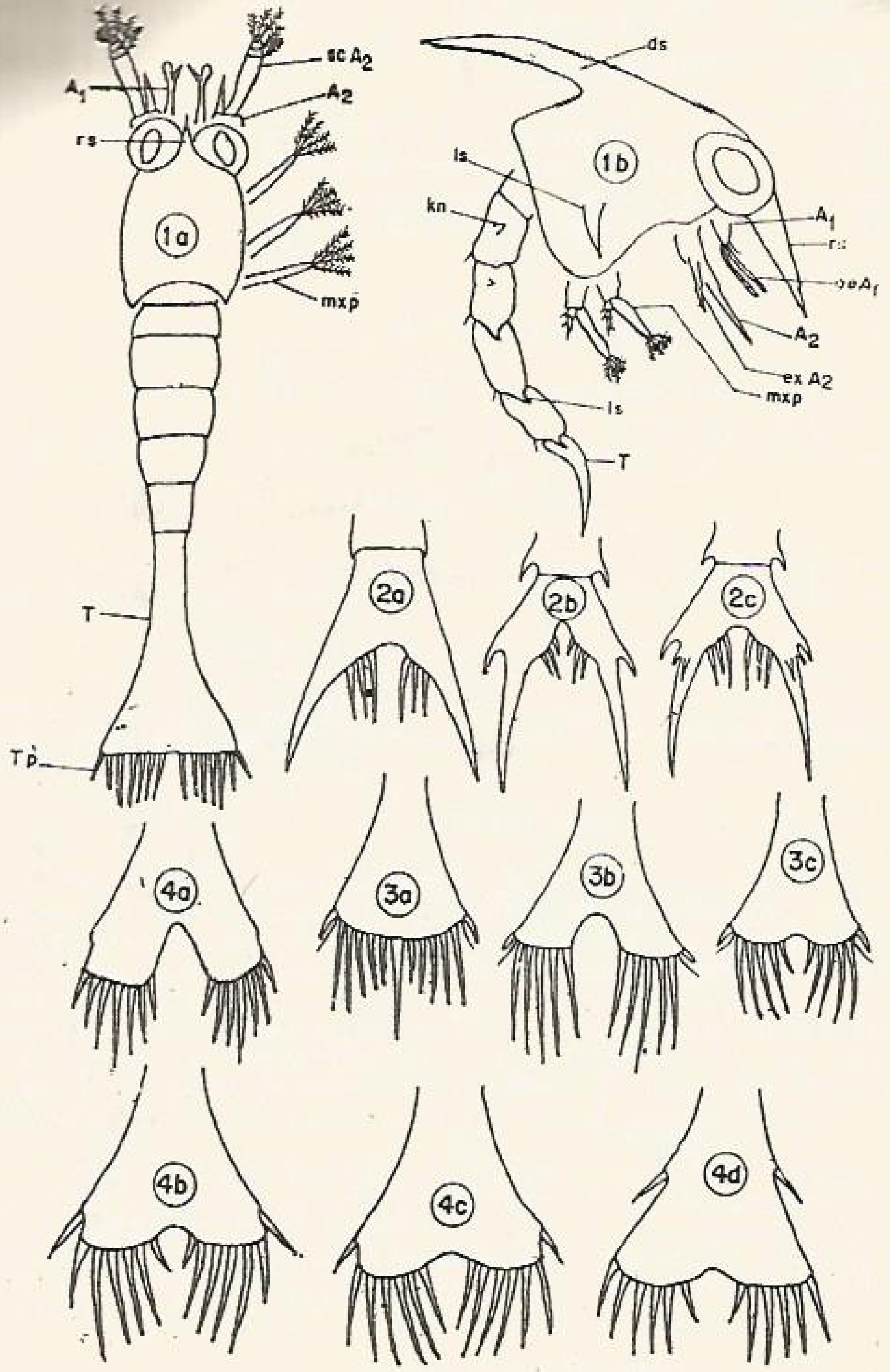
Figure 17 Anomuran antennae (a) *Upogebia;* (b) *Clibanarius.*

Figure 18. Xanthid antennae (a) *Panopeus,* (b) *Pilumnopeus.*

Figure 19. Grapsinae antennae: (a) *Pachygrapsus transversus; (b) P. gracilis and Goniopsis.*

Figure 20. Camptandriine antenna.

Figure 21. Sesarmine antennal expopods (a) Type A with smooth apex; (b) Type B with toothed apex.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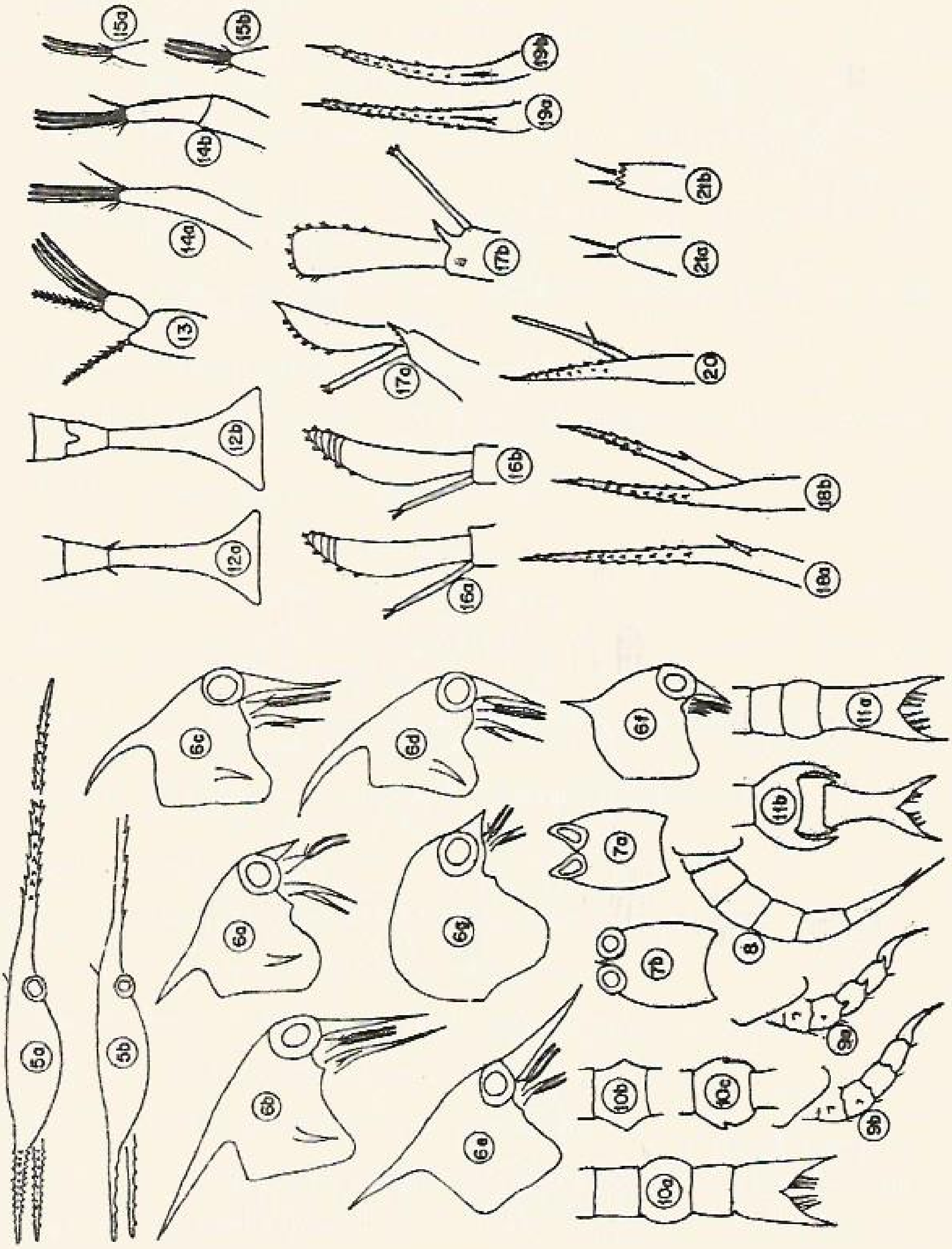

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A PRELIMINARY SURVEY OF THE HELMINTH FISH PARASITES IN IMO RIVER

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ABSTRACT

A preliminary survey of the helminth fish parasites was carried out in Imo River (around Umungwa Village). A total of 191 fishes belonging to 15 genera were examined and only 13.6% were infested with various species of helminth parasites which is a low percentage of infection.

The following helminth parasites were recorded:—

Wenyonia Virilis Kainji; Wenyonia sp., Procamallanus laeviconchus; Procamallanus sp., Sprionoura congolense; Spironoura sp., Cucullanus sp. and Serradacnitis serrata.

It was found that helminth parasites showed some degree of specificity in their distribution within their fish hosts. This specificity could be as a result of the physiochemical and physiological factors operating in the gut such as pH, Osmotic tension, Oxygen tension and Nutrient levels. The results also revealed that age and sex influence helminth parasites infections in fishes.

INTRODUCTION

By virtue of their economic importance to man, especially with the rapidly increasing human population and conssequent increase in protein demand (French, 1965), information on the parasites of fish becomes particularly important as these parasites may affect fisheries production. In natural populations, a complex dynamic equilibrium exists between organisms and their environment - both biotic and abiotic. Besides serving as food, the effect of worms as fish parasites is noteworthy (Nikolsky, 1976). There exists a relative susceptibility of different fish species to infection (Baldwin *et al*, 1967). The study of flatworms as parasites of fishes owes its first clarification to Zedar and Rudolphi. The study of helminth parasites and their life-cycles has contributed one of the most active fields of zoological research.

In Nigeria, not much work has been done on the parasite fauna of the local fishes. Some works include those done in Kainji Dam, River Niger, Benue and Ogun Rivers by Ukoli (1965) who investigated helminth infection of fish in the Niger River, Nwosu (1974) and Onyemachi (1976) who worked on parasites of fish in Opi Lake. This work, "A preliminary Survey of the Helminth Fish Parasites in Imo River", will invariably add to the work done on fish parasites in Nigeria.

MATERIALS AND METHODS

The fishes were caught by means of cast nets of varying mesh sizes (2.5 cm and 5 cm), palm fruit baited local traps with funnel-shaped entrance were set in shallow areas near the river edges, overnight and hooks (Nos. 7, 12, 14) baited with insects and earthworms. Both were harvested early the next morning. It was not easy to determine precisely the ages of the different fishes. Based on measurement of their total length and maximum width, the fishes were categorised into juveniles, medium, and adults. Sexes were determined only after dissecting the fishes and noting the presence of testes or ovary. Other parameters used for sex determination included size, colour, shape of anal fin especially for the Characidae.

Collection and Preservation of Parasites

The skin, gills and fins were examined with hand lens for the occurrence of an helminth parasites before being preserved in formalin. Consequently, the fishes were dissected and the different portions of the gut (Mouth, Oesophagus, stomach, intestines) were examined for endoparasites and noted. Extraction of parasites was done with the aid of camel hair brush and pin after rinsing the sections of the gut in saline solutions in petri-dishes.

Killing, Preservation and Fixing of Parasites

The different groups of endoparasites recovered were preserved by different methods. Preservation was in bottles or vials duly labelled indicating the name of host, date of collection and region of the fish from which the parasites were collected.

Preparation of Slides and Labelling

Two methods were used for preparing the slides. First, the lactophenol method of Franklin and Gooday (1949) and Heindenham's Iron Haematoxylin method (Panti, 1969) which was used for the cestodes.

RESULTS AND DISCUSSION

Out of 191 fishes examined, 26 (13.61%) were infected by helminth parasites.

A total of 441 helminth parasites belonging to two classes, the Cestoda and Nematoda were recovered from only the stomach and intestines. The following helminth parasites were recovered:–

Wenyonia virilis Kainji, Wenyonia sp, Procamallanus laeviconchus, Procamallanus sp. Spironoura congolense, Sironoura sp. Cucullanus sp, and Serradacnitis serrata (4).

No helminth parasites were recovered from the skin, gills and mouth. Thirty-four (34) helminth parasites (7.8%) were recovered from the stomach, while 402 (92.2%) were recovered from the intestines. This distribution of parasites in the gut of fishes could be due to the physio-chemical and physiological factors operating in the gut such as nitrient levels, pH, Osmotic tension and Oxygen tesnion. According to Smyth (1962), with the exception of blood sucking nematodes, the food materials of adult nematodes appear to be semi-solid or copious amount of absorbable materials. Also, the age and seasonal variation of fish food may affect the abundance of a parasite. These may account for the presence of helminth parasite in and preference for the intestines (92.2%). The juveniles showed no infection while the medium and adult showed 10.32% and 25.37% infection respectively. This investigation also revealed higher incidence of helminth parasites in females (28.1%) than the males (6.9%).

This was subjected to statistical analysis and was found to be highly significant. This result could be due to certain ecological factors emanating probably from feeding differences between the males and females.

Although, the overall helminth parasite infection rate in Imo River is rather low (13.61%), the infection rate is however enough to elicit much pathological effects on fishes by retarding their growth, causing tissue disruption and even death. This condition if prevented may held in improving the quality and quantity of fishes in Nigerian waters.

A proper study of the life-cycles of the helminth parasites of fishes could prevent infection of humans by such parasites whose intermediate or vector-host is fish.

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PRELIMINARY SURVEY OF PARASITES OF CLARIAS IN THE NIGER DELTA AREA OF NIGERIA

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ABSTRACT

A total of one hundred and sixty *Clarias lazera* were collected with line hood between April and June 1984 from the Niger Delta Area and observed for the presence of parasites. The results revealed the presence of three classes of endo-parasites - Trematodes (47%), Nematodes (46%) and Cestodes (7%).

It was found that, the parasites have great affinity for the Spleen (34%) and the Liver (28.3%). Also, smaller fish haboured more parasites than large fish.

Though the investigation is still continuing, the study reveals the presence of parasites in *Clarias* and calls for measures to prevent wide-spread infestation in fish ponds and suggests treatment of infested fish.

INTRODUCTION

African waters are rich in fishery resources and in spite of recent effort to increase catch, much of the potential supply fails to reach the great masses of the consumers. To combat this shortage of supply from capture fisheries, fish culture has a good prospect. One fish often considered for culture in Africa because of its wide distribution and hardy characteristics is the catfish - *Clarias* belonging to the family Clariidae (Elliot, 1976).

Much work has already been done on this group of fish including its parasitology (Khalil, 1961; 1972; Paperna and Thurston, 1968 Abolarin, 1971; Micha, 1972; Aderounmu and Adeniyi, 1972, Fischtal, 1972; Paperna, 1974; and Wakuke, 1980). However, little is known and recorded of the species of *Clarias* from the Niger Delta Area of Nigeria. This study was conducted to record the occurence of parasites and their site preferences in *Clarias* which hopefully would assist fish-farmers and consumers.

MATERIALS AND METHODS

About one hundred and sixty (160) of *Clarias lazera* (Cuv. et Val.) were collected with line hooks from four locations within the Niger Delta of Nigeria during the months of April to June 1984. These locations are all in the Rivers State, they are Agudama, Yenegoa Local Government Area (YELGA); Baalueku, Bori Local Government Area (BOLGA); Edagberi, Ahoada Local Government Area (ALGA); and Okpoma, Brass Local Government Area (BALGA).

As soon as the fish were collected, their general condition, location and date of collection and body length were noted. In addition, their external skin was examined with hand lens for for external parasites. They were taken to the laboratory in a bucket of water from their point of capture. In the laboratory, the fish were killed with Chloroform and the gill covers were cut open to expose the gills for examination. Then, the clinically dead fish was dissected and the different internal organs - stomach, intestine, spleen, liver, gills and gall bladder were examined separately for parasites and recorded. Parasites were identified from taxonomic key and description of Hoffman (1967) and Robert (1978).

RESULTS AND DISCUSSION

All fish for the study measured between 10.3 cm to 17.00 cm. No ectoparasites were observed on any of the fish, but when dissected, most fish showed yellowish patches on their gills and a somewhat rhythmic movement of the stomach, which indicates the presence of endoparasites. Summary of the results are shown in Tables 1, 2 and 3.

A detailed look at the results revealed a total of about three classes of endoparasites totaling 802 individuals. These classes are the Trematodes (47%), Nematodes (46%) and Cestodes (7%). Within each class one specie often predominates all others, for instance, ***Acetodoxtra*** spp 69.5% (Trematodes), ***Capillaria*** spp 84.9% (Nematodes), and Monobathrium spp 89.3% (Cestodes) (Table 1).

Data concerning attachment sites of the parasites on each shows a great affinity for the spleen (30.42%), liver (28.28%), intstine (17.71%), stomach (14.71%), gills (8.73%) and gall bladder (0.25%) (Table 2). The high incidence of parasites on the spleen is understandable, since the function of red blood cells destruction is ascribed to the spleen (Bond, 1979). The spleen hence, acts as a reservoir for destroyed erythrocytes and the center for the formation of lymphocysts antiboides and antitoxins. It is from the spleen that any resistant parasite could pass to the liver. The difference in infestation between the stomach and intestine could be in part attributed to the high acidity of the stomach whereby only the most resistant parasites can occur comfortably.

Furthermore, the study revealed that smaller fish (50% of the total sample, those less than 15.0 cm), habour more parasites than larger fish. The difference could be due to the high immunity response of larger fish. Also, this higher incidence of infestation of smaller fish could be attributed to the more benthic mode of feeding of the smaller fish. Whereas larger fish occasionally supplement benthic mode of feeding with carnibalism, thereby reducing the incidence of parasites in the partially decaying organic matter on the bottom.

The incidence of infestation appeared to be fairly uniform among the locations sampled. However, fish from Baalueku (BOLGA 33% and Agudama (YELGA) 27% had slightly higher incidence of infestation. All the genera of parasites were encountered from fish of these areas. Whereas only five species of parasites were found in Okpoma-Brass (BALGA) 21% and Edagberi (ALGA) 19% (Table 3). This lower incidence of parasites does not necessarily indicate a healthier fish or environment but, in part, could be as a result of the acidic charcterisitcs of the water and the swamps in these areas. For instance, Okpoma-Brass is in the saline swamps of the Niger Delta with a very high content of decaying and/or partially decomposing organic matters, hence should have high occurrence of parasites. Yet, the acidic condition may have reduced the number of parasites inhabiting these swamps.

Even though, the results presented here are preliminary, one could say with some degree of confidence that the occurrence and intesnity of infestation appear to be high. Therefore, if ***Clarias*** species are to be encouraged as pond fish, strategies for controlling the parasites and treating the infested fish should always be included in such development plans.

ACKNOWLEDGEMENTS

I acknowledge Mr. Ebimonyo J. Ikuromo for providing field assistance by collecting the fish for the study and Mr. S. S. Ovuru who aided in the identification of parasites.

TABLE 1A – PARASITES OBSERVED WITH % IN EACH CLASS

Trematodes	*No. of individuals*	*%*	*Nematodes*	*No. of individuals*	*%*	*Cestodes*	*No. of individuals*	*%*
Acetodextra	360	69.51	Capillaria	316	84.95	Monobathrium	50	89.29
Clinostomium	70	18.71	Metabroneium	32	8.60	Diphyllobathrium	2	3.57
Allocreadium	34	9.09	Spiroxys	18	4.84	Phyllobothrium	2	3.57
Centrovarium	10	2.67	Centrocoecium	6	1.61	Protocephalus	2	3.57
Total	**374**		**Total**	**372**		**Total**	**56**	
Percentage (%)	**46.63** **47**		%	**46.38** **46**		**%**	**6.983** **7**	

No. of individuals **%**

TABLE 2 – ORGANS OBSERVED WITH THE CORRESPONDING PARASITE BURDEN AND % INFESTATION

Organ where found / *Parasite species identified*	*Capillaria sp.*	*Acetodextra sp*	*Clinostomium sp.*	*Monobothrium sp.*	*Allocreadium sp.*	*Metabronenium sp*	*Spiroxys sp.*	*Centrovarium sp.*	*Contracaeium sp.*	*Diphythrobothrium sp.*	*Phyllobathrium sp.*	*Protocephalus sp.*	*Total*	*(%) Percentage*
Spleen	50	144	–	–	–	32	18	–	–	–	–	–	244	30.42
Liver	104	166	–	–	–	–	–	–	6	–	–	–	266	28.18
Intestine	106	–	–	6	26	–	–	–	–	2	–	2	142	17.71
Stomach	54	–	–	44	8	–	–	10	–	–	2	–	118	14.71
Gills	–	–	70	–	–	–	–	–	–	–	–	–	70	8.73
Gall bladder	2	–	–	–	–	–	–	–	–	–	–	–	2	0.25
Total	**316**	**260**	**70**	**50**	**34**	**32**	**18**	**10**	**6**	**2**	**2**	**2**		
%	**39.4**	**32.42**	**8.73**	**6.23**	**4.24**	**3.99**	**2.24**	**1.25**	**0.75**	**0.25**	**0.25**	**0.25**		

TABLE 3 – LOCATIONS WITH THEIR CORRESPONDING PARASITE BURDEN

Location Collection / Parasites	*Capillaria sp.*	*Acetodextra sp.*	*Clinostomium sp.*	*Monobothrium sp.*	*Allocreadium sp.*	*Metabronemium sp.*	*Spiroxys sp.*	*Centrovarium sp.*	*Contracaeium sp.*	*Diphythrobothrium sp.*	*Phyllobathrium sp.*	*Protocephalus sp.*	Total	(%) Percentage
Baalueku (BOLGA)	98	82	12	12	7	13	10	7	4	1	–	–	246	32.64
Agudama (YELGA)	56	76	22	10	6	19	8	3	2	1	2	2	207	27.15
Okpoma–Brass (BALGA)	98	48	14	13	10	–	–	–	–	–	–	–	183	21.04
Edagberi (ALGA)	64	54	22	15	11	–	–	–	–	–	–	–	166	19.10
Total	**316**	**260**	**70**	**50**	**34**	**32**	**18**	**10**	**6**	**2**	**2**	**2**	**802**	
Percentage (%)	**39.4**	**32.42**	**8.73**	**6.23**	**4.24**	**3.99**	**2.24**	**1.25**	**0.75**	**0.25**	**0.25**	**0.25**		

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VERTICAL AND SEASONAL DISTRIBUTION OF PHYTOPLANKTON IN THE SHEN RESERVOIR PLATEAU STATE, NIGERIA

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ABSTRACT

The phytoplankton distribution of the Shen Reservoir, Bukuru in the Jos Plateau, Nigeria tropical West African was monitored at 6 depths. Higher floral abundance occured within the upper 00–03 meters with highest values at the first 1 meter. Bacillariophyceae and Dinophyceae recorded higher values in March – April with lower values in July and January respectively. Phytoplankton were most abundant in the rainy season which is probably due to higher nutrient levels at this period. Secchi disc transparency was lowest in the peak of the rainy season (July) due to higher levels of suspended matter resulting from the increased run-off from surrounding farmlands of allochthonous materials as well as higher levels of phytoplankton population arising from the former factor. The low water temperature of December/January 15oC + 2oC might have depressed growth among the major groups of plankters but enhanced rapid multiplication of the chlorophyta, *Trachelomonas* which showed a bloom at this season.

INTRODUCTION

Shen Reservoir (longitude 8.51oE: 9.50oN) is situated within the Jos biotite granite complex in the upland Jos Plateau, Nigeria (Figure 1). The granite area from the flat slopes to the river bed form humps and bulges which crop up through laterite. The laterite is considerably thick. The uppermost laterite plane result from erosion. Another plane of alluvial sediments that are more recently formed out into the laterite plane leaving sand alluvial deposits. These latter deposits (baucite and brown iron ore detrital stone) are deposited on the river bed.

The Jos Plateau climate exhibits a hot dry season (February – April), a rainy season (May – October) and a hot dry season (November – January).

MATERIALS AND METHODS

Phytoplankton samples were collected at six depths – surface, 01, 03, 05, 10 and 15 metres at forthnightly intervals over an annual cycle using a closing type bottle. Phytoplankton was immediately preserved with 4% formalin or Lugols iodine solution. Enumerations were made from 1 ml subsamples of the preserved samples. Water temperature was measured using an eloctonic thermometer with a digital calibration secchi transparency was measured by the secchi disc (20–cm diameter). Rain-fall data was provided by the Plataeu State Water Board.

RESULTS

The vertical distribution of the algae (Table 1) shows that phytoplankton decreased from the surface 00m to the 15m depth throughout the period except between September – November when they occurred more within the 01m depth than at the surface.

The chlorophyceae had 46 genera belonging mainly to species of *Cosmarium, Chalamydomonas, Closterium, Ankistrodesmus, Cryptomonas, Earastrum, Micrasterium, Pediastrum, Sienedesmus, Staurastrum, Spirotaemia, Volvox, and Tetrastrum.* They were greater in the surface water (00m) than at other depths except for the period September – November.

The Bacillariophyceae were represented by 21 genera comprising mainly of species of *Melosira, Navicula, Nitzhia, Stephanodiscus, Synedra, Tabelloria, Pinnularia, Cymbella, Cychotella and Rhizosolenia.* They also showed preference for the surface water except for October when they occured more at 01 m than at the surface water and also in August when they occured more at 03 m than at 01 m depth.

The Cyanophyceae consisted of 20 genera belonging mainly to species of *Anaebena, Nostoc, Euglena, Microcystis, Trachelomonas, Lyngbya, Oscillatoria, Phacus, and Aphanizomenon.* They occured more at 01 m than at 00 m throughout the sampling period.

The Dinophyceae were represented by 9 genera comprising commonly of species of *Ceratium, Dinobryon, Peridinium, and Amphidinium.* They occur more at 00m than at 01m throughout the sampling period.

The pattern of seasonal variation (Figure 2) shows that total phytoplankton occured more in the rainy season, followed by the cool dry season and the hot dry season. However, the Dinophyceae occured more in the cool dry than in the rainy season.

Variation in water characteristics show that Secchi transparency was low between July – September. Rainfall was absent between November to February, but high between July to September.

DISCUSSION

The phytoplankton vertical distribution in the Shen Reservoir was significant throughout the sampling period. They occured mainly within the upper 03m representing 81.1% with 33.4% occuring at the 00m. On the whole, only 29% occured at 15m depth. The Chlorophyceae and Cyanophyceae were the most abundant groups at 00m.However, they occured more at 01m during the rainy season (Table 2). This was due mainly to an increase in weight as a consequence of higher nutrient input and subsequent faster growth rate. The greater abundance at the 01m depth is also associated with higher primary productivity and/or higher phytoplankton multiplication (Biswas, 1978) The low population of Dinophyceae in the rainy season may be related to the 'bloom' of the Cyanophyceae (Murphy *et al,* 1976) or to an efficiency in resource utilization.

The higher occurrence of the phytoplankton at 01–00m depth represented by 68.8% is associated with its spectral requirement for photosynthetic activity. Light attenuation has been shown to decreae with depth (Steemann-Nelson, 1975).

Dinophyceae showed a 'bloom' in the cool dry season. A surprisingly high abundance of the Myxophycean *Trachelomonas* was observed in this period. The low phytoplankton abundance in the cool dry season was due mainly to a decrease in the nutrients arising from ceasation of rains. The low phytoplankton occurrence in the hot dry season was due mainly to an increase in light radiation which had an inhibitory effect on algal growth (Tilzer and Schwarz, 1976).

The low Scchi transparency in the rainy season was due to increase in nutrient load and resuspension of recent sediments of the lake as well as inorganic and organic materials from stream inflows.

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TABLE 1 – MONTHLY MEAN VERTICAL DISTRIBUTION OF PHYTOPLANKTON 1^{-1} IN SHEN RESERVOIR BETWEEN JANUARY TO DECEMBER, 1984

Depth	Jan.	Feb.	March	April.	May	June	July	Aug.	Sept.	Oct.	Nov.	December
00m	2168	2237	2190	2190	2103	2282	2202	2450	6163	5780	4505	3622
01m	1654	1870	1883	1730	1618	1937	1867	1010	6724	6655	4545	2835
03m	870	1070	1083	1046	920	1125	1455	1200	3360	2850	2255	1595
05m	651	660	571	654	630	742	751	842	1781	1705	1340	1010
10m	390	387	446	426	417	423	426	480	1163	1084	803	585
15m	227	207	215	241	220	227	215	298	495	354	317	220

TABLE 2 – MONTHLY MEAN DISTRIBUTION OF PHYTOPLANKTON GROUPS IN SHEN RESERVOIR

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May.*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*X*
Bacillariophyceae	1307	1356	1386	1273	990	904	750	970	971	1127	803	1002	1070
Cyanophycease	1886	1914	1984	2059	1906	2328	2584	2778	7940	6170	3915	3365	3236
Chlorophyceae	1593	1871	1769	1726	1860	2540	2394	2574	8859	7680	4650	1515	3253
Dinophyceae	1990	1190	1277	1229	1152	964	782	960	1916	3454	4377	3985	1886

TABLE 3 – MONTHLY MEAN VARIATION IN WATER CHARACTERISTICS

Water Characteristics	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Water Temperature (00m) °C	18.8	19.3	26.5	25.3	24.1	23.6	23.6	24.5	26.0	24.2	21.7	19.7
Secchi Transparency (cm)	38.3	39.1	40.9	38.7	32.4	26.1	20.0	20.5	17.2	25.8	34.2	35.3
Rainfall (%)	0.0	0.0	0.3	3.2	8.0	12.4	26.6	24.0	20.2	5.3	0.0	0.0

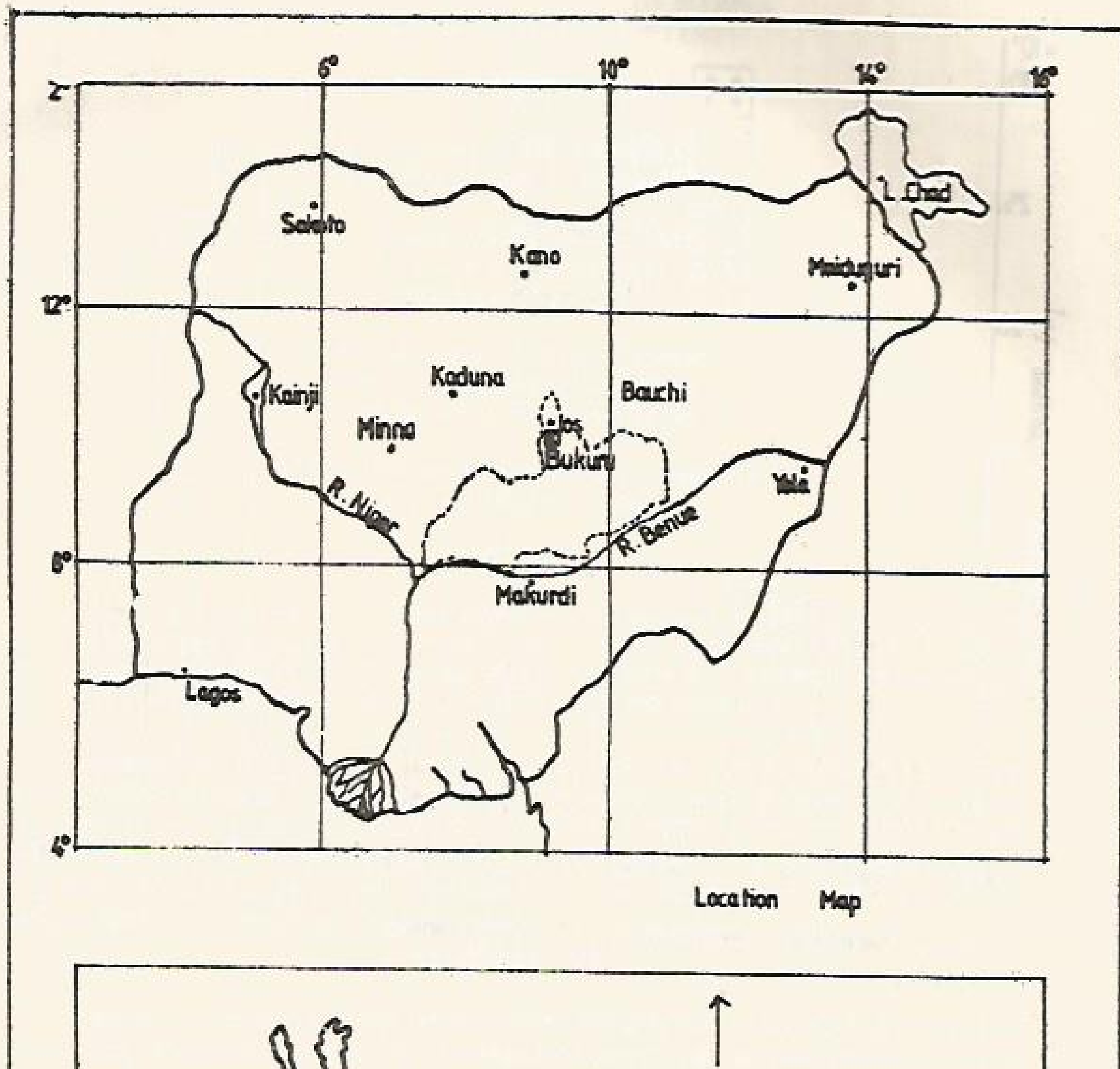

Fig 1 MAP SHOWING LOCATION OF SHEN RESERVOIR

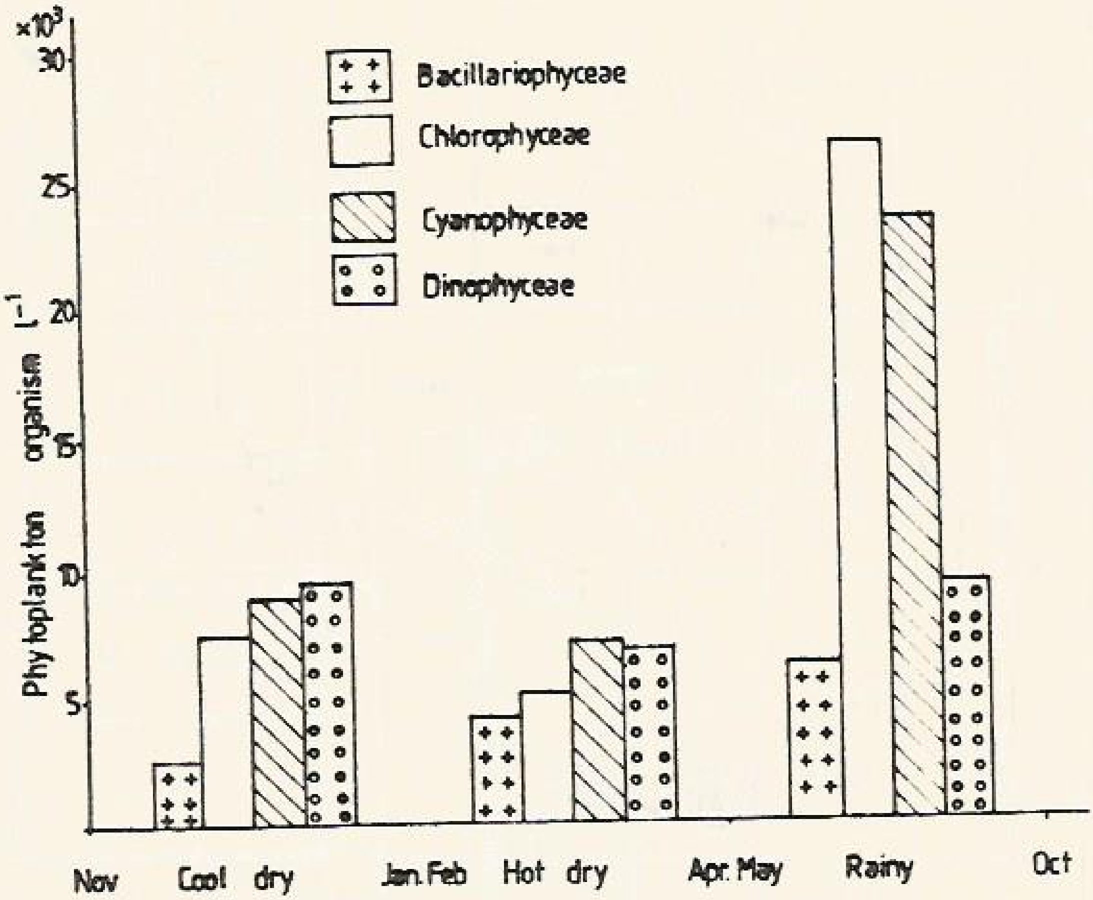

Fig. 2 Seasonal distribution of phytoplankton in shen reservoir.

PYRIDOXINE AND SURVIVAL OF TILAPIA
(Sarotherodon mossambicus PETERS)

By

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ABSTRACT

Pyridoxine requirements of tilapia *(Sarotherodon mossambicus* Peters) were studied in two separate experiments using case in-based diets. In Experiment 1, fish on pyridoxine supplemented diet (14.0mg/100g diet) showed no adverse symptoms and remained healthy while fish on a pyridoxine-free diet showed abnormal behaviour with high mortality.

Graded dietary pyridoxine (0.13 to 3.52mg/100g diet) was used in Experiment 2. Lower dietary supplementations of pyridoxine resulted in reduced weight increase, high mortality, high ratio of serum glutamate-oxal-acetate transaminase glutamate-pyruvate transaminase, and reduced blood sugar. The results suggest the dietary requirement of pyridoxine may be between 0.5g and 1.17mg/100g diet; higher supplementations did not appear to confer any further benefits.

INTRODUCTION

The need for pyridoxine in fish has been investigated by some workers. Deficiency symptoms of pyridoxine in fish, appearing 2-9 weeks after pyridoxine deprivation include anorexia, poor growth, hyperirritability, anaemia, nervous disorder, tetany and high mortality (Halver, 1972).

An extensively used clinical parameter is the tissue amino-transferase activities of pyridoxine-deficient animals. Smith *et al* (1974) observed a decrease in erythrocyte glytamic pyruvic transaminase (GPT; Ec. 2.6. 1.2; Alanine amino-transaminase) activity and an elevated liver GPT during pyridoxine deficiency in rainbow trout *(Salmo gairdneri)*. Ogino (1965) showed increased liver glumatic exalacetic transminase (GOT, EC 2.61.1; Aspartate amino transaminase) and GPT with increases of dietary pyridoxine intake for carp *(Cyprinus carpio)*; similarly with the liver and muscle GOT and GPT activities in turbot *(Scophthalmus maximus)* during dietary pyridoxine treatment (Adron et al, 1978). However, Bell (1968) obtained elevated plasma and serum GOT in poisoned and diseased salmon when compared with healthy salmon.

These studies were designed to investigate the need for pyridoxine in ***Sarotherodon massambicus***, the amount needed for maximum growth, and the effects of various dietary supplementations of fish performance and composition.

MATERIALS AND METHODS

Progeny of laboratory-reared broddstock of tilapia, ***Sarotherodon mossambicus***, Peters (Cichlidae) were used. In experiment 1 we investigated the need for pyridoxine; fifty fish were randomly distributed between two 10-litre fibre-glass central self-cleaning tanks to give 25 fish per tank. Mean weights of fish at the start of the experiment were 5.2 + 1.4 g and 5.6 + 0.6 g for pyridoxine free diet and pyridoxine supplemented diet, respectively.

In experiment 2, we studied the effects of graded supplementations of pyridoxine in the diet of tilapia; six 50-litre central self-cleaning plastic tanks were randomly stocked at 10-16 fish per tank. The tanks were connected to a close circuit water supply, heated to 26.5oC. The quality of the water was monitored for temperature, oxygen, pH, NO_2 and NH_3 twice weekly throughout the experimental period. Both experiments continued for 12 weeks.

Diet Preparation and Feeding

The dietary ingredients (Table 1), obtained from Sigma Chemical Co. Louis, were prepared in the same way; the only variable component being pyridoxine hydrochloride. For experiment 1, we used a pyridoxine-free diet (PFD) with no pyridoxine added, and pyridoxine supplemented diet (PSD) with 14 mg/100g diet. In experiment 2, supplementations varying from 0.13 to 14.0 mg pyridoxine-HCL/100g diet were prepared. Having carefully weighed out the ingredients, we dissolved the fat-solube vitamins in a portion of the corn oil, and the water-soluble ones in water, before mixing them with the other ingredients. Sufficient water was used to blend the mixture into a stiff dough in a Kenwood mixer, and it was then forced through a 4-5 mm aperture to form long strands. After air-drying for 12 hours at room temperature, they were broken and sieved to produce a diet of 2-3 mm particle sizes and stored at -15oC until used. The diets were fed at 3% of the fish body weight per day, adjusted weekly after weighing. Fish were fed three times a day on week-days, and once daily at week-ends.

For weighing, fish were transferred to a solution of benzocaine (0.5g/3 litres of water) for which the benzocaine was first dissolved in a small amount of acetone. When anaesthetized, surplus water on fish was blotted off with absorbent paper, and they were then weighed on a balance to + 0.01g.

Analysis

Specific growth rates (SGR) were calculated according to Brown (1957). At the termination of experiment 2, blood samples were taken for four fish per treatment, as described by Blaxhall and Daisley (1973), and pooled for glucose analysis using a Beckman Autoglucose Analyser. The pooled sera were also analysed for GOT and GPT using the colorimetric method of Hawk (1965). Moisture, fat, ash and protein contents of fish were determined by the standard methods of Association of Official Analytical Chemists (1970).

RESULTS

Experiment 1

Water temperature in all tanks for the period of both experiments was within the range 25.5 to 27.5oC. Other measures of water quality were always satisfactory.

Feeding remained normal until the third week when some of the fish on the PFD ceased active feeding. Mortalities first occurred 1 week after the start in the PFD (Figure 1) with characteristics behavioural changes of fish. When disturbed they swam rapidly in an erratic manner, and at times they swam on their backs with rapid movement and flexing of the opercula. These convulsive motions continued for 1 or 2 hours with the body in tetany before the fish eventually died, symptoms were observed within 2 weeks of feeding fish PFD, and larger size of fish were the first to die from the deficiency symptoms.

Out of the total dead fish on PFD, over 50% of them died within 12 – 24 hours following treatment with benzocaine for weighing, thus indicating that they were perhaps less resistant to stress. Mortality among fish on the PFD was high, reaching 44% by week 6, whereas none of the fish on the PSD had died at this time.

At the start of week 6, fish on PFD were returned to the PSD to confirm whether there was any correlation between the diet treatment and the symptoms and mortalities observed. Fish regained their appetite and no longerdisplayedthe behaviourral changes. Only one fish died within the week following the return to the PSD.

Experiment 2

Similar behavioural symptoms observed in fish on PFD were noted in fish on the lowest supplementation of dietary pryridoxine HCL, and mortality was highest in this group (Figure 1). The mean body weight of fish and the specific growth rate improved with increase in dietary pyridoxine content up to a maximum (P4) after which further pyridoxine HCL addition had no effecct. An increasing trend in blood sugar value was obtained in the sampled fish, while the sera GOT varied randomly with no correlation to the pyridoxine intake whereas the GPT values increased with higher pyridoxine intake to a maximum (P4) before declining off. The GOT/GPT ratios decreased from 3.4 to 1.2 with increased dietary pyridoxine HCL supplementations Table 3)

DISCUSSION

Behavioural deficiency symptoms observed in experiment 1 become apparent by week 2, and were similar to those reported in the literature in which development varied from 2–9 weeks in various species examined. The performance of the fish in experiment 2 improved as the dietary pyridoxine increased; mortality decreased to zero with the P5 and P6 diets, and there was a larger percentage weight increase from P1 through to P4. The lower figures (and the consequently low (SGR) for P5 and P6 may be due to their higher initial weights; large fish grow more slowely than small fish. Andrew and Murai (1979) reported anaemia in catfish fed higher amounts of pyridoxine, which might influence growth adversely. Anaemia (among other haematological changes) was observed in pyridoxine-deficient salmonids and cyprinids (Halver, 1957; 1972; Ogino, 1965; Smith *et al*, 1974).

The blood sugar of the fish increased with dietary pyridoxine supplementation. A similar observation was reported in rats by Huber *et al* (1964) who suggested that hormonal derangements (adrenaline and glucagon) might be responsible.

A reduction in tissue protein was observed in fish fed the lowest amount of pyridoxine, although the protein in ther diet was the same as that of fish receiving more pyridoxine. Various enzymes of non-oxidative amino-acid metabolism are dependent on pyridoxal–5^1-phosphate, any any impairment in their activity would thus affect the protein status of the fish. There was no correlation between pyridoxine supplementation and carcass fat deposition in the present study, although fatty or cirrhotic liver have been reported in monkeys deprived of this vitamin (Sauberlich, 1968).

Serum GPT showed an increasing trend with dietary pyridoxine (apart from one aberrant) value with the P5 treatment), while no pattern was seen in the serum GOT, agreeing with observations in other species (Caldwell and McHenry, 1953; Brin *et al*, 1960; Lumeng *et al*, 1978).

The GOT/GPT ratio is commonly used to assess the behaviour of these enzymes in various deficiency states; in rats, a ratio of 1.3: 1 is taken as normal (Hawk, 1965; Bergmeyer, 1974; Lumeng *et al* 1978). In the present study, this ratio was attained with the P3 and P4 treatments; this is believed to be the first time that the parameter has been employed for fish on pyridoxine treatments. Perhaps subsequent findings may define this ratio for fish. However, this ratio was obtained within the treatments where maximum growth and SGR were attained.

TABLE 1 – DIETARY INGREDIENTS USED IN PYRIDOXINE

Major Nutrients (g/100g Diet)

Casein (Vitamin-free)	35.0	Alpha cellulose	21.0
Corn Oil	12.0	Vitamin mix[1]	2.0
Codliver Oil	6.0	Mineral mix2	3.0
Dextrin	10.0	Carboxymethyl	
Alpha Starch (Potato)	10.0	Cellulose (C.M.C)	0.5
		Chromic oxide	0.5

1. The vitamin mix constituent (in mg/100g diet: thiamine HCL 14.0 riboflavin 45.00; nicotinic acid 60.00; calcium pantothenate 95.00; inositol 500.00 ascorbic acid 350.00; choline chloride 780.00; biotin 1.50; folic acid 3.50; para-amino benzoic acid 65.00; cyanocobalamin 0.15; alpha tocopheryl acetate 64.00; menadione 6.00.

2. The mineral mix contained (in g/100g mix): major minerals: calcium orthophosphate 13.6; calcium lactate $5H_20$ 32.7; ferric citrate $5H_20$ 3.0; magnesium sulphate $7H_20$ 13.2; dipotassium hydrogen orthophosphate 24.0; di-sodium orthophosphate 8.7; sodium chloride 4.4; Trace minerals: alluminium chloride (anhydrous) 0.008; potassium iodide 0.013; zinc sulphate $7H_20$ 0.15; manganese sulphate H_20 0.08; cobalt chloride $6H_20$ 0.10.

TABLE 2 -- PERFORMANCE OF S. MOSSAMBICUS ON DIFFERENT AMOUNTS OF DIETARY PYRIDOXINE (EXPERIMENT 2)

Pyridoxine Supplementation (mg/100g Diet)	*0.13*	*0.25*	*0.52*	*1.17*	*3.52*	*14.00*
Treatment Code	P1	P2	P3	P4	P5	P6
Initial Number of fish	16	14	15	15	13	10
Final Number of fish	11	12	14	14	13	10
Mortality (%)	31.3	14.3	6.6	6.6	0	0
Mean Initial	11.8	10.4	11.2	11.3	12.9	17.1
Weight (g) ± S.D.	±5.6	±4.2	±7.0	±6.7	±5.8	±4.4
Mean Final	18.5	19.8	22.8	23.9	21.6	25.3
Weight (g) ± S. D.	±6.9	±4.3	±9.9	±10.3	±5.5	±7.8
% Increase In	55.6a	89.0a b	104.0b	112.1b	67.7a	48.3a
Mean Weight ± S.D.*	±17.9	±12.0	±18.8	±21.1	±12.5	±15.6
Mean S.G.R. ± S.D.*	b.c 0.84±0.5	b.c 0.84±0.3	c 1.00±0.2	c 0.95±0.4	ab 0.67±0.2	a 0.51±0.2

**Figures with the same superscript are not significantly different (Duncan's Multiple Range test, P 0.05)*

TABLE 3 – ANALYSIS OF S. MOSSAMBICUS FOLLOWING VARYING DIETARY PYRIDOXINE TREATMENT

Pyridoxine Supplementation (mg/100g Diet)	*0.13*	*0.25*	*0.52*	*01.17*	*3.52*	*14.00*
Treatment Code	P1	P2	P3	P4	P5	P6
Number of fish analysed	4	4	4	4	4	4
Moisuture % ± S.D.	75.5±1.5	76.8±1.5	70.71±0.2	74.2±1.3	77.1±0.1	72.8±5.0
Fat % ± S.D.	7.7±2.5	11.3±4.3	8.8±1.7	10.2±1.3	8.4±1.3	11.7±2.2
Dry Tissue Protein % S.D.	43.2±7.5a	51.9±4.2b	57.6±5.1b	50.8±3.5b	53.1±1.5b	53.9±6.2b*
Blood Glucose (mg/100ml pooled)	31	41	65	81	188	159
Serumgot (Units/ml)	257	205	185	242	232	216
Serum GPT (Units/ml) pooled	75	90	147	180	117	175
GOT/GPT Ratio	3.4	2.3	1.3	1.3	2.0	1.2

**Figures with the same superscript are not significantly different (Duncan's Multiple Range Test P = 0.05).*

Comparison of the various analysis performed indicates the possibility of using the blood -sugar value as an inexpensive and simple method for diagnosis of pyridoxine deficiency in fish, but since it is not specific for this deficiency, it would need to be assessed alongside observation of behavioural symptoms which show up rather early in this species.

CONCLUSION

Based on the high mortality observed in this fish, pyridoxine – HCL is an essential dietary requirement for *S. mossambicus* and between 0.59–1.17mg pyridoxine–HCL/100g of diet enhanced optimum fish growth with subsequent reduction in mortality.

ACKNOWLEDGEMENT

This study was carried out at the Fish Culture Unit of the University of Aston in Birmingham (Great Britain), and grant was provided by the University of Port-Harcourt (Nigeria).

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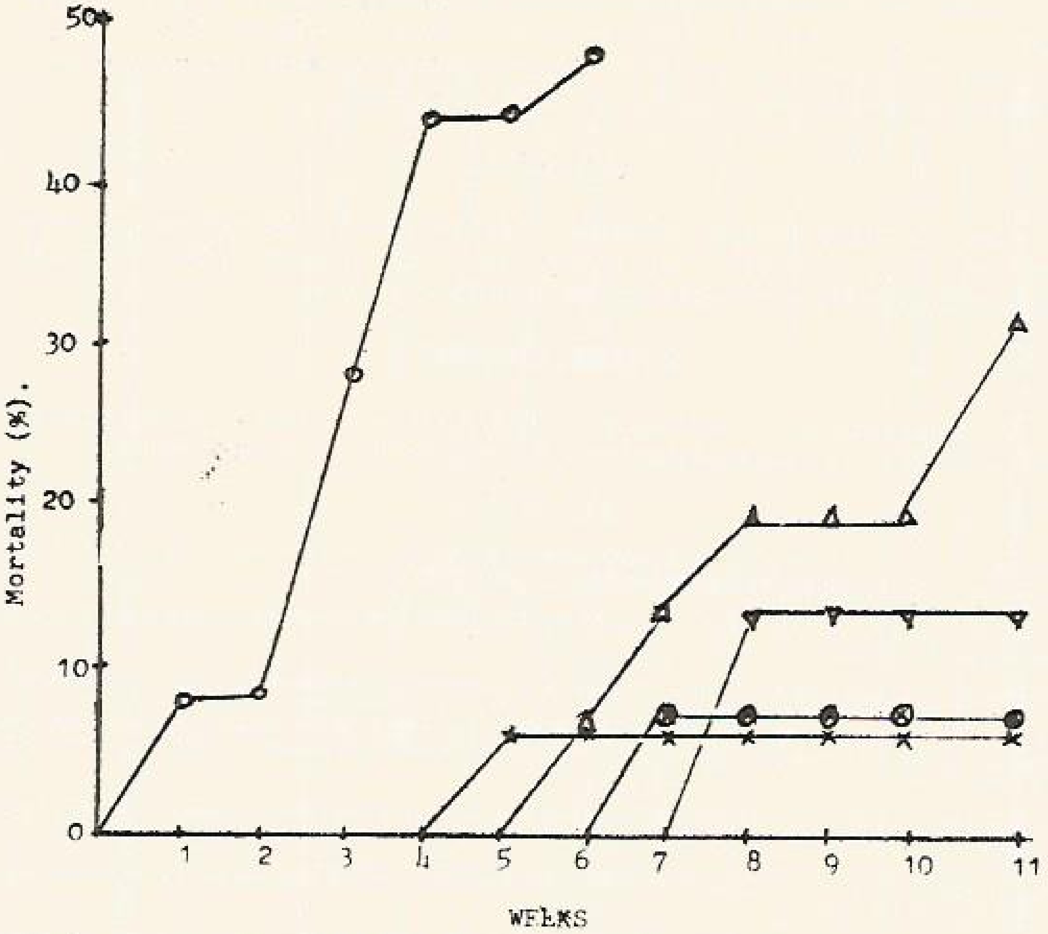

Fig.1: Weekly mortality (%) in Tilapia fed diets containing varying amounts of pyridoxine.

O = O = F = F (experiment 1): Δ-Δ = P_1; ∇-∇ = P_2; ⊗-⊗ = P_3;
x = x = P4, (experiment 2).

SECTION 5 – RESOLUTIONS AND RECOMMENDATIONS

FOURTH ANNUAL CONFERENCE OF THE FISHERIES SOCIETY OF NIGERIA (FISON)

COMMUNIQUE

At the end of the 4th Annual Conference of the Fisheries Society of Nigeria (FISON) held at the Nigerian Institute of Oceanography and Marine Research, Aluu, Port Harcourt between 27th – 29th November, 1985 the following communique was issued:–

(A) GENERAL.

– The need for a secretariat with essential staff was identified. This should presently be located in an existing establishment related to FISON'

– Sufficient funds should be made available to Research Institutes and Universities by the Government, private companies and individual philantropists to enable comprehensive research to be conducted into all Fisheries Programmes including Cage and Pen Aquaculture, identification of endemic cultivable fish species whose culture histories are yet to be established, appropriate supplimentary feeds etc, such Fisheries Research must be result oriented.

On Processing and Preservation

– The Conference recognised the fact that about 50% of all local fish product is lost through spoilage. Post harvest losses of fish should be substantially curtailed by the provision of sufficient and appropriate infrastructures to fishermen for the preservation of their catch.

– The Conference noted: staffing positions of all Fisheries Schools existing in the country and recommends further strengthening so that specialists in the various disciplines included in the curricula are appointed. In addition, more emphasis should be placed on practical training in order to make graduates of such schools effective in the economy. The need for the establishment of Departments of Fisheries in some selected Nigerian Universities was stressed. Such faculties should cater for specified courses in professional fisheries disciplines rather than in pure fisheries science alone. Such courses should include Fish farm planning and aquaculture practices, Fish preservation and utilization, Fisheries economics including marketing, and basic courses in Aquatic biology, Limnology and Oceanography.

– The need to organise fisheries shows annually was emphasized. This will bring together all fisheries workers and fishermen inorder to exchange ideas on how to foster the growth of the economy.

– It was recommended that National Fisheries Staffing Policy should be reviewed. This new staffing policy should be relevant to the needs of the fisheries economy. The staffing of Fisheries Establishments and Research Institutes should include, Marine/Mechanical Engineers, Hydrobiologists, Electronic and radio engineers, Ship building engineers, Skippers, Animal nutritionists, etc.

– The Society identified the importance of the Bonga fishery which exists prominently in Nigerian Inshore Waters. It implores the Government and the private sector to take a strong look at the canning of bongas for marketing in Nigeria. This will prevent post harvest losses as well as make more fish available to the Nigerian market.

– The Conference resolved that there should be continuous strong dialogues between the Research Institutes and the Government Fisheries Development Agencies so that results of research can be effectively utilized for fisheries development

In addition, there should be a strong link between the fisheries institutes and fisheries establishments with the private sector so that they can benefit from the results of research and surveys conducted.

(B) ON AQUACULTURE

– The Conference observed with dissatisfaction the low level of private investment in aquaculture compared with arable and poultry farming and attributed this to the numerous constraints militating against commercial fish farming. These constraints were clearly identified.

– The Conference, therefore, resolved that Government establishments and institutions should intensify their efforts to develop standard hatcheries for controlled and mass production of indigenous fish fingerlings. Simultaneously, these agencies should also intensify efforts to collect fingerlings of indigenous species from the wild particularly along our coastal shores where a vast resource of fingerlings, estimated at over 100 million a year, abound.

– It was noted that because of the currently low and unestimated demand for fingerlings in the country, it was necessary to keep down the cost of wild fingerling collection to make the venture profitable both to the fish farmer and the local fishermen who may subsequently take over the trade when the demand increases. The need for accurate statistics on fingerling demand in all the States was emphasized.

– The Conference also stressed the need for increased research on the production of standard cheap pelleted and powdered fish feeds for pond and cage culture systems in order to achieve high returns on investment since high feed cost could adversely affect the viablity of these culture systems.

– It was also noted that increased private investment in fish farming could only be guaranteed when source of seeds and feeds are guaranteed coupled with institutional guarantee on extension services in pond survey, construction and management technology in order to utilize the vast areas of brackish and fresh water environments available for fish culture in the country capable of producing an estimated one million metric tonnes (m.t) of fish annually.

(C) ON HARNESSING THE INLAND FISHERIES CAPTURE RESOURCES.

– The Conference observed that the country is blessed with numerous natural and artificial water bodies scattered all over the country currently estimated at about 2.4 million hectares and capable of producing over 500,000 metric tonnes of fish annually but which is currently producing only 30% of its estimated potential. Some of the major obstacles to increased inland fish production were identified.

The Conference, therefore, resolved that:–

(i) all the States Fisheries Departments in the country should update the inventory of water bodies in their States currently published by the Kainji Lake Research Institute (KLRI)

(ii) each State Fisheries Department should endeavour to liaise with relevant fisheries institutions in the country to plan strategies for the management of their inland capture fisheries.

(iii) mass fingerlings production from standard hatcheries should be budgetted for by each State for stocking fallow small reservoirs constructed for purposes other than fisheries, together with flood ponds, burrow pits and construction paddocks currently lying waste in the country.

(iv) the case for the promulgation of the Federal Inland Fisheries Laws and Regulations for Nigeria should be vigorously pursued by the Federal Department of Fisheries in order to bring about standardization in the management of water bodies shared by two or more States.

(v) regular collection of fish landing statistics from all water bodies should be embarked upon by all State Fisheries Departments to give some background information on the productivity of each water body and help decision taking regarding the management strategies to adopt.

(D) ON MARINE FISHERY RESOURCES.

– The Conference emphasized the immense fishery resource of Nigeria's estuarine, near shore and open marine environments in meeting the country's requirements in fish.

– The Conference recognized the positive role of basic oceanographic reserach and in particular the area of primary productivity research and fish stock assessment to the fuller exploitation of the country's marine fishery and calls on the Federal Government to provide greater financial support for such effort.

– The Conference further emphasized the need for:–

* Surveys and identification of stocks of some commercially important fish species along our coast.

* Research into the migrational patterns and the spawning grounds of our important food species.

* Conservation and Protection of our marine fishery resources for proper management and exploitation.

* Oil companies to help finance some aspects of marine research viz: Pollution problems, and Fin and Shell fish fisheries.

* Adequate facilities to be made available for the monitoring of our water to prevent fish poachers.

(E) ON FISHERIES DEVELOPMENT.

The Conference recommended:–

– That there should be an establishment of a proper mechanism for consultations between development (Government) agencies and Research Institutes at the early stages of plan formulations.

– That the capacity of the Federal Fisheries School, Lagos be upgraded to train skippers for industrial fishing.

– That there should be long term Fisheries Development Plan which should be split into smaller units for implementation.

(F) ON MANPOWER DEVELOPMENT AND TRAINING.

The Conference recommended:–

– That a permanent sub-committee on Fisheries Manpower Development and Training be set up by the NFDC to co-ordinate manpower development and training in the industry.

– That acceptance of students for industrial experience on board fishing vessels be conditional for issuance of fishing licence by the Federal Department of Fisheries (FDF).

– That fishing companies be made to subscribe to the Industrial Training Fund (ITF) so that they will be statutorily forced to develop indigenous manpower. Fishing Companies should be given minimum professional qualifications for various manpower cadre of their establishment.

That while the Federal Fisheries Schools could specialize in one area or the other, the training needs of their catchment areas should be taken care of.

(G) ON CRAFT AND GEAR.

The Conference recommended that: –

– Private enterpreneurs be invited to invest on the exploitation of marine fishery resources - thence vessels within and under 100 gross tonnage should be allowed to be imported into the country duty-free.

– Import licences should be automatic for such vessels, along with the corresponding fishing nets.

– Outboard motors for fishing should be allowed into the country along with the corresponding nets without import restrictions to aid the artisanal fisheries development in the country.

– The building of trawlers using indigenous materials be encouraged.

(I) FISHING GEAR RECOMMENDATIONS.

– FISON recognized the serious shortage of fishing gear materials (nettings), equipment and machinery spare parts and vessels. These fishing gear materials and equipment when available are also very expensive. The Society therefore, recommends that efforts should immediately be made by Federal Military Government to imporve the situation.

SECTION 6 – APPENDICES

DISCUSSION OF THE KEYNOTE ADDRESS

Rapporteurs's Report: Dr. Y. L. Fabiyi

Chairman – Mr. V. O. Sagua

Keynote Speaker – Mr. N. O. Fadayomi

Discussions

Mr. O. A. Solagbade, Al-Marine: The private sector has been looking towards the Society for the assistance in presenting the case of marine investors. This led to the formation of marine manufacturers in Nigeria. Fisheries Society has been expected to play a role and be all-embracing Not only to represent the academic community but also the business community within it. could the Society reassess its objectives and evolve policies that will take care of the private sector?

Mr. Onyia: Problem he sees is that the Society has not been able to implement its objectives. It is fine the Society formed an "Action Group" to agitate it. We need to re-examine ourselves to see whether we have the qualification to be members of the Society. Only qualified members should be allowed. Entrance should be vetted. There should be formed a National Institute for Fisheries. We should divert ourselves from Government sponsorship. Fund raising activities should be embarked upon as membership fee alone is not enough. Society spirit is not in the Fisheries Society of Nigeria (FISON).

Mr. Tobor, NIOMR, Aluu: Composition of the executive committee does not allow the Society to make an impact. Most executive members are Civil Servants who would want to protect their jobs. Government investment in training started in 1960s. He stated that biologists have made impact in fisheries development. Fund management is a problem. Universities have not helped much either.

Mr. A. A. Olaniawo, NIOMR, Lagos: Role of FISON and Federal Department of Fisheries (FDF): Federal Department of Fisheries now serves as clearing house for fisheries policy etc. Mr. Fadayomi should help get their colleagues in the private sector to serve in the FISON executive.

Mr. E. O. Ita, Kainji Lake Research Institute (KLRI): Aspects of Constraints: There is need to quantify the fisheries resources. Input–Output analysis is important. If the resources had been quantified, government could have invested in fisheries. Control of the number of fishermen who can exploits a new lake is important (1 boat/sq.km of water and 2 fishermen). Surface area of water available for production of fish all over the country has been surveyed. Effective management of the fisheries is essential. Multinationals are never allowed in inland fisheries. They are also restricted to particular areas of coastal waters.

Dr. Mgbenka, University of Nigeria, Nsukka: Supports establishing a professional body to register qualified fisheries scientists. Lobby groups are also essential. The Universities are facing financial constraint in adequately providing practical opportunities. Members in the private sectors should make use of University people.

Mr. Nsentip, MANR, Calabar: There is need to develop fishersies courses at the Secondary School level. FISON should help to fashion out syllabus for Secondary Schools to impart fishery knowledge in High Schools.

Mr. V. O. Sagua, Federal Ministry of Science and Technology, Lagos: A syllabus has been fashioned out. But there are no teachers and no text books for fisheries. FISON could contribute . by commissioning fisheries books to be written, for schools and colleges, based on approved syllabuses.

Dr. Ibe, NIOMR, Lagos: There is need for re-organization of FISON. Members will have psychological satisfaction for paying higher membership fee if there are successes recorded by the FISON. We need to broaden the base of FISON in such a way that people in relevant fields can be members.

Orientation of Fisheries Training Programme:

Need to move to systems biology rather than organism biology. A fisheries man needs to know something about their environment. Need for experts in related fields, such as oceanography, marine geology etc, to be members.

Mr. Adebolu, FDF, Lagos: Setting up of Secretariat for the Society, 2nd FISON Conference mandated the society to establish a secretariat. Special fund raising should be launched to provide fund for the siting of the Secretariat.

We need to appoint more patrons and also utilize the only Patron, Chief (Dr) Michael Ibru since the Society was founded in 1976. Communiques of annual conferences have always been passed to Permanent Secretary (Agriculture and Federal Ministry of Science and Technology). President of the Society should grant press and television interviews once or twice a year on the activities of FISON and fisheries.

Dr. Sorinmade, NIOMR, Lagos: FDF or NIOMR should for a start provide a room as FISON Secretariat and a staff provided by FISON. Need for membership drive committee to look for members and screen members for membership. Finance Committee to canvas for funds. Public Relations and Publicity Committee needed. Industrialists should encourage artisanal fishermen. There could be contract fishing between the peasant fishermen and fishing companies. Need for more fish farmers, FISON to enlighten the private farmers about fish-farming.

Mrs. Ajana, NIOMR, Lagos: Secretariat of F:SON should initially be established at FDF or any Institute. There is need for publications for the use of the public and farmers - whereby new technology should be published and disseminated. There is need for national fisheries extension service.

Chief Z. A. Adesanya, Ogun State: FISON has not fulfilled most of its objectives. Conferences have not been regular. Proceedings of the 1st Conference (1976) have not been published. Many executive members have not been attending meetings. Publicity of the Society is not effective. Handouts should be published by the Society stating its objectives and what its aims are and sent to various organizations.

Mr. J. Essien: Need for reorganization of FISON. Supports the call for an "action committee" There should be certification programme for fishery scientists while there is still need for large membership.

Mr. N. O. Fadayomi — Comments on the Discussion of his Paper:

We should be careful in separating members since every area of human endeavour has a role to play. We should avoid narrow definition of Fisheries Society membership. The Society should not be limited to only biologists. The Society must form an umbrella for the sort of people who have interest in fisheries.

There are quite a few fisheries in which the biology has been developed but the fisheries have not been developed.

SUMMARY

Chairman Mr. V. O. Sagua, FMST, Lagos

Who is a member of the Fisheries Society?

No up-to-date membership list is available, or if it is available, it has not been used. Criteria for membership has to be properly defined.

Need for selectivity of membership. A small membership committee should be set up to decide on criteria for membership.

Criteria for Performance

The Society has not functioned properly. There has been problems of logistic and finance. There is need for thought about location of the executive members. The Society's Proceedings of its Conferences have not been published regularly: the 1983 proceedings have not been published due to lack of funds.

Need for fund raising committee.

Secretariat

Room needed from Federal Department of Fisheries (FDF), NIOMR or from private group to start a temporary Secretariat. We need to persuade the Director of FDF or NIOMR to give a room for use by FISON as temporary secretariat. There is also need for regular publications of FISON.

Some Projects/Programmes should be initiated by FISON e.g. FISON could commission the writing of a text book on fisheries for Schools and Colleges or survey of a particular fishery resources in Nigeria. There is need to seek for patrons and matrons from whom help can be sought to re-awaken the Society towards the realization of her objectives.

TECHNICAL SESSION

Paper by Chief Adesanya on the Role of Government and Financing Institutions in Fisheries Development

Calls for loan by Government and Financial Institutions to the Fisheries sector especially the catch and culture fisheries.

Paper by E. O. Ita et al on Summary of the Inventory Survey of Nigeria Inland Waters

Paper by Mr. Alagoa on Hydrolic Engineering Potential in Niger Delta Region and its Contribution to Fish Production

Discussions

Mr. V. O. Sagua: How does Chief Adesanya see the issue of issuing fishing licence for fishing vessels and other outputs?

Reply: There is the problem of importation of fishing inputs. It takes 9 months to obtain an import licence. It has been impossible to open irrevocable letter of credit. The procedure is too cumbersome and the officials at the Federal Ministry of Finance are not making things easy. It is the Federal Government that should assist the States in acquiring necessary input.

Mr. A. D. Onyia: Advocates that the private sector should be involved in getting results concerning procurement of fishery inputs by governmental departments. They know how to do this. He wonders why Mr. Ita does not involve the consultants in doing some of the resource surveys.

The fishermen have been very difficult to deal with so recovery of loan becomes very difficult. Not many well articulated projects are available. Banks have very few fishery experts and therefore, fisheries projects do not receive attention. Importation of any thing to the country is very difficult because of the economic situation.

Dr. Ezenwa: Government could make or (force) the multinationals to invest in fisheries development e.g. fish farming.

Dr. Sorinmade, NIOMR: The figure for fish importation from 1983 in Mr. Ita's Table 4 does not look realistic. It appears too high especially in view of the economic stabilization programme. The criteria used should be made explicit.

Mr. Ita's answer: The projections referred to is that of the Green Revolution Study Group's Report.

Mr. Onyia: The figures were mere projections. The situation changed from the base worked with.

Dr. Nwadiaro: Was worried about Table 3 of Mr. Ita's paper dealing with Yield Potential and methods for getting the estimated yields.

Mr. Ita: The figures were based on established yield indices. The figures apply to African water bodies and not Nigeria alone. It is based on the work of Drs. Welcomme, Henderson etc. The methodoogy has been standardised. But one‚st..l needs to carry out proper sampling to determine the fish content in the form of stock assessment and actual catch statistics.

Mr. Sagua: Noticed that there is an underestimation in the surface area of water estimated for Nigeria's small rivers. It was advocated as lacking detailed topographic maps from which total lengths and areas of Nigeria's rivers can be calculated.

Mr. Udolisa: It is quite expensive to establish fishing projects. There is need for government to subsidize boat production as is done in the developed countries. Artisanal gill-net canoe fishing project might cost ₦20,000 – ₦30,000 to implement.

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(iii) Evidence of petitions and pleas to the Federal Government from frustrated fishing professional on the need to equip local institutions for the training of vessel skippers. These actions were prompted by inaccessibility of those concerned to foreign currency to pursue training abroad.

Thus, unless the Federal Fisheries Schools consciously share out the training of the manpower required for the various sectors of the industry, duplication of irrelevant courses will continue and the industry will continue to hire non-nationals with relevant expertise.

Suggestions for Meeting Future Manpower Needs of the Industry

In recent years, assessment of manpower for all the agricultural sectors of the country have been done. In the fisheries sector, for example, it has been estimated that the following field officers will be required by 1985 for the public sector:–

– Development Officers	314
– Research Officers	256
– Fisheries Superintendents	2,661

On the operative side, the following are estimated:–

	1980	*1985*	*1990*
– Skippers	60	120	150
– Mates	112	175	220
– Coxswains	157	232	290
– Deckhands	613	870	1,090
– Marine Engineers	60	120	150
– Marine Engineering Assistants	112	174	220
– Motormen	52	558	700

The 1990 estimates were based on an increase of 25% over the 1985 estimate since the growth rate of Nigeria's fisheries has been observed to be 5% annually. Despite the relatively (vis-a-vis other agricultural subsector) high growth rate the local manpower available by 1985 was about one quarter of the estimates, non nationals still dominate.

In view of the limited training resources of the three schools it is expedient to establish 'programme of excellence' for each of the schools. The writer has observed this trend in many of the fishing nations in South–East Asia e.g. South Korea, Malaysia, India and Indonesia. For example, in South Korea, the Korean Fisheries Training Centre (KFTC) established in 1965 and located in Pussan trains fishing skippers, marine engineers and radio operators for the country's deep sea and coastal fishing fleet; while fisheries (development officers and leaders of fishing villages are trained at the Fisheries Training Institute attached to the country's Fisheries Research and Development Agency (FRDA).

The training of the manpower listed earlier could be more effectively done by the three schools as follows:–

(i) Lagos (NIOMR).

To conduct mainly courses for coastal and distant water finsheries. These courses should produce fishing skippers at all levels - junior, middle, and senior. The School should also design courses for fishing net technicians, and marine engineers at all levels. The collaborative training programme with the National Nautical College, Oron should be implemented to further reduce duplication of courses and scarce resources.

WELCOME ADDRESS BY MR. J. G. TOBOR
DIRECTOR
NIGERIAN INSTITUTE FOR OCEANOGRAPHY AND MARINE RESEARCH, LAGOS

Your Excellency, the Governor of Rivers State,
President of FISON,
Distinguished Guests,
Ladies and Gentlemen,

It is my greatest pleasure to welcome you all to the 4th meeting of the Fisheries Society of Nigeria (FISON). The Institute asked for the post-ponement of the meeting originally scheduled for February/March 1984 because of the then prevailing circumstances which were totally beyond our control. I am, therefore, pleased that we can now host the meeting and would like to express my deep appreciation to the organisers for their understanding and cooperation.

In the next two days, we shall be discussing numerous topics on the Nigerian Fishing Industry, the fisheries and their development. It will be important to know, why, inspite of four development plans from 1962 to 1985, Nigeria is still unable to produce 60 per cent of her fish demand presently estimated to be 1.2 million tonnes.

We shall be asking ourselves questions on the status of the Nigerian fisheries and constraints to their development, fisheries data and their reliability for effective policy formulation, problems of ineffective extension services and poor monitoring of development projects. Others include the right incentives to fishermen to increase fish production, fishery resources and their potentials, status of manpower development at all levels for the fishing industry. We shall evaluate the extent to which we have achieved our objectives as a Society, how far our recommendations have reached appropriate quarters and got implemented for the development and growth of the fishing industry. Infact, have we as a Society made any impact on the development of fisheries in Nigeria? Are we recognised as a body with influence on government policy direction on fisheries development?

Other areas that are likely to engage our attention will be the funding of fisheries research and the financial contribution of users of fisheries research results to research. The problems of communication gap between researchers and government development agencies on one hand, and researchers and grass-root users of research results on the other hand are equally important.

The outcome of our discussions on some of the enumerated problems will throw light on the status of development of the Nigerian Fisheries and the possibility of achieving self-sufficiency in fish production before 1990. It will also tell us how the Society has performed since coming into existence almost a decade now. I hope this meeting will go beyond making recommendations and issuing a communique to taking practical actions directed towards the healthy growth and development of Nigerian fisheries for increased fish production.

Your Excellency, distinguished guests, Ladies and Gentlemen, please bear with us the moderate facilities we have been able to provide for the meeting under the prevailing economic condition of the country. I wish all of us fruitful discussions and a happy stay in Port Harcourt.

Thank you.

ADDRESS BY MR. V. O. SAGUA VICE PRESIDENT OF THE FISHERIES SOCIETY OF NIGERIA (FISON)

The Military Governor, Rivers State,
Honourable Commissioners,
Special Guests of Honour,
Invited Guests,
Distinguished Ladies and Gentlemen,

It is with great pleasure that I welcome you all to this Fourth Annual Conference of the Fisheries Society of Nigeria (FISON) holding in the great sea fishing port city of Port-Harcourt, the capital of Rivers State.

As some of you know, this Conference was supposed to be held in 1984 but had to be postponed due to the economic situation in the country. Although, the economic problems of the country are still with us, the Fisheries Society of Nigeria considers it very important to hold this Annual Conference at this time so as to bring together the wealth of expertise and experiences of its members in order to make our contributions to the solving of the problems of fish production and to make Nigeria more self-reliant.

The theme of the Conference is "Towards Harnessing Fisheries Resources of Nigeria" It is appropriate that the Society should address this important topic especially at this time in the Country's history when emphasis is being placed on the development of our local resources for national development.

The current level of fish production in Nigeria is approximately half a million tonnes per annum which is about 50% of the demand for fish in Nigeria. A big gap exists between the fish produced and the amount of fish available in the country.

Consequently, the country has been importing fish and fish products which amounted to about 444,000 tonnes valued at about ₦265 million in 1980; yet the potential for increasing production of fish internally and from the coastal sea and the EEZ remains not fully exploited. In fact, the total fish production in the country has been largely contributed by the artisanal small-scale fisheries in the lagoons, coastal waters, rivers and lakes. These fisheries together contributed over 95% of the domestic production, while the industrial sector contributes between 2% and 5% of the total production. The potential for fishery production in Nigeria will involve the exploitation of the EEZ especially the newly discovered stocks of tuna and other pelagic fishes; the reduction of post harvest losses which amount to about 45%; and more importantly, the development of aquaculture on large-scale country-wide.

It has been estimated that up to 0.5 million tonnes of fish can be produced by proper development of Aquaculture in Nigeria. It is, therefore, appropriate that Fisheries Society of Nigeria (FISON) has arranged a symposium on Aquaculture for this Conference. The careful planning and implementation of Aquaculture projects which takes cognisance of the roles of small holders in the rural areas, production of necessary infrastructure such as fish feed mills, fish seed multiplication on a large-scale are necessary pre-requisites for large-scale aquacultural development. Our National planners will have to take into consideration the existing problems in fish culture in Nigeria and make the best use of available technology in order to make aquaculture a major vehicle for providing the fish requirements of this Nation. Appropriate back up by research institutions is essential for success.

If we are to become self-sufficient in fish production, we will have to produce over one million tonnes of fish which is double our current production, before the end of the century. This is a task that requires the fullest attention and participation of our governments, the private and public sector as well as all our scientists. The harnessing of the fish resources of Nigeria is a task of utmost priority because it has been estimated that about 40% of the animal protein consumed by Nigerians comes from fish and fishery products.

It is appropriate that this conference is being held in Port-Harcourt a city with a tradition for fish and fisheries and which is the location of the African Regional Aquaculture Centre, which with the Nigerian Institute for Oceanography and Marine Research (NIOMR), is hosting the Conference.

I must add that the University of Port-Harcourt, a higher centre of learning in fisheries science has also participated actively in the organisation of the Conference. I want to thank the Director and Officers of NIOMR for their efforts and contribution to FISON.

I also thank the members of the Local Organising Committee for the arrangements they have made for the successful holding of the Conference and Symposium.

I hope that the members of the Society will take the opportunity to interact with each other and with the fisheries community during the Conference. We have to join hands to promote fisheries and fish production in the interest of our country. I wish all of us a successful conference

Thank you very much.

KEYNOTE ADDRESS BY MR. N. O. FADAYOMI MANAGING DIRECTOR, F.I.S.E.S.C.O. ON THE GROWTH OF NIGERIA'S FISHERIES ECONOMY SINCE INDEPENDENCE AND THE NEED FOR ARTICULATION OF A NEW STRATEGY TO MEET THE CHALLENGES OF THE FUTURE

GENERAL APPRAISAL

At independence, the Nigerian Fisheries Economy was at its infancy, with poorly organised public and private sectors. In the public sector, Fisheries was seen as an unimportant appendage of Agriculture. Officers of the Fisheries units were treated as inferiors to their counterparts in the main stream of Agriculture. The poor concept of the importance of Fisheries by Government led to the confusion as to where fisheries should be placed. At the Federal level, fisheries was placed under the Ministry of Commerce and Industry while some State Governments believed fisheries should be part of the Department of Forestry. This confusion left them wondering as to which discipline was best for the development of Fisheries. The emphasis was on fish farming, and this led to the establishment of a few government poorly managed fish ponds dotted here and there, which meagre fish products were distributed to high government officials at Easter and Christmas seasons. A campaign for the private sector involvement in small-scale aquaculture had already begun. Very few private farmers and a few institutions responded. Most of those that responded suffered some losses due to lack of support by government, by way of training, inability to supply fish seeds and inadequate expertise of extension workers. This poor performance was to negatively affect the future of Aquacultural development process in Nigeria.

At independence, fish capture was purely artisanal, exploiting the rivers, lakes, the estuaries and a few nautical miles off-shore. The industrial fishery sector was yet to develop, as very little was known of the fish resources of the marine environment. Fisheries research was done by rickety fishing vessels, while research activities took place just outside the bar off Lagos. The research programme was badly planned and implemented in a slip-shod manner. In fact, the old Federal Department of Fisheries made so little impact that the Ministry of Agriculture referred to it as a licensing agency, in derision, and as such, it attracted very little funding.

Fish supply was poor and only those people living close to shore and rivers had access to fish caught by artisanal fishermen. The fish supply situation improved through importation of frozen fish which took time to be accepted by the local population.

During the first 5 years of post-independence era, a new consciousness dawned on the Government, which brought about a change of attitude to Fisheries Development. Fisheries agencies were accorded the status of Departments and this resulted in the employment of mostly zoology graduates who were to steer the ship of development of Nigeria's fisheries economy Massive in-service training programmes were planned for these officers who, on return, were to accelerate the development of the economy. This Government initiative coincided with the revolution in the artisanal sector with the introduction of the nylon netting for set-gill-netting by John Holt Limited. This era witnessed increased fish production.

Simultaneously, in recognition of the fact that very little was known about the fisheries resources of Nigeria, the old Western Region invited the FAO to explore the territorial waters of Nigeria with a view to determining the types and the magnitude of the fisheries resources of commercial importance. This culminated to the birth of Industrial Inshore Demersal Fishery which started with the introduction of 2 industrial fishing vessels about 1965. The industry grew reasonably well with more private initiative, although landing/terminal facilities were non-existent. The private sector involvement grew in the early seventies with a few make-shift private jetties springing up as the investors expanded their fleet. Thus, local fish supply increased in pari-pasu with fish imports.

In spite of the heavy investment in training by Government, fisheries officers made very little impact on the fisheries development process in the nineteen sixties (1960s) through the early seventies. This was due to the fact that most of the officers were basically Biologists or Zoologists. Although, I admit, they were very knowledgeable in their own rights but unfortunately, they were yet to understand the full implications of fisheries. Officers did the little they could within the limits of their exposure. Because of these lapses, fisheries development programmes were badly articulated with the result that most plan periods ended without any appreciable growth in the fisheries economy

By about the middle of nineteen seventies a new consciousness emerged, resulting in the change of the staffing policy of Government whereby Economists, Planners, Agriculturists, Oceanographers, Geologists were recruited to join forces in the fisheries development process. Shortly before this new trend, a Fisheries School was established to train operative in the first instance and other fisheries workers both in the private and public sectors.

The aspiration of the Federal Government was further exemplified by acceding with Food and Agriculture Organisation of the United Nations, sometime during the 1979/80 financial year, to establish the Regional Aquaculture Centre, here in Alu, River State, where Fisheries Officers from Nigeria and those of other countries of the CECAF region can be trained in Aquaculture Planning and Practices. The efforts of the Federal Government in this direction, through the effective management of the Nigerian Institute for Oceanography and Marine Research, is praise-worthy and hereby acknowledged.

Since then, Nigeria gained better understanding of her aquatic resources through research, while more realistic and articulate programmes were planned. Given this new status, Government was emboldened to aim at self-sufficiency in fish production.

This new campaign led to the development of supporting terminal facilities such as Ebughu Borokiri and Igbokoda with a view to appreciably enhancing local fish production through fish capture. Simultaneously, Government embarked on an assistance package for artisanal fishermen, through the National Accelerated Fish Production Programme and the Inshore Fishing Project. Massive fish seed multiplication programme was embarked upon and a fish storage programme was launched to reduce post harvest losses. Although these programmes were well conceptualised, very little success was attained in the early nineteen eighties due to poor funding and inadequate well-trained staff to man these projects.

As regards Aquaculture, Nigeria has made little or no progress since independence, in spite of the fact that Government had invested a lot of money in the training of fisheries workers. In fact, before 1983 there were no official figures on fish production from fish ponds. A total fish production of 20,476 and 22,012 metric tonnes were recorded for 1983 and 1984 respectively in spite of the fact that about 1 million hectares of freshwater and about 800,000 hectares of brackishwater have been found suitable for aquaculture in Nigeria. It is my opinion that if these water resources were fully committed to fish farming, over 1.5 million metric tonnes could be realised from aquaculture annually. By so doing, not only will Nigeria be self-sufficient, she may even export some fish, assuming Nigeria's projected consumption estimate stands at 2 million metric tonnes as of 1985.

Nevertheless, looking back 25 years, we have come a long way, we have cause to rejoice at the new state of Nigeria's Fisheries Economy.