

FRONTIER

TANZANIA

COASTAL FOREST RESEARCH PROGRAMME

PRELIMINARY RESULTS OF A BIOLOGICAL SURVEY  
OF CHUMBE ISLAND - ZANZIBAR

12<sup>TH</sup> - 30<sup>TH</sup> MARCH 1993

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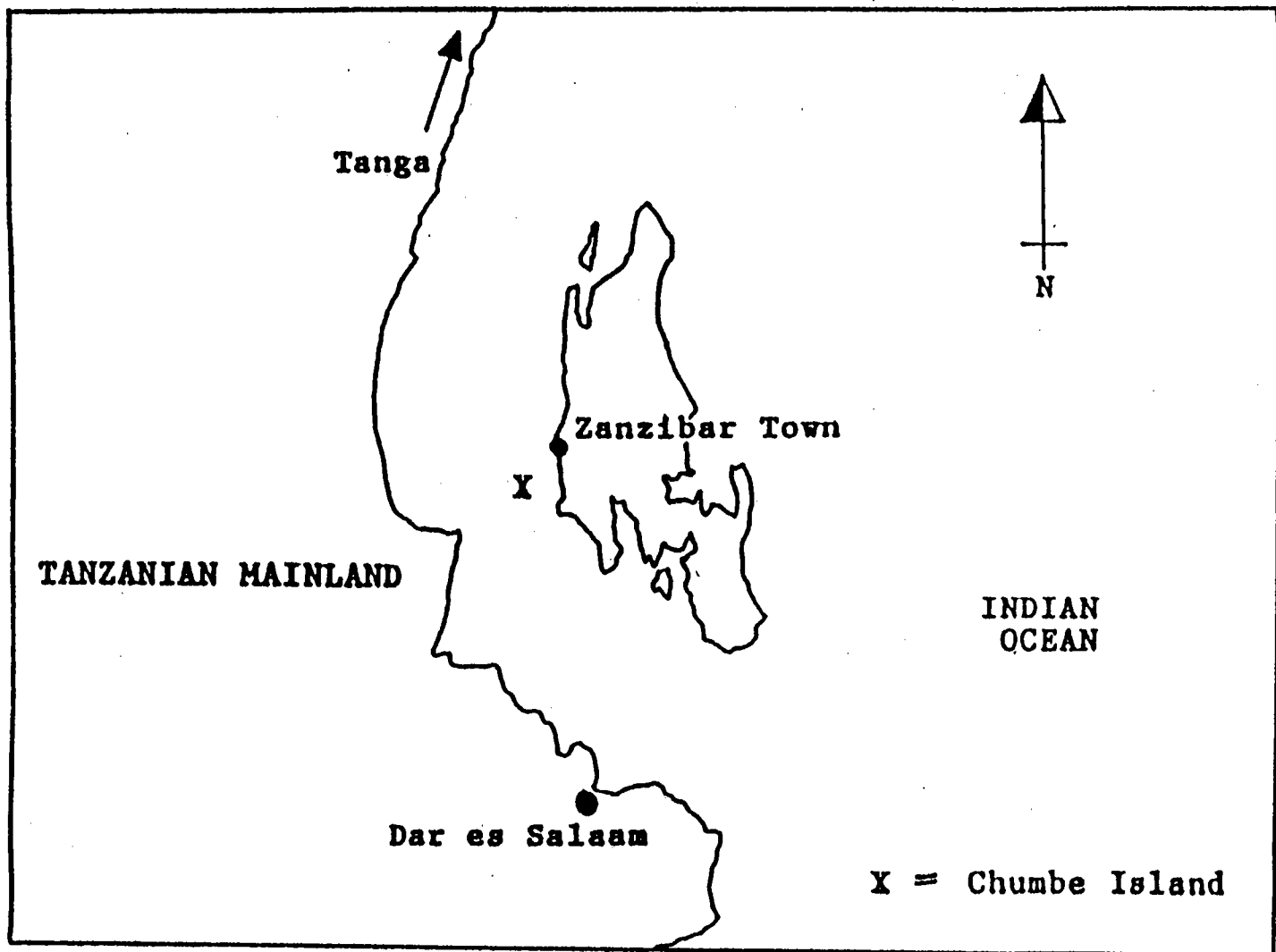
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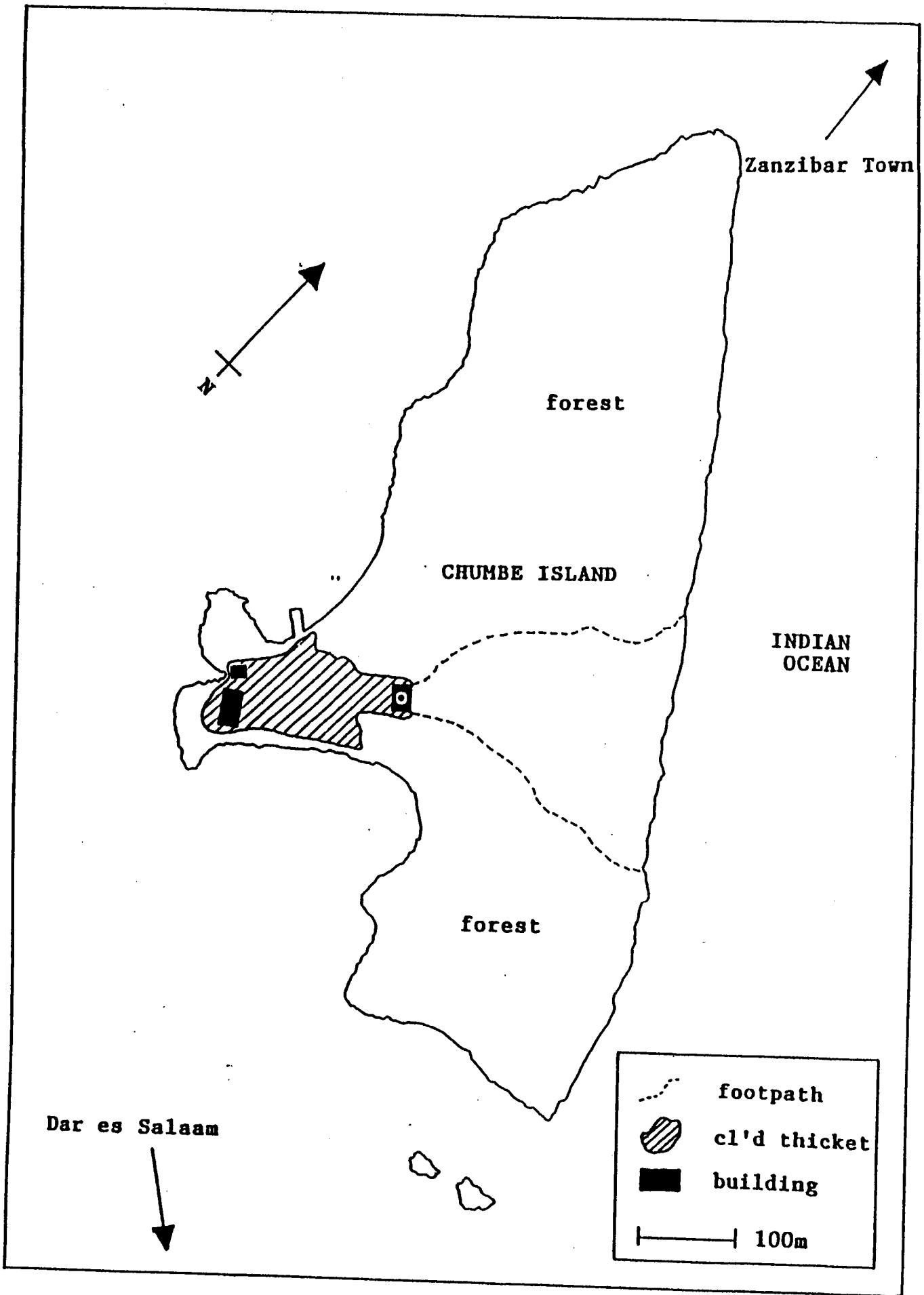
## ABSTRACT

The Frontier-Tanzania Coastal Forest Research Programme were invited to perform a basic biological inventory of the terrestrial resources of Chumbe Island, located 12km south-west of Zanzibar Town. This uninhabited island is being developed as an environmental education centre, also offering limited tourist opportunities. The primary feature is the fringing coral reef however, the island supports 10.5ha of natural coral rag forest, which will also be included in the Chumbe Coral Park Project.

**MAP 1 : Location of Chumbe Island off Tanzania, Zanzibar coasts**



MAP 2 : Chumbe Island



## 1.0 INTRODUCTION

This report presents a summary of the findings of the Frontier-Tanzania TZ15 Coastal Forest Research Programme (F-T CFRP) to Chumbe Island, Zanzibar between 12<sup>th</sup> - 30<sup>th</sup> March 1993.

General aims and justifications of the F-T CFRP are presented in Dickinson and Burgess (1991a).

### 1.1 AIMS

To conduct a comprehensive biological survey of the floral and faunal components of the island.

To make a preliminary evaluation of the diversity and abundance of the species present, indicating the conservation value of the site.

To make constructive suggestions on the future development of the conservation interest of the forest.

### 1.2 JUSTIFICATION

In 1992, the Revolutionary Government of Zanzibar formally declared the island "Chumbe Forest and Bird Sanctuary", and the area is currently a proposed Forest Reserve. Thus, a full investigation into the natural resources was required to fully determine the conservation value of this site. The research on Chumbe Island was considered as an opportunity of introducing Frontier to the relevant government and forestry departments on Zanzibar, and working together on a mutually beneficial project.

## 2.0 EXPEDITION SCHEDULE

12/3/93: Arrive in Zanzibar from Dar es Salaam

13/3/93: Travel to Chumbe Island

14/3/93: Establish camp on Chumbe

15/3/93: Return to zanzibar to collect 3 research assistants arriving from Dar es Salaam

16/3/93: Collect Mr. Saleh Khiari, Forestry Department Conservation Officer, and return to Chumbe

17 - 29/3/93: Conduct biological investigation

29/3/93: Pack up specimens and equipment

30/3/93: Return to Zanzibar. Plant specimen identification at Forestry offices by Jozani forest staff.

In total 78 man-days were spent working on Chumbe Island.

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### 3. FIELD PERSONNEL

Coastal Forest Science Co-ordinator - Leigh Stubblefield  
graduate; University of Newcastle upon Tyne:  
Countryside Management Bsc.

Research assistants:

Philip Bowen - graduate; University of Nottingham:  
Zoology Bsc.

Interests: ornithology, marine biology

Benjy Hayes - undergraduate; University of Ulster  
Environmental science Bsc.

Interests: Mammal and reptile collection

Dominic Johnson - Undergraduate; University of Derby  
Biological Imaging Bsc.

Interests: ornithology, wildlife photography

Samantha Munn - graduate; Royal Holloway & Bedford New College,  
University of London

Zoology Bsc.

Interests: vertebrate studies, butterfly collection

Andrew Radford - undergraduate, Girton College, University of  
Cambridge

Natural Sciences - Zoology Bsc.

Interests: ornithology, vertebrate studies, photography

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#### 4.0 CHUMBE ISLAND CORAL RAG FOREST

##### 4.1 BOTANICAL RESEARCH

###### 4.1.1 HERBARIUM COLLECTION

Systematic collection of plant species was carried out on 26-27<sup>th</sup> March in both coral rag thicket and forest vegetation to enable a full species list for the island to be established. The results appear in table 1 below:

TABLE 1: Results of herbarium collection

GROWTH FORM	FOREST		THICKET		TOTAL
	FERTILE	STERILE	FERTILE	STERILE	
TREE (SAPLING)	1 (0)	2 (15)	0 (0)	0 (0)	3 15
SHRUB	0	8	5	4	17
HERB	0	8	2	4	14
CREEPER	0	1	0	5	6
TOTAL	1	34	7	13	55

Specimens of mangrove species and the Euphorbia (cf *E. nyikae*) that are common on the island were not collected. Some of the sapling specimens collected could be the same species, the appearance being different depending on the level of maturity.

Botanical collection took place prior to the long rains (April - July), consequently the number of flowering and fruiting specimens was low. Further collection during the fertile season following the rains may add to the current plant species list.

The fertile specimens will be sent to the Royal Botanic Garden, Kew for identification and steriles to the Herbarium at the University of Dar es Salaam for confirmation and further identification. Habit, growth form, colour and bark notes for each species have been recorded as appropriate.

The plant specimens were given preliminary identifications by a

forest ranger and local forest guide from Jozani. A list of their swahili names appears in appendix 1 with the latin translation where available.

#### 4.1.2 VEGETATION SURVEY

A continuous band of thicket, on average 30m wide (see map 2), borders the 10.5ha forest zone. The forest-thicket margin is dense and often indistinct. The height of vegetation increases on moving inland, with an average canopy height of 9m. The thicket provides a buffer against the stunting and dessicating effects of hot, saline breezes. It is therefore essential to the continued existence of forest on Chumbe.

Signs of anthropogenic disturbance were common throughout the forest and thicket areas. Trees of DBH (diameter at breast height = 1.3m) less than 15cm had been cut for poles. Larger trees were also removed, possibly to provide timber or fuelwood. Paths led into the forest from all accessible points of the coral rag overhang that surrounds the island, and in some places damage was severe. Disturbance appears to have occurred over a considerable period of time - in the north of the island an overgrown man-made path of coral fragments has been constructed on a bearing to the lighthouse, it does not seem to have been completed.

As a result of such disturbance many lianes have exploited the increased light levels resulting from destruction of the natural canopy. Similarly there is abundant ground flora, dominated by fleshy shrubs including *Scadoxus multiflorus*. Shrubs are common though there is no distinct shrub layer in the overall vegetation structure, and their distribution is comparatively scattered. XX tree species were recorded, and saplings showing a continuous height range were observed. This suggests a healthy regeneration rate.

Many of the cut trees were naturally coppiced around the main stump, a possible indication that the level of disturbance has not severely damaged the regeneration potential of the forest. However, the dessicating effect resulting from the "opening up" of the forest is apparent, with many plants suffering from drought stress; particularly saplings and shrubs. some of these plants were observed to be suffering from fungal attack.

#### 4.1.3 QUANTITATIVE VEGETATION SAMPLING

A basic quantitative study was carried out in the forest area using a series of randomly placed 5 x 5m quadrats. The number and diversity of tree, shrub and herb species were recorded for each. Results appear in table 2.

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TABLE 2: Quantitative vegetation sampling results

	Average No. of plants / quadrat	standard deviation*	Average No. of species / quadrat	standard deviation
TREES (over 10cm DBH)	4.40	1.65	2.30	0.82
SAPLINGS (1-2m)	11.90	6.23	4.50	1.96
SAPLINGS (2-5m)	4.70	2.65	2.50	1.18
SAPLINGS (5m-canopy)	2.40	3.31	0.80	0.63
SHRUBS	% cover 29.0	% cover 23.9	4.60	1.65
HERBS	69.70	38.43	3.50	1.08

\* Standard deviation is a measure of the concentration or frequency about the mean.

The above results show that although diversity is low, the abundance of those species present is high, particularly regarding ground flora. The low standard deviations suggest that the average number of species for each growth form is relatively constant throughout the forest area. Creepers and lianes were found in all plots and were abundant in areas showing signs of disturbance.

#### 4.2 VERTEBRATE COLLECTION

##### 4.2.1 SMALL MAMMAL TRAPPING

Results suggest there are no indigenous small mammals present. Trapping yielded only domestic rats which are abundant on the island. Observations indicate that these rats have also become arboreal posing a threat to nesting birds. Some form of population control is advocated. A more intensive study over a longer period of time is required to investigate this aspect more thoroughly.

#### 4.2.2 BAT MIST-NETTING

Mist netting was restricted to open areas due to the dense nature of the vegetation. Normally nets are placed in natural "flightpaths" to catch bats as they fly to feeding sites. Bat calls were heard and indicated that the animals were flying above the canopy.

Both ground (to 3m) and aerial nets (to 10m) were used, and yielded only 1 bat: a *Hippersideros commersoni* (Giant leaf-nose bat), widespread throughout sub-Saharan Africa. This large insectivorous bat is commonest in woodland and savanna but they are also found in forest and occasionally occur in relatively arid areas (Kingdom, 1974).

Chumbe Island would provide an ideal habitat, especially during the fertile season, for *Eidolon helvum* (Straw Coloured fruit bat), capable of nocturnal migration to Zanzibar for feeding. However, no observations of this species were made.

#### 4.2.3 REPTILE COLLECTION

14 specimens of a possible 6 species were collected. One species of Gecko and the remainder were skinks. The gecko was common on the sides of buildings and has been identified as *Hemidactylus platycephalus* (flat headed tropical house gecko). The skinks were predominantly Mabuya species (striped skinks) from the forest, though one species frequenting bare coral rag and the intertidal zone may be a *Cryptoblepharus* species (coastal skink). All specimens await identification at the National Museum, Bulawayo, Zimbabwe.

#### 4.2.4 AMPHIBIAN COLLECTION

Throughout the Frontier visit, no Amphibians were heard. A specimen of *Xenopus* spp. was collected.

### 4.3 VERTEBRATE OBSERVATIONS

#### 4.3.1 ORNITHOLOGICAL STUDY

See Appendix 9.2

#### 4.3.2 GENERAL OBSERVATIONS

Two species of snake were observed but identification was not possible. One was arboreal and the other was a thread snake - *Leptotyphlopidae*

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#### 4.4 INVERTEBRATE COLLECTION

##### 4.4.1 GENERAL COLLECTION

Collection of invertebrates within the forest yielded disappointing results, abundance and diversity of species appeared low. In thicket and more open forest areas insects were more numerous. Further collection, especially in other seasons, would add to the list of known species. Two species of terrestrial mollusca were collected from the forest and await identification at the university of Dar es Salaam.

##### 4.4.2 MALAISE TRAPPING

A malaise trap was placed at two separate sites in the forest. Designed to catch flying insects the trap was placed across paths and maintained for a week at each site. Capture rates were low with 21 specimens caught from the groups: Coleoptera, Diptera, Hemiptera and Hymenoptera. The results may be affected by the dry climate and low number of fertile plants. The specimens have been sent to the University of Copenhagen and await identification.

##### 4.4.3 BUTTERFLY COLLECTION

See appendix 9.3

#### 4.5 SOIL SAMPLES

See appendix 9.4

#### 5. SUGGESTED AREAS FOR FURTHER RESEARCH

i) Conduct an annual (ideally 2 years) study of the terrestrial ecology of Chumbe island, enabling baseline information to be obtained. Thus the impact of future development may be assessed. Areas of particular interest include:

- The fruiting and flowering pattern of vegetation.
- Seasonal changes in vertebrate and invertebrate populations

ii) Establish permanent vegetation plots to estimate the natural regeneration rates of the coral rag forest. Through a comparatively small area of forest, information from Chumbe may be applied to other areas of similar vegetation possibly enabling acceptable levels of resource use to be determined.

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## 6. CONCLUSION

The presence of coral rag vegetation enhances the conservation value of Chumbe. However when considered singularly, preliminary results suggest the forest is of comparatively low biodiversity. The species presented show affinities to similar forests on Zanzibar and Pemba, though are of lower abundance, possibly limited by the extent of forest present. By allowing the forest to naturally regenerate species numbers may increase positively influencing the value of the site, especially when considering that the site will receive protective management as part of the Chumbe Coral Park Project. The Chumbe environment is a particularly harsh one and therefore the flora and fauna should show a high degree of specialization. A study over a greater period of time could discover possible endemics.

## 7. ACKNOWLEDGEMENTS

Acknowledgements are due to Mzee Omari of the Zanzibar Agricultural Research Council for permitting Frontier to conduct research on Chumbe Island.

Grateful thanks to Mrs. Sybille Riedmiller, the director of the Chumbe Coral Park Project and her staff for enabling the Coastal Forest Research Programme to work on the Island. Thanks are also due to Mr. Saleh Khiari, the Zanzibar Forestry Department Conservation Officer for his assistance and information.

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9. APPENDICES

9.1 APPENDIX 1

PLANT SPECIES LIST

NUMBER	BOTANICAL NAME	LOCAL NAME
C1		
C2		
C3		MOTOMOTO
C4		MTARA RAWANDA
C5		
C6		MBIBIKIU
C7		MDIMU MSITU
C8		
C9		MTONGO
C10		CHANI
C11		UWANGA DUME (OLD)
C12		KONGE
C13		MLAPAA
C14		
C15		MKANDIKA
C16		
C17		MTAGO
C18		MKONGA
C19		MFURUGURU
C20		
C21		KIVUMBASI DUME
C22		MLANUNGA
C23		MTIKIZA
C24		MSISA
C25		MCHTAPIA PUNJU
C26		
C27		MLANUNGA
C28		
C29		
C30		
C31		MTAGO MDOGO
C32		
C33		
C34		
C35		MKWAMBA MAJI
C36		UWANGA DUME (YOUNG)
C37		MKONGA
C38		
C39		KITATU (FAMILY)
C40		UWANGA
C41		KIVIZA
C42		Introduced garden spp.
C43		MTIKIPINDI
C44		FAGIU SPP
C45		KITATU
C46		MNUSI

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C47  
C48  
C49  
C50  
C51  
C52  
C53  
C54  
C55  
C56  
C57

DUNGUZE  
FAGIU SPP  
KI KWANGA KWANGA  
MKENETA  
FAGIU  
MKUNGUNI  
UWANGA  
YUGWA  
MNAVU KITUNGA  
MTUNGOU MAJI  
MKONGWA



## 9.2 APPENDIX 2

### ORNITHOLOGICAL STUDY - PHIL BOWEN

#### Introduction:

Chumbe is an uninhabited coral rag island covered by two major vegetation types. These create habitats for a recorded 40 species of birds (Kohler and Kohler, 1993). The aim of Frontiers work on the island was to carry out a general biological survey over a period of two weeks. Incorporated into this brief was a supplementary study of the local avifauna. For the purpose of this report the Chumbe ecosystem includes Chumbe island, two small islands off the southern tip and the entire intertidal zone.

#### Results:

SPECIES	VERNACULAR	HABITAT	FREQ.	OBSERV.
<i>Egretta gularis</i>	Reef Heron	Intertidal	1	Grey phase-R
<i>Haliaeetus vocifer</i>	African Fish Eagle	Intertidal		-R
<i>Falco subbuteo</i>	European Hobby	Offshore	4	passing through -M
<i>Charadrius hiaticula</i>	Ringed Plover	Intertidal	2	-M
<i>Pluvialis squatarola</i>	Grey Plover	Intertidal	2	-M
<i>Charadrius leucenautili</i>	Great Sand Plover	Intertidal	3	-M
<i>Numenius phaeopus</i>	Whimbrel	Intertidal	4	-M
<i>Sterna anaethetus</i>	Bridled Tern	Intertidal	4	-R
<i>Streptopelia semitorquata</i>	Red-Eyed Dove	Forest	1	-R
<i>Apus affinis</i>	Little Swift	Cleared thicket	1	around lighthouse -R
<i>Andropadus importunus</i>	Zanzibar Sombre Greenbul	Cleared thicket	3	-R
<i>Eremomela icteropyg.</i>	Yellowed Bellied Eremomela	Forest	2	-R
<i>Alissonax adustus</i>	Dusky Flycatcher	Cleared thicket	1	-R

<i>Egretta intermedia</i>	Yellowed-Billed Egret	Offshore	4	passing through	-R
<i>Nectarinia olivacea</i>	Olive Sunbird	Cleared thicket 1			-R
<i>Nectarinia vexillii</i>	Mouse Coloured Sunbird	Cleared thicket 2			-R
<i>Corvus splendens</i>	Indian House Crow	All habitats	1		-R

N.B. Frequency: 1 = more than one sighting per day; 2 = one per day; 3 = one per 2-5 days; 4 = one per 5 days or more

## DISCUSSION

Three habitat types which may be identified in the Chumbe ecosystem are given below:

1. Forest and Thicket (50% of ecosystem area)
2. Intertidal zone (45% of ecosystem area)
3. Cleared thicket and coconut grove (5% of ecosystem area)

N.B. Birds were also recorded from a fourth site; Offshore. These were birds that appeared to be passing through.

There is a clear discrepancy between the number of species seen in each habitat. The habitats may therefore be given a species-number value.

The intertidal zone (2) has the most number of species - 7

The cleared thicket (3) has - 5

The forest (1) showed a relative paucity in species - 2

This is particularly interesting considering that the forest habitat takes up 50% of the ecosystem area. These results may however be open to observation bias. The ease of location and identification of birds is far greater in habitats (3) and (2) than in (1) where the dense vegetation and increased elusivity of the bird species' makes observation more difficult. This difference is accentuated in our results by the comparatively short time spent on the survey.

During the survey a significant relationship between habitat type and species type was noted. Only one species, the ubiquitous Indian House Crow (*Corvus splendens*) was recorded in all habitats. Although a close habitat - species relationship is to be expected, these results emphasise the unusually sharp contrast in habitat types and hence species' type that can be seen in the Chumbe ecosystem.

The survey was carried out between 13th and 30th March. This period falls within a crucial season when many species in the

locality are passage migrants which return to temperate regions during summer months to breed. The resident status of species seen is given in the results. As can be seen a high proportion of Chumbe's birds are migrant species (30%). The islands importance as a refuge for these species is unknown and may be considerable. Similarly the status of resident species is difficult to evaluate from such a short study period. Certainly the ecosystem would appear to be able to provide breeding sites for most if not all species. The only resident bird of prey recorded was the African Fish Eagle (*Haliastur vocifer*). Although the main island is plentiful in trees of the *Euphorbia* spp, a favourite nesting tree for *H. vocifer*, they are relatively short and unsuitable. It seems more likely that the eagles are nesting on one of the islands at the Southern tip of the main island. On such isolated, inaccessible islands they have been known to nest on the ground. It has been noted that the eagles tend to return to these islands to eat their catches.

#### CONCLUSION

The Ornithological study was carried out as part of a more general Biological survey of Chumbe Island. The bird-species count is low compared to the more detailed study by Kohler and Kohler (1993). This however reflects the elusive nature of much of the islands bird life, particularly forest species. Within the forested area, sustained bird observation is difficult due to the dense vegetation. It is to be suggested that forest guides familiarise themselves with the calls/songs of local species.

Further recommendations for continued research:

An attempt to evaluate Chumbe's importance as a refuge for migrant species.

A study of the movements of resident species.

A study of the breeding status of resident species.

Chumbe's potential attraction to Ornithological ecotourists is significant: The species that were recorded remain of high intrinsic interest value.; i.e. species such as the African Fish Eagle (*Haliastur vocifer*), the Reef Heron (*Egretta gularis*), and the Zanzibar Sombre Greenbul (*Andropadus importanus*) have a higher than average attraction potential to visitors. If forest guides were able to locate and identify forest species by calls then the number of species recorded would increase.

#### LITERATURE CITED

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### 9.3 APPENDIX 3

#### BUTTERFLY SPECIES LIST, CHUMBE ISLAND SAMANTHA MUNN

##### INTRODUCTION

A preliminary study of the butterfly species present on Chumbe Island was carried out between 17th & 30th March 1993. Uninhabited, Chumbe Island is situated eight miles SouthWest of Zanzibar. At an altitude of 10 metres. It consists mainly of coral ragforest open regenerating thicket areas.

Both netting and Blendon butterfly trapping methods were used to collect specimens of each species, although trapping was far less successful due to the high number of fertile food plants in the open areas. A total of 13 species were identified (both through collection and observation), the majority of which were at very low abundance which may make them vulnerable to disturbance. No specimens were recorded in the forest areas, probably due to the thick canopy cover which allows little light penetration and most plant species being sterile during the study period. The *Colotis* species appeared to be the most common in the open thicket habitat. The highest activity periods seemed to be during the cooler hours of the morning and mid-afternoon, with little activity being observed during mid-day.

##### RESULTS

SPECIES	VERNACULAR
Lycaenidae	
<i>Hypolycaena philippus philippus</i>	Purple-brown hairstreak
Pieridae	
<i>Colotis pallene</i>	Bushveld orange-tip
<i>Colotis</i> spp. 1.	
<i>Colotis</i> spp. 2.	
<i>Catopsilia florella</i>	African migrant
<i>Belenois aurota aurota</i>	Brown-veined white
<i>Belenois thysa thysa</i>	False dotted-border
<i>Belenois zochalia zochalia</i>	Forest white
Nymphalinae	
<i>Hypolimnas misippus</i>	Diaderm (mimic)
Papilionidae	
<i>Princeps demodocus demodocus</i>	Citrus swallowtail

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Satyrinae

*Bicyclus safitza safitza*

Common bush brown

Hesperiidae

*Gegenes hottentota*

Latreille's skipper

Acraeinae

*Acraea zetes acara*

Large-spotted acraea

DISCUSSION

Even during this short period of study, seasonal population changes have been observed. Therefore, a year-round study would produce a comprehensive report on species abundance and flight period, as well as food plants. More species may also be identified which were not present at the time of study. Yearly monitoring of species diversity and abundance would also indicate whether the butterfly population was being adversely disturbed, for example through loss of food plants or larval host plants.

To enhance tourist interest, a butterfly display case could be mounted ( showing both male and female forms where they obviously differ in size and colouration) so that identification through observation can be made.

Attention should be drawn to the vegetation in the area between the lighthouse and the SouthWest coast-line, which appears to be a high priority food source for the majority of the butterfly species so far identified. This area should be taken into account during the islands development.

## 9.4 SOIL SURVEY - LEIGH STUBBLEFIELD

### SOIL OF CHUMBE ISLAND FOREST

The soils under Chumbe Forest were sampled and analysed to determine their physical and chemical properties, and the implications for future management of the islands natural vegetation.

The underlying substrate of (calcareous) reefal sediments of (Carboniferous) age, termed Coral Rag, has a profound effect on the nature and distribution of soil on Chumbe. Limited in depth to shallow (10cm) pockets in the rocky, broken topography the forest soils can be considered as Lithic Leptosols, according to the FAO/UNESCO system of classification.

The soil exhibits homogenous physical and chemical properties throughout the forest. Characteristically shallow of a single A horizon lying directly over bedrock. Soils are pale reddish-brown silty clays, occasionally grading to silty clay loams. The weak structure is reinforced by dense surface roots and humus. The rhizosphere is limited and plants exhibit rooting adaptations, such as growing through rock fissures, to fully exploit available water and nutrients.

Soil capability is enhanced by the addition of organic matter, and maintained by the closed nutrient cycle occurring in little macro-fauna was apparent, positively influencing structure and organic matter decomposition.

The average organic carbon content in forest soils of the humid tropics is approximately 4% (Yanney, 1980). Thus the soils of Chumbe comprise moderate humus levels. The higher temperatures and humidity characterising tropical climates increases the rate of biological activity and results in a faster rate of leaf litter decomposition than temperate regions, even though the amount deposited annually is greater. Organic matter has significant benefits to structure, water holding capacity, supply and availability of nutrients. The positive effect of this organic component is reflected by the comparatively high Cationic exchange Capacity ( $18 \text{ cmol kg}^{-1}$ ). The Cationic Exchange Capacity, also a function of the high clay fraction (49%), indicates the sum of total exchangeable cations the soil can absorb and directly influences nutrient availability. The soil reaction (pH) determines the concentration of inorganic ions in the soil solution. On average the soil has a slightly acid pH (6.0), possibly as a result of the maritime conditions for the availability of nutrients and for micro-organisms responsible for decomposing.

The available nutrients (table 1) are essential for healthy plant growth and function, thus the maintenance of soil fertility is crucial to the survival of Chumbe forest. The current nutrient status of the soil is high compared to those of mainland Coastal Forests (Stubblefield, in prep.).

Of all the plant nutrients only Nitrogen is not present in parent

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Sample	TEXTURE			Texture Class	MOIST FACTOR		EXCHANGEABLE							SATURATION BASES	
	% Sand	Silt	Clay		+ Air Dry	+ Over Dry	% Organic Matter	PH	CFC Meg/100g	Na Mg/g	K Mg/g	Ca Mg/g	PO <sub>4</sub> Mg/g	Mg/g NO <sub>3</sub>	
C1	-	50	50	Silty Clay Loam	10g	9.86	3.1	6.4	18.00	1.48	2.01	5.01	3.41	5.00	
C2	-	49	51	Silty Clay	10g	9.83	2.9	6.3	10.11	0.91	3.93	4.72	4.00	5.12	
C3	-	60	40	Silty Clay Loam	10g	9.89	3.0	6.1	13.20	1.26	2.12	4.59	5.00	6.92	
C4	-	57	43	Silty Clay	10g	9.89	2.7	6.3	20.96	0.38	2.21	4.33	2.00	5.19	
C5	-	50.5	49.5	Silty Clay	10g	9.89	2.5	6.3	23.67	1.12	2.36	4.11	4.12	6.23	
C6	-	50	50	Silty Clay	10g	9.95	3.0	5.1	19.50	1.65	2.40	4.21	4.12	5.09	
C7	-	48	52	Silty Clay	10g	9.84	4.0	5.5	20.00	1.44	1.21	5.00	5.00	5.21	
C8	-	46	54	Silty Clay	10g	9.87	8.9	6.1	20.02	1.26	3.45	3.12	5.13	5.03	





