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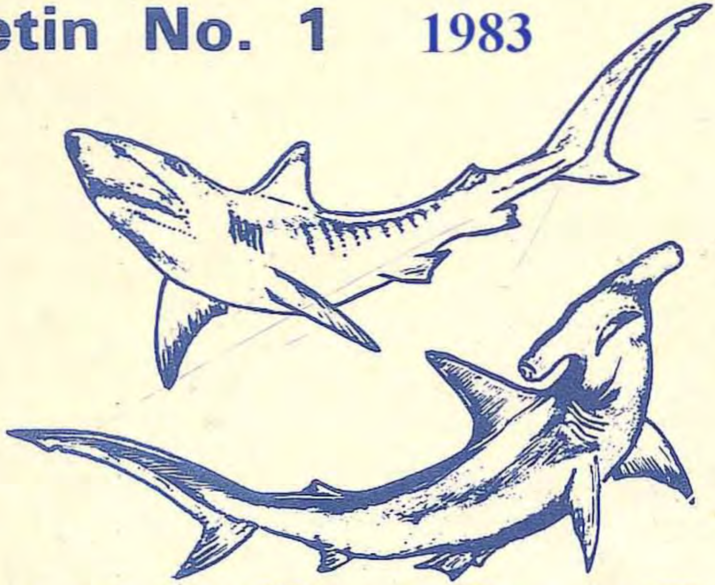

A BULLETIN OF
KENYA MARINE & FISHERIES
RESEARCH INSTITUTE

EDITORIAL NOTE

The need has been felt for a long time for a bulletin covering aquatic resources out-puts of the country quickly and comprehensively. The Board of Management of Kenya Marine and Fisheries Research Institute realised this need and directed the Institute to take immediate action for ensuring that information on aquatic resources is compiled for easy communication to the people.

The editorial group has decided to start reporting activities related to aquatic resources under the title "KENYA AQUATICA". As far as possible efforts will be made to include short scientific communications, critical reviews, seminar proceeding and other **ad hoc** publications. This comprehensive coverage will be possible only through cooperation of various Institutions, Departments, Societies and individuals who are concerned with aquatic resources.

Kenya Aquatica is a technical and extension series for rapid dissemination of information on aquatic resources and allied information from Research Officers, Fisheries Officers and any individual for transfer of Technology to the fishermen and industry and any other relevant information needed for National Development.

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MOMBASA

APPLICATION OF SCIENCE AND TECHNOLOGY IN THE DEVELOPMENT OF FISHERIES.

INTRODUCTION:

The importance of fish as a source of animal protein has been generally recognised and many countries throughout the world are engaged in intensive programmes to develop their fishing industries. In the developing countries fish forms the main protein food for the many million people and fish and fishery products have been used to counteract the problem of malnutrition.

In many countries fish is not merely regarded as a source of animal protein but as a valuable food generally. Some of the fishery products are internationally considered delicacies and do thus command very high prices in the market. The great increase in fish concuming population throughout the world has created excessive demand for fish such that the trend is for the fish to change from a cheap source of animal protein to an expansive good commodity beyong the reach of the low income groups.

The high demand for fish and fishery products necessitates institution of urgent development programmes to exploit the resources which are known to exist and which hitherto have been untouched or onlv slightly exploited. The purpose of fisheries development is to increase fish production by increasing the size of catches without depleting the number of fish in the water reservoirs. The increased production would result in better income for the fishermen most of whom live in rural areas, and this in turn would mean raising of the standards of living for these rural populations.

It is expected that proper development in the fishing industry should be able to attract foreign investment and thereby open overseas markets for specialized products. The foreign trade would certainly bring the advantage of foreign currency earning. The increased income from the industry is bound to create more employment opportunities and this way the industry would help in solving the unemployment problem facing many countries.

The main problems hindering fisheries development in many developing countries are the lack of scientific knowledge of the available resources and lack of modern technology required in the fishing industry. For rapid development of the fishing industry improvement is required in various aspects of the industry.

FISHERIES SURVEYS AND FISHING METHODS

Fisheries surveys are very important for determining the extent of the resources available and the level of exploitation which would ensure sustainable yields. Some fishery resources may superficially appear to be overexploited while the actual fish stock available may indicate a different picture. This is the case in Lake Victoria where although there are public anxiety about the depletion of fish stock, the survey conducted on the lake between 1967 to 1972 revealed that the standing stock of fish was about 750,000 metric tons.

The present fishery on the lake produces about 100,000 metric tons annually. However, it is estimated that about 250,000 metric tons could be landed from the lake annually without depleting the stocks. It should be pointed out, however, that of the total standing stock of fish about 600,000 tons are **Haplochromis,** the fish which do not feature prominently for direct human consumption.

In the survey conducted in Lake Turkana from 1971 to 1975 the preliminary estimates of the fish stock indicated that the maximum sustainable yield would be about 10,000 tons per year. However, in 1976 the fishermen on this lake landed over 17,000 tons of fish and there has not been any indication of adverse effect on the fish stock.

Various surveys have been conducted along the Kenya Coast starting as early as 1965. In the early surveys estimations were made of the Tuna resources within our reach. The estimations were made from the catches of the foreign fishermen including Japanese and Koreans. The conclusions reached confirmed that there were possibilities of developing Tuna fisheries from our coast, and deep sea fisheries project was initiated as a result of this.

Further surveys were conducted specifically for the Crustacea resources in the inshore areas. The survey conducted from 1969 to 1971 showed that the shellfish resources in the inshore waters were capable of supporting a fishery of upto 500 tons per year. The average annual landing of crustacea along the Kenya Coast has been about 200 tons. Under the Indian Ocean Fisheries Survey and Development Programme, a survey was organised from 1974 to 1976 to assess the resources in the eastern Africa areas of the Indian Ocean. This extensive survey revealed reasonable concentration of fish stocks in some parts. Although our coastal waters did not indicate rich fisheries resources, it was estimated that with modern mechanized fishing vessels it is possible to catch upto 7 tons of fish per day and that 3 to 4 tons of these could be the highly valuable crustacea.

The importance of fisheries survey have been demonstrated in the past. These surveys should be conducted continually in order to assess more accurately the fish stocks and also to determine the changes taking place in the fish population as efficiant fishing methods are introduced.

It is known that introduction of modern fishing methods could considerably increase fish production from the resources which are currently under utilized. using traditional and older fishing methods the fishermen in Lake Victoria are able to land an average of 50 kgm of fish per boat per day. However in the trials using mechanized boats equiped with trawl nets landing of upto 5 tons per hour for the large vessels and over 200 kgm per hour for the small vessels have been realized. At the coast small mechanized vessels equipped with trawl nets have been landing upto 500 kgm of prawns per day from the inshore waters while the traditional methods cannot produce more than 100 kgm.

Use of large mechanized fishing boats would enable fishermen to cary more fishing gear per boat and possibly to set the gears several times per day. Some of the modern fishing gears which have proved fairly efficient include, trawl nets, drift nets, purse seines and the long lines. The introduction of trawl fisheries and purse seining have enable fishermen to increase fish production considerably in many parts of the world. The practical demonstrations have shown that proper fishery surveys accompanied by introduction of modern fishing gears and application of advanced technology results in appropriate increases in fish production.

In Kenya where the fish production for 1976 was about 41,000 tons and with resources in Lake Victoria and Turkana and at the coast not fully exploited it is estimated that the total fish landing could be increased to over 80,000 tons by 1983.

FISH HANDLING AND PROCESSING

Many fishing villages are situated in remote rural areas far away from the centres of population concentration. Due to lack of handling facilities the fishermen in these villages are forced to land only sufficient fish which they can dispose of immediately. In some cases simple processing methods have been developed to take care of the excess fish usually landed periodically in the year.

In order to encourage increased fish production with introduction of modern fishing gears and methods proper handling facilities must be provided. In the various fishing areas these will involve provision of appropriate jetties and facilities for quick landing of the fish. It has been demonstrated that mere use of ice for chilling fresh fish, enables the fishermen to keep their fish in good condition for periods upto two weeks. For the handling of fresh fish and ensure increased fish production the preliminary facilities provided should include insulated cold rooms and where possible an ice plant from where fishermen would obtain ice for preserving fish right from the time the fish is removed from the water.

In large fishing centres more advanced processing facilities should be provided. These would include jetties equipped with conveyor belts for quick transfer of fish from fishing vessels into well established freezing plant. Provision of such facilities would estimulate the fishermen and thereby result in increased effort in fish production. A facilities of this type was established at the Kenya Coast in 1971 and this attracted many foreign fishermen who between 1971 to 1974 landed more than 25,000 tons of fish caught in the offshore deep waters. In Lake Turkana provision of simple handling facilities for fresh fish has encouraged greater production by the fishermen. These reactions have also been experienced at the coast in the remote fishing centres in Lamu District and in Vanga and Shimoni in Kwale District.

Where it is not possible to preserve all fresh fish landed, suitable processing methods should be developed. Many fishermen have resorted to sun-drying the fish as a simple method of preservation. The products produced though accepted by some communities are usually not of high standard and their self life is generally short. Due to lack of technological know-how, and the high demand for fish these products have featured prominently in the markets. It would be useful if better and modern processing methods such as smoking, using modern smoking kilns and canning were introduced to utilize the excess fish which cannot be absorbed in the fresh fish market.

The introduction of such fishing methods as trawling and purse seining usually results in catches of large quantities of fish which may be of low commercial value. This has been demonstrated in Lake Victoria where more than 80% of the trawl catches are **Haplochromis** and also at the coast in the Ungwana Bay where shrimp trawls catch large quantities of low value fish. For better development of the fishing industry it is necessary to find ways of processing these by-catch instead of discarding them at sea as is done in the shrimp fisheries. If the fishing vessels were properly equiped some of the so-called trash fish could be preserved for direct human consumption. One of the processing methods for these by-catch would be to produce fish-meal intended for animal feed.

Objections have been voiced against use of the fresh fish for reduction purpose especially in the developing countries where large populations still suffer from malnutrition. However it should be pointed out that even in the developing countries, the consumer preference would militate against use of large quantities of by-catch and such fish as **Haplochromis** for direct human consumption.

FISH MARKETING

One of the major problems affecting fisheries development especially in the developing countries is the poor means of communication between the fishing areas and the markets. Many fishing centres with rich fisheries resources are situated in remote rural areas without proper communication links with centres of population. Because of these problems the fish marketing systems in many developing countries traditionally consist of several middlemen handling progressively smaller quantities in the distribution chain from the fish landing to the point of consumption. These systemsiin some cases are fairly efficient or are often so deeply rooted that they have become difficult to change. Unfortunately with so many middlemen, the consumer price for fish is often much in excess of the landing price and this renders fish too expensive for the low and middle income groups who after all are the most undernourished.

For proper development of the fishing industry, fish marketing should be organised to eliminate the systems involving several unnecessary middlemen. It is felt that organization of fishermens co-operative or some other fishermen's trading groups to integrate fish supply and initial marketing functions would benefit the industry. However such organizations must be provided with qualified management and proper direction.

The marketing organization should ensure that the fish are preserved and processed properly and in accordance with the consumer preference. The organization should be equipped with suitable means of transportation by which the products can be moved from the fishing centres to the markets. For transportation of fresh fish and frozen fish products, refrigerated trucks have been employed successfully. However, proper roads well maintained are required for such transportation.

A dramatic result of the improvement of means of communciation has been experienced in Lake Turkana where the fish production increased from 5,000 tons in 1975 to more than 17,000 tons in 1976. Because of the slightly improved roads, traders were able to introduce modern fish transporters including refrigerated trucks. The fishermen have thus been enable to dispose part of their catch without any delays.

It is considered that a fish marketing organization properly established would stabilize fish prices, instil a sence of pride and security in the fishermen and also stimulate general spontaneous development. Such organization would be responsible for the selection of the various fish products conveniently processed for the appropriate markets.

CONSERVATION AND MANAGEMENT

The development of the fishing industry would be short lived if management measures are not instituted to ensure the conservation of the fish stocks. Fishermen in general are always keen to exploit the resources to produce maximum yields without considering the conservation of stocks. It is upon the responsible authorities to guide the fishermen by making rules and introducing adminstrative principles to ensure sustainable production.

The introduction of more efficient fishing gears has to be accompanied by strict law enforcement if the particularly valuable fish stocks have to be conserved. Even though appropriate measures may be introduced to regulate the fisheries, some types of fish will still be adversely affected by the use of more efficient gears. In these circumstances it is important to conduct scientific studies to determine whether the quantity of such fish could be increased by artificial culture and restocking of the reservoirs.

Programmes of artificial fish culture have been successfully undertaken for the Salmoid fishes (Salmon and Trout) and some warm water fishes such as Tilapia and Carp in many parts of the world. The Japanese have maintained the Salmon fisheries in their sea areas by artificial introduction of over five million young fish raised in culture farms every year. Many other countries are also supplementing their fish stocks by such practises.

In Kenya the Lake Naivasha fishery is based on successful stocking of Tilapia species and the black bass (**Micropterus salmoides**) in the lake.

Similar introductions were made in Lake Victoria where non-indigenous species of Tilapia including **Tilapia nilotica**, and the Nile perch (**Lates niloticus**) were stocked between 1955 to 1962. These introduced fish in Lake Victoria have done so well that now they feature prominently in the fish landings. These artificial fish cultures should be carefully studied and where practicable should be applied to improve the quantity of fish available. A part from the stocking of the natural reservoirs great potential exist for fish farming in Kenya especially in the Central, Nyanza, Western, Eastern and Coast Provinces. Some activities are already going on in fish farming in the country, however it is considered that with improvement of technology and exploitation of all the potential available fish farming alone could yield upto, 20,000 tons of fish per year.

In order to implement the developments outline above successfully, well trained personnel in the various field will be essential. The fisheries surveys require qualified and trained scientists while the improvement of fishing methods needs qualified and experienced gear technologists. Such personnel must be available for the various sectors of the fishing industry to ensure that the development initiated is maintained. It is very important to organise effective training programmes to enable the local personnel acquire the expertise in the necessary advance technology.

Summary and conclusions

The realization of the importance of fish as a valuable food has generated great demands for fish throughout the world. These demands being far in excess of the supply have resulted in fish becoming highly priced food commodity. The status of fish has therefore tended to change from the cheap source of animal protein to an expensive food commodity beyond the reach of the low income groups.

In many countries especially in the developing world, not all the available fishery resources are fully exploited. In these countries great potentials still exist for the development of the fishing industry to bring about increased production. The major problems in these areas are lack of scientific knowledge of the available resources and lack of modern technology required in the fishing industry.

For the accelerated development of the fishing industries in the developing countries it will be necessary to organise continuous scientific surveys to ascertain the extent of the resources; introduce modern mechanized fishing gears and methods; improve fish handling and processing and the marketing channels and communication to the markets. It is also important to institute conservation and management measures which may involve artificial culture of some stocks of fish and enforcement of regulations to ensure sustainable yields. It may therefore be concluded that application of science and modern technology would be useful in stimulating rapid development in fishing industries espesially in countries where extensive reasources are currently underexploited.

N. Odero

AN OVERVIEW ON RESPONSE OF RIVER FISHERIES TO FLOODING
(Tana River System)

Flooding is a major phenomenon in flood plain and river fisheries, which, except for those of large rivers, depend on the migration of reproductive fishes during the floods. Streams and rivers that drain the eastern slopes of Mt. Kenya, Abardares and Nyambeni ranges join to form the Tana River which is permanent though with regime flactuation between rainy and dry periods. During the rainy seasons, in March-May and October-November, the river swells beyond the banks causing heavy floods, especially in the lower Tana, covering the expansive flood plains. These flood plains support a seasonal fishery when numerous fish invade the plains for breeding and feeding. Being very shallow, flood plains are commonly fished by traditional gears such as baskets, spears and building of fences and mud barriers. Presently long lining and gill netting are also applied. From one year data (1981) collected from the lower Tana, four fish genera were found commonly landed viz Tilapia, Clarias, Labeo and Protopterus spp. Analysis on catch data for relative abundance indicated initial preponderance of the lungfish, Protopterus spp. in February, followed by Labeos in March - May and lastly Clarias dominate in June - July. Tilapia, on the other hand remained relatively low in the 1st half of the year, but dominated in the October - November period.

Superimposed on to the rainfall averages for the basin area, this displacement in catches reveal a strong relationship with the rainfall pattern. The entire basin receives two peaks of rains February - June with a peak in April and September-December with a peak in November. That protopterus dominate as the rains start and their catch fall too low in April, when the water level rises and again appear plenty in August when the floods have receeded and the remainant pools are drying. Biologically, Protopterus aestivate in the muddy plains as the dry season sets on. When next rains come, the aestivated fish reactivate. The high catches at onset of rains could be due to reactivated fish. As the rains continue, they get into the river and the general floods to grow and reproduce (spawn). When rains end, floods start receeding and most of these fish are left in muddy pools from where they are easily fished, hence their dominance in about August.

Labeos and Clarias are Potamodromous. Labeos in particular swim upstream to turbulent waters for spawning. Gonad analysis of the specimens revealed prevalence of mature fish, atleast stage IV, in June.

Studies on the Sabaki (lower Athi) have shown that clarias move both upstream and out of the main river into the lateral flood waters during floods for spawning and feeding (whitehead 1960).

Tilapia showed improved catches in May but fall immediately giving way to the Clarias. This being the time when floods were setting in, Tilapia could not withstand the very turbid waters. It's likely they moved out into shallower, sheltered waters where fishing is minimum. Clarias can survive in poorly oxygenated muddy waters associated with the open floods.

Sexually mature Tilapias (stage IV - VI) were commonly landed in March, July and sometime between September and November (data for September and October lacking). This also associates closely with the changing water condition.

In conclusion it may be fitting at this stage of the work going on to associate the nature of the river fishery, its changing fish composition with seasonal flooding regimes of the Eastern flowing river system. More work will be needed to establish the relationship and hence thraw some light on the necessary development and management strategies that can be practised.

E. O. Wakwabi

SOME OBSERVATION ON PETROLEUM POLLUTION ALONG THE KENYA COAST

1.1 MARINE POLLUTION

Recent years have experienced increasing awareness to marine pollution with due emphasis on chemicals introduced through man's industrial activities. The sea has been used as a damping ground for example, coastal town sewage, industrial effluents etc. from the point of view that bacterial and physical degradation will neutralise or dilute the toxic effects of any chemicals introduced. However, this has caused, with time, local high concentrations of these chemicals resulting in adverse effects on the general ecology and marine organisms. Several works have been done in the laboratory and on locations on the lethal and sublethal levels of some of the common toxic chemicals like petroleum hydrocarbons, mercury, lead, chlorinated hydrocarbons etc. on some marine organism and the projected effect on the welfare of human beings. Recent works emphasize more on the interesting long time sublethal levels of the chemicals on the marine organisms and environment, since the cases of lethaly high local concentrations are rare occurences.

1.2 SOURCES OF MARINE PETROLEUM POLLUTION

The single spontaneously serious, and most cases localised, source of petroleum pollution is oil spills from tankers, with other lesser sources like discharges of bilges from ships, discharges of oily water tanker washings, and to a still lesser degree effluents from refineries. The hazards of localised petroleum pollution were depicted by major oil spills like the Torrey Canyon and Amoco Cadiz disasters. and other smaller scale spills which necessited the need for standard control measures to be taken for prevention and combating petroleum pollution applicable internationally to oil tankers and petroleum products carriers, among other commercial vessels. Among resolutions passed by the Inter-governmental Maritime Consultative organization which is the governing body involved in the Tanker safety and Petroleum Pollution control, recommendations were given whereby tankers are required to adopt specific procedures in loading and washing tanks so that chances of accidents which might result in spills are minimized (Anon, 1978).

1.3 EFFECTS OF PETROLEUM ON MARINE RESOURCES

Several reports have been produced in investigations and observations made on the effects of crude oil and petroleum products on marine resources both in the laboratory and at actually affected areas.

The grounding and beaking - up of the Amoco Cadiz (O'Sullivan, 1978) in March, 1978, off the Breton coast near portsal in France, resulted in a spill of almost 220,000 tons of light Iranian and Arabian crude oil causing massive oil pollution. The preliminary biological effects observed were some mortlality of crabs, lugworms, fish and sea-birds. The predicted socio-economic effects were on tourism and other industries based on marine resources since beaches were extensively polluted.

An earlier oil spill in March, 1971 of petroleum products in Long Cove, Seaport Marine, U.S.A. (Dow, 1978), resulted in local concentrations of oil 250 ppm in intertidal sediments 15 cm - 25 cm deep, which continued to kill successive year class juvenile chams, as in normal growth behaviour they burrowed down through redistributed overlying clean sediments into the oil concentration below.

Other minor spill cases have also produced similar results (Bowman, 1978; Iliffe, et al, 1979, Moldan, et al, 1979) where effects have been observed on the general ecology, mortalities of sea-birds, sea-weeds, smothering of shore crabs, mud prawns etc. Effects of some kinds of fuel oils have also been investigated in the laboratory like embryonic mortalities caused by embryotoxicity of No. 2 fuel oil on common Eider eggs (Albers, et al, 1978).

1.4 SCOPE OF MONITORING PROJECT

With the busy trade route off the Kenya Coast, and the Port of Mombasa where oil tankers call continuously, it is inevitable that petroleum pollution posses a threat to the Kenya Coast and Marine resources. Hence, the need for continuous monitoring of the extent of petroleum pollution along the Kenya Coast.

The project involves making observations on the incidence of tar on some Kenya beaches at some randomly chosen stations. The aim is to investigate levels of tar concentration, and possibly identifying regions of different concentrations, and whether there is improvement or complete worsening of the situation with time.

Also included is a note on sea water sampling carried on tentatively for investigation into the levels of concentration of petroleum hydrocarbons dissolved and/or dispersed in sea water, at a few stations along the Kenya waters. The sea water samples which were partly extracted with carbon tetrachloride were stored in a refrigerator for analysis later, by a flourimetric method.

2. MATERIALS AND METHODS

2.1 FIELD SAMPLING

By the end of May, 1981, monitoring of tar on beaches had been continuing for about two years and two months at fourteen sampling stations located from the coast south of Mombasa to Malindi in the north coast. While the tentative sea-water sampling for dispersed and dissolved petroleum hydrocabons was initiated in October, 1980. Sea-water samples have been collected from twenty stations at random located at positions from the south coast near the Pemba Island to the North Kenya bank the North Coast. Figure 1 shows sampling locations both for tar on beaches and sea water sample.

The sampling procedure used is as recommended in the Guide to operational procedures for the IGOSS pilot project on marine pollution (Petroleum) monitoring, Manuals and guides 7, and suppliment to manuals and guides 7 by IOC/WMO/UNEP of UNESCO.

2.2 Tar Sampling on Beaches

The method of sampling tar on beaches is straight forward requiring no special skills. The equipment used consisted of a top loading field balance with a scale graduate to 0.2 of a gramme, a 30 meter measuring tape, sample bottles and optional steel sieve.

At a station three strips of 2 metre width of most of the sampling beaches (some beaches are more than 50 m wide at low tide), the length of the strips was decided such that it included a representative portion of the back-shore and the low-tide section. All the tar lumps found on each strip were then collected and weighed. Big tar lumps found were conveniently weighed in the field, otherwise small or lighter tar lumps were put in well labelled sample bottles and taken to the laboratory to be weighed, since the field balance was not reliable when it came to taking the weights of small samples. The approximate weight of tar per area of beach was then calculated for each strip and recorded in log sheets where the date, time of sampling, wind direction and other relevant comments were included. Sampling was done invariably or around low tide at once amonth per station.

3. Results

3.1 Tar on Beaches

Quite high concentrations of tar on beaches were recorded, particularly the sampling stations located near Mombasa. Tar concentration of about 29.5 g

m^{-2} was recorded for shelly beach south of Mombasa, where individual tar lumps weighing over 3 kg were obtained. So far the beaches located around Kilifi were found to be the least affected by tar, during a greater part of the year. A sample of the observations is given in the tables 1 and 2.

Table 1.
Average concentrations of tar on some beaches along the Kenya Coast.

Sampling was done at round low tide. (all figures are in g/m^2)

Year : 1979

Sampling	March	April	May	June	July	Oct.	Nov.
English Point	26.4	10.4	4.4	7.9	5.0	6.3	3.7
Nyali	13.6	16.7	5.2	2.7	3.2	3.2	2.9
Mombasa Hotel	7.3	13.5	—	10.5	0	2.1	3.2
Malaika	37.5	8.4	—	—	8.4	7.4	4.9
Whispering Palms	5.0	—	—	16.6	2.1	2.1	6.3
Kikambala Cottages	5.2	—	—	10.4	4.2	6.3	3.2
Harris Ranch Kilifi	—	—	3.2	4.2	6.3	4.9	2.1
Bofa Kilifi	—	—	2.1	0	3.2	6.3	0

Table 2

Average concentrations of tar on some beaches along the Kenya Coast. Sampling was done at around low tide.

(all figures are in g/m^2

Year 1980

Sampling Station	JAN	FEB	APRIL	MAY	JUNE	AUG.	OCT.	NOV.
English Point	0.7	9.7	4.9	5.7	8.2	2.6	5.1	2.3
Nyali	1.2	—	—	1.7	3.9	0.5	1.4	—
Mombasa Beach Hotel	0.7	4.2	—	—	1.9	0	—	0
Malaika	7.0	2.0	—	—	1.6	1.6	0	0
Whispering Palm	—	—	2.4	—	3.2	—	—	—
Kikambala Cottages	—	—	—	2.1	5.6	—	—	—
Harris Ranch	1.3	—	0.7	1.4	0	1.8	2.6	2.6
Bofa Kilifi	0	—	—	1.4	0.5	—	6.5	0

In both the tables where observations of zero concentration are recorded implies that the amount of tar obtained was insignificant or the beach was clean from tar. The dashes in the table signify that no sampling was done at that station during that particular month.

4. Discussion and comments

So far from the data collected it has been found that the average concentration of tar on beaches varies with time and location, It had been anticipated that the variation of the tar concentrations time would be found to be seasonal depending on the S.E. Monsoons (April - October), the N.E. Monsoons (November - March), the E.A. coastal current and the seasonal Somali current.

The continental shelf of the Kenya Coast and generally the E.A. coast is very narrow from the comparatively wider North Kenya banks. Therefore it has been assumed that the E.A. coastal current, the monsoons and the Somali current have a direct effect on the coast (Newell, 1957). However, it may be pointed out that there is little or no detailed information on the actual surface and subsurface water circulation due to tidal, longshore and reap currents which are supposed to make connection with the near shore coastal current (Johnson, 1980) on the basis of the above assumption, however, no obvious trend of the variation of concentration of tar with time and taking into consideration the seasonal currents can be obtained. Hopefully, with improved continuity in the collecting of data more conclusive results will be obtained. Otherwise, it can be stated that one possible reason why no trend related directly to the seasonal currents can be obtained is that most of the sampling stations are found near a busy trade route and the busy port of Mombasa where the effect of the currents is not so obvious. Also the coral reef located about two to three kilometres from the shore may have an effect on the total amount of tar deposited onshore.

It has been observed that beaches located near Mombasa exhibit a higher concentration of tar than beaches found farther off. A good example, is the Shelly Beach which had one of the highest recorded concentration of tar of about 29.5 g/m^{-2} or approximately 472.5 g/m. Here individual tar lumps weighing over 3 kg were obtained. The tar lumps were mostly soft, with sand embedded in. This realization can be attributed to the busy Mombasa Port as a possible sources of the petroleum tar.

D. MUNGA

DISTRIBUTION OF NUTRIENTS IN KENYA COAST DURING THE 1979 SOUTH EAST MONSOON

Introduction.

This note presents a brief analysis on the micro-nutrients, silicate, phospate and nitrate based on some of the data collected in offshore region 2-3°S of Kenya Coast during a part of the Indian Ocean Experiment (INDEX) in 1979.

Water samples were collected at various depths (0-350 m), between 200 and 100 m contour for four section, Mombasa and Ras Ngomeni (Southern section); Kinyika and Kiwayu (Northern section) and analysed for nutrients.

Distribution of silicate, phosphate and nitrate

The concentration and distribution varied considerably in the entire water column. The Northern section exhibited higher concentrations than the Southern ones, with occasional high and low concentration region in the surface layer (0-80 m) and the deep layer (120-300 m) below the thermocline layer (80-120 m).

The surface layer exhibited low concentration silicate 2.0 - 40/ugA/L (micro-gram atoms per litre), phosphate 0.2-0.4 /ugA/L, nitrate 0.1-0.5/ugA/L, with oceanward region of much less concentration close to the water surface (0-20 m).

The concentration in the thermocline ranged between 4.0 - 8.0/ugA/L for silicate, 0.2-05/ugA/L for phosphate and 1.0-8.0/ugA/L for nitrate. The thermocline appeared raised by about 30 m at Kiwayu section.

Relatively high concentration with values greater than 10.0/ugA/L for nitrate and silicate, and 0.8/ugA/L for phosphate occured between 80-150 m at landward station in Ras Ngomeni section.

In the deep water increased concetrations, of silicate 12.0/ugA/L, phosphate 1.0/ugA/L, nitrate 12.0/µgA/L were noticed. To the south of Ras Ngomeni, the deep layer showed regions of low concentration silicate less than 8.0/ugA/L, phosphate 0.5/ugA/L and nitrate 10/ugA/L below a depth of nitrate 10.0/ugA/L below depth of 240, m. No similar region were observed at Kiwayu section.

Factors affecting distribution.

The availability, concentration and distribution of the micro-nutrients largely depend on the biological and physical processes as well as on the characteristics topography of a given section.

Biotic factors have a vital influence on the distribution of nutrients, however, in Kenya a coast planktonic biomasses are characterised by periodic influence of the winds and monsoon driven currents, which have little been studied. However, the ultimost importance of the Sabaki and Tana effluent occuring close to northern section, the seasonal bottom resurspension of nutrient by strong currents passing over North Kenya bank complex and the front region (2-3°S) between Somali and East Africa coastal currents are recognised as features attributable to the observed northerly increased of nutrients. The regions of low concentration on the deep layer to the south probably arise from water masses associated with the South Equatorial Current while on the surface layer the features can be thought as offshore driff of small regions of water masses from the inshore.

More detailed work is needed to find out the topographic influence of the bank, and the extent of the two rivers. Tana and Sabaki on the micronutrient distribution, with a view to improving the understanding of the distribution of biological resources which largely depends on the availability of nutrients for phytoplankton organisms.

MUTUA M. N.

AN OVERVIEW OF FISHERIES MANAGEMENT, RESEARCH AND DEVELOPMENT

ABSTRACT

Fisheries management essentially involves the making of decisions on how resources can be harvested, and in this context fisheries research can be regarded as a tool for management which will enable those charged with making decisions and formulating policies to ensure control or adjustment of the fishing operation, purposely brought into play in order to optimize the use of the fishery resources. In a way therefore the development, research and management are three aspects which serve the same process, the utilization and exploitation of the resources. Opportunity for management strategies are varied, and this paper attempts to discuss the biological approach to fishery development and management.

Certain distinct components will be considered thus:

(1) Fishery Resources

The fishery resources are important because the abundance of the stocks contribute to the fisherman's perception of the supply. When the stocks are abudant and are at a higher density on the fishing ground, the fisherman can usually catch more fish per unit input.

For fishery management, therefore, it is important if factors that govern the stock characteristics are understood. The theory of population dynamics which describes the way a given stock or resources behave is very extensive. In general, however, when a given stock is subject to any degree of fishing intensity, the stock density is reduced. In addition to fishing induced changes in the stock there are other equally important causes which may contribute to the flactuations in the stock. Some of these factors are naturally induced and others are possibly related to pollutants or other habitant modifications.

Management problems associated with stock and resources involves controlling the size - specific, fishing mortality and the fishing effort so that the fishing effort will be optimal, will not exceed the maximum equilibrum yield, and will have a positive influence on yield per unit recruit factor. Besides, the management of any stock needs to be considered in relation to

that stock and other, perhaps, not utilized stock and which may be living in the same fishing ground. This consideration receives an increased importance in a divided fish stock, i.e., the fished stock and unfished component when it is realized that as price of fish change and as the technology of fishing also change more and more species come into commercial production.

(2). Fishery Management

Fishery management involves the making of decisions geared towards the development and exploitation of fishing industry and fish stock. The primary function of the management therefore is to establish regulations that increase benefits. It may be recognized that these types of regulations which generate benefit also generate costs. However, if the regulations are good, the generated benefits will be in excess of the costs.

Management objectives, means and standard therefore raise a number of questions:-

(a) How can maximum sustainable yield be determined, and what is its relation to fishing effort;

(b) What is the capacity and extent of the fishing vessels to harvest the optimum yield?;

(c) Should foreign vessels be allowed in a given local water?;

(d) If fees are to be levied, what are the appropriate fees?

Organised research activities will provide answers to most of these questions, It is known that the magnitude of the yield is related to the magnitude of the fishing effort. Thus the establishment of an optimum yield also implies an establishment of an optimum level of fishing mortality, which in turn implies optimal fishing effort.

There are problems connected with parameters discussed above. For example:-

1. The maximum Sustainable Yield calculations require an instantaneous response of the population to changes in recruit, growth, natural and fishing mortality, Fishing ground, being wild habitats which cannot precicely be monitored or controlled, do not allow most fish populations to respond instantenously to change in parameter value. Above all the marine fish characterists calculations are based on single species, and yet it is a fact that in a normal fishing ground and fishing activity a singly species acocystem is an abstraction.

2. **Development of resources**

Fishery management, basically manipulates variables with a view to reducing fishing costs and increasing the catch. Thus decisions by fishery managements can influence the shape and the supply and demand trend. There are various tools which management uses in this exercise.

(a) Research and development regarding new sources of raw materials;

(b) Creating and opening new markets;

(c) Increasing fishing efficience by adoption of more efficient technology as it becomes available;

(e) Reducing randomness and risks;

(f) Development joint ventures.

It is not intended to discuss all these variables in details. Management must take into consideration constraints which may go hand in hand with any new development.

Institutions Essential for Proper Management of the Fishing Industry

(a) The most important body involved in management of fishing in any given country is a relevant arm of the Government whose responsibilities include, among other, the formulation of policies, objectives and time schedule for different activities relevant to the industry. Occassionally lack of trained manpower means that this body (usually a ministry) does not undertake duties elucidated above, and more often therefore relies on information from down below.

(b) **A Department of Fisheries**

A department of a division of fishery is primarily concerned with the development, extension and implementation of policies, and rules, and generally the promotion of fishery development.

(c) **Planning Units of Agencies**

Planning units issue responsibilities for nations planning and coordination of all development activities. For some unknown reasons or factors in many developing countries, fishery planning is not done at all and fishery industries are therefore left to stagnate, or develop in a very haphazard manner.

(d) Research Institutions

These are primarily concerned with the development of production oriented research aimed at providing informations which can enable managers, developers planners and policv formulating and executing agencies to make proper decisions.

4. Kinds of regulations essential for proper Management of fishing industry.

These vary from country to country. In the main, however, they should include:

(a) Protection and conservation provisions, generally aiming at supporting protection and conservation of fish defined.

(b) Territorial waters and maritime zone legislations essentially made to provide the legal basis for a government to declare the limits of internal waters, teritorial waters, and the management and development of the resources therein.

Over enthusiasm can backfire and more often it is not true that the benefit accruing to a given country wil increase or mutiply many folds bv merely doubling legislations.

(c) Merchant shipping provisions to give and allowance to fishing vessels requirements as well as lay down requirements for manpower training. As with other existing regulations and legislations in a number of developing countries, provision to cater for the fishing industry is just not there.

(d) **Pollution Legislation**

Primarily to allow for measures to be taken which ensures that pollution is prevented and controlled in order to preserve the quality and ecological balance of the aquatic environment. The interest and

Concern shown towards this type of legislation is not in proportion to action being taken. In a number of developing countries, there is no definite legislation on pollution control.

This discussions are meant to form a baseline for management and development planning. The importance of coordination among various agencies is stressed if meaningful and planned exploitation of the aquatic resources is to be realized. In a way therefore, the purpose of the paper is to initiate and forment discussion among people and organizations that are charged with development and exploitation of the aquatic resources with a view to maximising the utilization of the same for the benefit.

S. O. Allela

BIOLOGICAL MEANS OF INCREASING FISH PRODUCTION IN PONDS AND SMALLER MANAGEABLE LAKES IN KENYA

Summary

In Kenya there are about 30,000 ponds ranging from 1.0 - 2.0 acres, with a total average of about 10,000 acres. The productivity of these ponds is low, 0.3 tonnes/hect/year as compared to 5-10 tonnes/hect/year in developed countries. Causes of these uneconomical low production are numerous, among them are:-

(a) lack of indigenous professional and extension experts who can work side by side with potential fish farmers.

(b) Lack of appreciation and awareness of the economic advantages of fish farming among local people.

(c) Lack of indigenous techinques on production and management procedures suitable to local conditions.

(d) Poor provisions for infra-structure required in potential aquaculture areas such as facilities for storage, transport and marketing.

In the tropical countries suitable fish for pond-farming have been identified. The problem has been the combination of the species so as to increase production as it has already been observed that polyculture yields more than monoculture.

A project has been launched to look into the possible species combination. **Tilapia, spirulus** and T. **andersonii** are taken as controls while six different species are used. The growing period is to be 9 months after which they will be harvested to look at the best combination. All spp used have been proved suitable for tropical aquaculture.

The experiment is still going on, but the productivity of the ponds have been very high. The phytoplanktons include **Spirogyra** sp., **Closterium** spp **Anabaena** sp. **Ceclastrum** sp. **Cosmarium** sp., **Chlorella** spp. and several baciilioriophyceae e.g., **Synedra** sp., **Navicula** sp., **Nitohia** sp. Zooplankton in these ponds include **Daphnia** sp., **Diaphanesoma** Moina sp. Cyclops sp., **Chidorus** sp., whereas the rotifers were represented by **Bracliianous** sp. and **Keratella** sp. Insect larvae or nymphs are present in fairly large numbers.

The initial species combination was based on the feeding habits of the fish and the availability of the species locally. At the end of the growing season the best combination will identified and the second part of the project will be to establish the stocking density.

J. Ochieng.

ASPECTS OF THE BIOLOGY OF THE REEF FISH SCOLOPSIS BIMACULATUS (RUPPELL) IN KENYA.

The demersal fisheries in Kenya are at present concentrated in the shallower region of the continental shelf, the shore and the outer edge of the ffinging reef. The coastal zone is heavily exploited by the artisanal fishermen using traps handlines, gillnets and seines. Although the subsistance fishery for the reef fishes in the coastal lagoons is well established there is little information on the biology of the exploited species.

Scolopsis bimaculatus occurs widely in East Africa reef and sheltered lagoons upto a depth of 60 metres: and forms a steady resource for the artisanal fishermen throughout the year. Apart from this rather scattered information, its general biology is virtually unknown. This paper represents results of analysis of data collected on **S. bimaculatus** at Vanga and Shimoni, in an attempt to describe certain aspects of its biology with view of management of the fishery at this area where Shimoni Marine Park acts as a reservoir for the reef unhabiting species.

S. bimaculatus was found to attain sexual maturity after reaching 16.5 cm total length at an age of 15 months and exhibits two peaks of spawning in March to May and September to November. Fecundity estimates were found to range 14,600 to 691,000 with mean fecundity of 35,200. The overall sex ration was found to be 1:1.7 males to females which deviated from 1:1 ratio ($p<0.05$ chi-square test). However, there was predominance of males upto 16.0 cm of females from 16.0 - 23.0 cm, and above 23.0 cm to sex ratio approached 1:1.

This species feed on bottom dwelling organisms mainly penaeid crustaceans forming 34.4%, mollusc, 10.0% echinoderms 7.8% and fishes 5.9%, and a high feeding intensity was observed after spawning. The length weight relationship was

$$\text{Log}_{10} W = -1.537 + 2.765 \log_{10} L$$ with correlation coefficient

$r = 0.986$. Age and growth were estimated by length frequency distribution; and the growth curves fitted to the von Bertalanffy equation gave asymptotic length.

L_{∞} = 39.0 cm and growth coefficient K = 0.09. Coefficient of natural

mortality of the population was found to be 0.3 and of fishing mortality 0.2 using traps of 4.3 cm mesh size.

R. M. Nzioka

PALINURID LABSTER BIOLOGY AND FISHERY IN KENYA WATERS

Appreciation of the presence and possible importance of crustancean resource (lobster, crab and prawn) came in 1946. In 1954 some experimental fishing using traps and various nets was tried out. Since then some trapping has been tried without much success. Trammel nets tried by Japanese fisheries workers and demonstrated to fishermen have never been adopted by fishermen due to high costs of purchase and maintenance of the nets due to damage at the coral reefs where most lobsters are caught. Due to its high price, there has been an increased fishing activity (about 18%) from, 1970 - 1980, with a result of decrease in size of the individuals caught.

To assess the state of fishery, data has been collected at Lamu - Pate archipelago. The commonest species caught were **Panulirus ornatus, P. hongipes, P. homarus** and **P. dasypus,** with **P. penicillatus** occassionally caught. Other palinurids found were **deep** sea species **Limuparus somuniosus, Puerulus angulatus** and **Palinustus mossambicus.** These are however, only caught by trawlers. The most adundant of the lobsters is **P. ornatus** which comprises over 60% and at times 90% of the catches. As one moves from Vanga in the South towards Kiunga in the north, the proportions of **P. homarus** and **dasypus** becomes greater and greater, until **P. homarus** becomes the chief species in Aden area.

Fishing Methods - Diving and catching live individuals. A few are accidentally caught in nets and traps set for fish. 80% of the fishing is during November to Mid-February (N.E. monsoon) when the sea is calm and diving conditions and visibility are at their best. S. E. monsoons churn up the sea causing much turbility which temporarily closes the fishing.

Reproduction - Breeding occur all year round with peaks in November - April. Female mature at 62 mm carapace length for **P. longipes** and 85 - 90 mm for **P. ornatus** and **P. versiocolor.** Life span has been estimated as 5 years. Larval life is long and complex with 10 recognized larval stages. Should overfishing occur in these organisms with such lengthy life cycle, recognition of the fact takes long and remedy steps may take as long to have effect on the fishery. **A 90 mm lower limit carapace length has been suggested. Molting and growth** - larval life is estimated as 11 months with several molts. Growth is greater in the earlier parts of the life. Towards sexual maturity females growth rate decreases considerably. Thus among mature individuals same size females will be older than males.

W. B. Mutagyera

HISTORY AND DEVELOPMENT OF FISH CULTURE

Introduction

This is taken from a paper 1 read at a training seminar for Fisheries Assistants at Matuga Community Centre and basically the speech was about history and development of fish culture. This has become an important issue in most developing countries, more so in countries of the African and South East Asian regions, and it might be of interest to examine the reason for this. The situation is slightly different in most developed countries.

With the continued expanding population, many of the developing countries have been stretched to the limit on their effort to meet the increasing demand of protein food. Second it is now evidenced that in these countries the normal source of supplies of protein food e.g. beef and other natural food production are always geared towards export market leaving very little for domestic need. In addition with rapid studies made in the development of fisheries the world over, it would appear that except in certain few countries, the fishery resources from natural sources, are being exploited to the limit. Further evidence available do not indicate increased food production from this source inspite of the E. E. Z. ! The introduction of E.E.Z. will perhaps help in equatable distribution of the fish resources and no more.

In a nutshell therefore development of fish culture is looked upon as a further instrument which will increase protein food supply. Under these circumstances, with increasing population in most countries coupled with dwindling food supply in a global scale, fish farming in natural and artificial ponds will assume a growing importance in national and world food supply planning: In most European countries and America, the requirements of animal protein are primarily covered by consumption of beef, pork etc. and the development of fish farming though not ignored has perhaps been geared towards production of specialised fish food - not for general consumption but rather to meet the demand of special tastes and dishes.

History of Fish Culture:

Fish culture was probably initiated in mainland **China** and **India** several thousand years ago and in Japan shortly thereafter. In this sense, it may be regarded as indigenous to these countries. The development in virtually all other countries came much later.

Fish culture practises proper started in India as early as 1126 BC, mainly in the eastern states of Bengal, Bihar and Orissa. Here great portentialities for this work were known to exist, fish being the main diet of the rice-eating population of this region. In the plains and deltar regions ponds were stocked with local species: **Labeo rohita Catla catla** and Labeo calbasu. Attempt at exotic species came much later. In 1841 gourami (Osphronemus gorami) was first tried and by 1865, this species had established itself as a major culture fish.

Expansion of fish culture into the whole of India did not come about until after the second world war, when soon after attaining independence, the government of India established Central Inland Fisheries Research Station at Culcutta to conduct the scientific investigation for proper appraisal of the inland fishery resources. The work of this centre has led to improved culture methods, including artificial breeding techniques.

In Indonesia, probably the first development was the establishment of the tambake' system for brackish water fish culture between 1200 and 1400 BC under influence of the Hindu Empire. In other South East Asia countries, the movement of Chinese traders and the establishment of trading posts was perhaps responsible for introduction of fish culture practises, particularly carp culture.

In the European region, fish culture in warm water ponds goes back to the middle ages, and, in France, Spain, particularily, was tied to religious practices of the time. Early practices confined themselves to carp culture for only recently has attempts at other species, particularly, Tilapia culture been made.

Fish farming is a recent practice in Israel. It was not until 1937 when actual fish culture (carp) was first introduced, following the arrivals of settlers who had learned the fundamentals of fish culture in Cental Europe. These settlers brought a number of common carps from Yogoslavia. The first ponds were located in the valley of Beth-shaan, which has many brackish water sources, and marshy land not easily put to any other agricultural use. The practice has since then greately improved, and with the application of scientific knowledge, Israel has been able to boast the highest limit production rate.

As in most new world countries, fish culture did not start in the North American Region until 1850. It was the immigrants to the new world who transplanted fish from water to water as they move inland, and by the beginning of this centurey numerous European species had been introduced to these new waters, sometimes with adverse effect on the indigenous species. In this sense thereof if could be said that fish culture is not indigenous to the North American region. There is no evidence that the fish culture was practised in the pre-Columbus era.

In our discussion so far no mention has been made of Tilapia culture. With the exception of Africa, Tilapia culture as we now practise it has been unknown, and except with Israel, and malaysia in the South Asian regions, Tilapia culture is very limited. In Israel, Tilapia culture now rivals carp farming, and with improved methodology and techniques, Tilapia culture will continue to form a greater proportion of fish culture production.

Soon after the first world war, fish culture was advocated as additional source of food supply. It was as a result of this world wide campaign that fish culture as now practised in Africa, was first introduced into a number of African countries.

Production of fish ponds started with the introduction of cold-water species, and by the beginning of the second world war in 1939 trouts had been introduced in Kenya, South Africa, Morocco and Lesotho.

The use of Tilapia for fish culture had been advocated in the earlier years of fish pond development in Africa. The end of the second world war saw another concerted campaign to popularise fish culture in Africa, sometimes without regard to methodology and scientific practices, and by 1960 Tilapia culture was widespread almost in all countries of Africa. Most of those early ventures were failures. They did not produce fish of sufficient size for domestic consumption, and this led to lack of enthusiasm on the part of rural farmers, and soon fish culture practices fell into disrepute. In between the years attempts were made to look for other suitable fish for fish culture in Africa, as it was now obvious that with exception of Trout culture fish pond culture was a profound failure. Carp was introduced in Nigeria in 1954, and carp farming took off in 1959. By 1969, carp had been introduced to a number of countries in Africa. Carp was first introduced in Kenya in 1968, when the first batch was sent from Kajanzi station in uganda. The second lot came from Japan in 1969.

Some strategies of fish culture development

I have so far discussed the constraints on food supply, and which perhaps.

more than anything else, led to wide spread and development of fish culture either between the wars or after the end of the World War 11.

Many other factors which do naturally contribute towards the development of fish culture, particularly in developing countries are:-

(a) The existence of vast areas of lands abandoned as unfit for any other agricultural land use. These include swamps, dams built for other agricultural use other than fish farming. This situation attains in most of the Inland countries of Africa, particularly Uganda, Zaire, Zambia and Kenya.

(a) The presence of relatively large areas brackish water, also found unfit for any other use agricultural land use. This situation is prevalent in most of the South East Asiatic Countries, particularly Indonesia, Phillipines, and South India, where shrimp culture is now major source of prawn.

(c) The general desire among locals to go for live (fresh) fish have meant that in rural areas even in areas where processed fish could be made available, there exist ready market preference for fresh cultured fish.

The development of fish culture during its rather long history has taken various aspects. However the common practices, have been governed in their choices by early access to cheap water, restricted land use and availability of suitable fish species.

Restricted land use has meant a search for methods which would increase fish pond production without adversely affecting or interfering with other agricultural and industrial usage. These considerations often, lead to various types of fish culture. In Japan for example, land constraint as a limiting factor, has led to the development of intensive fish culture methods including the running water system and paddy-cum-fish, fish culture. Both of these recent developments have found their ways into other developing countries as well.

In Israel, where land is quite a limiting factor in almost all human activities, concerted Scientific investigation during the past forty years has made it possible to develop Tilapia cultural (hybridzation and monosex culture) which now rival carp culture. Apart from constraint about by land limitation other factors which should be considered in the development of fish culture species are:-

(1) Adaptability of fish species to artificial fish food.

(2) Hardness on the part of fish species to diseases.

(3) Ability of such fish species to spawn and make fry available at regular periods.

(4) Above all pond fish selected should be able to reach acceptable marketable size within a reasonable period of time.

Conclusion:

I have found it difficult within the framework of this short paper to cover in details all aspects of fish culture: history and development. What has transpired is perhaps a summary of a very wide topic. I have merely confined myself to elements of fish culture history and development, methods and propagation practice, and if what is covered above could in a small way contribute to a further understanding of the need for fish culture, the paper shall have served its purpose.

Allela Samuel O.

MARINE PETROLEUM POLLUTION MONITORING ALONG THE KENYA COAST

Introduction:

The awareness to petroleum as a potential environmental pollutant was prompted by major oil spills, like the Torrey Canyon and Amoco Cadit disasters. Thus apart from oil spills from tankers, other sources of petroleum pollution are bilges from ships, effluents from refineries, ground sippage, oil drilling platforms, etc. The Kenya Coast being next to the busy Indian Ocean trade route plus the port of Mombasa, a frequent calling port for oil tankers supplying the refineries, is vulnerable to oil pollution. It is, hence, imperative that continuous monitoring of the extent of oil pollution is carried on.

Objectives:

At present, two components of oil pollution are being studied preliminarily to give base data; namely petroleum tar lumps deposited on the beaches, and dissolved and/or dispersed petroleum hydrocarbons in sea water. The aim is to study the variation of the two parameters in relation to physical factors e.g. the ocean currents and winds, and location. The former component was initiated in 1979 while the latter was initiated in 1980. The petroleum pollution monitoring project was initiated under the IGOSS pilot project on marine pollution (petroleum) monitoring, now the Marine Pollution (petroleum) monitoring (MARPOLMON) project.

Experimental

(1) Tar on beaches

The region covered for this component of the project includes the beaches located between Msambweni and Malindi sampling stations or beaches were chosen at random and the approximate concentration of tar (in gm^{-2} or gm^{-1}) measured, and recorded. Stations were visited at least once a month usually at or around low tide.

Preliminary results have shown that most of all beaches visited are affected by tar pollution in varying degrees with location and season. This is a matter of concern to tourist hotels located at the beaches since the beaches get soiled. Generally beaches located in vicinity of the Mombasa port are more polluted e.g. Shelly Beach tar concentrations of upto 29.7 gm^{-2} or about 180 gm^{-1} were found.

However the data still has to be analysed for possible correlation with other

physical factors. Also an attempt at identification of source of the tar using crude oil samples will be made.

(2) Dissolved and/or dispersed Petroleum Hydrocarbons in sea water. Sampling stations for sea water were located at random along the kenya Coast from Pemba Island (near Vanga) to the north Kenya banks. About 18 water samples were collected during three cruises on the "Rv. ujuzi" from mostly inshore stations. About 5 litres samples were collected at 1 metre depth at every stations. Extraction for dissolved (dispersed) hydrocarbons was done using carbon tetra-chloride and the final analysis was completed using a spectrofluorimeter with n-hexane as the solvent.

Preliminary results from a few samples which have been anaysed show quite low concentration of dissolved/dispersed hydrocarbons. Most of the concentrations measured are below ppb 80 far.

Similarly, attempts at identification of the hydrocarbons will be made in future, preferably by Gas liquid Chromatography technique.

Munga Daniel

A REVIEW OF THE NUTRITIVE VALUES OF FRESHWATER FISHES

Living organisms are composed of a complex inter-relationship between proteins, fats, carbohydrates and vitamins and minerals and water. These have to be maintained at levels that will vacilitate proper body functions including energy production, growth, and repair, and regulation or balance of proper internal environment. To achieve this it necessitates a regular dietary supply of each of the named component both in proper quality and quantity. No one dietary source can supply all of these, but available evidence has shown that fishes are an excellent source of a number of these components.

Broadly speaking, nutrition encompases food in general and those factors influencing its quality, quantity and availability to the body. Such factors include production, distribution and the affected communities. These factors are also influenced by the social, cultural, environmental and economic factors. In a developing country like Kenya where the population is said to be growing at alarming rates, cases of malnutrion may be uncommon, and could be fought by feeding the population with fish meal.

A general comparative picture of nutritive food value is indicated below.

Table 1. Average food values per 100 g.

	Energy Kj	Protein (mg)	Calcium (mg)	Iron (mg)	Vitamin A-	Thiamine (mg)	Ribot Lavin	Nicotinic acid (mg)
Meat								
Beef (lean)	670	20	10	3	0	0.1	0.2	5.0
Chicken	590	20	15	2	0	0.2	0.2	6.0
Liver	500	20	10	12	60	0-3	2.5	16.0
Mutton or								
(Sheep or goat)	640	20	10	3	0	0.2	0.3	5.0
Pork (lean)	1550	15	16	2	0	0.8	0.2	3.0
Fish								
Freshwater								
Fish	400	20	50	1		trace	0.1	1.5

Salt dried Fish	860	40	180	2	trace	0.1	0.2	5.0
Sea Fish	340	20	20	1	—	0.1	0.1	4.0

Rabecca Nyakundi

AQUATIC RESOURCES: AREAS OF COOPERATION

The exploration and exploitation of the sea and its resources by man have a long history of conflict and to some extent harmony and understanding. The future can bring only a deeping of this dichotomy. On the other hand scientific progress and technological advances can allow mankind to make efficent use of the sea and other waters, and its resources. It is definite though that this will only itensify confrontation among nations of the world over the exploration, search for knowledge, and subsequent exploitation of all the aquatic resources. It is to avoid such confrontation and achieve harmonized explotation based on scientific information that effective international cooperation genueinely becomes very important.

To fully utilize the aquatic environment it has become increasingly necessary to understand the sea and its ecosystem. It is now evident that the aquatic environments, particularly the sea is more than just a common medium for fishing, transport, trade and shipping etc. and naval warfare which incidently it has witnessed for many years. The fundamental role which the ocean plays in the earth's weather, is just now beginning to be understood. In addition, the aquatic environment, both inland and the sea, is being endangered by various forms of pollution by man or otherwise.

An apparent awareness is being therefore raised everywhere for the need to do something: to understand an aquatic environment and protect it. There is awareness too that this environment, particularly the sea represent a vast reservior of food, mineral resources and energy, which again needs rational balanced exploitation. The search for knowledge, aquatic research, is therefore one area of cooperation in which African countries would greately benefit. The search for knowledge is increasingly becoming very expensive, and with the introduction of the exclusive economic zones, many of the developing coastal countries will not be in position to mount any meaningful research.

On fisheries resources in particular, there are fundamental factors which influence their fuller exploitation. It is perhaps true that the most important element, that influence marine fisheries are those related to the biological characteristics. Fish first of all are mobile and migrate over a certain range within a space of time and without any respect to man - made boundaries, guided only by the natural condition of the aquatic environment, e.g. currents, temperature, salinities etc. For the fish therefore the world is a three dimensional one. This three dimensional concept therefore to a very large extent eliminates our own concept of ownership particularly with regards to migratory resources, especially tuna and other open water stocks.

The extension of jurisdiction and establishment of the exclusive economic zones have therefore a fundamental effect on the exploitation and management of fish resources. Many problems will definitely come as a result of the extended jurisdiction and some of these may be easier to solve, while others eg. management and exploitation of shared stocks may, because of technological factors (advancement of lack of means of exploitation) and political elements (exclusive and sovereign rights) will be difficult to solve. It is evident therefore that fisheries as an industry operate in a highly variable environment. Many stocks are fished by more than one country and their management obviously requires close coordination between countries concerned. if irrational exploitation is to be avoided. Although a full international cooperation among neighbouring countries remain elusive, there is a need nonetherless to initiate some forms of cooperation among African countries in particular and the world at large; a cooperation which will set in motion certain guidelines for rational exploitation of fish resources. Such guidelines will definately involve the development of appropriate regulatory controls which in effective will harmonize management policies and strategies among African countries, specifically to avoid unplanned under utilization and over exploitation of the fish resources.

In addition to the need for cooperation in the field of research as discussed above, rational future exploitation, and therefore proper management, is dependent upon a data base from which trends in fisheries could be obtained. In a variable situation such as with the marine fisheries, collection of such data will in most cases be done individually by each country. Again for meaningful cooperation in planning and management, African countries will have to cooperate in the compilation of data collected individually or collectively. In addition there will be need at some stage to cooperate too in the analysis of such data.

One result of the extended jurisdiction and exclusion economic zone in the management and exploitation of fish resource, has been the interest shown by the developed countries to go into joint ventures with developing countries. Technological factors and availability of capital for initial input in the developed countries has meant that joint venture phenomenon, as a means of exploiting the extended zone has, in a way, been always forced on the developing countries. There is need though for the African countries to look into the possibilities of going into joint ventures among themselves. Cooperation needed here is of utmost importance if African nations are to maximise the utilization of fish resources in their waters.

These discussions have mainly concentrated on the marine fisheries resources and very little has been said on the inland fisheries. This is deliberate. However the situation is not much different especially with case of common waters such as lakes Victoria, Tanganyika and Chad. In the cases of Lake Victoria, there is definitely an urgent need for a collective management arrangement to harmonize regulations needed for urge for a creation of a body or a working committee to look into the problems of Lake Victoria fisheries.

Definitely there are many areas which need cooperation among African nations. The exploitation, utilization and management of aquatic resources will if properly planned on cooperative basis go along way to alleviate poverty in Africa.

Allela Samuel

A REVIEW OF THE BIOLOGY OF TILAPIA SPECIES IN LAKE VICTORIA WITH SPECIAL REFERENCE TO ITS FEEDING AND BREEEDING HABITS

BACK GROUND

Lake Victoria whose size is about 68,000 km^2 is the second largest freshwater lake in the world. It has a potential fish resources which has almost no match in many parts of the world. Of the 170 fish species. **Tilapia** species are regarded as the most important of the freshwater fishes in Kenya. In East Africa, there are at least 20 species of fish belonging to the genus, **Tilapia.** Because of its popularity, the exploitation of **Tilapia** sp. has been most severe.

Over the period between 1968 to 1977, the production of **Tilapia** sp. in the lake has undergone a gradual decline. For instance, in 1969 a high catch of 4,645 tonnes was recorded while a meagre catch of 642 tonnes was recorded in 1975. In recent times this apparent decline in **Tilapia** fishery was almostly been associated fishery has mostly been associated with the predatory behaviour of **Lates niliticus** (Mbuta). However there is no convincing evidence to support this explanation. The considerable rise in lake Victoria water levels in the period 1961 - 1964 is also thought to have contributed to the decline in **Tilapia** fishery. Welcomme (1969) explained that this rise in water levels submerged and destroyed the nusery grounds of most **Tilapia** species.

In particular, **T. esculenta** which inhabits lagoons and prefers sheltered swampy margins fror nursery grounds is thought to have been hardest hit by this rise in lake levels.

The need for research to ensure an efficient management strategy cannot be over-emphasized. Knowledge of the Biology and Ecology of **Tilapia** sp. is therefore of utmost importance. In this report the feeding and breeding habits of two Tilapia species are highlighted. These are **Tilapia nilotica** and **T. esculenta.**

General Introduction:

The Genera **Tilapia** belongs to the family cichlidae. In Africa cichlidae are the predominant freshwater percomorph fishes and have long attracted the attention of many Biologists, both from the scientific and economic viewpoints. In Lake Victoria there are six species. Two of them are endemic, namely T. **Esculenta** and T. **variabilis** and the other four are non-endemic i.e. T. **zillii**, T. **melanopleura**, T. **nilotica** and T. **leucosticta** (Greenwood 1966).

The genus **Tilapia** mainly consists of specialized harbivorers, and many of its species are known to adapt to lacustrine conditions. Such features account for their suitability to pond culture. Hence **Tilapia** sp. have been used quite extensively for this purpose throughout East and Central Africa, including other parts of the world.

According to Kirk, **Tilapia** species are able to survive in extremely adverse environmental conditions. Very often they have been found in habitats which most other fish genera cannot tolerate.

Myers (1938) and steinlitz (1954) have suggested that **Tilapia** sp. evolved from a marine ancestor which penetrated freshwater. Such an ancestor would certainly explain the marked euryhalinity of certain Tilapia species (Chervinski, 1961 a).

Typical example is T. **nilotica** L. which is able to survive direct transfer from freshwater to 60 - 70% sea water (20.2 - 25.0% salinity). Further Lotan (1960) reports that this species can withstand a medium of upto 150% sea water (53.5% salinity) through gradual adaptation.

The rate of growth of T. **nilotica** at high salinity levels has been investigated by Chervinski (1961 a). The results obtained indicate that the growth rate in 50% sea water is not signicantly different from that of the same species in freshwater. A further observation made is that T. **nilotica** are able to breed in their first year in 50% sea water. However, he was quick to add that the number of young produced may be somewhat smaller than their freshwater counterparts. Based on work done by El saby (1951), T. **nilotica**, T. **gallilala** and T. **zillii** are all known to breed in the great bitter lakes of Egypt at salinities ranging from 13.5 to 29.0%.

According to the way the young are reared, **Tilapia** can be classified into two main groups, namely 'guarders' and 'Brooders'. In the former group, the eggs are deposited on specially cleared areas of the substrate, to which they adhere. These are then guarded by the parents until they hatch. For the Brooders, the eggs are picked up by one of the parents almost immediately after being laid, and are brooded in the mouth until the larval are fully developed. In nearly all known cases this is the female.

Due to the difficult in obtaining individuals with their broods intact (Lowe, 1956), rather insufficient observations have been made in determining the nature of brood, size and eggs production. Recent changes in fish stocks and water levels of lake Victoria (Welcome, 1964), however, have made available large number of T. **leucosticta** has been found to be approximately equal to the square of the total length (Welcome, 1966). This relationship has been found by Lowe (1955) to hold for T. **esculenta** and other mouth breeding **Tilapia** species. More especially since T. **esculenta** has a similar egg production as for T. **nilotica** (Linne) and T. **variabilis** Boulenger (Lowe, 1955).

Further, under favourable and uniform conditions, may spawn at frequent intervals throughout their reproductive life. However, in cases of marked seasonal climate changes, they may have a brief and well defined annual breeding season reports Lowe (Mc Connel) 1955. The number of spawnings a year can be determined by two varibales namely:-

(a) the duration of the breeding seasons. This appears to depend on climatic conditions.

(b) the frequency of spawning during the season which may be characteristic of the species.

Despite the fact that in equatorial waters **Tilapia** sp. tend to spawn throughout the year, there are seasons when increased breeding activity has been observed (Lowe 1955).

Incidentally these periods seem to coincide with the two rainly seasons in East Africa. Aronson, underscores the fact that this may also **follow the rainy seasons** depend on changes in light intensity and temperature. Where individual fish may have spawned several times, Lowe, (1955) suggests that a reduced number of eggs is produced towards the end of such periods. For example,

T. **leucosticta** shows a higher mean ovarian egg production at the beginning of the rainy season (October) than towards the end. This indicates that some increase in breeding activity occurs during the rainy season.

The occurence of certain losses of the eggs has been observed by picking up the eggs as they are laid. One therefore anticipates a gêneral oss of some fraction of the laid eggs before being picked on by the female. Welcôme (1966) has suggested that this is either due to the crowded condition of the lagoons, where fish may be interupted in the spawning act by other fish, or alternatively eggs being lost when the muddy bottom is stirred up.

There is also the possibility that in many lagoons, the developing embroys in the parents mouth may be subject to predation by a certain group of highly specialized predators. These are the **Haplochromis** described by Greenwood (1959) as eaters of fry and eggs of cichlids. However, it is yet to be established to what extent Tilapia sp. fall victim to this form of attack.

Many **Tilapia** species breed several times in succession within one breeding season. Lowe (1955) has observed that at least five B. A Tilapia species have three or four batches of young ones in succession.

Data on the frequency of spawning by individual fish in natural water are quite difficult to obtain. Nevertheless indirect evidence on the number of successive spawning can be obtained by examination of the ovaries. Evidence spawning can be seen in the ovaries as dark yellowish or brown flecks. While the number of size groups of small ova starting to develop indicates hatches of eggs that should ripen in future spawnings. By such examinations it is possible to tell whether a **Tilapia** is just staring, or is in the middle of, or is just completing a spawning period. Observation of the ovaries, suggest that many of the **Tilapia**, e.g. **T. esculenta**, **T. variabilis**, **T. nilotica**, etc. have 3, 4 or more batches of young in succession. But the duration which a particular batch of eggs may take to ripen is not known with any appreciable degree of accuracy (Lowe) (Mc Connel, 1955). On the contrary studies of the ovaries of some **Tilapia** living in open water in Lake Nyasa show that only one batch of eggs is normally produce per season.

One of the major problems in Tilapia culture is over population. This arises from the high rate of survival of the young ones. Consequently this leads into a marked fall in the growth rate, due to inadequate food supplies. Restricted growth rates are not only confined to pond populations. Stunted **Tilapia** from shallow lakes and lagoons have been reported (Lowe 'Mc Connel) 1958 and Coe, 1966). Several of the **Tilapia** sp. most suitable for culture have been found to breed at a very small size in a restricted environment. For instance, **T. nilotica**, which normally breeds at well over 20cm total length in large lakes, breed at 17 cm in experimental ponds (Lowe Mc Connel) 1958).

The realization of the fact that different **Tilapia** sp. possess different feeding and breeding habits, and that they differ in their ability to establish themselves in small bodies of water, has led to more interest being taken in the specific determination of these various species. In the genus, Tilapia, evolution appears to have been towards a reduction in the number of eggs produced and towards the development of a brooding habit.

Generally, in **Tilapia** sp. the number of eggs laid at a time increase with the size of the female (Lowe, 1955 c). In maternal brooders the larger females which lay more eggs also have larger mouths in which to brood. However, among paternal brooders there is no such relationship between the size of eggs produced.

In addition to the role of weed control, Tilapia sp. may be reared for recreational purposes, either as sport fish in their own right, or a folder for large conivorous fish. While Tilapia species might be expected to serve at a subsidiary level as consumers of unwanted vegetation, their main value, other than for angling purpose would be for consumption.

Feeding habits

General: The genus **Tilapia** comprises mainly of specialised harbivores. **Tilapia** species can be divided into two main types. The first type feeds on algae, being particularly adopted for filter feeding on plankton. This also broods the eggs and young in an oral pouch. **Tilapia** of the second type mainly feeds on macrophytes. The eggs and larvae develope into a nest on the substratum which the parents guard. Comparisons between fore and hind gut contents have shown that of the range of plant material eaten, only the diatomes are usually digested (Fish, 1955). Depending on the actual locality of feeding, four major types of stomach contents have been isolated in Tilapia sp. of Lake Victoria. These are:-

(i) Planktonic
(ii) Bottom
(iii) Epilithic or epithytic
(iv) Higher plants.

1. Tilapia esculenta

The food of this species comprises almost entirely of phytoplankton. Only the diatoms are digested (Lowe 1955 b;) Wothington, 1929; Graham 1929; Fish, 1955). Insect larvae and planktonic crustaceans occur less frequently, although they may contribute to the diet of young fishes.

In essence, T. **esculenta** is a plankton feeder. In dams, it does not seem to grow well, rarely exceeding 20cm. In Lake Victoria T. **esculenta** occurs in the sheltered gulfs, where the bottom consists of algaceas mud (Lowe, 1955). Although the food of T. **esculenta** mainly consists of phytoplankton, zooplankton and insect larvae have occasionally been recorded. According to Greenwoods (1953), Diatoms are the most important food elements of the phytoplankton, particularly the filamentous melosira.

In the evidence for his 'low of the distribution of the Ngege' Graham concluded that the simple gill-rakers of **T. esculenta** were not adapted for straining phytoplankton. Consequently, the species obtained its food from the living layer of diatoms in the bottom deposits. According to recent work on the feeding habits of this fish, it seems that a considerable proportion of the diatoms taken must be considered as trully planktonic and that the fish strains them from the water.

According to payne (1971), blue-green algae predominates in the stomach of **T. esculenta.** Moreover, diatoms in particular, Navicula and Rhopalodia are also common. Rotifers were encountered, whereas filamentours green algae occured occasionally, while Flagillates were common. In his work, he made monthly records of mean length and weight for experimental populations of **T. zillii** and **T. esculenta.**

The general observations was that the former grew faster and attained a greater final length and weight than the latter. This is largely attributable to the depression of the growth of **T. esculentas** which occured between the second and fifth months.

Payne related the reduce growth rate to two variables, namely:-

(i) The planktivorous habit of the species;
(ii) The low phytoplankton density prevailing in the ponds between the second and fifth months.

However, after the addition of ammonium sulphate ($NH_4(_2 SO_4)$) with consequent Phytoplankton bloom, both the growth and the number of ripe fish found in the sub-sample increased. Throughout the cause of his experiment, the stomachs of **T. esculenta** contained little of the supplementary food. It was only during the fourth and fifth months, during which the phytoplankton density was low, that large quantities of pawpaw leaves and rice waste were found in the stomachs. According to Payne, it seems therefore that **T. esculenta** would not use the supplementary food, unless its natural food is scarce.

The suitability of fish culture of a planktivorous species depends upon its ability to use the supplementary food given or upon the application of fertilizers to encourage the natural food. Supplementary food in African situations is rarely refined, both in rural and government schemes. This is due to lack of funds in both cases. Yet it is these very foods, e.g. cassava leaves, pawpaw leaves and rice waste, which the planktivorous species must be able to use. Whereas, **T. macrocheir** (Dumeril) which is basically planktivorous and algae feeding can use the above foods. **T. esculenta** cannot use these foods effectively (Payne. Accôrding to Hepher (1962) fertilizers are generally said to increase the carrying capacity and yield.

T. nilotica

The food of this species is principally phytoplankton (either in suspension or from the bottom deposits if which the diatoms provide the main nourishment (Worthington, 1929 a; fish, 1955; Poll and Damas, op. cit). Insects and crustaceans are also eaten and digested. In Lake Rudolf, **T. nilotica** is said to feed on Blue-green algae, but in other lakes, these algae are not digested by .this or other fishes. For the **T. nilotica** living in Lake Kivu, certain Bacteria are reported as forming a substantial part of its diet.

Other authors (Lowe, 1958) are also of the opinion that **T. nilotica** mainly feeds on algae. He concludes that, this species has more generalized feeding habits than **T. esculenta** Graham, which feeds almost entirely on phytoplankton. In one of this findings, Daget (1964) reports that **T. nilotica** feeds on phytoplankton, bottom animals and also swallows mud particles. Further, Yashouv and Chervinski (1961) have made the suggestion that in lakes, **T. nilotica** feeds on phytoplankton and empithytic diatoms, and when confined in ponds and lagoons on bottom organic debris.

In an experiment set up to determine the range of naturally occuring food organisms eaten by **T. nilotica,** rotifers, copepods, insect larvae, blue-green algae, diatoms and nannoplankton were found in fish all sizes. Cladocerans, were found only in the guts of fish upto 50 mm total length. While Euglena, filamentous algae and higher plants were found in the gut contents of all but the smallest fish of upto 20 mm (Yashouv and Charvinski, 1961).

In an evaluation of the various food items in the diet of **T. nilotica,** the fish were fed on phytoplankton, water bugs (Corixa), chironomids and cotton seeds, cakes either singly in various combinations. Though it was not possible to make valid comparisons of the nutritional value of various food items, the results show that the natural food spectrum of **T. nilotica** is very wide. Infact, even Juveniles weighing only 2.5 g weight were found to feed on plankton water bugs, other insects and cotton-seed cake, Kirk reports.

The fact that **T. nilotica** feeds both on planktonic and bottom material (Fish, 1955) is evidenced by the fact that both remains are present in its stomach contents. The origin of the planktonic material could either be from the plankton or from the flocculent deposits found in the bottom of some shallow bays (Welcome). The percentage of fish found with each type of food was

(a) Bottom material only.. 5.7%
(b) Bottom material and apparent planktonic material.................37.1 %
(c) Apparent planktonic material only................................. 57.2%

The principal stomach contents of some 35 **T. nilotica** (18.8 + 2.0 cm .) are given in table 1.

TABLE 1

The principle items in the gut contents of Tilapia nilotica

Item	percentage Occurrence
Filamentous green algae	17.2
Chlorophycea general	74.4
Pediastrum	71.5
Scenedesmus	60.0
Ankistrodesmus	34.2
Staurastrum	60.0
Botryococcus	37.2
Diatoms	100.0
Amphora	22.4
Cymbella	20.0
Fragillaria	2.8
Gomphonema	8.5
Melosira	91.5
Navicula	22.4
Pinnularia	17.2
Rhopalodia	5.7
Nitzchia	20.0
Surirella	57.2

Cyanophycea	
Lyngbya	80.0
Oscillotoria	17.2
Anaboena	22.4
Microcystis	40.0
Merismopedia	40.0
Dinoflagellates	11.4
Flagellates	22.8
Rhizopods	8.5
Rotifera	2.8
Crustacea	17.2
Insect remains	14.3
Bottom plants	40.0
Portions bitten off plants	2.8

On the other hand, food analysis results (Ogari, 1975) indicatė that phytoplankton in suspension or bottom living diatoms as the most important. While insect larvae and planktonic crustacea are of lesser importance. The blue greens, spirulina plantensis, S. laxisima, Anaboena spiroides, chroococus minutes were the dominating algae. In addition some microcystis species were observed. The diatoms included navicula lineolata, Ananeoneasis species with cymbella species forming the reminder of the phtoplankton in gut.

The insects found included Corixisa, chironomid larvae and planktonic crustacea, copepods and ostracods. In a few cases, watermites (hydrocarina) were identified Zooplankers were in general scare. So were mesocyclopes, Tropodiatomus Banforanus and Diaphranosoma exciseem.

Moreover, for fish less than 10 cm .total length, the stomach contents indicated the presence of small crustacea. While those above 10 cm TL contained a variety of food organisms in their stomachs.

The nature of food taken seems to depend on its availability factor. For instance the **T. nilotica** caught in ALLTA Bay, contained percentage of diatoms, whereas those caught in FERGUSON'S GULF (L. Rudolf) showed a higher percentage of both the blue green algae and crustacea.

Suffice to say, the fullness of the stomacn of Tilapia species has been found to depend on both the gonad state and the time of the day of the year. Most **Tilapia** sp. had either empty or almost empty stomachs around 0700 hours. However, in the cause of the day, the stomach fullness increased, infact by 16.00 hours some **Tilapia** had full stomachs. Thus, Tilapia species seemingly appear to start feeding early in the morning and ending up late in the evening, Further, spawning females with eggs in their mouth and breeding males had empty stomachs (Ogari)

BREEDING HABITS:

General:

Depending on the way the young ones are reared, Tilapia sp. can be classified into two main groups, namely 'guarders' and Broodeers. In the former, the males and females pair up before spawning. They then stay together until their young becomes independent. The number of young produced will therefore depend on the number of fishwhichpair up. For the latter, the females carries the young in the mouth. The ripe females makes a very brief visit to the spawning grounds. As soon as the eggs are fertilized, she collects them and then moves off to the brooding grounds. The males, remain in the spawning grounds, each one guarding a nest in his own particular territory. Thus segregation of males and females occurs after spawning.

Since the male fish can continue to fertilize over a long period, the number of eggs fertilized appears to be determined more by the number of ripe females than the number of males (Lowe Mc Connel, 1955). All species of Tilapia reared in ponds appear to start breeding at a very small size and to overpopulate the ponds very quickly.

According to Lowe, the male breeding colours of the maternal brooders serve for advertisement of the spawning grounds. This effect is further enhanced by the habit of many males congregating together in certain places to spawn. This advertisement effect is particularly marked among the species endemic to Lake Nyasa, where the breeding season is very much restricted.

The males congregate on well defined spawning grounds and are characterized by very definite breeding colours. This is black in several species. Furthermore, it shows little variation in intensity throughout the short breeding season. Infact the colour is even retained in the dead fish.

Nevertheless, in Lakes Victoria where some ripe **Tilapia** are normally found virtually at all times of the year, the breeding grounds are not so well defined. Moreover, the male breeding colours are not so intense. Infact in aquaria, Lowe reports that the colours are of the lake Victoria **Tilapia** show great variations in intensity with the activity of the fish. In any case, the colour halffades on the death of fish.

The fact that there are no so such sharp distributions between feeding and breeding areas in Lake Victoria is suggested as possibly due to the fact that the water inhabited by the **Tilapia** in this relatively shallow lake is more uniform than in Lake Nyasa.

In maternal brooders male breeding colours may also play an important role in species recognition and stimulating the female to lay.

For these species, the pre-spawning courtship is normally very short. The ripe females wonder from nest to nest to then suddently spawn in one nest, sometimes without any preliminary courtship. Further for maternal brooders nest formation occurs in addition to breeding colours. Moreover, associated behaviour may also be important for species recognition and release of egg laying; as the nests often have a characteristics form in different species, although this form may somewhat vary with the substratum.

Hence, for both subtratum - spawners and maternal brooders, the breeding dress assumed by both sexes in the former and the male only in the latter serves in advertising the spawning territory. The congregation of many males on the spawning grounds, among maternal brooders enhances this effect (Lowe).

Lowe further notes that the presence or absence of defined breeding seasons among **Tilapia** species depend on hydrological conditions. These are primarily dependant on the geographical latitude. For instance, Lake Nyasa which lies between 90 and 15°S, has a well defined annual hydrological, cycle quite in a cordance with annual wind and rainfall cycles (Beauchamp, 1940). On the other hand for equatorial lake Victoria, the hydrological cycle is less definite and differs in the main lake and the gulf (Fish, 1957).

Tilapia Nilotica

T. nilotica is a mouth brooder. Thus, the females carries the young. It is a very plastic species and on the whole grows well in dams and does not seem to breed so freely or runt as badly as some other species.

Breeding T. nilotica has been found over all types of bottom, but principally over sand in shallow waters between 10 and 30 feet deep. The onset of maturation in both males and females is at about 13 cm as indicated by the smallest sizes of fish with inactive gonads. The smallest ripe fish recorded by Welcome was a male 15.5 cm SL and a female 15.8 cm SL. Otherwise most fishes were still immature at 20.0 cm.

According to (Lowe, 1958), fish populations in poor condition start to breed at a smaller size than those in good condition. Thus by virtue of their high condition factor, the maturation size of fish from lake Victoria is smaller than would be expected.

The percentage of fish that are ripe varies little from month to month and breeding fish are present throughout the year. However, in Lake George, **T. nilotica** shows an increase in breeding activity during the rainy months (Fry and Kimsey, 1959). In non-equatorial waters, the species has a seasonal breeding cycle, usually associated with rains (Lowe, 1958). Nevertheless, no evidence is available to suggest that such seasonal fluctuations occur in the lake Victoria stocks.

As stated earlier on, occurance of defined breeding season among **Tilapia**, depends on hydrological conditions, e.g. the Geographical latitude. Lowe has observed that the effect of latitude and hydrological conditions on Tilapia breeding seasons is clearly shown in those species found over a wide latitudinal range. Thus **Tilapia nilotica** in northern Nigeria (about 10° to 13° N) have a restricted breeding season, breeding only in the rains, whereas in equatorial waters breeding fish are found at all times of the year (Lowe, 1958).

Both **T. nilotica** and **T. esculenta** are reported to have a black and red male breeding dress, unlike that of any other known **Tilapia**. The breeding dress is almost identical in the two species. This supports the view that these geographical replacement species are closely related as well as ecological counterparts in their respective waters.

Bayley (1972), conducted studies on **T. nilotica,** in an aquaria. In his study he placed both ripe male and female **T. nilotica** in an aquaria. The male was seen constructing nests in the substarate after obtaining the breeding colonation. This was carried out, by the fish staying vertically to the substrate. Then using its mouth, it picked up sand particles and deposited on the nest. This activity went on for two hours, during which 4 nests were constructed. After this activity both the male and female were seen occupying one of the largest nests.

Next the courtship period followed, continuing for another 2 hours, after which the female was seen depositing eggs. This was the time of mating and immediately after this, the female had eggs in its mouth, while the male was busy defending the territory the females stayed within the nests. Half an hour later, with alight distrubance, the female left the nest, but kept holding the eggs within the mouth. On the 2nd day the male began feeding and at the same time was loosing its breeding colour. On the fifth day both fish were rapidly loosing their breeding colors and after the sixth day eye ova were noticed.

Futher, on the ninth day, Alvelins were seen escaping through both the mouth and gills of the mother, but were collected alsmost immediately. On the tenth day. Alvelins were swimming freely and for the first time the female was seen feeding. The following day, the fry were noticed feeding.

The duration of the parental care is said to vary with the brood fish and individual fry. From the observations done, it seems if after the third day, the fry becomes less willing to re-enter the mouth of the female, and the number retrieved thereafter gradually declines.

Unlike in **T. galilaea,** where both the sexes share the duties it is the female, **T. nilotica** that carries the incubation duties. The smallest ripe T. nilotica female recorded 24.5 cm TL, whereas the average breeding size for the species is between 32 cm - 39.0 cm TL. gonad analysis of **T. nilotica** throughout the year show that breeding occurs throughout the year, but there appears to be periods of climax spawning.

This was manifested by the data collected both from the fry caught from foot seines: and the number of ripe female per month. Most ripe female were caught between April and June. Moreover, it was during the same period that most Tilapia fry of TL between 1.5 cm - 4.0 cm were caught in foot seine. This is the period, when rains come and the rivers flood resulting in lake level rise. Thus, for L. Rudolf it has been suggested (Ogari) that although breeding occurs throughout the year, there is at least a peak period during which most of the Tilapia breed. This period lies between April and June.

Some scattered observations exist in the literature concerning the number of eggs produced by **Tilapia**. Worthington, recorded a large female **T. nilotica** of unspecified length from L. Albert to be containing 2,000 eggs in her mouth. Further from a lagoon off from the lake Albert, three female **T. nilotica** between 12 cm and 31 cm long were reported to be carrying 50 and 24 eggs and 7 young fish respectively.

Worthington noted and I quote, "the eggs fo these small Ngege (**T. nilotica**) are about the same size as those of the large Ngege from the open lake, but the number in the broods is very small compared with the 2,000 from the mouth of the large Ngege. Perhaps this is a modification due to the cramped environment."

Lowe, 1955) proposes that the small number of eggs in the small female is related to the size of the parents, and not related to the size or depth of the lagoons. The maximum number of fertilized eggs recorded by (Worthington) from the mouth of a 30.5 cm long female **T. nilotica** were 705 eggs. Further, in all species where the young are brooded, they are retained until after occlusion of the yolk sac. The maximum size of the young recorded by the author from the broods of **T. nilotica** were 13.5 mm long, sac accluded (18 in brood).

Based on the size of young in which the yolk sac is occluded or nearly so, it seems probable that **T. nilotica** does not brood young ones larger than 13.5 cm long.

Tilapia esculenta

T. esculenta is a female mouth brooder. It has no well-marked spawning seasons. Greenwood (1966) has reported that the greatest breeding activity occurs between September and May. Further Lowe, (1955 b) gives a detailed account of its breeding biology. In lakes Victoria, most **T. esculenta** are sexually mature at a length of 25 - 26 cm. However, the modal adult size ranges from 30 to 32 cm TL.

The two Lakes Victoria species T. esculenta and variabilis (bith mouth brooders) occur naturally in lakes Victoria and Kyoga only. Nevertheless, they are now widely distributed in dams in Uganda and parts of Kenya and Tanzania within the L. Victoria drainage basin. According to Lowe (Mc Connel) 1955. Fry from brooding females of both species were taken to the fish farm at Korogwe in June 1950 and were breeding there at 16 - 19 cm long, six months later.

To mention on passing, the egg production in **T. esculenta** is approximately equal to the square of the total length, as for the case of **T. leucosticta** and **T. nilotica**. The growth rate of the species is difficult to determine but estimates done by Lowe (1957) from a variety of waters range from 0.55 cm TL per month to 1.25 cm per month. In the lake Victoria lagoons an estimate of the growth rate of juvenile fish (1.0 - 4.0 cm) was found to be 0.67 cm SL per month.

The signific of the growth rate is that it has a direct bearing on the fertility of the fish in influencing the increase in parent length between broods and thus brood number.

Criddland (1961) has showed that amongst **T. esculenta** in the laboratory, the number of eggs in successive broods increases. He records **T. esculenta** as spawning seven times in 24 months with individual broods as close together as 39 days.

Data on the frequency of spawning by individual fish in natural waters are difficult to obtain and the only direct evidence so far comes from two marked fish recovered by the Lake Victoria Fisheries Service (Lowe Connel, 1975).

(a) The **T. esculenta** Graham, when marked on 13th April, 1953 had fry in the mouth, and on being recaptured nine and a half weeks later (20th June, 1953) had eggs in the mouth.

(b) Another **T. esculenta** when marked on 4th March, 1953 had fry in the mouth and when recaptured 7 weeks later (26th April, the ovary was ripening again).

Worthington, recorded from the mouth of a female 29 cm **T. esculenta** a maximum of 711 yolked young fertilized eggs. On the other hand the maximum size of the young he recorded from the brood was 15 mm long yolk sac occluded and the young had started to feed (80 in brood). Thus from the size of the young in which the yolk sac is occluded or nearly so, **T. variabilis** and **T. esculenta** probably do not brood young much larger than 15 mm long.

Another interesting aspect is that all Tilapia species reared in ponds appear to start breeding at a very small size. This over - populates the ponds very quickly. This information is based on (Lowe (Mc Connel) 1955) personal observations on **T. esculenta, T. variabilis, T. nilotica T. leucisticta, T. zillii** and species from lake Jipe and the **Pangani** river, amongst others.

Lowe further reports that **T. esculenta which replaces T. nilotica** in the Nile **system above the Murchison fall, and T. nilotica both have a black and red** male breeding dress. This is unlike that of any other **Tilapia**. It is almost identical in the two species (Lowe, 1958) and supports therefore the fact that these geographical replacement species are closely related, as well as being ecological counterparts in their respective waters.

John M. Onyari

THE ADMINISTRATION SECTION

The Director as the Chief Executive is the overall head of the Institute and constituent laboratories. Under him are various heads of Sections who carry out admistratives duties, such as personnel, Finance, Supplies, Library and Heads of Research laboratories in Mombasa, Kisumu and Turkana.

The section has grown in strength since the establishment of the Institute by the science and Technology Act July, 1980 and an expansion which was necessary if the Institute is to carry out its objectives in the field of Scientific Research.

Establishment

Currently, the Institute has the staff establishment of 372 for both Kisumu, Mombasa and Turkana Stations.

The staff for the newly completed L. Turkana Laboratory have reported in the laboratory, which is under Mr. Fred Wambayi as the new Head of Laboratory. This is part of the expansion programme of the Institute. Further development beside the opening of the new L. Turkana Laboratory are the new Sangoro and Gogo Laboratories which are nearing completion in Nyanza. It is expected that the Institute will post Research Officers to head both Laboratories.

Death and Resignations

The Institute has regreteably lost some of her staff in the course of the year namely the late: Mr. Douglas Kiago of Mombasa, Mrs. Elijah Philipe Mombasa and Mr. James Onyango of Kisumu Laboratory. All are greatly missed.

Some of the Institute staff who have since left the Institute service are Mr. T. F. D'souza (Senior Research Officer) Miss. Lucy Muruthi (Assistant Research Officer). Miss Lucy Muruthi has joined the National Environment Secretariat in Nairobi, having got married to a Nairobian.

Major Activities and Highlights

The Institute has been fortunate in having very close collaboration with her former parent Ministry of Environment and Natural Resources and now enjoys the same with its new parent Ministry of Regional Development

Science and Technology. Soon after the Institute transfered to be under the new Ministry of Regional Development Science and Technology, we were honoured by a visit from Hon. N.K.K. Biwott MP Minister for Regional Development Science and Technology on 15th April, 1982. The Minister launched the Institute's first being research boat R.V. Maumba and planted a tree in memory of the occasion. It is expected that he will honour the Institute also by launching the Kisumu boat R.V. Utafiti, a boat of the same size a R. V. Maumba, and smaller one which is being built for L. Turkana Laboratory. (The boat is currently being built by Ferrocraft Limited in Kilifi).

Other visitors who have come to the Institute Mombasa Headquarter are Hon. Okuku, Assistant Minister Regional Development Science and Technology, Prof. Gacii, Permanent Secretary, Ministry of Regional Development Science and Technology. We hope their visits to the Institute to look at the progress and the problems experienced by a young growing organization, will not be the last.

The Institute has experienced a few problems as well as progressive developments. It is noted that the Institute has expanded rapidly since its establishment and the growth has perhaps outpaced other sections necessary for the functioning of the Institute.

Perhaps the Ministry could help us find a quick solution to the matter now that we have retirement age staff about to retire now ?

There are also other administrative problems in the Institute: There are due to geographical location of the Institute laboratories namely with Mombasa as the Headquater, it is becoming difficult to cordinate research and related activities and provide services for the constituent laboratories in Kisumu and Turkana. Considering the present economic freeze from Government, all forms of communication have had to be cut down and this may contribute to problems in Management of the constituent Institute laboratories.

A. C. Koske (Miss)

A CONTRIBUTION FROM AN ANONYMOUS CORRESPONDENS TO KENYA MARINE AND FISHERIES RESEARCH INSTITUTE BULLETIN

The Absencee Officer

It has been heard through rumours and few reliable sources that there is one notorious member of staff who spends more time away from work than at work, without an explanation.

Why does this Officer spend so much time away from the Office? When challenged he appears innocent. Watch out for the adventurous Officer as you might meet him in odd places. Perhaps he goes to old town in Mombasa, Kisumu?

Anonymous