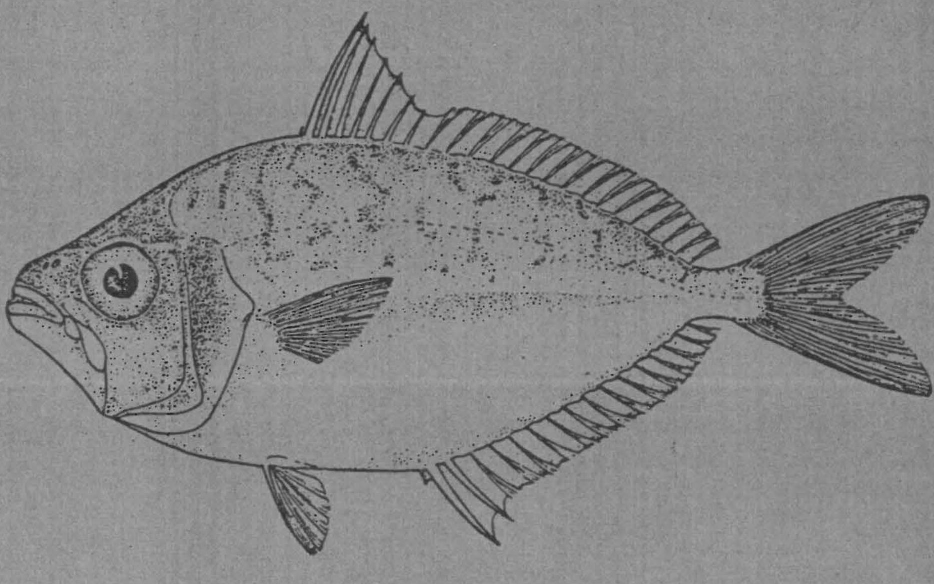
THE PROCEEDINGS OF THE NORAD-TANZANIA SEMINAR TO REVIEW THE MARINE FISH STOCKS AND FISHERIES IN TANZANIA

Mbegani, Tanzania, 6-8 March 1984



Fisheries Division, Dar es Salaam
Norwegian Agency for International Development
Institute of Marine Research, Bergen, Norway

Bergen 1984

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Edited by

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Bergen 1984
Reprinted 1986

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1. INTRODUCTION

The objectives of the seminar were to review the results of the "Dr. Fridtjof Nansen" surveys and other relevant information about marine fish stocks and fisheries in Tanzanian waters.

The seminar which was a joint venture between Tanzania and Norway by the Norwegian Agency for International Development (NORAD), was held at the Mbegani Fishery Development Centre, Tanzania, 6-8 March 1984. The centre is located on the coast about 60 km north-west of Dar es Salaam.

The Minister of Livestock Hm. H. Kiringini, M.P. opened the seminar as the caretaker of the Ministry of Natural Resources and Tourism. During the three days 14 papers were presented. The last day four working groups dealt with the topics fishery statistics, managament-development of the marine fisheries, education and research. The reports of these groups are included in section 6 and are based on the discussions and papers presented at the seminar.

The seminar was closed by the director of planning Matern Y.C. Lumbanga from the Ministry of National Resources and Tourism.

2. THE MARINE RESOURCES

PHYTOPLANKTON AND ZOOPLANKTON PRODUCTION IN TANZANIAN WATERS

by

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PLANKTON AND MARINE FOOD CHAINS

Plankton are microscopically small plants and animals drifting in the sea; they provide the basis of the food chain in the marine environment. Phytoplankton form the first trophic level as photosynthesising primary producers, although they have a very small biomass their turn-over rates are very high, and so they are able to sustain the productivity of the higher trophic levels: they are the "grass" of the sea. Zooplankton are consumers of the phytoplankton, forming the next step in the food chain as secondary producers, small herbivorous zooplankton are consumed by larger carnivorous zooplankton: they are the "insects" of the sea. Fish feed on phytoplankton and zooplankton, and small fish are eaten by larger fish. Thus we can make a simplified representation of a pelagic marine food chain as follows:

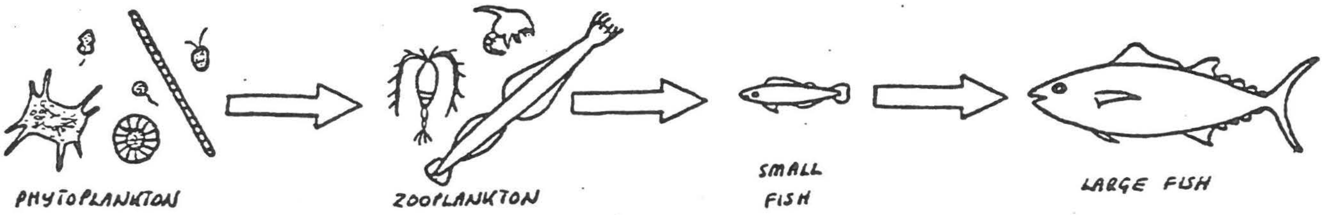

Figure 1. A simplified marine food chain.

In reality, however, the marine food web is much more complex than this, especially when benthic organisms are taken into consideration. Seagrasses, benthic algae and mangrove trees are also primary producers of inshore marine environments, as are symbiotic algae living in corals, but very little of these plants are directly consumed by fish and they mainly contribute to the marine ecosystem as detritus broken down by bacteria. Many benthic fish and invertebrate animals feed on plankton, and the great majority have planktonic larval stages.

An understanding of the ecological dynamics of marine phytoplankton and zooplankton, their distribution and productivity in relation to various inshore biotopes (e.g. coral reefs, mangroves, river estuaries, etc.), their daily and seasonal patterns of variation, and their interactions through the food chain with species of economic importance to fisheries, give the basis for a fuller understanding of the marine environment whose resources we wish to utilise.

It may provide clues about seasonal variations in catches of various species, preferred habitats, breeding cycles, migration patterns, and may also warn of problems of toxicity.

SPECIES COMPOSITION OF TANZANIAN PLANKTON

The phytoplankton and zooplankton of Tanzanian coastal waters are typical of the tropical Indo-west-Pacific region.

The most abundant species of the phytoplankton are nanoplanktonic phytoflagellates (mostly less than 10 µm in diameter), and small pennate diatoms are common inshore. There is a high diversity of larger diatoms (such as species of Chaetoceros, Rhizosolenia and Bacteriastrum) and armoured dinoflagellates (such as Ceratium spp.). During about six months of the year, a nitrogen-fixing planktonic cyanophyte (Oscillatoria) predominates in the phytoplankton.

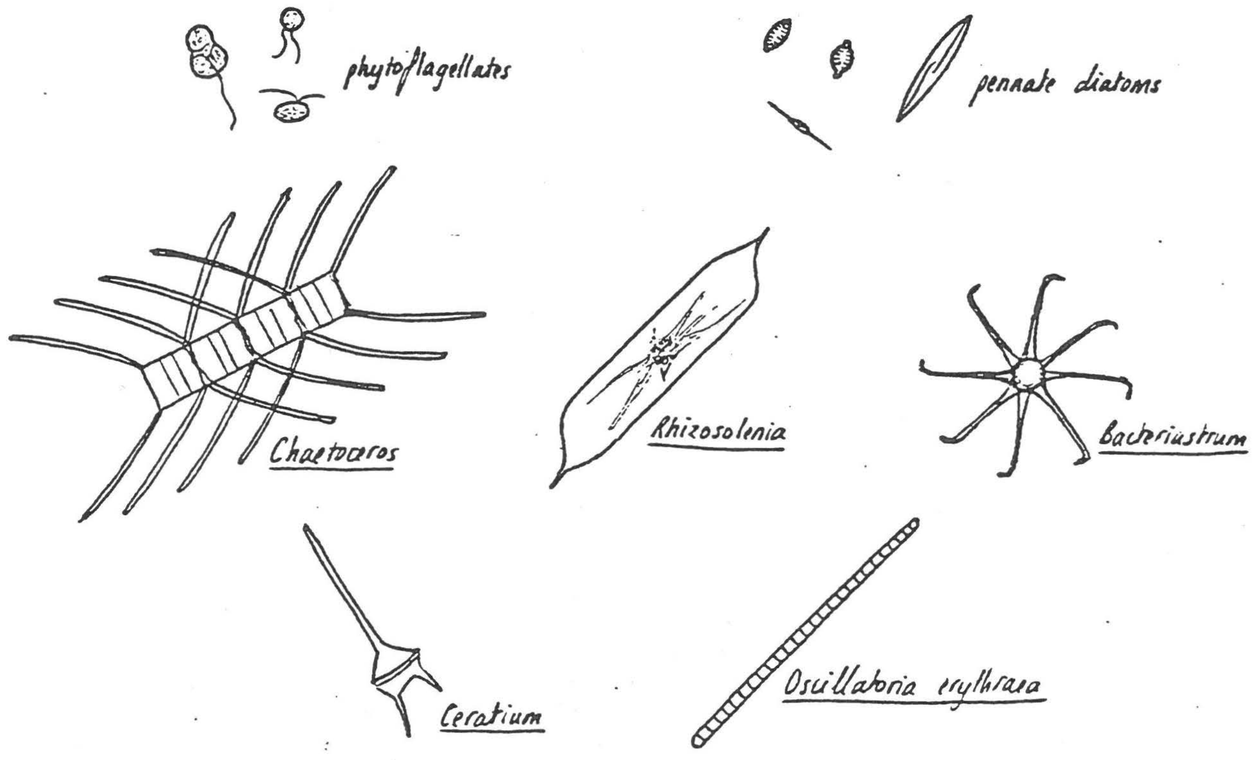

Figure 2. Some typical phytoplankton of

An ecological study of the phytoplankton of the coastal waters of Dar es Salaam (Bryceson, 1977) identified 265 taxa from ten classes of algae. Larger diatoms, dinoflagellates and cyanophytes were most readily identified, but quantitative enumeration revealed that the smaller species which were more difficult to identify were most numerous. Phytoplankton species composition varied considerably according to biotope (open sea, coral reef, mangrove and enclosed bay habitats were investigated), season, time of day or night, tide and wind.

A study of the zooplankton of the inshore waters of Dar es Salaam (Okera, 1971, 1974) identified a very diverse composition of species. The most numerous were calanoid copepods (accounting for 49% of zooplankton counts), followed by larvaceans (12%), cyclopoid copepods (11%), ostracods (6%) and caridean larvae (4%).

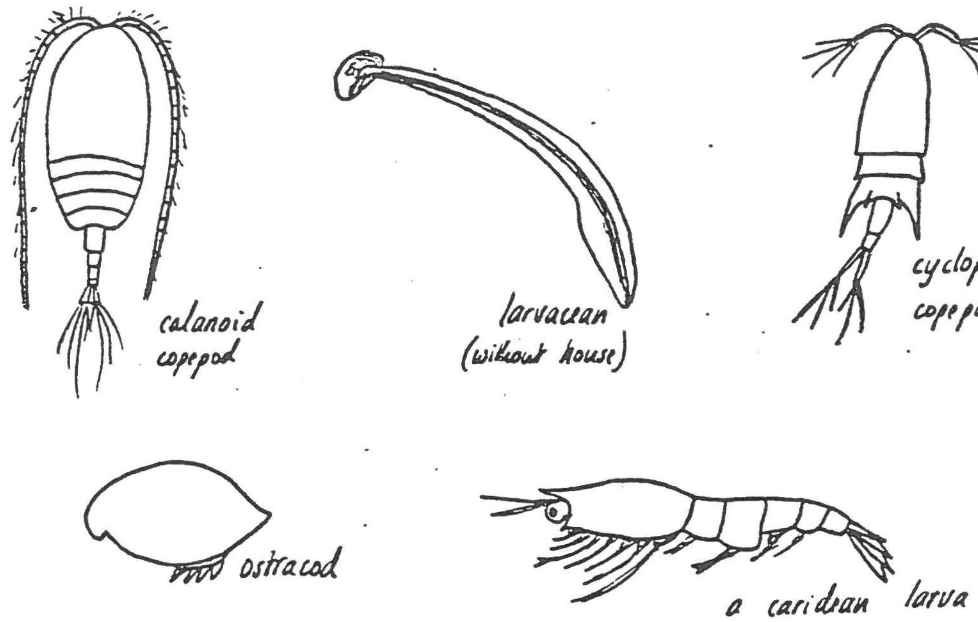

Figure 3. Some typical zooplankton of Tanzanian coastal waters.

Wickstead (1962, 1963) noted high species diversity off the coast of Zanizibar in the zooplankton populations; he also noted increased numbers inshore and differing species composition.

SPATIAL DISTRIBUTION OF PLANTON

Offshore phytoplankton populations generally have lower biomass (in terms of cell numbers or chlorophyll levels) in comparison to inshore waters, and have a greater component of oceanic species (mean counts over an annual cycle for a location offshore from Dar es Salaam were 97 cells per ml). Coral reef waters contain a greater component of normally neritic species, especially under windy or turbulent conditions (annual mean counts for a coral reef location were 104 cells per ml). Mangrove lagoons or waters with a tidal outflow from a mangrove estuary contain very high phytoplankton numbers, with especially large numbers of flagellates which include some toxic dinoflagellates, such as Prorocentrum (annual mean counts for a mangrove creek were 348 cells per ml). Waters in the vicinities of large river mouths become turbid with terrigeneous sediments suspended, especially following periods of heavy rainfall, and phytoplankton typical of estuarine conditions with wide salinity range tolerance and low light requirements, such as some small phytoflagellates, may predominate and benefit from the breakdown of detrital material. Shallow seagrass beds release substances stimulatory to phytoplankton, and turbulent water mixes epiphytic diatoms into suspension among the plankton. Enclosed bays have a large component of neritic species, such as pennate diatoms, but in the proximity of industries they may be subjected to effluents with deleterious effects on phytoplankton by pollution of the waters (annual mean counts in Msasani Bay, Dar es Salaam, were 149 cells per ml, excluding a period when meat wastes were flushed into the bay and cell numbers were drastically reduced to 18 cells per ml).

Comparative spatial distribution data from these biotopes for zooplankton are not available for Tanzanian waters. Wickstead (1963) did observe increased numbers of zooplankton inshore near Zanizibar. General observations for coral reefs indicate a higher zooplankton: phytoplankton ratio (Johannes, 1967) probably due to the availability of detrital food (such as mucus from corals) for omnivorous zooplankton species. Many species of fish and crustaceans utilise mangroves as spawning and nursery grounds, and many larval forms are observed in zooplankton of mangroves.

The results of research cruises in mapping the productivity of large areas of sea from a few isolated measurements should be treated with great caution. For instance, Ryther et al. (1966) mapped the western Indian Ocean and showed Mombasa to have a productivity of more than 1.00 gc/m^2/day in contrast to Dar es Salaam at 0.26-0.50 gC/m^2/day without their having taken any maesurements whatsoever between Mombasa and Dar-es-Salaam !! A scrutiny of their map reveals that in a transect from Mombasa to Madagascar they have simply confirmed the already well-known fact that productivity close inshore is higher than it is far offshore. It is very unfortunate that such erroneous observations could be published by an eminent scientist in a reputable journal and subsequently be quoted as "fact" for years to follw.

Plankton distribution can vary greatly over very small distances: it has a very "patchy" distribution, so replicate samples are necessary. Their distribution varies considerably with depth and time.

ANNUAL CYCLE OF PLANKTON

The annual cycle of phytoplankton appears to be divided into two main seasons: the northern monsoon ("kaskazi") from December to April, and the southern monsoon ("kusi") from June to October, with two periods of rainfall ("masika" and "vuli") in between the changing monsoons. The northern monsoon is characterised by lower wind speeds, calmer wave conditions, shallower thermocline, higher temperatures, slightly lower salinities, somewhat lower phosphate levels, much higher nitrate levels, and generally greater phytoplankton counts with especially abundant occurence of Oscillatoria erythraea. The southern monsoon, conversely, is characterised by a reversal of these conditions. The northern monsoon is considered to be more favourable to phytoplankton production due to less mixing of cells down to depths of below optimal light intensity, greater residence time in neritic conditions due to the slower coastal current, increased runoff from rivers injecting terrigeneous nutrients, and much enhanced availability of assimilable nitrogen derived from the nitrogen-fixing O. erythraea (Bryceson, 1977; Bryceson & Fay, 1982). Mean counts of phytoplankton were 130 cells per ml during the northern monsoon and 62 cells per ml during the southern monsoon, at an offshore location (the same pattern of seasonality was observed at the coral reef location and in the enclosed bay (excepting the polluted period), but in the mangrove creek there was no such pattern discernable).

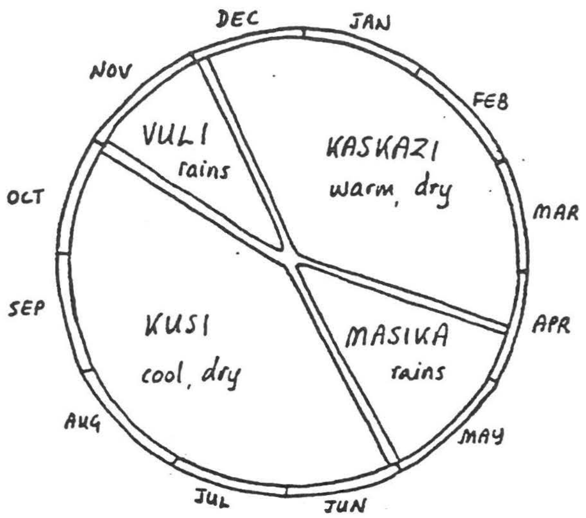

Figure 4. The seasons of the Tanzanian coast.

Okera (1971) observed greater zooplankton numbers from February to July, by a factor of three times more than numbers for the period from August to November. It would appear that the zooplankton respond to increased availability of phytoplankton as food, with a slight lag-time in their response.

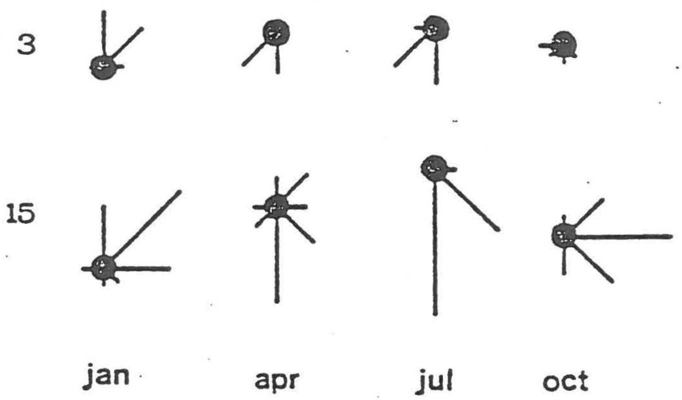

Figure 5. Mean monthly values of wind direction at 0300 and 1500 at Dar es Salaam (adapted from Niewolt (1973)).

The lack of seasonality observed in the tropical Atlantic and Pacific oceans is quite different from the monsoon-effected seasonality of the tropical Indian Ocean: similar patterns of monsoon seasonily have been observed in plankton studies from Madagascar (Sournia, 1969), Sri Lanka (Durairatnam, 1963) and India (Qasim, 1973).

The monsoon wind directions vary seasonally in a well-defined pattern and consequently the current patterns of the western Indian Ocean exhibit a unique seasonal reversal in direction off the coast of Somali and northern Kenya; this current reversal to the north of Tanzania causes the coastal current to be slower during the northern monsoon and effects physical and chemical oceanographic factors.

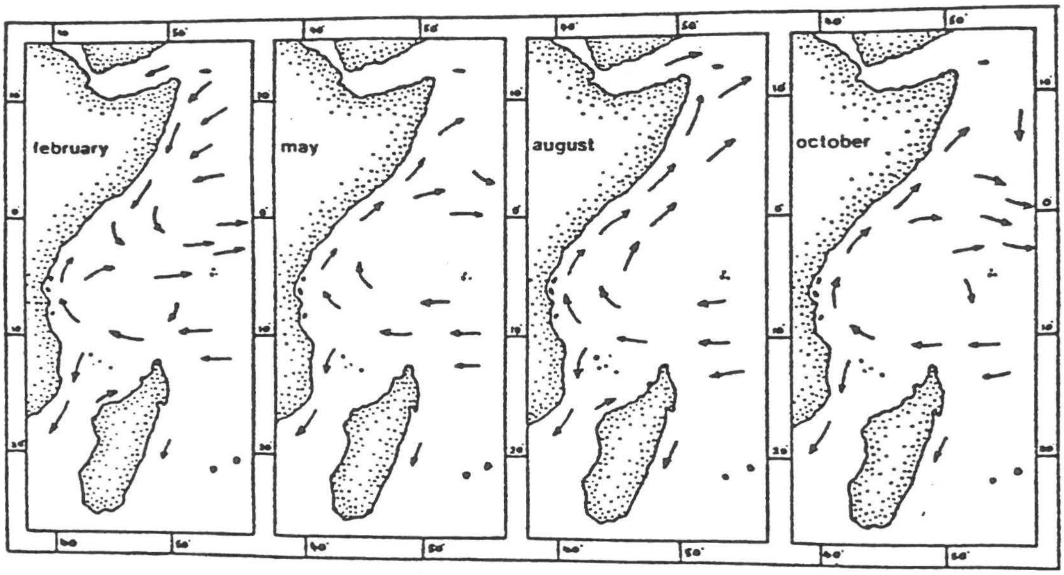

Figure 6. Surface currents in the western Indian Ocean (after Defant (1961), Newell (1959) and Wytrki (1971)).

Table 1. Seasonal variations of physical and chemical oceanographic parameters and phytoplankton populations at a location off the coast of Dar-es-Salaam (Bryceson, 1977).

date	tmp	trb	sal	o%s	pho	nit	chl	cells
17.01.75	28.5	12	35.1	96.6	0.3	4.8	0.9	126
12.02.75	29.6	14	35.0	96.3	0.2	2.1	0.7	109
26.02.75	29.8	10	35.0	100.7	0.3	7.5	1.4	229
17.03.75	29.7	10	34.9	98.9	0.3	2.6	0.5	129
10.04.75	28.0	7	34.3	98.7	0.1	1.8	0.8	127
12.05.75	28.0	9	34.0	101.3	0.3	0.4	0.6	114
12.06.75	27.0	15	34.4	97.4	0.5	0.0	0.2	70
19.07.75	26.6	18	34.6	99.1	0.4	0.0	0.5	57
08.08.75	25.9	22	34.8	100.6	0.2	0.0	0.2	65
03.09.75	26.2	20	34.9	95.5	0.4	0.0	0.4	50
29.09.75	26.6	17	35.1	-	0.4	0.0	0.4	62
27.10.75	27.7	22	35.1	98.5	0.2	0.0	0.6	67
17.11.75	28.8	15	35.3	96.6	0.3	0.0	0.3	60
16.12.75	29.0	15	35.3	102.0	0.1	1.3	0.6	103
06.01.76	29.2	11	35.2	99.1	0.2	2.5	0.6	90

abbreviations: tmp - temperature (°C) trb - turbidity (Secchi depth, m)
sal - salinity (°/oo) o% - oxygen percentage saturation (%)
pho - phospate (µg-at/l) nit - nitrate (µg-at/l)
chl - chlorophyll (mg/m^3): an indicator of plant biomass
cells - cell counts (per ml): including diatoms, flagellates and filaments of Oscillatoria erythraea.

All samples were taken at a location outside Mbudya island, Dar-es-Salaam ($6^{o}40'45''$S $39^{o}17'50''$E) on the dates indicated at approximately midday from a depth of 0.5 metres.

DIEL CYCLES OF PLANKTON

Diel variations in counts of phytoplankton in inshore environments appear to be affected by turbulence (generated by wind or tidal flows), and by light which stimulates some flagellates to swim from the sediment surface. Oscillatoria erythraea accumulates at the surface under calm conditions, but is mixed downwards rapidly if the wind begins to blow, as it usually does in the afternoons. Windiness and surf in the vicinities of coral reefs mix up pennate diatoms from the sediment surface into the plankton. In mangrove estuaries, cell number of dinoflagellates are high during outflowing tides, especially during day-time, whereas the numbers of pennate diatoms are higher during the inflowing tides since they have been suspended by the incoming water across the tidal flats.

Vertical migration by zooplankton upwards toward the surface layers during the night to feed, and downwards to the benthos or to depths of dim light intensity during the day to avoid predation from larger zooplankton or fish is a well-known phenomenon. The echo-recordings from the cruises of the "Dr. Fridtjof Nansen" clearly show this contrasting pattern in some of the day and night recordings. Small fishes (such as clupeids) and squid often feed on zooplankton near the surface at night, and larger fishes (such as carangids) come to feed on these in turn.

Fishing at night with artificial lights relies on the attraction of zooplankton towards the lamps (like flying insects to a light-bulb), and the subsequent attraction of fish to feed on these zooplankton: the method is particularily effective on moonless nights. Okera (1974) analysed the selective attraction by artificial lights of various species of zooplankton at night: he observed that mysids, caridean prawn larvae, hyperiids and ostracods were particularily attracted to the bright light, and calanoid and cyclopoid copepods to slightly dimmer light.

PLANKTON AS A NUISANCE TO FISHERIES

Although plankton constitute the foundation of nutrition in the sea, there are some instances of negative effects of plankton on fisheries.

Zooplankton organisms such as salps or ctenophores may compete for food against fish larvae, and some zooplankton may prey upon fish eggs and larvae, reducing the recruitment into growing stocks of fish. Fish have been observed to avoid waters containing high numbers of salps in some temperate seas. Fishermen may also face problems with clogging of their nets by medusae at times when these are abundant.

Certain species of dinoflagellates are toxic, and if bivalves or fish feed upon them they become unsuitable (perhaps fatally poisonous) for human consumption: this phenomenon is known as "ciguatera" in fish, and "shellfish poisoning" in bivales. It is important to note that a highly toxic dinoflagellate, Prorocentrum, is common in mangrove estuaries, and so, for instance, attempts to culture edible oysters in such a habitat might prove ill-fated.

"Red tides" are caused by blooms of toxic dinoflagellates, and are becoming increasingly common along the coasts of Europe and North America, aggravated by increased pollution. However, red tides have not been reported from the Tanzanian coast, although it is conceivable that in enclosed inshore areas (such as Dar es Salaam harbour, Msimbazi or Msasani Bay), that excessive eutrophication caused by effluents and sewage could give rise to localised red tides.

Blooms of Oscillatoria erythraea superficially resemble red tides when they accumulate as a reddish-brown scum on the surface of the sea during particularily calm days in the northern monsoon period; however these blooms are not harmful.

RELEVANCE OF PLANKTON STUDIES TO FISHERIES

For the assessment of the marine fish resources of an area, it is desirable to have a sound knowledge of physical and chemical oceanographic parameters, and of phytoplankton and zooplankton ecological dynamics (just as meteorology, soil science and pasture studies are relevant to the prior assessment of an area for cattle ranching development). Information concerning spatial variations in distribution and productivity, temporal changes in abundance as seasonal or diel patterns, linked with a clear understanding of interactions through the food chain with economically important species, provide the basis for rational utilisation of resources.

The "Dr. Fridtjof Nansen" did take measurements of temperature, salinity and dissolved oxygen, giving some information about the depth of the thermocline/halocline, and on the areal extent of estuarine influence of river runoff. But these were isolated measurements, by necessity, and cannot give a composite impression of the dynamics of these few hydrographic parameters.

Various previous research cruises have rendered hydrographic data from Tanzanian coastal waters (Newell, 1957, 1959; Winters, 1976), and oceanographic data together with assessments of phytoplankton (Bryceson, 1977) and of zooplankton (Okera, 1971) are available for the inshore wates of Dar-es-Salaam. However, this information is also limited.

Further research efforts should be based on the already available information and should aim at expanding our knowledge of oceanographic dynamics and plankton ecology. Descriptive oceanographic studies should concentrate on those areas not yet investigated, but which are of importance to fisheries, and should compare seasonal patterns along the coast. The study of fish eggs and larvae ("ichthyoplankton") provides much information about breeding cycles, food chain interactions and recruitment to new stocks: it would be extremely interesting to compare observations concerning the increased productivity of phytoplankton from December to May and of zooplankton from

February to July to seasonal abundance of ichthyoplankton, and to seasonal breeding cycles and catch statistics for clupeids, and to the seasonal migratory pattern of larger pelagic predatory fish.

Identification and mapping of the distribution of toxic dinoflagellates and studies of their response to localised pollution problems culd avert dangers of fish-poisoning, ciguatera and shellfish-toxicity.

Basic marine biological research, such as oceanographic and plankton studies, should be designed to provide useful background information and ecological understanding for more applied fisheries research and for the assessment and utilisation of resources, and those engaged in applied research should make themselves aware of the basic information available (Bryceson, Mwaiseje & Mainoya, 1982): in this way, mistakes and wasted efforts can be minimised. This seminar provides a useful forum for such communication between basic researchers, applied researchers, planners and policy makers.

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THE FISHERY OF CRUSTACEA AND MOLLUSCS IN TANZANIA

by

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1. INTRODUCTION

The demand for crustaceans in the world market is progressively increasing, particularly with the increasing consumption by rich countries (Peckham and Petterson, 1974). Of the World's crustacean production, prawns or sometimes called shrimps, constitute over 90%. The Indian Ocean, which has a high potential resources for prawns, contributes about 500.000 tonnes of prawns per annum (Peckham and Petterson, 1974).

Prawns in the Indian Ocean and elsewhere in the world are found in brackish waters which are the nursery grounds of the juveniles and in the deeper waters during the latter part of their lives or during breeding time. Prawn fishery of the western side of the Indian Ocean has not developed compared to that of the central and eastern side of the Ocean. It is only in countries like Madagascar and Mozambique, that one could speak of proper exploitation of prawns in the western side of the Indian Ocean. The remaining countries produce quite a small quantity (Gulland, 1979).

Most of the trawling grounds for prawns in East Africa are restricted to patches between coral outcroppings and in and around the river mouths. The East African continental shelf is fairly narrow and fringed with coral reefs which occur up to a depth of 20 meters. Trawling for prawns in this area is, therefore, restricted or influenced by the extent of corals in the region.

Crabs and lobsters are rarely caught by trawl nets as they live in areas where trawling is difficult. Ocassionally, crabs are caught by beach seines, especially Portunus pelagicus, during their breeding season when they come close to the shore. Lobsters (spiny or rock lobsters) are rarely caught by gillnets or trawl nets. They are usually caught by traps and other means. The presence of coral reefs and the extensive mangrove areas in the coast encourages both crab (P. pelagicus and Scylla serrata) and lobster fishery as these crustacea prefer such habitats.

There are a good number of varieties of sea shells in the region. Most of the shells are ornamental while a few are consumed by coastal fishermen and foreigners. The edible molluscs include octopus, cuttlefishes, Anadare spp Pinna spp, and Tridacna gigas. The first two, i.e. octopus and cutlefish will not be treated here as they are treated under fishes.

The report tries to review, the fisheries of both crustacea and molluscs of Tanzania, suggesting areas for improvement.

2. PRAWN FISHERY

As appointed above, prawn fishery is the major constituent of crustacean fishery of the world. Here in Tanzania, prawn fishery forms the bulk of crustacean fishery. There are more than thirty species of prawns in E. Africa. Of these only five are important, namely Penaeus indicus (H. Milne Edwards), P. monodon (Fabricius), P. semisulcatus (de Haan) P. latisulcatus (Kishinouye) and Metapenaeus monoceros (Fabricius). P. monodon is commonly called "Jumbo tiger prawn" and is the largest of marine prawns. This species is the main component of artisanal prawn fishery of the region. Subramaniam (1980) recorded a total length of between 171 and 180 mm as the dominant size for P. monodon whereas P. indicus, the medium sized prawn, were dominant at the length of 121-130 mm. The peak abundance for P. indicus is between April and July, April-May being the most productive months. Metapenaeus monoceros is the smallest size with a mean range of 81-90 mm total length. P. latisulcatus and P. semisulcatus do not seem to form any appreciable part of the commercial fishery. The possible reason advanced for the lack of these two species in commercial catches is their strong nocturnal activities and strong diurnal borrowing such that they are missed during day trawls (Subramaniam, 1980). All trawling for prawns is carried out during the day.

Documented evidence has shown that artisanal fishery accounts for more than 50% of the total catches. This consists of the use of stake traps "uzio" which are set in intertidal areas, cast nets and dragged scoop nets.

Commercial trawling for prawns was first experimented upon by the then East African Marine Fisheries Research Organization (EAMFRO) in 1959 using a research vessel M.V. "Manihine" and a research launch M.V. "Chermin" in the grounds off Tanga, Zanzibar, Pangani, Bagamoyo and Rufiji. The results were promising and this prompted future introduction of commercial prawn trawlers.

About ten years later after the trawl trial, a Japanese firm, conducted more survey using their ship M.V. "Sagami Maru". During this survey, more trawlable grounds were identified. This led to a joint venture between the Japanese firm and the Tanzanian government forming a company called New Mwananchi Ocean Products (NMOP). Trawlers for the joint company were restricted to 6-20 metres of depth in Bagamoyo and Rufiji.

2.1. Catches

Data obtained by the New Mwananchi Ocean Products (NMOP) indicate that prawn catches of 1968, 1969 and 1970 were 150, 197 and 196 tonnes respectively.

Prawn catches in Tanzania is summarised in Table 1. It is seen in this table that production steadily increased from 1968 to 1970 thereafter decreasing progressively, until NMOP wound up their activities in mid 1972 reaching the lowest in 1975 (166 tonnes).

A new company, Tanzanian Fisheries Corporation (TAFICO), was instituted in 1974 to carry out the activities of the defunct NMOP. TAFICO resumed operation in 1976 deploying 9 trawlers in the industry. During the early days of her operations TAFICO restricted her activities to areas close to Dar-es-Salaam. As a result of this, trawling was limited to the northern prawn grounds at a depth of between 10 and 20 metres. TAFICO is currently using a bigger ship, M.V. "Mama Tafico" in the prawn fishing. This ship, which was commissioned in September 1982 is now the main supplier of both fish and prawns to the company.

Table 2 compares prawn catches from M.V. "Mama Tafico" and prawns collected by artisanal fishermen together with smaller TAFICO vessels between 1982 and 1983. It should be noted here, however, that data from artisanal fishery is difficult to get and hence should be treated here as gross underestimates. From this table it is seen that catches from M.V. "Mama Tafico" increased rapidly in this period. The same trend is anticipated in 1984.

It has been pointed out above that a much lower data is given under artisanal fisheries. This low data actually came from the acutal prawns bought by TAFICO from this fishery, the rest of the catches are either sun-dried or sold directly to the local markets. This can very well be deduced from Table 1.

2.2 Fishing season and Fishing Grounds

Much of the large commercial fishery for penaeids is from shallow waters of between 10 and 80 metres and the catch tends to decrease with the increasing depth (Hall, 1964 Anon. 1969). The nursery grounds of penaeids are the mangrove areas, river deltas, brackish water lagoons and estuaries. These areas are well represented in Tanzania's coastline. Sub-adults migrate to the sea for further development and spawning (Anderson, 1956; Panikkar and Menon, 1956).

The major fishing grounds for prawns in Tanzania are located in shallow coastal areas, at estuaries, brackish water lagoons and river delta systems off the mouths of Rufiji, Ruvu, Pangani and Wami rivers. Rufiji area is by far the largest prawn grounds in the country. Most of the commercial fishery is based here. Artisanal fishing for prawns is mostly concentrated in the nursery grounds. Therefore the prawn catch from this fishery is composed of more than 50% sub-adults (Subramaniam, 1980). The adult stocks and their fishery depend very much or the survival rate at the nursery grounds. Therefore, there is great need to conserve the nursery grounds. High production could thus be achieved through expanding the fishery of adult stocks and restricting sub-adult fishing.

Results for the fishing season vary from region to region, from year to year and from individuals. Sankarankutty and Subramaniam (1976) for instance, found that the peak catch in the fishing ground off Ruvu was during the first quarter of the year (January to March) and two more peaks for grounds off Rufiji between April and July. Hall (1964) on the other hand, observed that the rainy season of September to April gave highest catches for artisanal fishery. Observations from TAFICO, however, show that prawns can be caught throughout the year, especially between January and October.

2.3. Discussion

It has been seen from the account given above that little exploitation of prawns is carried out by our commercial companies. Based on the extent of fishing and nursery grounds of prawns in Tanzania it is hoped that a lot more can be harvested without depleting the stocks. It is, however, important to note that if we are to conserve the stocks there must be restrictions as to the minimum depth to be covered by large trawlers. In Bagamoyo, where large TAFICO trawlers are fishing almost throughout the year, there could be signs of depletion of stocks especially when the catches include large quantities of sub-adults. The artisanal fishermen, thought to catch a good percentage of sub-adult prawns, are thinly spread throughout the coast. Therefore they do not pose any danger of depleting the stocks and moreover their catch per unit effort is much lower compared to large fishing trawlers.

There is need to increase the number of trawlers especially in deeper parts so as to catch more adult prawns. A clear breeding seasons should be ascertained so that the fisherman may avoid catching berried animals.

3. LOBSTER

Lobster fishery has not made any appreciable advancement over the past decade. This has mainly been contributed partly to lack of investment on the fishery and partly to the insistence on traditional means of capturing them. Not much research has been carried out on the lobsters of the area. Work by Bwathondi between 1971 and 1980 on lobsters of this region can be considered to be one of the most important contributions in the fishery. Workers at the then EAMFRO stations in Zanizbar and Mombasa also made some contributions to lobster biology of the region.

Bwathondi (1973) studied the biology and fishery of lobsters in Tanzania. He observed that there were five species of spiny lobsters in the region, namely, Panulirus ornatus, P. longipes, P. versidoler, P. homarus and P. penicillatus. Of the five species, the first two were the most abundant, constituting more than 80% of the total catches (Bwathondi, 1980).

Bwathondi (1973, 1980) reviewed the different methods for capturing lobsters in the region. He noted that lobsters are popularly caught by a hand net and an octopus, the latter is used to frighten them from their dens while the former is used to scoop them. This method is used throughout the coast. Bwathondi (op. cit.) noted that though the handnet and octopus method seem to be fairly popular, the acquisition or finding of octopus, which are always collected at low tides, hinders or delays operations. He suggested that artificial octopus could be substituted for real ones and this could improve efficiency in the whole operation. Lobsters are also caught by traps and gillnets set for catching fishes.

Bwathondi (1979, 1980) working on trapping of lobsters, recommended that box traps could be developed in the industry. In Zanzibar, however, the popular method for capturing these animals is by spear-gun. This method had been discouraged by many specialists world over because lobsters killed by spear guns or harpoon guns usually decompose quickly before they are exposed to the market.

Lobster production between 1966 and 1975 is summarised in Table 1, column 3. It is seen from this table that production has stagnated between 15 and 79 tonnes (tail weight). Table 4 gives data on lobster catches from four regions of Tanga, Coast, Dar and Mtwara in 1975 and 1976. It is seen from this table that the most favourable fishing season for lobsters is between January and June with maximum catch in April. This corresponds to the time of the end of northern monsoons and the beginning of the southern monsoon. It coincides with the peak of the breeding and post breeding period (January-May) (Bwathondi, 1973).

Most of the lobsters captured are either sold to the tourist hotels in Dar es Salaam or exported abroad.

3.1 Fishing Grounds

Bwathondi (1973) noted that most of the five species inhabit coral areas. With the expanse of corals in the coastline, it is expected that lobsters would be fairly abundant. This is the case in Kilwa area and the coral grounds off Mbweni and Mbegani areas. The only remarkable threat to the population of lobsters in the region is the indiscriminate demolition of corals by dynamite fishermen. Efforts are underway to curb this illicit trade. It is hoped that with the arrest of dynamite fishing and the regeneration of corals, the population of these animals will increase.

3.2. Discussion

One of the major problems affecting lobster production in this area is the development of effective gear. The main gear used at the moment, the handnet-octopus gear, is itself inefficient and mainly controlled by environmental factors. During the southern monsoon, there is a strong current flowing towards the north at a maximum speed of 4 knots. The wind is also strong and the ocean becomes fairly rough at times. The combined effects of currents and wind make diving operations very difficult. It has been seen above that production is highest at the onset of the southern monsoons. This means that an improvement of the fishing gear would increase production.

Bwathondi (1979) observed that, contrary to earlier belief, lobsters actually enter traps. A change from the weather controlled handnet-octopus method to the use of traps would not only ensure a constant supply of lobster in the market and an increase in production but would also help in the observance of the legal size regulation.

4. CRABS

Crab fishery in Tanzania is as old as lobster fishery. Because of their appearence/morphology, they have not been popular to most of the upcountry people living in the coastal towns. Most of the coastal fishermen have not considered crab meat a delicacy, but have only consumed the meat when there was no fish. Crabs and lobsters were therefore regarded second grade sea foods. This is principally due to local people's eating habits.

Like lobsters, crabmeat finds its markets in the city tourist hotels. Records do not show that crabs are exported.

The most popular crabs found along the Tanzanian coast belong to the genera Lupa or Portunus and Scylla. V.B. Riyami studied the biology and fishery of the mangrove crab, Scylla serrata of Kunduchi creek and Dar- es-Salaam area between 1979 and 1981. Bwathondi and Pratap are carrying out studies on the abundance of Lupa = Portunus pelagicus. Their study includes biometrics and egg development and emigration and immigration into the creek. On the whole, little work has been carried out on crabs of Tanzania.

5. MOLLUSCS

In this text the molluscs will include only the sea shells; octopuses and cuttlefish will be excluded. Mwaiseje (1982) reviewed the potential for non-conventional fisheries in Tanzania. In his paper, he mentioned that though a lot of sea shells are collected and consumed by a small group of coastal people unnoticed, it would be a good idea if the habit of consuming such animals is popularised. People along the coast consume oysters (in small quantities), bivalves such as Anadara and Pinna. The fishery of such animals has not developed as the bivalves are not popular in the people's menu. In Dar-es-Salaam, for example, both women and children collect Anadara along Banda Beach, boil them, remove the meat from the shell and then sell the meat in the city. Because the city inhabitants come from different parts of the country mainly from the upcountry, the habit of consuming bivalves is alien to them. It is being recommended that more efforts be placed on utilization of such useful bivalves which are quite abundant in the area.

Apart from using sea shells as a source of food, they are used in the tourist industry. The collection of sea shells for ornamental purposes has been carried out by private individuals for a long time now. Such private dealers also used to sell the shells both locally and abroad. It was not until recently (ca. 1983) that TAFICO became the sole exporter of this valuable commodity. Table 3 give some of the most popular sea shells collected along Tanzanian coast. Most of these shells are collected along the beaches, in the reefs and shallow waters during low tides.

Data collected since 1963 show that there is an upward increase in production. Since little or no knowledge on the biology and fishery of these sea shells is available, it may be possible that a rapid increase in production over the years may lead to overexploitation. There is need therefore, to conduct studies on these organisms.

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Table 1. Production/export statistics for Crustacea & Molluscs (in tonnes) 1963-1980:

Year	Crustacea Prawns	Crustacea Lobsters	Crustacea Total	Mollusca Sea shells
1963	-	-	-	43.0
1964	-	-	-	67.0
1965	-	-	264.0	93.0
1966	335.0	15.0	350.0	229.0
1967	-	-	400.0	150.0
1968	448.4	58.6	507.0	533.0
1969	555.6	41.4	597.0	769.0
1970	509.0	76.0	585.0	478.0
1971	364.3	26.7	391.0	479.0
1972	305.2	25.0	330.2	966.2
1973	307.0	-	307.0	492.0
1974	101.0	79.0	180.0	268.0
1975	166.0	50.0	216.0	557.0
1976	272.9	-	272.9	5.8
1977	238.0	-	238.0	136.8

Source: Annual Reports, Fisheries Division of the Ministry of Natural Resources and Tourism, Dar es Salaam.

Table 2. Production of prawns by "Mama Tafico" compared to the rest of TAFICO collections 1982-1983:

Year	"Mama Tafico"	Rest of collection	Total
1982	16,560	11,556	28,116
1983	119,430	6,072	128,502

Source: TAFICO.

Table 3. Type of ornamental molluscs harvested and exported in Tanzania.

English name	Local name	Where found	When collected
Red Cameo	Madondo	Zanzibar, Kilwa, Kisiju, Pangani Dar es Salaam.	Rainy season at low Tide.
Tiger Cowries	Makururu	Mafia, Kisiju & Bagamoyo	"
Murex Ram.	Miiba	Mafia & Kilwa	"
-	Nyangale	Kilwa Mafia Kisiju & Bagamoyo	"
African Cones	Viwangwo	Bagamoyo & Pangani	"
Buttercups	Bakuli	Bagamoyo	"
Trumpet	Baragumu	Mafia	"
African Harps	Shela	Mafia, Kuruti Kisiju, Bagamoyo	Not well known
White Natica	Mweze Mweupe	Bagamoyo	
-	Kete	Kisiju- Buyuni & Bagamoyo	Low tide
-	Simbi	Bagamoyo	"
Yellow Helmet	Pasi	Mafia, Kisiju	Not known
Clandus Strankeny	Vibini Vyekundu	Zanzibar	"
Mother of pearl	Chaza	Mafia, Bagamoyo, Kisiju, Pemba, Mnazu. (Found in the stony areas).	Throughout
-	Majeta	Kisiju	Low tide.

Table 4. Monthly catch of spiny lobsters in 1975 and 1976. Data taken from four regions.

Month	1975 kg	1976 kg	1975/1976 %
January	1561	1414	6.60
February	627	4337	11.15
March	2963	2866	13.09
April	3626	2555	13.88
May	2764	3116	13.20
June	1895	1602	7.85
July	930	1297	5.00
August	1082	1167	5.05
September	1346	1409	6.19
October	2335	584	6.56
November	2441	788	7.25
December	1388	437	4.10

INSHORE FISHERIES OF THE TANZANIAN COAST

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1. INTRODUCTION

During the period 1950-1977, investigations into the marine fisheries of Tanzania have been conducted by the East African Marine Fisheries Organisation (EAMFRO). However, much of the work was concerned with the taxonomy and bioloby of coastal fish populations (Talbot 1957; Williams 1958 (a); 1959, Wheeler 1959; 1960(a), 1960(b), Talbot 1960, Wheeler 1961). The exploratory and experimental fisheries programmes of EAMFRO were hampered by the limitations of the research vessel, RV MANIHINE, an unmanoeuverable, unreliable and ancient side trawler built in 1903. Nevertheless, the research programme concentrated on the potential for the development of fisheries for offshore and coastal pelagic species (Williams 1956; Merret 1964; Losse 1964, 1966; Merret 1968) and for demersal species on the North Kenya Banks (Williams 1958(b); Morgans 1958, 1959, 1964). Investigations necessary for the further development of artisanal fisheries were largely neglected by EAMFRO until 1968 when a programme was initiated to study the potential for expansion of the reef fishery into the deep reef slope. This involved an examination of artisanal fishing gear and its relative success, a study of a representative artisanal fishery, and the investigation of potential fishing grounds in the unexploited area on the outer reef slopes and coral banks (Morris 1971, 1972; Tarbit 1975, 1976). An earlier and related study was the survey of the fish populations at Tutia reef, south of Mafia Island, which revealed much information on the ecological relationships of reef fishes (Talbot 1965). A recent study of the biology and catch composition of species taken by gillnet in the inter-reef areas of the Zanzibar Channel has inferred that a fishery of this nature may be economically feasible, but the necessary fisheries parameters are not given (Darracot 1977).

Catch statistics have been collected from the coastal fishery by the Tanzanian Fisheries Department since 1967, and allowing a period for the system to become established, catch and effort records since 1970 may be regarded as accurate. For statistical purposes, Tanzanian fish landings are separately calculated for the 4 coastal regions:- Mtwara, Lindi, Coast and Tanga, and for the offshore islands of Zanzibar and Pemba.

Early estimates of the fishery potential in the inshore areas were based on the application of regional or environmental averages to an estimate of the available area (Kerr 1966; Prasad et al 1970; Shomura 1970; Cushing 1971; Moal 1971; Prasad and Nair 1973; Abidi and Desai 1979). Predictably, the resulting estimates of potential yield have often borne little relationship co recent landings and some early estimates have been largely exceeded.

2. THE COASTAL FISHING GROUNDS

The Tanzanian coastline extends for approximately 800 km. It is particularly characterised by a narrow coastal shelf, the outer edge of the reef usually lying within 1 km of the mainland coast and the eastern coasts of the off-shore islands. Within the islands of Zanzibar and Mafia there are relatively extensive areas of shallow shelf which offer smooth trawlable substrates with frequent patch reefs and coralline islands. The artisanal fishery is particularly concentrated in the area between the shoreline and the outer edge of the fringing reef, and on the shallows of the Mafia shelf and the Zanzibar Channel. Outside the reef, slope extends offshore to a depth of 70-100m where there is usually a shoulder at which point the seabed descends steeply to depths of over 300m. This general pattern is indicated in Figure 1, which profiles obtained from echograms made during the deep reef slope fishing operations of EAMFRO (Tarbit 1976).

The area available to the artisanal fishery was estimated at over 12,000km^2 by Wijkstrom (1974), regionally divided as follows:

Mtwara	310 km^2
Lindi	1,550 km^2
Coast	8,100 km^2
Tanga	2,200 km^2

However this estimate excludes Zanzibar and Pemba, and more accurate figures for the total area between shoreline and 400m depth were recently presented (FAO 1979), totalling approximately 19,000 km^2.

DEPTH	0-200			200-400m
SUBSTRATE	Reef	Interreef	Mangrove	
Kenya Border to 5°30'S	888	1,312	+	+
5°30'S to 7°05'S		6,192		400
7°05'S to 9°00'S	7,936		320	+
9°00'S to Mozambique border	1,295	65	500	+

Area of coastal substrates (km^2); + - negligeable area (from FAO 1979)

The figures indicate the limited area for artisanal fishing along the Northern and Southern coasts and the lack of any extensive area between depths of 200-400m.

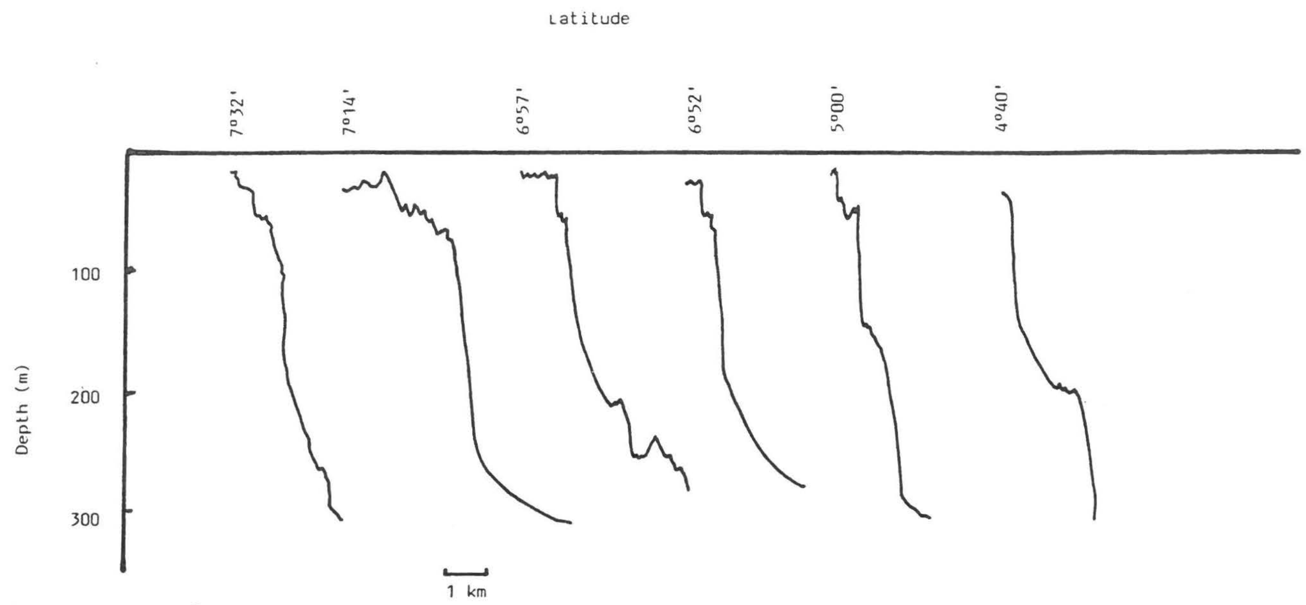


Fig. 1a) Representative profiles of the Tanzanian coast. Profiles between 08°45'S and 07°14'S are taken from the outer edge of the Mafia Shelf, and that at 06°57'S is taken at Latham Island. Others commence at the foot of the fringing reef slope.

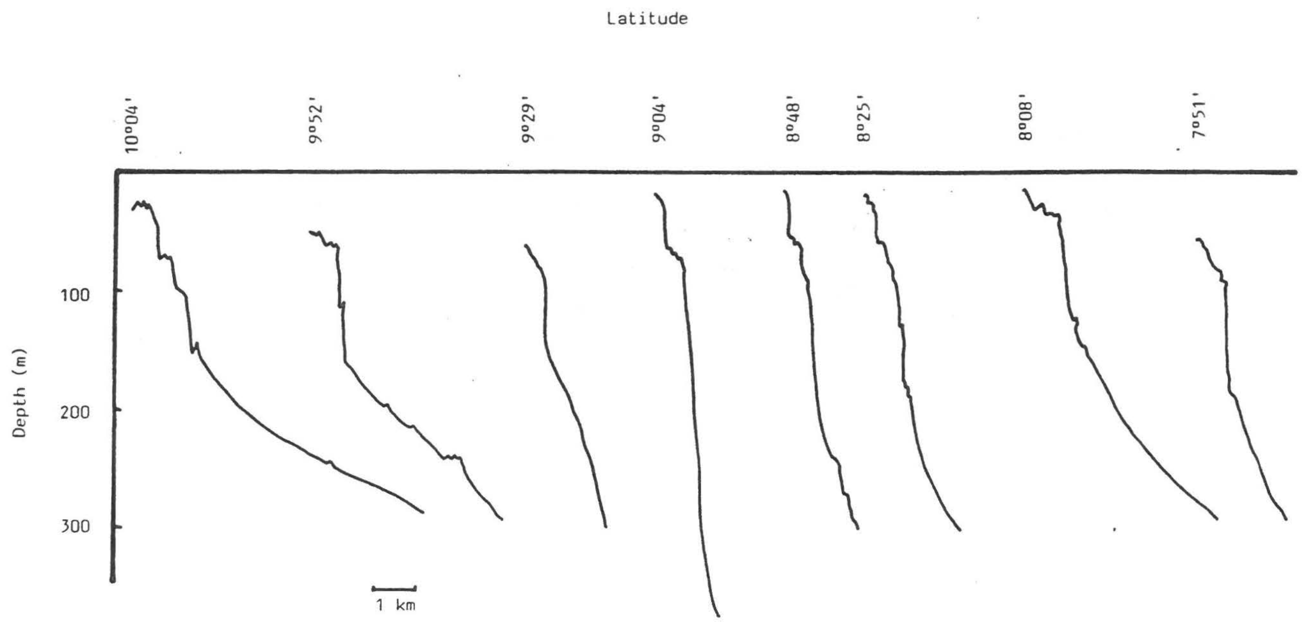
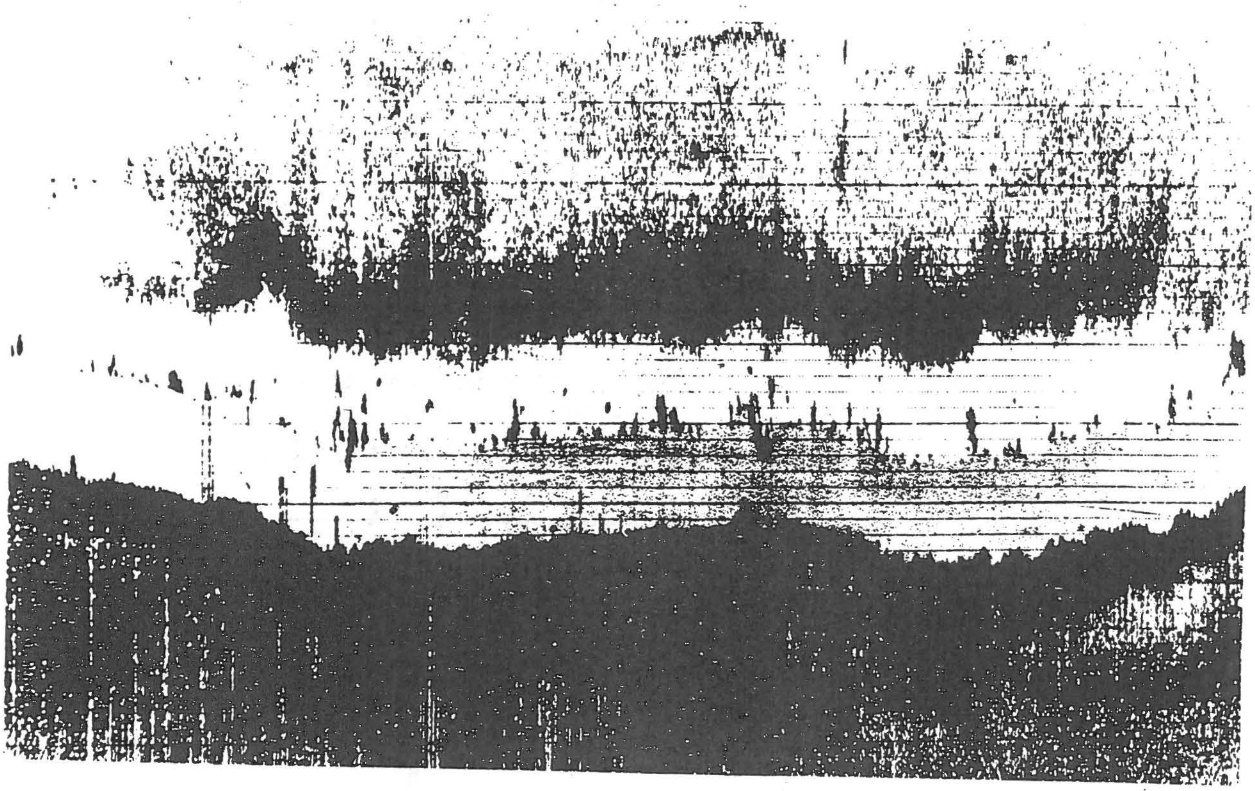


Fig. 1b) Representative profiles of the Tanzanian coast. Profiles between 08°48'S and 07°14'S are taken from the outer edge of the Mafia Shelf, and that at 06°57'S is taken at Latham Island. Others commence at the foot of the fringing reef slope.

Fig 2 Demersal fish populations on rough substrate at 65m depth off the East coast of Mafia Island



3. THE ARTISANAL FISHERY

An early estimate of total landings in Tanzania was provided by Hall (1962) who indicated that possibly 50% of the 20,000 tonnes/annum were landed in Zanzibar and Pemba. Fisheries Department statistics for total landings since 1971 show that there was a steady increase in effort and yield until the mid-seventies when they entered a continuing period of decline (Table 1).

The records suggest that the catch per fisherman has increased significantly since the early seventies and has not fallen despite the reduction in total catch. This increased efficiency probably arose as a result of the successful introduction of nylon gill nets which are stated to have increased from 2,900 in 1971 to 12,400 in 1981. A decrease in the number of relatively inefficient handlines was recorded during the same period.

The decline in total landings has resulted from a reduction in the number of fishermen and fishing vessels involved in the artisanal fishery. A recent socio-economic survey of the artisanal fishery in Kilwa District (Hasset 1983) has indicated that the exodus of fishermen from the industry may be caused by two factors in particular. Dynamite has been used to kill fish in inshore areas since the late 1960's, its use mainly centred on the urban areas of Dar es Salaam, Mtwara and Lindi. Although this method of fishing requires little skill and produces good returns in the short term, it causes widespread destruction of the coralline environment resulting in a decline in productivity and in the catch rates of traditional fisheries. The use of dynamite is increasing in response to extreme shortages of imported conventional gear, especially gill nets which now constitute the most important element in the artisanal fishery. This observation conflicts with the number of gill nets recorded recently by the Fisheries Department (FAO 1982). This gear shortage has also affected fishing effort in the Lindi/Mtwara regions (Wilkinson, personal communication) despite the provision of gill nets under the British Technical Aid Programme to fishermen in the region. The lack of hooks and nylon twines for handlining and for mending gill nets has forced many fishermen co revert to the use of traditional traps (Hasset 1983). It is suggested that the combination of falling catch rates from traditional gears, and the difficulty in obtaining imported gear has resulted in the reduced effort noted in the statistical record. Fish landings on Zanzibar and Pemba

Table 1. Marine Catch and Effort Statistics 1971-1981 (FAO 1979; 1982)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Total Catch (tonnes '000)	20.9	27.6	22.2	25.2	31.2	-	46.3	46.7	33.1	28.5	28.2
Number fishermen ('000)	8.2	8.5	8.2	8.3	8.5	11.2	10.0	9.8	8.1	7.0	6.5
Number of vessels	2.4	3.1	2.9	2.9	3.1	3.7	4.1	4.5	2.9	2.2	1.9
CPUE (tonnes/man)	2.5	3.2	2.7	3.0	3.7	-	4.6	4.7	4.1	4.0	4.3

were estimated to be 2,750 tonnes in 1974 rising to 10,757 tonnes in 1977 (FAO 1979). This increase is probably the result of improvement in statistical collection rather than the implied radical improvement in fishing practice. Recent estimates of fishing effort and total landings on Zanzibar and Pemba suggest that there has been a real and significant decrease in the catch per fishing vessel which has accompanied the increased landings:

YEAR	NO. VESSELS	CATCH	CATCH/VESSEL	
1975	2,000	8,500	4.25	(Tarbit 1976)
1977	2,844	10,757	3.78	(FAO 1979)
1981	6,370	15,000	2.35	(FAO 1982)

Thus it would appear that the artisnal fisheries of mainland Tanzania and the offshore islands are currently operating under differing conditions and constraints, whereby effort is falling on the mainland and increasing on the islands whilst efficiency is falling on the islands and maintaining previous levels on the mainland. It will be important for these problems to be carefully examined in the near future to enable necessary adjustments to the management regimes.

The inshore fisheries of Zanzibar were studied by EAMFRO during 1974-76 when data was collected from three major landings where the fishing effort concentrated on:

a. the shallow waters of the Zanzibar Channel including the patch reefs and inter-reef areas (Zanzibar Malindi);
b. the northern entrance of the Zanzibar Channel with access to the deepwater Pemba Channel (Mkokotoni);
c. the shallow mangrove-lined bays, Cymodocea beds and reefs of the east coast of Zanzibar (Chwaka).

These three environments are representative of much of the available inshore fishing area of the Tanzanian coast, and the recorded catchrates of artisanal fishing gear may be more widely applicable, although probably not to areas where dynamite fishing has been widely practised.

The artisanal fishery on Zanzibar deploys fishing gear as follows:

a. Traps

The Uzio or Wando are permanent stake traps in shallow waters, particularly found in Chwaka district, catching mainly Carangidae and Rays. Traditional chevron traps are of two types, Towe and the larger Dema. Dema are usually set in open areas such as the Cymodocea beds of the reef flats and the major components of their catch are Siganidae and Labridae. In the coralline areas where the Towe are set, catches are dominated by Lethrinidae, Scaridae and Scolopsis spp. Zanzibari fishing vessels operate an average of 9-10 traps each.

b. Handlines

Handlines are used on the patch reefs of the Zanzibar Channel to produce catches dominated by Lethrinidae. At the northern edge of the Zanzibar Channel where small pelagic species seem concentrated, handlines make substanital catches of the predatory Sphyraenidae, and on the reef bound eastern coast of Zanzibar, the catch of Lutjanidaie is important. Trolling lines are used by most fishermen during the seasonal abundance of Scombero-movrus spp.

c. Seines

The Juya is an open water or beach seine, up to 400m in length and operated by at least two vessels and a large number of men. It is frequently set around patch reefs which are then broken up to force fish into the net and the catches often contain a significant proportion of immature fish. Despite these destructive aspects, the Juya is the only gear currently capable of exploiting the substantial stock of reef-bound pelagic fish, such as Caesio spp and catch rates may be high.

d. Gillnets

Traditionally, the large mesh Jarife with mesh sizes up to 16" have been set to catch rays, sharks and turtles in the Zanzibar Channel. Smaller mesh nylon gillnets, Nyavu, of 5-6" mesh were introduced in the late 1960's and have greatly increased in popularity, especially at Mkokotoni where 70% of the catch is Scombroidea, especially Euthynnus affinis and Scomberomorus spp.

e. Scoop nets

Small pelagic species are concentrated by light and landed with surface scoop nets. This fishery operates during moonless periods in the Zanzibar Channel and large catches may be made, especially during the period of the NE Monsoon.

The catch per vessel and proportion of landings derived from these fishing gears is presented in Table 2, with the species composition of the catch. The data indicate the complex nature of the artisanal fishery. The gear deployed in each area reflects the capacity of the area to sustain catches. Access to the Pemba Channel has encouraged the fishermen of Northern Zanzibar to concentrate largely on gillnet fishing for large pelgic species, whilst at Chwaka, the east coast fishermen exploit the extensive reef flats with traditional traps. The large expanse of the shallow Zanzibar Channel with its patch reefs have led to the substantial use of seines and scoop nets for reef-associated small pelagic species. Consequently, it is difficult to make accurate estimates of the potential yield from inshore fisheries without careful examination of the coastal topography.

Based on his calculation of shelf area and Fisheries Department Statistics, Wijkstrom (1974) calculated the relative yield of the coastal fishery as follows:

Region	Tonnes/km^2
Mtwara	4.5
Lindi	5.7
Coast	0.8
Tanga	2.4

Table 2. Parameters of the Artisanal Fishery in three Districts of Zanzibar (CPUE expressed in kg/vessel/day)

	Zanzibar (Malindi)	Mkokotoni	Chwaka
No. landings sampled	2,730	2,112	2,166
Total recorded catch (kg)	139,885	73,842	28,744

Fishing Gear	CPUE	% Total Landings		CPUE	% Total Landings		CPUE	% Total Landings	
Traps		14.0			9.9			47.7	
Dema	19.1		6.0	18.6		6.5	19.5		39.3
Towe	17.0		8.0	11.6		3.1	9.2		2.1
Uzio	-		0			0.3			6.3
Handline	17.7	14.3		16.1	0.4		11.3	15.4	
Seine	217.0	37.6		72.9	1.1		26.0	32.3	
Gillnet	43.0	18.6		39.9	87.6		22.7	2.4	
Others (speargun, scoopnets)	-	15.9		-	1.0		-	1.9	

Species Composition of Landings		%		%		%
	Rays	26.0	Euthynnus affinis	34.6	Lethrinidae	25.7
	Scomberomorus spp	11.4	Rays	13.0	Siganidae	22.[illegible]
	Caesio spp	9.7	Sailfish/Marlin	10.2	Scaridae/Labridae	12.[illegible]
	Scolopsis spp	7.2	Lethrinidae	8.4	Lutjanidae	7.2
	Lethrinidae	6.3	Sharks	6.9	Mullidae	6.[illegible]
	Rastrelliger spp	4.1	Siganidae	5.9	Carangidae	5.[illegible]
	Sailfish/Marlin	3.8	Scomberomorus spp	5.6	Epinephelidae	4.1

Table 3. Variation in Catchrate and Species Composition in Short Setline Catches off the Mafia Shelf

Depth Range (m)	45-60	60-75	75-120	120-250
Catch Rate (kg/100 hooks)	33.2	20.9	19.5	15.9

Species Composition	Rough Substrate	%	Coral Rubble	All Substrates	
		19.4	Lethrinella wagiensis	Pristipomoides spp	31.9
	Lutjanus sanguineus	15.9		Sharks	29.8
	Lutjanus bohar	9.7		Etelis spp	10.6
	Epinephelus flavocaeruleus	5.2		Epinephelus spp	7.6
	Lutjanus rivulatus	2.7		Polysteganus spp	6.9
		2.5	Lethrinus nebulosus		
		1.7	Lutjanus sebae		
	Sharks	17.3	Sharks		

On this basis he forecast a great potential for increased fishing in Coast and Tanga regions. However, much of the fishing effort at that time was strongly associated with reefs and little fishing occurred in the interreef areas of the Zanzibar and Mafia Channels (Darracot 1977). When the data was recalculated and related to the area of reef in each region, the relative yields were comparable, as was a similar calculation for the fishery of Zanzibar (Tarbit 1975).

Region	Tonnes/km^2
Mtwara/Lindi	4.88
Zanzibar Channel	4.78
North Tanzania Coast	5.64

A potential yield of 5 tonnes/km^2 was subsequently adopted for coralline coastal areas based on yields from trap fisheries in the SW Indian ocean (FAO 1979). The daily catch per trap varied from over 5.0 kg on the lightly exploited reefs of Mahé in the Seychelles, to 1.0-1.5 kg on the over-exploited reefs of Mauritius. The Tanzanian catch rate of 2.4-4.5 kg was considered to represent an optimum rate of exploitation. The average catch in the Zanzibar fishery was 1.1-2.1 kg/day which may therefore indicate excessive fishing pressure since the size and method of use of the traps are common to the whole SW Indian Ocean region. It is of interest to compare these figures with catchrates on the Caribbean reefs where average daily catches were 2.7 kg, with heavily exploited reefs yielding only 0.3 kg (Munro 1977).

Recent work indicates that the density of the fish population and thus the potential yield from shallow tropical coastal shelves depends largely upon the extent of coral cover (Nagelkerken 1977). Whilst the whole reef ecosystem to 100m depth may produce yields of 3-6 tonnes/km^2 (Marshall 1980) dense reef structures are relatively more productive and fisheries on such substrates may yield more than 8 tonnes/km^2 (Hill 1978, Alcala and Luchavez 1981).

4. EXTENSION OF THE ARTISANAL FISHERY

Traditionally the coastal fishery has concentrated on exploitation of the reef and reef flats and the use of gill nets in the inter-reef and offshore areas is a relatively recent introduction. The Mkokotoni fishermen have shown that substantial catches of large pelagic species can be made by the artisanal fishery whilst Darracot (1977) revealed potenital for a gill net fishery in the inter-reef areas of the Zanzibar Channel, probably equally applicable to the Mafia Channel. Previous records of gill net fishing on the East African Coast are encouraging. A Malindi fishery for the same species as recorded by Darracot yielded 7.9 kg/net/night (Anon 1968) whilst a trammel net fishery in the Zanzibar Channel caught 8 kg/net/night (Hall 1962). Current catch rates in the Zanzibar fishery average 10.8 kg/net/night in the Zanzibar Channel and 9.2 kg/net/night at Mkokotoni.

Further expansion of the gill net fishery is probably hindered by the inability of the fishermen to obtain imported nets and twines and the low output of locally manufactured netting.

Given the probability that the fishery potential of the reef environment is being fully exploited, any extension of this fishery must explore new grounds. The logical step is to move further offshore and adapt traditional fishing gear to operate in deeper waters on the reef slope. The reef slope extends from the foot of the fringing reef to a depth of 70-100 metres where it descends steeply to 300m. A marked thermocline is usually located at depths between 80-110m (Newell 1957, 1959).

The reef slope carries substantial densities of fish as revealed in Figure 2. Both the reef slope and the sub-thermocline depths to 300m provide good catch rates to hook and line fishing, whilst the observation that herbivorous fish form up to 50% of reef populations (Talbot 1965) suggests that this slope may also provide some return to trap fishing. Trawl fishing at 60m depth on the Seychelles plateau produced catches of species normally exploited by trap fishing in shallow water (Tarbit 1980), and some of the species of the shallow reef trap fishery of the Tanzanian coast may occur at depth on the reef slope.

Handline fishing in shallow waters produced catch rates of between 7 kg/vessel/ day (Morris 1971) and 11-17 kg vessel/day (Tarbit 1976). Elsewhere in the SW Indian Ocean, handline catches on deeper substrates, at 40-70m, are significantly higher.

North Kenya Banks	10-14.5 kg/line/hour (Allfree 1956,1957,1958,1961)
North Kenya Banks	5.0 kg/line/hour (Morgans 1964)
Seychelles Plateau	9.5-17.0 kg/line/hour (Wheeler and Ommanney 1952)
Amirante Plateau	4.5-6.8 kg/line/hour (Harris 1980)

It was recorded that vessels operating from Dar es Salaam fished depths of 35 fathoms and recorded catches of up to 10,000 fish in trips of 60 days (Anon 1966). Assuming an average weight of 5lb this represents a catchrate of 380 kg/vessel/day.

It is likely that artisanal fishing with handlines would make good catches on the reef slope, but the strength of the East African Coastal current prevents regular exploitation in this manner. In order to explore the potential for this fishery, EAMFRO conducted exploratory and experimental fishing exercises with handlines, droplines and longlines during the period 1969-1976, with most of the effort concentrated on the deep reefs at the entrances of the Mafia and Zanzibar Channels. The major problem was to counter the limited efficiency of the hook by deploying a large number of them in an efficient manner. Droplines were unable to catch fish at commercial rates because of the limited number of hooks (Morris 1972) whilst longlines of traditional length were difficult to set and retrieve in the strong currents and on the rougher substrates where catch rates were high. A short setline was evolved which could be rapidly and easily operated, accurately placed, and which would allow a daily fishing effort of over 2,000 hooks. The effectiveness of this gear was tested along the whole length of the Tanzanian coast (Tarbit 1975; 1976).

The species composition and catchrate varied with depth and with the nature of the substrate as shown in Table 3. In addition to the reduction in catchrate with depth, recorded in Table 3, yield varied from rates up to 50 km/100 hooks on rough substrates to less than 35 kg/100 hooks on open substrates of coral rubble. Areas of rough substrate were only extensive at the entrances of the Mafia Channel. The reef environment is an important nursery area for species of the reef slope, but the sub-thermocline populations seem to be independent of the shallow reefs and their early life history is unknown.

Variations in the depth of the thermocline have been recorded which may enable cold, sub-thermocline water to flow on to the surface of the deep reef slope (Newell 1959). The occasional catches of Pristipomoides spp and other sub-termocline species at relatively shallow depth (50-70m) is thought to be associated with the phenomenon.

Table 4 indicates the potential daily catch rate with an assumed effort of 2,000 hooks/day. The figures suggest some potential for semi-industrial fishing at the Northern and Southern entrances to the Mafia shelf where the area available for exploitation may exceed 500 km^2, and initial catch rates may approach 1 tonne/day. In areas other than these, catch rates may be expected to vary between 200-400 kg/day. The high catch rate of sub-thermocline species in the Pemba Channel (4^oS-5^oS) is significant since this area has already been exploited by an artisanal fishery operating handlines for Pristipomoides and Etelis species, and it was recorded that "bites come immediately and regularly indicating considerable density of fish" (Smith 1954).

Table 4. Short Setline Catch Rates off the Tanzanian Coast

	Depth Range								
	50-100 (m)			100-200 (m)			200-400 (m)		
Latitude (^{o}S)	E	C	CPD	E	C	CPD	E	C	CPD
4	1,026	135	263	605	214	707	416	27	130
5	3,275	382	233	952	122	256	616	199	646
6	1,399	187	267	463	133	574	621	123	396
7	4,039	2,030	1,005	260	52	400	-	-	-
8	1,171	293	500	638	66	207	130	5	77
9	360	54	300	130	20	307	-	-	-
10	182	27	296	159	0	-	-	-	-

E = effort in No. hooks
C = Total catch in kg
CPD = Catch per day in kg/2,000 hooks

Dense populations of sub-thermocline fish were also recorded in the Seychelles (Forster et al 1970) where droplining produced 564 fish from 548 lines and catches of quality fish exceeded 100 kg/100 hooks, the greatest proportion of the catch being Etelis spp. A Japanese fishery in the NE Indian Ocean fished a narrow band of reefs at 80-120m depth off the Malayan and Thai coasts yielding 350-850 kg/day, mainly of Pristipomoides spp (Senta et al 1973). Artisanal fisheries using recently developed methods for line fishing on the deep reefs at depths of 40-110 fathoms around Pacific islands have reported acceptable catch rates with a species composition similar to that recorded off Tanzania (Eginton and James 1979).

New Hebrides	3.5 kg/line/hour
Western Samoa	4.1 kg/line/hour
Cook Islands	3.5 kg/line/hour
Tuvalu	2.5 kg/line/hour
Solomon Islands	5.7 kg/line/hour

An attempt to estimate the density of fish on the reef slope off the Mafia shelf based on the probable range of attraction of the baited hook during a soaktime of one hour, produced figures of 15 tonnes/km^2 for rough ground and 3.8 tonnes/km^2 for substrates with less profile. This enabled an estimate of approximately 3,000 tonnes for the standing stock of species available to a line fishery on the Mafia shelf (Tarbit 1975). The validity of the method is not established, although similar values (0.3-14.0 tonnes/km^2) were calculated by Gulland (1970) from the data of Wheeler and Ommanney for handline caught fish on the Seychelles plateau.

5. CONCLUSION

Although currently experiencing difficulty in obtaining imported fishing gears the artisanal fishermen of Tanzania are approaching the upper limit of exploitation on their traditional fishing grounds and any expansion must be directed further offshore. This is especially true of the extreme northern and southern coasts where the shelf is narrow and largely occupied by the heavily exploited reef associated structure which are suffering damage and reductions in productivity due to the activities of dynamite fishermen.

On the more extensive shelf areas of the Coast region, an improvement in the supply of gill nets would enable substantial increases in fishing effort on the flat substrates of the inter-reef areas and near the edges of the shelves.

The operations of EAMFRO were limited to the conduct of research programmes and the organisation had no authority for any involvement in the transfer of exploratory fishing studies to pilot scale development. This is a function of the Fisheries Department and the successful development of reef slope fishing on a scale large enough to influence annual landings will greatly depend on the ability of the Fisheries Department to influence and encourage artisanal fishermen. Working closely with the Fisheries Department and the local fishermen, the Coastal Fisheries Development Project of the British aided Lindi/Mtwara RIDEP will seek to achieve this extension of the artisanal fishery in the coastal waters off Southern Tanzania.

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Addendum

Recent information provided by the Department of Fisheries in Dar es Salaam indicates that in 1982, fish landings slumped to 20,000 tonnes whilst the number of fishermen increased slightly to 7,870. Thus the catch per fisherman was approximately 2.5 tonnes/year and has apparently fallen significantly, reaching the level recorded in 1971. This parallels the reduction in fishing efficiency of the artisanal fishermen of Zanzibar which was recorded on p.34 of this report. It therefore becomes more likely that the reduction in total catch results from the inability of fishermen to obtain imported gill nets, the failure of local industry to supply enough nets to meet the demand, and the reluctance of fishermen to return to traditional, less effective fishing methods.

TANZANIAN MARINE FISH RESOURCES IN THE DEPTH REGION 10-500 m INVESTIGATED BY R/V "DR.FRIDTJOF NANSEN"

By

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ABSTRACT

During 1982-1983 three surveys were carried out in Tanzanian waters by the R/V "Dr.Fridtjof Nansen". The fish resources in the depth region from 10 m to about 500 m were investigated and the main hydrographical regime was charted.

The distribution and abundance of fish were investigated acoustically and by trawling. The estimated fish biomass in the investigated area varied between 100 000 and 175 000 tonnes during the three surveys. The estimates do not include the areas within the reef. This is a very productive area where the fishery takes place to day.

The main part of the biomass was observed in waters shallower than 200 m and particularly in waters shallower than 50 m. The potential yield in the investigated area was estimated at 25 000-45 000 tonnes. This indicates that by extending the fishing area beyond the reef the potential catch may increase by 50-100% However, a rather large portion of this yield will be silver bellies which are of limited value for the fish market. The observed fish density was generally too low to support any significant trawl or purse seine fishery. Therefore the first step to increase the catch of today, will be to introduce the traditional fishery from the inner area to the area outside the reef.

1. INTRODUCTION

1.1. Programme and objectives

By agreement between the Government of the United Republic of Tanzania and the Norwegian Agency for International Development (NORAD), the fishery research vessel "Dr.Fritjof Nansen" carried out three surveys of the fishery resources in Tanzanian waters in 1982-1983.

During these surveys the fish resources living in the depth region 10-500 m were investigated, and the hydrographical situation was studied. The programme was carried out by a joint team of Norwegian and Tanzanian scientists. The timing and the scientific staff of the different surveys are shown in Table 1.1. A cruise report was presented after each survey

(Anon, 1982a, 1982b, 1983). Later in this report the surveys are referred to as number one, two and three.

1.2. General geographical description

The coastline of Tanzania extends from the northern boundary with Kenya, latitude 4°38'S to the southern boundary with Mozambique, latitude 10°30'S (Fig. 2.1.). The coastline has a total length of approximately 800 km. There are many small and medium sized islands, most of which are fringed by coral reefs. The biggest are Zanzibar, Pemba and Mafia, in that order.

The two typical seasons are the Southwest Monsoon which lasts from April to October/November and the Northeast Monsoon from November to March (Newell, 1957). The Northeast Monsoon period is climatically characterized by higher air temperatures, lower wind speeds and consequently calmer sea. During the Southwest Monsoon the air temperature is lower, the wind stronger and the sea is rougher. The short rains occur intermittently between September and December (Bwathondi, 1980). The coast receives the heavy rains between March and May.

Table 1.1. Timing and scientifi staff of the three surveys with R/V "Dr.Fridtjof Nansen" in Tanzanian waters.

Survey No.	1	2	3
Time	16 June-8 July 1982	12 Nov-3 Dec 1982	11-26 May 1983
Staff:	NORWAY	NORWAY	NORWAY
	H. Kismul	S.A. Iversen*	K. Hansen
	K. Lauvås	H. Kismul	S. Myklevoll
	S. Myklevoll*	S. Myklevoll	R. Sætre*
	B. Bakken	B. Bakken	B. Bakken
	T. Mørk	E. Øvretveit	H. Abrahamsen
	TANZANIA	TANZANIA	TANZANIA
	M.M. Hassan	P.K. Chisara	E.F.B. Katunzi
	K.M. Lwiza	O.S. Faki	S.P.N. Kimaro
	B.A.S. Mwamoto	M.V. Haule	G.D. Msumi
	M.A.K. Ngoile	M.A.K. Ngoile	H.B. Pratap
	J. Yonazi	J.Yonazi	
		FAO	
		G. Bianchi	

*)Cruise leader

The major rivers of Tanzania (Fig. 2.1.) are: Pangani, Wami, Ruvu, Rufiji, Mbwemkuru and Ruvuma. The peak outflow from these rivers occurs in

March-May. However, the influence of the freshwater outflow from the rivers is restricted to the inshore waters, most probably due to the prevailing wind and current conditions. Fig. 3.6.1. shows that all patches of low salinity are moved slightly northwards, even for a big river like the Rufiji. The rivers carry a lot of silt which builds up deltas, e.g. the Rufiji delta which covers about 400 km^2. Mangrove trees thrive at the river mouths. The trees are important for productivity of the inshore waters.

The Rufiji mangrove forest is the largest single stand on the eastern shore of Africa. The Rufiji delta is today the most important source of prawns in Tanzania, producing over 80% of the total prawn catch (Mwaiseje, 1982).

The continental shelf is generally narrow. The minimum width to the 200 m depth contour is less than 2 km at latitude $9^{o}30'$S. The maximum width is approximately 80 km at latitude $6^{o}25'$S, this includes the Zanzibar island. Unlike Zanzibar, Pemba island does not form part of the shelf. It is separated from both the mainland and Zanzibar by a deep channel.

2. MATERIAL AND METHODS

As shown in Table 1.1. three surveys were carried out along the Tanzanian coast with the R/V " Dr. Fridtjof Nansen" during 1982 and 1983. Two surveys in 1982 covered the total coast, while the survey in May 1983 covered the area north of Kilva Kiwinje. The survey courses, hydrographical and fishing stations for each of the surveys are shown in Figs. 2.1.-2.4. During the first survey the Pemba and Zanzibar channel was covered twice (Fig. 2.1. and 2.2.). During the first survey the area was covered for hydrographical and acoustical purposes. During the second survey many trawl hauls were carried out in the Pemba and Zanzibar channel and on the east coast of Zanzibar.

For collecting hydrographical data such as temperature, salinity and oxygen content, reversible Nansen water bottles were applied at the depths 5, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400 and 500 m. Samples from the surface were collected by a bucket. During the first survey (Fig. 2.1.) eight hydrographical sections were carried out. These sections were repeated during the second survey (Fig. 2.3.). During the third survey three of the sections were repeated (Fig. 2.4.), and a rather dense net of stations for observing temperature and salinity in the surface was added.

The R/V "Dr. Fridtjof Nansen" is equipped for acoustic investigations of fish abundance. The vessel has three scientific sounders (120, 50 and 38 kz), two echo integrators, one sonar and one net sonde (50 kHz). Each of the integrators has two channels. One of the integrators was connected to the 38 kHz sounder with the two channels operating in 4-50 m and 50-250 m. The other integrator operated together with the 120 kHz sounder in the two depth intervals 4-50 m and 50-100 m varying with depth. Echo integrator values were read as mm deflection for each nautical mile and averaged every fifth nautical miles. These readings were scrutinized daily. Integrator values from false bottom and those caused by non-biological targets were deleted. The integrator readings were divided into the cate-

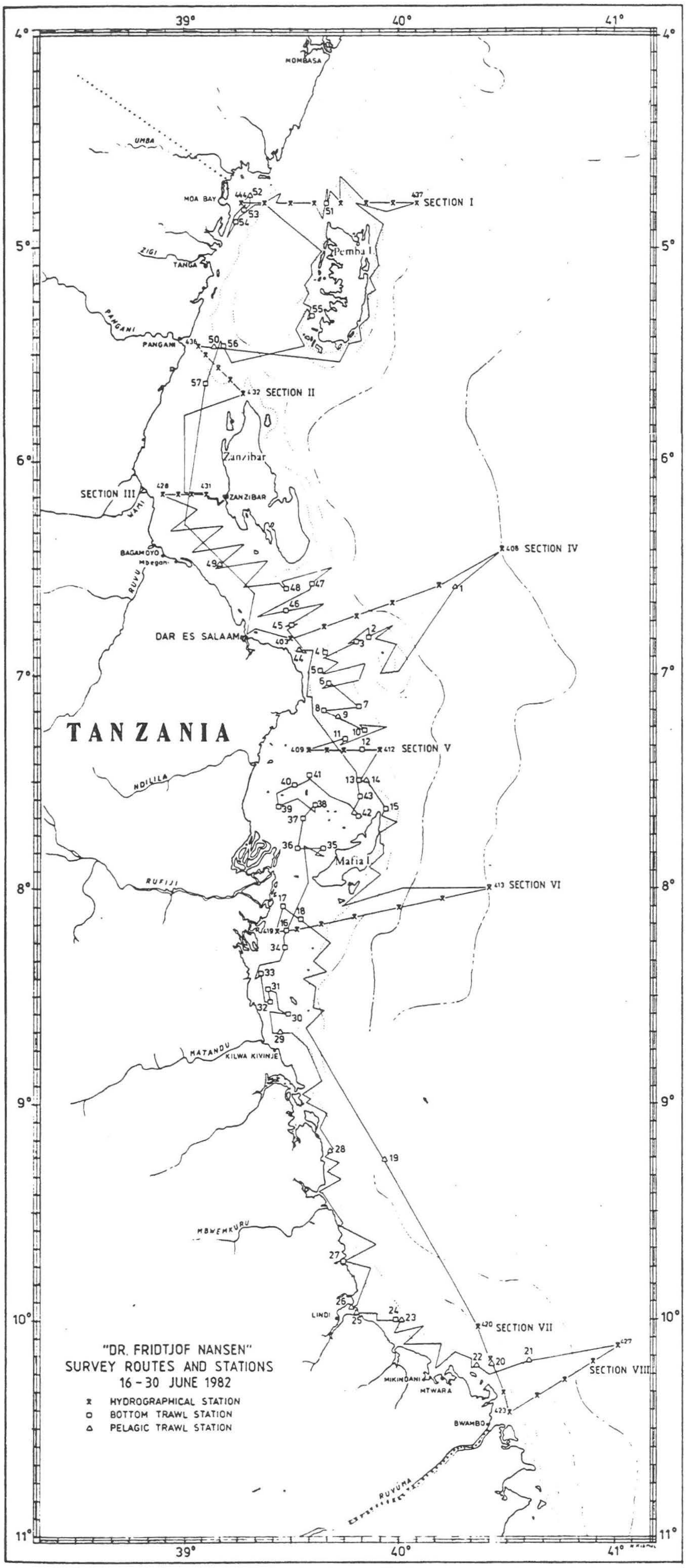

Fig. 2.1

Survey routes and stations during the first part of the first survey (16-30 Jun 1982).

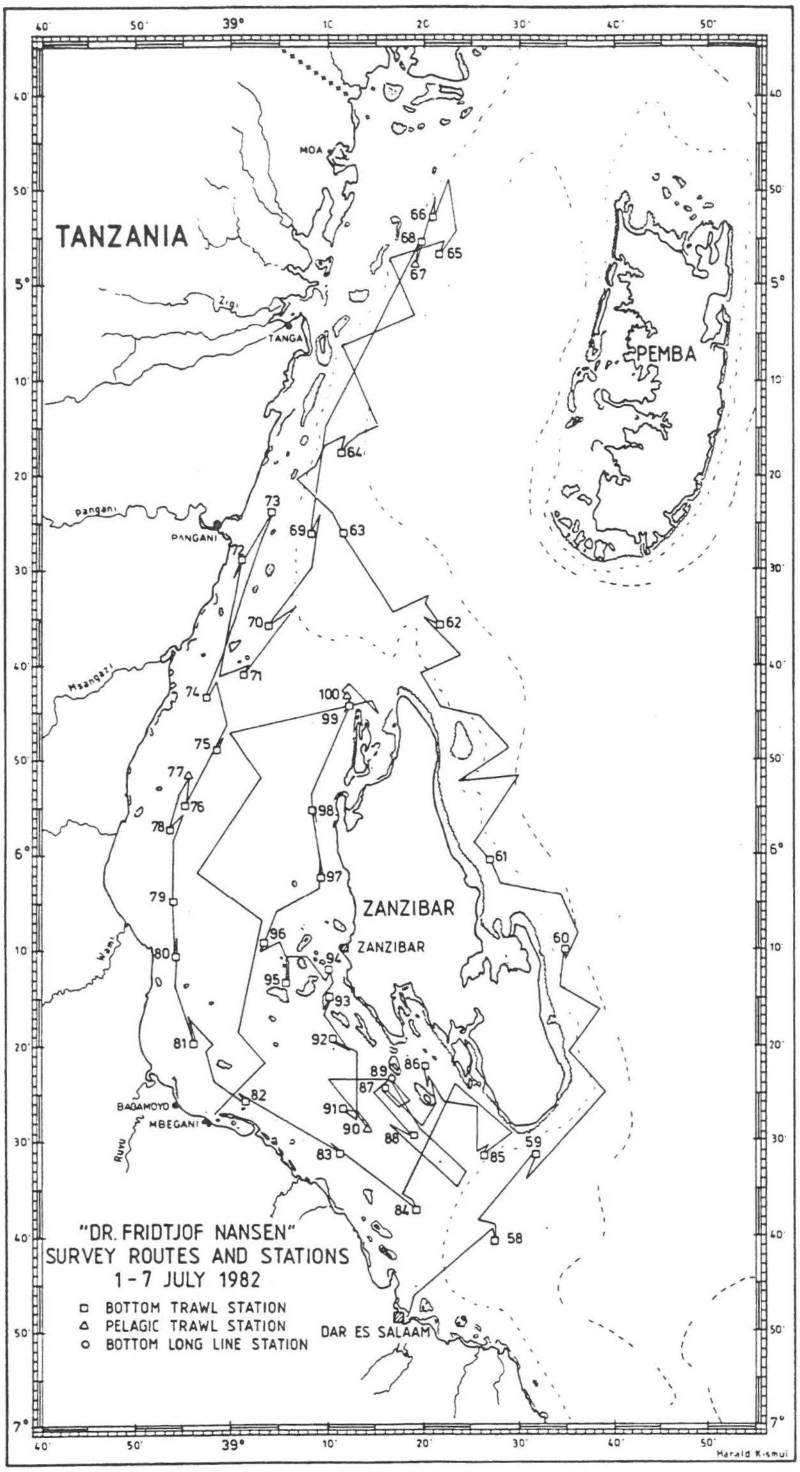

Fig. 2.2. Survey routes and stations during the second part of the first survey (1-8 Jul 1982).

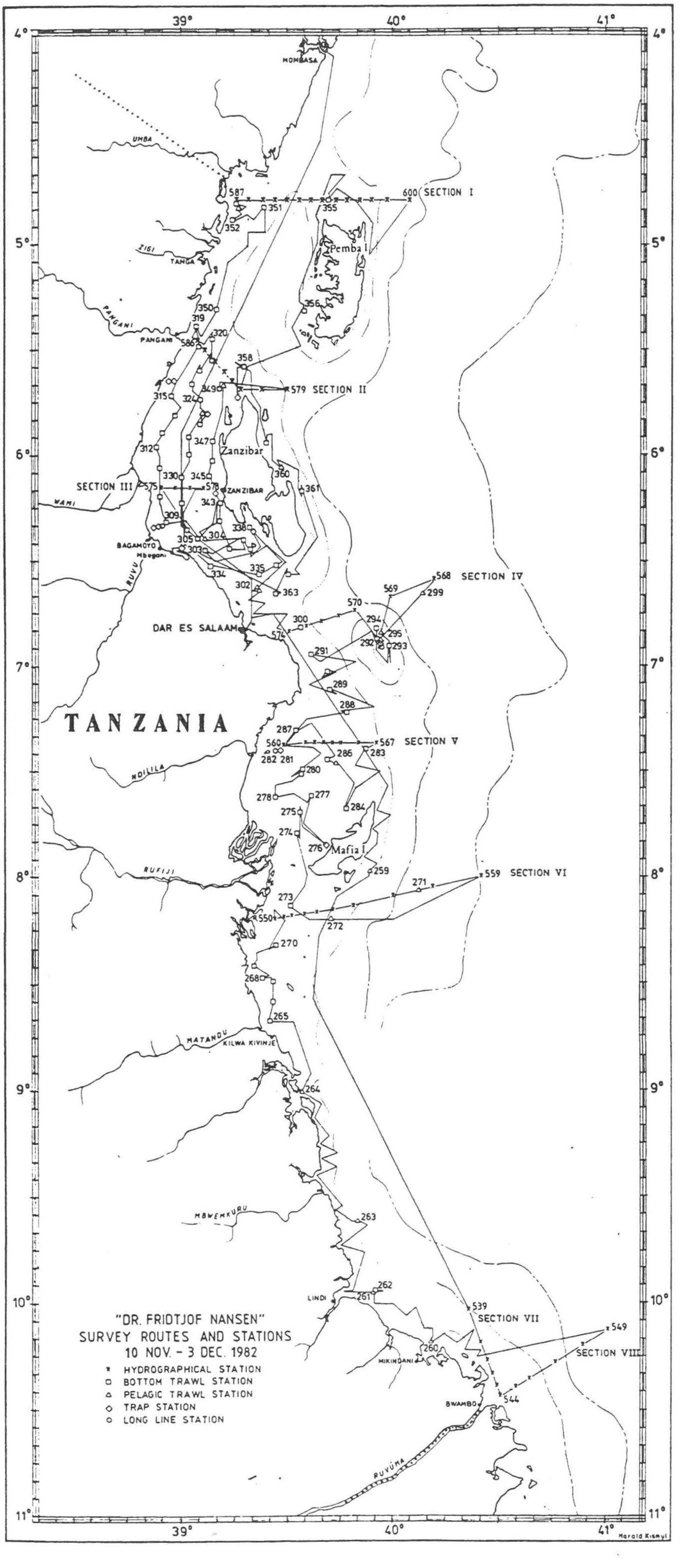

Fig. 2.3

Survey routes and stations during the second survey.

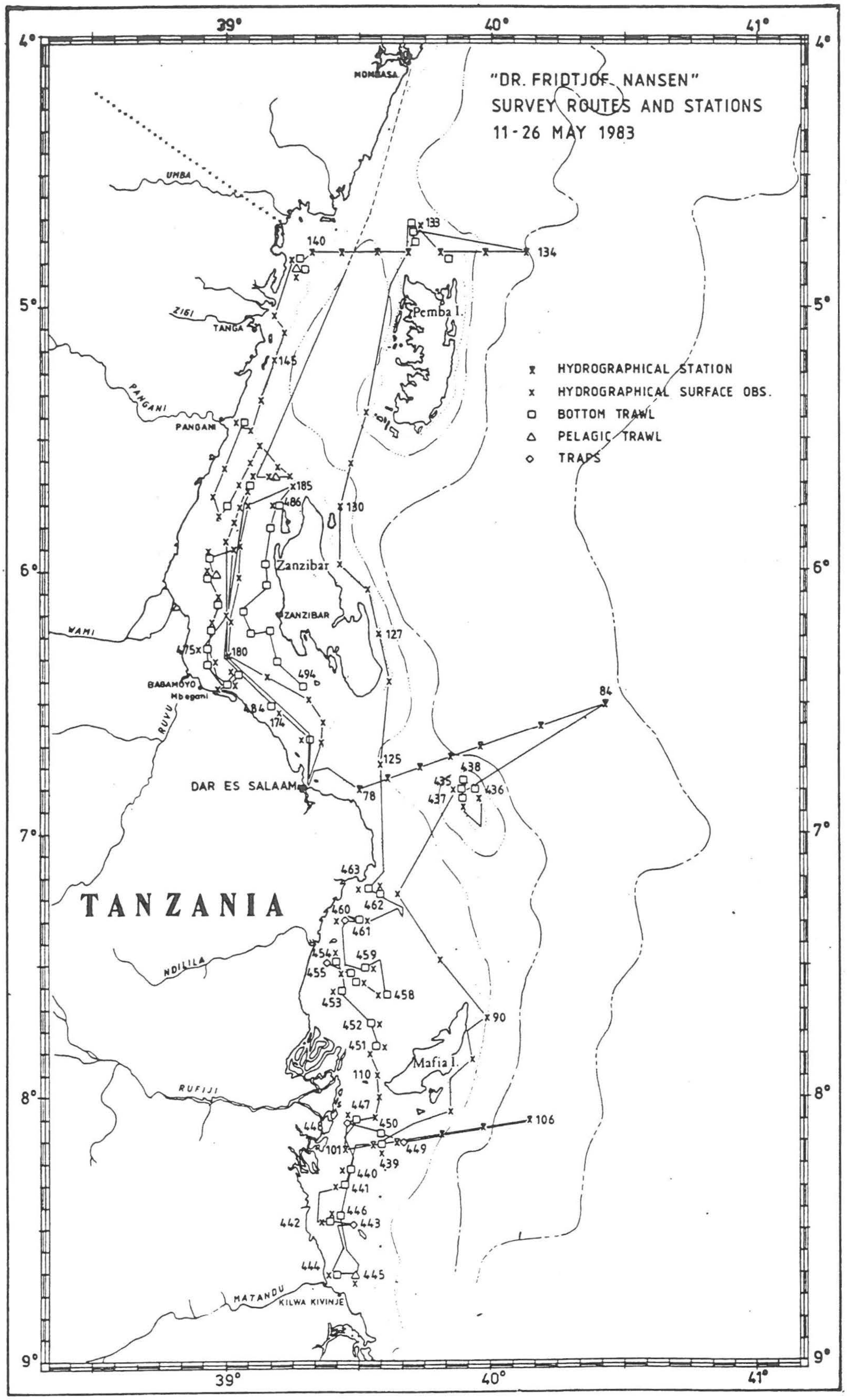

Fig. 2.4. Survey routes and stations during the third survey.

gories: plankton/fish larvae, mesopelagic fish, pelagic fish and demersal fish. In the shallow areas the two latter categories were impossible to separate, therefore readings were assigned to the category "fish". Average values for the fish readings were calculated within rectangles of 30 x 15 nautical miles.

The R/V "Dr.Fridtjof Nansen" is equipped with a demersal trawl and a pelagic trawl. The specifications of the trawls are given in Table 2.1. Pelagic trawl hauls were carried out either to identify scattering layers or to investigate the surface layer for fish. The net sonde was connected to the pelagic trawl to control that the correct depth was sampled. However, rather few pelagic trawl hauls were carried out, because pelagic scattering layers of fish were scarce and poor.

Table 2.1. Specifications of the trawls.

Demersal trawl:	High opening shrimp and fish trawl with rubber bobbins. Headline 41 m. Height during trawling, about 6 m. Mesh size in the wings 40 mm, gradually reduced to 20 mm in the codend.
Pelagic trawl:	Capelin trawl. Width about 41 m. Vertical opening during trawling about 15 m. Mesh size in the codend 21 mm.

The demersal trawl hauls were placed at random in trawlable areas. The same areas were trawled during each survey. The effective trawling time was 30 minutes with a speed of 3 knots. All the demersal trawl hauls were carried out during daytime. On the basis of these randomly chosen stations, fish biomass estimations could be carried out according to the swept area method. The investigated area was divided into different strata geographically and according to depth. The areas chosen (Fig. 2.5.) were the Pemba area (04°30'-05°35'S), Zanzibar area (05°35'-06°35'S), Mafia area (06°35'-09°-00'S) and the Southern area (09°-10°40'S). The depth intervals in the areas were chosen as less than 20 m, 20-50 m, 50-200 m and deeper than 200 m. The average fish density based on demersal trawl catches were calculated for each stratum. The fish density was obtained from the mean catch rate and the area swept by the trawl. The area swept by the trawl is the distance between the trawl wings (18.5 m) multiplied by the trawling distance. The efficiency of the trawl or the ability to catch is a very important parameter for such investigations. As little is known about this, the efficiency was set at one which means that all fish ahead of the trawl was caught. By multiplying these densities by the size of the stratum the fish biomass could be estimated. The size of the areas for the different depth intervals were measured with a planimeter (the U.K. Admirality charts

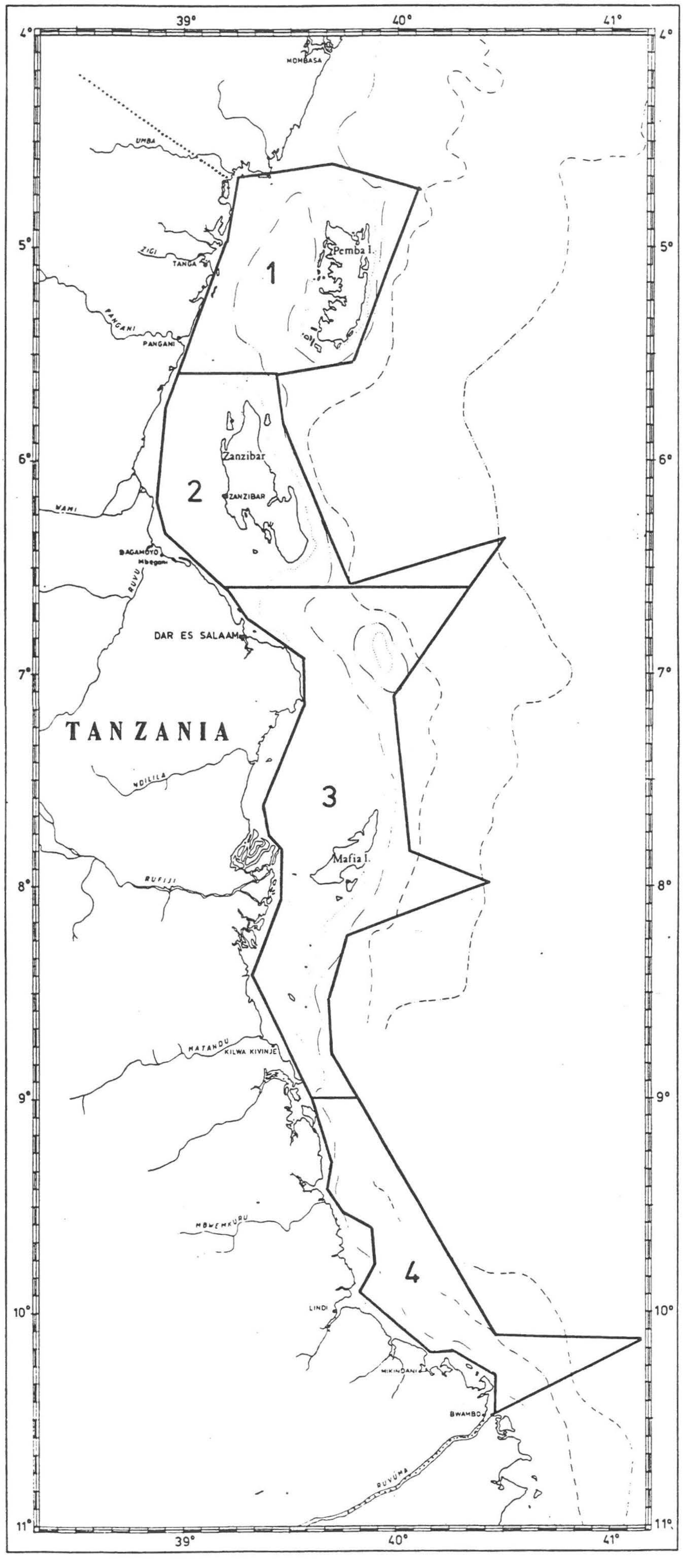

Fig. 2.5

The investigated areas:

1) Pemba
2) Zanzibar
3) Mafia
4) The Southern area

No. 3309 and 3310). The standard areas shown in Fig. 2.5. were surveyed three times north of 09°00'S and two times south of this border.

The most important species were measured by length and weight. Small species were measured to the nearest 0.5 below, while larger species were measured to the nearest 1 cm below.

During the second survey parallel trawling was carried out at four fishing stations by the Mbegani fishery training vessel "Mafunzo" and "Dr.Fridtjof Nansen". These trawl hauls were made in the western part of the Zanzibar Channel (Trawl stations 312-315, Fig. 2.3.) in the depth region 19-45 m. "Mafunzo" is equipped with a North Sea "Calypso" trawl made in Norway. The opening of this trawl is about 2.5 times that of the "Dr.Fridtjof Nansen" trawl.

In selected areas longlines and special fish traps were used (Figs. 2.1.-2.4.). The fish trap which is collapsible, consists of aluminium and iron frames (130 x 45 cm), floats and net. The traps were usually used in chains of five.

Fig. 2.6. shows a fish trap floating and expanded due to the floats attached to the upper (aluminium) frame.

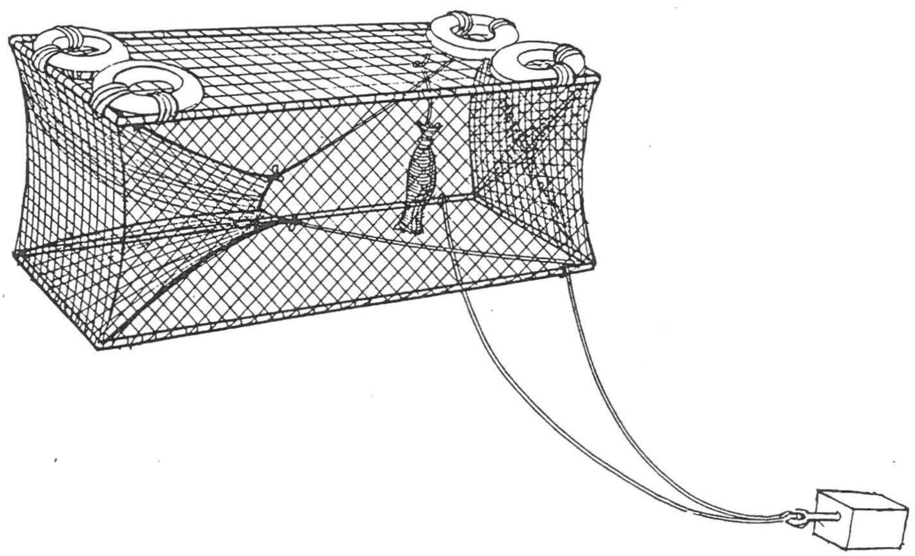

Fig. 2.6. The collapsible fish trap.

3. HYDROGRAPHY

3.1. Introduction

The South Equatorial Current (Fig. 3.1.1.), situated at about the latitude of 10°S, diverges at Cape Delgado as it impinges on the coast, and feeds the

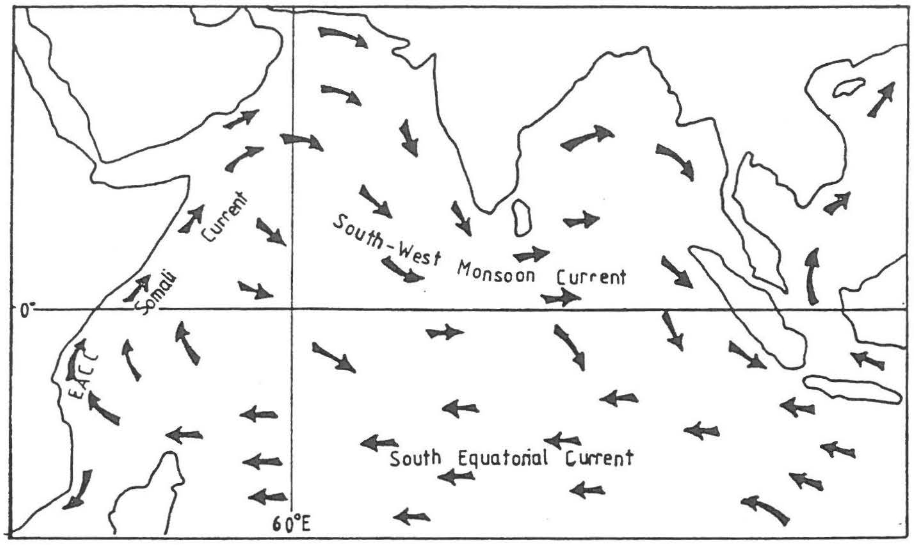

Fig. 3.1.1. The surface currents of the Indian Ocean in the Northern summer.

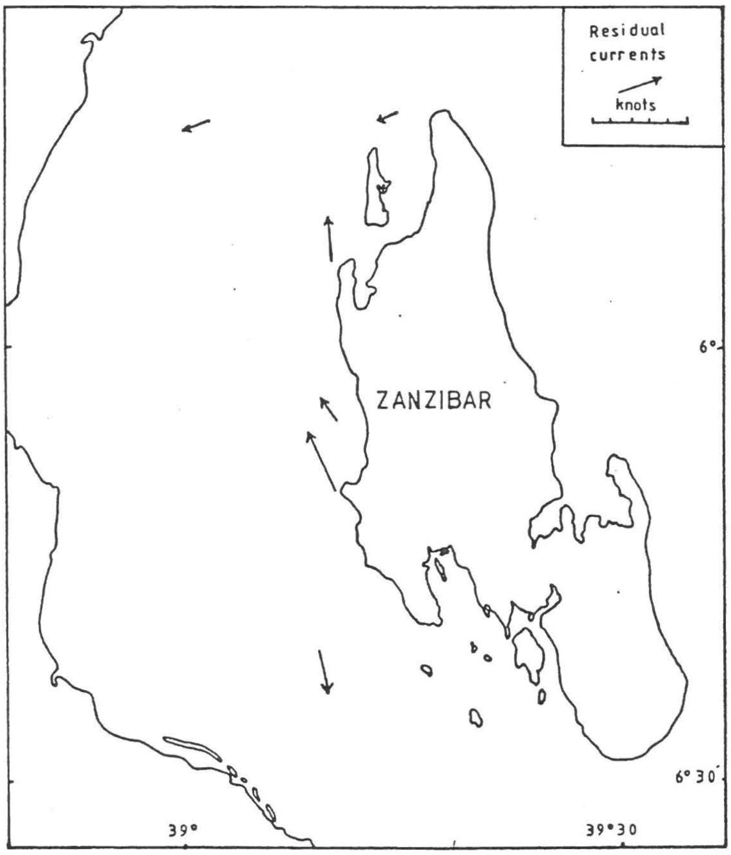

Fig. 3.1.2. Residual currents in the Zanzibar Channel (Harvey, 1977).

south-flowing Mozambique current and the north-flowing East African coastal current (Newll, 1957). The velocity of the East African coastal current varies between 2 and 0.25 m/s, being faster during the Southwest Monsoon season. During the first survey there were no current measurements done with the exception of station 408 on section IV where the current was found to be 1.4 m/s with direction 342°.

Most authors consider that the East African coastal current, which flows northwards off the coast of Tanzania throughout the year, leads to northward flow through the Zanzibar Channel and still persists during the Northeast Monsoon. Harvey (1977), however, analyzed current measurements from H.M.S. "Dalrymple" (from surveys done between 1951 and 1954) and found that the vector mean residual currents at three of the six positions in the channel had a southward component, see Fig. 3.1.2. He claims that the majority of the observations used were made during or at the end of the Southwest Monsoon, and none was made during a period of predominantly northerly winds.

Fig. 3.1.3. shows that the tidal amplitudes on the Tanzanian coast are comparatively larger than most places in the Indian Ocean. The mean neap and spring tidal ranges, for Dar es Salaam, are 1.1 m and 3.3 m, respectively. The ranges for other places on the coast do not differ very much from these values.

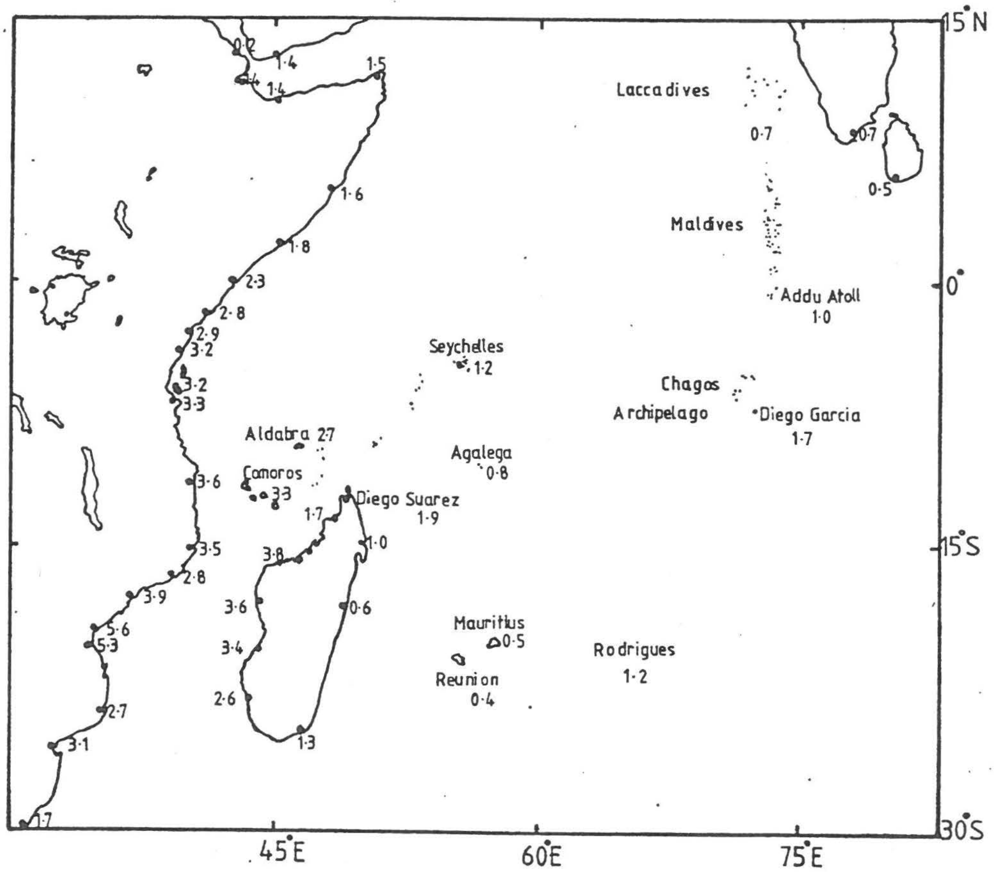

Fig. 3.1.3. The spring tide ranges (m) in the Western Indian Ocean.

3.2. Wind and Runoff

At the time of writing this report, the meteorological observations for 1982 were not available at the Meteorological Office in Dar es Salaam. Therefore, the data used are those from 1978 and 1979. The monthly wind direction at six land stations along the coast of Tanzania are shown in Table 3.2.1. At Zanzibar station, however, observations for the months of May, November and December were carried out only at 0300, 0600 1200, 1500 and 1800 hours.

The Southwest Monsoon season lasts from April to October and the Northeast Monsoon from November to March. In March the winds tend to subside for all stations. This is the transition period, at which time there is reversal from the Northeast to the Southwest Monsoon. Another transition period occurs in October. During the Northeast Monsoon, at Tanga the wind blows from the northeast, at Zanzibar from the north, at Dar es Salaam from the east-northeast, and at Mtwara from the north. The wind blows from the south for all stations during the Southwest Monsoon. Records from Zanzibar station show that the frequency of winds from the westerly direction is almost double than those of other stations. This is most probably due to the fact that the station is situated on the western part of the Island, a kind of a leeward side.

On the other hand, wind data from the ship during this survey are as follows:

a) During the first survey the wind was blowing from the south, all along the coast.

b) During the second survey the wind was blowing from the southeast.

c) During the third survey the wind blew from the southeast and the south.

It is evident that the land topography affects the wind observations. Offshore wind observations, therefore, may differ slightly from those on land. The records, also, show a strong diurnal variation. There are pronounced nocturnal offshore winds. However, the winds tend to calm down between 2100 and 1300 hours except for the months of May and June.

Fig. 3.2.1. shows the monthly freshwater discharge from six major rivers for each particular year. The records are old because of lack of equipment and logistic problems facing the Water Authority. The figure is intended to show the seasonal variations in freshwater discharge into the ocean. For example, the figures for the Rufiji river could be misleading because in 1967 the hydroelectric power plant at Kidatu had not been built yet.

The peak outflow from these rivers occur between March and May. During October/November the outflow is at its minimum. Apart from Pangani, there is a well pronounced seasonal variation for all the rivers. The outflow of the Pangani river runs more or less constant throughout the year except for the months of May and June. This uniformity can be attributed to the nature of the drainage area. The drainage area of Pangani gets rain almost throughout the year.

Table 3.2.1. Frequency distribution of wind direction (number of observations, C=calm).

Tanga 1978

	C	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WNW	W	WNW	NW	NNW
JAN	85	30	24	47	27	27	0	0	0	0	0	0	0	0	0	2	5
FEB	108	10	6	23	22	47	2	3	1	0	1	0	0	0	0	0	1
MAR	147	10	3	11	7	25	8	9	2	11	0	3	2	5	2	3	0
APR	101	0	0	0	0	0	2	7	14	41	21	17	35	19	0	0	0
MAY	29	0	0	0	0	1	5	10	20	79	38	36	21	11	0	0	0
JUN	2	0	0	0	1	1	15	27	46	55	82	9	1	1	0	0	0
JUL	21	0	0	0	0	1	31	40	36	55	57	6	0	0	1	0	0
AUG	71	0	0	1	0	12	56	23	17	27	26	12	2	1	0	0	0
SEP	109	0	0	0	1	21	49	23	12	16	14	0	1	0	0	0	0
OCT	133	0	1	0	3	29	44	15	3	8	7	2	0	0	0	0	0
NOV	118	1	8	4	11	16	31	16	6	10	6	0	3	0	5	0	1
DEC	88	47	26	9	3	5	1	1	3	5	1	1	2	2	4	7	20

Zanzibar 1978

	C	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WNW	W	WNW	NW	NNW
JAN	60	74	20	16	24	30	1	0	0	1	0	0	0	5	2	0	8
FEB	56	48	16	9	22	37	4	0	2	5	1	0	7	4	3	0	6
MAR	112	14	7	1	17	24	7	1	11	17	5	0	8	18	2	0	3
APR	49	7	3	7	6	14	11	0	13	44	24	5	3	8	1	0	4
MAY	14	2	0	0	0	4	6	0	26	54	22	3	19	3	0	0	1
JUN	50	0	0	0	0	3	1	2	43	85	35	5	9	4	0	0	0
JUL	34	0	0	0	0	2	2	5	80	69	34	6	14	1	0	0	0
AUG	73	0	0	0	0	6	10	16	65	31	35	0	9	3	0	0	0
SEP	87	0	0	0	0	12	20	12	42	36	15	0	9	7	0	0	0
OCT	68	3	1	3	1	26	31	7	20	16	32	1	4	6	0	0	0
NOV	64	1	2	0	5	37	8	2	16	20	6	3	11	4	0	0	0
DEC	51	33	17	2	22	31	0	1	5	7	1	0	5	4	4	3	3

Dar es Salaam 1979

	C	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WNW	W	WNW	NW	NNW
JAN	107	6	17	14	37	24	2	1	1	17	8	2	2	3	4	6	8
FEB	62	23	42	36	36	15	0	2	0	1	2	0	2	2	0	0	3
MAR	110	1	12	3	17	25	6	2	6	22	24	7	7	4	1	0	1
APR	83	1	2	6	3	5	7	3	13	42	45	11	11	3	2	0	0
MAY	44	0	0	0	0	1	1	4	15	60	77	31	15	8	0	0	0
JUN	40	0	0	0	0	1	1	0	11	63	75	37	12	2	0	0	0
JUL	42	1		1	1	3	7	17	28	76	60	5	2	0	0	0	0
AUG	52	0	2	3	0	12	26	20	38	46	37	7	2	2	0	0	2
SEP	35	2	3	2	4	19	29	45	28	38	22	5	2	5	1	0	1
OCT	62	1	1	9	28	56	24	8	10	29	10	2	4	3	0	0	0
NOV	60	7	25	23	54	5	5	2	5	12	12	12	1	0	1	1	1
DEC	57	9	38	33	40	17	6	2	2	21	7	5	2	2	3	0	2

Mtwara 1979

	C	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WNW	W	WNW	NW	NNW
JAN	120	20	10	8	7	6	3	5	9	21	14	6	7	1	3	1	7
FEB	82	60	14	4	2	0	0	1	0	0	3	0	3	1	11	11	43
MAR	115	22	18	2	4	3	5	7	6	19	26	7	5	3	1	1	3
APR	31	0	3	3	3	3	4	8	26	81	60	12	1	1	1	0	0
MAY	7	0	0	0	0	2	2	11	20	108	91	7	0	0	0	0	0
JUN	7	0	0	0	0	2	1	2	34	89	98	6	0	0	0	0	0
JUL	18	1	0	0	2	0	7	8	32	92	76	13	2	0	0	0	0
AUG	34	0	2	4	12	20	5	13	36	66	47	8	1	0	0	0	0
SEPT	66	0	9	13	15	26	19	5	17	43	20	3	2	1	0	0	1
OCT	93	3	15	19	39	41	8	9	9	6	5	1	0	0	0	0	0
NOV	92	16	21	13	43	35	11	0	6	1	2	0	0	0	0	0	0
DEC	73	22	27	14	15	10	5	5	5	12	5	1	4	6	3	1	2
	C	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WNW	W	WNW	NW	NNW

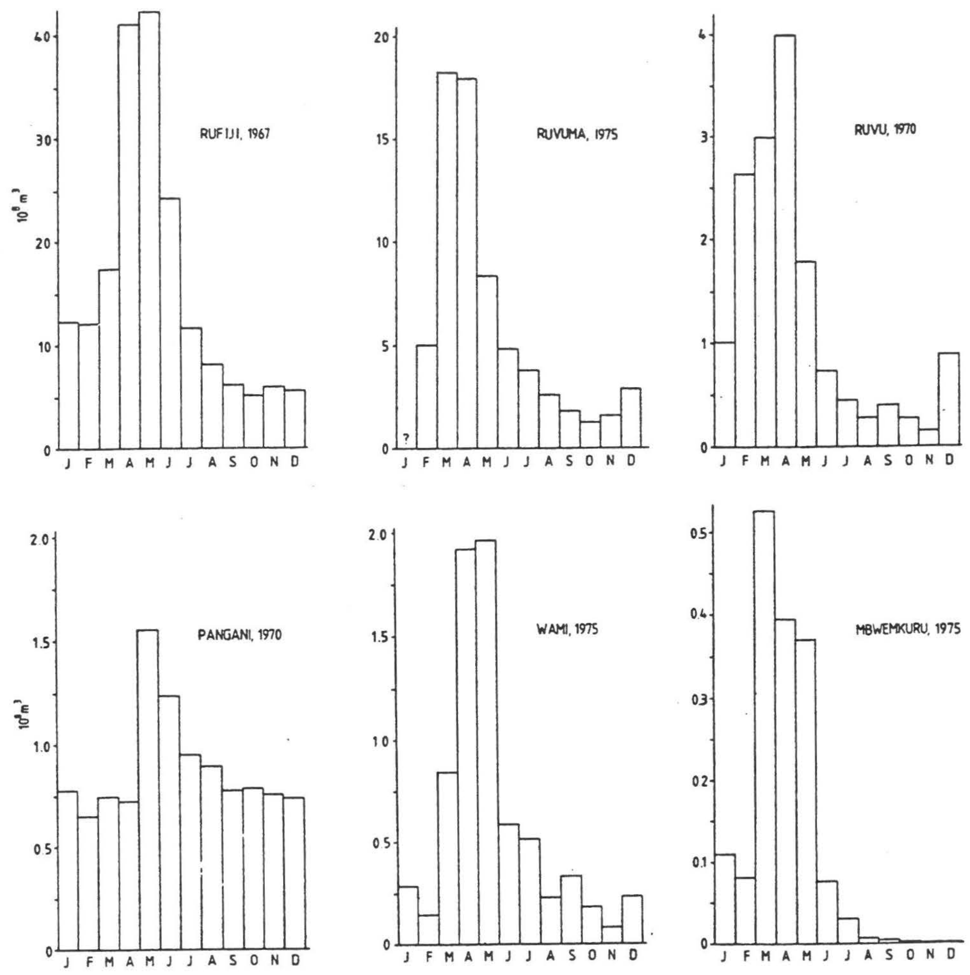

Fig. 3.2.1. Monthly average freshwater runoff from six major rivers (? = data not available).

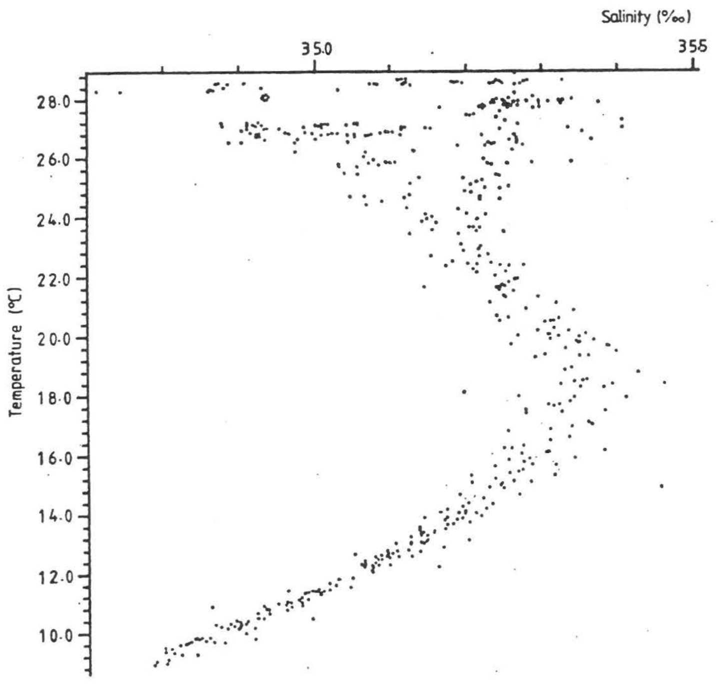

Fig. 3.3.1. The temperature/salinity relationship for all stations observed during the three surveys.

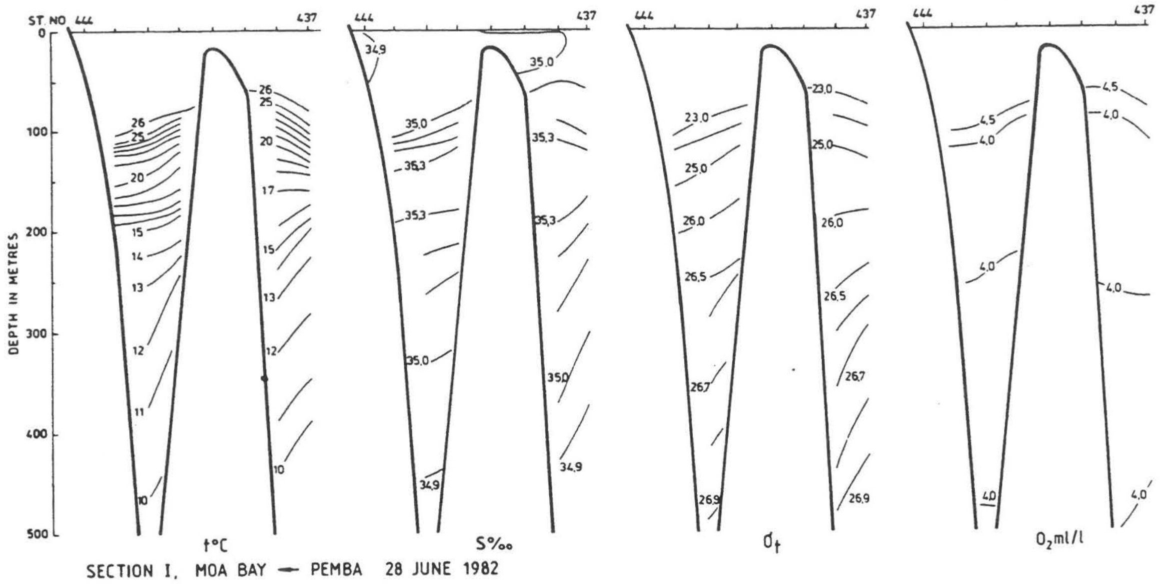

Fig. 3.4.1. Temperature, salinity, density and oxygen content at Section I during the first survey.

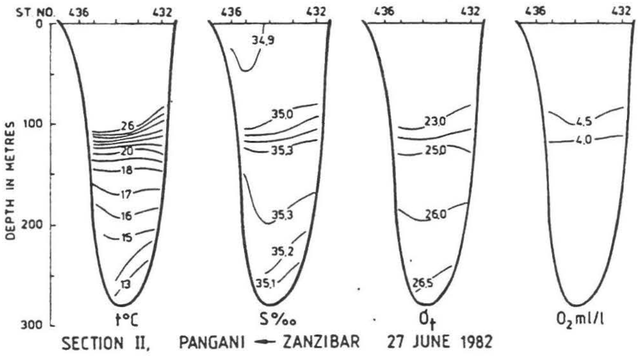

Fig. 3.4.2. Temperature, salinity, density and oxygen content at Section II during the first survey.

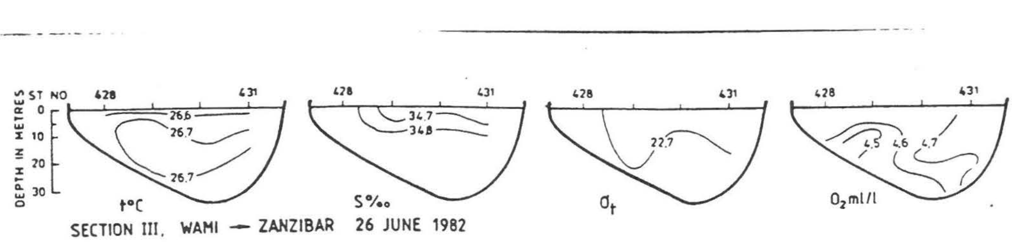

Fig. 3.4.3. Temperature, salinity, density and oxygen content at Section III during the first survey.

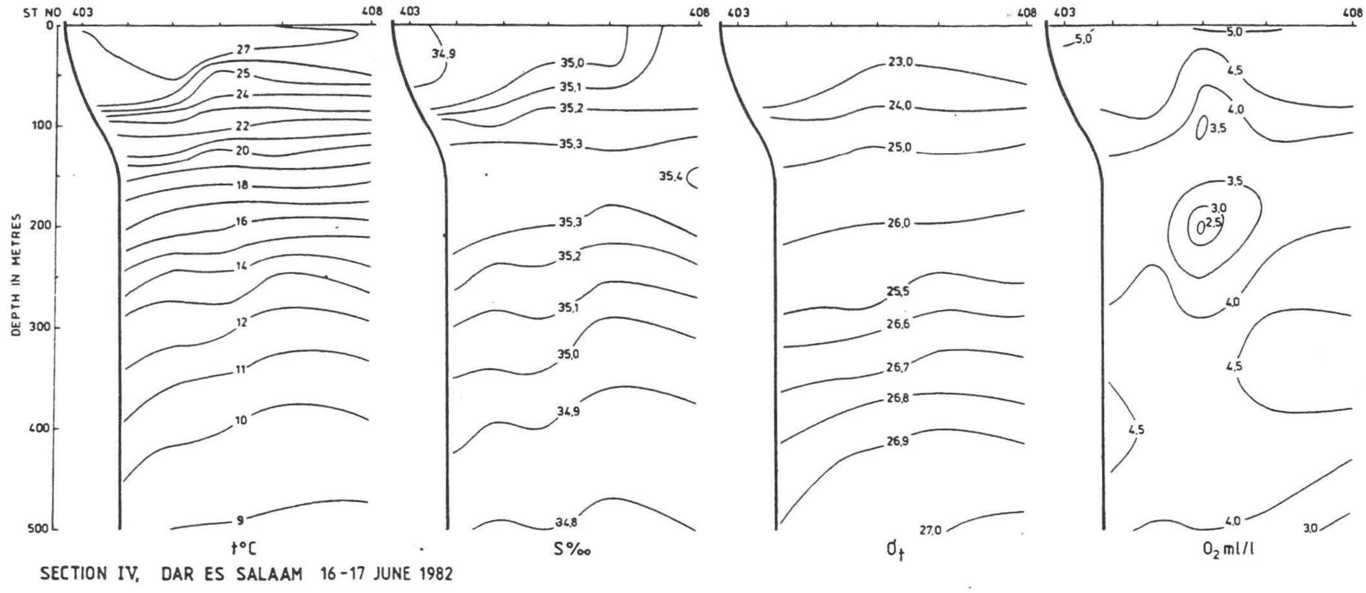

Fig. 3.4.4. Temperature, salinity, density and oxygen content at Section IV during the first survey.

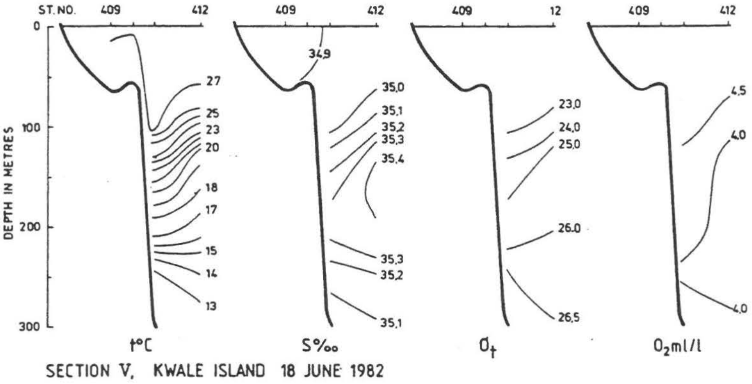

Fig. 3.4.5. Temperature, salinity, density and oxygen content at Section V during the first survey.

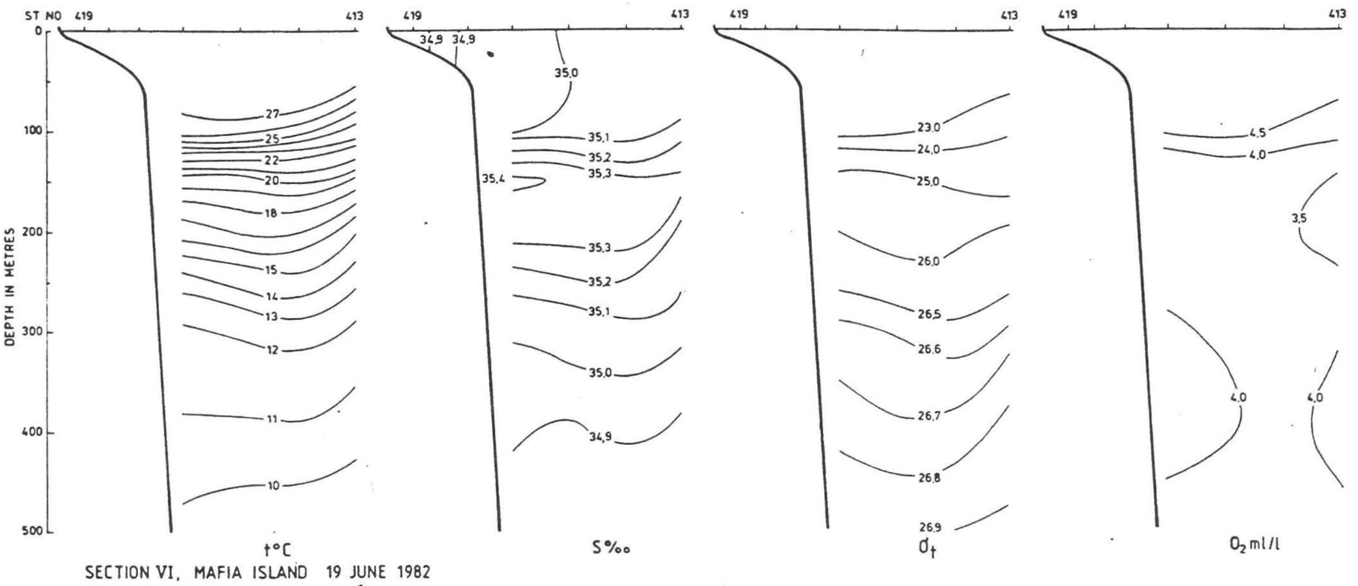

Fig. 3.4.6. Temperature, salinity, density and oxygen content at Section VI during the first survey.

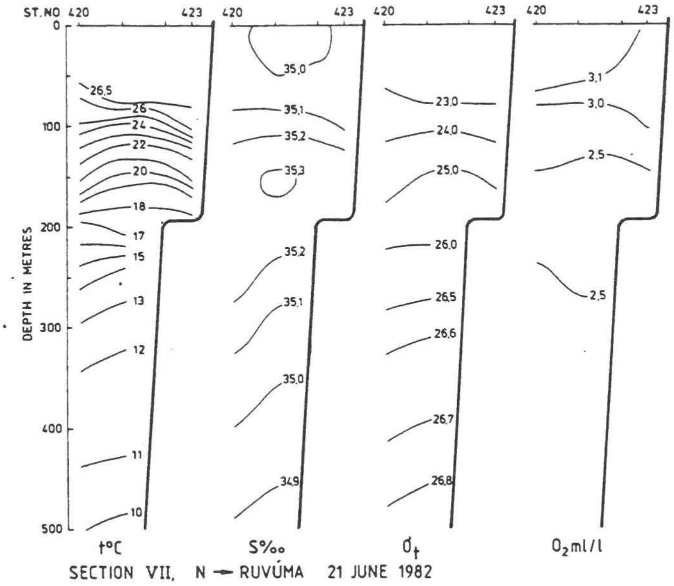

Fig. 3.4.7. Temperature, salinity, density and oxygen content at Section VII during the first survey.

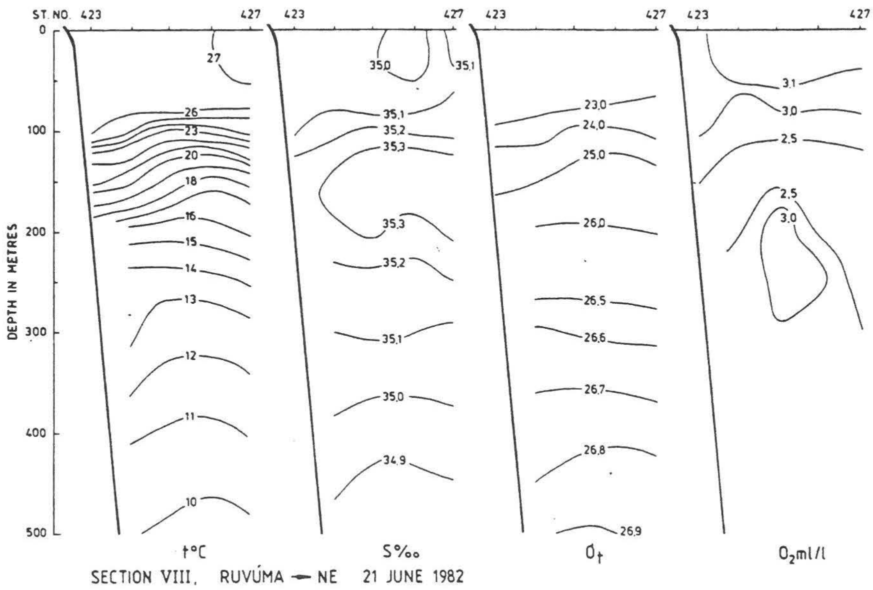

Fig. 3.4.8. Temperature, salinity, density and oxygen content at Section VIII during the first survey.

3.3. Characteristic hydrographical features and water masses

Vertical profiles for temperature, salinity and oxygen for section IV, June 1982 are presented in Fig. 3.4.4. It shows most of the hydrographical features common to the Tanzanian coastal waters. σ_t sections were not drawn because σ_t is largely controlled by temperature. However, where salinity decreases with increasing depth the rate of increase of σ_t with depth is reduced.

The thermocline lies between 50 and 200 m. There is a shallow salinity maximum at about 150-200 m depth. The minimum zone in the vertical profile of oxygen is found slightly below or at the same depth as the salinity maximum, (c.f. Sætre and Silva, 1979, p.39).

Fig. 3.3.1. shows the temperature/salinity relationship from the three cruises of this survey for all stations. The main water masses have been identified by using Rochford (1964), Warren et al. (1966) and Wyrtki (1971).

Surface Water: This is a water mass lying above 100 m. It is formed in the Bay of Bengal and the Eastern Indican Ocean area and brought to the west by the South Equatorial Current. The temperature range is 22 to 30^{o}C, whereas its salinity lies below 35.4 o/oo. Near to the coast the salinity is kept low by the freshwater runoff.

High Salinity Water: Fig. 3.3.1. also shows a salinity maximum between 18 and 19^{o}C, which corresponds to 150-250 m depth. According to Wyrtki (1971), there are two possible sources of this water, namely, Subtropical Surface Water and Arabian Sea Surface Water. These are best seperated in the temperature oxygen diagram (ibid.). This water is formed in the northern Arabian Sea and spreads southwest to the eastern coast of Africa. Rochford (1964) shows that at the Equator it widens and develops a branch that flows southeast. At about 10^{o}S all branches turn to flow to the east. However, the outermost on section IV, during the second and the third cruise, had two maxima. This could be caused by an intrusion of lower salinity water, most probably coming from the eastern side of the Indian Ocean within the South Equatorial Current (Harvey, 1977).

Indian Ocean Central Water: The layer between 250 and 500 m has a linear T-S relationship. This layer is thought to belong to the Central Water Mass. It was not possible to identify other water masses because the hydrographic sections covered the upper 500 m only. However, literature shows there are deeper water masses. For example, the Antarctic Intermediate, the Indian Ocean Deep and the Red Sea water.

3.4. Hydrographic structure in June-July 1982

The vertical distribution of temperature, salinity and oxygen in the eight hydrographic sections are presented in Figs. 3.4.1.-3.4.8. The surface temperatures were 26-27^{o}C. As already mentioned in section 3.3., a salinity maximum and an oxygen minimum occupy more or less the same depth, about 200 m. Following Wyrtki (1971) the mixed layer depth, D, is defined as $t_S - t_D = 1^{o}C$, where t_S is the temperature at the surface and t_D the temperature at D, but where there was a shallow thermocline less than 10 m in depth the drop in temperature across this thermocline was ignored in determining the depth of the mixed layer.

Section I (Fig. 3.4.1.). No calculations were made for the geostrophic velocity but visual inspection indicates that there was a northward current. The average surface temperature was 26.5°C. The depth of the mixed layer was 85 m. The salinity profile shows that low salinity water is produced around Moa Bay, probably from the runoff.

Section II (Fig. 3.4.2.). In this section the depth of the mixed layer was about 95 m. The section failed to show any discernible direction for the geostrophic current. The average surface temperature was 26.48°C. There was a tongue of low salinity water near the coast on the mainland side.

Section III (Fig. 3.4.3.). This was the shallowest section, not deeper than 40 m. Its average temperature was 26.41°C. The surface salinity decreased seaward. The water appeared to be well mixed because of the combination of strong tidal currents and the wind in the Zanzibar Channel.

Section IV (Fig. 3.4.4.). There were indications of a weak northward current. The surface decreased towards the coast. The oxygen minimum of 2.5 ml/l was situated about 50 m below the salinity maximum. The average mixed layer depth was about 60 m. The average surface temperature was 26.93°C.

Section V (Fig. 3.4.5.). The average surface temperature was 27.12°C. The baroclinic structure suggested a northward current. The depth of the mixed layer was about 92 m.

Section VI (Fig. 3.4.6.). The effect of freshwater discharge from the Rufiji river is shown clearly by the vertical isolines with salinity increasing seaward. The outermost stations indicate a northward current. The average surface temperature was 27.12°C and the mixed layer was about 91 m deep.

Sections VII and VIII (Figs. 3.4.7. and 3.4.8.) showed a weak cyclonic eddy. The average surface temperature was 26.52°C, while the mixed layer depth was found to be 88 m.

In general the surface temperature decreased from north to about 6°30'S along section IV and rose again. The average temperature for the cruise was 26.64°C. The average depth of the mixed layer was 84 m, being shallowest along section IV, where it was 40 m.

3.5. Hydrographic structure in November-December 1982

A few more stations were added during this cruise. The surface temperatures were 1-2°C higher and the thermocline was not as distinct as in the previous cruise. The salinity in the upper layer was also higher (0.1-0.2 o/oo). The oxygen content was similar for the sections I-VI as observed in June-July but for sections VII and VIII the oxygen content was up to 2 ml/l higher.

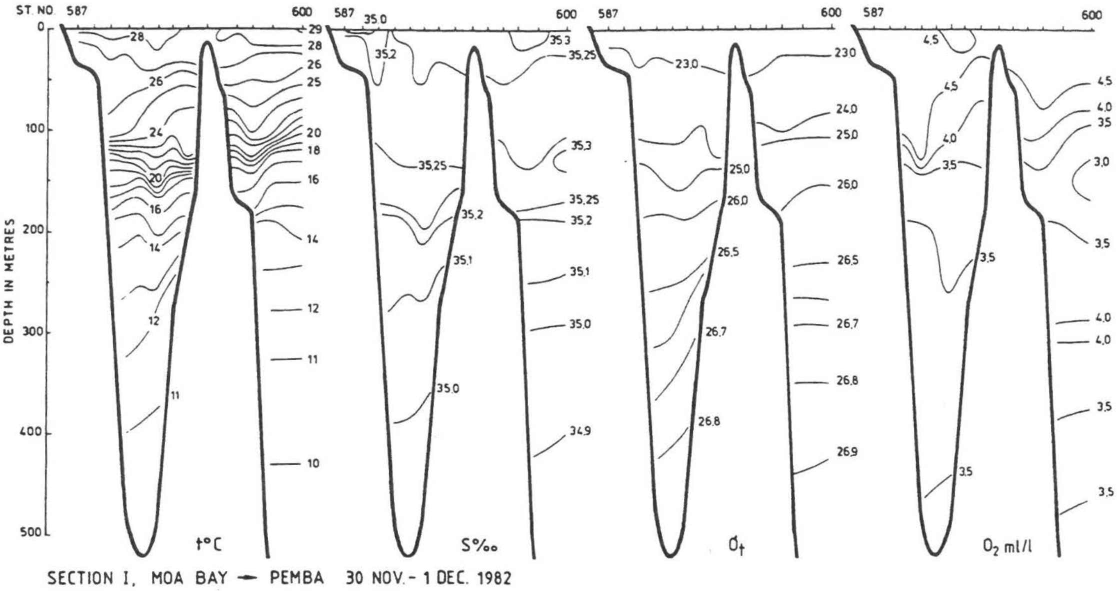

Fig. 3.5.1. Temperature, salinity, density and oxygen content at Section I during the second survey.

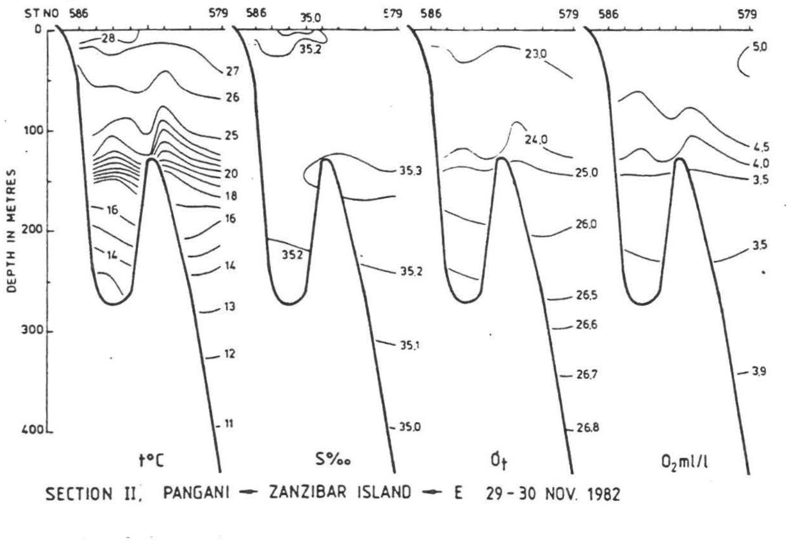

Fig. 3.5.2. Temperature, salinity, density and oxygen content at Section II during the second survey.

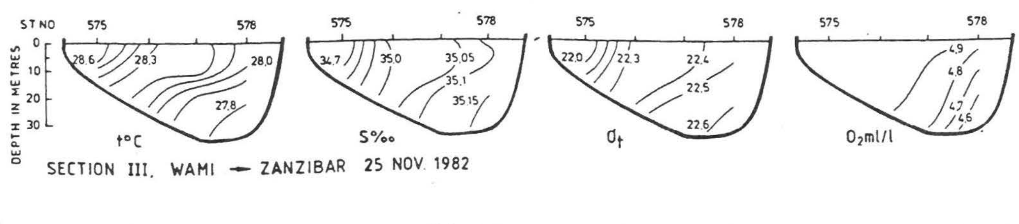

Fig. 3.5.3. Temperature, salinity, density and oxygen content at Section III during the second survey.

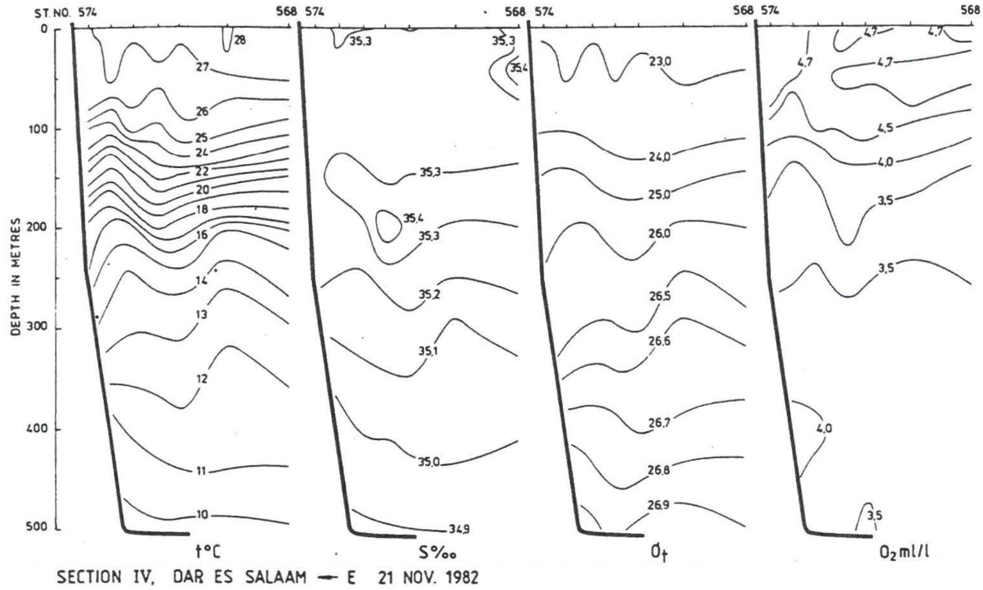

Fig. 3.5.4. Temperature, salinity, density and oxygen content at Section IV during the second survey.

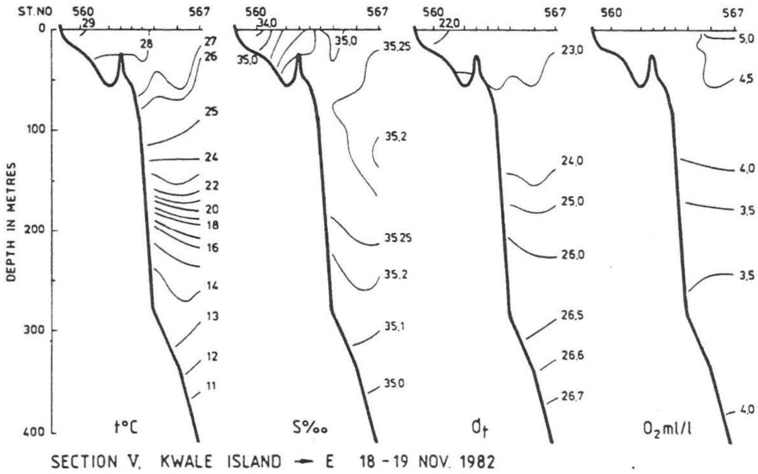

Fig. 3.5.5. Temperature, salinity, density and oxygen content at Section V during the second survey.

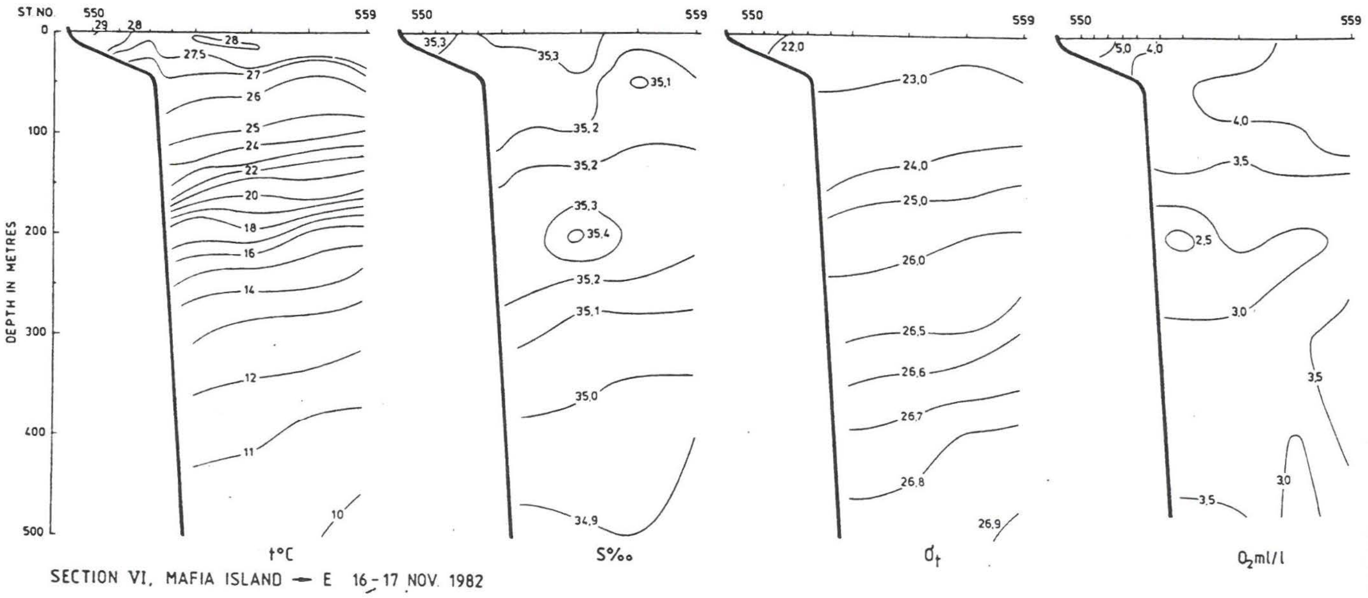

Fig. 3.5.6. Temperature, salinity, density and oxygen content at Section VI during the second survey.

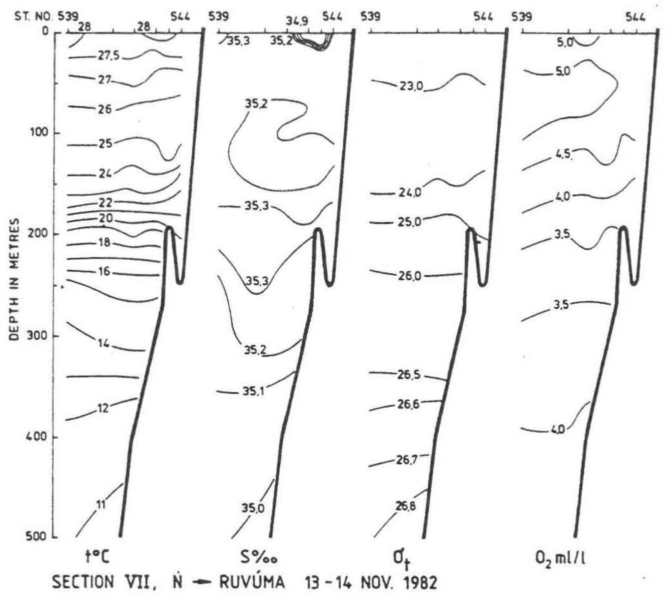

Fig. 3.5.7. Temperature, salinity, density and oxygen content at Section VII during the second survey.

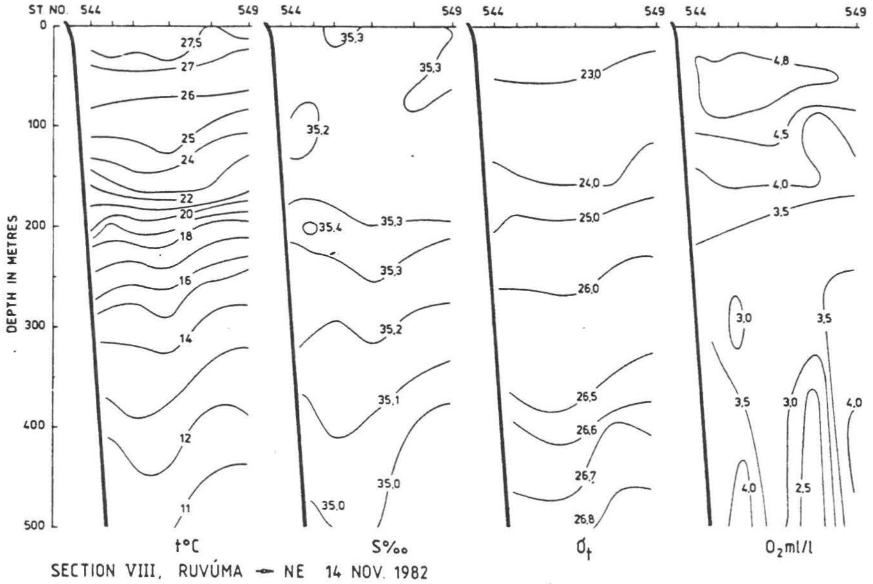

Fig. 3.5.8. Temperature, salinity, density and oxygen content at Section VIII during the second survey.

Section I (Fig. 3.5.1.). The baroclinic structure was weak. There were no indications of any current except in the Pemba Channel where there were slight indications of a northward current. The average surface temperature and the depth of the mixed layer were 28.22^{o}C and 28 m, respectively.

Section II (Fig. 3.5.2.). This section was extended by adding two more stations seaward. The average surface temperature was 27.84^{o}C and the mixed layer depth was 28 m.

Section III (Fig. 3.5.3.). Both the temperature and the salinity profiles show an intrusion of a warmer and fresher water from the mainland side. The average temperature was 28.52^{o}C.

Section IV (Fig. 3.5.4.). The temperature distribution indicates a strong current shear, especially below 200 m. Near the coast the current had a northward direction. The average surface temperature was 27.70^{o}C and depth of the mixed layer was 47 m. At station 568 two salinity maxima were observed at 50 and 200 m, respectively.

Section V (Fig. 3.5.5.) shows a wedge-shape salinity distribution. The average surface temperature was 28.21^{o}C and the depth of the mixed layer was the same as in section IV. The core of maximum salinity was observed to be shallower than during the previous cruise.

However, the zone of maximum salinity in section VI (Fig. 3.5.6.) was deeper than during the previous cruise. There was an indication of a northward current. The average surface temperature was 28.14^{o}C and the mixed layer depth was 39 m.

Sections VII and VIII (Fig. 3.5.7. and 3.5.8.). The baroclinic structure was weak, and the southward transport was small. The depth of the mixed layer was 49 , and the average surface temperature was 27.79^{o}C.

The average surface temperature for the whole cruise was 28.05^{o}C and the mixed layer depth was 40 m. The depth of the thermocline was shallower than during the previous cruise. The oxygen content for the water column 5-500 m was above 2.4 ml/l.

3.6. Hydrographic structure in May 1983

In addition to the usual eight sections many other surface samples were taken for salinity and temperature. The surface temperature varied between 27.5 and 28.5^{o}C. The surface salinity distribution (Fig. 3.6.1.) demonstrated the influence of the freshwater outflow, especially off the mouths of major rivers, e.g. Rufiji, Ruvu and Pangani.

Section I (Fig. 3.6.2.). Inside the Pemba Channel the baroclinic structure did not show any sign for current. The outer stations, however, showed a northward current for depths below 200 m, while the surface water was going south. The average temperature was 28.07^{o}C and the depth of the mixed layer was 66 m.

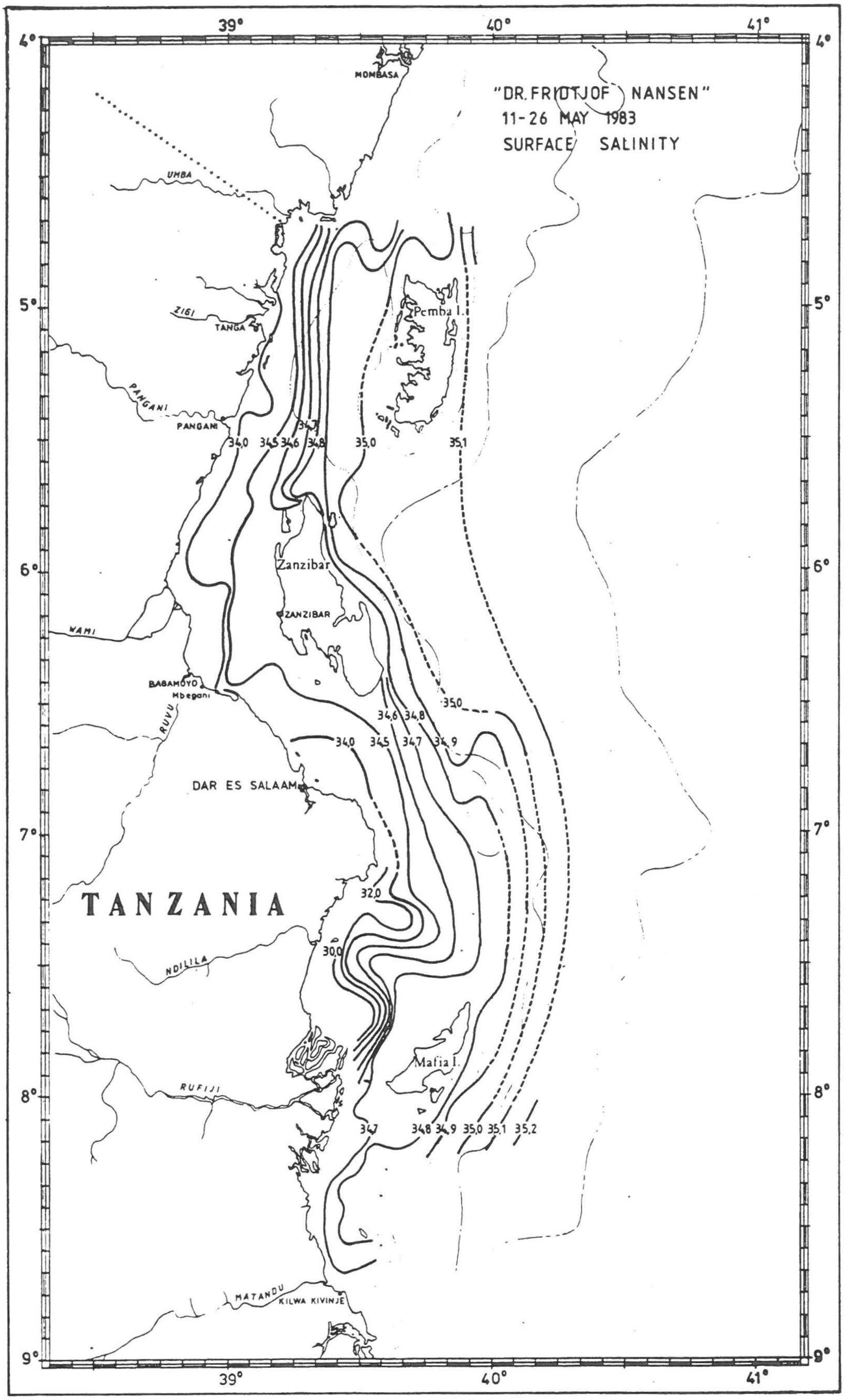

Fig. 3.6.1. Surface salinity distribution during the third survey.

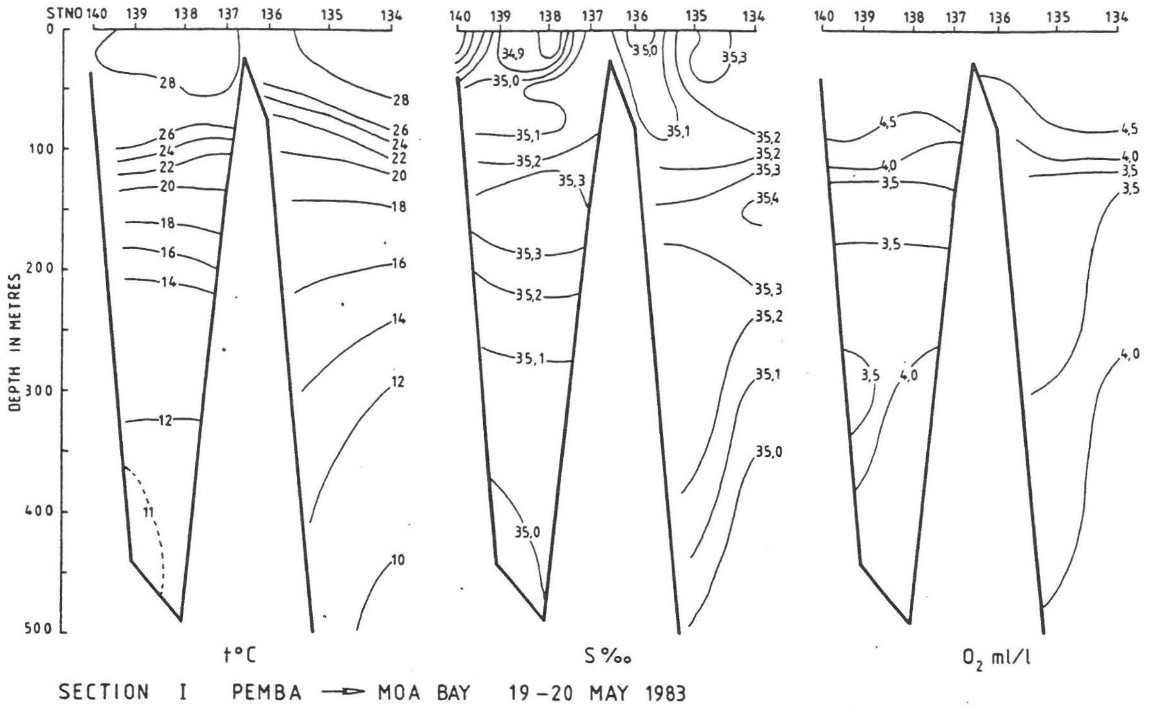

Fig. 3.6.2. Temperature, salinity, density and oxygen content at Section I during the third survey.

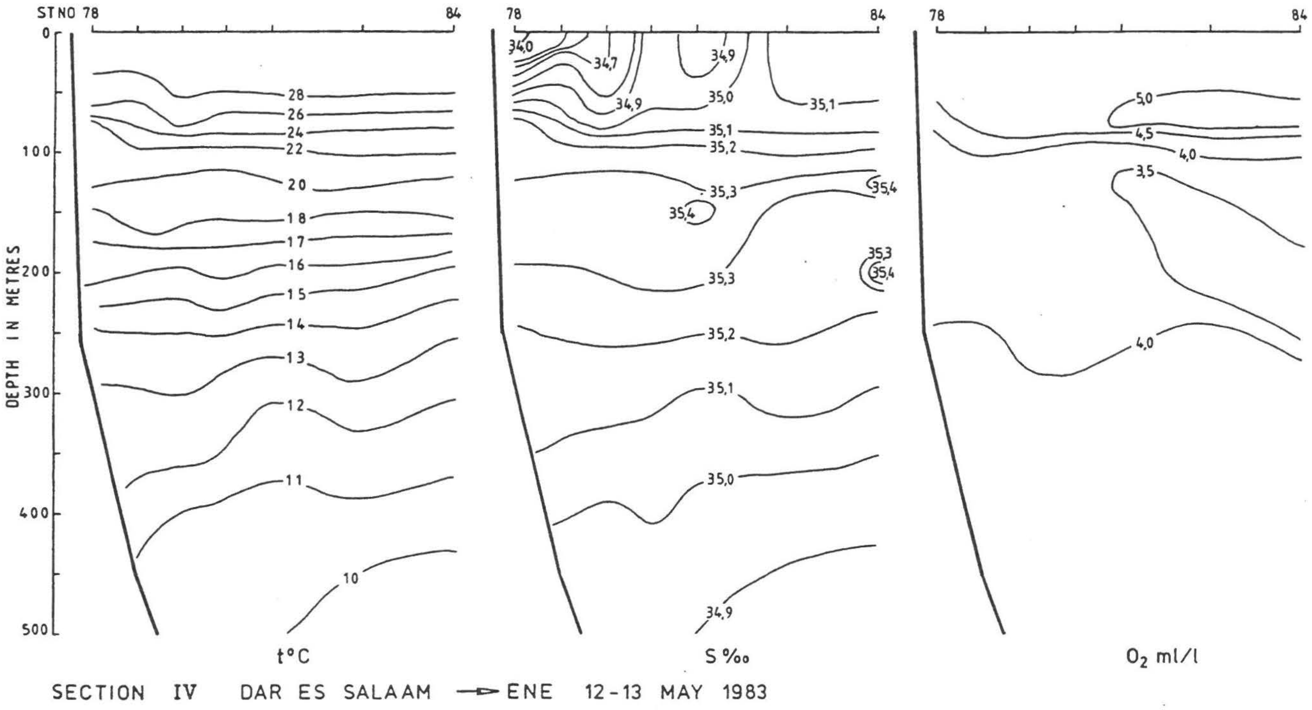

Fig. 3.6.3. Temperature, salinity, density and oxygen content at Section IV during the third survey.

Section IV (Fig. 3.6.3.) shows two distinct cores of maximum salinity for station 84, one at about 130 m and another at 200 m. A tongue-like low salinity water (source unidentified) was well pronounced. Below 200 m there was an indication of northward current. Average surface temperature and depth of the mixed layer was 28.36°C and 56 m, respectively.

Section VI (Fig. 3.6.4.) had a southward current. Freshwater runoff from the Rufiji is clearly indicated in the salinity distribution. Average surface temperature was 28.43°C and the mixed layer depth was 83 m. The rest of the sections were not carried out due to lack of time.

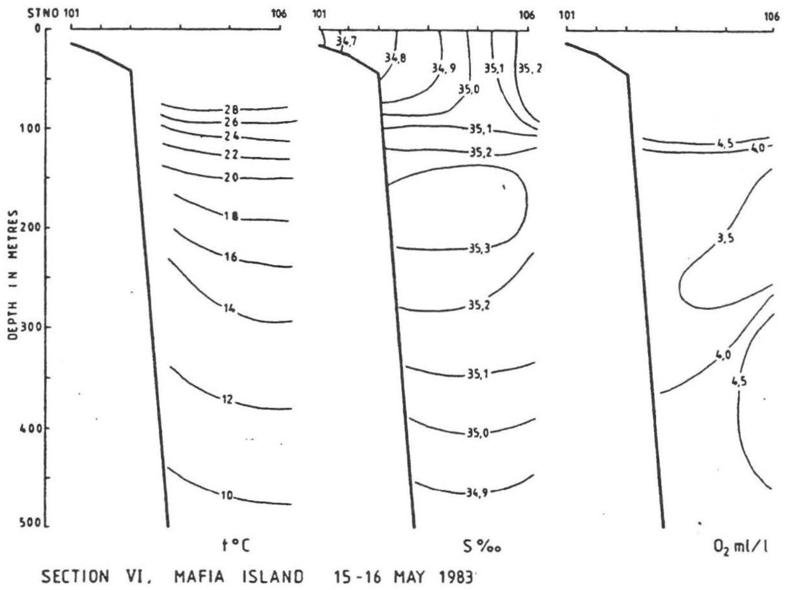

Fig. 3.6.4. Temperature, salinity, density and oxygen content at Section VI during the third survey.

3.7. Discussion

Since no surveys have been carried out during the Northeast Monsoon it is difficult to talk about seasonal variations of any parameter. However, Harvey (1977) found that for the surface water maximum temperature occurs in March, whereas August-September was the time for minimum temperature. He also found that the annual range was greatest in the areas furthest from the equator (4.6°C) and least for the area between 5°30' and 7°S. The depth of the upper mixed layer varied from 20 m (March and November) to 100 m (June/July). This reflects the seasonal variations of the wind speed and direction (Table 3.2.1.).

In November the surface salinities were at maximum. They are at minimum in May following the peak freshwater outflow (Fig. 3.2.1.). Bryceson (1977), however, found that the salinity started to decrease in February before the onset of the rains and attributed this to the advection of lower salinity water from the south. The combination of high salinity and (relatively) low temperature during the second cruise suggest a high rate of evaporation, especially on Section IV.

The freshwater from the river discharge is very much restricted to the inshore waters. This is due to the fact that wind blowing from the south (in the southern hemisphere), parallel to a coast on its left, causes an Ekman transport to the left. Consequently, water piles at the coast.

The oxygen content observed during this survey cannot be said to be a limiting factor on fish distribution. The oxygen minimum increased during the November-December cruise. This means either there is a seasonal variation in the oxygen minimum zone or that another water mass is fed into the area at the time of the monsoon reversal, as suggested earlier by Bryceson (1977) and Harvey (1977).

The current pattern disturbances observed around Latham Island during the third cruise are eddies which cause a localized upwelling. This idea is supported by the existence of a shallow thermocline and indications of cyclonic eddies along Section IV. Similar conditions apply to the area north of Pemba Island. The geostrophic current was observed to flow north. This does not necessarily mean the current is always northbound unless some cruises are scheduled during the Northeast Monsoon season and prove so.

4. FISH RESOURCES

4.1. Species composition and distribution

The species composition in the demersal trawl catches in different depth intervals are shown in Table 4.1.

Table 4.1. Distribution in percent of different biomass categories based on demersal trawl catches in different depth strata.

Survey No.	1				2				3			
Depth (m) : Category	< 20	20-50	50-200	> 200	< 20	20-50	50-200	> 200	< 20	20-50	50-200	> 200
Leiognathidae	44	43	2	0	32	32	3	0	32	40	+	-
Pelagic fish	18	16	44	6	12	12	9	10	9	22	10	-
Demersal fish	34	36	44	60	54	54	76	46	14	34	76	-
Rays & Sharks	3	3	9	20	1	1	9	27	45	3	14	-
Crustacea	1	+	1	10	0	0	+	15	+	+	+	-
Squids	0	+	+	4	1	1	3	2	+	1	+	-
W(kg/hour)	552	461	97	162	255	255	297	116	313	390	269	-
Number of hauls	11	31	8	29	9	9	14	14	13	27	11	0

+) indicates less than 0.5%

4.1.1. Leiognathidae

According to Table 4.1. this group is very abundant in waters shallower than 50 m. About 20-40% of the catches in this depth belonged to this group. The most important species were Leiognathus leuciscus, L. equulus, L. fasciatus, Secutor insidiator and Gazza minuta. In the Zanzibar Channel and about 20 nautical miles north of Kilwa Kiwinji catch rates of 900-

1500 kg/hour were obtained. In waters deeper than 50 m the catches of Leiognathidae were very poor. In Indonesian waters the Leiognathidae were most abundant at a depth of about 25 m (Pauly, 1977).

4.1.2. Pelagic fish

Pelagic fish families as Clupeoidea, Engraulidae, Carangidae and Sphyraenidae were most abundant in the demersal catches from waters shallower than 200 m (Table 4.1.). The pelagic species observed in the Tanzanian waters were rather small fish. In the typical pelagic community various species of sardinella and scads contributed the main part. Amblygaster (Sardinella) sirm, S. gibbosa, S. albella and to some extent the Amblygaster (S.) leiogaster were the most abundant and widespread clupeoids in the shallower area. Some kingfish (Scomberomorus spp.) and large jacks (Caranx spp.) were present throughout the area. Important scads were Decapterus russelli, D. macrosoma, Atule mate and a variety of Carangoides spp. At the Mafia plateau during the last survey some schools of pelagic species mainly Indian scad (Decapterus russelli), were observed by the acoustic equipment as "knots" close to the bottom in daylight.

Pelagic trawl hauls were intended for identification of pelagic scattering layers. However, registrations of pelagic fish were poor. Such registrations were few and far apart, and therefore few pelagic trawl hauls were carried out for identification purposes. During the first survey a rather large pelagic catch was made in the Kilwa Kiwinje area. The main species in this catch of about 260 kg per hour were Sardinella albella, S. gibosa and Dussumiera acuta. North of Mafia about 80 kg per hour of Decapturus kurroides and Dussumiera acuta were taken. D. kurroides were relatively often caught in deeper waters. During the second survey about 50 kg of Stolephorus spp. larvae were caught in the Zanzibar Channel north of Dar-es-Salaam. Some Stolephorus spp. larvae were also caught in the surface on the western coast of Zanzibar. During the third survey about 300 kg per hour of the anchovy Stolephorus punctifer were caught in the Zanzibar Channel.

Catches and registrations of mesopelagic fish were very poor. The catch rates never exceeded 5 kg per hour. The registrations were made in the upper 200 m in the area outside the shelf.

4.1.3. Demersal fish

The demersal species were most abundant in the trawl hauls from deeper waters. The demersal fish were mostly of small size. Only a few larger specimens were caught, mainly snappers (Lutjanidae) and sweetlips (Pomadasyidae). Rock cods (Epinephelus spp.) were present in small numbers in several catches. A big Epinephelus tauvina of about 150 kg and 2 m long was caught south of the Mafia Island during the first survey. Lizardfishes, mainly the Brushtooth lizardfish (Saurida undosquamis) were present in fair numbers in most catches in shallow areas. Some were also caught in deeper waters and they were usually of a larger size.

In the central part of the Zanzibar Channel catches of 200-300 kg per hour of damselfish (Teixeirichthys jordani) were made. This is a small fish (5-10 cm) of low commercial value.

During the two last surveys some trawl stations were made around the Latham Island. The best catch was made west of the island during the second survey at about 140 m depth. The catch rate was about 1.700 kg per hour and the main species were Pristipomoides filamentosus and P. sieboldii. The individual weights were 1-4.5 kg. This trawl haul was done due to good registration at the bottom on the acoustic equipment.

The main species caught in demersal trawl hauls in deeper waters were Saurida undosquamis, S, tumbil and Shortnose greeneye Chloropthalmus agassizi.

4.1.4. Rays and sharks

The most common species were Daysyatis spp., Rhizoprionodon acutus and Centrophorus moluccensis.

Except for the third survey, Table 4.1. demonstrates that the catch rates of rays and sharks increased with increasing depth within the investigated area. The highest observed average catch rate of rays and sharks were 144 kg in waters shallower than 20 m during the last survey. This was due to a big catch of devil rays (Mobulidae) east of Mbegani. The catch rate was 1.800 kg per hour. Each of the rays weighed about 20 kg.

4.1.5. Crustacea and squids

The catch rates of shrimp and prawns were rather poor. The biggest catch of shrimps was made east of Dar-es-Salaam during the first survey. The haul gave 130 kg per hour at 325 m depth.

The lobster and squid catches were also very small. Most of the catches especially in the shallower areas contained a small amount of squid. The largest catch of small squids was taken in the northern entrance of the Zanzibar Channel. This was in the deeper part of the channel, about 300 m, and the catch was about 50 kg per hour.

4.2. Abundance

The average integrator readings for fish were calculated within rectangles of 30 x 15 nautical miles for each of the three surveys as shown in Figs. 4.2.1.-4.2.3. During the three surveys rather good concentrations of fish were observed in the Zanzibar Channel. In the deper parts of the investigated area the integrator values were low. The fish biomass was estimated within each rectangle according to the formula: $B = C \cdot \bar{M} \cdot A$ where B is biomass, C is a conversion coefficient, $\bar{M}$ the average integrator reading and A is the area of the rectangel. The C value was calculated according to $C = 0.8 \cdot \bar{l}$ where $\bar{l}$ is the average length of the dominant species. Based on the weighed modal length of the most important species contributing about 75% of the total catch for the different surveys, the representative length to go into the formula was estimated at 14-17 cm. The biomass was estimated according to an average length of 15 cm. The fish biomass estimates are shown in Table 4.2.1.

Table 4.2.1. The estimated fish biomass in thousand tonnes for the three acoustical surveys.

Survey	1	2	3	1	2	3
Area	Investigated area			Inshore waters		
North of 9°S	128	83	72	34	8	12
South of 9°S	46	23	-	4	5	-
Total	174	106		38	13	

As seen from this table the largest fish biomass was observed during the first survey. The area south of 9°S was not covered during the last survey. From the two first surveys it seems that about 25% of the biomass were observed in the southern area.

This indicate that the total biomass for the last survey is in the order of 90 000-100 000 tonnes. Therefore a similar fish biomass was observed during the two last surveys being about 40% lower than observed during the first survey.

The acoustic estimates are probably underestimated due to several factors. The acoustical equipment is not able to observe fish close to the bottom or in the surface layer. The poor catches of the pelagic trawl in the surface layer indicate that the biomass was not seriously underestimated due to this. Investigations in other areas (Olsen et al., 1982) have demonstrated that the noise of the research ship might scare the fish away, and thereby dilute the fish concentrations. The C value in the formula is very essential for the biomass estimate, and thereby the representative length to go into this formula. The estimates were carried out with an average length of 15 cm. By changing this length by 1 cm, the biomass estimate will increase or decrease by about 7%.

The inshore waters were not investigated during the three surveys. If the fish abundance in these waters is similar to the abundance observed in the western border of the investigated area, an estimate of the fish biomass in the inshore waters could be carried out (Table 4.2.1.). According to this the fish biomass in the inshore waters and the investigated area is in the order of 100 000-210 000 tonnes.

The size of the strata within the standard survey area applied for estimating fish biomass based on the swept area method are shown in Table 4.2.2. The average catch rates and numbers of demersal trawl hauls for the different

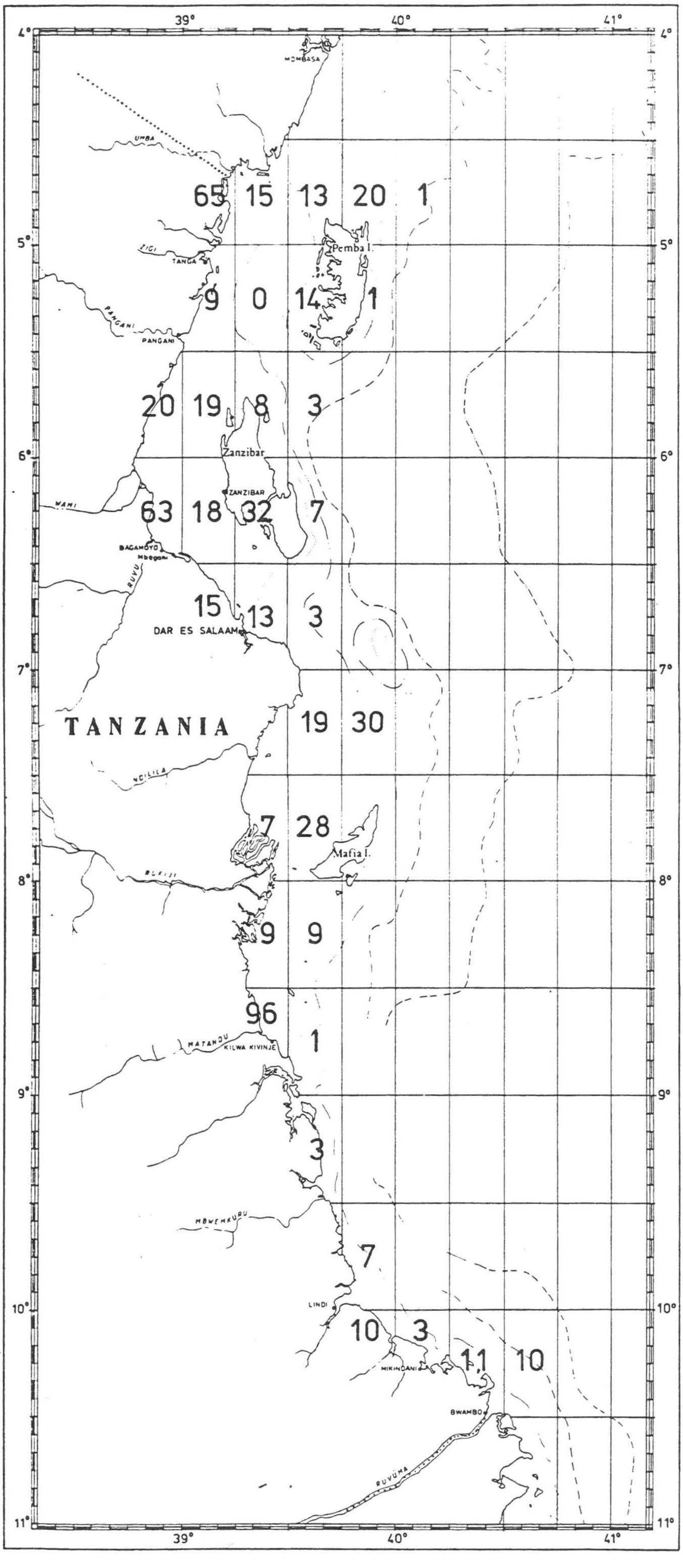

Fig. 4.2.1

Distribution of fish during the first survey. Average echo integrator values in mm x 10 per nautical mile for rectangles of 30' x 15'.

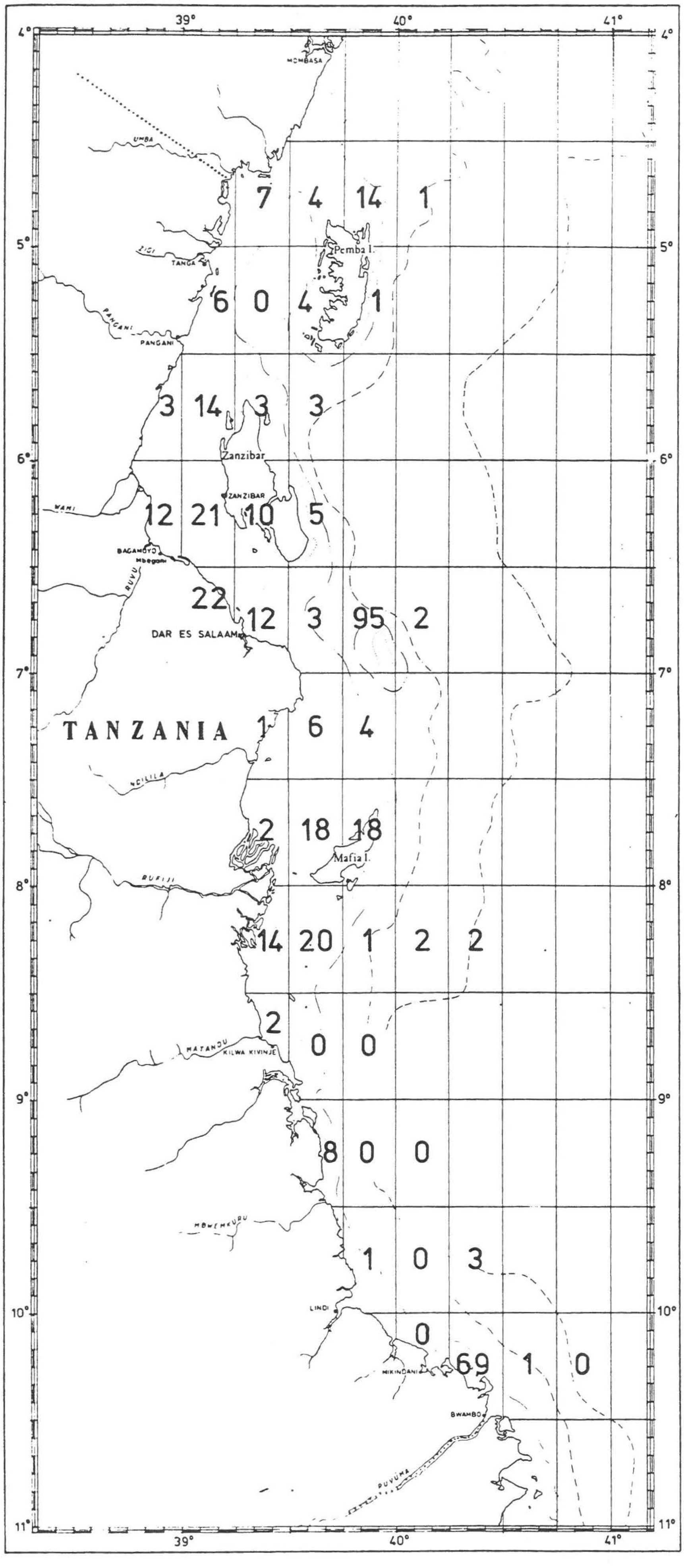

Fig. 4.2.2

Distribution of fish during the second survey. Average echo integrator values in mm x 10 per nautical mile for rectangles of 30' x 15'.

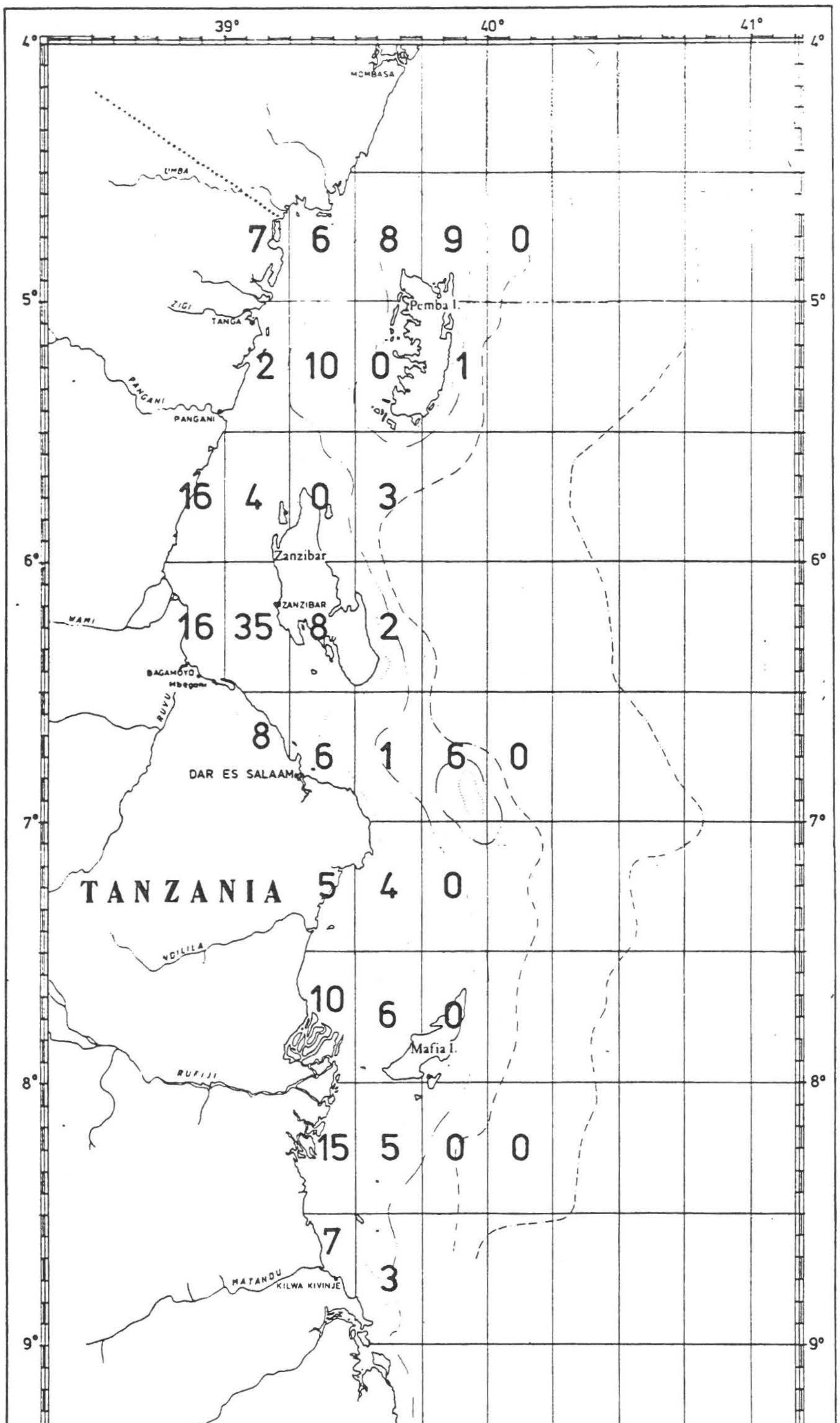

Fig. 4.2.3

Distribution of fish during the third survey. Average echo integrator values in mm x 10 per nautical mile for rectangles of 30' x 15'.

strata are shown in Table 4.2.3. The catch of sharks and rays are not included in the catch rates. The trawl hauls around Latham Island have also been excluded because they were aimed at fish concentrations recorded by the acoustic equipment. For the southern area too few trawl hauls were carried out to give an estimate based on the swept area method. The biomass estimates for the area north of 9°S are given in Table 4.2.4.

Table 4.2.2. The area of the different strata in square nautical miles (Fig. 2.5.).

Depth interval (m) Area	<20	20-50	50-200	>200
Pemba	100	150	1000	850
Zanzibar	150	800	910	370
Mafia	600	600	770	2150
The Southern area	10	10	100	2200

Table 4.2.3. Average catch rates ($\bar{W}$=kg/hour) and numbers (N) of demersal trawl hauls for the three surveys in each strata. (Exclusive rays and sharks).

Survey		1				2				3			
Depth (m) Area		< 20	20 50	50 200	> 200	< 20	20 50	50 200	> 200	< 20	20 50	50 200	> 200
Pemba	$\bar{W}$	-	209	-	64	-	382	-	78	-	109	118	-
	N	0	5	0	8	0	6	0	5	0	3	4	0
Zanzibar	$\bar{W}$	806	149	126	140	104	288	106	47	159	384	238	-
	N	5	15	3	4	4	18	9	2	4	14	2	0
Mafia	$\bar{W}$	340	959	25	185	305	282	312	183	176	445	74	-
	N	5	11	5	16	4	11	1	7	9	10	1	0
Southern area	$\bar{W}$	145	-	-	54	-	-	-	97	-	-	-	-
	N	1	0	0	1	0	0	0	1	0	0	0	0

Table 4.2.4. The estimated fish biomass in thousand tonnes for each of the three surveys based on the swept area method. Area north of 9°S.

Survey	1	2	3
Biomass	56	50	50

As seen from Table 4.2.3. no trawl hauls were carried out in the depth interval 50-200 m in the Pemba area during the two first surveys. During the last survey no trawl hauls were carried out in deeper waters than 200 m. When estimating the biomass as shown in Table 4.2.4. the catch rate obtained from the third survey in the Pemba area with depth 50-200 m was applied to the two first surveys. For the areas deeper than 200 m the average catch rates obtained during the first and second survey were applied to the last survey.

The estimates based on the acoustic method are 1.4 to 2.3 times greater than the swept area estimates. Therefore the efficiency of the trawl is probably less than one. The same difference between the acoustic estimates and swept area estimates were observed in similar investigations with "Dr.Fridtjof Nansen" in Kenyan waters (Iversen, 1984). The difference in biomass of about 40% between the first and the two next surveys as observed by the acoustic equipment, is not reflected in the swept area estimates. These estimates were quite similar for the three surveys. This was also observed in the Kenyan waters (Iversen, 1984). The acoustic estimates include fish located above the part of the water column fished by the demersal trawl. The opening of the demersal trawl is about 6 m. Fish in this blind zone is included in the estimates based on the swept area method.

According to Iversen (1984) the fish biomass is 5-6 times higher than in Kenyan waters. This difference in fish biomass is reflected in the catch statistics for the two countries. The average catch in Tanzanian waters during the period 1975-1980 was about 40 000 tonnes. The average catch in Kenyan waters during the same period was about 5 000 tonnes.

The target strength of sharks and rays is rather low. Therefore, for comparison with the acoustic estimate, they were excluded in the biomass estimate based on the swept area method. The biomass of the elasmobranchs estimated by this method was about 5 000 tonnes for the two first surveys and about 10 000 tonnes for the last survey. The relatively larger biomass estimated for the last survey was mainly due to big catch of devil rays east of Mbegani (section 4.1.4.).

4.3. Fishing experiments

4.3.1. Experiments with fish traps and longlines

During the two last surveys 13 and 5 fish trap stations were made. In addition 3 longline stations were carried out during the second survey. The traps were placed in chains of 5, 9 or 10 in depths ranging from 3 to 40 m. The catch rates were quite good. As much as 3 kg fish per trap per night was caught. The largest specimens caught were *Epinephelus* spp. (9.3 kg/ 82 cm), and *Lutjanus coccineus* (7 kg/80 cm). However, the small *Therapon theraps* was the most numerous species in the trap catches. The bait was mainly small squids, but small fish was used in some of the traps. However, no difference in catch according to bait was observed. The longlines fished rather well. They were in the water for about one hour, and the bait was squid. The best catch was taken about 25 nautical miles northwest of Mafia.

The main species were Arius thalassinus, Dasyatis jenkinsii and Muraenidae. Placed in proper areas the traps and longlines fish very well.

4.3.2. Comparative trawling

Four trawl stations in the Zanzibar Channel were worked together with "Mafunzo" during the second survey. The depth range was 20-43 m. The catch rates are shown in Table 4.3.1.

Table 4.3.1. Catch rates (kg/hour) for the comparative trawl experiments.

Depth (m)	20	29	32	43
"Mafunzo"	362	368	476	198
"Dr. Fridtjof Nansen"	176	94	238	384

The most important species in the catches were Leiognathidae and Mullidae. On average "Mafunzo" caught twice the catch of "Dr.Fridtjof Nansen". This is in accordance with the difference in the area swept by the two trawls. The opening of the "Mafunzo" trawl is about 2.5 times larger than the opening of the "Dr.Fridtjof Nansen" trawl. However, the two trawls are of different types and thereby it is difficult to compare trawl efficiency directly. The "Mafunzo" trawl had no bobbins and operated further away from the vessel than the "Dr.Fridtjof Nansen" trawl.

5. CONCLUSION

The fish biomass estimates made in this report are in the order of 100 000-175 000 tonnes for the area investigated by R/V "Dr. Fridtjof Nansen". Today there is practically no fishery in this area. Therefore the potential yield (y) from this biomass could be estimated according to Gulland's formula:

$$Y = 0.5\ M\ B_o$$

where M is natural mortality and B_o the biomass. In FAO (1979) 0.5 is suggested as an overall value for natural mortality for similar species compositions as observed during the "Dr.Fridtjof Nansen" surveys. The potential yield was estimated at 25 000-44 000 tonnes. The size of the potential yield depends on the chosen value for natural mortality. If the natural mortality is closer to 1 than 0.5 the potential yield is increased by 100%. Big fish as snappers and rock cods have low natural mortality and therefore these stocks could only support a low fishery. Species with higher natural mortality could support a relatively higher fishery. It is possible that larger species in general will decline faster than smaller species because the different species will not react the same way to fishing pressure.

In the inshore area the averager catch for the period 1975-1980 was about 40 000 tonnes. By extending the fishing area beyond the reef it seems that the yield at least may be increased by 60%. However, the fish density is rather low in this area and therefore it may be difficult to fish the potential yield. Silver bellies are the most abundant species in this area.

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TANZANIA

Resource surveys other than those by DR FRIDTJOF NANSEN

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1. INTRODUCTION

Large systematic surveys of the marine resources of Tanzania have not been carried out prior to the DR FRIDTJOF NANSEN surveys. The R/V PROF MESYATSEV, of comparable size and with similar equipment, included Tanzania in three surveys from 1975-77, but the amount of work done was much less and the general approach less systematic in concept. Of the other surveys, mention should be made of those by Japanese shrimpers from 1968-70 and by EAMFRO's small research vessel MANIHINE.

Assessments based on data collected from commercial and/or artisanal fisheries are not available, therefore most of the figures on fisheries potential for Tanzania are based on educated guesses and comparisons with similar areas. This practice was followed in the FAO/IOP Workshop on the Fishery Resources of the Western Indian Ocean, South of the Equator, held in Mahe, Seychelles, from 23 October-4 November 1978, after completion of the survey programme of the PROF. MESYATSEV.

In 1979 the prawn and other fisheries of the Rufiji delta area were reviewed with particular reference to the effects of a dam to be built at Stiegler's Gorge. Also in 1979, a joint venture between the Tanzania Fisheries Corporation (TAFICO) and Gulf Fisheries Ltd. started the further exploitation of shrimp in the Rufigi area, followed by a similar exercise between TAFICO and Atlantic Fishing Company in 1980. Both joint ventures were not commercial successes. Among the many reasons given for the failure was "lack of information on the resources".

Tanzania's marine resources can be divided into 10 main groups. These groups differ in biotope and behaviour and therefore require different methods for survey and catching, as indicated in Table 1.

Group 1, the large pelagic fish, an oceanic resource, has been surveyed in Tanzania by Williams (1956) and recently in small scale pole and line surveys around Zanzibar.

Group 2 form the main topic of the DR FRIDTJOF NANSEN surveys, which also include small demersal fish, as far as these become accessible to acoustic assessments, e.g. at night and in waters deeper than 20 m. This group was also covered by the PROF. MESYATSEV.

Groups 3 and 4 can best be assessed by a systematic trawl survey with small meshed trawls. This kind of survey has only been carried out by the Japanese shrimpers, but that survey was commercially oriented. Also the DR FRIDTJOF NANSEN and the PROF. MESYATSEV have contributed data. Groups 5 to 10 have hardly been surveyed systematically (apart from Group 6A in Zanzibar by Hall (1960)), and estimates of their potential are therefore mainly based on statistical data and extrapolations.

Resource surveys can be divided into two main categories:

i) Systematic, random surveys to obtain a biomass estimate of one or more of the above groups;

ii) Exploratory surveys, a fisherman's approach trying out various types of gear on different grounds. Larger vessels would be fishing mainly on the basis of indications on the echosounder.

A third category of data is formed by trawl hauls made during an acoustic survey to identify traces on the echosounder and to sample for size and species composition. These data cannot be considered part of a random trawl survey pattern as indicated under i).

2. THE PROF. MESYATSEV SURVEYS

The results of the three surveys carried out in Tanzanian waters are given in Birkett (1978), VNIRO (1978) and Burczynski (1976) and were used in the Seychelles Workshop (FAO/IOP, 1979).

2.1 Acoustic surveys

The tracks used for the acoustic surveys cover only a part of the shelf area. The methodology used to convert echointegrator readings into biomass of fish differs considerably from the method followed on the R/V DR FRIDTJOF NANSEN. The method is described in Appendix IV of Burczynski (1976) and is based on integration of a layer covered by the TRESKA bottom trawl, thus directly relating catch and integrator readings assuming a linear regression P = aM+b, where P is the catch (in tonnes) and M the echointegrator output in mm for the layer covered by the trawl and over the same length of time. It should be noted that drawings in the reports indicate a relatively large mesh size of 100 mm. According to some of the participants in the survey a smaller mesh lining was used elsewhere and may therefore also have been applied in Tanzania. Anyhow, the large mesh size was not especially taken into account and a general efficiency of 40% was calculated on the basis of wingspread and bridle length (see Fig. 1). The correlation between catch and integrator readings was not very convincing and the correlation coefficient r of 0.78 was mainly based on 3 hauls made in high density situations. The absolute biomass estimates obtained by this method as given in Table 2 should therefore be taken as rough indications only, also because of the incomplete coverage of the shelf area. A potential yield of 20 000 t was calculated in the Workshop (FAO/IOP, 1979) based on the highest biomass estimate.

2.2 Trawl surveys

The surveys in Tanzanian waters were performed from 5-7 January 1976, 12-25 July 1977 and 8-19 November 1977. A total of 77 hauls were made during this period, the trawls were towed for a total of 336 n.mi. catching 56 t of fish and crustaceans.

The surveyed part of Tanzania is broken down into 5 zones (Fig. 2):

i) Pemba Channel adjacent to the mainland

ii) Northern part of Pemba Channel adjacent to Pemba Island. Great depths (350-800 m) begin near the line of offshore reefs. No fish were detected at these depths. Only off the northern extremity of Pemba Island catches of 400 kg of fish were made at 170 m depth. Only a small zone between 150 and 200 m was found suitable for trawling.

iii) Northern and central parts of the Zanzibar Channel.

iv) Southern part of the Zanzibar Channel.

The central part of the Zanzibar Channel, with depths of about 30 m has a sandy bottom with numerous rocky and coral formations. The northern and southern parts have a smooth bottom falling to 100-120 m, followed by a sudden edge to depths of about 200-230 m further smoothing out. At depths of 50-80 m the bottom is regular and sandy. The 100-200 m depth range is untrawlable. The southern part is more convenient for trawling and the largest catches were obtained there (Table 2).

The round scad Decapterus macarellus made up the bulk of the catches. Large spiny lobsters, identified as Linuparus somniosus and Norway lobsters, Nephrops andamanicus were regularly caught in moderate quantities at depths from 250 to 320 m, with catchrates up to 50 kg/hr.

v) The open part of the shelf off Zanzibar Island and Mafia Island.

Fishing operations in this area at depths greater than 300 m did not give noticeable results.

Surveys with the PROF MESYATSEV have contributed to the knowledge of the distribution, abundance and biological characteristics of groups 2, 3 and 6b.

3. FAO/IOP WORKSHOP AND SHRIMP SURVEYS

Estimates of the biomass of demersal species in trawlable areas covered by the PROF MESYATSEV, as derived in the FAO/IOP Workshop, are presented in Table 3 together with estimates of the potential of non-trawlable areas. The potential of the reef areas was taken as $5 t/km^2/yr$, which was probably based on actual catches reported by Wijkström (1974).

The total potential yield for Tanzania derived from these calculations and presented in Table 3 is only 15 260 tons, over a total area of more than 18 000 km^2, which means an average potential of 0.8 t/km^2 or 8 kg/ha, which is very low.

The Workshop also considered a paper prepared by IOP, A preliminary assessment of shrimp resources in Tasmanian waters, based on fishing data of Mwananchi Ocean Products Ltd. (FAO/IOP, 1979, Appendix 7).

The average catch rates of a Taiko Maro trawler using 2 nets of 19 m headrope, trawling at a speed of 2 knots varied from 22.3 to 26.4 kg/hr in the Bagamoyo area and from 25.4 to 31.8 kg/hr in the Rufiji area. The swept area was taken as 60% of 2 x 19 m x 2 x 1.85 km^2 = 0.0851 km^2 per haul. It was further assumed that all the shrimp in this area were caught. Using an annual natural mortality rate M = 3.0 in the formula $Y = \frac{1}{2}MB_0$, where B_0 is the unfished biomass, a potential of 1 830 tons was reached for the two areas combined.

The two fishing grounds were considered to have areas of respectively 950 and 2 880 km^2, total 3 830 km^2. There is no indication how the extent of these areas was determined, but they were said to lie beyond the areas covered by the artisanal fisheries.

The highest combined landings of artisanal fisheries and Mwananchi Ocean Products were reported in 1970, with a total of 706 m.t. An earlier report issued by the Kanagawa Prefectural Government in May 1969 provides many details on a preliminary survey in 1968. The conclusion drawn in this report was that a potential existed of 200 m.t. Further details on the shrimp fishing grounds and the fisheries in the Rufiji Delta are given by Dorsey (1979). It would seem that these and similar data could be used in a further detailed analysis.

It is obvious that further research on this valuable resource is much needed both at sea, based on trawl catches, and on land via data collection from artisanal fisheries.

4. LOBSTER SURVEYS

Cushing (1971) reports data obtained by Hall (1960) on catchrates of spiny lobsters obtained by divers in eight areas around Zanzibar. The combined catchrate for the six least exploited areas was 13.56 lb/man/day, and in the two more exploited areas 9.98 lb/man/day.

If similar data could be obtained over a number of years, an estimate of the maximum sustainable yield could be obtained provided the fishing methods have not drastically changed. Dorsey (1979) informed that the area from Somanga to Kilwa Masoko is a good spiny lobster ground.

5. SURVEYS FOR LARGE DEMERSAL FISH

Tarbit (1976) summarises the results of exploratory surveys with short bottom longlines, handlines and traps in Tazanian and Kenyan waters. The main problem in deriving standing stock estimates from catchrates with such gears is that the effective fishing area is not known. Tarbit has assumed a different radius of attraction for hooks on rough and smooth grounds. A possible solution to this problem has been given by Munro in Jamaican trapfisheries, comparing catchrates of known and heavily fished grounds, with those of unfished grounds. Off East Africa such methods could be applied, e.g. by fishing with traps in protected and unprotected areas and by comparing the catchrates.

Tarbit obtained estimates of standing crop on the Mafia Shelf between 45 and 120 m depths of 3 036 m.t., composed of 1 520 t from 100 km^2 rough grounds and 1 516 t from 400 km^2 smooth grounds.

These types of surveys relate directly to existing artisanal fisheries and can be carried out with relatively unsophisticated means and small vessels.

6. CONCLUSIONS AND POINTS FOR DISCUSSION

Although this brief summary may not have done justice to numerous small survey efforts carried out in the past by research and training institutes as well as commercial enterprises, it is immediately obvious that the surveys reported here have not lead to results that are of great direct use for planners and investment. Valuable resources like shrimp, lobster and large demersal fish have remained unsurveyed and consequently their present rate of exploitation is unknown.

Large research vessels have big limitations when it comes to surveying shallow waters or waters full of coral reefs and similar obstacles. Surveys on shrimp could be carried out by the existing commercial fleet, based on a properly designed sampling plan. Surveys of large pelagic/reef fisheries should be based on a descriptive survey of the existing fisheries and from there expanding into underexploited areas.

Deep-sea resources as discovered by the R/V PROF MESYATSEV require a large trawler with a capacity to fish up to 400 m depth in waters with strong currents. The total biomass of the resource and the catchrates would have to be fairly high to warrant special investments for this resource. A further assessment may be needed before exploitation can be considered.

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Table 1: Biotopes, survey methods and fishing gears for species groups encountered in Tanzania and Kenya

Group	Biotope	Survey methods	Fishing gears
1. Large pelagic fish tunas, sailfish, etc.	Oceanic surface	Aerial, sightings fishing with different gears	Gill nets; pole and line, longline, trolling, purse seines
2. Small pelagic fish sardines, horse mackerels, mackerels	Shelf, surface to bottom	Acoustics	Gill nets, purse seines, beach seines, pelagic and high opening trawl
3. Small demersal fish	Shelf, trawlable bottoms	Trawl (acoustics)	Bottom trawl (small mesh)
4.a. Shrimps (Penaeids)	Shelf, shallow usually muddy bottom	Trawl	Shrimp trawl (traps, etc., inshore)
b. Deep sea shrimp	Off the shelf	Trawl	Trawl
5. Large demersal fish groupers, snappers	Shelf, very often untrawlable	(Lines) (gill nets) (traps) (diving)	Lines, gill nets, traps
6.a. Spiny lobsters	Shelf, reefs, untrawlable	Traps (spears) (diving)	Spears, traps, gill nets
b. Deep sea lobster (Puerulus, Nephrops)	Just off the shelf, trawlable	Trawl	Trawl
7. Squid, octopus	Shelf, mid-water reefs	Trawl, pots	Trawl, pots, jigging
8. Gastropods, bivalves		Sighting, sampling	Collection, dredges
9. Seaweeds	Shore	Sighting, sampling	Collection
10. Bêche de mer 1/	Reefs	Sighting, sampling	Collection

1/ sea cucumber

Table 2: Trawl catches in Tanzanian waters R/V Prof. Mesyatsev, 1976-77

Zones (see text)	No. of hauls	Mean catch rates kg/h	kg/n.mi
January 1976			
1	-	-	-
2	3	310	60
3	1	310	70
4	3	850	220
5	-	-	-
July 1977			
1	7	168	38
2	4	159	33
3	-	-	-
4	24	1059	239
5	5	179	36
November 1977			
1	2	178	47
2	-	-	-
3	7	420	86
4	9	1816	393
5	10	153	42

Table 3: Biomass estimates and potential yields in Tanzania (FAO/IOP, 1979)

Pelagic biomass (m. tons) Prof. Mesyatsev surveys	Carangids	Scombrids	Clupeids	Total
Average biomass from day trawls	34570	2989	5113	42672
Acoustics (Jan. 76)				43000
" (12 July 77)				23000
" (24 July 77)				15000
" (Oct. 77)				10000
Potential yield:	20000 (based on 43000 t biomass)			

Demersal biomass	Area (km^2)	Trawlable	Density a/ t/km^2	Biomass t	Pot. Yield t
Pemba reef	888	no	?	?	(4440) b/
Pemba other	1312	yes	1.65	2165	540
Zanzibar < 200 m	6192	yes	1.65	10220	2500
Zanzibar > 200 m	411	yes	2.7	1110	280
Mafia mangrove	320	no	?	?	?
Mafia other	7936	yes	(0.45)	3532	900
Mtwara-Lindi reef	1295	no	?	?	(6500) b/
Mtwara-Lindi other	565	?	?	?	(100) c/
Total	18919				(15260)

a/ Based on Prof. Mesyatsev catches

b/ Assumed potential $5t/km^2$

c/ Assumed potential $0.5t/km^2$

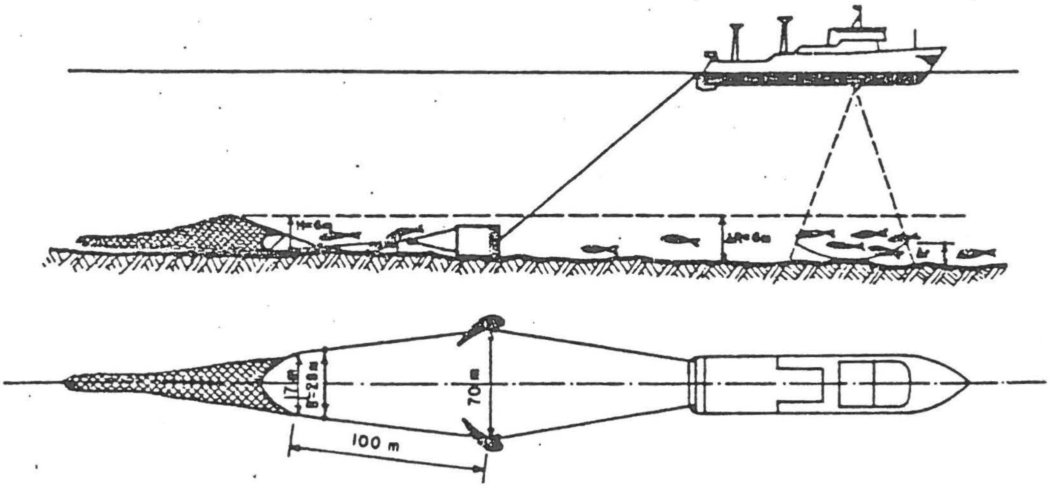

Figure 1. Calibration of the echo integrator by means of catch.
(Source: Burczynski, 1976)

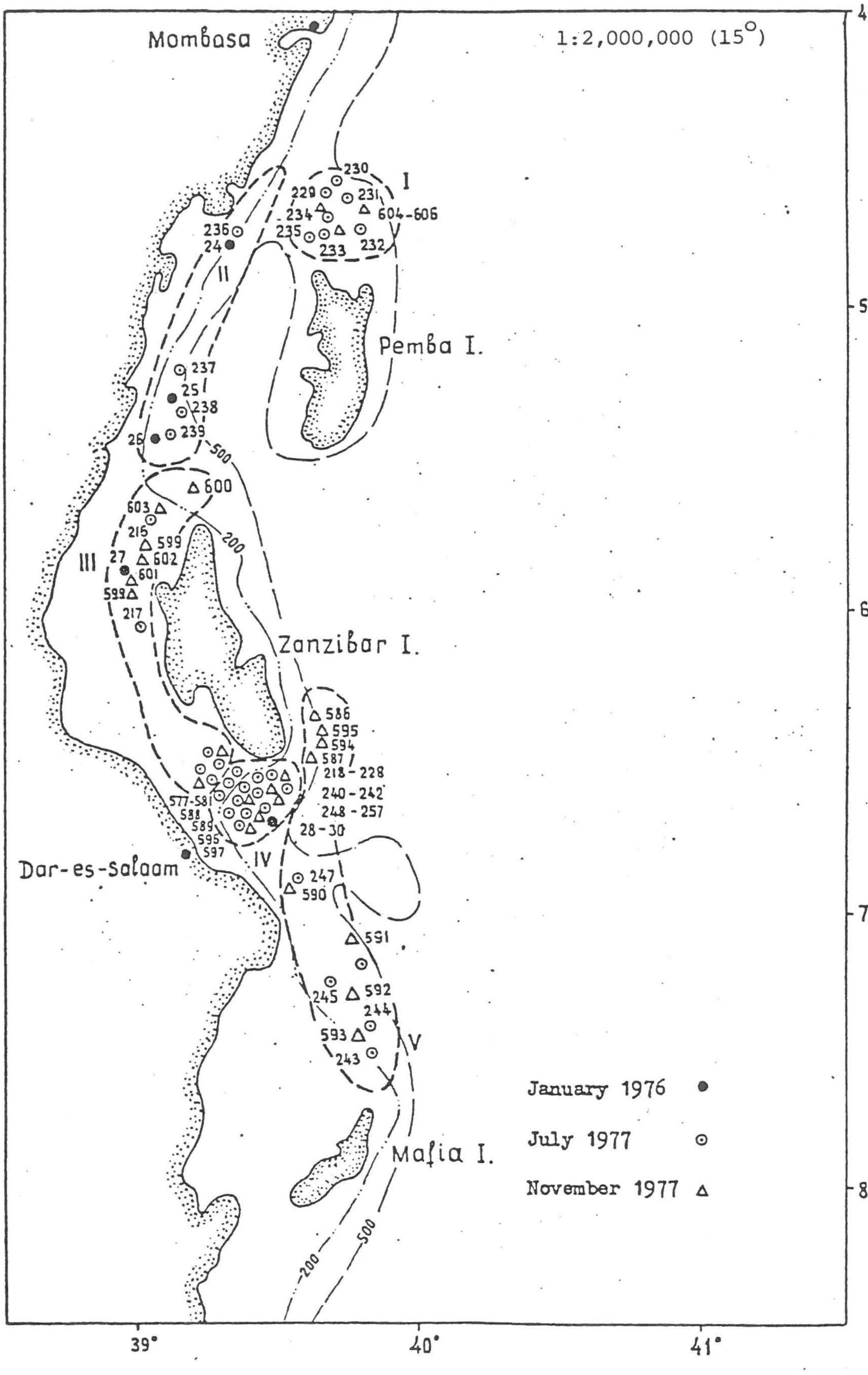

Figure 2. Trawling locations in Tanzanian waters.

(Source: VNIRO, 1978)

TUNA FISHERIES IN THE SOUTH WEST INDIAN OCEAN[x]

by

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1. *Tuna Species and their Distribution in relation to Geographic and Oceanographic Conditions*

The tuna species common in the SWIO area are listed below, together with their biological characteristics and distribution (Appendix 1).

Little tuna are generally a coastal species found on shallow banks, whereas the other species are oceanic.

Tunas are unique among fishes in having limited thermo-regulatory capacity. Blood can be shunted through vessels close to the skin, or along the vertebrae in order to conserve or dissipate heat. Their preferred temperature range is however fairly limited (Table 1), and prolonged excursion outside this range can result in death.

Another characteristic of the tunas is the limited development of their swim bladders. Skipjack have no swim bladder, while in the other species, only the older individuals develop one; concurrently with an increase in body fat which reduces density.

Table 1 : Temperature preferance and Oxygen tolerance of main SWIO tunas.

	Common name		Scientific name	Temperature preference	Oxygen tolerance (10 minute) 50–70cm tuna
a)	Skipjack	-	Katsuwonus pelamis	20–32°C	2.5–3.0 ml/L
b)	Yellowfin	-	Thunnus albacares	23–32	1.5–2.5
c)	Big-eye	-	T. obesus	11–23	0.5–1.0
d)	Albacore	-	T. alalunga	15–22	1.7–1.4
e)	Little tuna (Kawakawa)	-	Euthynnus affinis	18–29	

As a consequence, tuna have to swim continuously to avoid sinking. This effect is particularly marked for skipjack and juveniles of the other species. Their metabolic requirements are therefore very high, and in consequence, their requirements for food and oxygen (Table 1).

Sharp (1979) has, on the basis of long-term average sea temperature and oxygen records (Fig. 2), predicted the areas of the Indian Ocean in which the various tuna species are seasonnally accessible to surface fisheries.

Conditions may however vary considerably from these averages in any given year in a given area. Coastal areas, whether they be of the mainland or of island groups and oceanic banks, may also sufficiently perturb water temperatures and oxygen concentrations to make them accessible to tuna during a season where the general area is inhospitable.

x) Prepared for the NORAD Seminars in Kenya, Tanzania, Mozambique.

Similarly, it should be remembered that tuna are not primarily surface-dwelling species. They more generally inhabitat the temperature oxygen stratum which suits them - often close to the thermocline - and make more-or-less brief excursions to the surface or to greater depths, despite possibly stressful temperature or anoxic conditions in one case or the other.

It has been proved, nevertheless, that there is a direct relationship between the productivity of purse-seining and the emergence of the 15°C and 23°C isotherms above the maximum and minimum immersion depths of purse seines. This may be related to the more frequent presence of tuna schools at the surface under these conditions, as there are many examples of tuna diving out of seines through the thermocline, and early results from the SWIO purse seine fishery indicate that many successful sets are made despite a deep thermocline. This is also confirmed by the co-existence in this area of longline and purse seine fisheries, which had previously thought to be mutually exclusive in that longlines, fishing typically between 50 and 200m deep, would normally be in conditions inhospitable to tunas where the thermocline is shallow and structured.

2. Tuna Fisheries

(a) Traditional and Artisanal

Other than trolling, generally carried out on the way to and from fishing grounds and often more directed to Scomberomorus than to tunas, only in the Comoros is there (in the SWIO region) a fishery specifically directed to catching the larger tunas: this is by droplining using live fish as bait. Yellowfin are the usual target species, but albacore and billfish are also caught.

This fishery has developed in the Comoros Islands due largely to the very sharp drop-off of the shelf to deep water, which allows tunas to come close inshore where they are accesible to fishermen in dug-out canoes. Typically, the bait-fish, kept alive in a basket immersed in the sea, are hooked through the eye. The line is weighted by small stones which are released at a predetermined depth, allowing the bait-fish to swim more easily. Some 1800 tonnes of tuna are caught annually by this method.

Other artisanal means of fishing are:

1. Gill netting : (drift nets) - widely used in Sri Lanka and India - applied experimentally with some success in association with FADs: particularly effective if livebait is used also.

2. Pole-and-line with Livebait : used in Maldives (20 000t/year), particularly with driftwood-associated schools of skipjack and juvenile yellowfin. Livebait, caught by chumming with tuna "paste" among coral reefs, is kept alive in the bottom of the boat (dhoni) which is holed to permit water circulation. This bait is used to chum tuna, frequently assocated with driftwood, which are caught with bamboo poles fitted with a short line and lure or baited hook. Artisanal livebait fishing will be tried with FADs in Mauritius and Rodriguez.

(b) Industrial

The three major industrial fishing gears for tuna are longlines, pole-and-line (livebait) and purse seines.

(i) Longline: *Tuna longlining was first developed in the Indian Ocean in the early 1960's by Japanese vessels based mainly on Mauritius, and later at Mombasa, in Seychelles, in Durban and in Réunion. The gear is illustrated in Fig.3.*

Target species with this gear was albacore (with a significant bycatch of blue shark) during the Southern winter months, and yellowfin the rest of the year. As from the 1970's, the majority of the fleet was from South Korea and Taiwan, as the profitability of this fishery declined with lower catch rates, increased costs and stagnation of prices. The nature of this fishery started changing as from 1976 with a gear modification, the elimination of alternate buoys, which allowed the gear to fish deeper and catch significantly more bigeye tuna. This species has a higher value for consumption as sushimi (Japanese raw fish) if frozen and stored at very low temperatures (-60° C/-45° C). This increased value justified the re-entry of the Japanese into the fishery, and the major fishing area became the Seychelles, the vessels fishing for cannery fish remaning at the Southern ports.

The landings of longline-caught fish are shown from 1974 to 1981 in Fig. 4.

(ii) Pole-and-line: *The gear is illustrated below in Fig.5.*

Tuna, usually skipjack and juveniles of yellowfin and bigeye in surface-swimming schools are attracted to the fishing vessel by small fish (often anchovies or sardines) kept alive in wells on the fishing vessel and thrown into the sea when a school of tuna is approached. The tuna are then caught on the barbless hooks illustrated. There are thus two distinct fisheries: that for bait and that for tuna.

Apart from the traditional Maldivian fishery described above, the first attempts at this type of fishing in the area were those based on Nosy-Bé (Madagascar) from 1973 to 1975. Technically a success, as annual catches of over 1 000t. of tuna per vessel were achieved, this fishery folded up for financial reasons.

This method then formed the basis for a fishery project in Seychelles in 1979-80, but was a failure on acount of difficulties in catching baitfish, and for organizational reasons. The Seychelles operation was however taken up again experimentally by two Spanish vessels in 1980-81, and the problems of catching both bait and tuna were resolved for at least part of the year. It is planned to resume this fishery, which has the great advantages of reasonable investment and technological requirements, under a Seychelles-Spanish joint venture. Test-fishing projects using livebait are also operational or due to start shortly in Zanzibar, Mozambique and Mauritius, and Madagascar also plans to resume the fishery.

(iii) Purse seining: *Purse seining has for number of years been the main fishing method for tunas in both the Eastern Pacific and Ocean and the Atlantic. It was believed, however, that the Western basins of the Pacific and Indian Oceans did not offer suitable oceanographic conditions for purse seining, notably as concerns the structure of the thermocline. Test fishing run concurrently by Japanese and FAO-chartered vessels in the Western Pacific around 1975 on driftwood-associated schools invalidated this assumption.*

The first attempts at purse seining tuna in the SWIO region took place in 1979 and were inconclusive due to weather conditions. These were followed by more successful attempts in 1980 and 1981. As from 1983, the fleet based in Seychelles has built up from one to four to fourteen vessels, and by the end of the year there could be as many as thirty vessels in the zone.

Early results in the area indicate that from October to March, a fishery for free swimming schools of large yellowfin tuna (40kg +), while the main catch the rest of the year is on driftwood-associated skipjack. In 1983, however, the catch in July/August was negligeable due to strong winds.

Purse seine gear is illustrated in Fig. 6.

Oceanic seiners in use at present vary typically between 50 and 75m in length, with hold capacities of 500-700t of tuna refrigerated in brine. This type of vessel evolved with the need to travel long distances searching for tuna, the 70m class vessels actually fishing across the width of the Atlantic. Investment and fuel costs have now risen to such an extent, however, that a certain standardisation appears to be evolving on the 50m class which has identical catching capacity on shorter range operations, and can more profitably fish on small schools of tuna.

Purse seining is more dependent on weather conditions than other tuna fishing methods, not only as the fish have to be available at the surface for a relatively long time, but as the gear cannot be operated in rough seas. Typically, wind strengths of more than 15kts make fishing impossible, as do the presence of shear currents in the upper 200m of the ocean. On the basis of conditions suitable for tuna to be present in surface waters and weather conditions suitable for purse seining, charts can be made showing the "window" accessible to purse seining under average conditions (Fig. 7). It should be noted that shelf areas are totally inacessible to this gear because of the risk of snagging the sea floor.

(c) Fish Aggregation Devices

Fish Aggregation Devices (FADs) are of interest to both artisanal and industrial fisheries. Typically as concerns tuna they are floating rafts, usually with appendages hung underneath (palm fronds, old netting, used tyres...), which may be anchored (such as the Philippine 'payaos'), or drifting (Fig. 8). Migrating tuna aggregate around FADs, sometimes for periods of several weeks, and are then much more accessible to fishing, both due to the reductioon of searching time (the fisherman knows the location of his FAD), and due to the fact that the swimming speed and range of the fish are reduced.

Drifting FADs are normally used by oceanic seiners, and are located by means of radio buoys (such buoys are also used to track driftwood which attracts tuna in the same manner as FADs-both techniques have been used successfully in the Seychelles fishery). Anchored FADs are used both by coastal seiners and by artisanal fisheries. It is significant that the vessels used to seine FAD-associated fish are generally much smaller and less sophisticated than oceanic seiners.

As a cautionary measure, FADs should not be used in the context of an intensive fishery. Typically, juvenile tuna associated with FADs are more vulnerable to fishing as they are found at shallower depths. In the Philippines where payaos are concentrated in a tuna nursery area, it is suspected that despite the high fecundity of tunas, growth overfishing may occur (Pauly, 1982). Catches of yellowfin as small as 18cm are reported from this fishery in quantities which are unknown as they are frequently landed with scads.

Experimental FADs have now been set in Seychelles, Mauritius, Comoros, Zanzibar, *Mozambique, Maldives and Sri Lanka. Many of the FADs have had short service lives due to engineering problems and vandalism, but their efficacity in attracting tuna is proved for those which were properly located. FADs are likely to be a sine qua non condition for the development of surface tuna fisheries in this region if the problem of surface currents is resolved (SWIOP is currently testing designs for deployment in regions with strong coastal currents). Growth overfishing is not likely to occur in the forseeable future as this depends on the existance of coastal seiners, and of high local market demand for small fish (canning is not economic for these sizes).*

3. State of Exploitaton of Stocks

To date, the state of exploitation of stocks have been considered only with respect to longline fisheries, mainly because the exploitation of skipjack and juvenile tunas was at too low a level to permit any evaluation.

At a workshop on the State of Tuna Fisheries and Tuna Stocks in the Pacific and Indian Oceans, held in Shimizu, Japan, 13-22 June 1979, the following conclusions were drawn from available data:

"In all the longline fisheries, the catch rate, in numbers and weight, has declined since the start of the fisheries in some cases very drastically. The general shape of the relation between the total longline catch and the total amount of fishing (standardised number of hooks) seems to be much the same for all species- a general flattening out to a level of catch which can be maintained over quite a wide range of fishing efforts- although the development of the fishery along these curves vary:

(a) Fishing effort on yellowfin in the Indian Ocean, southern bluefin and billfish could be decreased without any loss of sustained catch.

(b) The maximum level of albacore catch has been approached.

(c) Increased fishing for bigeye can be expected to give increased total catches, possibly at the expense of reduced catch rates."

The relationships for CPUE and Mean Effort for yellowfin and bigeye in the Indian Ocean are illustrated in Fig. 9.

A meeting of the joint IOFC/IPFC Committees on the Management of Indian Ocean and Indo-Pacific Tunas is scheduled to be held in conjunction with the IPFC meeting later this year in order to update estimations. If, however, the relationships between catch and effort made at Shimizu are valid it can be seen from Fig. 4 that even bigeye stocks are fully exploited.

Estimates of tuna potential for surface fisheries can only be made on the basis of analogy with other oceans or on trophic levels based on primary productivity. The validity of these estimates may however be highly questionable, as the Indian Ocean differs from the other oceans not only in oceanographic conditions, but also in biological pathways (eg. the preponderence of myctophids in the pelagic stocks of the Northwestern margin).

The work of the South Pacific Commission skipjack programme indicate that, in that area, exploitable skipjack resources may approach 1 million tonnes- far more than originally thought, and that the 'turnover' of skipjack in any given coastal area could be as high as 20% monthly. Consequently, although surface fisheries may permit an increase of only some 40% above longline catches of yellowfin, stocks of skipjack may be higher than the 200-400 000t provisionally quoted for the Western Indian Ocean.

Inherent in the concept of stock is that of its distribution. Tuna are commonly classed as a 'highly migratory species', and this concept may be misleading. In the Pacific, opinions vary as to the number of skipjack stocks, between one and five. Superimposed on this is the possibility that each shoal area may have a 'resident' sub-population of skipjack which have 'chosen' not to follow the oceanic migration pattern, and in order to compensate for the stressing temperature and food conditions in these areas, exhibit a reduced growth rate. Similarly, Sharp has demonstrated in the Eastern Pacific that yellowfin do not normally migrate outside a radius of 600n miles.

If these concepts prove valid for the Indian Ocean, high levels of fishing effort, as may be found with the development of the Seychelles purse seine fishery, may not greatly affect other areas, at least in regard to coastal fisheries.

4. Prospects for Expansion

Development of long line fisheries by SWIO countries, based on the model of the fleets now exploiting the Indian Ocean does not appear to be an attractive proposition until such time as fishing effort of these fleets in substantially reduced. This is particularly true as the Seychelles purse seine fishery is at present catching a substanial proportion of large yellowfin, and this can be expected to further reduce long line catch rates.

This, however, does not preclude the possibility of developing coastal long line fisheries, based on the use of smaller boats and reduced crews. Experimental fishing in the Eastern Pacific with boats of about 15m and crews of 3-4 men have given economically positive results.

As regards surface fisheries, prospects appear much better, in respect both to stock size and availability of fish in coastal regions. In fact, the seasonality of coastal fisheries for tuna off the East African coast may be more linked to the inability of fishing craft to acceed to the fish offshore due to weather and current conditions, than the non-occurrence of fish.

The strategy of development of coastal fisheries, however, will be conditioned as much by investment needs and market opportunities as by the availability of fish. Tuna have generally been regarded as destined to export markets rather than meant for local consumption.

Two problems exist: the high investment needs for an export oriented industry, and the present depressed state of the main tuna markets.

Export marketing requires a high quality frozen product, involving freezing or the use of ice on board and sufficient freezing and storage capacity ashore to justify the displacement of reefer ships. Minimum yearly production of 1-2,000t is therefore needed unless tuna trans-shipment or processing facilities which are able to absorb progressive landings of tuna already exist locally. These conditions are found in Mauritius (cannery) and now in Seychelles (foreign surface fisheries).

World tuna prices are largely dependent on the US market, which is, at over 200,000t (1978) the largest importer of tuna. In 1975 and 1981, prices dropped dramatically due to lowered livestock and poultry prices (soja and cereal prices dropped), and at present, prices have not recovered due to accumulated stocks. Sushimi on the Japanese market is between U.S.$1 500 and 2 000 per ton, whereas skipjack is at $750/t. Albacore sells at $1 650/t, and yellowfin on the Italian market is at $1 500/t.

At these prices, acount taken of the need for high investment and imported expertise in a new fishery, setting up export-oriented tuna fisheries is a doubtful proposition. An FAO Investment Centre mission to a SWIO country recently evaluated the internal rate of return of a pole-and-line venture at under 4%, despite the existence of processing facilities ashore.

It would appear, therefore, that the best strategy for countries of the region at this stage is to develop coastal fisheries aimed principally at local consumption. This will permit the constitution of a core of competent tuna fishermen, who will be available when conditions are favourable for the development of an export industry.

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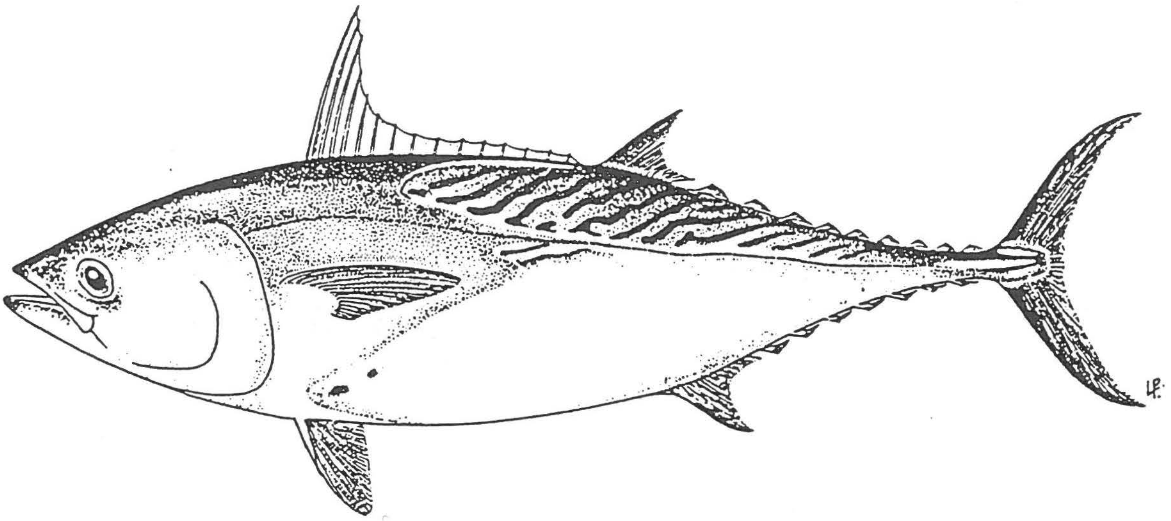
Appendix 1.

Euthynnus affinis (Cantor, 1849)	SCOMBR Euth 2

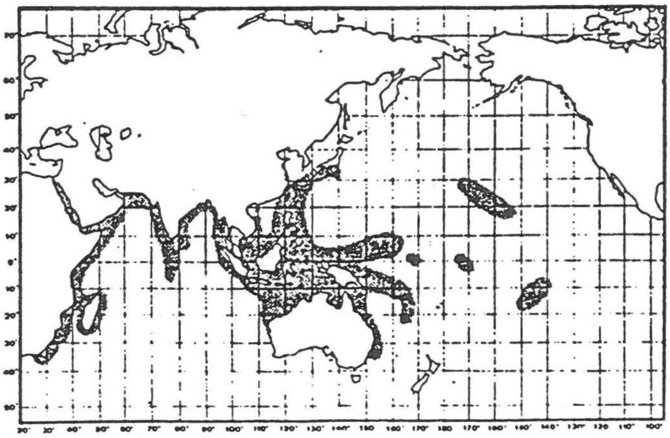
Thynnus affinis Cantor, 1849, J.Asiatic Soc.Bengal, 18(2):1088-1090 (Sea of Penang, Malaysia).

Synonymy : Euthunnus yaito Kishinouye, 1915; Wanderer wallisi Whitley, 1937; Euthunnus affinis affinis - Fraser-Brunner, 1949; Euthunnus affinis yaito - Fraser-Brunner, 1949; Euthunnus alletteratus affinis - Beaufort, 1951; Euthunnus wallisi - Whitley, 1964.

FAO Names : En - Kawakawa; Fr - Thonine orientale; Sp - Bacoreta oriental.



Diagnostic Features : Gillrakers 29 to 33 on first arch; gill teeth 28 or 29; vomerine teeth absent. Anal fin rays 13 or 14. Vertebrae 39; no trace of vertebral protuberances; bony caudal keels on 33rd and 34th vertebrae. Colour: dorsal markings composed of broken oblique stripes.



Geographical Distribution : Throughout the warm waters of the Indo-West Pacific, including oceanic islands and archipelagos. A few stray specimens have been collected in the eastern tropical Pacific.

Habitat and Biology : An epipelagic, neritic species inhabiting waters temperatures ranging from 18° to 29°C.

Like other scombrids, E. affinis tend to form multispecies schools by size, i.e. with small Thunnus albacares, Katsuwonus pelamis, Auxis sp., and Megalaspis cordyla (a carangid), comprising from 100 to over 5 000 individuals.

Although sexually mature fish may be encountered throughout the year, there are seasonal spawning peaks varying according to regions: i.e. March to May in Philippine waters; during the period of the NW monsoon (October-November to April-May) around the Seychelles; from the middle of the NW monsoon period to the beginning of the SE monsoon (January to July) off East Africa; and probably from August to October off Indonesia. The only available information on fecundity applies to Indian Ocean material: a 1.4 kg female (ca 48 cm fork length) spawns approximately 0.21 million eggs per batch (corresponding to about 0.79 million per season), whereas a female weighing 4.6 kg (65 cm fork length) may spawn some 0.68 million eggs per batch (2.5 million per season). The sex ratio in immature fish is about 1:1, while males predominate in the adult stages.

E. affinis is a highly opportunistic predator feeding indiscriminately on fish, shrimps and cephalopods. In turn, it is preyed upon by marlins and sharks.

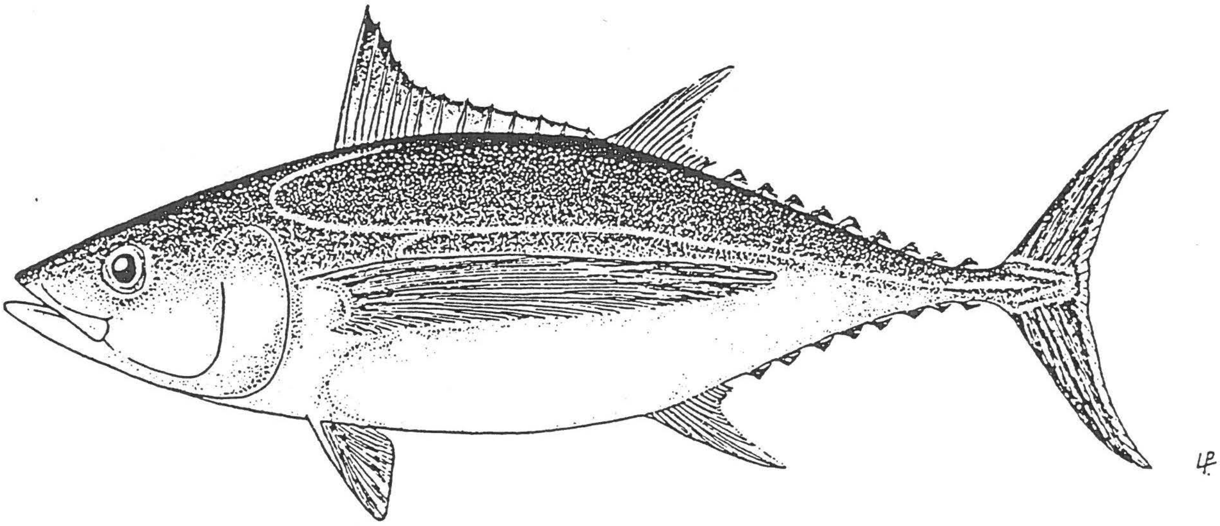
Size : Maximum fork length is about 100 cm and weight about 13.6 kg, common to 60 cm. The all-tackle angling record is a 11.80 kg fish from Merimbala, New South Wales, with a fork length of 96.5 cm taken in 1980. In Philippines waters, maturity is attained at about 40 cm fork length, while in the Indian Ocean it is reached between 50 and 65 cm in the 3rd year of age.

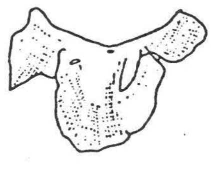
Thunnus alalunga (Bonnaterre, 1788) | SCOMBR Thun 1

Scomber alalunga Bonnaterre, 1788, Tableau Encyclopédique et Méthodique, Ichthyologie:139 (Sardinia)

Synonymy : Scomber alatunga - Gmelin, 1789; Scomber germo Lacepède, 1800; Orcynus germon - Cuvier, 1817; Orcynus alalonga - Risso, 1826; Thynnus alalonga - Cuvier in Cuvier & Valenciennes, 1831; Thynnus pacificus Cuvier in Cuvier & Valenciennes, 1831; Orcynus alatunga - Gill, 1862; Thunnus alalonga - South, 1845; Thunnus pacificus - South, 1845; Orcynus pacificus Cooper, 1863; Orcynus germo - Lütken, 1880; Germo alalonga - Jordan, 1888; Albacora alalonga - Dresslar & Fesler, 1889; Germo alalunga - Jordan & Evermann, 1896; Thynnus alalunga - Clarke, 1900; Germo germon - Fowler, 1905; Germo germo - Jordan & Seale, 1906; Thunnus alalunga - Jordan, Tanaka, & Snyder, 1913; Thunnus germo - Kishinouye, 1923; Germo germon steadi Whitley, 1933.

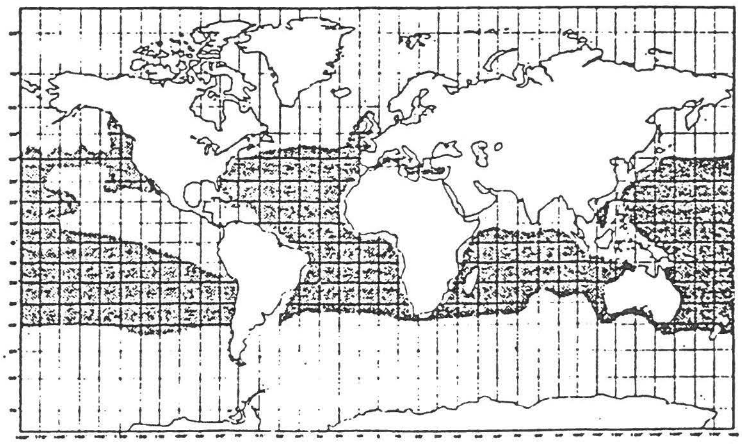
FAO Names : En - Albacore; Fr - Germon; Sp - Atún blanco.





liver

Diagnostic Features : A large species, deepest at a more posterior point than in other tunas (at, or only slightly anterior to, second dorsal fin rather than near middle of first dorsal fin base). Gillrakers 25 to 31 on first arch. Second dorsal fin clearly lower than first dorsal; pectoral fins remarkably long, usually 30% of fork length or longer in 50 cm or longer fish, reaching well beyond origin of second dorsal fin (usually up to second dorsal finlet). Fish smaller than 50 cm will have proportionately smaller pectorals than other tunas, i.e. T. obesus. Ventral surface of liver striated (vascular network). Swimbladder present, but poorly developed and not evident in fish smaller than about 50 cm fork length. Vertebrae 18 precaudal plus 21 caudal. Colour: a faint lateral iridescent blue band runs along sides in live fish; first dorsal fin deep yellow, second dorsal and anal fins light yellow, anal finlets dark; posterior margin of caudal fin white.



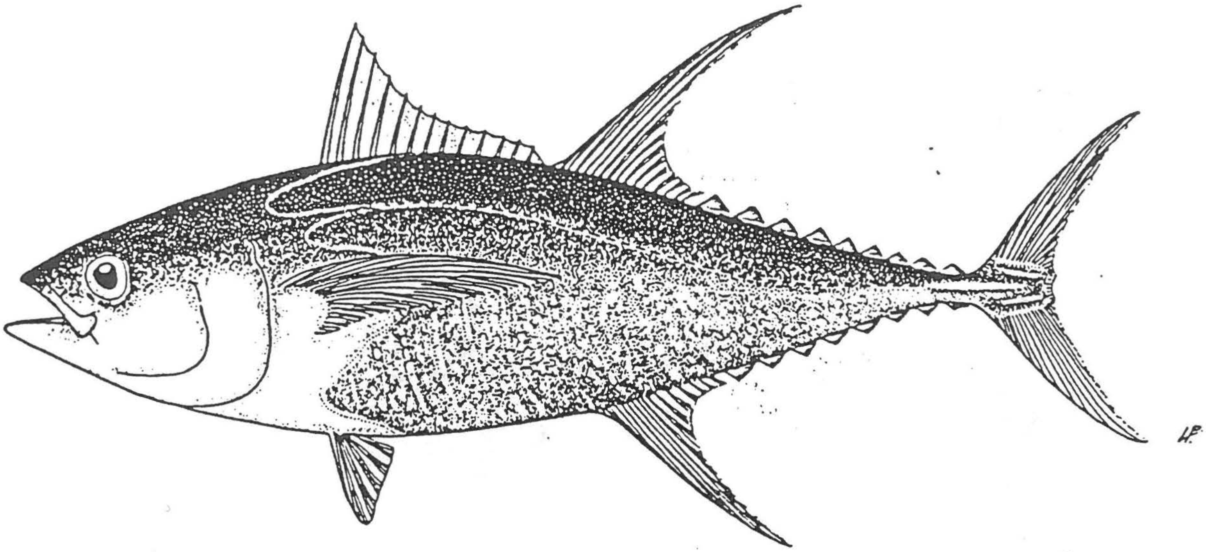
Geographical Distribution : Cosmopolitan in tropical and temperate waters of all oceans including the Mediterranean Sea, extending north to 45 to 50°N and south to 30 to 40°S, but not at the surface between 10°N and 10°S.

Habitat and Biology : An epi- and mesopelagic, oceanic species, abundant in surface waters of 15.6° to 19.4°C; deeper swimming, large albacore are found in waters of 13.5° to 25.2°C; temperatures as low as 9.5°C may be tolerated for short periods. In the Atlantic, the larger size classes (80 to 125 cm) are associated with cooler water bodies, while smaller individuals tend to occur in warmer strata. According to data presently available, the opposite occurs in the northeastern Pacific. Albacore tend to concentrate along thermal discontinuities (oceanic fronts such as the Transition Zone in the north Pacific and the Kuroshio Front east of Japan) where large catches are made. The Transition Zones are preferred to cooler upwelling waters which are richer in forage organisms but poorer in oxygen content. Minimun oxygen requirements are probably similar to those of yellowfin tuna, that is about 2 ml/l. Albacore migrate within water masses rather than across temperature and oxygen boundaries.

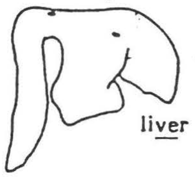
Thunnus albacares (Bonnaterre, 1788)

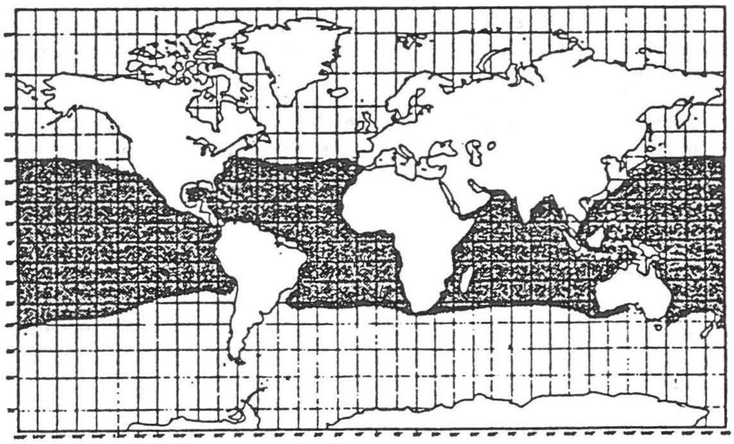
SCOMBR Thun 3

FAO Names: En - Yellowfin tuna; Fr - Albacore; Sp - Rabil.



Diagnostic Features: A large species, deepest near middle of first dorsal fin base. Gillrakers 26 to 34 on first arch. Some large specimens have very long second dorsal and anal fins, which can become well over 20% of fork length; pectoral fins moderately long, usually reaching beyond second dorsal fin origin but not beyond end of its base, usually 22 to 31% of fork length. No striations on ventral surface of liver. Swimbladder present. Vertebrae 18 precaudal plus 21 caudal. Colour: back metallic dark blue changing through yellow to silver on belly; belly frequently crossed by about 20 broken, nearly vertical lines; dorsal and anal fins, and dorsal and anal finlets, bright yellow, the finlets with a narrow black border.





Geographical Distribution: Worldwide in tropical and subtropical seas, but absent from the Mediterranean Sea.

Habitat and Biology: Epipelagic, oceanic, above and below the thermocline. The thermal boundaries of occurrence are roughly 18° and 31°C. Vertical distribution appears to be influenced by the thermal structure of the water column, as is shown by the close correlation between the vulnerability of the fish to purse seine capture, the depth of the mixed layer, and the strength of the temperature gradient within the thermocline. Yellowfin tuna are essentially confined to the upper 100 m of the water column in areas with marked oxyclines, since oxygen concentrations less than 2 ml/l encountered below the thermocline and strong thermocline gradients tend to exclude their presence in waters below the discontinuity layer. Larval distribution in equatorial waters is transoceanic the year round, but there are seasonal changes in larval density in subtropical waters. It is believed that the larvae occur exclusively in the warm water sphere, that is, above the thermocline.

Schooling occurs more commonly in near-surface waters, primarily by size, either in monospecific or multispecies groups. In some areas, i.e. eastern Pacific, larger fish (greater than 85 cm fork length) frequently school with porpoises. Association with floating debris and other objects is also observed.

Although the distribution of yellowfin tuna in the Pacific is nearly continuous, lack of evidence for long-ranging east-west or north-south migrations of adults suggests that there may not be much exchange between the yellowfin tuna from the eastern and the central Pacific, nor between those from the western and the central Pacific. This hints at the existence of subpopulations.

Spawning occurs throughout the year in the core areas of distribution, but peaks are always observed in the northern and southern summer months respectively. Joseph (1968) gives a relationship between size and fecundity of yellowfin tuna in the eastern Pacific.

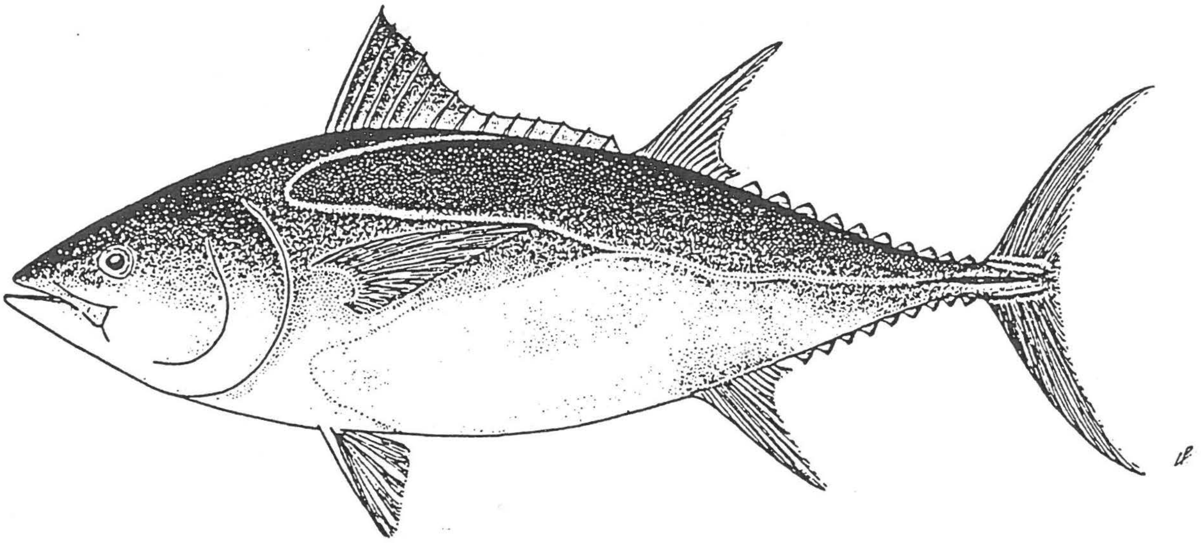
Size: Maximum fork length is over 200 cm. The all-tackle angling record was a 176.4 kg fish of 208 cm fork length taken off the west coast of Mexico in 1977. Common to 150 cm fork length.

Thunnus maccoyii (Castelnau, 1872)	SCOMBR Thun 4

Thunnus maccoyii Castelnau, 1872, Proc.Zool.Acclim.Soc.Victoria, 1:104-105 (Melbourne, Australia).

Synonymy : Thunnus phillipsi Jordan & Evermann, 1926; Thunnus maccoyii - Jordan & Evermann, 1926; Thunnus thynnus maccoyii - Serventy, 1956.

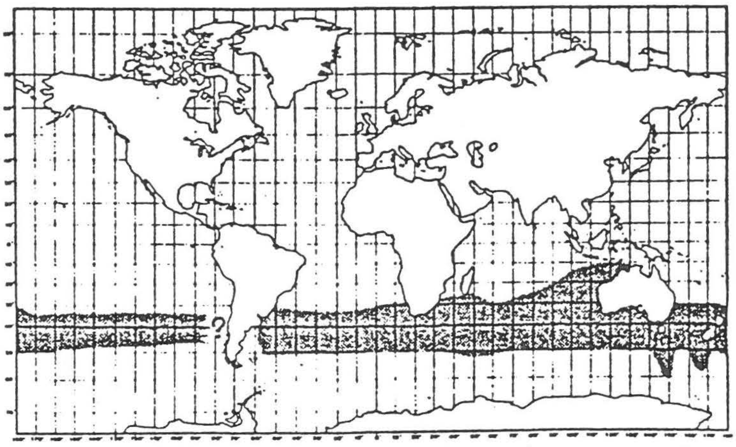
FAO Names : En - Southern bluefin tuna; Fr - Thon rouge du sud; Sp - Atún del sur.



Diagnostic Features : A very large species, deepest near middle of first dorsal fin base. Gillrakers 31 to 40 on first arch. Pectoral fins very short, less than 80% of head length (or between 20.2 and 23% of fork length), never reaching the interspace between the dorsal fins. Ventral surface of liver striated. Swimbladder present. Vertebrae 18 precaudal plus 21 caudal. Colour: lower sides and belly silvery white with colourless transverse lines alternated with rows of colourless dots (the latter dominate in older fish), visible only in fresh specimens; first dorsal fin yellow or bluish; anal fin and finlets dusky yellow edged with black; median caudal keel yellow in adults.

T. maccoyii

Geographical Distribution : Probably found throughout the Southern Ocean south of 30°S.



Habitat and Biology : Epipelagic, oceanic in cold temperate waters, confined to temperatures between 5° and 20°C for much of its life span; spawning fish and larvae, however, are encountered in waters with surface temperatures between 20° and 30°C.

In adults, seasonal migrations are observed between the warm water western and northwestern Australian spawning grounds (maximum catches are recorded at temperatures between 23° and 26°C) and coldwater feeding grounds off Tasmania and New Zealand (at temperatures of 13° to 15°C). The spawning season extends throughout the southern summer from about September/October to March. Fecundity of a 158 cm long female with gonads weighing about 1.7 kg each was estimated at about 14 to 15 million eggs.

The food spectrum, covering a wide variety of fishes (cold and warm water species from different depth strata), crustaceans, molluscs, salps and other groups, reveals the southern bluefin tuna as an opportunist. It is in turn preyed upon by sharks, dolphins, seals and billfishes.

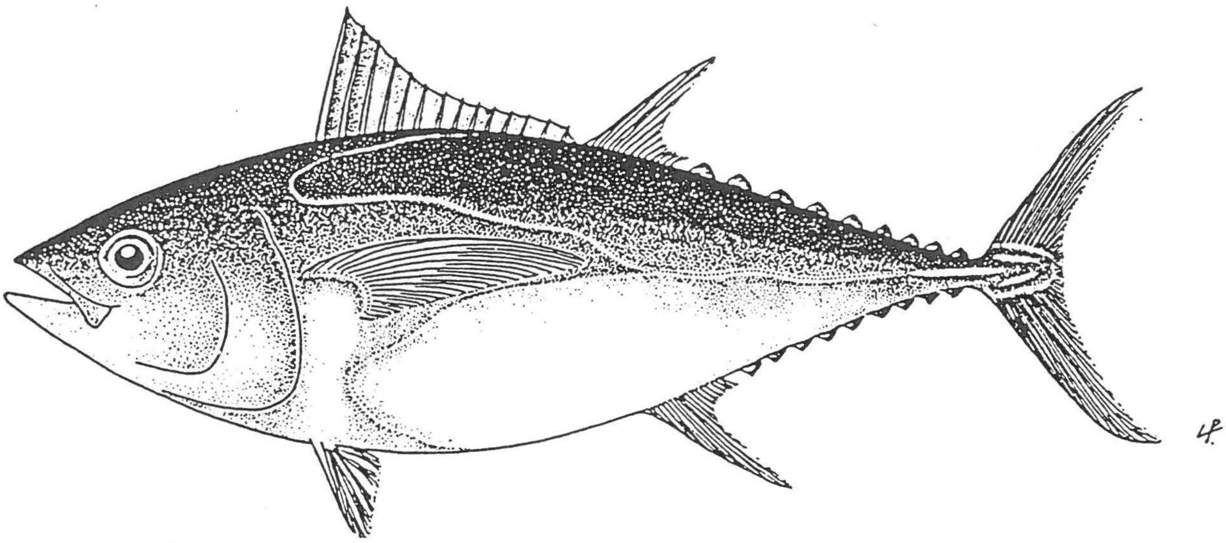
Thunnus obesus (Lowe, 1839)

SCOMBR Thun 5

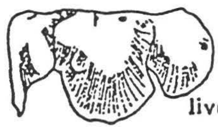
Thynnus obesus Lowe, 1839, Proc.Zool.Soc.London, 7:78 (Madeira).

Synonymy : Thynnus sibi Temminck & Schlegel, 1844; Orcynus sibi - Kitahara, 1897; Germo sibi - Jordan & Snyder, 1901; Thunnus sibi - Jordan & Snyder, 1901; Thunnus mebachi Kishinouye, 1915; Parathunnus mebachi - Kishinouye, 1923; Parathunnus sibi - Jordan & Hubbs, 1925; Parathunnus obesus - Jordan & Evermann, 1926; Germo obesus - Fowler, 1936; Thunnus obesus - Fraser-Brunner, 1950; Neothunnus obesus - Postel, 1950; Parathunnus obesus mebachi - Jones & Silas, 1961; Thunnus obesus sibi - Jones & Silas, 1963a; Thunnus obesus mebachi - Jones & Silas, 1964.

FAO Names : En - Bigeye tuna; Fr - Thon obèse; Sp - Patudo.

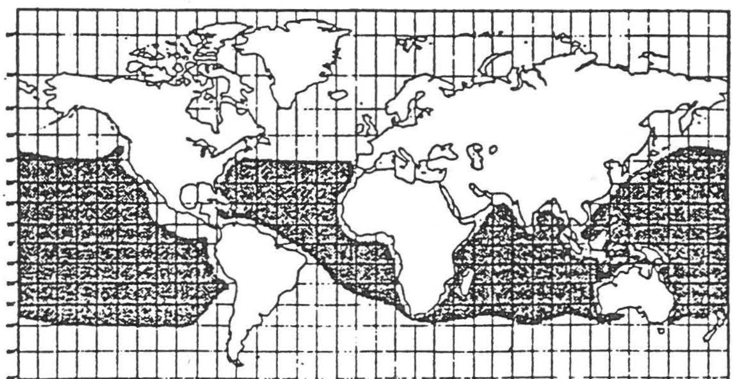


Diagnostic Features : A large species, deepest near middle of first dorsal fin base. Gillrakers 23 to 31 on first arch. Pectoral fins moderately long (22 to 31% of fork length) in large individuals (over 110 cm fork length), but very long (as long as in T. alalunga) in smaller individuals (though in fish shorter than 40 cm they may be very short). In fish longer than 30 cm, ventral surface of liver striated. Swimbladder present. Vertebrae 18 precaudal plus 21 caudal. Colour: lower sides and belly whitish; a lateral iridescent blue band runs along sides in live specimens; first dorsal fin deep yellow, second dorsal and anal fins light yellow, finlets bright yellow edged with black.



liver

Geographical Distribution : Worldwide in tropical and subtropical waters of the Atlantic, Indian and Pacific oceans, but absent from the Mediterranean.

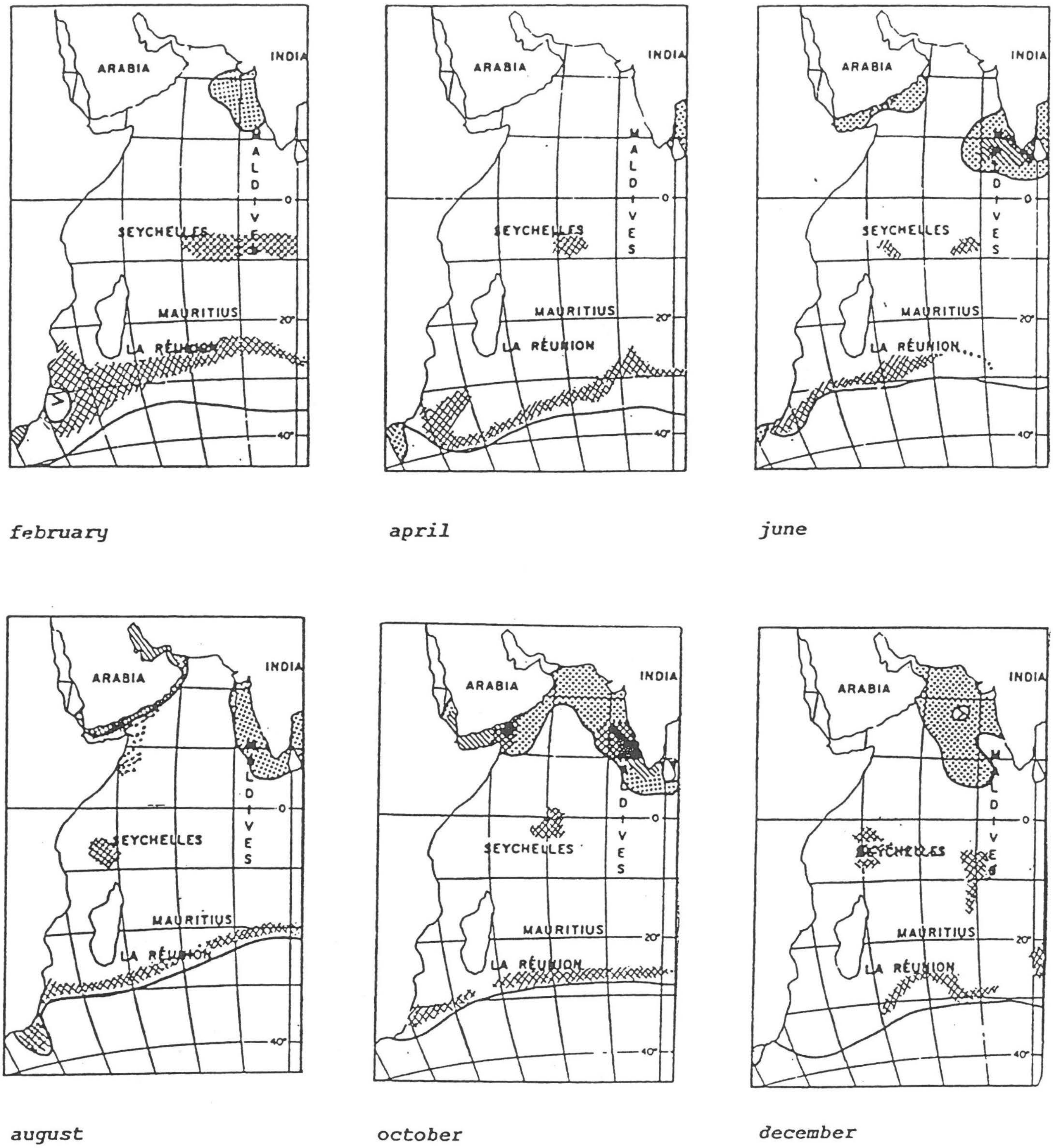


Habitat and Biology : Epipelagic and mesopelagic in oceanic waters, occurring from the surface to about 250 m depth. Temperature and thermocline depth seem to be the main environmental factors governing the vertical and horizontal distribution of bigeye tuna. Water temperatures in which the species has been found range from 13° to 29°C, but the optimum range lies between 17° and 22°C. This coincides with the temperature range of the permanent thermocline. In fact, in the tropical western and central Pacific, major concentrations of T. obesus are associated with the thermocline rather than with the surface phytoplankton maximum. For this reason, variation in occurrence of the species is closely related to seasonal and climatic changes in surface temperature and thermocline.

Juveniles and small adults of bigeye tuna school at the surface in mono-species groups or together with yellowfin tuna and/or skipjack. Schools may be associated with floating objects.

In the eastern Pacific some spawning is recorded between 10°N and 10°S throughout the year, with a peak from April through September in the northern hemisphere and between January and March in the southern hemisphere. Kume (1967) found a correlation between the occurrence of sexually inactive bigeye tuna and a decrease of surface temperature below 23° or 24°C. Mature fish spawn at least twice a year; the number of eggs per spawning has been estimated at 2.9 million to 6.3 million.

The food spectrum of bigeye tuna covers a variety of fish species, cephalopods and crustaceans, thus not diverging significantly from that of other similar-sized tunas. Feeding occurs in daytime as well as at night. The main predators are large billfish and toothed whales.



2.5 ml/L Oxygen levels between 50 & 80m - skipjack vulnerable

Oxygen levels very low near surface - skipjack occurence unlikely

20°C isotherm between 50 & 80m - skipjack vulnerable
20°C isotherm shown as dark line.

Fig. 2a. Areas of vulnerability of skipjack to surface gears.

Occurrence of albacore or yellowfin unlikely due to lack of oxygen at 80m.

Area of vulnerability of yellowfin to surface gears.

Area of vulnerability of albacore.

15°C isotherm is light line and 23°C is dark line in Southern ocean.

Fig. 2b. Areas of vulnerability of yellowfin and albacore tunas(Sharp 1979).

LINE
deep longline, drifting
Korean type
tuna, marlin, shark
Pacific and Indian Oceans

LIGNE
palangre dérivante profonde
type coréen
thon, makaire, requin
Océans Pacifique et Indien

LINEAS
palangre de deriva a profundidad
tipo coreano
atún, marlin, tiburón
Océanos Pacifico y Indico

REFERENCE
G. Pajot
FAO (Sri Lanka)

VESSEL	BATEAU	BARCO	
Loa	Lht	Et	43-55 m
GT	TJB	TB	290-500
hp	ch	cv	500-1200

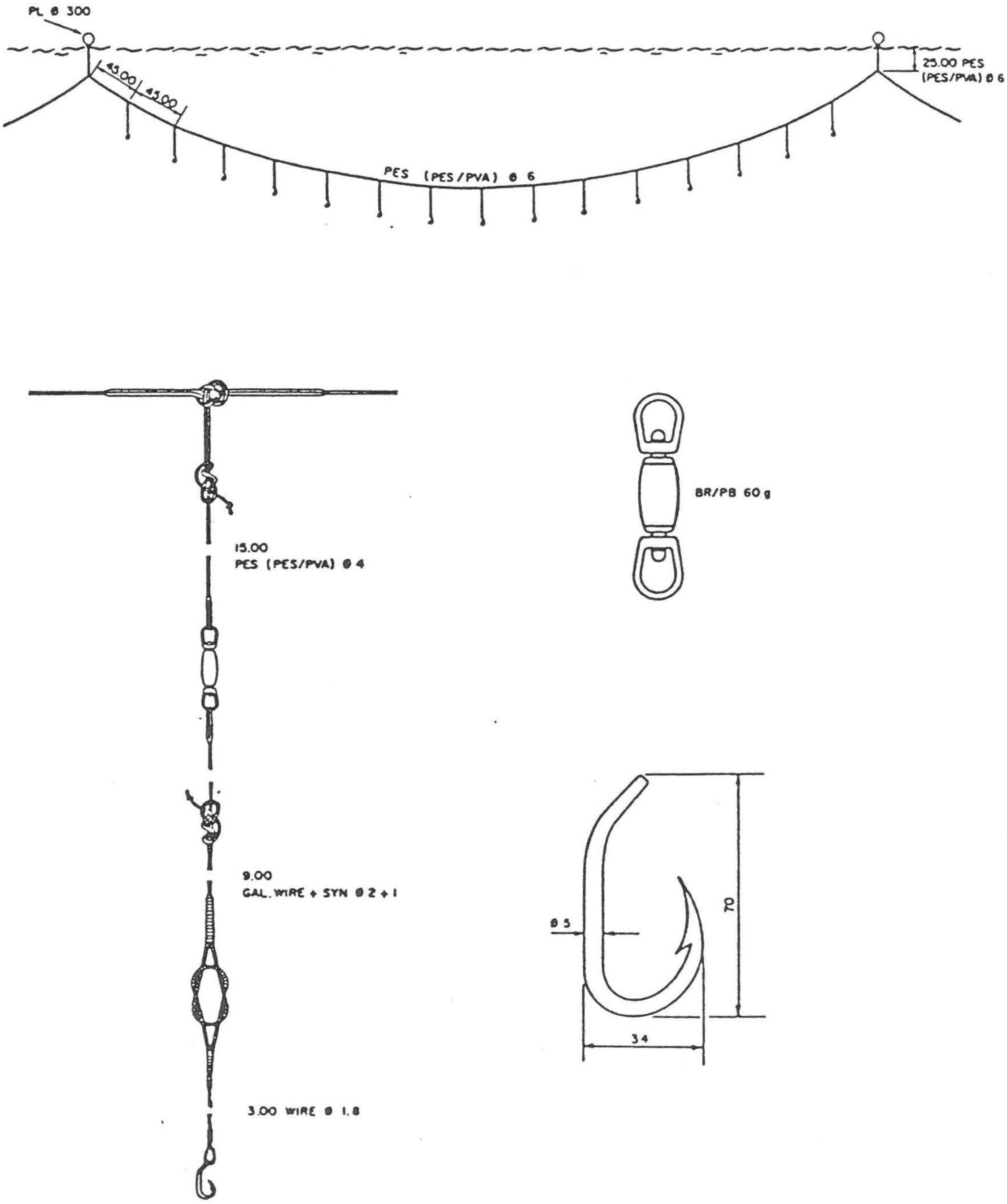


Fig. 3. Longline gear.

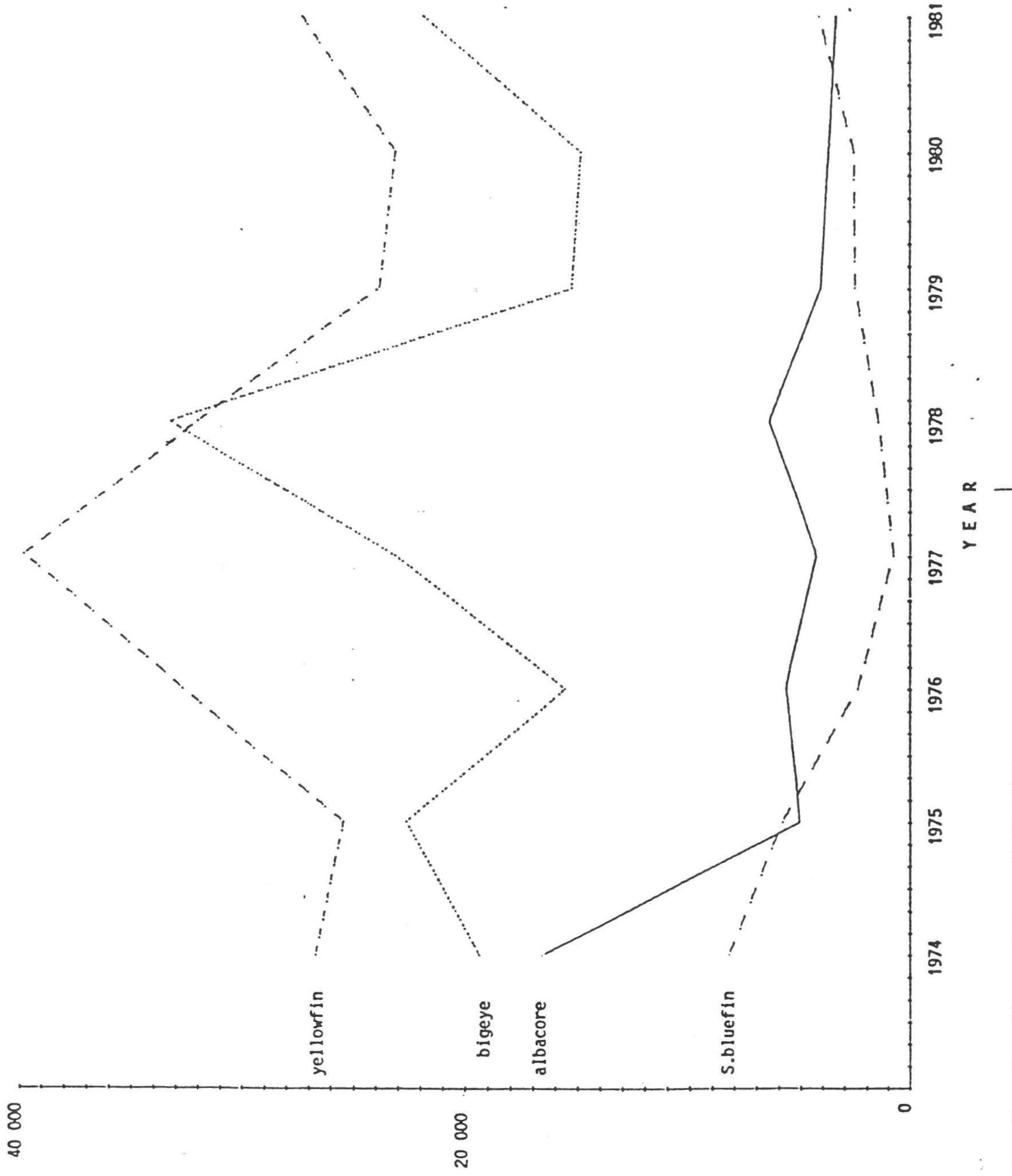


Fig. 4. Tuna longline catches, 1974–1981.

LINES	LIGNES	LINEAS
Pole, with live-bait Tuna Pacific, Fiji Islands	A la canne, avec appât vivant Thon Pacifique, Iles Fidji	Con caña, con carnada viva Atunes Pacífico Islas Fiji

REFERENCE

R.M. Stone
Fisheries Division
Lami, Suva, Fiji

R. Lee
FAO

VESSEL	BATEAU	BARCO	
Loa	Lht	Et	15 m
GT	TJB	TB	-
hp	ch	cv	-

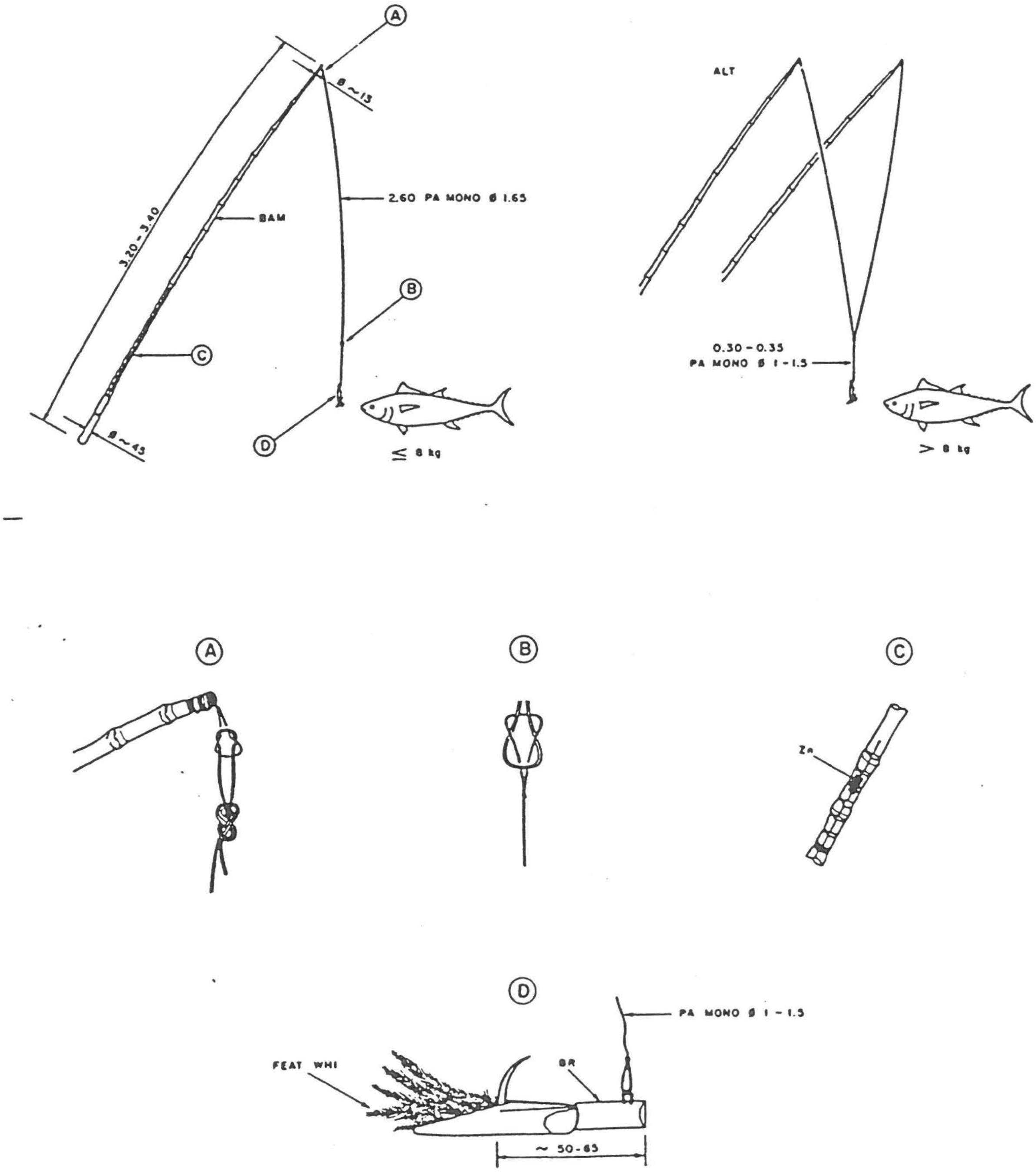


Fig. 5. Pole-and-line gear.

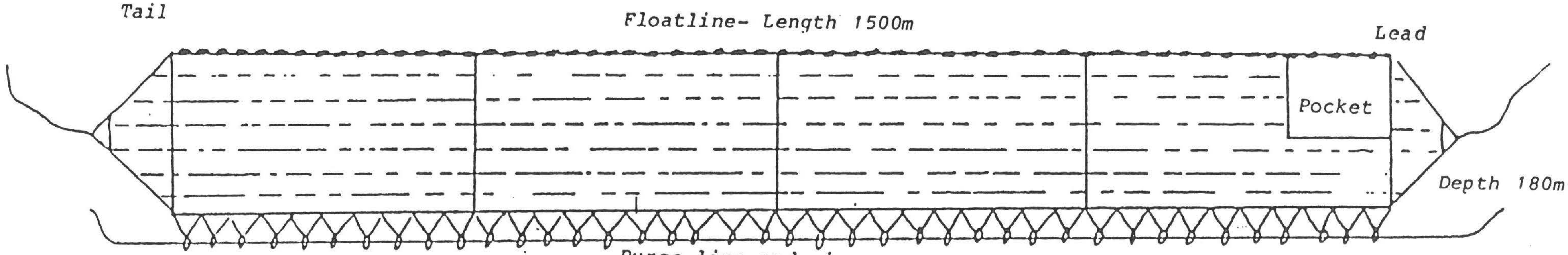


Fig. 6 : Purse seine- West Africa (French) - General arrangement (From ORSTOM)

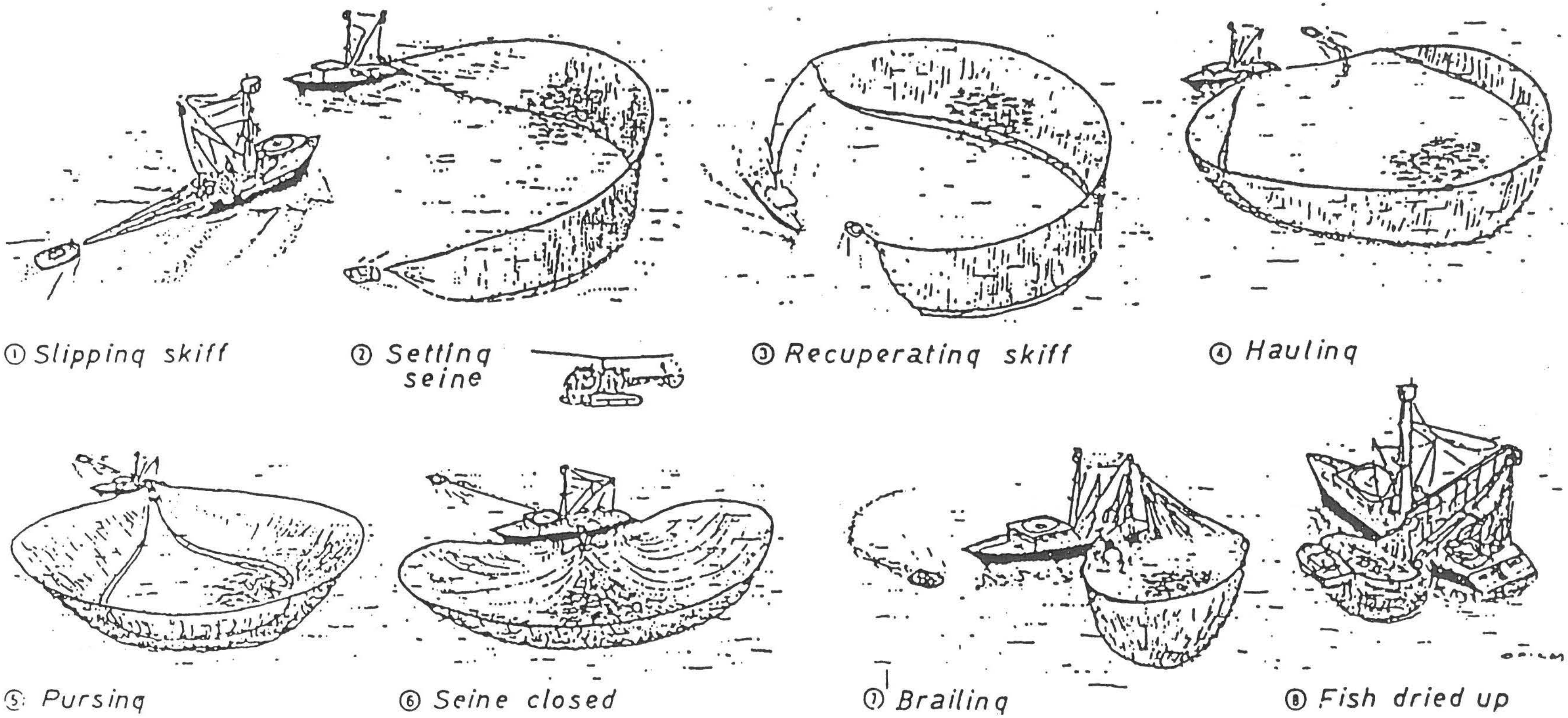
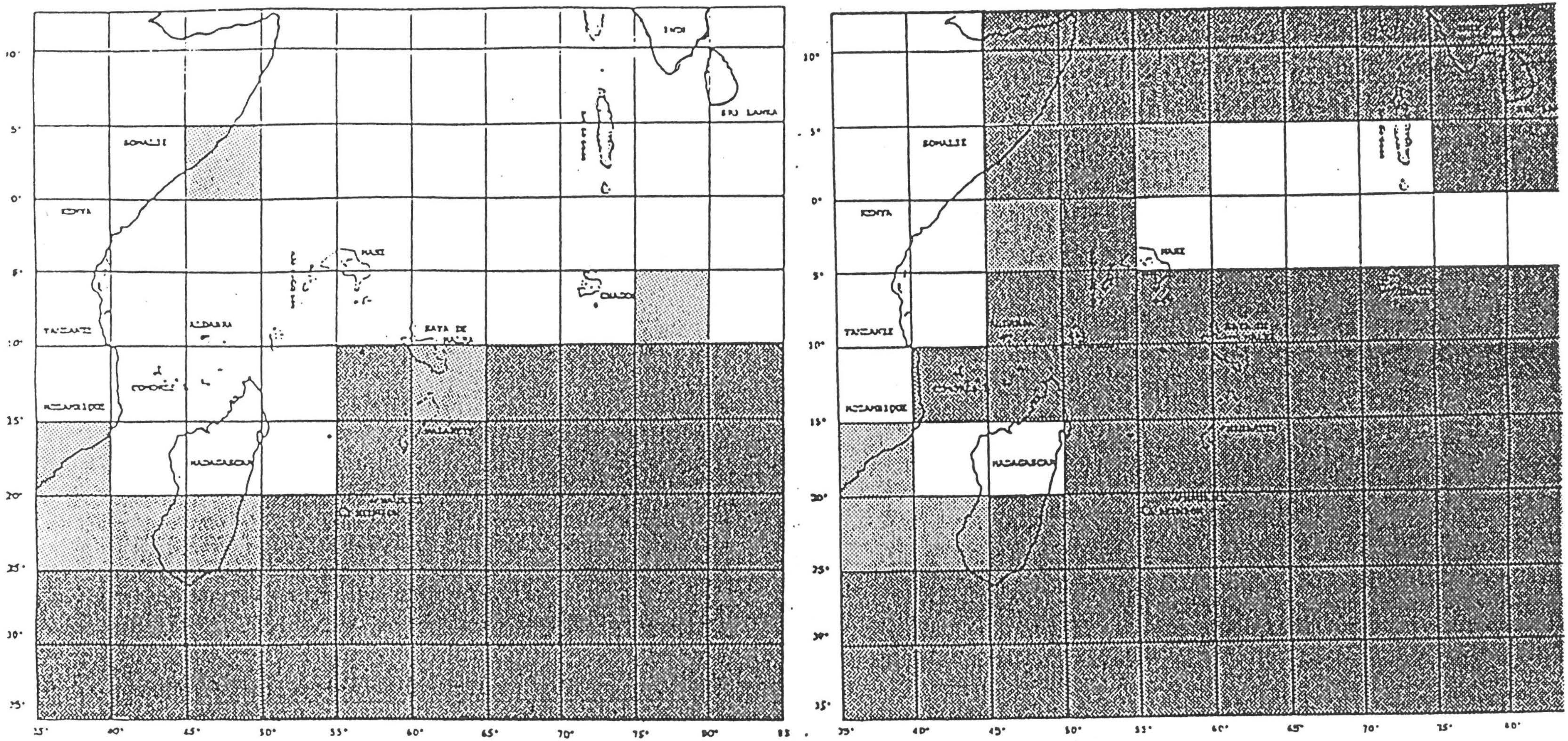


Fig. 6b : Purse seining operations (From ORSTOM). Scale of vessel and seine vary.



NOVEMBER to APRIL | *MAY to OCTOBER*

Area favourable to surface fisheries: less than 30% occurrence of winds over Force 4 during 3 months.

Area unfavourable to surface fisheries: 60% occurrence of winds of Force 4 or over.

Intermediate zone.

Fig. 7. Areas having suitable weather for surface fisheries. (Data extracted from Defence Mapping Agency Hydrographic Centre - USA. From ORSTOM).

A: FAD developed for purse seining- Fiji.

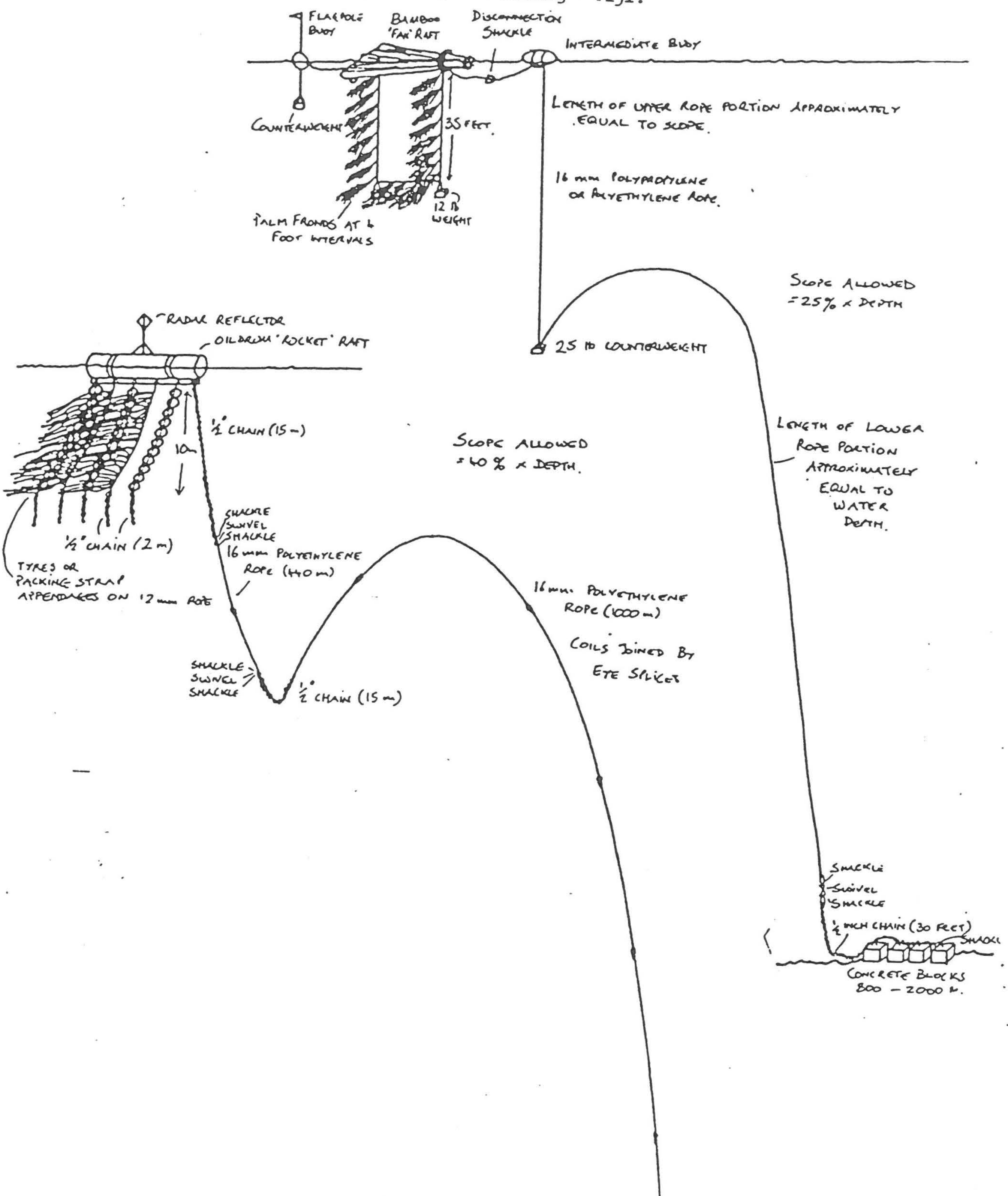
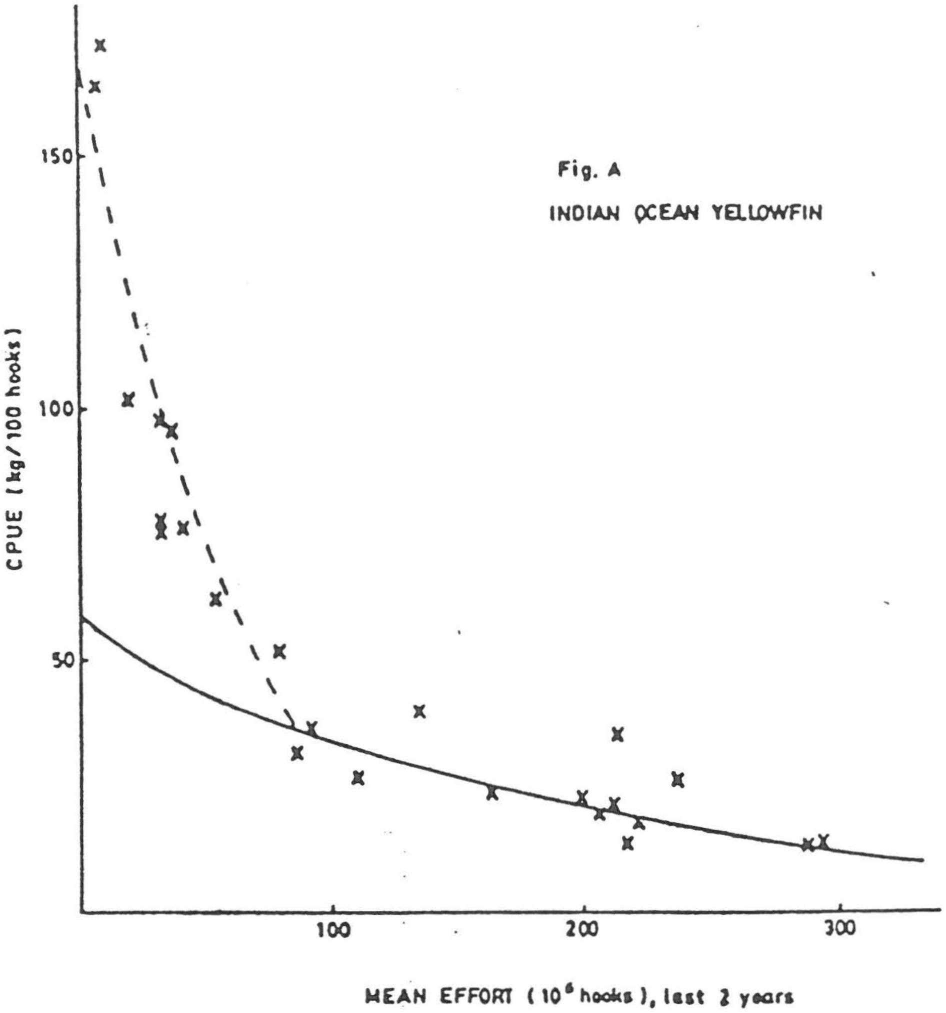


Fig. 8. FAD designs.

B: FAD design for pole-and-line- Fiji.



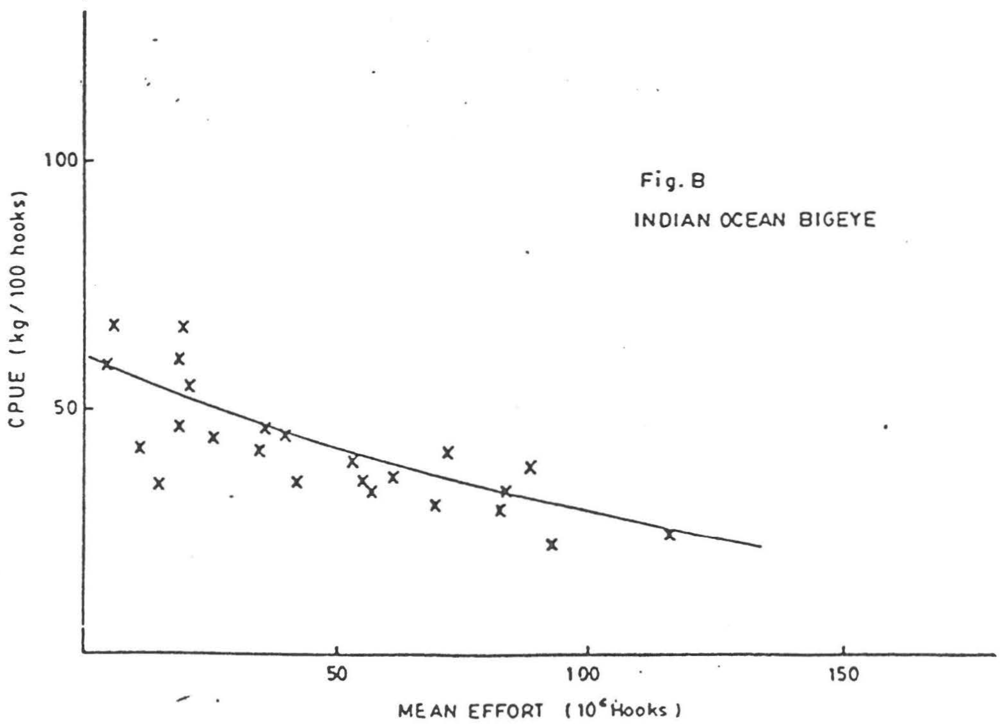


Fig. 9. Curves showing catch reduction with increased longline fishing effort.

3. THE FISHERY STATISTICS

FISHERIES STATISTICS IN MAINLAND TANZANIA

by

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1. INTRODUCTION

The Statistics Section of the Fisheries Division acts as an intelligence agent whose primary task is to provide both specific, comprehensive and detailed fisheries information in a regular flow manner needed by fisheries planners, economists, scientists and fishermen. In order to accomplish this exercise the method of collecting fisheries information had to be found.

2. THE SURVEY METHOD USED TO COLLECT DATA

This method comprises of two parts, Viz.1. The fishing village survey, and Viz.2. Recording of fish landings and related characteristics from a selected sample of fish landing centers (recording stations).

The survey is usually conducted in November-December. The survey is of a census type. Each and every fishing village is visited by the assigned recorder to collect the required information. The items of information collected are a) Number of fishermen (residents and non-residents), b) Number of fishing vessels (registered and non-registered), c) Number of fishing gears by type and size, d) Number of engines (outboards and inboards). All the fishing villages of Tanzania are supposed to be covered by this annual survey.

Statistics on fish landings and related characteristics are collected on a daily basis from selected fish landing centres (recording stations). At each station data are collected from as many landing stations as possible. The items of information collected are a) Type of fishing boat, b) Number of fishermen in the fishing unit, c) Weight (kg) of fish landed by species and d) Value (TAS) of fish.

At present there are more than 120 selected recording stations throughout Tanzania. The production estimates are worked out at the respective Regional Fisheries Offices as follows:

For a region, the daily totals of the selected recording stations are added up for a month and thereby catch per boat per day is obtained for the region. In addition to this, in each station the fishing activities of a selected number of boats are recorded daily from which the average number of active fishing days per month is obtained.

The estimate of daily catch is made by multiplying the average catch per boat per day by the number of boats in the region obtained from the latest fishing village survey. By multiplying this by the number of fishing days, normally 20-25 days a month, the monthly catch is estimated. The monthly estimates are then added up to yield annual estimates for a region. Statistics at the national level are compiled at the Fisheries Division on the basis of returns received from the regions and the data subsequently published in the Annual Report of Fisheries statistics of the Division.

2.1 Limitations of the method

i) Need of a great numbear of recorders (field staff).

ii) Control of the equipment and estimation of statistical errors are difficult and bias is inevitable.

iii) The organization of training and recruitment of the staff is expensive, therefore only unskilled ennumerators are involved in the job.

2.2 Suggested future improvements

My eight years experience in the Fisheries Statistics Section has taught me a lot. The accuracy and validity of our data have been questioned by different quarters of our users, some of the users of statistics. The basis of this is equivalent to questioning whether the method is scientific or not. The system of collecting statistics in fisheries currently used is scientific. This method, first introduced by FAO in 1968, suited the level of one fisheries industry at that time. With expanding state of the industry, improvement of any scientific method is inevitable. May I call upon the seminar to concentrate on improvements rather than introducing a new method which may or may not guarantee us a sound and accurate fishery statistical data bank.

3. RECOMMENDATIONS

Basing on:

i) Scarcity of skilled manpower employed in fisheries statistics at all levels.

ii) Inconveniency and inefficiency of securing statistical materials.

iii) Loss of control of field staff from the Headquarters to all levels.

iv) Difficulties to develop and implement uniform standard diffinitions and classification which are continuously changing.

v) Failure of scientific works not having a strong recognition and backing by some heads of governments.

vi) Difficulties of fisheries statistical staff not being answerable to their qualified head of section.

May I call upon the seminar to endorse the need to centralize statistical duties so that they have direct control from the Fisheries Division.

Table 1. Marine water fishery statistics Tanzania Mainland.

SUMMARY ON FISHING BOATS, FISHERMEN GEARS AND ENGINES 1972-1982											
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
FISHERMEN	8531	8188	6697	9657	11157	10033	8091	7437	7354	9366	10025
FISHING BOATS	3113	2894	2346	3162	3717	3509	3016	2811	2238	2841	2706
H/LINE HOOKS	3558	3121	2993	4799	6976	6226	3568	3097	3416	5051	4344
B/SEINE NETS	479	112	455	352	276	591	176	205	158	248	132
SHARK NETS	1791	1724	1598	2106	2333	3198	1758	1349	1298	1987	2434
BASKET TRAPS	5459	4528	3974	6048	8383	8032	5139	5439	2701	3230	4039
FIXED TRAPS/FENCES	148	491	159	4991	352	886	128	34	753	343	394
OUTBOARD ENGINES	19	118	76	28	251	390	62	72	18	18	9
INBOARD ENGINES	93	32	22	5	47	33	23	31	13	7	3

Table 2. The Coast Region.

ANNUAL SURVEY FIGURES ON BOATS, FISHERMEN, GEARS AND ENGINES MARINE WATERS - 1972-1982											
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
FISHERMEN	3289	3348	1737	1501	1519	1691	1889	1191	2121	2711	2794
FISHING F.BOATS	956	897	538	447	497	494	557	339	559	819	864
H/LINE HOOKS	1629	1118	715	629	1128	970	1106	443	1258	3299	2617
B/SEINE NETS	41	31	14	8	11	25	6	25	25	29	39
SHARKNETS	779	1049	747	660	519	669	640	317	565	786	939
BASKET TRAPS	1247	1346	947	379	628	676	374	629	448	1118	1257
TRAPS/FENCES	127	278	75	48	308	345	36	1	515	131	195
OUTBOARD ENGINES	6	84	26	17	22	18	7	6	-	12	9
INBOARD ENGINES	88	18	-	1	-	1	1	-	-	1	3

Table 3. The Mtwara Region.

ANNUAL SURVEY FIGURES ON BOATS, FISHERMEN GEARS AND ENGINE
MARINE WATERS - 1972-1982

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
FISHERMEN	1240	1315	1563	1353	1537	1517	1537	1537	402	2642	2705
FISHING F.BOATS	372	358	330	398	419	377	846	849	190	780	351
H/LINE HOOKS	244	215	277	849	449	449	529	529	233	305	100
B/SEINE NETS	68	23	345	100	58	58	58	58	40	89	70
SHARKNETS	251	119	292	340	258	258	350	350	133	259	200
BASKET TRAPS	1171	1168	1226	1038	1406	1406	1774	1774	440	489	587
TRAPS/FENCES	-	118	14	13	8	8	-	-	19	30	30
OUTBOARD ENGINES	-	2	5	11	10	10	-	10	7	-	-
INBOARD ENGINES	-	-	2	4	3	3	-	3	4	-	-

Table 4. The Lindi Region.

ANNUAL SURVEY FIGURES ON BOATS, FISHERMEN GEARS AND ENGINES
MARINE WATERS - 1972-1982

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
FISHERMEN	1360	1312	1059	1519	2176	1996	1794	1808	1952	1711	1799
FISHING F.BOATS	800	852	650	625	917	883	828	837	696	618	611
H/LINE HOOKS	745	766	635	583	959	514	514	706	595	431	313
B/SEINE NETS	342	42	42	96	110	83	83	92	57	94	-
SHARKNETS	373	250	215	324	512	350	350	264	365	321	917
BASKET TRAPS	1081	597	390	1017	962	1322	1322	1367	780	450	527
TRAPS/FENCES	-	95	70	-	-	41	41	33	185	182	121
OUTBOARD ENGINES	1	3	5	-	9	8	8	9	11	6	-
INBOARD ENGINES	1	3	4	-	10	5	5	10	9	6	-

Table 5. The Tanga Region.

ANNUAL SURVEY ON BOATS, FISHERMEN GEARS AND ENGINES
MARINE WATERS - 1972-1982

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
FISHERMEN	2642	2213	2338	2642	3129	3111	2871	2901	2879	2302	2727
FISHING F. BOATS	985	787	828	846	1011	882	785	786	793	624	880
H/LINE HOOKS	940	1022	1366	1391	1849	1391	1419	1419	1330	1016	1314
B/SEINE NETS	28	16	54	74	35	51	29	30	26	36	23
SHARKNETS	388	306	344	391	497	631	418	418	435	621	378
BASKET TRAPS	1960	1417	1411	1807	3661	1774	1669	1699	1033	1173	1668
TRAPS/FENCES	21	-	-	89	36	118	51	-	34	-	48
OUTBOARD ENGINES	12	29	40	-	60	49	47	47	-	-	-
INBOARD ENGINES	4	11	16	-	24	18	17	18	-	-	-

THE COLLECTION OF FISHERIES STATISTICS IN TANZANIA SUGGESTIONS FOR IMPROVEMENT

by

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1. INTRODUCTION

Fisheries Statistics are among the major tools used for the planning, management and the development of the fisheries. It is because of their importance that a country like Tanzania spends its limited resources on the collection and analysis of data on the fisheries catch and the effort expended in the capture of fish.

The acquisition of statistics on the marine fisheries of Tanzania mainland started in the late 1960's when a number of fishing villages were selected as centres where data on the fish landings were to be collected on a continuous basis. These centres were selected on the basis of their accessibility and their relative importance as fishing ports. They were selected in each administrative region along the coast hence they covered the whole of the Tanzanian coast.

Ideally, two recorders were stationed at each centre. They were supposed to record the weight and value by species, of all the fish landed by every fishing vessel. They also recorded the respective number of fishermen and gears used to catch the fish in each vessel. At most recording centres, sheds were built at which the catches were brought to be weighed before they were sold. At the end of the month, the records from the fishing centres were sent to the regional fisheries office for analysis and estimation of the catch.

During the seventies, som improvements were made to the methods of data collection at the landing centres and their analysis. Lists of fish species groups of commercial importance were compiled and distributed to all regions in order to try to standardize the species-wise data collection. Weighing scales were provided at most centres to enable actual weighing of landings thus eliminating estimates of weights by age which introduced unknown biases. Short courses on the collection of fish landing data were conducted to improve the performance of the recorders, hence the quality of their data.

2. SHORTCOMINGS

It was also in the early seventies that the Government of Tanzania decided to decentralize its authority to enable the regions to make their own development plans and decision on their priorities of development projects. The effect of this decision as far as fisheries statistics is concerned was to vest authority on the supervision of data collection and analysis on the regional officials with advise, if needed, from the Fisheries Directorate. In practice, fisheries statistics were relegated to a very low status in most regions and the little supervision and training that had been there in the early years gradually diminished due to lack of funds until there was virtually no supervision. The consequence of this is that the quality of the data collected has deteriorated until the moment there is much doubt as to the accuray and even the usefullness of the data collected.

Another problem that has been inherent in the statistics is the incomplete coverage of the main three phases of the fishing industry. The data selected are only fish production statistics which cover the primary phase of the industry. Little or no data are collected on the fish processing (the secondary phase) and on distribution and marketing (the tertiary phase). There is need for data to cover the complete spectrum of the characteristics of the industry in order to assess its economic performance in addition to evaluate the stocks and their potential yields.

Furthermore the statistics obtained so far only cover the artisanal fisheries. Presently data from the industrial fisheries are scarce and irregular as they depend on returns from the fishing companies whose submissions are not consistent. Besides, some of the returns have inadequate information as som fishing companies have chosen to ignore to complete the official form and they make returns in their own formats which often leave out vital information.

Both the artisanal and industrial fisheries are confined to the territorial waters withing 80 km from the coast. There is no system of obtain information from foreign vessels which might be fishing within our (yet to be declared) EEZ. This is an important omission which may have serious consequences on the stocks of oceanic fisheries like tuna and billfishes in our EEZ.

3. SUGGESTIONS FOR THE FUTURE

Information on the fisheries is essential both for management and for planning their future development. Analyses of fishery statistics lead to useful information on a fish stock, indicating how catches can be expected to respond to increase or decrease in effort and consequently indicate the level of effort necessary to achieve the optimum yield. On the long term basis the use of statistics enables the formulation of policies designed to maximize fish yields of particular components or species mix in the catch from a stock.

Most techniques of stock assessment assume the existence of a database available from systematic recording and sampling of commercial catches. These data must be long time-series and the most important sets of data are these of catch and effort. For more useful analyses, catch statistics should be available by species or species group composition, area and time of capture. Effort data should state the type of vessels and gears used as well as fishing time (days) spent.

To enable the provision of sound scientific advice on the management and development of the fisheries, the statistics on the fishery must be <u>reliable</u>, as otherwise very erroneous and misleading conclusions, hence plans, would be made if based on unreliable data. Unfortunately, the current situation regarding the collection and analysis of fishery statistics in Tanzania leaves one without any option but to question the authenticity hence the reliability of the data.

One of the possible remedies is to place all fishery statistics activities under one authority. This would ensure, among other things, the effective supervision and accountability of the personnel concerned. The authority would ascertain that all beach recorders (enumerators) are well trained to do their job effectively and that they known the purpose of collecting fishery statistics so that they appreciate the importance of obtaining factual information. They should not be assigned any other duties in order that they can accord top priority to their task.

The authority would have the responsibility of setting up and executing an adequate and reliable fishery statistical system based on scientific sampling techniques. The system should enable the calculation of the percentage error of the estimates so as to assess the reliability of the data collected. The Food and Agricultural Organisation (FAO) established a catch assessment survey (CAS) system for the continuous collection and analysis of statistical data on the traditional fisheries of Lake Tanganyika. Two surveys were carried out in Tanzania between 1973 and 1976. The CAS is a probability sample survey conducted on a monthly basis. The method used for the CAS was a multi-stage stratified sampling for space and a simple random sampling for time.

Unfortunately, this system was not adapted by the fisheries administration on account of its alleged "high cost" of operation. Nevertheless there is need to acquire accurate and reliable data hence the proposed statistical authority should study and adapt the CAS method to the prevailing conditions in the country.

It is suggested that the task of setting up an efficient fishery statistical system should be initially that of the end-users of the data. Among those with urgent need of reliable stastistics is the Tanzania Fisheries Research Institute (TAFIRI). The Institute has identified the improvement of fisheries statistics as a top priority in its research programme. It is therefore evident that TAFIRI is the most appropriate institution to take up the rôle of the proper statistical authority for a limited period of say two years. Once TAFIRI has organised and executed a statistically sound system of data collection, compilation and analysis, the function would then be handed back to a properly established statistics section of the fisheries administration for continued routine operation. TAFIRI intends to carry out a CAS for Lake Tanganika using the method of the FAO project for obtaining reliable catch and effort statistics. These would then be used for purpose of estimating annual catches and establishing time series of such data for use in assessing maximum/optimum sustainable yields and other studies.

The other step that needs to be taken is the standardization of statistical definitions and classifications to conform to international practice. This is necessary not only for the purpose of establishing national standards but also for regional and global compatibility and integration. Specifically, definitions and classifications of fishing gear, effort and species groups should follow the recommendations adopted at the FAO Seminar on fishery statistics held in Maurituies in December, 1983.

In order to improve sectoral coverage, the industrial fisheries should be required to submit catch returns on forms designed to provide adequate information on these fisheries. It should be made clear to the fishing companies that one condition of their fishing licence is the submission of correctly completed data on the prescribed forms. The statistics authority should make periodic checks as to the accuracy of the information provided by sending enumerators on bcard the fishing vessels. Alternatively, data on fish landings of industrial vessels should also be collected by enumerators as is the case with the artisanal fisheries.

Until Tanzania declares its EEZ, it will not be possible to obtain fish catch information from the foreign fleet fishing within 200 miles off our coast. This will remain as a drawback in obtaining complete data on the exploitation of fisheries resources off our coast. This important gap in information also hampers the efforts in data acquisition by countries with EEZs adjacent to ours.

Another inadequacy is the present lack of sufficient information on the secondary (proseccing) and teriary (distribution and marketing) phase of the industry. There is need to collect such information to enable the assessment of the contribution that fisheries make to the national economy apart from assessing the industry's economic performance.

4. CONCLUDING REMARKS

The foregoing remarks have indicated that the fisheries statistical system of Tanzania does not satisfy the various demands and needs of end-users such as government planners, decision makers and others including research institutions.

The present system has a number of limitations which are a result of a lack of funds and other support. This is a consequence of the low priority placed by some government officials on statistics so that attempts to develop an adequate, accurate and sound statistical system are doomed to failure. One example of this neglect is the lack of facilities for processing the data even at the national level. Whereas the current trend is to use automatic data processing techniques (e.g. microcomputers) to maximize use of data and minimise data handling errors, our national fisheries statistics office does not have even a simple calculator or adding machine for data analysis.

If it is accepted that good fishery statistics are a useful tool for the planning, management and development of fisheries, then we should make an effort to design and execute an adequate, accurate and sound system of collecting and analysing data using modern processing techniques.

Lastly it would be worthwhile for Tanzania to endorse and implement the recommendations made at the FAO (SWIOP) seminar on statistics which was held in Mauritius in December, 1983.

4. THE FISHING COMPANIES

BAGAMOYO FISHING COMPANY LTD. A SHORT DESCRIPTION OF BOATS, GEARS OF THE FISHERY

by

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BAFICO, Bagamoyo

1. INTRODUCTION

This presentation try briefly to explain the situation experienced in small fishing companies exemplified by the Bagamoyo Fishing Company Limited (BAFICO).

The contents comprise the general fishing practice and the applied fishing gears (types of nets), technology, and the fishing grounds. The presentation also highlights the main problems confronted by the company as a whole, correlated to the catch by the company boats.

The type of boats and nets applied depend heavily on the nature of the fishing grounds and the season.

2. BOATS

The Company owns four 32 feet wooden stern trawlers locally constructed, all powered with Yanmar 3 cylinder diesel engines, each with a maximum power of 56 horse powers.

The design of the boat is the V type with a chine. Generally the design of the boats is good, but the construction is bad due to poor workmanship (lack of appropriate experience); therefore, the hull of the final product (the boat we are using now) is weak and very leaky with relatively poor installation of engine accessories.

However, all necessary requirements for a small trawler are provided except an insulated fish store.

3. FISHING GEARS AND METHODS

Fishery practised is exclusively bottom trawling with two seams trawl nets.

3.1. Fishing gear description

Since the commencement of fishing in February 1982, various trawls have been constructed in trials to develop a trawl with optimal performance. Since June 1982 we have used a trawl well suited for our boats and equipment. When fishing, we aim for both fish and prawns which inhabit the depths we are able to fish.

3.1.1. Wings

Both top and lower section meshes measure 80 mm and have twine size 210/72. The upper part has 5 meshes while the lower one has 60 meshes. The total length of the wings is 7 m.

3.1.2. Bellies

Top Belly. This piece is made up of 140 meshes at the top and 118 meshes at the bottom, the size of the meshes are 40 mm and twine size 210/72. Total length is 4.5 m.

Lower Belly. Sizes of the mesh and twine are the same as for the top belly, i.e. 40 mm and 210/72. The number of the meshes in the upper part is also the same as in the top belly - 140 meshes; while at the lower part it is 122 meshes and the total length is 4.2 m.

3.1.3. Codend

This part is made up of the same number of meshes both at top and lower parts, measuring 35 mm and twine size 210/42. Total length of the codend is 7.5 m.

3.1.4. Mountings

Head rope measures 18.2 m while foot rope measures 19 m.

4. FISHING GROUNDS

Due to the conditions of the boats and facilities provided fishing is done close to the harbour (Mbegani) so that the boats can leave the habour daily in the morning and return in the evening. Normally fishing is restricted to two depths strata, 2-5 fathoms and 7-13 fathoms depending on the time of the year.

4.1. Depth stratum 2-5 fathoms

According to our experience the appropriate time of the year for fishing in this depth stratum is January - May. The usual grounds covered are Changwahela and Kaole (Poyogo), Mkadini, Ruvu river estuary, Utondwe, Kitame Sadani and Buyuni. The main catch from this area is prawns and small sized silver bellies (about 90% of the fish catch) and various species such as goatfish, lizard fish and damselfish. The area is preferred during this period due to relatively good prawn catches.

4.2. Depth Stratum from 6-13 fathoms

Fishing is concentrated in this stratum from June to August/ September mainly because only small quantities of prawns are found in depth 2-5 fathoms. The catches in the stratum 6-13 fathoms consist of relatively larger fish in greater quantity during this period than in the shallower area in January-May.

The dominant families in the catches are Leiognathidae, Mullidae, Pristipomoidae, Gerres spp, Callyodon spp, young cat fish and flat fish. During August/September for the two consecutive years we have been fishing big quantities of prawns of bigger size than those found from January to April in the Mwambakuni area. Main areas covered in this stratum are Mshingwi, Mwambakuni Ukiwas Winde, Ruvu juu, Utondwe Sadani and Machuis.

5. CATCH

Bagamoyo Fishing Company started fishing with one boat in February 1982, a second boat started in September 1982, a third boat in January 1983 and a fourth boat in August 1983. When all the catch is combined the average daily catch per boat up to end of December 1983 was: mixed small fish 166 kg and mixed prawns 11 kg.

As already stated earlier, fishing is done in two main depth strata, i.e. January-April fishing is mainly done between 2-5 fathoms depth while from May to the end of the year main areas are between 7-13 fathoms depth. Below is a summary of the catch rates expressed as average catch/day/boat for bottom trawling according to season and depth.

	JANUARY-APRIL		MAY-SEPTEMBER		OCTOBER-NOVEMBER	
	Depth 2-5 fathoms		7-13 fathoms		7-13 fathoms	
	Mixed prawns kg	Mixed small fish kg	Mixed prawns kg	Mixed small fish kg	Mixed prawns kg	Mixed small fish kg
1982	47	106	20	280	3	100
1983	23	90	4	236	2	170

The peak season for prawns in 1982 were in February when a boat landed 68 kg and in August when it landed 60 kg/day. In 1983 the peaks were in January when a boat landed 55 kg and August when it landed 11 kg/day. Peaks for fish were 460 kg in June 1982 and 320 kg/day in July 1983.

6. PROBLEMS FACING THE COMPANY

As mentioned earlier the design of the fishing vessels is rather good, but the quality of the vessels is very bad with leaking hulls and improper installations of engine accessories.

The company lacks cooling and freezing facilities both on the ships and on land. There is a small old ice machine with half tonne capasity, but it has been out of order for a long time and efforts to repair it have been frustrated by both high prices and lack of spare parts.

Lack of preservation facilities has a direct effect on income. Because there is no preservation means on board, fishing is limited by both time and distance from the harbour.

As we have no storage facilities the catch has to be sold immediately after landing and at the mercy of fishmongers as it is obvious that if the fishmongers refuse to buy, all fish will be thrown away.

7. REPAIRING FACILITIES

On average each boat is able to make 10 daily fishing trips per month instead of the planned 20. This is mainly due to breakdowns. A lot of time is spent by repairing the vessels. As all the work is done on the beach, we are very much limited by high and low water levels and also by the lack of an appropriate workshop.

8. COMPETITION IN FISHING GROUNDS

The fishing grounds best suited for the Bafico vessels due to reasons given above are the same grounds as fished by the Tafico boats. It is not uncommon to find all our boats, and 5 or more Tafico boats plus Malkia wa Bahari ploughing same grounds simultaneously, mainly 3-6 fathoms depth. Since the last week of December 1983 and onwards the "Mama Tafico" has spent all her fishing time between Ruvu estuary and Kaole in depth of not more than 6 fathoms. This is the most suitable fishing area for Bafico, but now we are forced to look for other grounds as prawn catches have gone down by more than 50%.

9. FISHING GEAR

To have an effective fishery the trawls used for prawns should be changed after the prawn season to a more suitable trawl for fish. However, this is not possible due to lack of materials to construct such trawls. Therefore the company applies the same trawl all the time.

THE ROLE OF TAFICO IN THE DEVELOPMENT OF TANZANIA FISHERIES

by

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1. INTRODUCTION

Tanzania Fisheries Corporation (TAFICO) was established by a Government notice No. 58 published on 1/3/1974 as a Public Corporation; this was in accordance to the Public Corporation Act No. 17 of 1969.

The major aim and purpose for the establishment of this Corporation was for the promotion of Fisheries Development Industry in the country. The detailed functions could be enumarated as follows:

- to enter into business of all types of fish and fish products and gears.
- to participate in sponsor and enter into national and international ventures for the purpose of improving the fishing industry.
- undertaking all commercial ventures related to the fisheries industry.
- act as a Government agent in entering into any business with any legal body or person for the good of the fisheries industry.
- promote the interest and encourage local governments in establishing co-operative societies in fishing industry. As well as giving moral and financial support of the same.

These duties can be performed directly by the Corporation itself or through a contractor or sub-agent.

TAFICO has gone a long way to fulfill some of these aims and functions but is still far from complete. The Corporation is still young and need various supports in trying to implement what is required to.

2. DEVELOPMENT LEVEL OF TAFICO

Since it was established, TAFICO like any other Corporation in Tanzania tried to develop with a lot of difficulties. The Corporation started by inherting old assets donated by the Directorate of Fisheries. These included buildings, boats and fishing gears. So it was evident that the starting was rather difficult.

To fulfill the goals for the formation of Corporation, TAFICO had to consolidate most of these assets and form projects, e.g. boat building, fish receiving, prawn collection etc.

3. BOATBUILDING

TAFICO has three boat building yards in the country, that is Mwanza, Mikindani and Kigoma. All these boatyards build wooden boats up to 38 ft. The Mwanza boatyard recently established a subsidiary yard at Pasiansi for metal boats.

For the 1982/1983, 24 boats of various sizes were built; Mwanza 2, Mikindani 8, and Kigoma 13 but the operations were not at a profit. For 1983/ 1984, we project to build 44 boats of various sizes; Mwanza boatyard 12, Mikindani 17 and Kigoma 15.

Table 1 gives the projected production of boats for 1983/1984 by sizes and valves.

4. FISHING OPERATIONS

TAFICO as a Fisheries Corporation had to have a fishing and marketing set-up. Presently TAFICO has a fleet of 16 boats of various sizes, 12-25 metres. However, only about ten of these are working to day. Major constraints in the fishing operation are availabilities of spare parts and high running costs due to frequent breakdowns.

The fishing operations are presently only in marine waters in Dar-es- Salaam. TAFICO has no fishing activities in fresh waters. Our monthly target for small boats is 42 tons of fish and about 5-10 tons of prawns. Our production for the year 1983 had an average of 32.2 tons of fish per month; which is about 76% performance level. For the year 1983 our total production target was about 504 tons while we actually produced 386.4 tons.

TAFICO fleet is comprised of various sources, namely Japanese, British, Finnish and Australian boats. Boat performance has been quite good with Japanese boats though they are rather small.

Their fishing is 2 - 3 days with a target of one metric ton per trip. They have, however, been fishing above the target, up to twice the target. The larger Australian and Finnish boats are rather better as their capabilities of 4.0 tons in 5 days is more profitable. These have been fishing up to 10 tons in 5 days.

TAFICO is therefore thinking seriously of phasing out the small boats for the larger ones. TAFICO, in September, 1982 acquired a modern shrimp trawler named "MAMA TAFICO". This is a factory ship. She mostly goes for prawns rather than fish and her target is 10 - 15 tons of prawns monthly, which is exported to Japan under special arrangements.

Table 2 shows the fish production data for 1983.

5. MARKETING OPERATIONS

TAFICO as a fishing Corporation would like to streamline its marketing operation. When the Corporation started, it had to make itself known. It established various marketing centres locally and aggressively established foreign markets for the products. Major export products are prawns to Japan, UK and U.S.A.; shells, beche-de-mer and seaweeds.

With regard to domestic markets TAFICO has refrained from retail business and is doing wholesales to NCCO for all the fish caught. Minor retails are for the staff.

Our sales to NCCC are under special agreement which govern the quality and prices for at least one year 1983/1984.

Table 5 shows the volume of sales since the wholesale system was started. Previous retail arrangements were abandoned for better control of the sale.

With regard to external marketing, export data in Table 3 and 4 and self-explanatory.

Table 3 shows the export data for 1983.

Table 4 shows comparison of export performance for 1982 and 1983.

Export of other products than prawns are still growing up and needs time to be consolidated.

For 1983/1984 our projected sales are 451 tons of fish locally and a total of 144.8 tons of prawns will be produced, of which 27 tons will be sold locally and 109 tons exported. This is expected to generate about TShs. 13.65 million from fish and TShs. 14.61 million from prawns. (TShs. 28.26 million). This is an increase of TShs. 16.89 million from 1982/1983.

6. PROJECT SUPPORT

As one of the main functions, TAFICO is expected to promote the interest of local authorities in forming fishing groups or companies. TAFICO is a major share holder (up to 60%) in most of the district fishing companies formed by the different District or Region Development Corporations, e.g. Bagamoyo Fishing Company (BAFICO), Nyamifico and Uvuvi Kigoma. TAFICO supports these young companies in the form of expertise and materials, either as contribution or its share of donations. Staff have from time to time been seconded to these companies from TAFICO during the initial stages and financial assistance offered whenever necessary.

TAFICO acting as a holding company have received loans from foreign donors through the Tanzania Rural Development Bank (TRDB) to finance these new ventures as well as acting as a caretaker corporation.

7. OTHER ECONOMIC PROJECTS

TAFICO have from time to time embarked on short and long term economic projects to improve its earning. These projects vary from prawns and fish collection from distant fishing villages, shell collection for export markets to ice making and sales to the general fishing society and hoteliers. Presently there are two ice plants in Dar-es-Salaam, capable of producing up to 15 tons of ice daily.

8. TECHNICAL SUPPORT

TAFICO is supposed to have technical ability in the fisheries industry, as well as to give technical and other support to other small companies and individuals.

She has the authority to buy all fishing materials and engines for the local Tanzania market.

Recently TAFICO acquired a 4.5 million loan from the Government to buy engines and fishing gears from outside. It was, however, not possible to do this due to limited foreign exchange available, arrangements are, however, being made to get the same from other sources.

9. FINANCIAL CAPABILITIES

The Corporation is self-supporting as a commercial entity. Much of the funds generated come from the fishing operations, boat building, prawn export, ice making and also consultancy services.

Presently our funding situation is at break even point. However, it is encouraging in the part of fishing operation, especially "MAMA TAFICO" operations. Fishing operations are so far self-supporting and are able to contribute to the general existence of the Corporation.

Loans and aids are from time to time made available by friendly countries like Japan, Finland and U.K. for fishing gears and infrastructural facilities. Development funds are, however, given by the central Government under the normal annual budgeting.

10. LONG-TERM PLANS

TAFICO is now building a shorebase station at Ras Mkwavi (across the ferry) where all the offices will be based, and all operations controlled from. We are also expanding our local and external marketing capabilities as well as fishing operations. It is expected that TAFICO will eventuelly go for deep-sea fishing operations. Boat building yards are being expanded to produce double the present production. With a clear increase of funds generation from TShilling 6.5 to 16.0 million from 1982-1983, it is a clear indicator that by say 1985, TAFICO's production should stand well over TShs. 20.0 millions.

11. JOINT VENTURES

TAFICO is empowered to enter into joint commercial ventures with the object to improve Tanzania's fishing industry. The industry needs a sizable and concentrated injection of finance, expertise, effort and determination to develop infrastructure and aucillary facilities. This, of course, is not within the capability of the Tanzania Government at the moment. Joint fishing ventures, if properly pursued, would provide the short-term solution, although a complicated procedure of negotiation and legal formulation is necessary.

Table 1. TAFICO project boat building construction 1983/1984.

Boat size (ft)	Mwanza Boatyard Number	Price	Value	Mikindani Boatyard Number	Price	Value	Kigoma Boatyard Number	Price	Value	Total Number	Value
6½'	-	-	-	-	-	-	-	-	-	-	-
11½'	2	13,000	26,000	-	-	-	-	-	-	2	26,000
15'	-	-	-	4	20,000	80,000	-	-	-	4	80,000
17'	2	18,000	36,000	2	22,000	44,000	-	-	-	4	80,000
21'	-	-	-	-	-	-	12	20,000	240,000	12	240,000
24'	2	40,000	80,000	5	40,000	200,000	2	40,000	80,000	9	360,000
25'	1	50,000	50,000	-	-	-	-	-	-	1	50,000
25'	1	90,000	90,000	3	80,000	240,000	-	-	-	4	330,000
28'	1	250,000	250,000	1	250,000	250,000	-	-	-	2	500,000
32'	1	300,000	300,000	1	300,000	300,000	-	-	-	2	600,000
35'	2	350,000	700,000	1	350,000	350,000	-	-	-	3	1,050,000
38'	-	-	-	-	-	-	1	370,000	370,000	1	370,000
Σ	12	-	1,532,000	17	1,464,000	1,464,000	15	-	690,000	44	3,686,000

Source: TAFICO

Table 2. Fish production data for 1983.

VESSEL	NO. OF TRIP DAY	LONG	DAYS AT SEA	FISHING DAYS	CATCH WEIGHT IN KGS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Tasi	-	24	124	73	2945	1207	-	-	-	434	4125	4386	648	3957	2169	1626	21497
Mclungu	-	42	209	123.5	2853	2367	2855	4245	6898	4306	5785	5432	3374	5831	3831	4220	52034
Sargara	-	41	203	123.5	2747	1704	2413	3979	7982	3242	6298	6089	4577	4437	4874	4733	53075
Tumaini	1	16	123	83	5646	7278	-	8172	16958	13392	13729	24655	14739	-	-	-	103670
Kamba	-	11	56	33	900	1222	1908	1770	1948	-	-	-	-	-	-	-	7749
Pangani	2	19	98	56	686	2671	-	8063	7197	3548	3876	3515	1667	-	-	-	31224
Nangaru	-	21	104	60	400	1205	2781	3419	8561	3914	4164	4340	-	-	-	-	28784
Maendeleo	2	17	119	63.5	705	-	3653	4727	13133	-	7386	12081	10810	12601	2219	7758	75073
Karbakochi	2	14	71	38	-	-	1622	682	-	446	1956	2737	-	2460	-	-	9904
Shangani	7	-	7	7	-	-	-	-	-	-	-	46	356	630	38	-	1070
TOTAL	13	205	1114	660.50	16883	17654	15233	35058	61778	29212	47319	63281.5	30171.5	29916	13168	18337	384031.5

Source: TAFICO

Table 3. Monthly summary of exports for the year 1983.

MONTH	EXPORT OF PRAWNS		EXPORT OF BECHE-DE-MER		TOTAL EXPORTS	
	WEIGHT (KGS)	VALUE T.SHS.	WEIGHT (KGS)	VALUE T.SHS.	(WEIGHT KGS)	VALUE T.SHS
January	16,123	822,812.00	-	-	16,123	822,812.00
February	13,933	722,957.00	-	-	13,993	722,957.00
March	10,650	499,974.00	-	-	10,650	499,974.00
April	-	-	4,000	125,800.00	4,000	125,800.00
May	16,272	850,866.00	-	-	16,272	850,866.00
June	15,180	981,140.00	-	-	15,180	981,140.00
July	10,560	650,587.00	-	-	10,560	650,581.00
August	10,404	681,370.00	-	-	10,404	681,370.00
September	9,252	571,901.70	-	-	9,252	571,901.70
October	2,952	122,434.20	-	-	2,952	122,434.20
November	18,264	1.210,349.80	2,250	50,675.00	20,514	1.261,024.80
Desember	1,848	77,549.00	-	-	1,848	77,549.00
TOTALS	125,503	7,191,940.40	6,250	176,475.00	131,753	7,368,415.40

Source: TAFICO

Table 4. Comparison of export performance for the year 1982 and 1983.

MONTH	1982 EXPORTS		1983 EXPORTS	
	WEIGHT (KGS)	VALUE T.SHS	WEIGHT (KGS)	VALUE T.SHS
January	-	-	16,128	822,812.00
February	2,625	98,860.70	13,993	722,957.00
March	1,110	44,701.25	10,650	499,974.00
April	990	59,473.65	4,000	125,800.00
May	1,000	58,675.20	16,272	850,866.00
June	-	-	15,180	981,140.00
July	-	-	10,560	650,587.00
August	12 (Sample)	405.00	10,404	681,370.00
September	-	-	9,252	571,901.70
October	805	30,873.25	2,952	122,434.20
November	-	-	20,514	1,261,024.50
December	-	-	1,848	77,549.00
TOTALS	6,542	300,989.05	131,753	7,368,415.40

Source: TAFICO

Table 5. Sales of small sea fish to N.C.C.O.

MONTH	WEIGHT KGS	VALUE IN T.SHS
May 1983		
(last week only)	14,059	273,180.00
June	34,787	756,920.00
July	47,660	953,200.00
August	63,009	1,260,180.00
September	34,878	790,581.00
October	29,081	639,782.00
November	13,072	287,584.00
December	18,224	393,740.00
SUB TOTAL	254,770	5,355.167.00

"Mama Tafico "sales" to N.C.C.O.

MONTH	WEIGHT KGS	VALUE T.SHS
June	4,330	125,070.00
July	4,794	139,029.00
August	8,804	254,074.00
September	7,209	223,479.00
October	11,154	345,774.00
November	10,884	321,964.00
December	-	-
SUB TOTAL	47,175	1,409,390.00
GRAND TOTAL	301,945	6,764,557.00

Source: TAFICO

5. RESEARCH, EDUCATION AND MANAGEMENT

ONGOING MARINE FISHERIES RESEARCH PROGRAMMES IN TANZANIA

by

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Tanzania Fisheries Research Institute
Dar-es-Salaam

Marine fisheries research in Tanzania dates as far back as the beginning of cooperation among the East African states in common services. Most of the research carried out on marine fisheries was based on taxonomy, production and biology of different species of fish. The headquarters of EAMFRO in Zanzibar carried out a lot of research on the fisheries of the region.

Between 1964 and 1965, the university of East Africa agreed that research in Marine Biology should be carried out by the Zoology and Marine Biology Department of the University of Dar-es-Salaam. It was not, however, until 1971 that the first Ph.D. graduate in marine fisheries was produced. This was that of Dr. W. Okera (working on sardines, Sardinella spp.). Since then, the University of Dar-es-Salaam has produced a number of graduates in marine sciences, particularly fisheries. These graduates work in fisheries- or in fisheries oriented research.

The marine fisheries research was not only done by the University of Dar-es-Salaam alone. Kunduchi Fisheries Research and Training Institute and Mbegani Fisheries Development Centre, though actively engaged in teaching, have carried out in one way or another some marine fisheries research.

The marine fisheries research has not only been carried out by the local institutions but also by foreign/international institutions through cooperation with local researchers or through short visits of research vessels, e.g. "Dr. Fridtjof Nansen" and "Prf. Metsyastsev" and many others.

Ongoing/current researches on marine fisheries

The research in fisheries which have been carried out in the region over the past two years are listed below:

1. Work on rabbitfish, by Mzirai, University of Dar-es-Salaam.
2. Work on the culture of rabbitfish, by Bwathondi, TAFIRI.
3. Work on parrotfish, by Rubindamayugi, University of Dar-es-Salaam.
4. Work on demersal fisheries of Tanzania, by Ngoile, I.M.S.
5. Work on the biology and fishery of prawns in Tanzania, by Haule, Kunduchi Fisheries & Training Institute.
6. Work on the biology and fisheries of prawns in Tanzania, by Subramaniam, I.M.S.
7. Work on the biology and fishery of Scylla serrata, by Riyami, I.M.S.

8. Work on the culture of oysters, by Jiddawi, I.M.S.
9. Work on the biology and taxonomy of oysters, by Mndeme, University of Dar-es-Salaam.
10. Work on the fishery of sardines, by Nhwani, TAFIRI.
11. Work on catch compositions of Kunduchi fishery, by Bwathondi and (TAFIRI) and Pratap (University of Dar-es-Salaam).

THE LINDI/MTWARA RIDEP PROJECT

by

W.A. Wilkinson
RIDEP, Lindi

RIDEP is the acronym for Rural Development Programme. There are four "RIDEPS" in Tanzania, funded respectively by West Germany, Japan, UNDP and Great Britain. The two southern regions of Lindi and Mtwara are under funded by the British Government. Lindi and Mtwara regions are known as the two most impoverished regions in the country. Road communications are poor as indeed are communications by sea. The British Government commenced it's RIDEP project in 1980 on the planning stage and since has been involved in supporting the various economic sectors with particular attention being paid to the natural resources sector including livestock development, agriculture and fisheries. It is in this latter sector that I am involved, and which I would like to talk about today.

Three main priorities have been identifieed. These are:

a) The resuscitation of the fresh water fisheries sector.
b) The establishing of a special revolving fund to enable fishermen to purchase fishing gear imported from the U.K.
c) The evaluation of the marine resources not presently being exploited by local artisanal fishermen.

Despite many constraints and difficulties, progress has been made in all sectors.

These are summarised briefly:

In the fresh water sector, a long disused fish pond complex at Mahiwa some 150 km from Lindi has been resuscitated: This involved the total clearing of the area - redigging the pond sites and constructing new raceways and pond "Monks". The first stock of Tilapia - 80 individuals of T.melamopleura - were obtained from the FAO Agriculture Project at Morogoro and subsequently a further consignment of 650 S.niloticus were imported from the Tilapia culture farm at Bamburi north of Mombasa, Kenya. This particular species has shown remarkable growth rates from an average size when stocked of 2-3 cm to an average of 25-30 cm in 6-7 months. The average crop from the larger stock pond (.75 Ha) was 1,400 kg after six months feeding; this is equivalent to 3,733 kg Ha. per year. A flock of 25 ducks were established (a local Muscovy duck Cairina moschata) and these have had two useful functions by increasing primary production and decreasing the Bilhartzia vecting snail which is endemic in this area.

a) A second duck house has been built closer to the pond and further 25 ducks will be introduced. The whole complex comprises eight ponds. The larger holding or stock measures .75 of a Ha. The other seven are smaller and measures .25 of a Ha.

To date, a total of 45,000 fingerlings have been stocked in the many dams, lakes and ponds in both regions. The culture of Tilapia in fresh water pond is an age old practice. It is well suited to conditions in subsistence type societies as it involves a minimum of technology and monetary investment. It is ideally suited to village conditions in East Africa, producing animal protein direct to the community reducing distribution costs. Its practice should be supported and encouraged.

b) It is clear that unless fishermen can get the tools of their trade they cannot pursue their livelihood, which is the catching of fish. The RIDEP Gear Project is a simplistic one. Grant in aid funds from U.K. have been used to buy British fishing equipment which is imported and sold direct to fishermen for cash. No credit is allowed, and so far there has been no problems - the fishermen find the cash somehow and, it is believed, appreciate the service. Local funds derived from the sales are credited to a locally administered "revolving" fund and used for further development projects in the fishing sector. As a direct result of the availability of fishing gear, there has been an increase in local landings and a diminution of the use of explosives to kill fish in the Lindi region. The fund is to be expanded to cover the Mtwara region in the coming year.

c) The third project has been an evaluation of the marine resources not being currently utilised by the local fishermen. Clearly, unless one knows what the resource is, it is impossible to categorize future developments. It is unlikely the local artisanal fishery based on reef species mainly will materially increase production. It has remained productionwise static for many years and is probably exploited to it's optimum. However, relatively little fishing is carried out beyond the reefs, particularly of the surface feeding species such as the Little tuna (Euthynnus affinis) the Skipjack tuna (Katsuwonus pelamis) and the Yellowfin tuna (Thunnus albacares) and the Frigate mackerel (Auxis thazard). Since January 1983 some preliminary work has been done using a 9.5 metre wooden vessel, built by Tafico at the boatyard in Mikindani for the I.D.A. coastal fishing development centres. This vessel is far from ideal for the purpose - it is designed as a stern trawler for shallow water areas. It has no facilities on board for extended trips, lacking toilets, bunk accommodations and cooking arrangements. This has restricted operations considerably. A small "Seascribe" echo sounder has been installed. Results so far have been encouraging. Schools of surface fish were seen on all days, almost without a "blank" day. As mentioned, these comprised all the main species which are exploited commercially in tropical environments.

It would be unwise to postulate the potential production from the "schools" sighted: Clearly it is a resource of many hundreds of tons not being exploited at present in the southern regions of Tanzania: The survey will be extended to cover areas North and South Kilwa and Mtwara regions respectively: Other "RIDEP" involvements have been in training fisheries personell overseas. In conjunction with the British Council, the fisheries statistics section has also been strengthened by the employment of enumerators and provision of weighing scales.

THE MBEGANI FISHERIES DEVELOPMENT PROJECT AND THE IMPLEMENTATION OF A PROGRAMME FOR CARRYING OUT STANDARDIZED TRAWL HAULS FOR FISH ABUNDANCE INVESTIGATIONS DURING THE TRAINING CRUISES WITH T/V "MAFUNZO"

by

Fritz N. Jensen
Mbegani Fisheries Development Centre, Bagamoyo

1. INTRODUCTION

The Mbegani Centre is located approximately 7 km south of the historical township of Bagamoyo and about 60 km north of Dar-es-Salaam.

A Fishermen's Training Centre was established here in 1967 for the training of local fishermen and refresher courses for fisheries staff. After the first courses were completed an expansion programme was carried out, and with the new facilities the Centre was able to start the first two years Certificate Course in 1971.

This continued up to 1977 when the Certificate Courses were replaced by three years Diploma Courses. The boat building yard at Ras Mkwavi in Dar-es-Salaam had been transferred to Mbegani in 1973 thus expanding the scope of the activities at Mbegani.

The bottleneck, however, was lack of training facilities and therefore in June 1976 Tanzania and Norway signed an agreement whereby Norway would undertake the expansion of the training facilities at Mbegani. In order to facilitate proper implementation of the project, NORAD contracted a Norwegian firm, FIDECO, to administer the project.

The expansion programme came to a halt in 1980 when some of the buildings were destroyed in an earthslide. The project was then reviewed and reorganized and the work continued with a new contractor named NOREMCO, under the supervision of the Norwegian consultancy firm NORPLAN.

The work, that was completed in December 1983, included construction of several staffhouses, marine engineering workshops, fishermen's workshop, a fish processing plant, classrooms, laboratories, library, hostels and a jetty. The boatyard and old staffhouses were refurnished and also infrastructure such as water and main lines, drainage system, roads and sewage systems were up-graded and expanded.

2. TRAINING OBJECTIVES

According to the agreement between Tanzania and Norway, the training objectives are as follows:

a) The Centre shall provide technically qualified manpower for the fisheries and allied industries. The training will be provided by giving courses primarily according to the needs of the fisheries sector in Tanzania. Emphasis shall be given to the practical aspects of the subjects taught at or from the Centre.

b) The Centre will provide training for officers to the fishing fleet and coastal fleet of Tanzania up to the level of the lowest certificates required for deck and engine officers to these fleets. The Centre shall also aim at recruiting instructors trained at the Centre for the different levels of subjects taught at or from the Centre.

c) The Centre will develop ways and means in order to develop and improve the more traditional fisheries of Tanzania. The agreement also emphasizes that training shall be the main concern of the Centre and shall have priority over any other activity.

3. TARGET GROUPS

The training programmes to be developed and implemented at or through Mbegani are focusing on three different target groups, as follows:

a) The TECHNICIANS. Form 4 and Form 6 leavers to be trained through a diploma course, either in nautical subjects, marine engineering, fish processing or boat building. These service/preservice students should be able to work as teachers/instructors and fill posts in the administration and production units on district and regional levels when having completed their courses.

b) The MECHANICS. Standard 7 leavers (or higher), with relevant experience, to be trained through certificate courses. After the training these students will perform their duties on the district and village level. Those who have shown special interest and have the right skills should be utilized as instructors on the Short Courses for fishermen and other villagers.

c) The FISH VILLAGE POPULATION. The artisanal fishermen, the local boatbuilders, the local mechanics, the fisheries co-operative staff, the fisheries co-operative members and committee members and the village administration.

4. TRAINING PROGRAMMES

The Institute is per to day offering the following Diploma and Certificate Courses:

4.1. Master fisherman diploma course

The 3 year course is intended to train Deck Officers Grade IV. These officers will be able to take command of fishing vessels up to the size of 200 g.r.t. after having obtained sufficient experience.

4.2. Boat building diploma course

The main objective of this 3 year course is to train students in wooden boat construction and repairs. The students are supposed to acquire the necessary skill and knowledge to build modern fishing boats locally up to the size of more than 20 feet.

4.3. Marine-refrigeration engineering diploma course

This 3 year diploma course starts with a 1½ year basic course where the students are trained together. They are then divided into two classes:

a) The marine engineering students will get a Class IV certificate which will enable them to take command a running, maintenance and repair work of marine engines up to the size of 200 KW.

b) The refrigeration engineering students should have acquired sufficient knowledge and skills to enable them to take charge of maintenance and repairing of refrigeration plants and equipment used in cold storage facilities in Tanzania.

4.4. Fish processing and marketing diploma course

The main objective of this 2 year course is to train people capable of handling and processing fish and fish products, with emphasis on improving traditional processing methods.

4.5. Fisherman certificate course

This 2 year certificate course aims at training extension staff and instructors for The Artisanal Fisherman's Courses. After having completed the course the candidate should be able to operate a small fishing and fish production unit.

4.6. Boat building certificate course

The aim of this 2 year course is to train mid-level manpower with the right practical skills to be able to repair and maintain local fishing boats and construct small modern fishing crafts suitable for Tanzanian waters.

4.7. Marine mechanics certificate course

This 2 year course aims at training mid-level manpower with the right practical skills to be able to improve the efficiency of the production units within the fisheries and allied industries by carrying out proper maintenance and repair work. They should also be able to train local fishermen to operate and maintain in/outboard engines.

4.8. Fish processing and marketing certificate course

Having completed this 2 year course the students should be able to use the diffenrent processing methods and work in a fish processing plant at a level of foreman.

As mentioned before, the diploma courses aim at training people to be able to work as instructors/teachers and fill posts in the administration and also production units on districts and regional level. The certificate students will perform their duties on district and village level. The certificate holders should also be able to act as instructors for the short courses for the third target group - the fishing village population. We have developed a 9 week course for artisanal fishermen which is ready for implementation. Other short courses will be developed when needed.

For the time being (school year 1983/84) we have 70 diploma students; 24 in marine - and refrigeration engineering, 25 in nautical science, 13 in fish processing and 8 in boat building.

From schoolyear 1984/85 we intend to start the certificate courses and short courses for fishermen.

In additon we are also carrying out a staff training programme and on-the-job training.

5. DEVELOPMENT

One of the objectives for the centre is to develop ways and means on how to improve the traditional fisheries in Tanzania.

This objective is very general and give room for almost all kinds of experiments as long as the aim is to improve the traditional fisheries.

We could easily have followed the footsteps of other fisheries development projects that have been implemented in various areas along the East African coast and in the lakes during the last two decades by introducing modern fishing technology, European type of mechanized boats etc. But, we think it is more appropriate to introduce a technology that is:

- socially and environmentally acceptable and feasible
- economically obtainable (copyable)
- technically understandable in terms of operation, maintenance and economy

This approach means that we will focus on the traditional local fishing crafts and fishing methods and see how to improve them and make this known to the trainees, instructors and the fishermen.

So far we have identified and selected the following developmental tasks:

5.1. Manpower development

This is taken care of by our training programmes. Suitable curricula will be developed at the Centre when needed.

The Centre has got the capacity to train all kinds of personell needed for the various sectors and can also finance special training abroad, mainly for our own staff, if needed.

5.2. Improve fishing methods

We will systematically try out all local fishing equipment and methods and incorporate this in the training of the students. Use of local material such as cotton for fishnets, mangrove roots for floats, local made traps etc. will be tested and compared with more "modern" equipment.

5.3. Improve traditional fishing crafts

The institutionally trained boat builders do not know how to build a traditional fishing craft, and therefore the local fishermen gets no service from the existing governmental boatyards, including Mbegani.

We have embarked on a programme to build some local fishing crafts in order to make our boatbuilders and students acquainted with these type of boats and at the same time find ways and means to improve the traditional fishing boats.

5.4. Improve fish handling and processing

We are trying different fish processing methods suitable for the various areas of the country. The students training emphasize on traditional methods and techniques that can reduce post-harvest losses and maintain fish quality.

5.5. Provide technical assistance

An external service unit has been established in all departments under the Training Division. These units are composed of a senior officer and two skilled craftsmen from each department. The main objective is to bring fish production units into operation again. There is a great demand for repairing boats and engines, which very often are difficult to bring to the Centre.

5.6. Trial fishing and stock assessment

Our training vessel "Mafunzo", and the new training vessel II, which will be operating within the end of this year, will carry out a trial fishing and stock assessment programme. This programme will be implemented ultimo March this year and can be seen as a continuation of the R/V "Dr.Fridtjof Nansen" surveys in Tanzanian waters 1982-83.

T/V "Mafunzo" has been fishing for the Institute for some time now and the catch statistics for the last 17 months is presented in the following part of this paper.

6. UTILIZATION OF THE TRAINING VESSELS FOR TRIAL FISHING AND STOCK ASSESSMENT

The academic year 1981/82 was a so called "zero" year with no training activities, due to construction work on this site. From August 1982 a number of new experts and local staff had taken up their assignments at the Centre and by primo September the first batch of students were enrolled.

The Centre has a 70 feet stern trawler which we want to utilize for training purposes, but at the same time we also look into the possibilities of carrying out trial fishing and stock assessment. It has already been decided that another - smaller - training vessel of approximately 35 feet should be built at our own boatyard. That vessel - the training vessel II - will be in operation from January 1985.

We started by formulating the following aims for the trial fishing and assessment programme:

a) To increase the Institute's knowledge of the marine fish resources and to find out what combination of vessel/gear that represents the best utilization of the stocks.

b) Investigate seasonal variations and availability for species caught by the gear tested.

c) To register parameters important for fishing, such as wind, currents, light conditions, sea temperature, and salinity and bottom conditions.

d) To improve the catchability of the existing gears in the trial area and to introduce other types of gears and adjust these to the abvailable vessels and the species to be caught.

e) Carry out trials with the aim of improving the quality of landed fish.

The operational area for the two training vessels was divided in four zones:

Zone 1 from the Kenyan boarder to Pangani River
Zone 2 from Pangani to Dar-es-Salaam
Zone 3 from Dar-es-Salaam to Kilwa
Zone 4 from Kilwa to the Mozambique boarder

T/V "Mafunzo" will operate mainly in areas with water deeper than 10 fathoms and the training vessel II will operate in shallower waters. It was decided that the effort should be concentrated in the northern part of the coast, mainly in the Zanzibar Channel.

We started a system for registration of fish catches in October 1982. Although we did not have the expertise to determine the species composition of the catches, we have collected some information about fish density, seasonal variations, etc. We soon realized that we needed a scientist to assist us in implementing a more comprehensive research programme and therefore NORAD was approached in May 1983. NORAD has now confirmed that a scientist from the Institute of Marine Research, Bergen, Norway, will arrive here mid March 1984.

M/V "Mafunzo" is equipped with a North Sea Calypso bottom trawl without bobbins. The opening is about 32.5 m x 3.5 m. The mesh size in the wings is 100 mm, in the belly 40-30 mm, and in the cod-end 18 mm.

Effective time of trawling has varied, but has been registered. All the trawl hauls are carried out during day time. The depths trawled have varied from 7 to 25 fathoms.

In addition to the trawl, other gears such as gill nets, bottom long lines, traps, hooks and line have been used in the training programme. The catches taken by these traditional fishing methods have been rather small. I will not elaborate the reasons for this here.

Most of the trawl hauls have been carried out in Zanzibar Channel north of Wami Patches. In the period August 1983 to February 1984, 90% of the trawl hauls were taken in the northern part and the rest in the southern part of the channel (Fig. 1). The area north of Wami Patches is not normally utilized by TAFICO and BAFICO and data obtained by T/V "Mafunzo" from that area is therefore of some value.

During the 17 months we have collected data the vessel has been in the Mafia Channel two times. Allthough the catches per trawl hour seem to be higher for this area than for parts of the Zanzibar Channel, the area is too far from the Centre to be worked regularly by the training vessel.

The composition of cathces and average catch per towing hour is shown in the attached tables. The average catch is composed of 8-9% big fish, approximately 10% medium (sorted) fish and close to 80% small fish, and some rays, sharks etc. The data we have collected so far indicate seasonal variations, but since we have not used fixed trawl stations and have not carried out a scientific survey we will just leave the data as they are presented in Figs. 2 and 3, and Table 1 and 2.

7. CONCLUSIONS

The main objective for the Centre is to provide technically qualified manpower for the fisheries and allied industries in Tanzania. This is, however, a rather broad guideline and needs to be supplemented by a manpower projected plan. But how to make a reliable plan without having the necessary data about the potential yield from the coastal and inland waters available, the technology to be used to collect the fish, the number of fishermen, fishing boats and processing/marketing facilities etc. needed?

The estimated potential yield from waters deeper than 20 m based on R/V "Dr.Fridtjof Nansen" indicates that there is not much room for expanding the so called modern fishing activities. This of course is a valuable input for our manpower projection plan. We hope that our training vessels can be partly utilized to follow up the "Dr.Fridtjof Nansen" investigations. Reliable statistics are a vital tool in planning and we hope that this seminar will give us some information about the fisheries statistics in Tanzania to day.

Table 1. Catch composition in trawl hauls from the Zanzibar Channel and Mafia Channel.

Month	No. of hauls/ hours	Area	Composition of catch Big kg	%	Medium kg	%	Small kg	%	Rays, Sharks etc. kg	%	Total kg	Catch per hour kg
10/82	2/4	Zanzibar	23	1.5	75	4.9	1,325	87.2	96	6.3	1,519	380
11/82	19/31	"	1,051	17.1	108	1.8	4,488	73.0	445	7.2	6,152	198
12/82	6/12	"	187	6.9	308	11.4	2,112	78.3	90	3.3	2,697	225
1/83	8/15	"	300	6.5	628	13.6	3,525	76.5	153	3.3	4,606	307
2/83	3/6	"	296	9.9	230	7.7	2,321	77.7	142	4.8	2,989	498
2/83	4/6	Mafia	251	10.6	133	5.6	1,610	67.7	384	16.1	2,378	396
3/83	4/7.5	Zanzibar	193	4.1	293	6.2	3,896	84.3	159	3.4	4,731	631
4/83	3/5	"	120	3.1	196	5.1	3,383	87.9	141	3.7	3,850	770
5/83	8/16	"	827	9.6	1,018	11.8	6,418	74.4	364	4.2	8,627	539
6/83	10/20	"	880	8.6	3,295	32.1	5,192	50.6	904	8.8	10,271	514
8/83	5/10	"	232	8.8	390	14.7	1,732	65.4	293	11.1	2,647	265
9/83	18/36	"	762	5.9	1,725	13.4	9,136	70.8	1,282	9.9	12,905	358
10/83	16/32	"	1,018	7.6	1,126	8.4	10,783	80.1	535	4.0	13,458	421
11/83	22/42.5	Mafia	2,011	8.1	1,187	4.8	20,893	84.6	629	2.5	24,710	581
11/83	5/10	Zanzibar	142	6.7	125	5.9	1,778	83.9	74	3.5	2,119	212
12/83	5/11.5	"	158	4.5	1,013	28.8	2,111	60.1	231	6.6	3,513	305
1/84	24/49.5	"	1,405	8.3	2,009	11.9	13,103	77.3	433	2.6	16,950	342
2/84	37/77.5	"	2,586	9.3	1,731	6.2	22,859	81.8	778	2.8	27,954	361

Table 2. Average catch in kg per trawl hour per month for the Zanzibar Channel (Z) and Mafia Channel (M).

Year	1982			1983													1984	
Month	Oct	Nov	Dec	Jan	Feb		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov		Dec	Jan	Feb
Area	Z	Z	Z	Z	Z	M	Z	Z	Z	Z		Z	Z	Z	Z	M	Z	Z	Z
BIG FISH	5.8	33.9	15.6	20	18.5	41.8	25.7	24	51.7	44	-	23.2	21.2	31.8	14.2	47.3	13.7	28.4	33.4
MEDIUM FISH	18.8	3.5	25.7	41.9	38.3	22.2	39.1	39.2	63.6	164.8	-	39	47.9	35.2	12.5	27.9	88.1	40.6	22.3
SMALL FISH	331.3	144.8	176	235	386.8	268.3	519.5	676.6	401.1	259.6	-	173.2	253.8	337	177.8	491.6	183.6	264.7	295
RAYS SHARKS	24	14.4	7.5	10.2	23.7	64	21.2	28.2	22.8	45.2	-	29.3	35.6	16.7	7.4	14.8	20.7	8.7	10
TOTAL	380	198	225	307	498	396	631	770	539	514	-	265	358	421	212	581	305	342	361

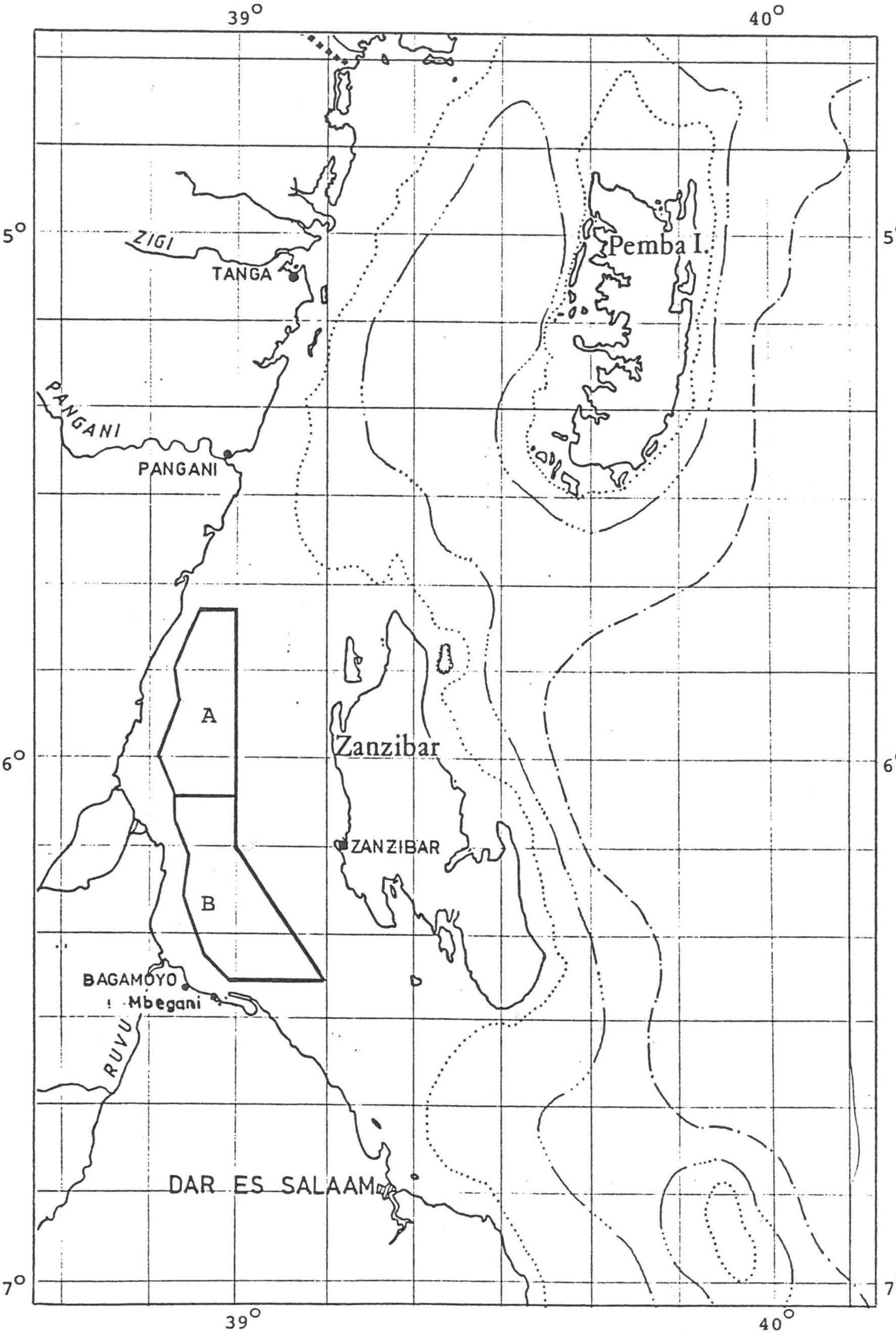

Fig. 1. The area fished by T/V "Mafunzo" during the period August 1983-February 1984. About 90% of the trawl hauls were carried out in area A.

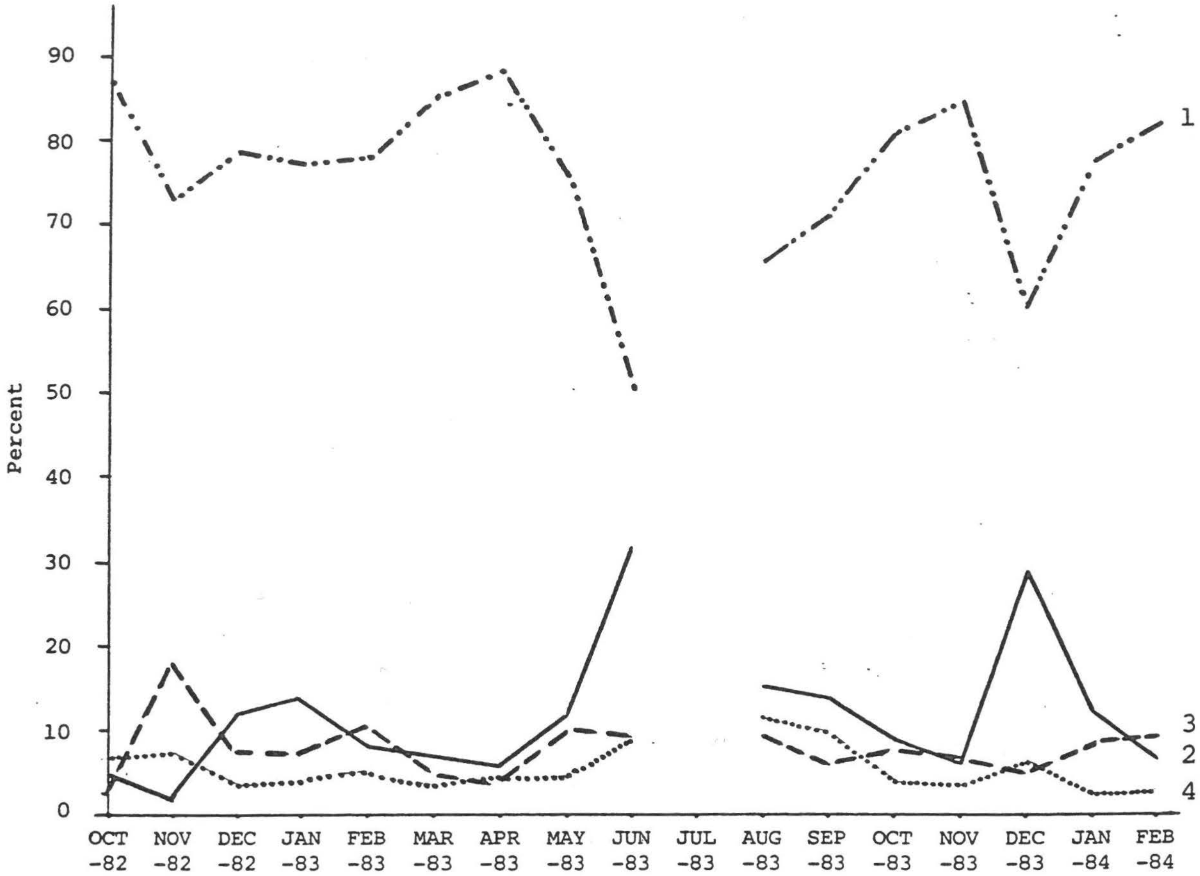

Fig. 2. The size group composition of catches taken by T/V "Mafunzo" during the period October 1982 - February 1984. 1) Small fish, 2) Medium fish, 3) Big fish, 4) Sharks and rays.

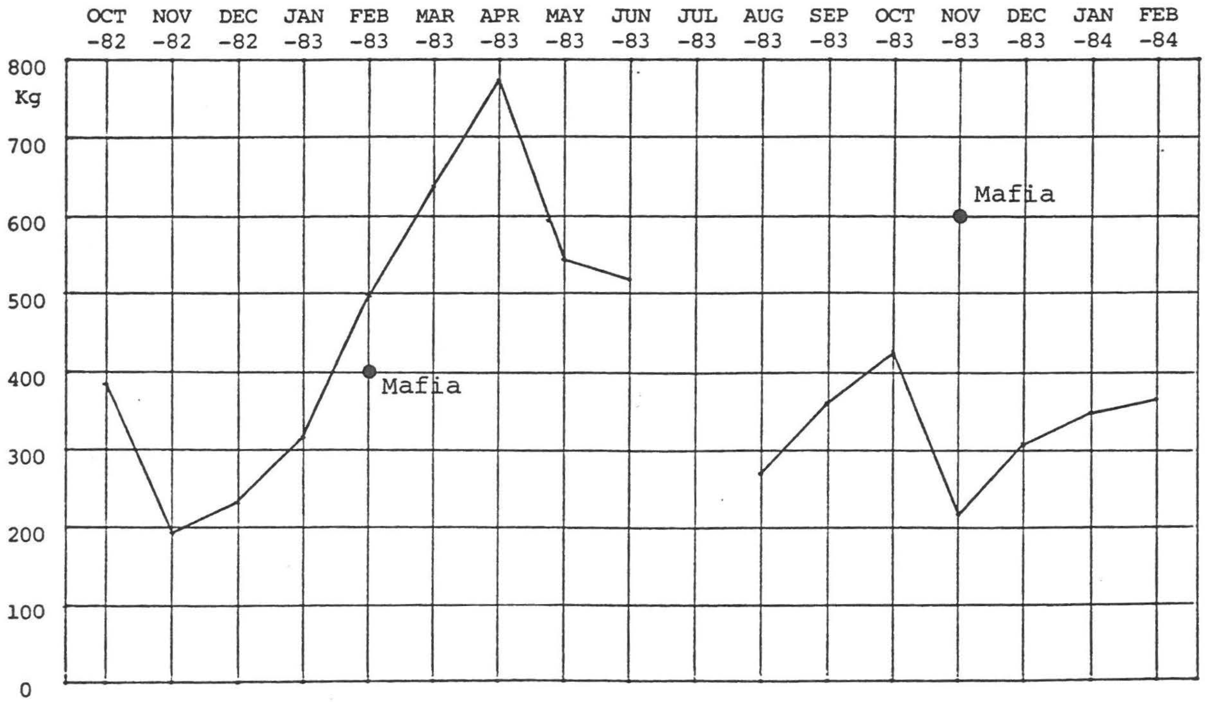

Fig. 3. Average catch per trawl hour by T/V "Mafunzo" in the Zanzibar and Mafia Channel.

THE RELATIONSHIP BETWEEN MARINE FISHERIES RESEARCH AND FISHERIES POLICY, PLANNING, MANAGEMENT AND EDUCATION

by

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Fisheries Division, Dar-es-Salaam

1. INTRODUCTION

Tanzania mainland has a coastline of approximately 800 km. The continental shelf has a width varying from a minimum of 6 km to maximum of 64 km and has an area of about 12 000 km^2 out of which approximately 1 500 km^2 is available for trawling at a depth of 20 m and 2 000 km^2 at a depth of 60 m. The remaining area is characterized by coral formations which reduce the effect of strong winds on the coast. The climate conditions and productivity of the ocean waters is influenced by the East African Coastal Current. Hydrological analysis indicates that the water is deficient in the growth of plankton which affects the fish food chain and consequently the distribution of marine living resources that can be exploited.

2. FISHERIES RESOURCE POTENTIAL

Presently the catch data for marine fisheries make up 20% of the total fish landed. The marine fisheries supports between 8 000-10 000 fulltime traditional fishermen who contribute more than 80% of the landed catch.

The main fish species exploited are sardinella, seerfishes, sharks, various demersal fishes and seasonal quantities of migratory pelagic fishes like king-fish (nguru in Kiswahili).

Good fishing grounds are located between the Rufiji delta and the Mafia Channel. In the Rufiji delta and off Sadani (north of Bagamoyo town) prawns are caught by traditional fishermen and commercial fishing vessels belonging to Tanzania Fisheries Corporation (TAFICO), Bagamoyo Fishing Company (BAFICO) and others. Sardines are commercially exploited by light attraction with purse seines or by use of dip nets. Small scale fishermen use gillnets, shark nets, beach seines (juya in Kiswahili), traps of different designs, and handlines. Dynamite fishing, though prohibited, is used and may be responsible for damage on coral formation and the beautiful under water gardens.

Productivity per boat has remained low due to the nature of the gear used and increased fishing pressure on the fishing grounds.

All the fish landed is marketed internally. Crustacea related products, mainly prawns are exported and account for the fish and fishery products that enable the country to earn foreign exchange.

3. MARINE FISHERIES POLICY

The marine fisheries policy is part of the general fisheries policy which is guided by the national policy of Socialism for Self Reliance (Ujama na Kujitegemea). The main policy objectives are:

i) To increase fish production as a means of providing the much needed animal protein at a reasonable price. This should result in increasing per caput fish consumption.

ii) To ensure fishermen raise their income and standard of living.

iii) To promote and consolidate fisheries training, research, statistical data collection and improve the administrative machinery of fisheries related production institutions like parastatals, cooperatives and small scale fishermen.

iv) Promote regional cooperation in working out a strategy for managing and exploiting fisheries resources which are shared with other states.

v) Promote and consolidate national capability to exploit marine fisheries resources within our area of jurisdiction.

vi) To earn foreign exchange from sales of surplus fish, crustacea and marine aquatic products.

vii) To consolidate the national policy of socialism for self reliance in the fields of fishing, fish processing and preservation, marketing and distribution of fish and fishery products through strengthening fishing villages, cooperatives and parastatals.

4. ROLE OF MARINE FISHERIES RESEARCH

Marine fisheries is a very important tool in achieving the fisheries policy objectives. Priority areas of marine fisheries research need to be set aiming at maximum utilization of the resource base. Presently scanty information is available on the size of the fish stocks in our territorial waters. This problem is likely to increase when Tanzania declares an Exclusive Economic Zone (EEZ). It is considered necessary to strengthen research in the following fields;

a) Stock assessment with a view to understand the size of the fish stocks, their distribution, migration pattern, species composition, age composition etc.

b) Investigate suitable techniques for maximizing the exploitation of the fish resources by local fishermen and commercial fishing companies.

c) Evolve better extension service methods to match with the resource base.

d) Determine the type of training to be undertaken to provide the technical and professional personell necessary for rational exploitation of the fish resources.

5. MARINE FISHERIES RESEARCH VERSUS FISHERIES PLANNING AND MANAGEMENTS

The East African Marine Fisheries Research Organization of the defunct East African Community was responsible for undertaking marine fisheries resource studies off the Tanzania coast utilizing the research vessels R/V "Manihine". The research undertaken was not reguler enough and did not cover the fishing areas utilized by traditional fishermen who contribute the bulk of the fish landed.

Periodic surveys were also undertaken under the UNDP supported plan for the Fishery Development in the Indian Ocean (Project 10FC/DEV/71/1) utilizing the soviet fishery research vessel R/V "Professor Mesyatsev". This vessel undertook cruises on the Western Indican Ocean in December 1975 to June 1976 and July 1977 to December 1977.

These cruises have been followed by those of R/V "Dr.Fridtjof Nansen". This vessel has undertaken three cruises, the results of which are the main subject of discussion at this meeting.

It is worth to note that cumulative consistent research data on the size of the fish stocks is necessary as a guide for proper planning and subsequent rational exploitation. Management measures to be taken will rely heavily on how much information which is available on the resource base.

The decisions to be made utilizing data from the fisheries resource studies will include:

a) The method of fishing to be undertaken and the number of fishermen who can be licenced.

b) The size of the investment which will include the number of fishing vessels, their sizes, manning requirements and the need of other support and shorebased facilities.

c) Deciding on suitable fishing areas, the fishing method for each area and the best fishing period.

d) Negotiations on joint venture agreements or issuing of licences to foreign vessels to exploit fish resources in the Exclusive Economic Zone (EEZ).

e) Short and long term planning for exploiting the resources by the traditional fishermen and the commercial fishing operations.

Proper fisheries resources management and planning for its economic utilization can be realised once consistent data on the resource base is available. Plans for exploiting and managing the resource will call for:

a) Plans for setting up shore-based facilities to service the fleet.

b) Investigation how to utilize abundant fish resources which are underutilized but could form a major source of protein food.

c) Establishing fish receiving, processing, preservation, marketing and distribution facilities.

d) Introducing management measures which will control overfishing and sustain the resource.

e) In the EEZ exploitation of the resource will demand introduction of a surveillance system to minimize poaching by foreign vessels. Depending on the size of the resource base and the fact that surveillance of a large area is expensive, it may be necessary to form a joint surveillance system by involving neighbouring countries.

6. MARINE FISHERIES RESEARCH AND FISHERIES EDUCATION

Fisheries training in Tanzania has been undertaken by utilizing the Government owned Kunduchi and Nyegezi Fisheries Institutes which provide training at Diploma and Certificate levels respectively. Graduates from these institutions from the bulk of staff in national and regional fisheries establishments. These graduates are responsible for:

a) Management and administration of fisheries at regional and district levels.

b) Extension service support.

c) Technical support in fisheries research, training and commercial establishments.

Training of professionals has been undertaken by utilizing places available at the University of Dar-es-Salaam and training institutions overseas. Training abroad covered the following areas: marine biology, oceanography, limnology, aquaculture, fisheries management and administration and fish processing technology.

Short courses tailored to meet specific needs of the fishery industry have been organized under the auspices of FAO, UNDP, UMEP, SIDA, NORAD, DANIDA and British Technical Assistance. Such courses have combined theory with practice and in a number of cases they have taken place in a developing country with conditions similar to our own.

The research cruises so far undertaken in our waters have ensured full participation of local scientists.

Norwegian development assistance has been available to expand and improve training facilities at Mbegani Fisheries Development Centre. The centre is providing skilled technical personell in the fields of nautical science and gear technology, boatbuilding, marine engineering and refrigeration and fish processing and marketing. The skills gained at Mbegani are considered as a backbone for large scale fisheries operations.

There is a limited scope for local post graduate training in specialised fields of fisheries. The University of Dar-es-Salaam conducts post graduate courses in marine biology and aquatic sciences which does not meet the varied needs of the fishing industry. Higher professional training in most fields of fisheries is dependent on overseas institutions. Training in overseas institutions is dependent on financial support being available either from foreign donors or from Government foreign exchange allocation. Given this financial situation it is not possible to plan smoothly for training in overseas institutions.

Training requirements have been forecasted based on the long and short term development plans of the fishery industry. In all cases the forecasting has tried to incorporate the anticipated expansion of the public sector and the private sector.

In the absence of reliable data on the fishery resources the manpower training projections have assumed a constant expansion of the fishing industry based on data obtained some years back. In most cases the anticipated growth has not been achieved. The resource base has not been consistent enough to be able to attract both local and foreign investors.

Consistent fishery research resource data will assist fishery education in the following manner:

i) Assist in proper forcasting of the manpower needs of the different fisheries fields with the purpose og optimizing resource exploitation. This will facilitate proper educational planning at all levels.

ii) Stimulate planning for maximum utilization of locally available training facilities for short and long term training programmes.

iii) Facilitate identification of areas requiring specialized training and the actual number of such personell required.

iv) Ensure funds available for training are channelled to areas where maximum benefit can be obtained.

v) Create a pool of skilled personell who can be used by investors who would otherwise not have risked investing in fishing.

7. CONCLUSIONS AND RECOMMENDATIONS

Marine fisheries resources data plays a key role in formulating a fisheries policy and the subsequent action plans. It holds the key to sound fishery management, developing and education decisions. The symposium should come up with clear suggestions on how to maintain an up to date resource assessment, development and management programme. The following considerations will guide in drawing up a long term resource survey and development strategy:

i) Resource assessment is an expensive undertaking which requires expensive equipment and skilled personell. All the same it is a necessary prerequisite if proper management and exploitaion of the resource is to be realized. The assistance of NORAD and other donors will continue to be required to facilitate surveys like the ones which have been undertaken by the "Dr.Fridtjof Nansen".

ii) Resource surveys have to be periodic to provide the fisheries administrator with accurate and up to date resource data for management, developing and decision making.

iii) Strengthen the mechanism for collecting fishing data from small scale and commercial vessels. This data, if analysed and combined with data for a resource assessment vessel like the "Dr.Fridtjof Nansen", should facilitate the preparation of a marine fisheries resource map of Tanzania. Such a map should have detailed information on the major fishing grounds and the major commercial fish species which can be exploited.

iv) By-catch from trawling for prawns is difficult to handle and process and is discarded by prawn trawlers due to lack of storage space. Long term planning should incorporate full utilization of the by-catch.

v) The establishment of an Exclusive Economic Zone (EEZ) will require an increase in investment for resource studies and surveillance.

vi) An economic marine fisheries resource utilization plan has to be drawn up once accurate information on the sustainable yield for the small scale fishermen and commercial fishing grounds is established. This plan can take the form of:

a) Expansion of the fishing capability of existing fishing institutions.

b) Joint venture agreement between foreign institution and a local institution.

c) Any other option considered benefical to the country.

vii) Appropriate measures have to be taken to ensure existing national research and training institutes and the University of Dar-es-Salaam participate fully in the future plans of resource surveys, rational exploitation and development of the marine fisheries resources.

viii) Assess the potential for mariculture on the coast. If found feasible, work out the strategy for undertaking mariculture as a rural activity for coastal villages, especially in villages where there is a decline in catches by the traditional fishermen.

6. THE WORKING GROUP REPORTS

REPORTS FROM THE WORKING GROUPS

The last day of the seminar four working groups discussed topics concerning education, statistics, research, mangagement and development of the marine fishery. The discussions were guided by some questions given beforehand. The reports from the groups were discussed in plenum and the final versions are printed here. The different working groups were chaired by:

1. EDUCATION - W. Jensen
2. STATISTICS - L.B. Nhwani
3. RESEARCH - P.O.J. Bwathondi
4. MANAGEMENT AND DEVELOPMENT - T. Maembe

1. THE EDUCATION WORKING GROUP

1.1. Guidlines for the discussion

1.1.1. This group will deal with education of the following five target groups:

a) Fishing village population
b) Mechanics
c) Technicians
d) Administration personel
e) Scientific personel

In view of possible further development of the exploitation of available resources the group is asked to review the training requirements on various levels. Consideration should be given to:

- Training in using traditional gear, equipment and vessel.
- Training in the use of mainly imported technology.
- Introduction of new methods, based on technology that can be developed locally, e.g. methods from Asia and the Caribbean.
- Improvements in fish handling, marketing and processing.
- Training in maintenance of vessels, gear and equipment.
- Education of fishermen in the consequences of using dynaurite and other techniques dehimental to the resources.
- What categories of man power are mostly needed.

1.2. Conclusions

The discussion was centered on the following target groups:
a) Fishing village population
b) Mechanics
c) Technicians
d) Medium and high level cadres

1.2.1. Training in using traditional gears and vessels

a) The practical aspects should be more emphasized in the sense that the students should go out to sea in the traditional vessels and use them. The institutions should try to improve the traditional gears.

b) The institutions should take the responsibility of hiring a local fisherman to instruct in fishing methods.

c) The institutions should build or acquire 2 "ngalawa" and one "mashua" for teaching purposes.

1.2.2. Training in using imported technology.

This section includes two types of technology, i.e. high and low level technology. With the prevailing economic conditions in the country it is necessary to modify the traditional fishing methods using cheap local materials or methods from other developing countries e.g. Carribean and Asian countries.

1.2.3. The curricula for the fisheries institutions should emphasize methods relevant to Tanzania e.g. smoking, drying and salting rather than refrigeration, and canning.

1.2.4. The group stressed the importance of maintenance especially as a preventive measure more than a repairing one.

1.2.5. Institutions should also arouse the consciousness among the people to fight against dynamite fishing.

1.2.6. Training needs for each category

a) The manpower development program for 1981-85 is not realistic and should therefore be revised.

b) The mechanics level should be emphasized but right now it cannot be said at what rate for reasons given in (a).

c) Fisheries education for institutes in the country should be standardized i.e. the period one should take to obtain a diploma and a certificate.

d) There should be an integrated system that links all institutions dealing with fisheries education and research.

e) Finally the group suggested that the institutions should establish and informal link rather soon.

2. THE FISHERY STATISTICS WORKING GROUP

2.1. Guidlines for the working group.

2.1.1. Review of the present situation of fisheries statistics in the country.

2.1.2. Recommendations for improvements on:

a) Administrative set up

b) Coverage
- sectional (traditional and industrial)
- geographical (inshore and offshore including EEZ)
- phases (production, processing, marketing)

c) Statistical system adapted
- method for collecting the data
- data processing
- data disseminnation/publishing

2.1.3. Role of bilatecal and multilateral organisations e.g. NORAD, FAO, SWIOP etc. in assistance of:

a) Provision of expertise and advice in setting up and executing and improved statistical and data processing system.

b) Provision of equipment for data collection, data processing and transport for supervision to ensure quality control of data in the field. Facilities to be considered include:
- weighing scales at sampling sites
- transport facilities for enumerators/recorders and supervisors
- transport for National Statistical Office to check data aquisition and processing in the field and regions.
- provision of micro computer for data processing at National Statistical Office and simple calculators in the regional statistical offices.

c) Assist in preparation and production of a national field guide for species identification for statistical purposes.

2.2. CONCLUSIONS

Limitations of the present statistical system for the artisanal fishery:
The lack of 1982 data from the Dar es Salaam region illustrates the shortcomings of the present system. They are attributed to:

a) Partial coverage of landings in time and space.
b) Lack of training of enumerators.
c) Lack of scales for weighing the catches.
d) A system which depends on an expensive annual frame survey which shows a static picture of an essentially dynamic situation.
e) Lack of supervision of enumerators.

2.2.1 <u>Recommendations</u>
If the present decentralised system is maintained, the following steps would be needed.
a) Stronger links between the central statistical office and the regional offices.
b) Regional fisheries officers be given means to supervise the enumerators.
c) Common level of selection and training of enumerators be applied.

However, it would be preferable that the collection of statistical be centralised to ensure uniformity in the data collected.

Statistical system

Sufficient information exists from the present system and the annual frame surveys to enable to design of a more reliable data collection system. The new system should provide the following data:

- Number of days fishing
- Fluctuations in effort by gear
- Better spacial and temporal coverage of the landings
- Weighing of landings by species or species groups including fish retained by fishermen for their own consumption
- Cross checking of data returns

It is proposed that raw data be supplied to the Fisheries Division for processing by means of a micro computer to eliminate arithmetical errors. It is therefore essential that the micro computer to be acquired should be compatible with those in use at SWIOP, FAO/FIR and the Kenya Marine and Fisheries Research Institute. This will facilitate the transfer of software and data. The forms designed for the enumerators should be compatible with the software. SWIOP should be requested to provide assistance in the design of the data forms and the prosessing of the data.

In the design of an improved data collection system, as a first step the central and Regional authorities should critically examine the available data in order to find information on the relative importance of the landing stations in terms of fishermen, boats, gears, annual landings etc. As a second step, consultant advise may be needed for the design of the improved system. Finally, training of enumerators and supervisors is considered essential in the implementation as is the supply of adequate forms, scales etc. Equipment required should be very simple and robust. As a minimum, supervisory staff should be provided with motorbikes as a means of transport to the landing places. For the industrial fisheries, statistical data should be based on log book returns. Standard log books should be designed in a form suitable for the needs of the fishing fleet and for future processing. SWIOP should be requested to assist in the design and processing of the data.

Geographic coverage

Statistical coverage of the EEZ essentially conserns the tuna fishery. This is necessary for information but not necessary for managements. In view of the fact that foreign fishing vessels are largely involved, the steps in obtaining the data would be:

a) Declaring the EEZ
b) Passing legislation involving the obligation of all vessels to submit statistical data preferably in a form compatible with that used in neighbouring countries and internationally.
c) The establishement of umbrella agreements with the goverments or fishing associations of countries having fleets likely to exploit Tanzanian waters. These could include Japan, USSR, Korea, Taiwan, France, Spain, Mauritius and Seychelles.

Processing and Marketing Data

The consensus was that such information was secondary to that on primary production hence it was considered that limited resources should not be used to obtain information on processing and marketing.

Assistance Requirements	Probable source
a) Consultancy of design of the improved statistical system	SWIOP/FAO
b) Design of data collection forms and processing by micro computer	SWIOP/FAO
c) Weighing scales for landing/places	NORAD
d) Transport (motorbikes) for supervisory staff	NORAD
e) Micro computer for data processing	FAO

3. THE RESEARCH WORKING GROUP

3.1. Conclusions

The "Dr. Fridtjof Nansen" has surveyed the waters outside the reef during the months June/July, November/Desember and May. The rainy season, January-April, was not covered. The group felt that this is a rather important season to investigate. This period will be covered, at least the Zanzibar Channel, by the planned research program carried out by T/V "Mafunzo" from the Mbegani Fishing Development Centre. More work should also be done in the area inside the reef where the artisanal fishery takes place. Important information about the resource situation in this area could be obtained by collecting biological data on the beaches where the catches are landed and onboard the boats.

Data from the prawn trawlers should be collected to evaluate the economically important prawn stocks. Staff from TAFIRI should go onboard the trawlers and sample the catches.

Research on pelagic offshore stocks as tuna should be encouraged. The group felt that reseach on fishing gears should not have first priority for the time being. However, it is of great importance to test and try to improve some of the traditional artisanal fishing gears.

4. WORKING GROUP ON MANAGEMENT AND DEVELOPMENT OF MARINE FISHERIES RESOURCES

4.1. Guidlines for the working group.

4.1.1. What are the major problems affecting the exploitation of marine fisheries?

a) In shallow water, depths between 10m-100m.
b) In waters deeper than 100 m.

4.1.2. What options do you find appropriate for commercially exploiting the resources?

a) Role of small scale fishermen
b) Role of parastatals
c) Financial and other imputs.

4.1.3. How can abundant but presently under-utilized fish species be made available for human concumption?

4.1.4. Are there any management measures required to facilitate better utilization of the resources?

4.1.5. How can fishing be organized to provide more employment opportunities and greater participation by women?

4.2. Conclusions

4.2.1. The group noted that the lack of fishing gears and the unseaworthiness of the fishing crafts are the greatest problems facing the industry to day.

Rcommends the need to inititate a mechanism for ensuring that fishing gears and spareparts are adequately provided.

- The bigger commercial companies are faced with lack of maintenance facilities and in some cases complete administrative control of the fishing operations is observed.

- Lack of information on the fisheries in shallow waters, especially the effect of fishing gears like beach seines on the stocks.

- Need to investigate and restrict the use of beach seines.
- Need to recognize that estuaries form major feeding and breeding grounds for prawns and that there is an increase in intensity of vessels exploiting these grounds. The group considers it necessary to gather adequate information about these grounds and introduce appropriate control mechanisms which should be in the form of:
    - Limiting the mesh sizes to be used.
    - Limit the sizes of prawns which can be landed.

The committee notes there is heavy investment involved in exploiting resources in the EEZ as present crafts and gears can not be utilized. Recommend to consider licencing of foreign vessels for exploiting resources withing the EEZ.

4.2.2. It is possible to increase the amount fish landed by the small scale fishermen by providing them with adequate gears and crafts, and a better market for their catch.

It may be necessary to demarcate between areas suitable for traditional fishing and fishing by commercial trawlers.

The effect of the large scale fishing by TAFICO and BAFICO in the shallow water fishing grounds should be investigated. The group notes there is a lot of red tape involved in operating parastatals fishing operations and recommends the need to reduce these to put the parastatals in efficient commercial operation.

The fishing operations of TAFICO should be expanded to cover the whole coast instead of concentrating on a few fishing grounds.

There is need to guarantee foreign exchange for maintraining the machinery even for institutions which are not exporting fish and fish products.

The export of fish and fishery products should be through TAFICO to be able to control and account for the foreign exchange earned. - All institutions contributing to the exported products should be provided with a corresponding share of foreign exchange earned.

There is an urgent need to set up a Fisheries Development Fund which will finance infrastructural facilities required to keep the industry active e.g. provision of spareparts for cold storage facilities, repair of roads leading to fishing grounds.

4.2.3. Utilization of abundant under-utilized fish species by improving distribution and marketing for direct human consumption of these species.

There may be a need to process excess fish for animal feed or food for fish utilized in mariculture.

4.2.4. Need to have a follow-up seminar to collect, analyse and interpret fishing data available from small scale fishermen, the BAFICO and the TAFICO vessels and from the research cruises.

4.2.5. Women participate in fishing for shrimp, bivalves, and processing and marketing of fish.

Note the need to encourage further participation of women in net wending, net weaving, fish-trap making etc.

Mariculture if initiated would also form a field where women participation can be encouraged.

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