REPORT
OF
FISHERIES INVESTIGATION
IN ZANZIBAR

MAY 1975

JAPAN INTERNATIONAL COOPERATION AGENCY

Contents

Fisheries Investigation in Zanzibar

Tokyo University of Fisheries

Yutaka Uno
Akiyoshi Kamatani

I. Introduction

We made an investigation trip to Zanzibar and Pemba in Tanzania as investigators of fisheries at the request of the Japan International Cooperation Agency from Aug. 9, to Sept. 2, 1974. There we made investigations into the marine life and conditions of fishing grounds in the shallow regions around the islands. In this report we have considered the possibility of modernizing the fisheries of Zanzibar on the basis of our investigations.

For the investigation, we owed a great deal to the Zanzibar Government, Mr. J. Kubota, the counselor of the Japanese Embassy in Tanzania, Mr. Inagawa, the commercial secretary of the Embassy, Mr. M. Hirata of Nishizawa Company, and many others. We here express our profound gratitude to these persons. In addition, our field investigations were assisted by Mr. Ibrahi M. Tudadawi and his assistants of the Zanzibar Fisheries Cooperation in establishing relations with fishermen of the islands.

II. The Method of Investigation and Regions Investigated

We made full-scale investigations on the basis of preliminary investigations made during Oct. 18-23, 1973.

We conducted investigations from the following angles: the investigation of market fish in the main fishing villages in Zanzibar and Pemba; the investigation into sea bed conditions, and fauna and flora in shallow regions through snorkel and SCUBA diving; the investigation into fauna and flora in tidelands; measurements of water temperature, PH, salinity, and Phosphorus and Silicon as nutrient salts indicators. We made an effort at SCUBA diving to record bottom conditions and modes of life of fauna and flora in shallow regions using submarine camera. The investigation into tidelands centered on the ecological behavior of animals and plants there; we especially endeavored to confirm the importance of tidelands as the habitat of young shrimps of the Penaeus family. We gathered them by using a kind of dredge equipped with electrical stimulating device shown in Fig. 1.

As shown in (III), when the dredge is towed along the beach just near the water line at low tide, young prawns, which have hidden themselves in the sand, jump out of the sand due to a 3-4V electric "shock" and are caught in the net.

We gathered sea water, and carried it on shore and measured, at least within 24 hours, its PH, specific gravity, P and Si. The measurements of P and Si were carried out using a spectrometer manufactured by Hitachi.

Sites investigated are shown in Table I and Fig. 2: 35 sites in four districts - Zanzibar, Fumba, Paje and Mkokotni in Zanzibar Island, and four districts - Wete, Taponi, Majiwa Ngombe and Tumbe in Pemba Island.

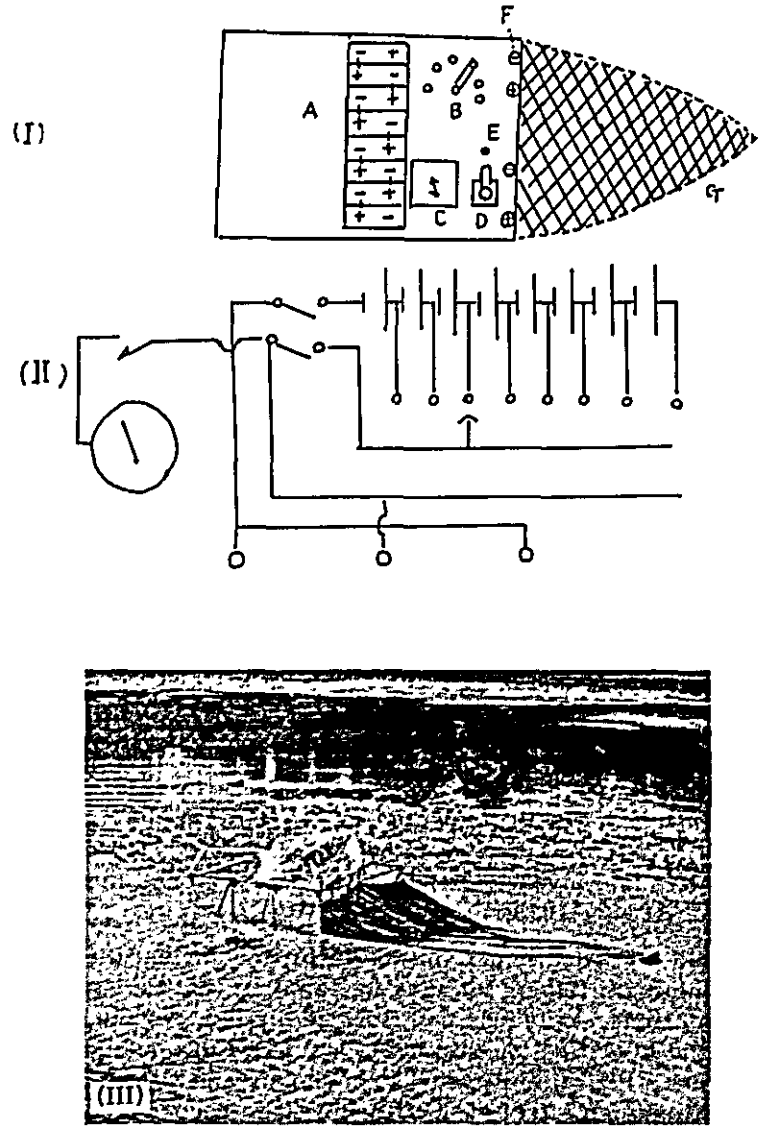


Fig. 1. Electric dredge to collect juveniles of prawn.
(I) arrangement, (II) wiring diagram (III) photograph of dredge.
A. dry battery (1.5V x 8), B. pressure regulator, C. voltmeter,
D. main switch, E. meter switch, F. terminal of electrode,
G. seine.

III. Results and Considerations

A. Zanzibar region (Fig. 3)

At nine sites, around the coral reef off the Zanzibar coast, we carried out an investigation under water. St. 1 is outside Zanzibar port, and in 40m, of water. The water temperature remained unchanged from the surface to a depth of 20m, viz. 25.6°. Transparency is rather low, being 6.7m.

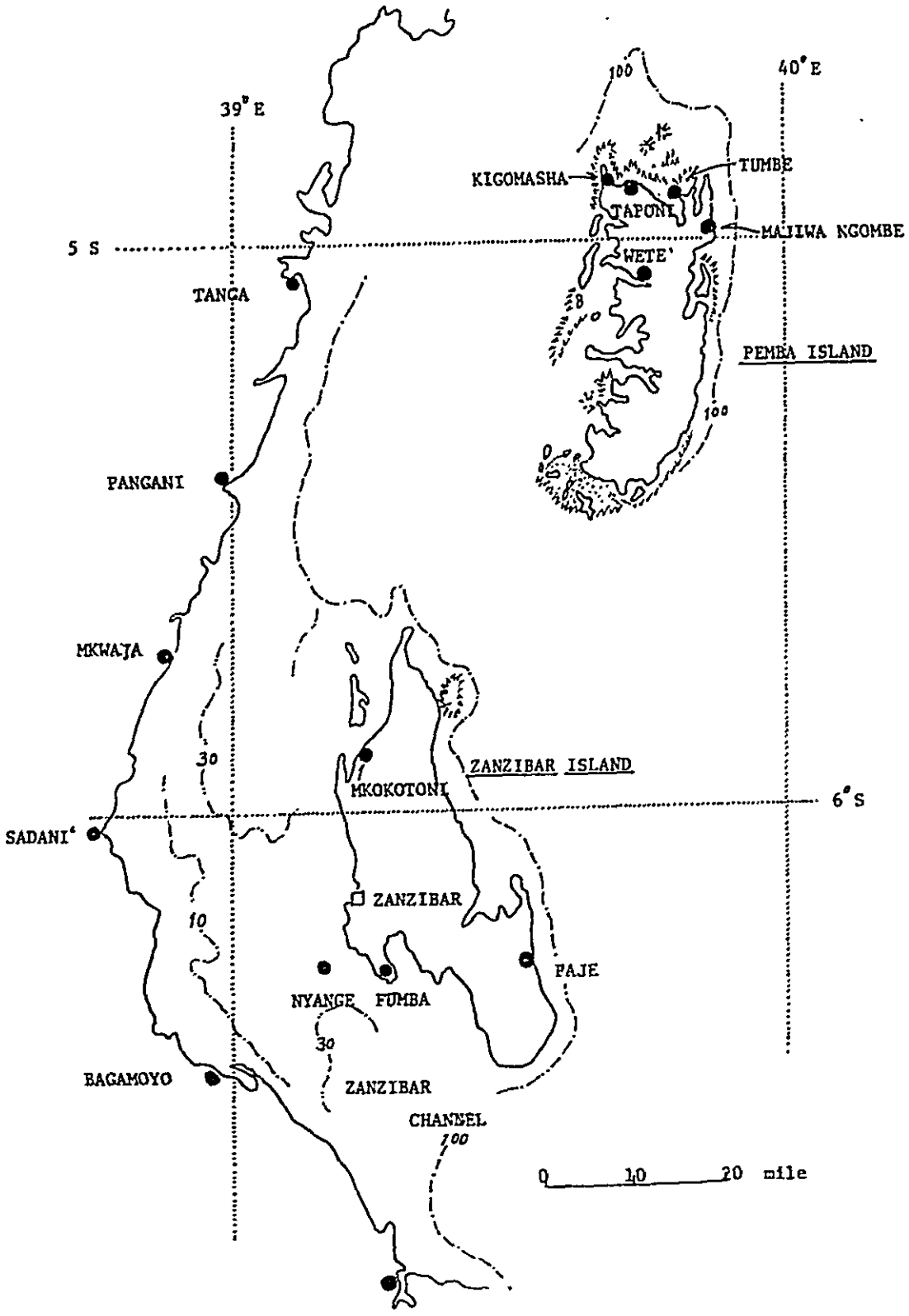


Fig. 2. A map of Zanzibar and its adjacent waters

Table 1. Research sites in Zanzibar

Item Localities	Research Areas	Date	Remarks
Zanzibar Is.			
Zanzibar	Nyangi Bank Areas (St. 1-9)	Aug. 14-15, 1974	SCUBA diving obs.
Faje	Coral reef off Paje (St. 10-15)	Aug. 16-17	SCUBA diving
Fumba	Dry beach offshore Bweleo and Fumba (St. 16-17)	Aug. 18	Tideland obs.
Mkokotoni	Mwanda Estuary Area (St. 18-19)	Aug. 19	Fish market obs. Juvenile prawn sampling
Pemba Is.			
Taponi	Coral reef offshore Taponi (St. 20)	Aug. 21	SCUBA diving
Majiwa	Dry beach offshore	Aug. 22	Tideland obs.
Ngombe	Majiwa Ngombe (St. 21)		
Wete	Mangrove areas off Wete and Mwangeni (St. 22-29)	Aug. 23	Juvenile prawn sampling on tideland
Taponi and Tumbe	Ras Kigomasha and Mibali Is. *(St. 31-35)	Oct. 10-15	Snorkel diving

* Research information from Mr. S. Watanabe, Japanese Volunteers for Fisheries.

At St. 2 the coral reef is not very developed, and species such as Fungia fungites, Montipora sp, Acropora sp, Porites lutea are found here and there. The main sorts of fish are Scarus and Abudefduf. St. 3 is to the south of Nyange Bank, and the coral reef has developed here to much the same extent as St. 2. In the shallow areas of this site, however, the Thalassia zone has developed, and Gracilaria are growing thickly. Many Thelenota and Holothuria, and Diadema setosum and Echinothrix also inhabit the place. St. 4 is a sandy sea bottom, 4m in depth, and rock beds can be seen here and there. Table corals are abundant. St. 6, 7 are places around flat Funge made up of coral sand, and here fauna and flora are scarce. St. 8 is the most developed coral reef in the regions we investigated. Corals such as Montipora and Acropora have developed remarkably and it is a favorable habitat for coral fish including Scarus and Labridae. St. 9 is a region where Gracilaria grow thick and Sargassum, Ulva and Padina build colonies. In this region there are many large-sized pearl oysters (Pinctada margaritifera). If pearl culture is eventually established, this site will be one of the important grounds for mother of pearl shells. The sea bottom of this site is shown in Fig. 4.

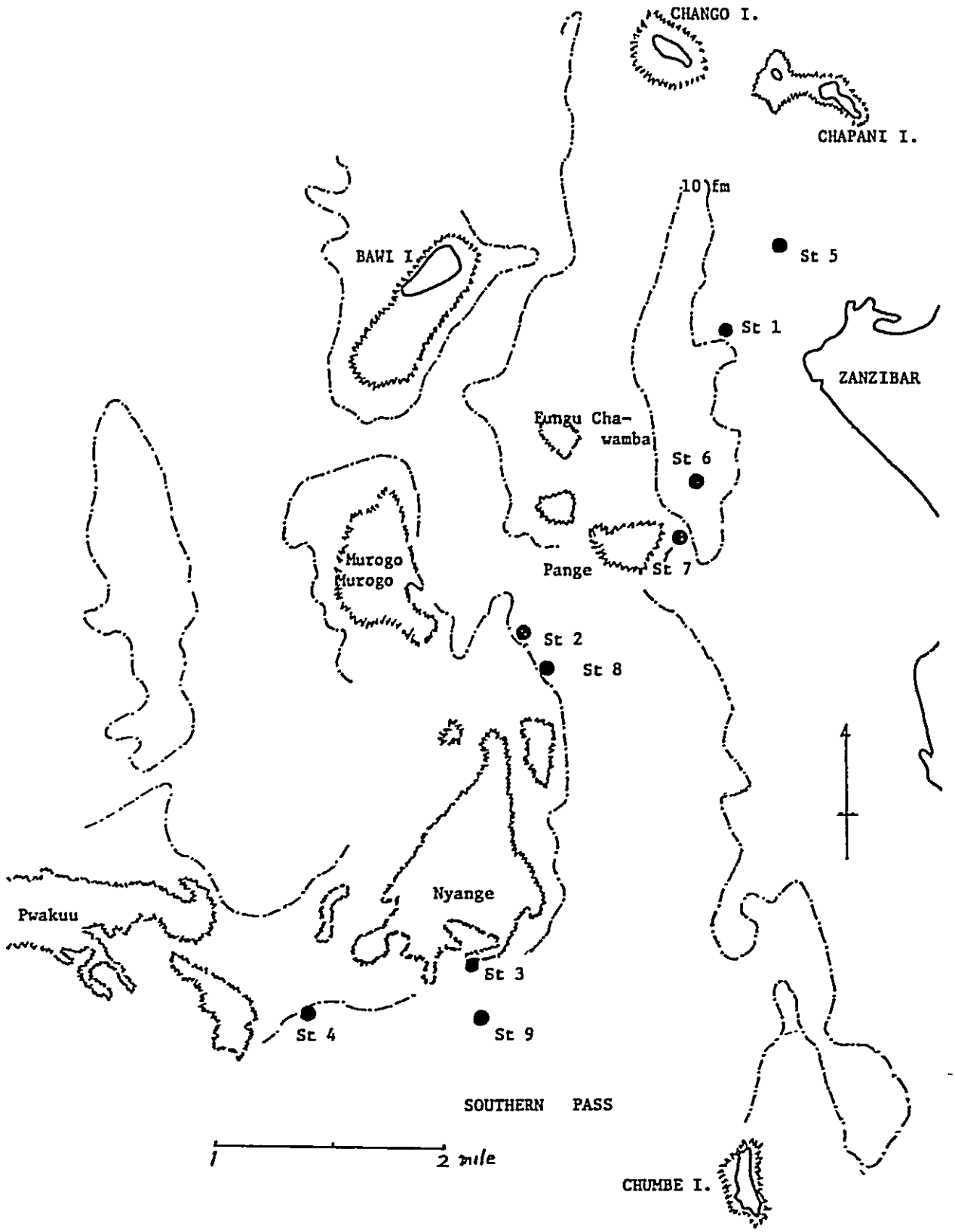


Fig. 3. Research sites at Zanzibar

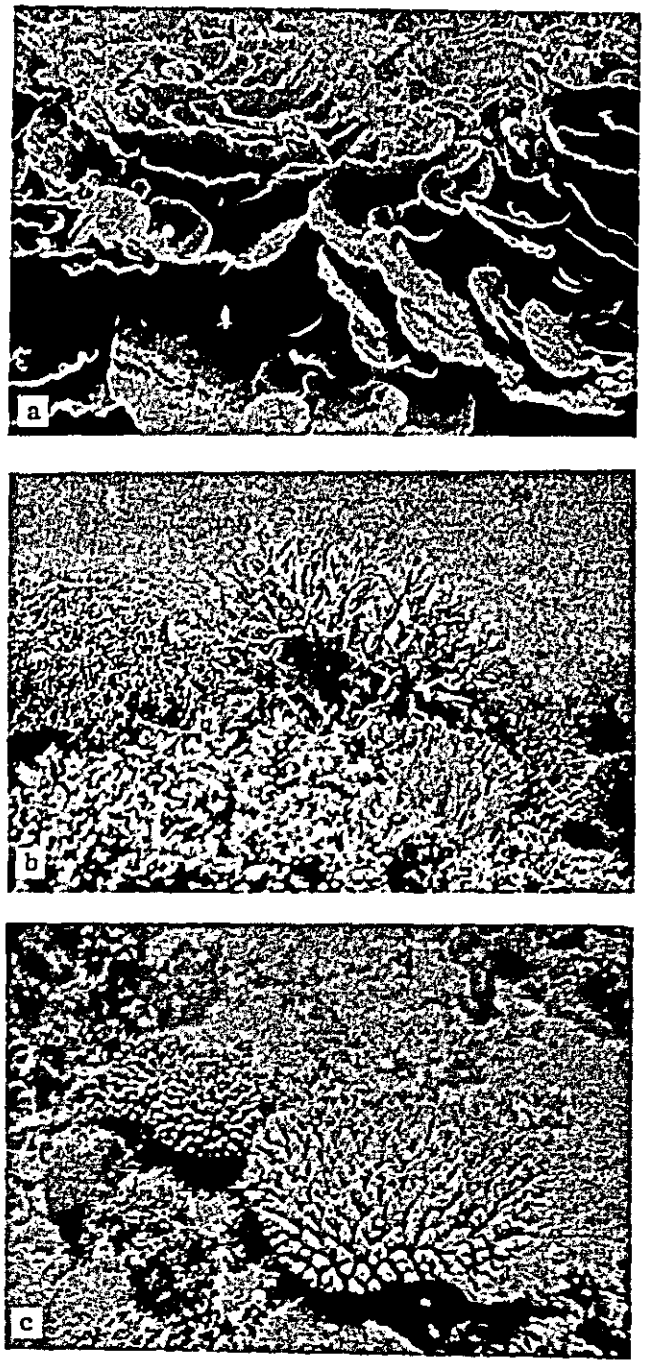
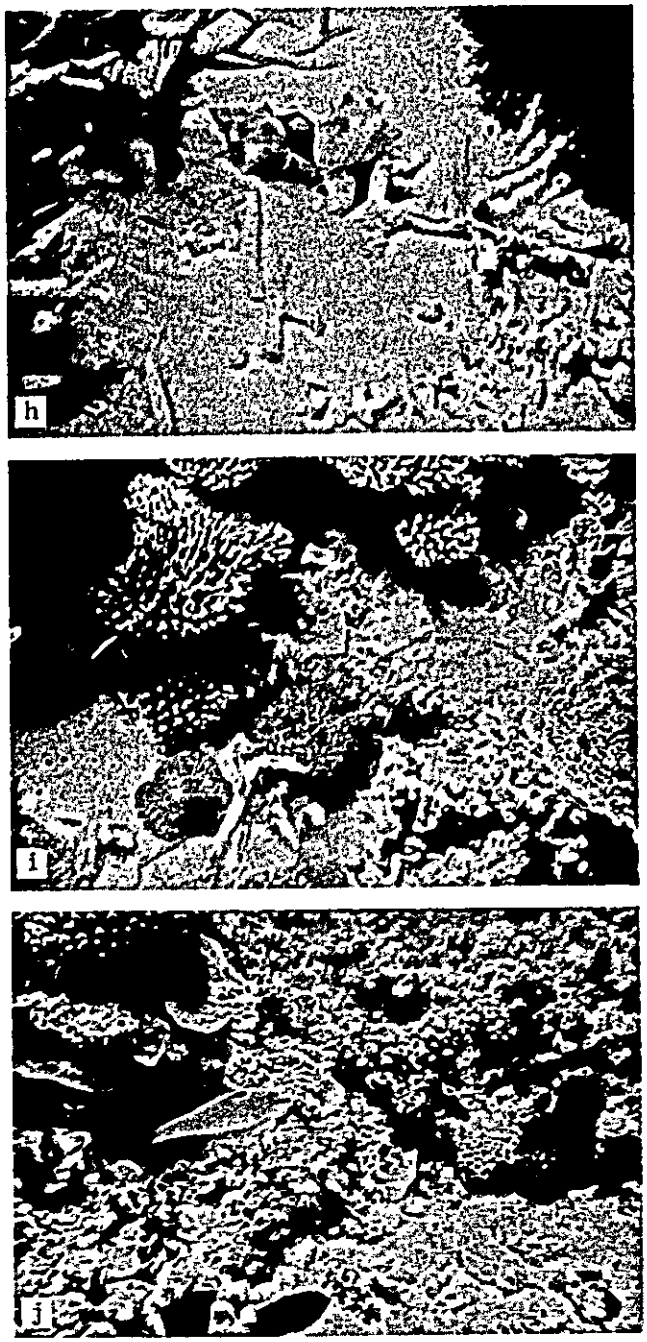
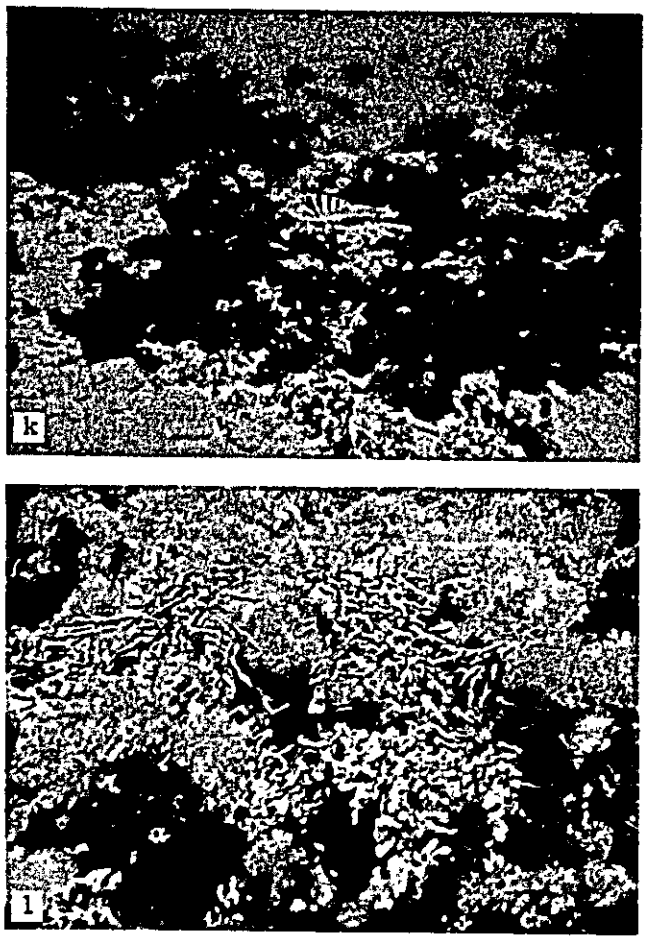


Fig. 4. Underwater photographs at St. 8-9, near Nyange Bank, offshore Zanzibar Is. a. Montipora sp, b-c. Acropora sp, d. Leptoria sp, e. Acropora sp, f. School of Abudefduf sp, g. Acropora sp and Polites sp, h. A couple of Pleuroploca trapezium, i. Acanthaster planci, j. Halichoeres sp, k. Canthigaster sp (?), 1. School of Plotosus anguillaris in the Sargassum zone.

- Fig. 4. continued -



- Fig. 4. continued -



- Fig. 4. continued -

B. Paje region

This is situated off the east coast of Zanzibar Island, looking out upon the Indian Ocean, and for a long time has been known as a region abundant in Pinctada margaritifera. Extensive coastal stretches composed of white coral sand have developed. Off the coastline spreads a coral reef 500-1000m in width. Within the reef, a coral platform has been formed and here various kinds of corals grow, making a small coral reef patch. The coral platform is open to the ocean through a narrow channel. The investigation was carried out at three points on the coral platform off the site of Jambiani Hospital (St. 10, 11, 12), on point (St. 13) in the narrow channel, and two points (St. 14, 15) in parts of the coral reef facing the open sea. The platform within the reef is shallow, with many tidal pools and connecting streams appearing at low tide. At high tide lagoons of calm water are formed, but here there is little fauna and flora. In the coral reef patches, scattered here and there, live Cladiella sp, Dendronephthya sp, and Microspicularia etc.; Echinothrix, Heriochidaris and Diadema etc.; Tridacna squamosa (Fig. 5 a-c).

Among the seaweeds the Ulva sp. grows well but Sargassum is rare.
In the lagoons there are abundant Octopus vulgaris and Sepia sp.

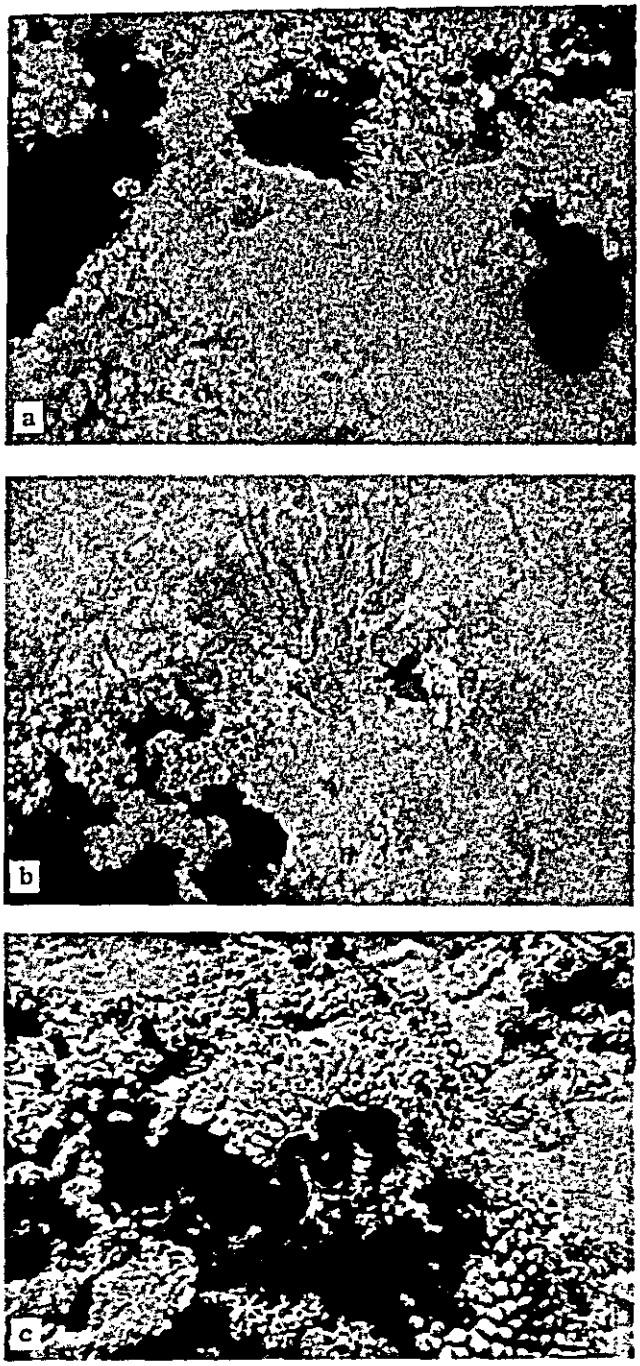
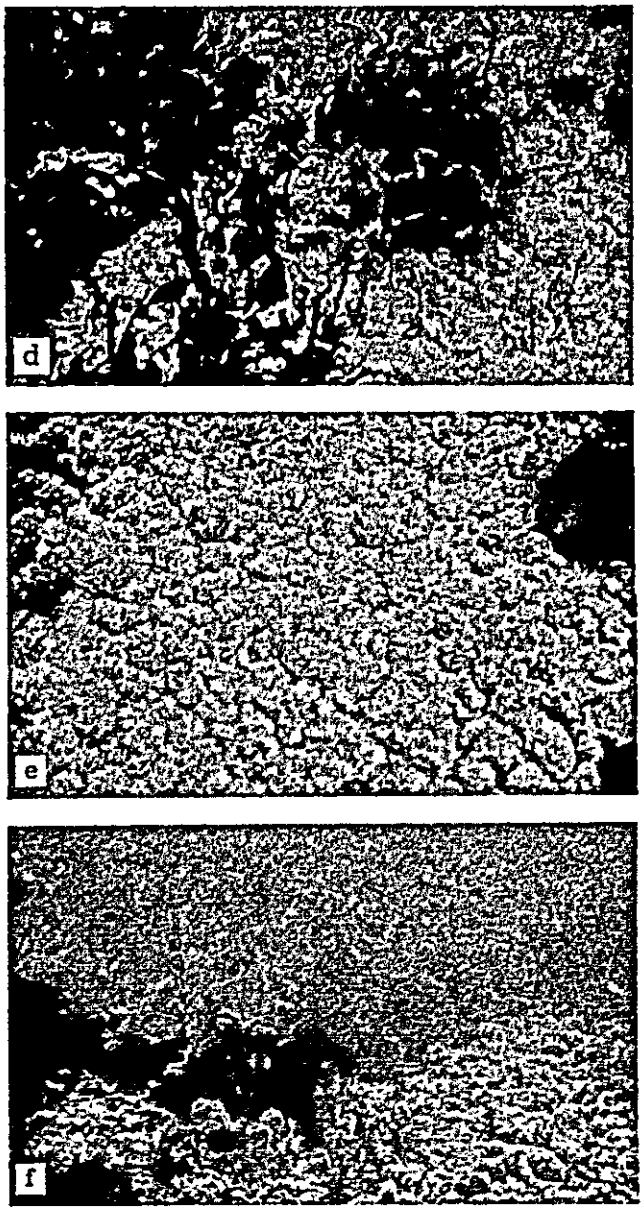


Fig. 5. Underwater photographs of the lagoon off Jambiani hospital, Paje. a. Sea urchin, Echinothrix diadema, b. Microspidularia sp. (?), c. Tridacna squamosa, d. Thalassia sp. at the narrow channel of coral reef, e. Coral pebbles on the narrow channel bottom, f. Ulva and Thalassia zone.



- Fig. 5. continued -

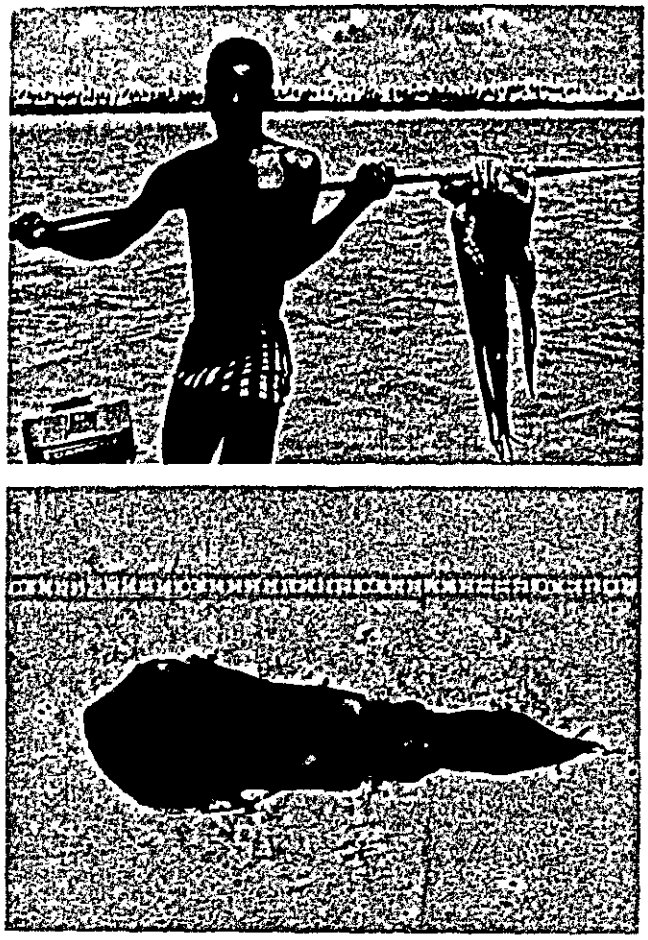


Fig. 6. Octopus vulgaris and Sepia sp caught by spear fishing in lagoon off Paje, Zanzibar.

They come in from the open seas and become the main catches for the fishermen (Fig. 6). Many young Penaeus monodon and P. indicus live in tidelands in the lagoons. Therefore, the off-shore areas here should become good fishing grounds for these pawns, and it may be necessary to conduct a further investigation in the future. The tide runs strong through the narrow channels which lead to the open sea from lagoons. The channels are covered with coral gravels, as shown in Fig. 5 d-g; and seaweeds such as Thalassia and Ulva grow well. The region outside the lagoon and facing the open sea is abundant in massive coral, but poor in resources such as black lip. We observed in the open sea fish schools such as the Sigauns, Axinurus, Epinephelus, Priacanthus, Pseudupeneus, and Scolopsis etc.

C: Fumba region (St. 15-16)

The region is situated off the southern tip of the Zanzibar Island. Here exists a vast coral platform, and the Thalassia zone has developed well. On the tip of Bweles, there exists a rocky beach, and many Gracilaria can be seen (raw agar - agar) and others (Fig. 7). Fauna is extremely rich here especially Bivalvia, such as Anadara, Periglypta, Pinna, Pinctada and Ostrea as compared with other regions. Many kinds of gastropoda, such as Cypraea tigris, Cypraea annulus, inhabit the region, and many Vasum turbinellus, a large-sized shell, can also be found. In the sandy mud in tidelands there are may Annelid such as Ochetostoma and Claeosiphon, which are used as bait. Many Octopus and Sepia also inhabit the region, and are the main fish catches of the region.

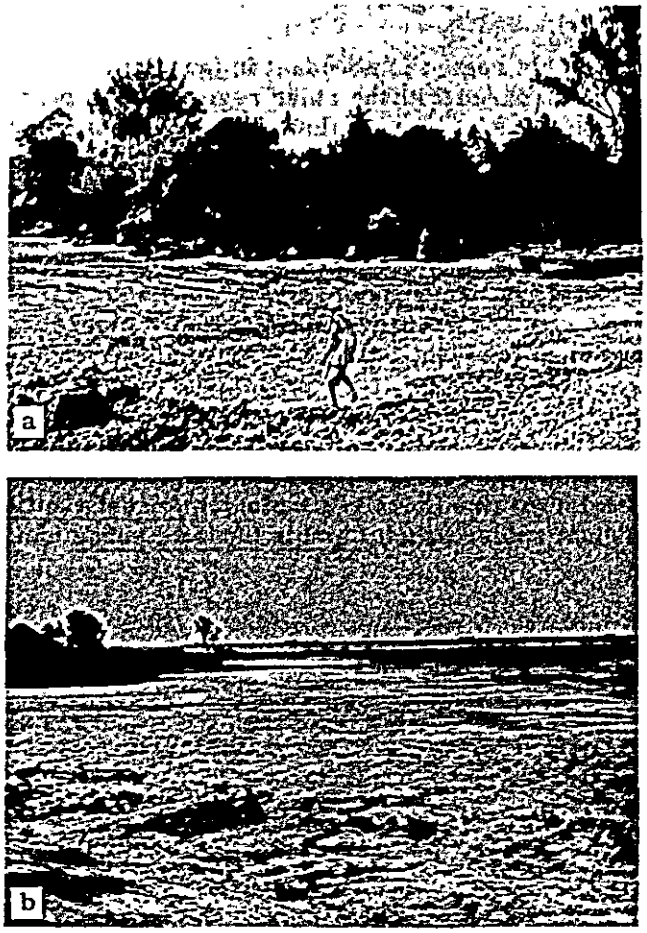
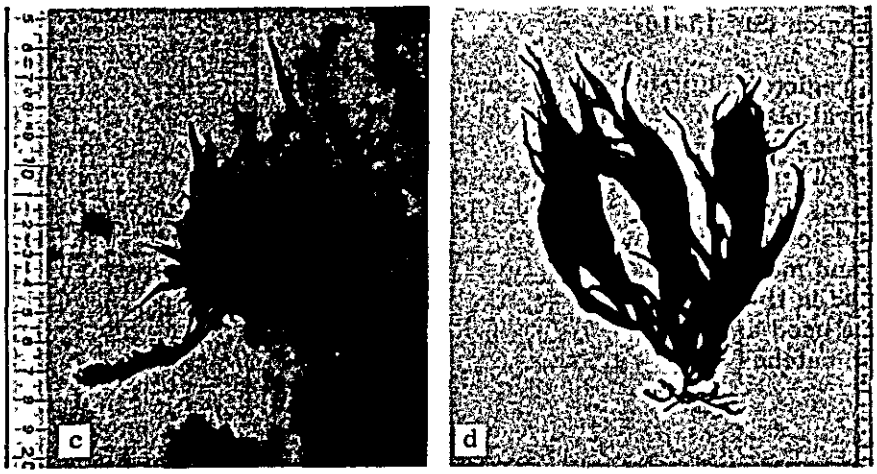


Fig. 7. Coral platform on Fumba beach. a. Rocky beach near Bweleo, b. Fumba beach, c. Agarophyte Gracilaria sp. d. Agarophyte Gracilaria sp.



- Fig. 7. continued -

Considering that this region is abundant in fauna and flora, and also in P and Si as nutrient salts as compared with the other regions, it is promising as an oyster and pearl oyster culture bed. The shallow water region below the low water mark seems especially to have a bright future.

D. Mkokotoni Region (Fig. 8)

The region faces Zanzibar channel, and large-sized sharks, prawns, bonitos and yellow-fin tunas are caught for the Mkototoni fish market. Especially, large-sized fishes such as bonitos Euthynnus pelamis, yellowfin tunas Thunnus albacares, Sphyraena jellow, Gaterin schotaf, Cybium commersoni can be caught here (Fig. 9). The investigation of tidelands was carried out at two points, St. 18 and St. 19, on Mwanda Island off Kidutani. In the region small-sized set nets are used, and small-sized fishes are caught. The tidelands are mainly composed of sandy coral and mud, and here numerous large-sized bivalves including Anadara antiquata and Cardium pseudorima, and giant spider conch Lambis truncata sebae can be caught.

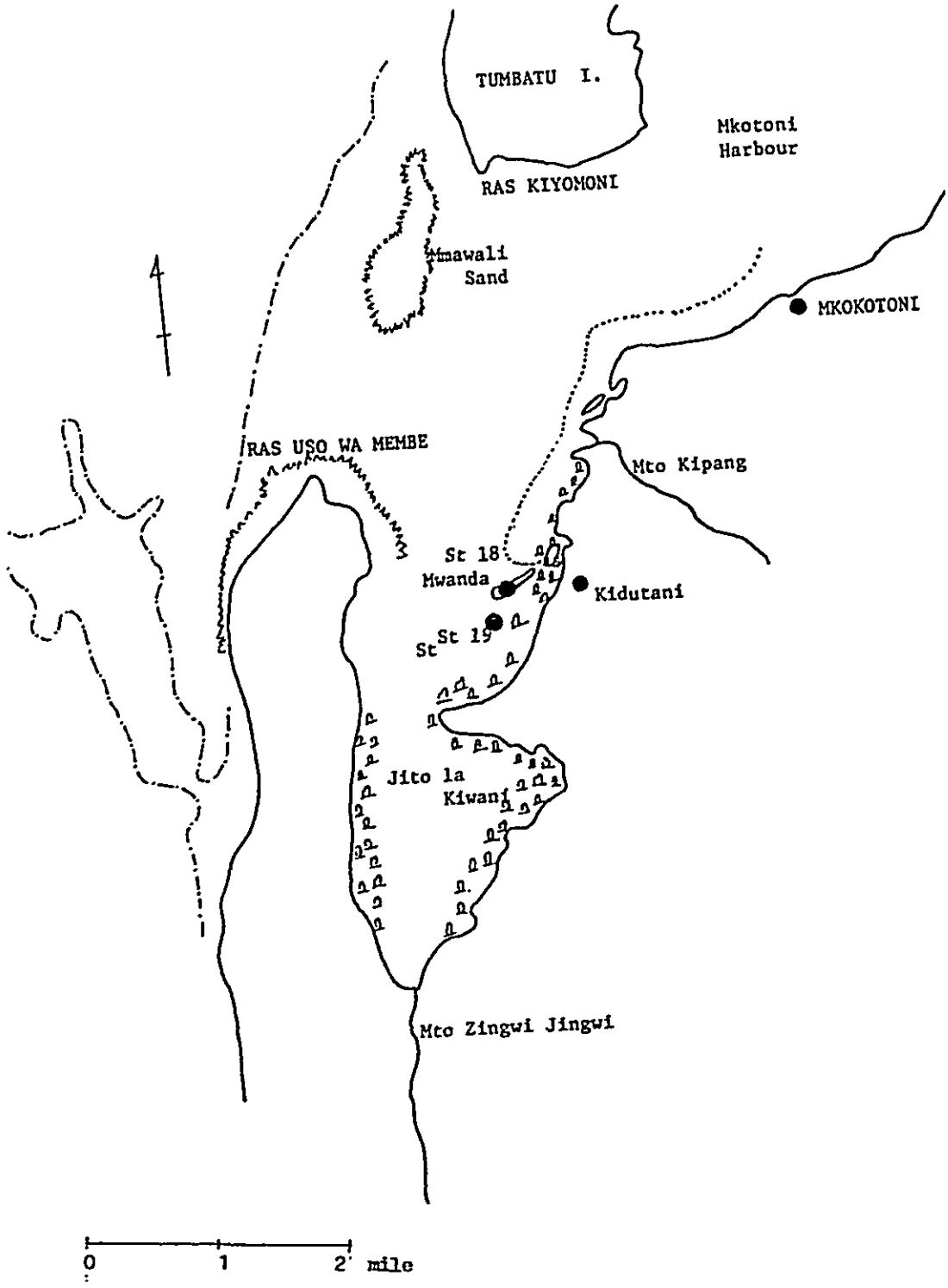


Fig. 8. Research site at Mkokotoni region, Zanzibar

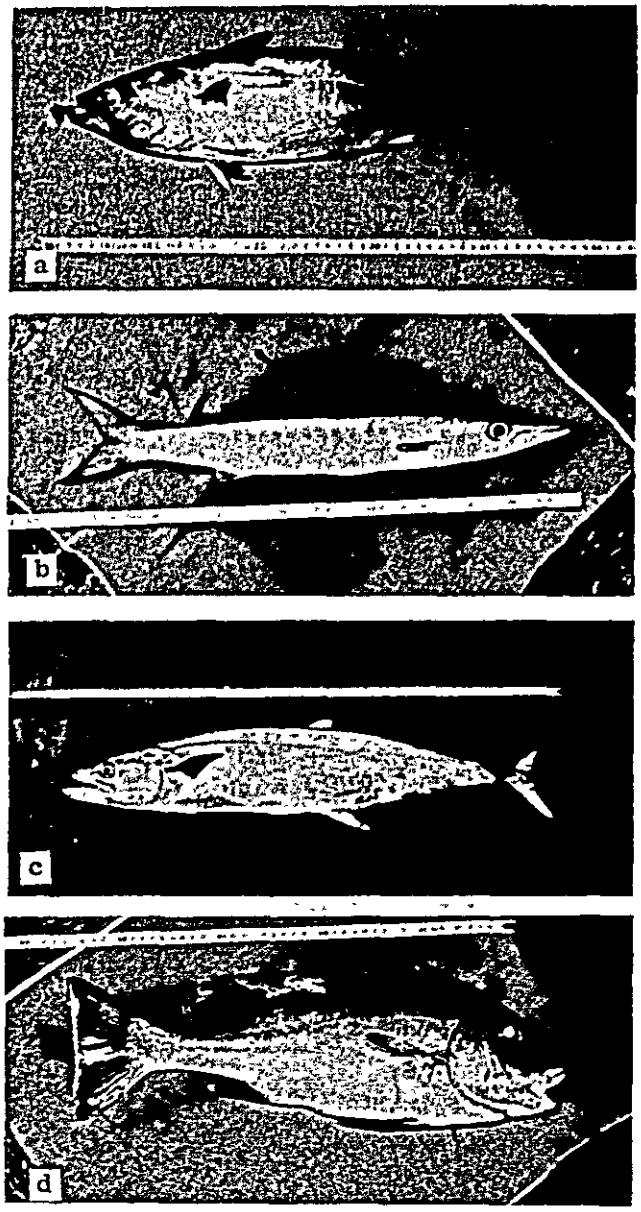


Fig. 9. Commercialley important fish landed at Mkokotoni fishmarket. a. Bonitos Euthynnus pelamis, b. Giant sea pike Sphyraena jello, c. Barred spanish mackerel Cybium commersoni, d. Grey sweetlip Gaterin schotaf.

Table 2. WATER TEMPERATURE, PH, PHOSPHORUS AND SALINITY AROUND ZANZIBAR ISLAND

St.	Water depth (m)	Sampling depth (m)	Water temp. (°C)	PH	Si (μg atom/L)	P (μg atom/L)	S (%)
1	19.5	0	25.6	8.2	2.1	0.16	35.30
		15	25.7	8.3	1.5	0.18	35.32
2	3.0	0	25.6	8.3	1.1	0.18	35.26
		2	25.5	8.3	1.3	0.08	35.34
3	2.5	0	26.0	8.3	1.3	0.19	35.27
		2	26.0	-	1.5	0.10	35.33
4	3.0	0	25.0	8.3	0.5	0.20	35.14
		2	25.6	-	1.5	0.19	35.39
5	2.0	0	26.0	8.3	2.9	0.14	35.33
		1.5	25.8	-	2.6	0.26	35.34
6	18.0	0	25.4	8.3	1.3	0.15	35.24
		15	25.4	-	2.1	0.17	35.14
7	18.0	0	25.3	8.3	0.7	0.18	35.37
		15	25.2	-	0.6	0.18	35.37
8	9.0	0	25.4	8.3	0.7	0.21	35.21
		8	25.5	-	1.5	0.20	35.30
9	2.0	0	25.9	8.3	1.6	0.17	35.21
		1.5	25.8	-	0.7	0.18	35.21
10	1.5	0	23.8	8.3	5.4	0.16	33.87
11	2.0	0	24.2	8.3	4.4	0.19	34.70
12	5.0	0	24.6	8.3	2.2	0.22	35.21
		4	24.4	-	5.1	0.21	35.21
13	1.5	0	25.0	8.3	0.7	0.24	35.17
14	24.0	0	24.8	8.3	3.7	0.16	34.87
		22	24.8	8.3	2.4	0.16	35.13
15	15.0	0	24.8	8.3	2.8	0.25	35.07
		13	24.8	8.3	2.4	0.20	35.15
16	-	0	26.4	-	6.6	0.20	35.10
17	-	0	31.2	8.3	7.2	0.23	35.23
18	-	0	25.5	8.3	14.1	0.27	35.02
19	-	0	25.4	8.3	7.7	0.24	34.90

From tidal pools in tidelands many young Penaeid shrimps were collected. There is a strong possibility that the offshore area of the region can be developed as a fishing ground, especially for Penaeus indicus and P. monodon.

The results of the analysis of sea water gathered at the abovementioned 19 points of four regions of Zanzibar Island are shown in Table 2. There is little perpendicular change of water temperature in all points. There is little P and Si here, as compared with the coast of the Arabian Peninsula facing the Indian Ocean. However, rather large quantities were found at St. 5 off Zanzibar port at St. 10 - 15 at the point Harbour of Paje, at St. 16 - 17 at the point of Fumba, and at St. 16 - 19 in Mkokotoni. The investigation into fauna and flora, and the analysis of nutrient salts mentioned above show that Fumba and Mkokotoni are most suitable for mariculture. The diurnal variations of water temperature, salinity, Si and P in Zanzibar harbour are shown in Table 3, the table showing only small variations.

Table 3. Diurnal variation of temperature, silicon, phosphorus and salinity at pier, Zanzibar harbour, 1974

	Time	Temp. (°C)	Si (μg atom/L)	P	S (%)
Aug. 17th					
	06 15	25.2	4.4	0.25	35.05
	12 00	26.5	6.7	0.30	34.35
	15 55	25 6	4.4	0.30	34.95
	18 00	25.2	4.8	0.34	34.99
	23 45	25.3	4.4	0.13	34.91
Aug. 18th					
	06 30	25.2	6.7	0.20	34.91

E. Taponi region (Fig. 10)

We carried out the investigation under water, about three miles off Taponi. The region is abundant in massive coral Porites lutea but is very poor in Acropora. We found very little pearl oyster in the region. Taponi is the center of fishery in Muska Bay, and long line, basket trap, spear fishing and so on are employed in the region. It is noteworthy that milk fish can be caught here. The large-sized ones, 90 - 120 cm in length, are said to arrive in schools in September. They seem to spawn in the bay at this time of the year. It is presumed that the spawning ground is in the inland side of the bay. Regions of St. 31 and 32 are very abundant in Pinctada vulgaris, but unfit for growth of mother shell for largesized pearl culture.

Milk fishes are cultivated in culture ponds in Southeast Asia, especially in Formosa, Philippines and Indonesia. The fish grow quickly and are herbivorous, making them easy to culture. In Formosa 600 - 1300 kg/ha of the fish are raised yearly (Lin, 1968).

It is a fish that can be bred well using intensive fish culture methods. But sources of juvenile fishes, spawning and life cycle still remain to be investigated.

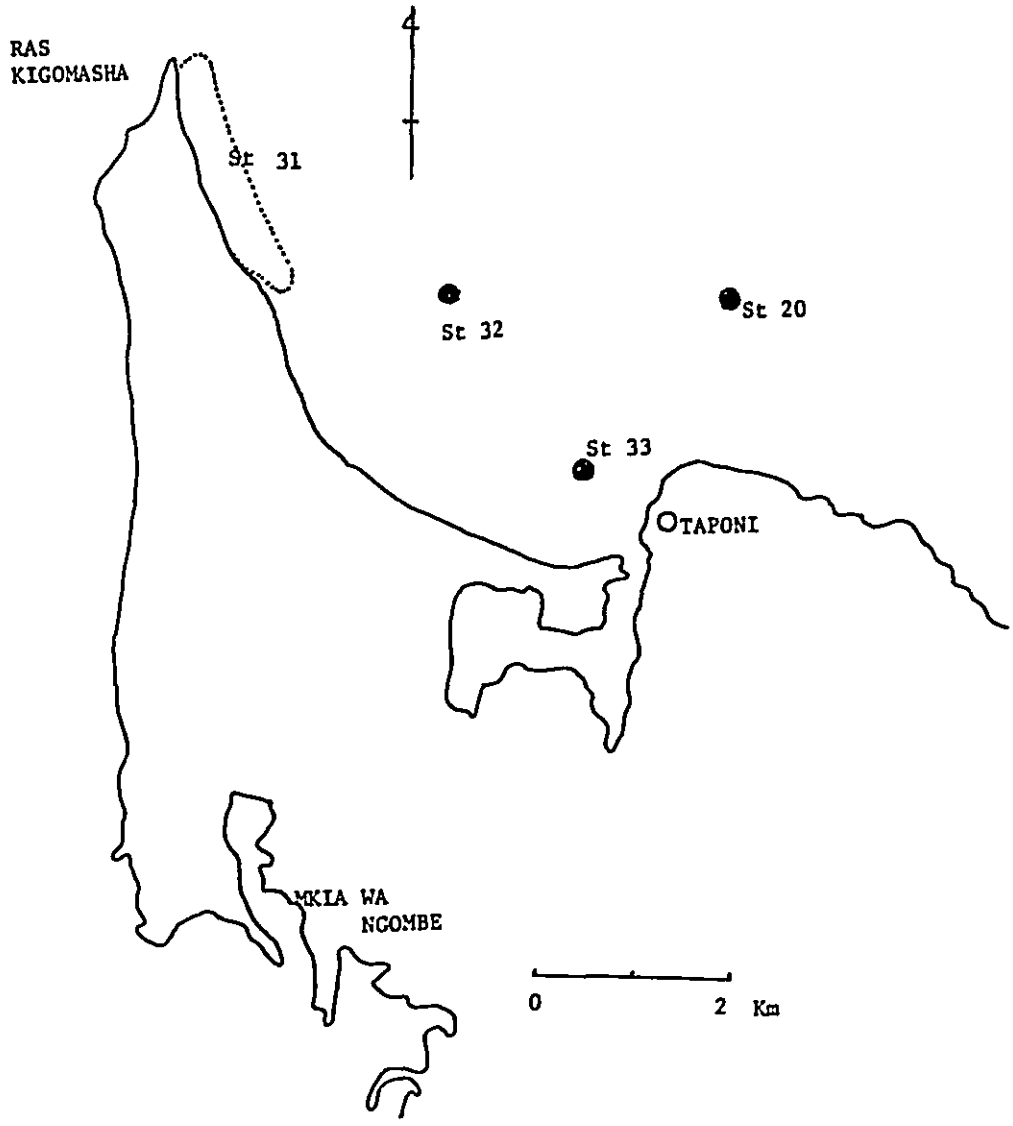


Fig. 10. Research site at Taponi region

F. Jumbe and Maziwa Ngombe region (Fig. 11)

We heard from local fishermen that large-sized pearl oysters can be found in this region. However, investigation under water at four points --- St. 34 - 35, Tumbe and St. 1, Maziwa Ngombe --- resulted in the collection of only five oysters. The region is very abundant in Pinctada vulgaris, but the large-sized P. margaritifera are found only scattered here and there, and we could not find any areas where they live densely. In Pemba Island, large-sized oysters are found in almost all areas of the sea around the island.

However, the areas where we could confirm their habitation were Ras Kiuyu, Maziwa Ngombe, Kojani and Kangagani off the coast facing the Indian Ocean, and Ras Fungwe, Mtambwo Is. Ras Kiuumoni, Ras Mkumbun, Mkoani and Kangani near Zanzibar channel. They are not present in large numbers, but scattered in various areas.

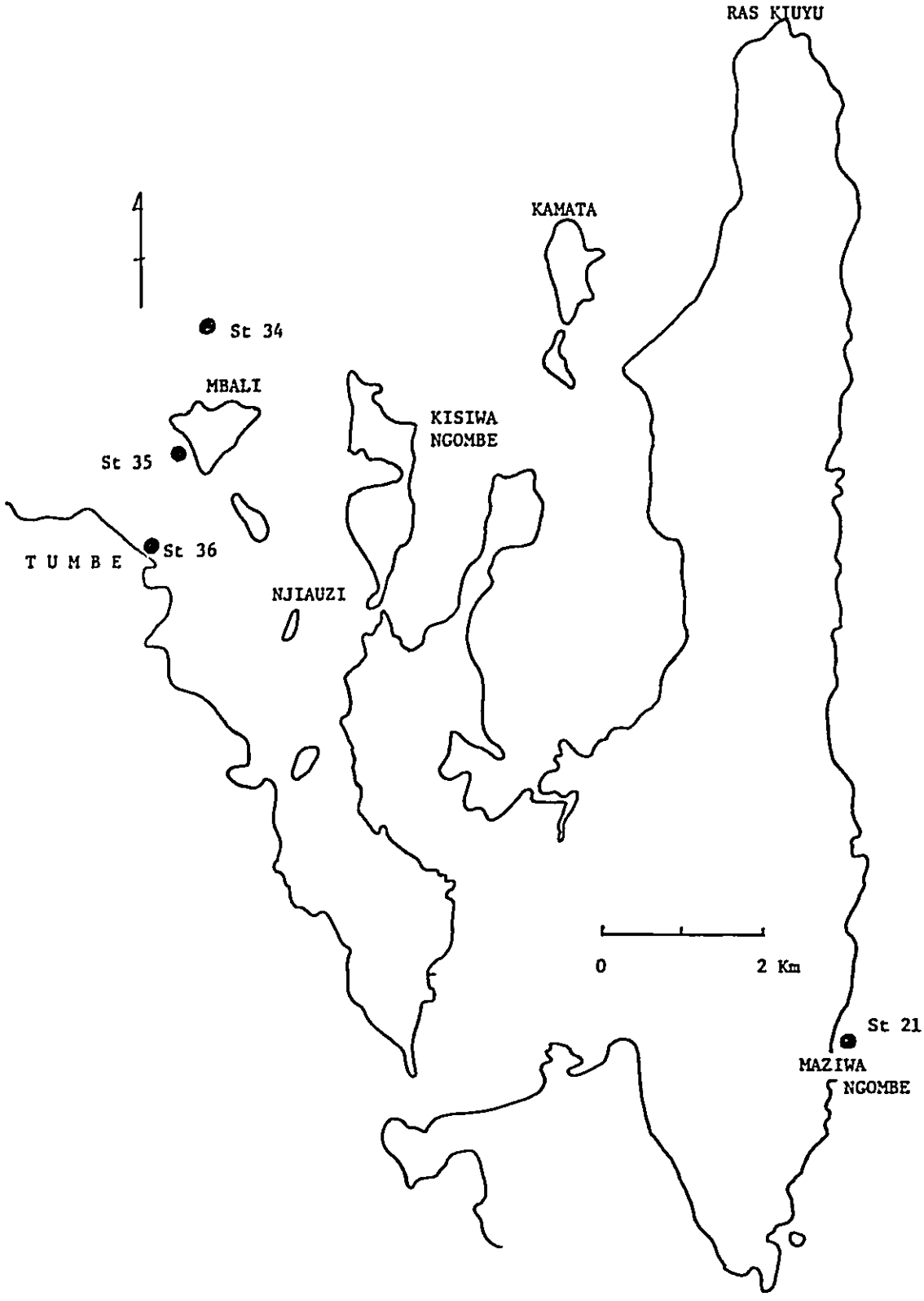


Fig. 11. Research site at Tumbe and Maziwa Ngombe

G. Wete region (Fig. 12)

Eight points, St. 22 - 29, from mangrove areas in Mwungeni to Port George, were the objects of our investigation. The sea bottom from St. 24 to St. 25 is made up of sand and mud and the area is suitable for Penaeid prawn. The area from St. 26 - 28 is inhabited abundantly by Palaemon sp. Mangroves grow densely in the water in the areas from St. 22 to 29, and many mangrove crabs Scylla serrata are said to inhabit these areas, but the islanders do not eat them. This region is, as shown in Fig. 12, calm inland sea and suitable for mariculture. The results of measurements of water temperature, Ph, Si, P and salinity at 11 points in Pemba are shown in Table 4. St. 20 - 24 are poor in nutrient salts, and the tendency for the salts to become more concentrated further out in the bay was noticed.

Table 4. WATER TEMPERATURE, PH, SILICON, PHOSPHORUS AND SALINITY AROUND PEMBA ISLAND

St	Water depth (m)	Sampling depth (m)	Water temp. (°C)	PH	Si (μg atom/L)	P (μg atom/L)	S (%)
20	3.0	0	25.2	8.3	2.6	0.27	35.16
		2.0	25.4	-	2.5	0.22	35.19
21	Tide pool	0	-	-	3.1	0.28	35.59
22	4.5	0	24.9	8.3	2.5	0.33	35.30
		4.0	24.8	-	4.8	0.32	35.30
23	3.0	0	25.0	8.3	2.5	0.30	35.30
24	12.0	0	25.4	8.3	2.7	0.27	35.30
		10	25.2	-	7.7	0.57	35.28
25	6.5	0	25.6	8.2	14.1	0.27	35.30
26	2.5	0	25.6	8.1	6.2	0.24	35.30
27	1.5	0	25.5	8.0	13.8	0.26	35.27
28	4.0	0	25.4	-	10.4	0.30	35.37
29	1.0	0	24.6	-	12.7	0.35	34.13
30	2.5	0	25.4	-	25.0	0.26	34.97

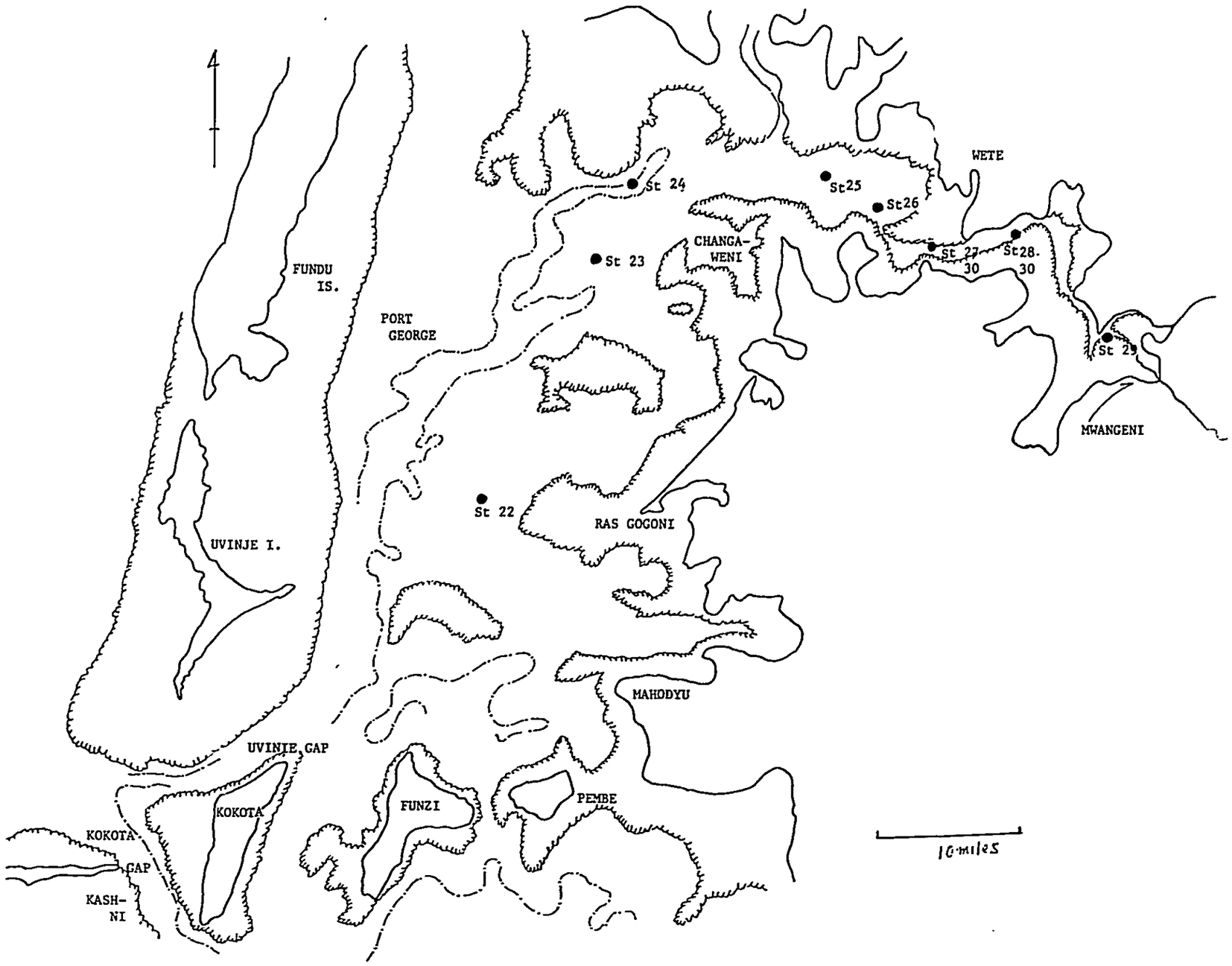


Fig. 12. Research site at Wete area, Pemba Is.

Ⅳ. Conclusion

We will consider the fisheries in Zanzibar on the basis of information we received during the period of our investon and the actual results of our activities.

A. Schooling Pelagic fish Fisheries

Zanzibar and Pemba are both small islands, the former with an area of only 640 square miles and the latter with only 380 square miles. Their geographical conditions are similar to those of Japan. Therefore, the two islands are in a favorable situation for the islanders to utilize the sea resources. However, they have little knowledge of modern fishery techniques. There are no accurate fishing statistics and no investigations employing scientific research. The FAO data on Tanzanian fish catches are shown below;

Year	1938	'49	'55	'56	'57	'58	'59	'60
Catch x 10^3 tons	32.5	29.5	61.2	63.8	63.8	63.8	68.8	67.1
Year	'61	'62	'63	'64	'65	'66	'67	'68
Catch	70.7	70.8	84.2	100.2	102.9	102.0	128.4	152.1
Year	'69	'70	'71					
Catch	150.2	195.1	199.1					

(FAO Yearbook of Fisheries Statistics, 1971)

The statistics show that the total catch in 1971 amounted to 199,100 tons, but only about 10 percent of the catch was marine fish, and only a small part of these were caught in the regions around Zanzibar.

According to Gullard (1970), the East African continental shelf spreads from Kenya to Zanzibar and it covers an area of 10 x 10^3 km^2; its density is estimated at 10 - 20 kg/ha/year, and its potential demersal resources at 10 - 20 x 10^3 tons/year. It can be supposed that the regions around Zanzibar are abundant in fish resources, as it is suspected that very few of these fish are being caught. This fact can be concluded from the results of fisheries investigations carried out off Tanzania. The results of fishing schooling pelagic fish with stick-held dipnets and lamplight and also by purse seine are excellent. Using purse seine, an average catch of 1.8 tons per ship/per night was recorded during 1963 - 66. Therefore, if the fishing grounds near Zanzibar are developed through the introduction of modern fishing techniques we can expect a considerable increase in the fishing industry. Schooling pelagic fishes caught here are shown in Fig. 13. These fish now constitute subsistence type fisheries. On the other hand, they can also become important as bait for bonito and tuna fisheries, and when the development of high sea fisheries is given practical consideration in the near future, they will be an important source of bait. Among possible sea fisheries, the most important are tuna and bonito. The distribution of yellowfin in the Indian Ocean is shown in Fig. 14, and in particular the regions around Zanzibar can be considered to be abundant in these resources. In the Mkokotoni market, in fact, these two kinds of fish are marketed the whole year round. These large-sized fish are caught in Zanzibar channel two or three miles off the island using the simple technique of pole and line fishing. The island is well situated as

a fisheries base since the fishing grounds are quite near and bait is in good supply. We saw, during the investigation, many common octopus and cuttlefishes being caught in the lagoons in the coral reefs. They have perhaps entered into the lagoons from the open sea near Zanzibar. The Gulf of Oman and Gulf of Aden are known as good fishing grounds for various kinds of cuttlefish. The seas near Zanzibar may also become equally as good. This may be a subject for future investigations.

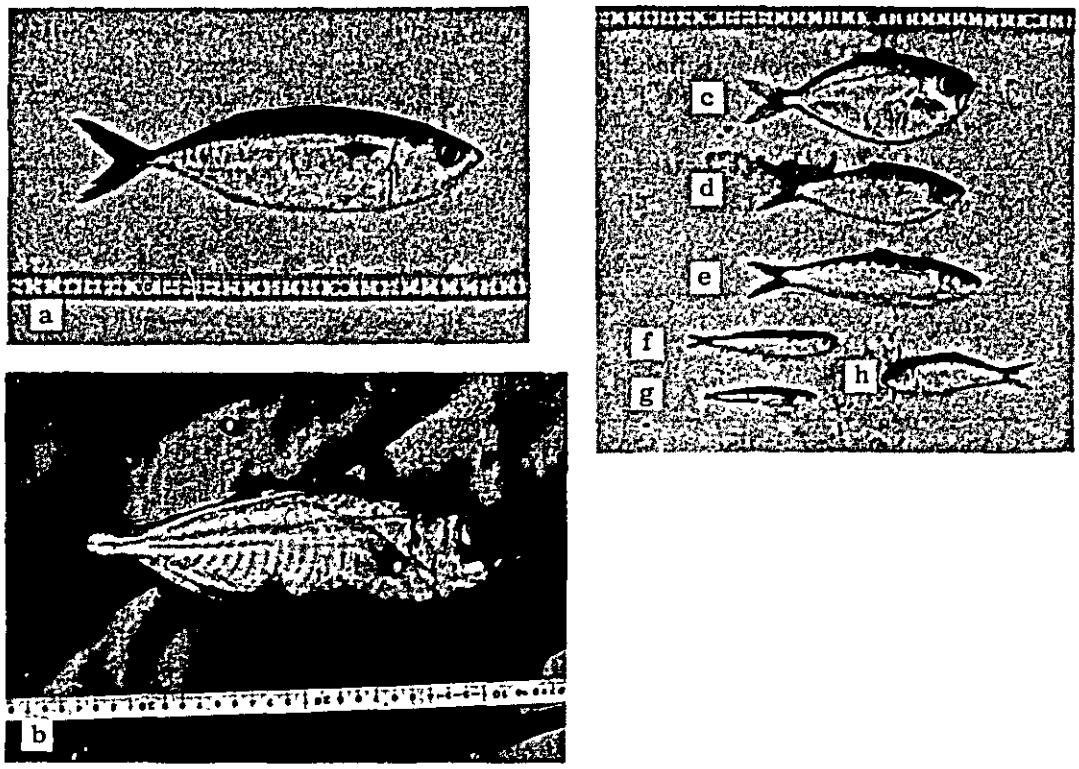


Fig. 13. Schooling pelagic fish in Zanzibar. a. Trachiotus russelli b. Selar sp, c. Secutur ruconius, d. Sardinella albella, e. Sardinella malanura, f. Anchoviella commersoni, g. Anchoviella indica, h. Sardinella sp.

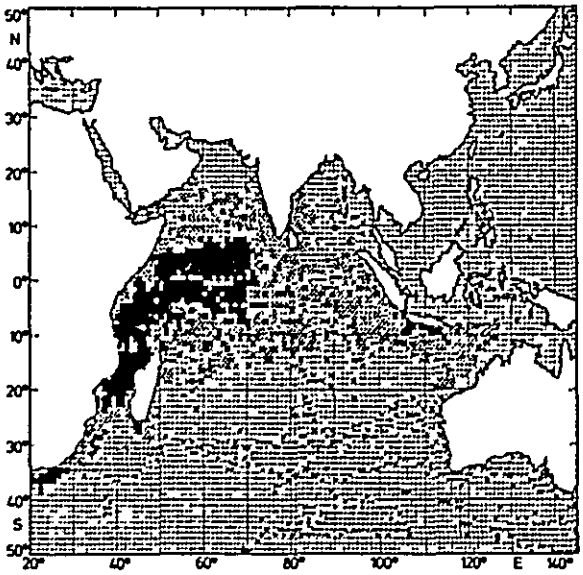


Fig. 14. Distribution of longline hooking rates of yellowfin tuna in the second quarter of the years 1966 - 1968 expressed as maximum average hooking rate for each 1° square. (Filled circle <1.0; cross 1.0 - 3.0; black square 3.0) (Suda, 1973)

Fishing port facilities are necessary in order to make the development of modern fisheries possible. Facilities of the fishing port in Zanzibar are, as shown in Fig. 15, very poor.

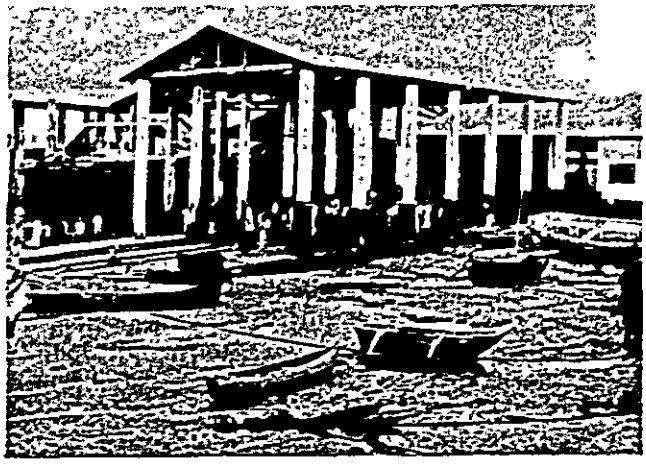


Fig. 15. Fishmarket at Zanzibar port, Zanzibar

The port has almost no facilities for ice-making, freezing and cold storage, to say nothing of those for unloading of fish. The smooth development of fisheries cannot be expected without providing the port with proper and necessary equipment.

At the present time shallow water fisheries are chiefly being conducted here, and it is necessary to mechanize the fishing boats and to introduce efficient fishing implements for increasing catch. The fishing boats now in common use are the Ngalawa and Mashua. The former is a sailing outrigger canoe and the latter a large planked open boat with lateen sail fitted, as the case may be, with an outboard engine (Fig. 16).

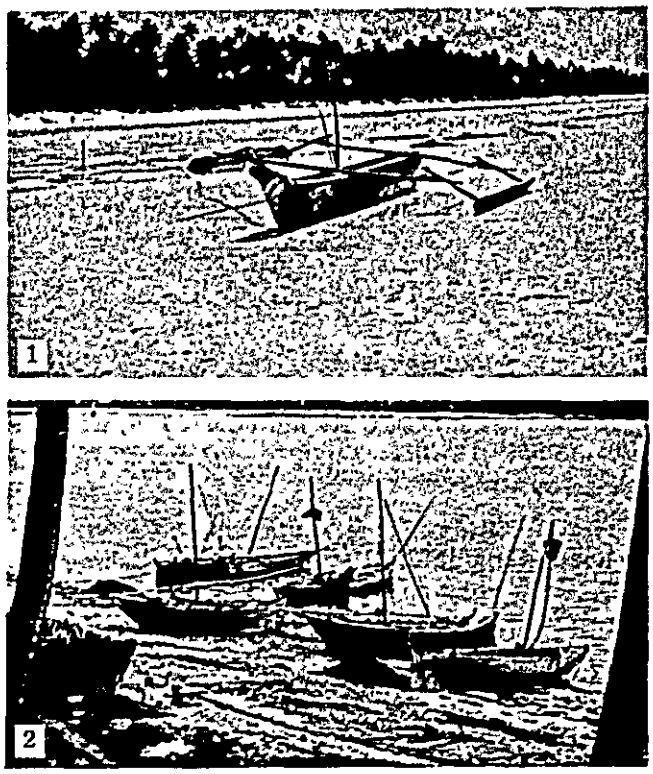


Fig. 16. Fishing Boat. 1. Ngalawa, 2. Mashua

It may be better to fit both kinds of boat with inboard engines rather than outboard ones. Outboard engines break down easly when covered with sea water during stormy weather, and after breakdown they cannot be repaired as there is no repair shop. In spite of their higher cost, inboard engines are durable and can be said to be suitable to the present circumstances. Anyway, since mechanization needs considerable finance, administrative considerations such as granting long-term loans for improvement of fishing boats, will become necessary.

As for fishing equipment, islanders mainly employ fishing lines, gill nets fish traps and fishing spears etc. Such equipment is very simple as shown in Fig. 17.

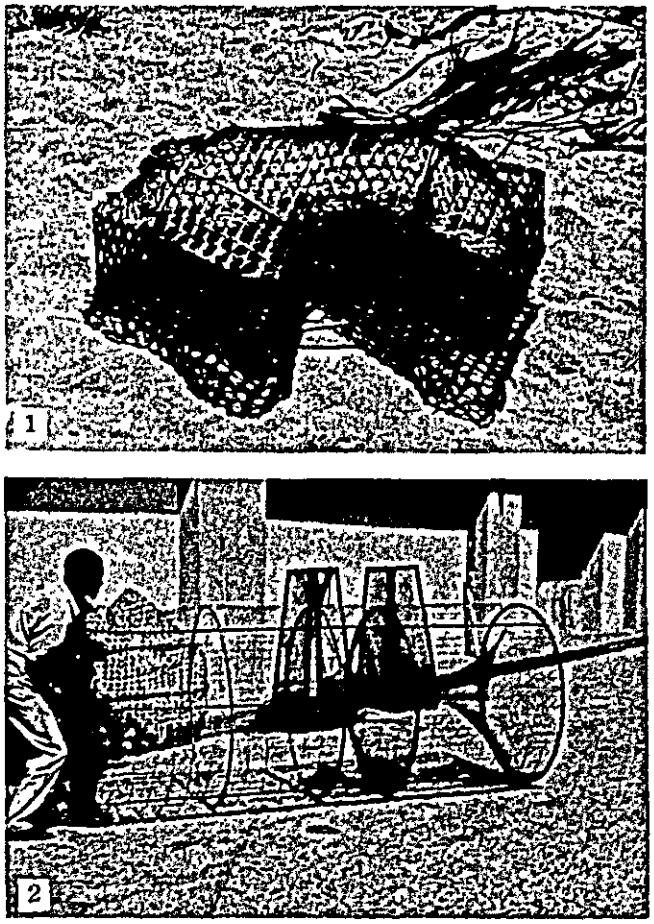


Fig. 17. Traps in Zanzibar. 1. Traditional hexagonal bamboo trap, 2. New type.

As to pelagic fish such as horse mackerel, mackerel and sardine it is necessary to introduce purse seine fishing in order to get better catches.

Manthly catches of spiny lobster in Zanzibar are shown in Table 5 (Fig. 18) Spiny lobsters, which have been caught by spear fishing, are liable to become rotten, unless they are quick-frozen immediately after fishing. At best, they will lose some of their freshness, and be a poor quality market product. In this case, catching them by gill net will facilitate retention of freshness. Fishery interests must give consideration not only to increasing catches, but also to the collection and the preservation of marine products, since perishability is the main weak point of fish. They will be able to provide exportable aquatic products only when a system for keeping the products fresh is established. As for Penaeid shrimp, we found a considerable number of shrimp larva living in tidelands.

Table 5 Monthly variation of spiny lobster in Zanzibar, 1973 - 1974

Month / Year	Weight (pound)	Number
1973		
Jul.	492	670
Aug.	576	745
Sep.	1,102	1,529
Oct.	431	529
Nov.	2,670	3,119
Dec.	1,431	1,867

Month / Year	Weight (pound)	Number
1974		
Jan.	1,443	1,724
Feb.	1,211	1,431
Mar.	240	509
Apr.	1,137	1,489
May	844	1,160
Jun.	540	722
Total	12,055	15,486

Many Penaeus indicus live in these areas and it is necessary to investigate the fishing grounds for this species around Zanzibar.

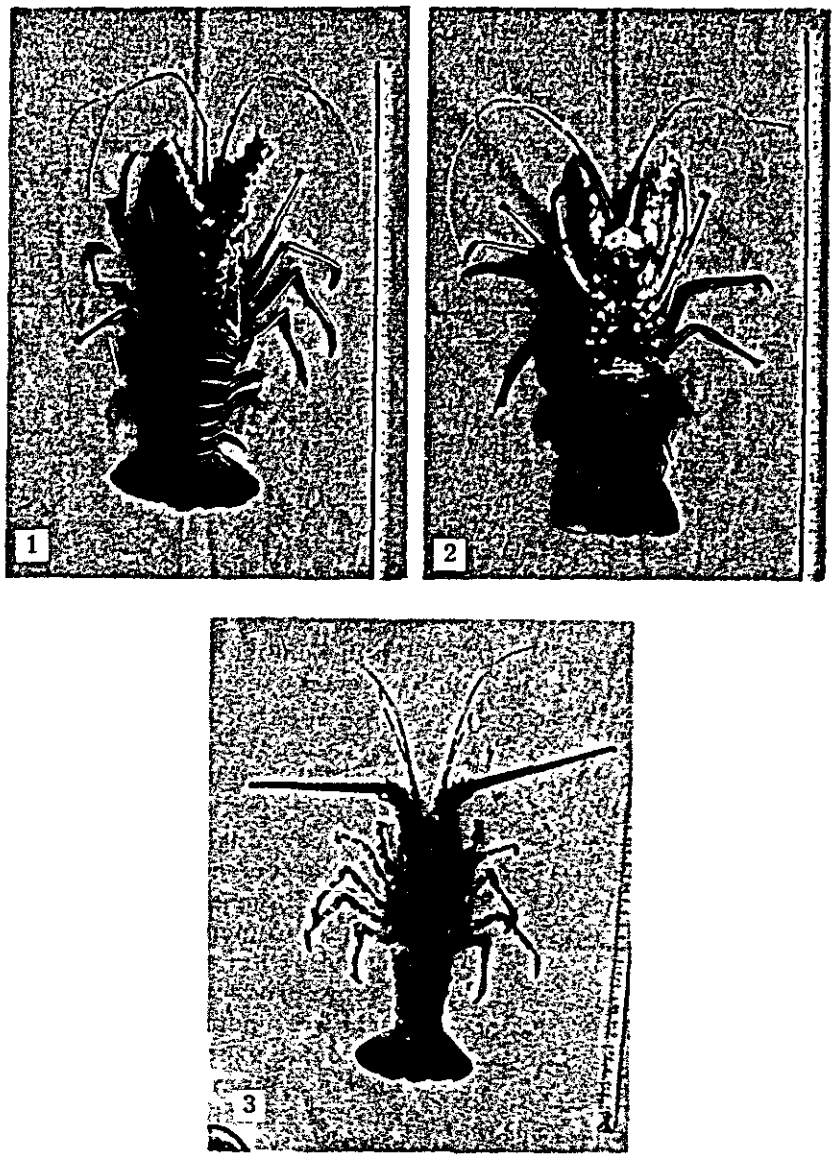


Fig. 18. Spiny lobster in Zanzibar
1 and 2. Panulirus versicolor, 3. Panulirus ornatus

Good fishing grounds must be developed in continental shelf waters for prawn, spiny lobster, octopus and cuttlefish. It is also necessary to catch efficiently pelagic fish such as sardine and mackerel by purse seine, and to extend the tuna and skipjack fisheries to the open sea after bait fishing has been established.

B. Fish Farming

In Zanzibar, fish farming is not carried on at all, but there exist large areas of water suitable for such farming. Therefore, the business of fish farming must start using easier techniques. The extensive type of mariculture which does not require feeding, may be most suitable. Oyster farming is also practicable. Crassostrea cucullata is a common species living in these waters, and it would be a good thing if native seed oysters can be cultivated here. It is also possible to introduce Japanese seed oysters and employ the rack hanging culture method. The large areas such as the regions off Fumba, Mkokotoni, Wete and Mkoani may be fit for such farming. Another promising field for culture activity is pearl culture using black-lip shell Pinctada margaritifera as the mother shell. We estimate from our investigation that about 30,000 pieces of black-lip shell, although this volume is not really enough for commercial exploitation, can be gathered per year. Further investigation of this point is advisable. As there are sufficient resources of P. vulgaris, it would be possible to culture pearls for the domestic market.

As for Penaeid prawn, fisheries of P. indicus and monodon are promising. It would be advisable to develop natural fishing grounds, rather than to use culture techniques.

Taking into account the above-mentioned investigation results, the following points will have to be considered for the development of Zanzibar fishing industry.

1. Development of Shooling Pelagic Fish Fisheries

For the promotion of efficiency of schooling pelagic fish fisheries, it is desirable to introduce the stick-held dispet and round haul seine using lamps. This is necessary for the establishment of fisheries for bait to be used by open sea fisheries such as skipjack and tuna. As seas adjoining Zanzibar are presumed to be abundant in these fish, there is a good possibility that modern fisheries will be established and developed, and that these products can be exported.

2. Fish Farming

Fish farming must start with extensive type mariculture. Among the fish fit for fish farming are oysters and pearl oysters.

3. Research Study

A research study system must be established in order to acquire knowledge of many forms of life in the sea and to introduce and develop fishing methods. For this purpose, it is necessary to make efforts to do at least the following tasks:

a. oceanographic investigation in regions around Zanzibar.

b. investigation in fishing grounds in regions around Zanzibar, and fishery biological research for resources.

c. increase the number of research workers specialized in marine life, fishing techniques, handling and processing fish catches, and marine environment.

In short, it is essential to establish a fisheries research station and a 50 - 70 ton class research ship for development of fisheries.

4. Education

It is urgently required to cultivate men of ability who will be able to introduce and develop modern fishing techniques. At this time, it seems necessary to carry out the following plans:

a. to dispatch research workers to advanced countries to acquire specialized, not general techniques. Subjects for study should be:-

   a) study of fishery science and techniques, especially techniques for use of round haul net and stick-held dipnet.

   b) techniques of research in fishing grounds.

   c) investigation of marine environment.

   d) techniques of oyster and pearl culture.

   e) techniques of cultivation of Penaeid prawn.

b. to send abroad beginners to enter colleges of advanced countries where they learn elementary knowledge. For students who want to receive Japanese Government scholarships, they may take either of the following two courses:-

   a) take a two year specialized post-graduate course.

   b) take a four year specialized undergraduate course.

Literature:

Gullard, J. A. 1970 The fish resources of the ocean.
F. A. O. Fish, Tech. Paper No. 97: 1 - 425

Line, S. Y. 1968 Milkfish farming in Taiwan.
Publ. Taiwan Fish Res. Inst. 1 - 63

Munro, I. S. R. 1955 The marine and fresh water fishes of Ceylon
Dept. Ext. Affairs, Canbera.

Smith, J. L. B. 1969 The sea fishes of Sothern Africa
Central News Agency Ltd.

Spry, J. F. 1968 The sea shells of Dar es Salaam Part I.
Gastropods. Tanzangika Note & Records No. 56: 1 - 33.

Spry, J. F. 1964 The sea shells of Dar es Salaam Part II.
Pelecypoda. Ibid No. 63: 1 - 41.

Zeitzschel, B. 1973 The biology of the Indian ocean pp. 432.