A Technical Report on a Survey of Potential Sites for Eucheuma and Kappaphycus Farming in Kenya.

A TECHNICAL REPORT ON A SURVEY OF POTENTIAL SITES FOR *EUCHEUMA* AND *KAPPAPHYCUS* FARMING IN KENYA

SUBMITTED TO COPENHAGEN PECTIN A/S, DENMARK.

BY

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ABSTRACT

Upon the interest of Kenya and Copenhagen Pectin A/S of Denmark to introduce and develop Eucheumatoids farming along the Kenya coastline, a field survey of potential sites for seaweed farming was conducted. A survey was carried out during the South-East Monsoon rainy season, from 14th April to 19th May, 1995, and covered the entire coast. Fourteen (14) sites were surveyed and six (6) were identified as suitable for *Eucheuma* test planting. The survey resulted in sufficient information which was used in the formulation of a project proposal for test planting at selected sites. This proposal is appended to this paper and means for its implementation are recommended.

1.0 INTRODUCTION

Kenya, through, Kenya Marine Fisheries Research Institute (KMFRI), has been conducting field experiments on seaweed culture along the coast, with the aim of developing seaweed farming as alternate source of income for the local community. Copenhagen Pectin A/S of Denmark (C.P) has also been developing seaweed farming in areas away from the world's major seaweed producing sites of Far East. This is partly because the company feels that the concentration of seaweed farming in the Far East was becoming too high and risky. This coupled with the fact that carrageenan industry is growing at a steady annual growth rate of 5-6%, resulted in C.P expressing an interest in developing seaweed farming in Kenya. This is to provide an additional source of seaweed supply for their factory. Through KMFRI initiative of inviting CP to Kenya, a memorandum of understanding (MOU) was signed by both parties, expressing their interests in

the introduction and development of seaweed farming in Kenya, particularly in the seaweed species, *Kappaphycus striatum* (= *Eucheuma cottonii*). Shipmarc Ltd 2of Mombasa also expressed their interest in providing support to the project. It was felt among the parties, that in order to launch the project a field survey of potential sites for *Eucheuma* farming was necessary. This report presents the results of this survey which was carried out from 14th April to 19th May, 1995.

1.1. BACKGROUND INFORMATION

A brief review of the work done on Kenya seaweeds shows that it is mostly of floristic and ecological in nature. There is very little information on the practical aspects of seaweed research in Kenya. Recent work on *Eucheuma* in Kenya is only in its initial stages and concerns mostly the introduction and feasibility studies on *Eucheuma denticulatum* in Kijangwani reef (Wakibia, 1995; Wakibia, unpublished data), as well as limited survey work on potential seaweeds of economic importance in Kenya (Yarish and Wamukoya, 1990).

1.2 OBJECTIVES

The main objectives of the survey were to identify suitable sites for seaweed farming, particularly, *Kappaphycus striatum;* and to formulate a test planting programme for monitoring the growth of these seaweeds.

2.0 MATERIALS AND METHODS

2.1 PRE-SURVEY PREPARATIONS

Upon the arrival of Messrs. Klaus Rasmussen and Tirasan Lirasan of Copenhagen Pectin in Mombasa, meetings were held with Dr. Ezekiel Okemwa, Director KMFRI,

Mr. Joseph Wakibia, KMFRI marine scientist and Mr. Jorgen Nielsen of Shipmarc Ltd. The meetings dealt with field activities, transport and logistic support during the survey. The plan and programme for actual field surveys were prepared and discussed with Messrs. Joseph Wakibia and Tirasan Lirasan. Selection of potential areas to be surveyed was discussed using the oceanographic maps of Kenya coast. Topographical maps at a scale of 1:50 000 and 1:250 000 were used.

2.2 FIELD SURVEYS

The Kenyan coast is tropical, lying between $1^0$41'S and $4^0$41'S, and is about 600km in length. The coastline, except in creeks and bays, is relatively indented and is characterized by a fringing reef which lies from 0.5km to 1.5km offshore. Between the fringing reef and the shore are found Lagoons which are the suitable locations for *Eucheuma* farming. During the survey, the reefs with Lagoons were selected on basis on their spatial extent as appearing on oceanographic maps and accessibility by either road or water. A total of fourteen (14) sites in four districts (Kwale, Kilifi, Mombasa, Lamu), were selected to cover the entire coast. Five (5) sites were located in Kwale and Kilifi districts, one in Mombasa district. Four sites were located in Lamu district in the North Kenya banks (Fig.1). The selected sites were visited at low tide so that the area of Lagoons suitable for farming could be estimated by wading from the beach to the reef, and also to gather ecological data for each site easily. The evaluation and assessment of the various sites was based on the following criteria: ecology of the site, size (area), accessibility and the population size.

2.2.1. Ecology of the site

In each of the selected sites, the ecological factors were observed, measured and recorded on field notes. The main factors that were taken into consideration included: nature of substratum, absence or presence of natural stock of *Eucheuma* or *Kappaphycus*, dominant fauna and flora, indicator species; water depth; water movement and other factors such as water transparency, temperature and salinity. During the field visits, samples of the dominant seaweed species growing in the sites, were collected and placed in collecting bags for identification purposes. The materials were identified using the seaweed guide by Jaasund (1976). Where identificaion of the seaweed collections was not possible, voucher specimens were mounted onto herbarium sheets and taken to KMFRI herbarium for subsequent identification, using additional Taxonomic resources available.

2.2.2. Size (area)

Suitable areas for *Eucheuma* farming were estimated by using Oceanographic maps and field visits. The authors waded through the areas and estimated areas covered by water of 0.3-0.5 depth at low tide. This was done in all the sites by estimating the length and width of suitable lagoons and then multiplying to get acreage.

2.2.3. Accessibility of the area

Accessibility to the area was assessed by trying to drive to the site as near as possible and then estimating the distance from the site to the nearest main road and urban centres with efficient infrastructure. The transport by water was also noted from the main harbours. The distance from the nearest

village to the site was also estimated.

2.2.4. Population size

The population size (number of people) was determined by conducting field interviews with the fisheries officials, village elders and local fishermen at each field site.

3.0 RESULTS AND DISCUSSION

3.1. Environmental characteristics

A summary on the environmental characteristics of the various localities that were visited is given in Table I. The surface water temperature and salinity in the various sites ranged from 27^0C - 29.5^0C and 22.0 ppt - 36.0 ppt respectively. The low salinity of 22.0 per thousand recorded at Wasini Island was presumably due to fresh water seepage during this rainy period of 18th April, 1995. Natural stocks of *Kappaphycus striatum* and *Eucheuma horridum* were observed growing in patches in some of the sites particularly in Chale and Wasini Islands. However, the plants were stunted and showed lesions due to intensive grazing by fish and sea urchins, implying that commercial harvesting of these seaweeds is not feasible.

(continuation: Table 1)

Locality	Salinity (ppt)	Temperature (^{0}C)	Ecological notes and observations
8. Bofa Reef	35.0	27.5	Narrow reef; uneven bottom surfaces; soft sand smelling of rotten eggs due to H_2S from decomposition of plant materials; violet waves and currents
9. Uyombo Reef	34.0	28.5	Southward boundary of the Watamu Marine Park, coralline sand, moderate water currents; *Thalassia* and *Halimeda* dominant; colonies of soft corals, reef not exposed even at low tide.
10. Muyungu Reef	32.5	28.0	Wide lagoons; within the Malindi-Watamu marine reserve, 50-60 hectares of suitable areas for *Eucheuma* farming, excellent water exchange, intensive fishing; water depth of 0.3-1.0m at low tide; a potential area for *Eucheuma* farming
11.Ras Kitau Reef	35.0	28.0	Narrow; rocky reef; violet wave action, stunted growth of *Laurencia; Gracilaria* and *Hypnea*
12. Kizingoni Reef	36.0	28.0	Loose sand with high percentage of sand dune; wide reef exposed at low tide; poor marine plant vegetation, water current moderate, no human activity wide reef exposed at low tide, loose sand dunes, poor algal vegetation, moderate water current, turbid water. Tourist activities.

(continuation: Table 1)

Locality	Salinity (ppt)	Temperature (^{0}C)	Ecological notes and observations
13. Manda Toto Island	35.0	28.0	Wide reef exposed at low tide, loose sand dunes, poor algal vegetation, moderate water current, turbid water, tourist activities
14. Shingoni	35.0	28.0	Wide reef, fully exposed at low tide, patches of coral and algae covered by silt, very turbid water, no human activity.

3.2 Suitable farming sites

The potential area suitable for *Eucheuma* and *Kappaphycus* farming in the visited areas is given in Table II. The site with highest suitable area is Muyungu reef followed by Chale Island and Wasini Island. About 260 hectares were estimated to be suitable for *Eucheuma* farming along the Kenyan coast.

Table II Potential areas suitable for *Eucheuma* farming in Kenya (estimated in Hectares).

LOCATION	POTENTIAL AREA (HECTARES)
Andromache reef	15 - 20
Kinodoo reef	30 - 40
Chale reef	40 - 50
Wasini Island reef	30 - 40
Sii Island	Negligible
Jumba ruins reef	30 - 35
Kijangwani reef	3 - 4
Bofa reef	Negligible
Uyombo reef	3 - 5
Muyungu reef	50 - 60
Ras Kitau reef	Negligible
Kizingoni reef	3 - 5
Ras Shingoni reef	Negligible

3.3. Recommended sites for *Eucheuma* farming

The results of the evaluation and assessment of the various sites are presented in Table III. Six (6) out of the fourteen (14) sites surveyed are recommended for seaweed farming. These are the sites in Andromache Reef, Kinodoo Reef, Chale Island, Wasini Island, Jumba Ruins and Muyungu Reef. Although Muyungu reef

Table 3. Evaluation of potential sites for seaweed farming in Kenya

	Name of sites	ECOLOGICAL FACTORS											
		Local stock 10%	Water current 10%	Indicator species 10%	Substratum 10%	Depth 10%	Community 10%	Predator 5%	Water quality 5%	Area (size) 10%	Accessibility 10%	Population size 10%	Total point 100%
1.	Andromache reefs	9	9	10	10	10	10	4	4	10	5	10	91
2.	Kinodoo reef.	9	10	10	10	10	10	3	4	10	8	10	94
3.	Chale Island	10	9	10	9	9	10	3	3	10	7	10	90
4.	Wasini Island	10	9	10	8	9	9	4	3	10	8	10	90
5.	Sii Island	2	6	5	4	5	5	5	2	4	5	5	48
6.	Jumba Ruins	9	9	10	10	10	10	3	4	10	10	10	95
7.	Kijangwani	10	9	9	8	9	9	3	4	8	9	10	88
8.	Bofa reef	3	7	4	6	5	4	3	2	4	10	10	58
9.	Uyombo reef	7	8	10	10	8	8	2	3	8	6	10	80
10.	Muyungu reef	9	10	10	10	9	10	4	5	10	9	10	96
11.	Ras Kitau	3	3	3	2	5	5	5	2	3	4	5	40
12.	Kizingoni	8	5	4	5	4	5	3	3	4	5	8	54
13.	Shongoni	6	6	5	3	3	4	3	2	3	4	3	42
14.	Mande Toto Island	5	5	4	3	2	3	3	3	2	4	4	38

has a vast reef acreage of approximately 50-60 hectares, cultivation of seaweed would be restricted because the area is part of the protected Malindi-Watamu marine park and reserve. However, this area could be used for seaweed farming in future if initial farming does not have profound negative environmental effects on marine ecosystems in areas under seaweed farming.

3.3.1. ANDROMACHE REEF, LIKONI, MOMBASA DISTRICT

The reef is 5km long and 1.0 km wide with the northern part of the reef forming Kilindini harbour (Fig.2). The reef edge is completely exposed at low tide. A lagoon covering half of the reef was noted suitable for *Eucheuma* farming. The area is dominated by *Thalassia hemprichii* and *Halimeda opuntia* which cover 80% of the reef flats. In the deeper part of the lagoon, the seagrasses *Thalassodendron ciliatum* and *Syringodium isoetifolium* were also observed. *Turbinaria ornata, Sargassum binderi* and *Hypnea sp.* were also common. Colonies of soft corals and patches of dead and live corals were recorded towards the reef edge. Approximately 50 fishermen were found fishing in the area. The local fishermen were also collecting shells, corals and sea cucumbers for the tourism industry hotels. According to Mr. Patrick Ngatia, a local contractor, there were 6500 local persons in this area carrying fishing activities, coral stone mining and subsistence agriculture. A high concentration of tourist cottages were also observed in the area.

3.3.2. KINODOO REEF, KWALE DISTRICT

The site is situated in the southern part of the famous Diani chain Hotels. The reef stretches southward towards the Chale Island. The site is accessible by the

Chale Island - Diani road which is approximately 30 km from Mombasa city (Fig. 3). The site once supported rich coral gardens as evident by large area with dead corals. Presumably this was due to intensive fishing and collection of corals, since there is no other source of income to the local community. According to Mr. Bakari Mwambawo, vice-chairman of Kinodoo fishing cooperative society, the average fish catch per fisherman five years ago was 10-20 kg per day while currently the fish catch has been reduced to about 2 kg per day. The reef is characterized by a rich seagrass community comprising of *Thalassia hemprichii* and *Halophila ovalis*, *H. stipulacea* and *Thalassodendron ciliatum*. The bottom is quite irregular towards the reef edge. The substratum is composed of firm sand of coral and *Halimeda* segments origin. The water is clear with a good water exchange. The seaweed species associated with the seagrasses consisted mainly of Articulated Corallines and *Gracilaria corticata*. Many other species of *Sargassum*, *Padina*, *Turbinaria*, *Hypnea* and, *Cystoseira* and many other less dominant species were observed.

3.3.3. CHALE REEF, KWALE DISTRICT

The site is approximately 30 km from Mombasa (Fig. 3). The reef forms the south west part of the Island. Half of the reef is exposed at low tide leaving an area of 2-3 km long and 100 m wide covered by a water column of 0.3-0.5 m deep. Deeper water lagoons of 1-2 m were common towards the Gazi Creek. The area is quite large and is protected from strong waves by a fringing reef. The current is moderate but can be strong towards the reef edge especially during the South East Monsoon. The bottom is firm with coralline sand and coral fragments on the reef edge. Towards the Gazi creek, there is soft sand with turbid water. Natural stocks of healthy populations of *Kappaphycus striatum*

were observed growing in the lagoons towards the reef edge. Other dominant seaweeds recorded were *Cystoseira myrica, Laurencia papillosa, Hypnea* and *Sargassum.* Colonies of soft corals were estimated to cover 80% of Lagoons and reef flats. Accessibility to the reef site by road is poor. However, usage of boats by the local fishermen was very common. The fishermen normally cross the deep Gazi channel to the reef for fishing activities. The nearest villages to this reef are in Gazi and Msambweni areas, a distance of 2-4km from the reef.

3.3.4 WASINI ISLAND, KWALE DISTRICT

The site is approximately 1 hour boat trip from Shimoni (fig. 4). This site is quite impressive in terms of its farming potentials for *Eucheuma denticulatum* and *Kappaphycus striatum.* The site is large consisting of 30-40 hectares of farmable area. The area has a moderate local water movement. It is characterized by a plant community with *Thalassia hemprichii* and *Enhalus acoroides*,being the dominant components. Patches of the edible variety of *Caulerpa racemosa* were abundant together with a *Halimeda* community. Tufts of the blue-green alga, *Lynbya* and natural stock of *Kappaphycus striatum* were also recorded. Salinity in this site was significantly lower at 25 ppt than in all the other sites. This was probably due to fresh water runoff during the survey.

3.3.5. JUMBA RUINS REEF, MTWAPA, KILIFI DISTRICT

The reef is approximately two kilometers away from the main Mombasa-Malindi Highway (fig. 5). The site which is about 1.5-2.5 km long and 400-470m wide is covered by a water column of 0.3-0.6m deep at low tide. The reef edge is completely exposed at low tide. The bottom slightly dips and becomes uniformly flat towards the shore. The substrate covering the reef is mainly coarse

coralline sand with coral and *Halimeda* fragments. The area is characterized by highly diverged flora of which many species are indicators of good water movement, a primary Oceanographic factor important for *Eucheuma* culture. The common marine plants observed in this area were species such as *Sargassum, Padina, Udotea, Halimeda, Caulerpa, Dictyota, Hormophysa triquetra, Cystoseira myrica, Halophila, Thalassia hemprichii,* and *Thalassodendron ciliatum.* Beside these plants, the bottom is characterized by the abundance of benthic animals and coelenterates. The soft corals, *Xenic elongata* and *Anthelia glauca* were common. Various species of sea urchins mainly *Tripneustes gratilla, Toxopneustes pileous and Diadema setosum* were also recorded. Although *Eucheuma* species were not observed in the area, its introduction in the site seems feasible. This area is highly recommended for *Eucheuma* and *Kappaphycus* test planting. The accessibility of the site from Mombasa by land transport is an advantage for the management of the site. The farmable portion of the reef is approximately 30-35 hectares with a population size of 10,000 persons from the surrounding villages.

3.3.6 KIJANGWANI REEF, VIPINGO, KILIFI DISTRICT

This is the present site of small scale pilot studies of *Eucheuma denticulatum* and *Kappaphycus striatum.* A growth rate of 2.7-6.7% day^{-1} have been recorded in the area (Wakibia unpublished data). The reef is approximately 400 m wide and 3 km long and covered by a water column of 0.3-0.4 at low tide. The water in the area is clear with a moderate water motion. The area is dominated by *Thalassia hempichii* and *Halimeda opuntia.* Patches of live and dead corals were also observed. Colonies of soft corals and seaweed species such as *Acanthophora specifera, Halimeda, Sargassum, Padina* and *Dictyota* were common. *Kappaphycus striatum, Eucheuma denticulatum* and *Eucheuma horridum* were also observed

growing in the area. Farmable portions of the reef are approximately 3-5 hectares.

4.0. SUMMARY AND RECOMMENDATIONS

4.1. Kenya has approximately 260 hectares lagoonal area suitable for *Eucheuma* farming. This undoubtedly could provide a home to many farming projects.

4.2. Based on this initial field survey as well as cultivation trials conducted in Kenya, it has been shown that there is a need to assess the feasibility of *Eucheuma* farming in Kenya. This could possibly start by test planting, followed by establishment of pilot demonstration farms in the most suitable sites as identified in this study.

4.3. Based on initial results on work done, one hectare could produce 15.5 tons (dry wt) per year. The reef acreage of 260 hectares found suitable for *Eucheuma* growing during the survey, could produce approximately 4000 tons (dry wt) per year. With efficient farming activities, this production could even double. This could be quite a substantial amount of seaweed for Copenhagen Pectin A/s and could fetch a valuable income for the local community. Seaweed farming activities in these areas could probably support over 4000 families. As a result of this survey, it is recommended that Kenya has good potential for seaweed farming.

4.4. In the light of the information gathered during this survey, it is

recommended that test planting of *Eucheuma denticulatum* and *Kappaphycus striatum* be carried out at the following sites: Andromache reef, Jumba ruin reef, Wasini Island, Chale Island and Kinodoo reef. This should be done for a period of 6-12 months. The results from the test planting would give data on growth rates and biomass production in Kenya. This information is essential in the formulation and implementation of commercial production of *Eucheuma* and *Kappaphycus* in Kenya.

4.5 In order to conduct the above outlined test planting, it is recommended that KMFRI should supply manpower to monitor the growth of the test plants, while Copenhagen Pechin and/or Shipmarc Ltd. are requested to look into the possibility of securing funds for the proposed follow-up activities. A project proposal is appended to this survey report.

5.0 ACNOWLEDGEMENTS

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APPENDIX I

FIELD SURVEY PROGRAMME (14 April - 20 May, 1995)

10-12 April	Presurvey preparations at KMFRI.
13 April	Buying supplies and arrangements for transport and logistic support.
14 April	Field observation at Andromache reef.
15 April	Field survey in Diani - Kinodoo reefs.
16 April	Field survey in Chale Island and Gazi Bay.
17 April	Field observation at Funzi Island.
18-19 April	Field survey in Wasini and Sii Islands.
20-26 April	Identification of marine algae and seagrass.
27 April	Field survey at Jumba reef and Kikambala.
28-29 April	Field visits at Kijangwani and Vipingo reefs.
30 April	Field visits in Bofa and Mtondia reefs.
1-2 May	Field survey in Malindi-Watamu reef.
3-10 May	Identification of marine algae and seagrass.
11 May	Preparation for the Lamu field trip.
12 May	Departure for Lamu by plane.
13 May	Field visits in Ras Kitau.
14 May	Field visits in Chingoni reef.
15 May	Field observations in Manda Toto island.
16 May	Field visits in Ras shongoni.
17 May	Field visits in Pate Island.
18 May	Leave for Mombasa.
19-20 May	Discussion of the field observations.

APPENDIX II

PROJECT PROPOSAL SUBMITTED TO COPENHAGEN PECTIN A/S

Title: Development of *Eucheuma* and *Kappaphycus* farming in Kenya.

1.0 BACKGROUND AND JUSTIFICATION

A field survey was conducted in Kenya from 14 April to 20 May 1995 to determine suitable reef sites for *Eucheuma* farming. This was a joint project involving KMFRI, Copenhagen Pectin A/S and Shipmarc Ltd. Five sites were identified as suitable reef area for seaweed farming. These sites had good environmental factors which were presumed to be ideal for farming of *Eucheuma denticulatum* and *Kappaphycus striatum*

As a result of the surveys, the authors recommended that farming of *Kappaphycus* and *Eucheuma* on the Kenya coast has a good potential for development. Other results from growth experiments of *Eucheuma denticulutum* also revealed that one hectare can produce approximately 15.5 tons dry seaweed per year (Wakibia, unpublished data). Consequently, from these results, it is necessary to conduct preliminary investigations on seaweed farming in Kenya.

This proposal has been designed to assess the feasibility to growing *Eucheuma* on a commercial scale. This project will conduct test planting in selected sites.

2.0 AIM

The main aim of this project is to provide information necessary for the formulation of a large scale commercial seaweed farming. The results will answer questions such as: What is the optimum growth conditions for *Eucheuma* and *Kappaphycus* in Kenya? How long does it take for the weight to double? What is the optimum monthly and annual productions per hectare? Can seaweed farming be a profitable venture in Kenya?

3.0 OBJECTIVES

3.1 Long term objectives

1. To provide employment and income to the coastal fishermen and their families.

2. To provide additional source of seaweed supply to Copenhagen Pectin A/S.

3.2. Immediate objectives

1. To monitor the growth of *Kappaphycus* and *Eucheuma* in selected sites along the Kenya coast.

2. To train some selected local fishermen on farming procedures for the effective implementation of the project.

3. To establish pilot farms of seaweed in suitable sites for further development of commercial farming.

4. To carry out a cost - benefit analysis of *Eucheuma* farming in Kenya.

4.0 MATERIALS AND METHODS

4.1. Study sites

Among the five identified suitable sites, Jumba ruins reef and Wasini Island will be selected for test planting. In each location, 2 sites will be identified for test planting. Both Jumba ruins and Wasini Island have a good water exchange, firm substratum and are accessible by road and boat. The test planting activities are proposed to take one year period so as to measure the seasonal growth of *Eucheuma* and *Kappaphycus*.

4.2. Seed materials

Eucheuma denticulatum cuttings will be collected from the Zanzibar seaweed farms, while *Kappaphycus* cuttings are expected from Philippines. A field visit of 1-2 weeks is proposed for a KMFRI scientist to visit Zanzibar seaweed farms to collect *Eucheuma* plants and learn how to construct *Eucheuma* farms. This will also help in noting areas with healthy growth of *Eucheuma* and their ecological characteristics.

4.3. Growth experiments

The construction of the *Eucheuma* farms will be carried out as described by Doty (1973) and seaweed farming manual (1988). Within each sites, 50 healthy thalli (cuttings) of 50-100g will be tagged. The cuttings will be weighed after every 7 or 15 days during the whole experimental period. The rate of growth expressed as % increase per day will be calculated according to the formula of Haglund and Pedersen (1993):

$$gr \;.\; = \frac{(Nt)}{(No)}\,\frac{1}{t} - \frac{1}{2} \times 100$$

where gr= relative growth rate.
No = wet weight at start
Nt = wet weight at time, t
t = time in days.

4.3. Total biomass production (Tbp)

The Total biomass production (Tbp) of the *Eucheuma* farms will be estimated by adding up all the harvested seaweeds during the experimental period and on completion of the study. The cuttings will be harvested after reaching a harvestable weight of 400-700g to avoid losses during the spring tides and the south east monsoons.

4.4. Experimental variables

The primary environmental factor at each site will be measured during the weighing period. These will be the water temperature salinity, light, water turbidity and water movements.

5.0 WORK PLAN

The project will be implemented through KMFRI.

	PROJECT ACTIVITIES	LOCATION	PROPOSED DURATION
A.	Establishment of pilots demonstrations farms		1 year
1.	Identify sites for *Kappaphycus* and *Eucheuma* test planting	Jumba ruins and Wasini Island	2months
2.	Develop techniques for *Kappaphycus* farming and make estimates of productivity of local and exotic species	Wasini Island	2 months
3.	Growth rate studies.	Wasini Island and Jumba ruins	1 year
4.	Monitoring of ecological parameters	-do-	1 year
B.	Training provisions		
1.	Training of local fishermen in the field		first 2 months
2.	Training of local elders, party officials and administrators.	-do-	first 2 months
	Field visit to seaweed farms	Zanzibar	1-2 weeks
C.	**Cost/profitability study**	Jumba ruins and Wasini Island	After 12 months
D.	**Evaluation of progress of the project**	- -	After 6 months

6.0 BUDGET

	ITEM	(US$)
6.1	**Equipment and Expandable**	
	Mangrove Poles	60
	Nylon ropes	100
	Monoline	200
	Field knive	10
	Buckets	10
	Baskets	10
	Floaters	10
	Weighing balance	40
6.2	**Supplies and publication**	
	Photocopies	60
	Drafting	60
	Stationary	50
	Publication costs	50
6.3	**Field visit to:**	
	Zanzibar farms for 2 weeks (Transport and accommodation)	1000
6.4	**Transport**	
	Mombasa - Jumba ruins x 24 Trips	150
	Mombasa - Wasini Island x 24 Trips	590
6.5	**Field allowances**	
	Two fishermen at each site @ 3000 Ksh/mont	2600
	Research scientist @ 40 US$ / day x 120 days	4800
6.6	MISCELLANEOUS	100
	Total for the whole year	10000

BUDGET JUSTIFICATION

1. Transport is calculated at Ksh 15 per Km of travel using the standard car rental rate.

   Mombasa - Jumba ruins approximately 15Km
   Mombasa - Wasini Island " 90km

2. Scientist allowance is calculated at the present KMFRI contract rates of Ksh. 2200 / day.

3. US$ = Ksh. 55

FIGURES

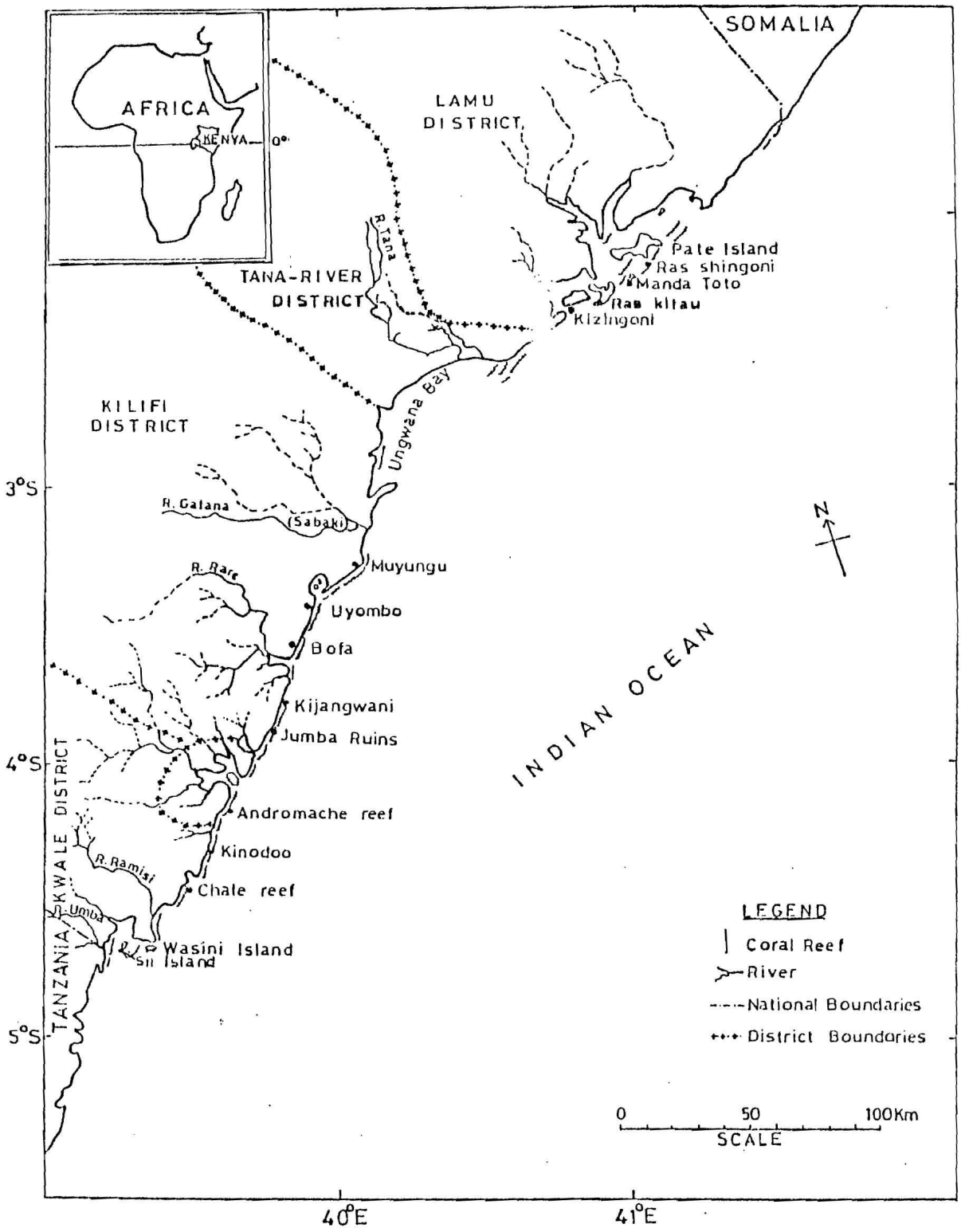

Fig 1. Map of kenya showing the general locations of sites visited.

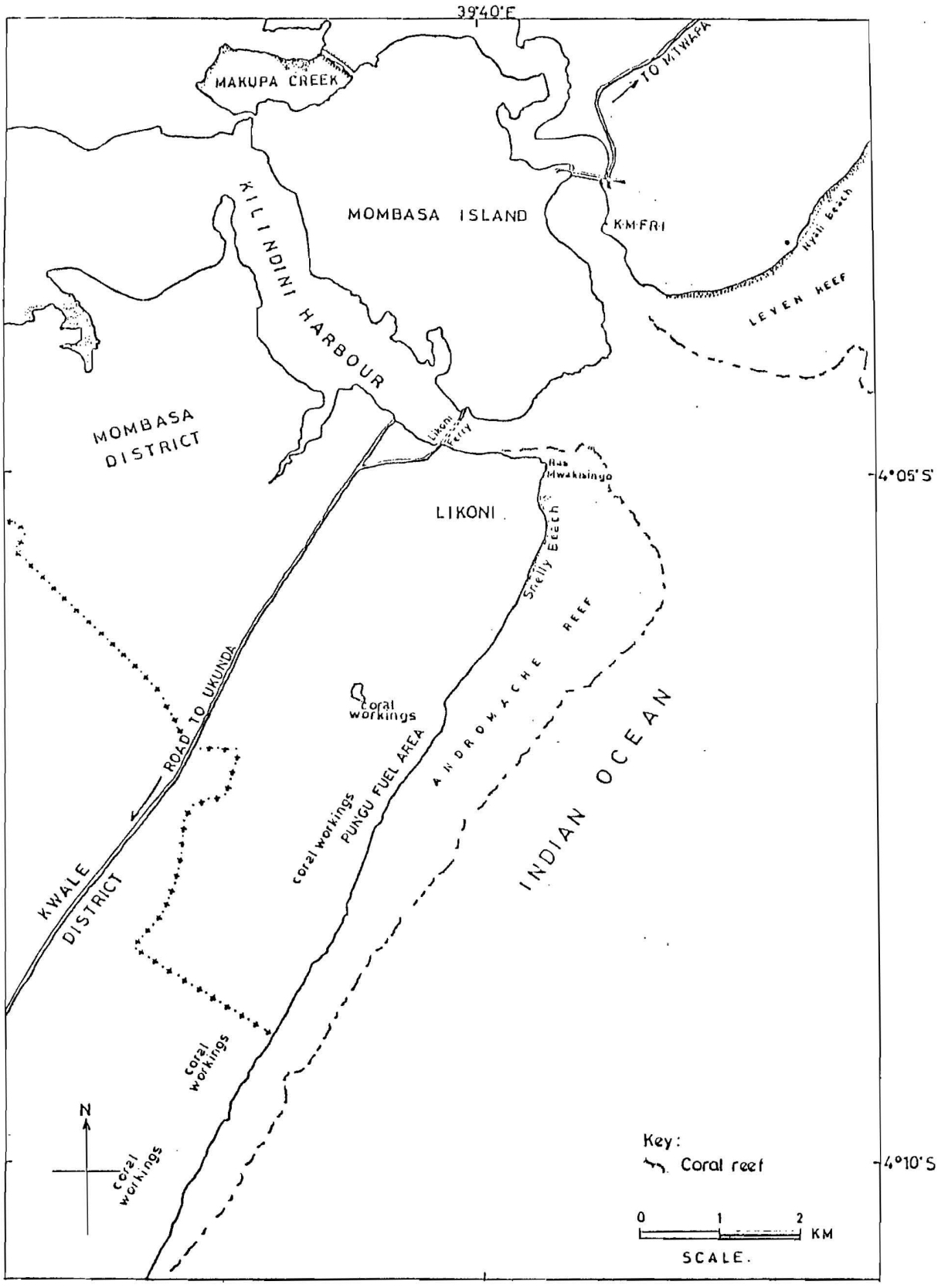

Fig. 2. Map showing areas surveyed in Andromache reef, Likoni, Mombasa district.

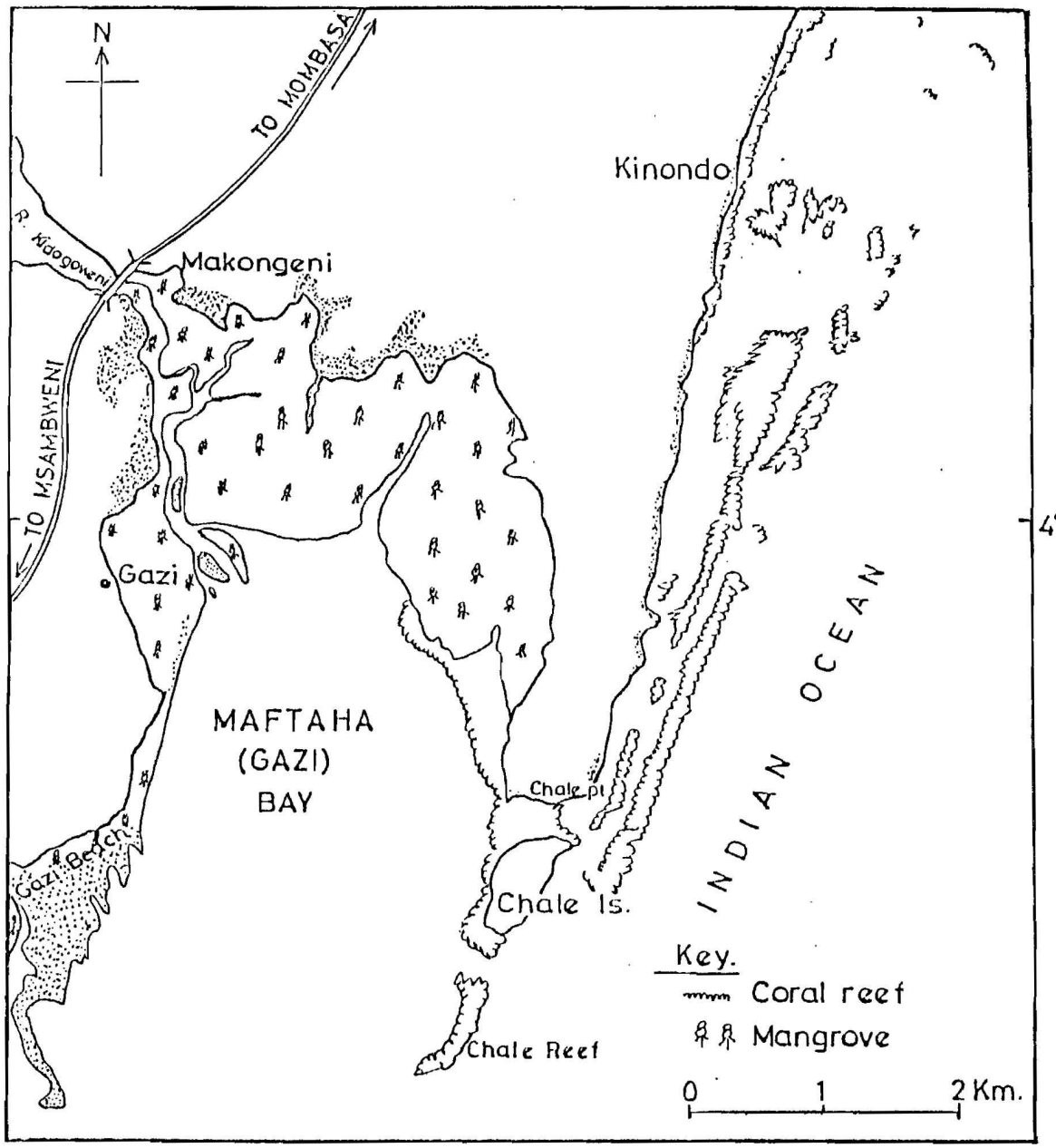

Fig. 3. Map showing areas surveyed in Kinondo and Chale reefs, Kwale district.

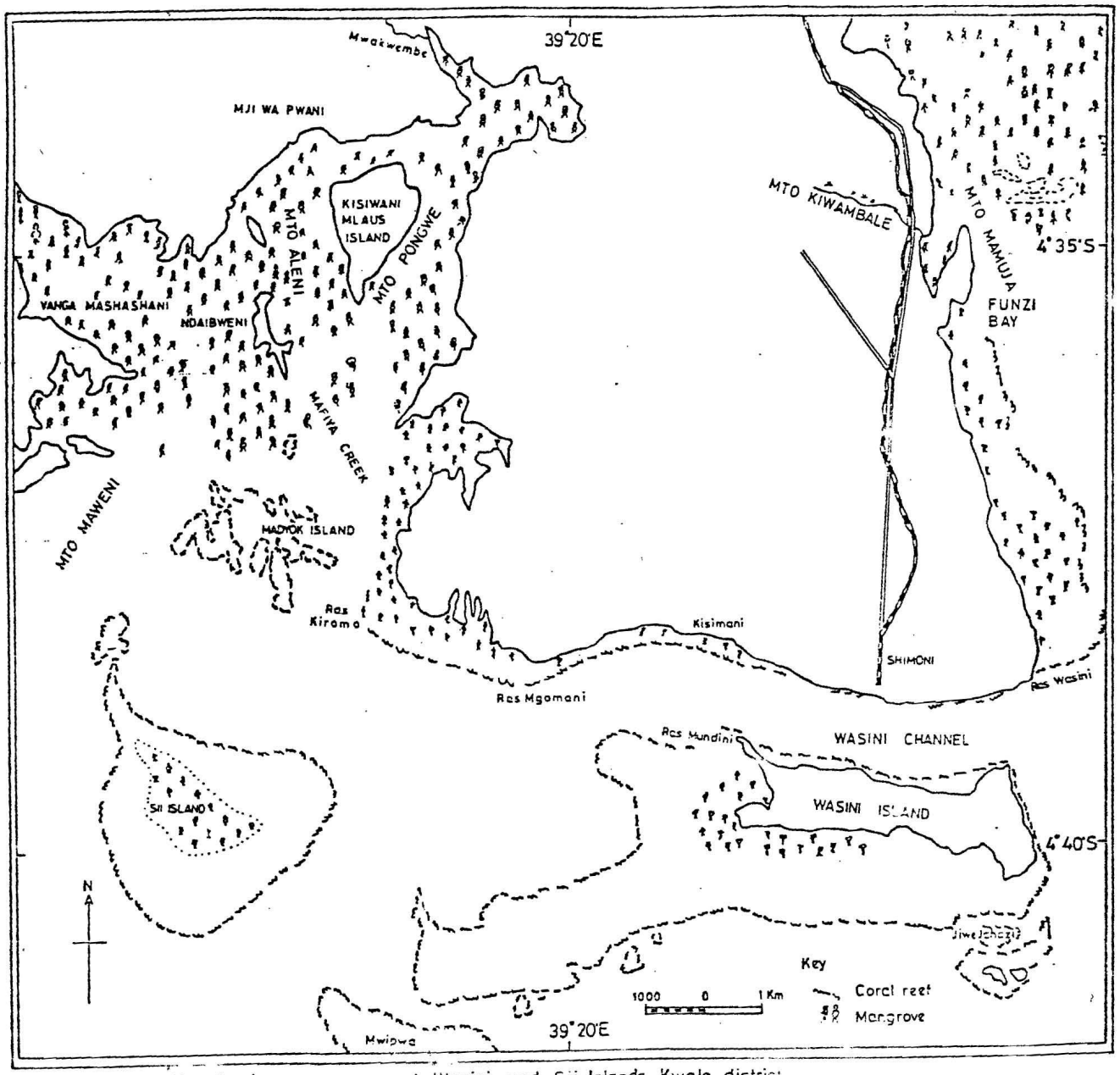

Fig 4. Map showing area surveyed Wasini and Sii Islands, Kwale district.

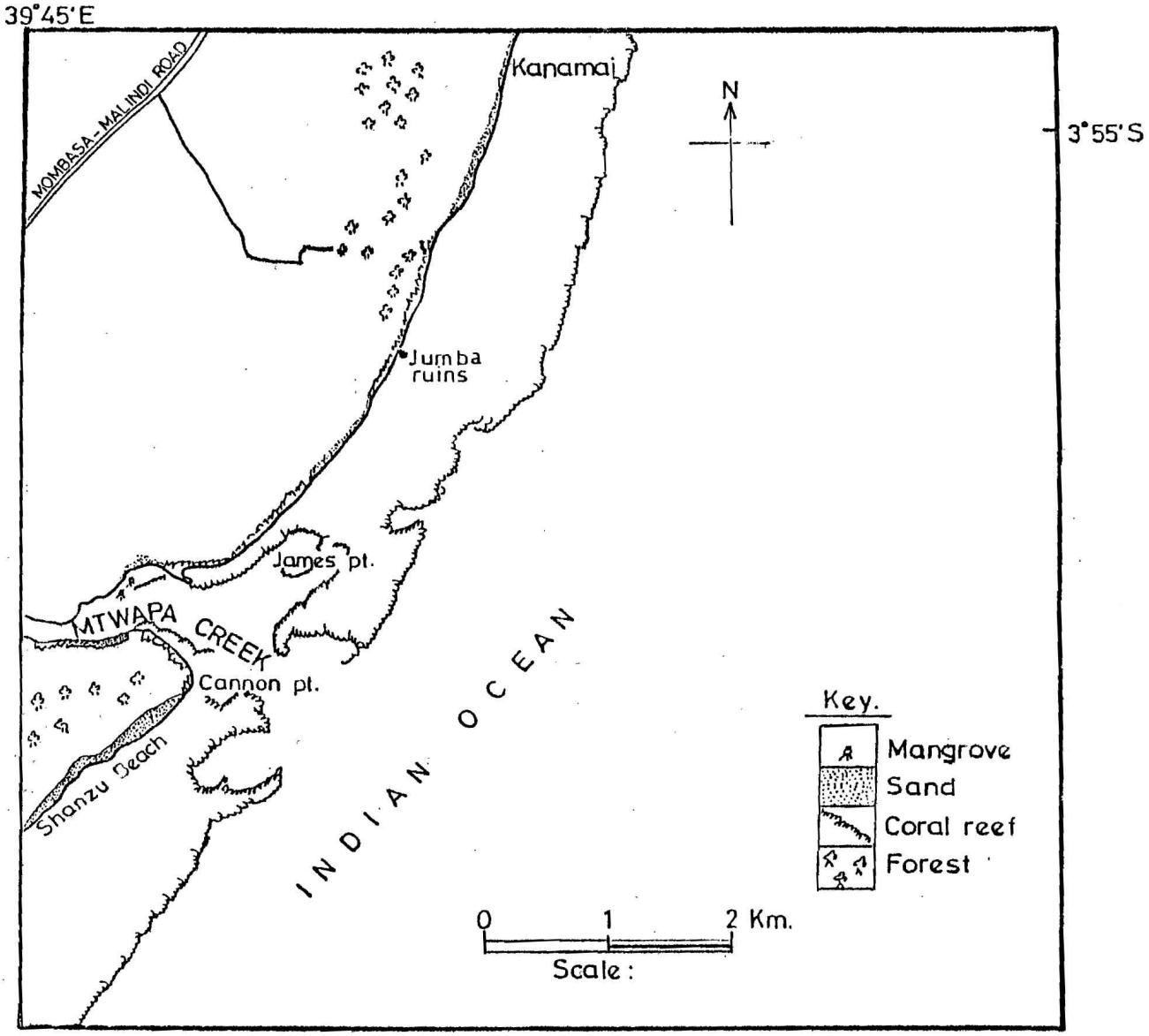

Fig. 5. Map showing areas surveyed in Jumba ruins, Mtwapa, Kilifi district.