FRONTIER TANZANIA

INTERIM REPORT

Preliminary results of biological surveys in Zaraninge (Kiono) and Kierengoma (Matumbi Hills) Coastal Forests, Tanzania:

January to March 1990

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October 1990

THE SOCIETY FOR ENVIRONMENTAL EXPLORATION

PREFACE

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Frontier-Tanzania started in July 1989 and to date has involved over 200 people from both Tanzania and overseas. Field research is being undertaken on a variety of habitats in Tanzania's coastal zone, chosen for their high biological interest and conservation value. Habitats under study include mangroves, coral reefs, coastal forests and savanna. The projects have been developed with the assistance and collaboration of the Ministry of Lands, Natural Resources and Tourism, Tanzania National Parks and the University of Dar es Salaam.

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CONTENTS PAGES

LIST OF FIGURES

SUMMARY

Tanzania's coastal forests, support globally important and unique ecological communities, but are scientifically poorly known and are severely threatened from logging and agriculture.

The objective of this expedition was to contribute to the inventory of forest flora and fauna in two poorly-known coastal forests (Zaraninge and Kierengoma). Additional descriptive information was also gathered as background and to augment existing knowledge. The field research projects were organised by a team of scientists from Tanzanian and European institutions. The team comprised botanists, foresters and zoologists including lepidopterists and ornithologists. These persons were assisted at all times by voluntary European participants whose enthusiasm and willingness to learn provided the major input to the project.

This report documents the work undertaken in these two coastal forests between January to March 1990.

The results are divided into background information which provides the context for the work with some descriptive information, and the scientific findings of the projects. In many cases only preliminary observations and results can be reported as the vast amount of collected material and documentation will take many years to be fully processed and final conclusions reached.

The background information draws on formal projects to map the forests and to interview local inhabitants as well as more informal data gathering. These operations formed a particularly significant proportion of the work undertaken at Zaraninge. Kierengoma had been surveyed and researched by the previous (October to December 1989) Frontier expedition.

All specimens collected were passed to the University of Dar-es-Salaam for further processing, identification, and distribution to relevant

experts. In some cases the expedition members were able to contribute to the further processing, preliminary categorisation and organisation of these collections.

Botanical collection was undertaken in both forests and yielded about 700 replicated sets of specimens, or about 4,000 individual herbarium specimens. Full documentation of the locality, local name and uses was made for each specimen. All material has been sent to the Royal Botanic Gardens at Kew for identification, but no results are available. Transects were also established and scale diagrams of the forest profiles drawn. Moreover, field work aimed at evaluating the agroforestry potential of leguminous trees at the Nambunju Village (Kierengoma) was also accomplished.

Zoological collection was undertaken in both forests using a wide variety of techniques. Many tens of thousands of specimens were collected, with most components of the fauna being well represented. Preliminary species lists for vertebrates are presented and include many significant records. Different taxonomic groupings of invertebrate material have been sent to relevant authorities around the world, but it is likely that much of this material will not be identified for several years. However, many of the invertebrate groups collected (e.g.arthropod soil fauna) have never been sampled previously and should provide much material new to science, and unique to the coastal forests.

Mist-netting and direct observation of birds was also carried out at both forests. All birds caught were measured, documented and ringed. This work led to many notable records being made and to the first comprehensive species list for the Kierengoma Forest.

These field projects have generated a great deal of material, both physical and documentary. It is most significant that virtually all species recorded provide new distributional information, and although it is unlikely that this material will be fully identified for several years it is clear that much notable data have been generated.

ACKNOWLEDGEMENTS

We wish to thank all those who worked to make this expedition possible, most of whom are listed in Appendix 6. We are also indebted to Professor Juma Kapuya (Head of Department of Botany, University of Dar es Salaam (UDSM)), Professor Kim Howell (Department of Zoology, UDSM), Kaj Vollesen (Royal Botanic Gardens, Kew) and Jon Lovett (Missouri Botanic Garden and Department of Botany, UDSM) for their support and assistance. We would also like to thank all other Tanzanian scientists who participated and the Tanzanian authorities who gave assistance, especially the Chama Cha Mapinduzi (CCM) of Sadani and Mbwara.

1.0 INTRODUCTION

1.1 BACKGROUND TO TANZANIAN COASTAL FORESTS

1.1.1 Context

Unlike many other equatorial countries Tanzania has little natural closed forest. The extent of evergreen and semi-evergreen forest is estimated to be between 1 - 2% of the country's land area. Concern about tropical forests and their conservation has therefore been focused on other nations. It is, however, becoming increasingly clear that Tanzania's forests have a biological importance that is greatly out of proportion with their limited extent. This significance has been widely recognised for the 'Eastern Arc' montane forests, but many of the smaller forests that lie scattered across the country are also starting to reveal remarkable biodiversity. In particular, the forests along the coastal strip (coastal forests) have been highlighted as requiring further detailed scientific work so that their true biological wealth can be revealed (Lovett, 1989).

1.1.2 Definition of coastal forest

The coastal forests of Tanzania constitute part of the Zanzibar-Inhambane Regional Mosaic of White (1983a). There is, however, no single agreed definition of 'coastal forest' (see Hawthorne, 1984 for discussion on the difficulty of defining typical coastal forest flora). Varying levels of disturbance further complicate this problem as degraded forest and thicket may preserve some characteristics of the previous forest communities.

The definition of coastal forests adopted in this publication is as follows:

1) Coastal forests would under natural circumstances be dominated by woody species which regenerate successfully within mature forest.

2) Coastal forest is subject to the monsoonal climatic cycle from the Indian Ocean, and its existence depends upon the rainfall associated with these systems.

3) Extensive clearance of coastal forests would lead to invasion by predominantly woodland species.

A definition of this type has the advantage of excluding mangrove and montane habitats without describing overspecific site characteristics or forms of vegetation.

1.1.3. Biological importance and history

Despite their limited size, Tanzanian coastal forests are increasingly recognised as major centres of species diversity and endemism (Bensted-Smith and Msangi-Msangi, 1989; Lovett, 1989; Kingdon, 1990). For example, of the 190 recognised forest tree species in the coastal region 92 are endemic to this area (White, 1983a). This high level of endemism is remarkable when compared with more extensive Tanzanian habitats.

The unique and diverse species composition of the coastal forests can be viewed in relation to historical and biogeographical factors of the region (see White, 1983b; Hawthorne, 1984; Kingdon, 1990). Some of the most important of these are outlined below:

1) Previous epochs of higher sea levels would have created genuine islands of many coastal forest areas. The long term isolation of these "island habitats", both as genuine islands and more generally as discrete areas of true forest, has allowed the independent evolution of specialised communities in the context of the local geology, climate and other factors.

2) The Indian Ocean has maintained an exceptionally stable temperature over the past 40 million years. This has led to a consistency in the coastal climate over geological time. This is especially significant in the context of the last ice-age and the

more recent increases in aridity of much of Africa's lowlands (Hamilton, 1982).

The presumed stability in the local climate of the coastal forests has given rise to two important concepts: firstly that these forests may have provided a refuge for species wiped out elsewhere as a result of environmental changes, and secondly that climatic stability allows for the steady development of communities with a high degree of specialisation and specific adaptation.

3) Species elements from a wide range of origins can be found in the coastal forests. The closest relatives of some species lie in the moist forests of Central and West Africa, others on the islands of the Indian Ocean, and others from areas much further north and south along the coast. These affinities are not random as there are characteristics that distinguish northern coastal forests from those to the south (Hawthorne, 1984), but they are poorly understood at present.

Taken together, these factors suggest that forests on lower lying land would have been inundated by more recent sea level changes and hence are unlikely to contain as high a biodiversity as those on higher ground. Both Kierengoma and Zaraninge forests lie on raised areas of land and therefore might be expected to have escaped inundation and thus support a rich flora and fauna.

Systematic scientific research has been largely restricted to a handful of Tanzania's coastal forests and these two project sites have received little previous scientific investigation (Lovett, pers. comm.). Moreover, the Rufiji river is believed to form a barrier for many floral and faunal elements and the study site at Kierengoma should provide useful biological information to test this hypothesis.

1.1.4 Current situation and status

The entire area of known coastal forests in Tanzania constitutes no more than a few hundred km^2. Individual forests rarely cover more than ten km^2, and form a fragmentary mosaic of forested areas along the coast, often on areas of slightly raised ground (Burgess *et al.*, in prep.).

In many areas these remnant coastal forests have been severely affected by human activities, such as logging for timber or for charcoal production, removal of poles, and land clearance for agriculture or plantation forestry. This disturbance frequently results in invasion of secondary vegetation into the remaining forest.

Many remaining forests fall within Forests Reserves and in these sites timber extraction is licensed by the State. However, the level of extraction is often too high to be sustainable.

1.1.5. Future developments

There is hope that some conservation measures will be taken to preserve these forests, as stated in the Tropical Forestry Action Plan (Bensted-Smith and Masngi-Msangi, 1989). Several national and international organisations are currently developing a strategy for the better management of these systems but there is a clear need for much basic research to provide data on the biological importance of sites.

1.2 BACKGROUND TO THE EXPEDITION

1.2.1 Context

Kierengoma and Zaraninge coastal forests were selected for examination during this, the third, Frontier expedition as they were known to be of great interest. Zaraninge had been previously studied for three weeks during the first Frontier expedition (Burgess, 1990), and Kierengoma had been previously studied for three months by the second Frontier expedition (termed Matumbi

Hills: Kingdon, 1989). Improved information was, however, urgently needed on both these forests to assist national and international policy formulation, and improve prospects for their conservation. The location of both forests is presented in Figure 1

1.2.2. Aims

The primary aim was to undertake comprehensive biological inventory at Zaraninge and Kierengoma, with the production of exhaustive species lists for all aspects of the forest flora and fauna. A secondary objective was to gather information on forest status, local usage, and any other general descriptive information.

1.2.3 General Methodology

Research activities were carried out in two areas of the coastal forest for the periods stated below.

Zaraninge (Kiono)	15/1/1990 - 30/1/1990
	25/2/1990 - 18/3/1990
Kierengoma (Matumbi)	31/1/1990 - 22/2/1990

A team of scientists from Tanzanian and European institutions formulated and organised the research and collecting activities of the project. The team comprised qualified botanists, geologists, foresters, zoologists, lepidopterists and ornithologists. All members of the field team are listed in Appendix 6.

Although collection constituted the major part of the work it should be recognised that much of the descriptive information not only provides a context for this work but is important data in itself. For instance, an evaluation of threats and local land use practices are clearly crucial to developing a rational policy towards habitat protection.

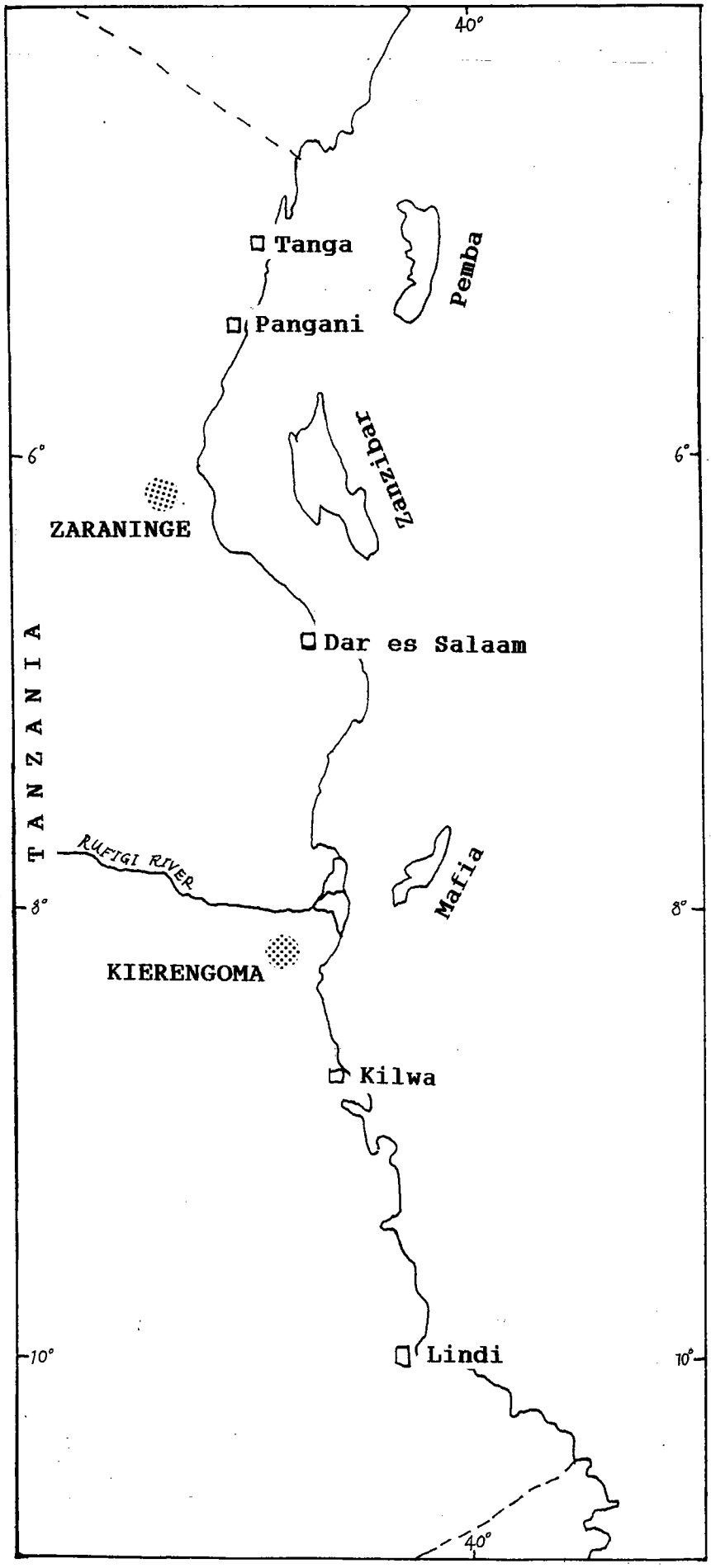


Figure 1. The coast of Tanzania showing location of Zaraninge (Kiono) and Kierengoma (Matumbi Hills) Coastal Forests

2.0 SITE DESCRIPTIONS

2.1 ZARANINGE (KIONO) FOREST

2.1.1 Location

The forest is situated between 6°6′ and 6°10′S and 38°35′ and 38°39′E on the Zaraninge Plateau in Bagamoyo District, Coast Region (Figure 1). The Plateau, which rises to 300 metres, is inland from the Sadani Game Reserve, lying about 10 Km due west from the coast.

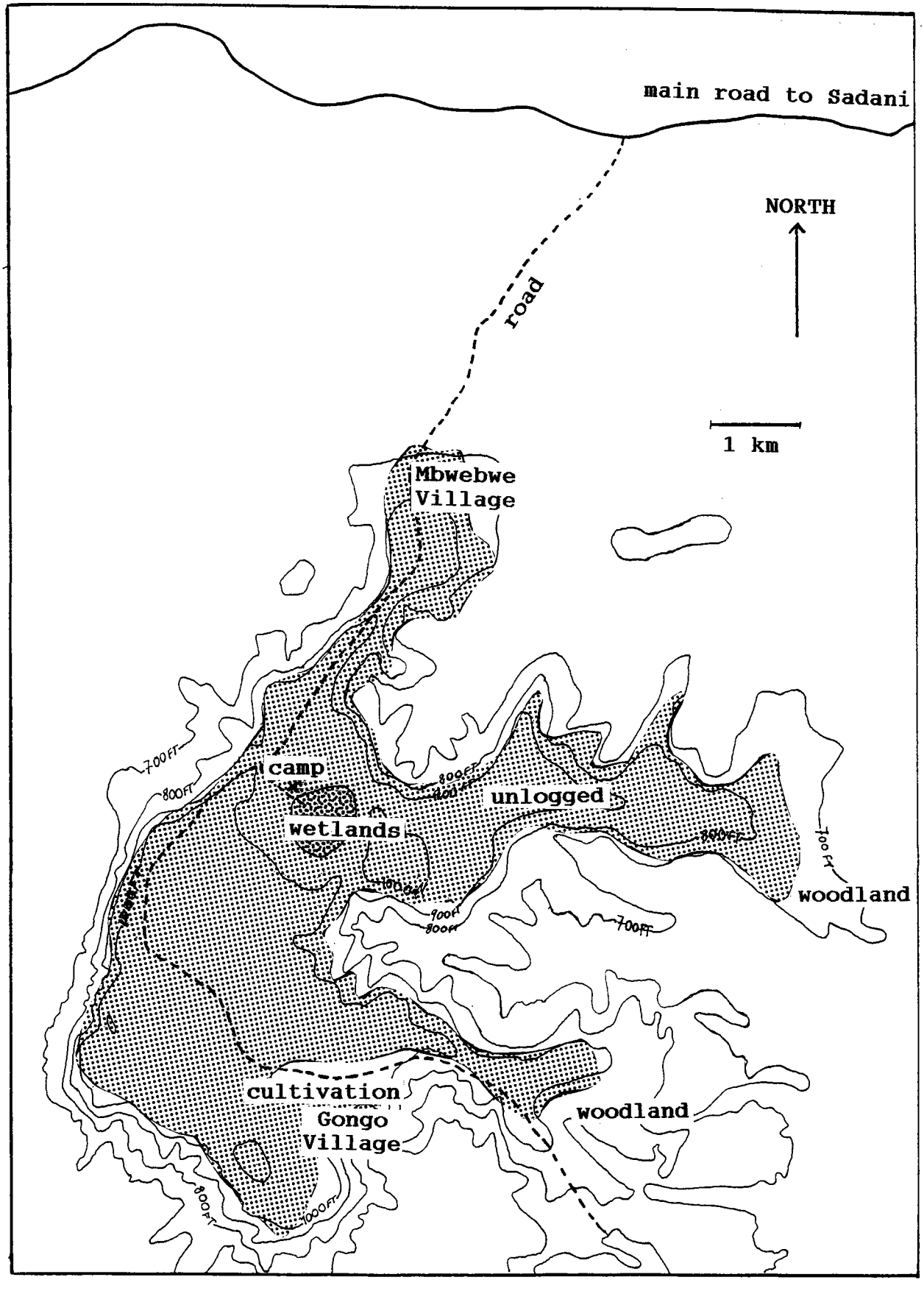
The expedition camp was located to the north of the plateau wetlands at 38°36′E 6°8′S (Figure 2).

2.1.2 Geology Topography and Soil

The Plateau is composed of limestone and calcareous sandstone which may date from the Jurassic (N. Burgess, pers. comm.), although the Cretaceous-Neogene boundary is also believed to be exposed (Hawthorne, 1984). The underlying rock is only revealed as weathered sandstone outcrops on the steeper edges of the plateau and possibly exhibits pyroclastic metamorphosis (S. Jacques and T. Waters, pers. comm.). The steepest slopes are on the west and south-west edge of the plateau. To the east the slope to the coastal plain is more gradual, although localised areas of steep gradient can be found on all sides of the central high ground.

The soil is sandy in all areas, both in the forest and within the plateau wetlands and appeared fairly homogeneous to the depth revealed by the root plates of fallen trees and our own (2 metre) well diggings. The humus layer contributes dark organic matter to the soil but this is rarely deep. In the wetlands there is a slight "peatiness" to the sand which tinted the ground water. The lower slopes of the plateau also have a sandy soil but with a high level of small quartz pebbles and often carbon from past fires.

Figure 2. Map of Zaraninge (Kiono) Coastal Forest and surrounding area



2.1.3 Forest Description and Extent

Forest cover is fairly homogeneous reflecting the level topography and similar soil type. The greatest variation (anthropogenic factors apart) occurs where forest grades into either woodland or wetland. Some variation also occurs at the plateau edge and slopes where rocky outcrops break the surface and forested gullies occur.

The Forest Reserve covers some 200 km^2 of which only 19-22 km^2 is true coastal forest (see SECTION 3.1). A few tens of hectares of the forest are presently under cultivation, and approximately 1 km^2 under dense scrub arising from former cultivation. Most of this clearance is focused on Gongo village. Mbwebwe and a few isolated shambas to the north account for only a few hectares of cleared forest land.

2.1.4 Legal Status

The entire extent of the true forest has been within the Zaraninge Forest Reserve since 1954. It has previously been referred to in maps and writing as "Kiono Forest", "Kiona Forest", "Mkange Forest" and "Miono Forest". The present boundary was mapped in 1987 and contains roughly 200 km^2 of land, most of which is woodland. The northern perimeter of the Reserve is marked by a section of the Miono-Sadani Road. A section of the Dar-es-Salaam to Tanga Railway represents the eastern boundary. The western and and southern perimeter is irregular in shape. The western boundary lies at the western edge of the plateau with the southern boundary located such that much of the area cleared by Gongo villagers lies within the Reserve.

2.1.5 History and Local Practices

The region has been home to the Wazigua and Wadoe tribes for several centuries. The Dar-es-Salaam - Tanga Railway was built by the British Administration between 1945 and 1947 and a major station was built at Matapwili (Wami Station). The road from Wami to Gongo was constructed in the 1950s. These events shifted trade

south from Sadani, the previous major market, to Wami Station. From 1975-77 the Government brought the people together to form settled villages. Previously the rural population lived in widely scattered shambas. The villages are not growing significantly as most women marry into distant settlements and the majority of the young men leave to obtain employment in urban areas.

Forested land has traditionally been cleared for cultivation and older people remember that the forest used to be larger in extent. Ginger plants associated with past settlement have been found on the lower plateau slopes and within the open wetlands on the plateau top, although there is no obvious sign of any recent clearance in these localities.

In choosing land to be cleared for agriculture, preference is given to areas with darker soil and a low density of larger trees. Land is cleared from September and the whole process can take many months. All but the larger trees are cleared manually, the resulting debris being collected and burnt around the base of these remaining trees. Once fired, the resulting dead trees are left to fall. Each shamba processes about a hectare of forest every two to three years.

Maize is planted in March. Permanent crops such as bananas and coconuts are intercropped into the maize and dominate in the third year forcing maize cultivation into newer clearings. An alternative strategy favoured in Mbwebwe is to plant Maize for three years then cassava for one year and only then to plant bananas and coconuts. Pineapple appears to be the favoured cash crop, grown on the best forest soil, with scheduled trucks to export them from Gongo. Other crops include millet, potatoes, limes, oranges and mangoes. Chickens are the only livestock.

There is some effort to control monkey and baboon damage to crops and this may involve active trapping and hunting.

2.1.6 Forest Exploitation

Large animals were previously hunted in the Forest Reserve but this illegal activity is now reduced. The local population recognise that a higher concentration of game species exists in the woodland areas of the Reserve rather than in the genuine forest. The local villages collect firewood, fruits, tubers, honey, and mushrooms from within the forest. Many of the plants are valued and collected for their medicinal values. There is some tapping of "sandarusi" gum which is exported to Arabic nations. Building poles are collected legally on a permit from the forest authorities, and are sold for two shillings each in Wami. There is no charcoal production in the Reserve.

Most logging is undertaken by external enterprises which obtain their licenses from Dar-es-Salaam. Local villagers are employed only to cut and load wood. Logging started in the 1950s after the road through the forest was built. Early demand was for railway sleepers. The logs are transported unprocessed to the railway by truck and relatively little financial benefit accrues to the local people. Most accessible, quality timber has been extracted and there has been little exploitation since 1985 although trucks are still returning to remove the cut timber.

2.1.7 The Future

It is rumoured locally that the Forest Reserve may be merged with the adjacent Sadani Game Reserve to form one area under the juristiction of the Wildlife Division of the Ministry of Lands, Natural Resources and Tourism.

Confusion exists locally as to whether Gongo village is within the Forest Reserve. This may stem from the redrawing of the boundaries in 1987. Villagers are not aware of the true position of the Reserve boundaries and illegally encroach onto the plateau. The Government has recently surveyed the village and prepared plans to build a school and a dispensary in the present location. This is

within the mapped Forest Reserve and leads to further confusion as to the official status of the area. Villagers of Gongo state that they have recently been informed that they may be asked to move south to Wami. This may only be the case if the area is to become part of the adjacent Sadani Game Reserve.

Mbwebwe Village also admits some confusion as to the precise location of the Forest Reserve boundaries. At present villagers are clearing in woodland areas outside the reserve until this situation is clarified. The inhabitants of Mbwebwe seem concerned to demonstrate that they inflict the minimum of damage on the forest and believe that their methods are, and indeed must be, sustainable.

2.1.8 Sources and Contributors

Mapping work was coordinated by Douglas Sheil with the assistance of Jason Rubens, Frank Mbago and Andrea Green. Tertia Waters, Cleo Small and Mary Lane also contributed.

Interview material was provided by Mary Lane from verbal questionnaires that were completed with the assistance of Frank Mbago who acted as interpreter. Shabani Kikwape (70 years old, Gongo Village) Ramadhani Athumani Mtaula (about 80 years old, Mwebwe Village) and our guide Saidi Kikwape (39 years old, Gongo Village) were all interviewed.

2.2 KIERENGOMA (MATUMBI HILLS) FOREST

This section of text draws extensively on data collected by the previous Frontier expedition to Kierengoma between October and December 1989 (Kingdon, 1989).

2.2.1 Location

The Matumbi Massif is an area of high ground south of the Rufiji river, straddling the boundary between Rufiji District - Coast Region, and Kilwa District - Mtwara Region. The Kierengoma Forest Reserve is located on the northeastern side of the massif within Rufiji District, and lies between 38°54′ and 38°58′E and between 8°20′ and 8°23′S (Figure 1). There are undoubtedly several forests on the Massif but geographical considerations would suggest that they are unlikely to receive as high a rainfall.

The expedition camp was located on the northern edge of the forest in Nambunju Village 38°58′E 8°19′S.

2.2.2 Geology Topography and Soil

The Matumbi Massif is composed of Jurassic sandstones and shales and rises to slightly over 900 meters just to the southwest of the reserve.

There are several deep sandy-bedded valley systems which drain northwards out of the Reserve. The two main valleys are quite distinct - the Nambunju Valley has a bed characterised by angular rocks and exposed bed rock and the Mwengei Valley has a greater preponderance of fluvial material, rounded stones and rock-forms on the river bed indicative of a high discharge rate. There also appears to be locally permanent water beneath the sand which reaches the surface in several pools along the Mwengei Valley.

There are many examples of extreme landforms in this area which create a diversity of physical environments. Springs arise in some

locations where faulting is exposed and the underlying material is impermeable.

There is some variation in soil colour, notably the redness of the predominantly sandy soil. Other variations include the deeper humus of the true riverine forest, and the homogeneous clayey, aardvark-disturbed soils under much of the varied "woodland" vegetation types that predominates on the ridge tops.

2.2.3 Forest Description and Extent

The variety of physical environments and vegetation histories has created an intricate and heterogeneous mosaic of vegetation types. Under natural circumstances one might have seen evergreen forest in the valleys, a semi-evergreen forest on the valley sides, and a herb-rich forest or woodland on the ridge tops (depending on soil).

Superimposed on this basic pattern is a mosaic of secondary vegetation of varying ages corresponding to relict cultivation, fires, elephant damage and even tree planting. For the most part, secondary growth comprises regeneration of woodland species sometimes mixed with disturbed growth forms of the previous forest vegetation e.g. the dense liane tangles composed of low growing woody creepers that occur on many steep hill sides.

Approximately 20-25 km^2 of forest occur in the Forest Reserve, but exact figures are difficult to calculate.

2.2.4 Legal Status

The majority of the genuine forest occurs within the Kierengoma Forest Reserve where our studies were centred. The Reserve is administrated by the Forest Division of the Ministry of Lands, Natural Resources and Tourism. All felling within the reserve requires a licence and all hunting is illegal. There is also a significant area of forest on the Kilwa side of the Reserve boundary, the status of this land and the other pockets of neighbouring forest that can be seen from the Nambunju-Mwengei road

is unclear. The signs of recent widespread clearance suggest that none of the forest outside the Reserve area is protected although there appears to be some effort to retain cover on steep river banks (possibly as an erosion control measure).

2.2.5 History and Local Practices

The Wamatumbi have lived in the region for many centuries. There have probably been many changes in the pattern of settlement and it seems likely that the Reserve has witnessed intermittent periods of cultivation interspersed with forest regeneration. Controlled cutting and fire seem to be the standard method of land clearance.

This pattern of scattered cultivation has been maintained until recently with the last major evacuation of settlers occurring in 1962. Only the steepest and most rocky areas appear untouched.

Extensive planting of trees has occurred at certain locations on the flatter valley bottoms and on the shoulders of higher ground. These areas are usually products of a previous Forest Division policy to convert evergreen forest to plantation through the "taungya" system and provide good quality poles for building (see Evans, 1982). In some locations mango trees and other species stand as evidence of past occupation.

2.2.6 Forest Exploitation

Local uses of the forest include the harvesting of medicinal plants, honey and building poles. Hunting continues although traps were only observed once (C. Clunies-Ross, pers. comm.). An Elephant skeleton with a hole that may have been caused by a bullet indicated active hunting, although another skeleton seen nearer to the village was from an animal killed to protect crops.

Since 1986 there has been intense cutting of the best African mahogany trees from all accessible riverine forest areas. Pit-sawyers come from Iringa to extract the timber and local people do not gain very much. The actual practices employed are exceedingly

wasteful of the forest resource. Trees often fall in inaccessible places and are not processed further. The timber is often not of prime quality (due to defects not visible from the outside prior to cutting) or splits on felling and most is rejected. At most only a few meters of the trunk ever seems to be taken.

Much felling is unlicenced and if illegal trees are discovered by an official from the Forestry Division they are marked and cannot be used. The felled timber trees are massive and bring down much of the smaller vegetation. One result of this rapid and unsustainable exploitation is that the canopy along most of the valleys' riverine forest has been severely fragmented.

2.2.7 The Future

There are a few examples of fresh settlement within the Forest Reserve and it is likely that such incursion will continue if the Reserve status is not enforced. Logging will undoubtedly continue and the future of the riverine forest is bleak, indeed populations of light sensitive species such as the familiar and extremely rare *Saintpaulia ionantha* (the "African Violet") (Johansson, 1978) may become extinct.

3.0 BOTANICAL SURVEY

3.1 FOREST SURVEY AND DESCRIPTION AT ZARANINGE

3.1.1 Abstract

Full survey and preliminary description of the forest-types was undertaken at Zaraninge. The area of forest and other vegetation was calculated and the plateau forest, plateau wetlands and forest margins were described.

3.1.2 Introduction

Extensive survey work and preliminary descriptions of the forest vegetation had not been completed at Zaraninge (but see Burgess, 1990). This situation contrasted with that at Kierengoma where extensive survey and characterisation had already been undertaken (Kingdon, 1989).

During the periods at Zaraninge, a general policy of recording any relevant data was adopted and augmented by several specific mapping and observational exercises. The aims were to produce an estimate of the area of forest at the site and a description of the gross forest-types present.

3.1.3 Methodology

1) Survey

On tracing the existing Mbwebwe-Gongo road onto existing maps of the topography, it became clear that the villages were not correctly located on the published maps (e.g. sheet 168/1, series Y 742, edition 2TSD, published by the Survey Division, Ministry of Lands Forests and Tourism, 1963). With these reference points established and the wetland area more clearly delineated the entire forest edge was recorded in a series of "orienteering" type mapping exercises.

2) Forest description

During the forest-mapping exercises the extent of natural vegetation types was assessed and floral descriptions were produced of large-scale vegetation divisions by means of transects.

The botanical expertise and knowledge of Mr Frank Mbago, Department of Botany, UDSM was especially valuable in this work.

3.1.4 Results

1) Survey

This survey has calculated the total area of forest as between 19 and 22 km^2 (Figure 2). Within this total area, a few tens of hectares are presently under cultivation, and approximately 1 km^2 under dense scrub arising from former cultivation. Most of this clearance is focused on Gongo village. Mbwebwe and a few isolated shambas to the north account for only a few hectares of cleared forest land.

Most undamaged forest remains on the less accessible and steeper sides of the plateau. Fires and agricultural incursions have led to progressive deforestation of the lower slopes.

The eastern area of plateau forest is notable for its high density of standing dead timber and fallen trees resulting in a broken canopy and dense patches of impenetrable regeneration. Trees of all age classes seem to have died off and are in an advanced stage of decay. Most fallen trees are large specimens. Mortality is largely confined to the locally common species "Msandalusi" and "Mtengwe" (in Kizigua, the local language). There is no sign of human activity associated with this phenomenon and the loggers have to a large extent left this area unexploited.

Discussion with local people has resulted in the hypothesis that the observed synchronous tree mortality corresponds to a period of severe drought in 1973 and 1974, said to have been followed by a cyclone in 1976 or 1977 that may have brought down larger dead or weakened trees. Such events have clearly had a major ecological impact on the local forest community. It would be valuable to monitor the regeneration of the forest, especially in the light of current theoretical debate on the role of large scale habitat disturbance in the maintenance and generation of forest species diversity (e.g. Whitmore, 1974; Holm-Nielsen *et al.*, 1989).

Most of the larger timber trees have been removed from all but the eastern most section of the plateau forest described above. This extraction has occurred in the last two decades, leaving the majority of the forest criss-crossed with extraction paths and truck roads. However, forest species are regenerating strongly, even on the more recent extraction tracks.

Areas of abandoned cultivation are covered with a dense thicket cover of predominantly woodland species.

It appears that much of the woodland linked to the eastern edge of the forest is in an intermediate stage in the succession to forest as shown by the preponderance of forest species including tree seedlings in the undergrowth.

The woodland to the east of the main forest is unusually dense in many places, often creating closed canopy conditions. The distinction of true forest was critical in such regions and was based on the presence of forest species in the canopy: areas with forest canopy species were mapped as forest and areas without as woodland. Considerations of understorey species alone would probably have added a few extra km^2 to the

extent of the forest; many such areas are apparently undergoing succession to true forest.

2) Forest description

Three vegetation types were recognised within the forest area and are described below:

a) Plateau Forest

Maximum tree height is generally little more than 20 meters. The canopy is principally evergreen and is rich in legume species. Dominant trees include the tall Gum Copal Tree *Hymenaea verrucosa* (Caesalpinaceae), *Baphia kirkii* (Papillionaceae), *Haplocoelum* spp. (Sterculiaceae), and less commonly Wild Kapok *Bombax schumannianum* (Bombaceae) which is frequently and widely harvested to provide cheap and easily workable building material.

In the sub-canopy the trees *Cola* sp. (Sterculiaceae) are prevelant along with *Manilikara* sp. (Sapotaceae) and members of the Sapondaceae and Euphorbiaceae. The shrub layer principally comprises seedlings of the canopy species along with legumes such as *Millettia* sp., and members of the Rubiaceae and Euphorbiaceae.

Millettia sp., *Asparagus* spp. and a grass *Panicum* sp. are prevelant in the herb layer.

The forest has a low epiphyte diversity, though one epiphytic orchid, a *Microelia* sp., is common. Creepers and lianes are diverse and abundant and included Apocyanaceae such as *Landolphia* sp. and *Carrisa* sp., Convolvulaceae, Leguminaceae, Linaceae such as the climbing shrub *Hugonia* sp., and Commelinnaceae such as *Aneilema* spp. and *Commelina* spp. A "strangler fig" *Ficus* sp. is also widespread.

b) Plateau Wetlands

The "Plateau Wetlands" (Figure 3) occur in a slight depression on the top of the plateau at an altitude of just under 300 meters. They encompass a roughly circular area devoid of tree cover approximately 0.5 km^2 in extent. Seasonal shallow flooding occurs and there are scattered pools of more permanent water. The water is soft (as testified by its taste and lathering quality with soaps and supported by the observed low abundance of shelled molluscs in the water).

The change from forest vegetation to open sedge wetland vegetation is natural and occurs over a variety of distances in different localities (from 10 to 100 meters) (Figure 4). The following generalised sequence of vegetation types from forest to open water was distinguished:

Zone 1) Plateau Forest: see description above.

Zone 2) Mixed Canopy Forest/Woodland: composed of a varied matrix of light demanding and more shade tolerant species. The vegetation was dense with creepers such as *Mimosa pigra* and maintained forest understorey regardless of canopy composition. This region was often impenetrable and contained a high density of large termite mounds.

Zone 3) Semi-Open Woodland with Palms: woodland species dominate. The trees appear to become progressively smaller away from the forest as scattered palms become more abundant. The rich herb layer gives way to grasses and sedges. No *Brachystegia* species are found, common woody species include *Pteleopsis myrtifolia* and *Dichrostachys cinerea*.

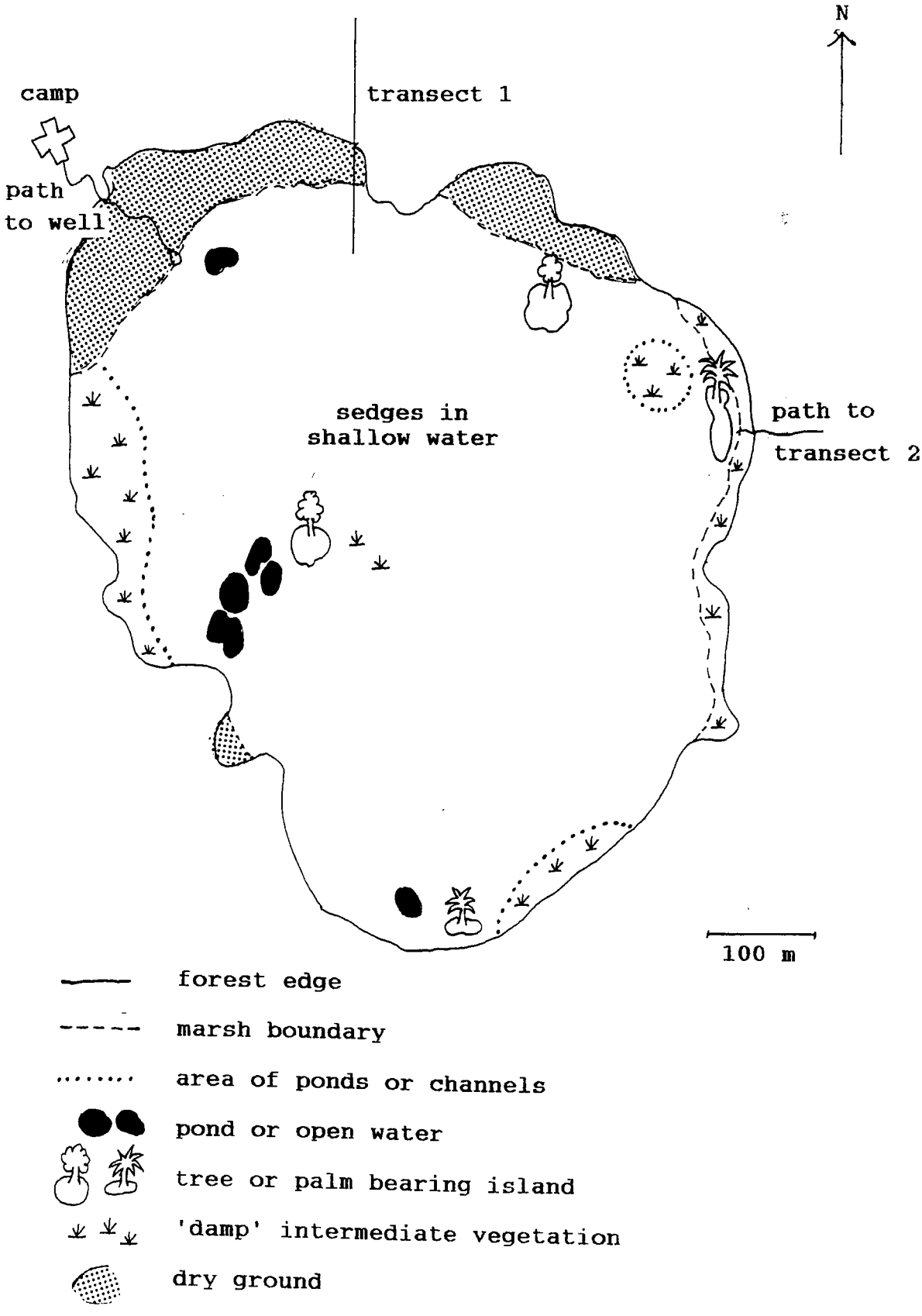


Figure 3. Detail of Plateau Wetlands, Zaraninge (Kiono)

Zone 4) Wetland Edge Zone: grass and palms give way to flooded areas of sedges. At this interface abundant creeping herbs include *Dissotis* sp., *Crotaria* sp., and *Tephrosia* spp..

Zone 5) Flooded Sedge Zone: this area is subject to seasonal flooding (50cm is probably the greatest depth) Dense sedge vegetation occurs and includes *Kyllinga* spp. and *Cyperus* spp..

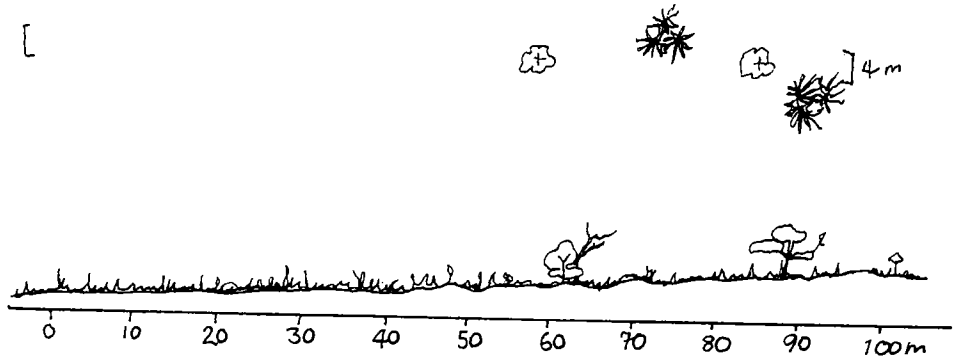
Zone 6) Freshwater Pools: these widely scattered pools are included for completeness. These pools are up to a meter in depth and are almost definitely permanent. Apart from microscopic algae the only plant life appeared to be water lilies (Nymphaeaceae) and a possible species of Hydrocharitaceae.

Vegetation islands occur in zone 5 and tend to be composed of patches of species characteristic of zones 2 and 3. These islands appear to be due to giant termite mounds and rise 1 to 2 meters above water level.

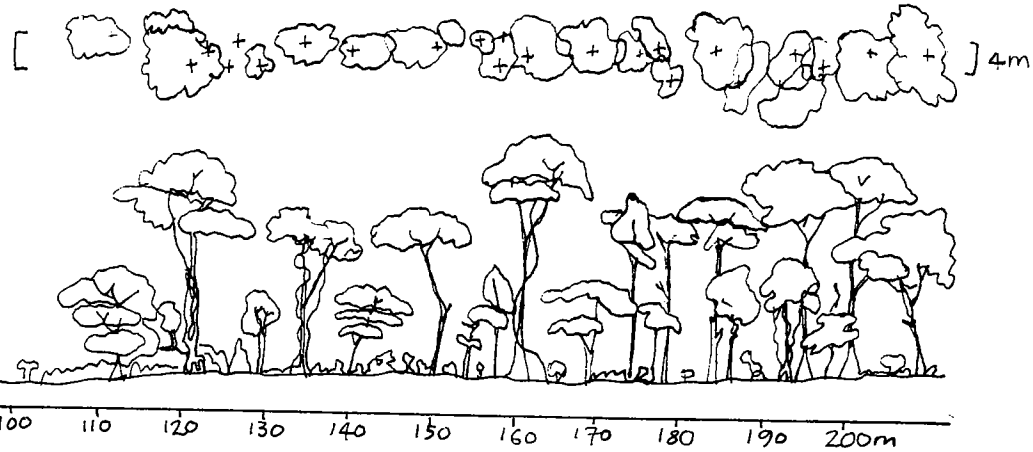
c) Plateau Edge

Variety in floristic composition at the plateau sides results from some inclusion of forest edge and woodland species, and herbaceous plants able to root on the exposed rock surfaces. Species which are more abundant on the plateau edge include the wild yam *Dioscorea* sp. and succulent tree euphorbias *Euphorbia* sp..

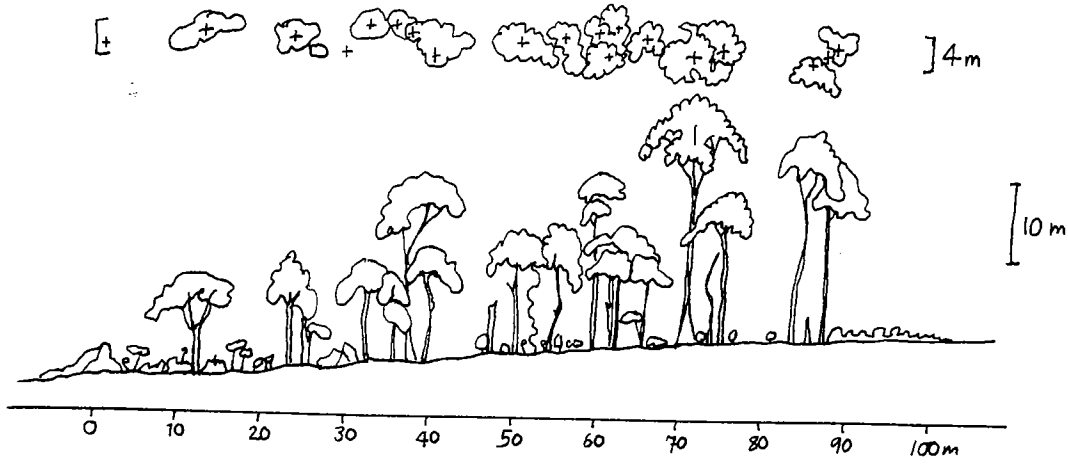
Figure 4. Diagrams of forest structure at Zaraninge (Kiono): Transect 1 (forest/wetland interface); Transect 2 (eastern plateau forest)



PLAN AND ELEVATION OF TRANSECT 1 (METRES 0-100)



PLAN AND ELEVATION OF TRANSECT 1 (METRES 100-200)



PLAN AND ELEVATION OF TRANSECT 2

3.2 BOTANICAL COLLECTION AT ZARANINGE AND KIERENGOMA

3.2.1 Abstract

Botanical collection was undertaken at Zaraninge (Kiono) forest and Kierengoma (Matumbi), complementing previous collections at the two sites (Burgess, 1990; Kingdon, 1989; Vollesen in litt. (Kierengoma)). Approximately 4,000 individual specimens were taken, of which about two-thirds were taken at Zaraninge (Kiono).

Three hundred meters of 4m wide transect line were also established at Zaraninge (Kiono) with full botanical collection, description and profile diagrams (Figure 4) being accomplished.

3.2.2 Introduction

There is a lack of detailed scientific data published on the botanical composition of all but a few of Tanzania's coastal forests (see Hawthorne, 1984). The objective of this project work was therefore to collect all vascular plant species within the chosen localities. All collections are likely to produce new species and notable distribution records. By collecting through the seasons, as this project is attempting, valuable phenological data is also being accrued.

3.2.3 Methods

A "wet method " of collection was employed to preserve botanical specimens in the field and during storage at camp. The selected plant material was pressed flat in labelled newspaper sheets. Later, at the camp they were transferred, still in newspaper to large plastic bags (approximately 100 to 150 specimens to a bag). The paper was saturated with 100% commercial methylated spirit and the bags sealed for storage. This methodology subjects the specimens to minimal risk from fungal attack during prolonged storage.

Priority was given to collecting plants in their fertile state; this included duplicating species if they were found in the fertile state after being previously collected sterile.

Where possible, all specimens were collected as a set of six individual herbarium specimens. Full documentation was kept on site locality and characteristics, growth form, colouration, bark-slash description and other factors as appropriate. Local names and uses were provided by our guides, and carefully recorded. Drying and further treatment of specimens was undertaken by the Herbarium staff in the Department of Botany, UDSM. By collecting in sets of six, full collections will be available for study by other Tanzanian and International herbaria. The University of Dar-es-Salaam has a policy of distributing specimens to Sokoine University, the East African Herbarium in Nairobi, the Royal Botanic Gardens at Kew (UK) and Missouri Botanic Garden (USA). The latter facilitates the labelling of specimens.

Three hundred meters of four meter wide transect were established at Zaraninge (Kiono). Transect 1 was 200 meters long covering the ecotone from the forest and out through several different forms of vegetation to the open wetlands (see SECTION 3.1). Transect 2 was 100 meters long and placed in unlogged forest and included tree fall clearings and standing dead timber (see Figures 2 and 3 for transect locations and Figure 4 for vegetation profiles). Access to this region required the establishment of a few kilometres of well cut and clearly marked path. The path was marked with red and white plastic tape and may be observable for several years.

On the transects all trees with a DBH (diameter at breast height) over 10cm were enumerated for their location, height, DBH, crown width and height of lowest branching. This enabled precise scale profile diagrams, revealing canopy and forest structure, to be drawn. All species within the transects were recorded, mostly by local name, and notes made on their locality and status. All previously unsampled species were collected even if no fertile

material was available. The use of transects should ensure that the collection includes all dominant and characteristic species even if sterile material may not be identified to species level.

In Kierengoma (Matumbi) the transects established between October and December 1989 were re-examined so as to provide further phenological data and species identifications.

The Herbarium (UDSM) has sent one complete collection to Kaj Vollesen of the Royal Botanic Gardens, Kew who has agreed to assist with the identification of specimens. As an authority on the relevant vegetation types he will identify all specimens as far as possible to species level.

The collection work was co-ordinated by Douglas Sheil with assistance from Cass Clunies-Ross. Expertise in systematic botany was provided by F.Mbago (at Zaraninge) and H.Suleiman (at Kierengoma, Matumbi), both from the Herbarium of the Botany Department, University of Dar-es-Salaam (UDSM). Amanda Lawton, Elizabeth Burns, Adele Ratcliffe, Cleo Small and Mary Lane and all other Frontier volunteers contributed. Transects were established by C. Clunies-Ross assisted by F. Mbago, Amanda Lawton, Andrea Green, Jason Rubens and Stephen Jacques. Profile diagrams were drawn to scale by Adele Ratcliffe.

3.2.4 Results

The collection consisted of multiple sets of approximately 720 distinct botanical specimens. Including duplicates, about 4,000 individual herbarium specimens were collected. Collection at Zaraninge accounted for over two-thirds of the specimens taken and included many non-forest species from the open wetlands situated on the plateau top.

Full analysis will clearly have to wait until all specimens are identified. The information collected will not only provide data on the individual forests but will also contribute to a project

aiming to systematically map the distribution of the entire Tanzanian flora.

3.3 NITROGEN FIXING LEGUMES FROM KIERENGOMA

3.3.1 Abstract

Nodulating legumes were collected from the vicinity of the Kierengoma with the aims of identifying the species concerned and then isolating and characterising the symbiotic *Rhizobium* bacteria in controlled conditions. This work may isolate promising species to enable further research into sustainable agroforestry systems.

3.3.2 Introduction

The aim of the field work was to collect nitrogen fixing legume species which may have some value in the development of agroforestry systems. By subsequently evaluating new genotypes it is hoped that valuable phenotypic characteristics can be developed by crop-trials. In this way the effectiveness of current agroforestry systems may be improved upon or adapted to various situations. The unique flora of Tanzania's coastal forests presents significant potential for the discovery of novel genotypes.

3.3.3. Method

After an initial evaluation of the forest, collections were concentrated in the vicinity of the campm where open growing species were more common. Leguminous species were manually uprooted and inspected for the presence or absence of nodules. Up to ten specimens were negatively inspected at one locality before it was concluded that the species lacked nodules. If a nodulating species was recorded then a herbarium specimen was taken, labelled and the nodules stored in 100% commercial methylated spirit.

This work was conducted by Mr A M Ako, of the Department of Botany, University of Dar es Salaam, who is currently undertaking an MSc in Applied Microbiology on nitrogen fixing legumes. Botanical expertise was provided by Mr H. Suleiman of the Herbarium, Department of Botany, UDSM.

3.3.4 Results

Twelve different plants were collected, consisting of 3 small trees, 5 shrubs and 4 herbs. Specimens await identification. Full laboratory evaluation and subsequent field trials will take many months or even years to complete.

However, several potentially interesting species were collected. One is a variety of *Mimosa pudica* (the "Sensitive Plant") collected from a waterlogged area. Abundant nodules were found on the roots and more remarkably on the stem (10-20cm from the ground) suggesting that the plant may be adapted to nitrogen fixation in a waterlogged environment. If nitrogenase enzyme activity is shown by laboratory assay techniques then the potential to use such a species in a water-logged agroforestry system may be investigated. Another example was a tree of the Caesalpinoideae, known as "Mtanga" in Kimatumbi the traditional local language. Villagers claimed that the tree stimulated increased yields in the crops grown underneath it. Such a species could have potential for use in more formalised cultivation systems. Discoveries of this kind demonstrate the practical value of coastal forests areas as a genetic resource.

4.0 ZOOLOGICAL SURVEY

4.1 COLLECTION OF INVERTEBRATE AND VERTEBRATE SPECIMENS

4.1.1 Abstract

The aim of this work was to thoroughly sample every element of the fauna in the two forests and thus enable comprehensive species lists to be produced. The resulting collections are extensive: they will probably include many new species, and undoubtedly will provide significant distributional information on little known and restricted species. Full evaluation of the data will take many years, however it is clear that both forests are species-rich and possess specialised faunas.

4.1.2 Introduction

A variety of collecting techniques were employed to sample the forest fauna at Zaraninge and Kierengoma. Previous collections at Zaraninge were limited (Burgess, 1990), but extensive collections had already been made in Kierengoma between October and December 1989 (Kingdon, 1989).

Alex Dickinson was in charge of all Zoological collecting. Volunteers were trained in the theory and practical details of a wide range of collection techniques.

The field work benefitted greatly from a short visit by Mr Charles Msuya, Department of Zoology, UDSM. Mr Kenneth Kilumile, an experienced Tanzanian entomological collector, worked continuously during our period at Kierengoma. Tertia Waters and Andrea Green helped with general processing and organisation of specimens and equipment, Steve Jacques with mammal trapping, Adele Ratcliffe with the collection of Lepidoptera, Jeremy Webb with specimen photography, and Lucy Thorburn with the soil samples. Professor Kim Howell, Department of Zoology, UDSM provided the vertebrate list given here, and organised the distribution of all specimens

for identification by appropriate Tanzanian and International experts.

4.1.3 Methods

In general collection methods aimed to obtain mature male and female specimens of all species, without undue duplication.

1) Active Collecting

a) Invertebrates

Beating trays and sweepnets were used to sample foliage fauna. This was carried out in a wide range of vegetation types including the transect localities in both forests (Section 3.0 of this report and Kingdon, 1989).

By spraying limited areas of tree bark and rock surfaces with a mist of biodegradable insecticide (pyrethrum from a hand pump), such surfaces could be systematically hunted for invertebrates. These were collected as they fell onto paper sheets laid out below the spraying area.

Litter and earth samples were spread thinly on a white surface to aid specimen location. This material was searched for organisms which were collected with an aspirator.

b) Vertebrates

Opportunistic hand collection was pursued by all personnel at all times. The efficiency of this method was increased by carrying suitable containers such as metal tins and cloth bags for collecting small reptiles and amphibians.

Active searching was undertaken in several forms. Many frogs could be tracked at night by following the sound of their calls. Nets were used for aquatic fauna. Live tortoises were caught, identified and released. Attempts to dig lizards from their burrows and to "drive" animals into nets

proved fruitless. Snakes were only collected when safe opportunities arose.

A bone collection was made from the base of a Crowned Eagle's nest on Kiwengoma Hill at Kierengoma. Examination of these bones will provide data on the diet of the Crowned Eagle and a sample of the forest fauna as the eagles hunt exclusively within the forest. A nest site was also located in Zaraninge but due to dense vegetation it was not possible to gain access to the area beneath it.

2) Trapping

a) Invertebrates

Malaise traps were set in semi-permanent and temporary localities and proved an effective method of capturing flying insects. Intercept traps, though used initially, proved to be much less efficient.

Baited plates (usually old banana) hung beneath bells of net were efficient live traps for Lepidoptera and some other insects.

A powerful light bulb powered by a portable petrol-driven generator, was used to illuminate a white sheet during the night, on which insects settled. Once on the sheet insects were aspirated or lifted off. A tungsten filament light source was used.

Berleze funnels were employed to extract smaller leaf litter fauna. Leaf litter and animal nest material was laid onto a $2mm^2$ grill recessed in the top of custom-made tin funnels. These funnels were arranged in a ventilated black metal box that was allowed to reach high temperatures in direct sunlight and provided shelter from rain. Small pots of

alcohol placed below the funnels collected animals falling through the grill.

Pitfall traps were an efficient method of sampling mobile ground fauna. Plastic cups were used as pitfall traps on overnight trips. Larger and more permanent pitfall arrays were created using 2 litre buckets with rain cowls. The effective catchment of these arrays was greatly increased by employing 5 meter plastic sheet "drift fences" as baffles to channel animals to the pitfalls, but attempts at baiting produced disappointing results. The arrays were left for several weeks and caught a great deal of material including small vertebrates. Five centimetres of 10% formalin and some detergent was added to the bottom of each trap in order to preserve and aid the capture of specimens. The sides of these traps were greased to prevent animals from climbing out.

b) Vertebrates

Mist nets, placed across open water, were used to capture bats. However, a pond dug within the forest at Zaraninge to attract bats proved unsuccessful. Rodents and frogs were occasionally caught in mist nets (including those being used for bird capture).

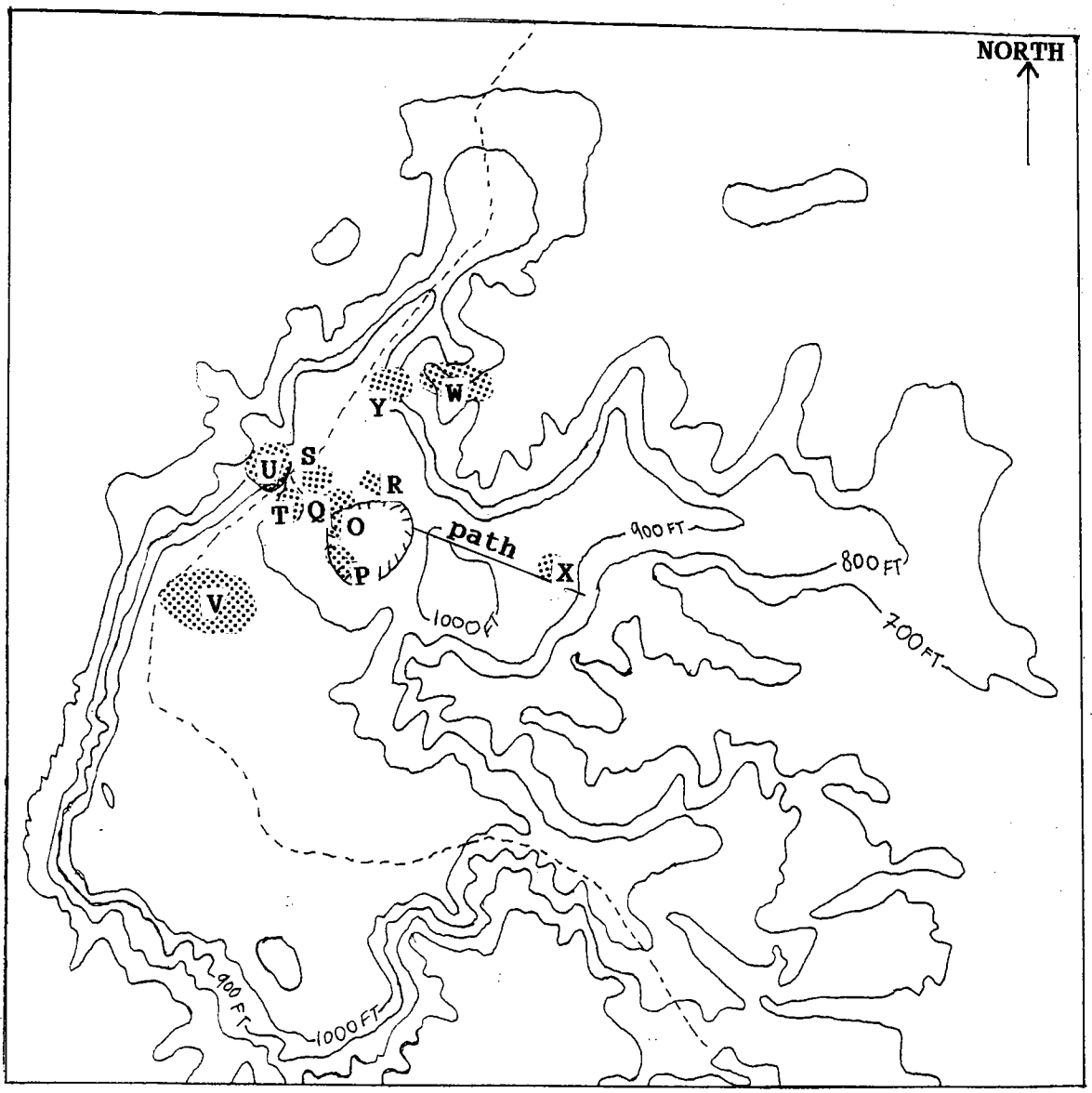
Lethal traps ("Little Nipper" and "Museum Special") were set on the ground, and arboreally, to capture small rodents and shrews. Bait was a varied mixture of fruit, fish, ground nuts, baked beans and meat. Ants were a serious problem both cleaning traps and damaging specimens overnight.

A small fish trap was baited and used in deeper water at Zaraninge. By rapidly drawing it out it was possible to catch fish and crabs.

Arrays of pit fall traps were also used to catch small vertebrates. The compound "MS222" was added to the solution in the traps to ensure the rapid onset of anaesthesia in amphibians. Pot sides were coated with grease to reduce the potential for animals to climb out. Twenty litre buckets with three radial baffles were used to capture larger organisms in selected localities.

Figures 5 and 6 show the positions of vertebrate and invertebrate collection and trapping localities in each forest.

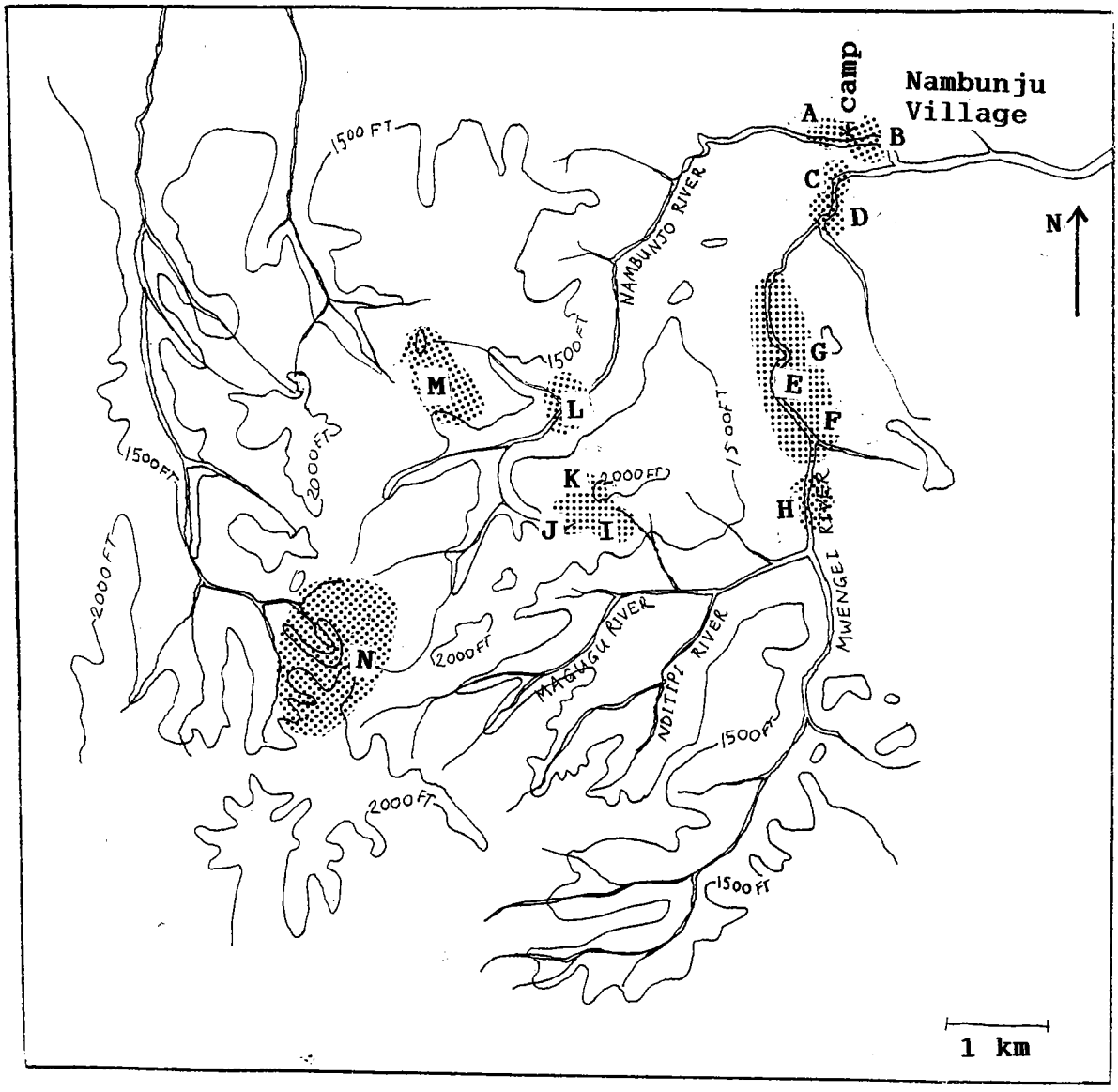
Figure 5. Invertebrate and Vertebrate trapping sites at Zaraninge (Kiono)



COLLECTING METHODS	LOCATION
MIST NETTING (BIRDS)	OQRSTY
MIST NETTING (BATS)	OPQW
MAMMAL TRAPPING	OQRSUVW
FISH/CRAB TRAPPING	OP
PITFALL TRAPPING (CUP)	S
PITFALL TRAPPING (2 LITRE)	PTX
PITFALL TRAPPING (20 LITRE)	OT
INTERCEPT TRAPPING	OPS
MALAISE TRAPPING	OPRST
BUTTERFLY TRAPPING	OQR
LIGHT TRAPPING	OQRSW

site Y was the location of bird netting
July - September 1989

Figure 6. Invertebrate and Vertebrate trapping sites at Kierengoma (Matumbi Hills)



COLLECTING METHODS	LOCATION
MIST NETTING (BIRDS)	E(ACFK)
MIST NETTING (BATS)	ACDEJL(ADEHK)
MAMMAL TRAPPING	BCDEJL(ABDF)
FISH/CRAB TRAPPING	E
PITFALL TRAPPING (CUP)	(ADKL)
PITFALL TRAPPING (BAITED CUP)	BD
PITFALL TRAPPING (2 LITRE)	GL
MALAISE TRAPPING	HL(A)
BUTTERFLY TRAPPING	ADEK
LIGHT TRAPPING	ABFI(ADFJK)

localities in brackets refer to previous collecton
October - December 1989

3) Preservation and storage

a) Invertebrates

Invertebrates, except samples from Berleze funnels, were sorted to their respective class. Insects and arachnids were further sorted into their appropriate orders. A binocular dissecting microscope was used to sort the finer mixed material.

Most invertebrates were preserved in 80% ethanol, small specimens being stored in tubes, and larger specimens in pots or bags.

Specimens of Lepidoptera, Odonata, Neuroptera and Ephemeroptera were sun dried, and wrapped in paper for storage. Black metal surfaces in sunlight were used to dry specimens held in covered petri-dishes. Ants proved a serious threat to unattended specimens, but cloths soaked in kerosene tied around the table legs prevented serious losses.

b) Vertebrates

Vertebrate specimens were preserved whole in 10% formalin. All mammals collected were weighed and morphological measurements taken prior to preservation. Any ectoparasites were removed and preserved separately.

4.1.4 Results

a) Invertebrates

Many tens of thousands of specimens were collected. Identification will be undertaken by experts for each taxonomic grouping, but may take many years to complete.

Some of the Lepidoptera collected from Kierengoma were passed to Kenneth Kilumile and these specimens are being processed

4.1.4 Results

a) Invertebrates

Many tens of thousands of specimens were collected. Identification will be undertaken by experts for each taxonomic grouping, but may take many years to complete.

Some of the Lepidoptera collected from Kierengoma were passed to Kenneth Kilumile and these specimens are being processed separately. Specimens from the families Lycenidae, Satyridae, Pieridae, Acraeidae and Hesperiidae are awaiting the attention of Jan Kielland, an authority on the taxonomy of these groups.

Jean-Pierre Lequeux has determined some of the specimens collected from Kierengoma belonging to the Papilionidae family and the Charaxinae group. His results are presented in Appendix 1.

Preliminary results from the previous project work in Kierengoma (October to December 1989: Kingdon, 1989) have indicated the richness of the area for other invertebrate groups. For example, 16 species of millipede are new to science, including 7 new genera. New spider and Neuropteran genera were also found. (K Howell pers comm.). Results from previous and current work in Zaraninge are not available.

b) Vertebrates

Species-lists of vertebrates collected and observed in the two forests are presented in Appendixes 2 and 3.

Not all specimens collected have been identified, however it is believed that a significant proportion of the various faunal elements of the two forests are represented in the collections, with several of these providing unique data

(e.g. soil fauna). Undersampling currently occurs in the upper canopy, and species which have been scantily collected include seasonal invertebrate forms, migratory species, snakes, skinks, bats (at Zaraninge) and arboreal mammals such as galagos.

The two forests revealed different characteristics in their faunas. Kierengoma showed the highest diversity and density of fauna in the valley bottoms, especially the Mwengei River Valley, with the ridge tops being much poorer. At Zaraninge the fauna seemed generally much scarcer, probably due to the absence of valleys or permanent water within the forest. The Plateau Wetlands had a separate and non-forest fauna.

4.2 ORNITHOLOGICAL SURVEY

4.2.1 Abstract

Ornithological surveys were carried out at both Zaraninge and Kierengoma forests. As the study period coincided with the breeding season it was possible to assess populations by song as well as by netting and direct observation. Birds netted were weighed measured and ringed before release.

4.2.2 Introduction

Ornithological research in coastal forests has already generated significant scientific interest (Collar and Stuart, 1985). Certain forest species with a globally limited range appear to inhabit only a sub-set of the coastal forests, for largely unknown reasons.

Some netting and observation had been carried out previously at Zaraninge but not in the months January to March (N. Baker, pers. comm; Burgess, 1990). Limited ornithological work had also undertaken between October and December 1989 at Kierengoma (Kingdon, 1989). Further research was required in both locations.

4.2.3 Methods

a) Zaraninge (Kiono)

At Zaraninge, mist netting was carried out within 1km of the camp (see Figure 5). In January, a total of 60m of net was used for 12 days, catching 42 birds. In March 160m of net was used for 8 days and 110m for 11 days, catching 204 birds (recaptures within the month excluded). 22 species were netted and many more were recorded by song and observation.

b) Kierengoma (Matumbi Hills)

At Kierengoma, mist netting was carried out at four sites located along the bottom of the Mwengei River Valley (Figure 6). A total of 160 birds of 17 species were handled.

Mr C Mlingwa, currently undertaking an MSc in the Department of Zoology, UDSM, and Mr S Davies of the Royal Society for the Protection of Birds (RSPB), undertook the project. Cleo Small undertook habitat description and assisted with bird handling. All volunteers contributed. Liz Burns and Adele Ratcliffe provided regular help. Mr N. Baker of the Wildlife Conservation Society of Tanzania provided practical advice during his short visit to Kierengoma.

4.2.4 Results

a) Zaraninge (Kiono):

The species-list of birds recorded at Zaraninge is presented in Appendix 4.

16 species were added to previous lists. Only two species recorded previously were not recorded in this study, these were Orange Ground Thrush and Paradise Flycatcher.

Some of the species recorded at Zaraninge are classified as globally scarce in the International Council for Bird Preservation (ICBP) and the World Conservation Union (IUCN) Red Data Book (Collar and Stuart, 1985). The Sokoke Pipit (*Anthus sokokensis*), categorised as "vulnerable", was sighted within the netting area but never caught. The Uluguru Violet-backed Sunbird and the Plain-backed Sunbird were caught and are classified as "near-threatened". The Tiny Greenbul, Kretschmer's Longbill and the Chestnut-fronted Helmet Shrike were all identified and are classed as "candidate" Red Data Book Species i.e. they may be globally scarce but not enough information is currently available (ICBP, pers. comm.).

b) Kierengoma (Matumbi Hills)

The species-list of birds recorded at Kierengoma is presented in Appendix 5.

The species recorded included the most northerly breeding record of African Pitta in East Africa. This species is thought to be recorded in the forests north of the Rufiji river only as a post-breeding visitor.

ICBP/IUCN listed globally scarce species (Collar and Stuart, 1985) recorded at Kierengoma were the "near threatened" Southern Banded Snake Eagle and Uluguru Violet Backed Sunbird, and the "candidate" Tiny Greenbul, Kretschmer's Longbill and Chestnut-fronted Helmet Shrike.

Several species of note were observed near the base camp, outside the Forest. These included Lillian's lovebird (a range extension of *c*.400 km) and the Scarce Swift.

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APPENDIX 1

PRELIMINARY SPECIES-LIST OF THE PAPILIONIDAE AND CHARAXINAE FROM KIERENGOMA

PAPILIONIDAE
Papilio ophidicephalos ophidicephalus
Papilio dardanus tibullus
Papilio nireus lyaeus
Graphium polistratus polistratus
Graphium leonidas leonidas
Graphium philonoe philonoe

CHARAXINAE
Charaxes macclouni macclouni
Charaxes cithaeron kennethi
Charaxes violetta maritima
Charaxes protoclea azota
Charaxes jahlusa kenyensis
Charaxes etesipe tavetensis
Charaxes brutus alcyone
Charaxes castor flavifasciatus
Charaxes zoolina zoolina
Charaxes bohemani bohemani
Charaxes varanes vologeses
Charaxes candiope candiope
Euxanthe wakefieldi wakefieldi
Euxanthe tiberius tiberius

APPENDIX 2

PRELIMINARY VERTEBRATE LIST FOR ZARANINGE (KIONO)

(N= non-forest species, F= definite forest species)

FISH

(perhaps 2 species from the Plateau Wetlands)

AMPHIBIANS

Anura

Hyperoliidae (treefrogs)

N *Leptopelis argentus*
F *Leptopelis flavomaculatus ?*
N *Hyperolius argus*
N *Hyperolius nasutus ?*
N *Hyperolius parkeri*
N *Hyperolius tuberilinguis*
Hyperolius sp.
N *Afrixalus pygmaeus*
N *Afrixalus fornasini*
N *Kassina maculata*
N *Kassina senegalensis*

Ranidae

N *Hemisus marmarotus* (abundant)
N *Ptychadena* sp.
N *Phrynobatrachus* sp. (abundant)
N *Pyxicephalus adspersus*

Bufonidae

N *Bufo gutturalis*

Pipidae

N *Xenopus* sp. (African clawed frog)

Arthroleptidae

F *Arthroleptis* spp. (? 2 or 3 species ?)

REPTILES

(Snakes)

Colubridae

Dipsadoboa aulicus (Marbled tree snake)
Thelotornis capensis (Vine snake)
Crotaphopeltis hotombeia (Herald snake)

Typhlopidae

Typhlops sp.

(Lizards)

Varanidae

Varanus niloticus (Nile monitor)

Gekkonidae
Hemidactylus spp. (3 species)
Lygodactylus sp. (affinities uncertain)

Scincidae
N *Mabuya maculilabris* (+ 3 or so other species)

Cordilidae
Cordylus tropidesternum

Chameleonidae
N *Chamaeleo dilepsis* (some specimens with eggs)
Rhampholeon spp. (3 species, some with eggs)

A terrapin shell (*Pelusios* sp.) was also collected.

MAMMALS

Rodents

Muridae
F *Beamys* (a new locality, live with new born now being kept at UDSM - a valuable opportunity to observe this rarely collected animal)

(Additional species - unidentified)

Muscardinidae
Graphiurus sp. (Dormouse)

Insectivora
Soricidae (shrews)
Suncus varilla (a probable new record for Tanzania)

Chiroptera
Single species - unidentified

Miscellaneous observations:

Sykes monkey (*Cercopithecus* sp.)- common
Black and white colobus (*Colobus polykomos*)- widespread
Red tailed and non-red tailed squirrels
Elephant shrews (*Rhyncocyon*) abundant (has dark shoulder band)
Galagos (*Galago* spp.) abundant.
Buffalo (*Syncerus caffer*) and Bush pig (*Potanochoerus porcus*) -seen in wetlands.
Clawless otter (*Aonyx capensis*) - scats observed.
Forest cobra (*Naja melanoleuca*).
Turquoise backed arboreal "flying lizards".
Several larger skinks unrepresented in samples.

Mr Nyamandala our game guard reported tracks and sightings of several other species within the forest (Kiswaheli names given for clarity in some examples):

Leopard *Panthera pardus*;
Genet *Genetta tigrina*;
Mongoose (Nguchiro);
Civet *Viverra civetta* (Fungo);
Suni *Neotragus moschatus*;
Duiker - 3 types probably Abbot's *Cephalophus spadix*; Common *C.grimmia* and Red *C.natalensis*;
?Hedgehog (Kalunguyeye = *Holaspis guentheri*?);
Python *Python sebae* (Chatu).

Notable absences were hyrax, aardvark and porcupine. No burrowing skinks, leaf litter toads or foam making frogs were observed.

APPENDIX 3

PRELIMINARY VERTEBRATE LIST FOR KIERENGOMA (MATUMBI HILLS)

AMPHIBIANS

Anura
Hyperoliidae

F *Leptopelis vermiculatus or ? flavomaculatus*
N *Leptopelis argentus*
Hyperolius mitchelli
N *Hyperolius tuberilinguis*

Bufonidae

F *Stephopaede* sp. (species recently discovered, not yet described)
N *Bufo gutturalis*
F *Mertensophryne microantis* (or *Mertensophryne rondoensis - specialist review required)*

Rhacoohorodae

N *Chiromantis xerampelina* (foam nest species)

Microhylidae

N *Breviceps mossambicus*

Ranidae

N *Phrynobatrachus* sp. (puddle frogs)
N *Ptychadena* sp. (ridged frogs)
N *Hemisis marmoratus*

Pipidae

N *Xenopus* sp.

Arthroleptidae

F *Arthroleptis* sp/spp. (number of species unclear maybe 1 or 2, or more, inhabits leaf litter)

REPTILES

(Snakes)
Typhlopidae

Typhlops sp. (burrowing snake)

Colubridae

Aparallactus werneri (found only in Coastal Forests and the Usambaras)

Atractaspididae

F *Atractaspis* sp. (Stilletto snake)

(Lizards)
Geckos
Hemidactylus
Cnemaspis africana
Cnemaspis spp. (possibly 2 species including a new sub-species)
Lygodactylus sp.

Scincidae (Skinks)
Melanseps sp. (Legless form)
Seps sp. (Reduced limb burrowing)
N *Panaspis wahlbergi*
N *Mabuya maculilabris*

Chameleonidae
N *Chamaeleo dilepis*
Rhampholeon sp. (? 2 species)

Cordylidae
Cordylus tropidsternum

MAMMALS

Chiroptera (bats)
Pteropodidae (fruit bats, Megachiroptera)
Myonycteris relicta (a rare fruit bat, a significant new locality)
Roussettus aegyptiacus (netted and released, a widespread species)

Insectivorous bats (Microchiroptera)
Hipposideridae
Hipposideros ruber (a widespread species)
Hipposideros commersoni (the largest African member of the genus)

Vespertilionidae
Scotopholis sp.

Molossidae
Tadarida sp. (a new record from the locality)

Insectivora (shrews)
Soricidae
Crocidura hirta (two specimens)

Primates
Galagidae
Galago sp. (this may be an undescribed species)

Rodents
Muridae

F *Beamys hindei* (a rarely collected species)
Praomys sp. (a common species)
Acomys sp. (Spiny mouse, typical of rocky outcrops)
(Two additional species unidentified)

Miscellaneous observations:

Blue monkeys were widespread
Baboons (*Papis* sp.) and Vervet monkeys (*Cercopithecus* sp.) - restricted to the forest edge.
Galagos (*Galago* spp.) - calling at night suggested several species
Leopard (*Panthera pardus*) could be heard and one jaw was collected.
Porcupine (*Hystrix cystata*) - quills widely found.
Aardvark (*Orycteropus afer*) - burrows were common.
Elephant (*Loxodonta africana*) - signs common though they were only directly observed once - their activity is apparently seasonal occurring mainly between March and May.
Duiker (*Cephalophus* sp.) - glimpsed only.
Elephant shrews (*Rhyncocyon cirnei* and *R.tetradactylus*) - Commonly seen.
Marsh mongoose (*Herpestes paludinosus*)
Clawless otter (*Aonyx capensis*) - scats observed.
Buffalo (*Syncerus caffer*) and Sable antelope (*Hippotragus niger*) - tracks only observed
Cane rat (*Thryonomys swiderianus*)
Nile monitor (*Varanus niloticus*) - some of large size, were fairly abundant in the valley bottoms.
Forest cobra (*Naja melanoleuca*) - included specimens of considerable size.
Bell's hinged tortoise (*Kinixys belliana*) - fairly common although it was clear that the local people were aware of their market potential.

Notable absences were colobus monkeys and hyraxes.

APPENDIX 4

BIRDS RECORDED AT ZARANINGE (KIONO)

Species recorded : * = netted, F = forest species (probably breeding), + = additional to previous lists.

+	Black-breasted Snake Eagle
F+	African Goshawk
F+	Crowned Eagle
+	African Fish Eagle
	Kenya Crested Guinea-fowl
	Red Eyed Dove
	Emerald Spotted Wood Dove
	Tambourine Dove
	Green Pigeon
	Brown Parrot
	Livingstone's Turraco
+	Klaas Cuckoo
	Yellowbill
+	Spotted Eagle Owl
	African Wood Owl
	Speckled Mouse Bird
*F+	Narina's Trogon
*	Brown-hooded Kingfisher
*F	Pygmy Kingfisher
*+	White-throated Bee-eater
	Little Bee-eater
	Broad-billed Roller
	Green Wood Hoopoe
	Trumpeter Hornbill
+	Crowned Hornbill
	Yellow-rumped Tinkerbird
	Green Tinkerbird
	Golden-tailed Woodpecker
F	Little Spotted Woodpecker
*F	African Broadbill
	Drongo
*F	Square-tailed Drongo
	African Golden Oriole
	Black Cuckoo Shrike
F	Yellow-bellied Greenbul
*F	Nicator
*F	Tiny Greenbul
*F	Fischer's Greenbul
*F	Yellow Streaked Greenbul
+	Common Bulbul
*F	Eastern Bearded Scrub Robin
*F	Red-capped Robin Chat
*F	Red-tailed Ant Thrush
F	Black-headed Apalis
*	Grey-backed Camaroptera
	Pectoral-patch Cisticola
F+	Kretschmer's Longbill

	Tawny-flanked Prinia
*+	Ashy Flycatcher
*F	Forest Batis
	Little Yellow Flycatcher
*	Crested Flycatcher
F	Sokoke Pipit
	Black-backed Puffback
	Tropical Boubou
	Grey-headed Bush Shrike
	Four-coloured Bush Shrike
	Chestnut-fronted Helmet Shrike
+	Black-breasted Glossy Starling
	Collared Sunbird
F+	Uluguru Violet-backed Sunbird
*F	Plain-backed Sunbird
*F	Olive Sunbird
F	Dark-backed Weaver
*+	Peter's Twinspot
*+	Green-backed Twinspot
	Bronze Mannikin

APPENDIX 5

BIRDS RECORDED AT KIERENGOMA (MATUMBI HILLS)

Species recorded : * = netted, B = forest species (probably breeding)

	Hammerkop
B	Southern Banded Snake Eagle
	African Goshawk
B	Crowned Eagle (4 nests)
	Kenya Crested Guinea-fowl
*	Tambourine Dove
	Brown Headed Parrot
	Livingstones' Turaco
B	Barred Long Tailed Cuckoo
	Klaas Cuckoo
B	African Wood Owl
B	Narinas' Trogon
*B	Pygmy Kingfisher
	Trumpeter Hornbill
	Crowned Hornbill
	Yellow-rumped Tinkerbird
	White-eared Barbet (southern race)
	Golden-tailed Woodpecker
B	Little Spotted Woodpecker
*	African Broadbill
*B	African Pitta (6 nests Found)
	Black Roughwing
B	Square-tailed Drongo
*B	Yellow-bellied Greenbul
*B	Fischer's Greenbul
*B	Yellow-streaked Greenbul
*B	Tiny Greenbul
*B	Nicator
*B	Eastern Bearded Scrub Robin
*B	Red-capped Robin Chat (numerous)
B	Red-tailed Ant Thrush
*	Grey-backed Camaroptera
B	Broadbill (good population)
B	Kretschmer's's Longbill
B	Livingstone's Flycatcher
*	Crested Flycatcher
B	Black and White Flycatcher
	Black-backed Puffback
	Sulphur Breasted Bush Shrike
	Four-coloured Bush Shrike
	Tropical Boubou
	Chestnut-fronted Helmet Shrike
	Black-breasted Glossy Starling
	Collared Sunbird
B	Uluguru Violet-backed Sunbird
*B	Olive Sunbird
B	Dark-backed Weaver

*B Peter's Twinspot
*B Green-backed Twinspot
Red-headed Weaver (southern race)
Black-headed Oriole

APPENDIX 6

LIST OF EXPEDITION MEMBERS

Michael Ako - Currently working for an MSc in Applied Microbiology by research at the department of Botany, UDSM. He joined Frontier in Matumbi where he was able to examine and collect specimens for his research. "I believe that field collection of this sort may prove very valuable in allowing us to identify new strains of nodulating bacteria, and host plants, that are adapted to specific conditions and may contribute to the development of practical agroforestry systems."

Elizabeth Burns, RGN - Camp medic. "..responsible for maintaining camp hygiene, water purification, health and safety, and medical care - all of which I enjoyed. I particularly enjoyed (but initially found very daunting) .. having to rely on my own judgement." She also made a major contribution to the botanical, and other, field work.

Cass Clunies-Ross, BA Natural Sciences (Botany) MSc Forestry - Camp Leader. Ensured the smooth running of the camp. Organised supplies, finance and work schedules, also played a leading role in the botanical collection including transect implementation. "Publications from this expedition should provide a good reference for further research into a more sustainable use for these forest resources."

Stan Davies - Ornithologist, RSPB. With the expedition for the full period at Matumbi, and a couple of weeks at Zaraninge. His enthusiasm for his science was a valuable contribution to to the project. "Its wonderful to work here in this season ... when all the birds are calling."

Alex Dickinson, BSc Zoology - Project Zoological Coordinator. "Responsible for obtaining samples of every aspect of the faunas of the two forests. I have learnt a lot in my six months out here, about both people and nature, and I have enjoyed the opportunity to work with a variety of British and Tanzanian scientists. I am glad to have been able to contribute to the knowledge of these poorly known and fast vanishing habitats."

Andrea Green, BA Social Science - Research Assistant. Worked mainly on the zoology. She gained responsibility for several areas of work including soil-funnel samples, Zaraninge survey work, insect netting and writing up our final accounts. "It was a completely new field of study for me. I hoped to gain some insight into the processes involved in the conservation sphere." "Ten weeks on and I feel like saving the world - my expectations have been more than actualised."

Stephen Jaques, BSc Geography - Research Assistant. Worked mainly on Zoology, taking charge of rodent trapping. He assisted for a

week in the monitoring of experiments set up in the Rufiji Delta by the Ministry of Marine Science, Zanzibar, on a previous expedition. "At the end of it all my memories are good ones, though they do include suspected malaria and drinking water smelling of elephant dung."

Saidi Kikwape - Botanical Field Guide in Zaraninge. He was able to provide many local names, and information on the forest. His good humour greatly enriched our stay at Zaraninge. He played a key role in our relations with local villages.

Kenneth Kilumile - Field Lepidopterist, with over eight years experience all over Tanzania. Worked with us for the three weeks at Matumbi. With his energy and goodwill made a welcome contribution to both science and camp.

Mary Lane, BA Natural Sciences - Research Assistant. Worked in all areas and conducted information gathering interviews at Zaraninge. " I was concerned to find how small Zaraninge actually is ... I hope our work has contributed to its preservation." She also worked in monitoring the Rufiji experiments.

Amanda Lawton, BSc Plant Sciences/Environmental Studies - Research Assistant. Was a key contributor to the botanical work including transects. "I believe that obtaining a complete species list of both flora and fauna is very important. Time is running out for Coastal Forests ... from our mapping exercise one realised just how small the forest is."

Frank Mbago - Botanist, UDSM. Present for most of the period at Zaraninge including the recce. He was an energetic and dynamic member of the camp and a valuable source of expertise in systematic botany. "This work is very good. We can all learn from it." He will be overseeing the processing of the botanical collection.

Abdullah Abdul Mbonde - Field Guide and local liaison at Matumbi, former game guard and guide, and assistant to the director of the Miombo Research Centre at Kingupira. A highly respected member of the local community, we benefitted greatly from his friendship. He provided us with information on the forest and plants distilled from generations of herbalist knowledge. His perfect memory of the details of our own botanical collection was an invaluable asset on many occasions. There is little doubt that Abdullah has increased the effectiveness and value of our work at Kierengoma several fold.

Charles Mlingwa - Ornithological Scientist, UDSM. Presently undertaking research on the Ecology of the Coastal Forest Bulbuls for an MSc. With us for the whole field period, he worked with a steady dedication. His eloquence was a valuable source of inspiration as was his willingness to train complete beginners in his science. "This expedition has worked very well. Frontier has done a lot for me. My science has gained enormously."

Charles Msuya - Zoologist, UDSM. Though only able to be with us for just over a week at Matumbi he was able to make a major contribution to the project. It was an education to have such an experienced and capable field researcher to work with.

Adele Ratcliffe, BSc Applied Biology - Research Assistant. Contributed to all work, especially the entomological collection, and provided skilled diagramatical representations of the transects. "Already I can see that the work Frontier has done out here has increased awareness of the value of the value of Tanzanian Coastal Forests from a scientific view point. Hopefully this will extend to a wider appreciation."

Jason Rubens, BSc Philosophy - Research Assistant. "I am more than glad that I took my chances in coming to Tanzania and am grateful to Frontier for providing the opportunity to take part in some excellent work. I have been particularly involved with the zoological collection work, with the task of mapping the geography of the forest at Kiono (Zaraninge) and with constructing a transect of the vegetation in the same forest."

Dr Z.K. Rulangaranga - Botanical Ecologist, Associate Lecturer Department of Botany, UDSM, and Acting Coordinator Frontier Project. It was valuable for Frontier's University representative to be able spend some time in our field camp. "Due to my unfortunate ill health the phenological project was not fully comprehensive but I certainly hope to get a chance to continue with it in the future".

Cleo Small - Research Assistant. Contributed to all areas, concentrating on the ornithological work including quantitative habitat evaluation and learning bird handling. "I've learnt a lot, not only in terms of a valuable introduction to forests and to different areas and methods of study, but also within the life of the camp, and the very experience of travelling through this country, and meeting its people."

Douglas Sheil, BA Natural Sciences, MSc Forestry - Forest Project Director and Frontier Forest Projects coordinator. Responsible for all aspects of the project other than health.

Haji Suleiman - Botanist, UDSM. Worked with us at Matumbi and was a valuable source of botanical assistance and information. Assisted Mr Ako and Dr Rulangaranga with their own projects, and willingly taught the relevant areas of taxonomic botany.

Lucy Thorburn, BSc Economics - Research Assistant. Working mainly on the zoological project. "I arrived knowing absolutely nothing about botany or zoology, but this did not seem to matter as everyone had to learn the various different collecting techniques at the start - science degree or not." "I really enjoyed working alongside the Tanzanian scientists some of whom became great friends, and it made me realise how worthwhile Frontier's work is."

Tertia Waters, BSc Geology - Research Assistant. Played a key role in the zoological work particularly the processing of specimens. "I knew nothing of the Coastal Forests before I came to Tanzania. I now feel that I have acquired a basic knowledge as to why they need studying and how to go about this. I see the need for much more work in the Coastal Forests, especially noting their individual differences. ... Thanks to all, shall never forget the experience."

Jeremy Webb - Expedition Photographer. Spent a month and a half with the project before moving on to another Frontier camp on Mafia Island. "I found the landscapes, flora and fauna, stunning in their variety and beauty. The warmth and cooperation of the Tanzanian people was striking, and the group morale between all members was solid and strong throughout."