FRONTIER TANZANIA Technical Report No. 9

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The Frontier-Tanzania expedition phase TZ05 worked in the coastal forests of Tanzania between 7th July to 8th September 1990. During this period the expedition visited seven forest sites on the mainland to the South of Dar es Salaam, and one on Mafia Island.

The first expedition camp was established at Kiwengoma Forest Reserve, Rufiji District (38°58′E - 38°54′S, 8°23′E - 8°20′S). Over a two week period botanical and zoological collections were made in the Nambunju and Mwengei valleys, adding to previous work carried out by Frontier expeditions TZ02 and TZ03 under different seasonal conditions. Surveys were made of the elephant population in the forest and the extent of logging activity in the forest.

Using the Kiwengoma camp as a base, Namakutwa Forest Reserve (4km North of Kiwengoma Forest Reserve), Rufiji District, and Ton'gomba Forest Reserve (39°02′E - 38°58′E, 8°26′S - 8°32′S), Mbinga Forest Reserve (38°47′E - 38°52′E, 8°32′S - 8°29′S), and Nan'goma Caves (38°54′E, 8°30′S) in Kilwa District were visited to assess the types and condition of vegetation present. Ton'gomba contained a large extent of evergreen forest in good condition, and Namakutwa and Mbinga supported some forest, but mainly woodland. Nan'goma was found to be a sinkhole containing a tiny forest patch (including rare species), leading to an extensive and unmapped cave system.

Mchungu Forest Reserve (39°15′E - 39°18′E, 7°46′S - 7°42′S) was visited for 6 weeks from late July to early September 1990. The Reserve was surveyed and mapped: small areas of coastal forest (*c.* 2km^2) were identified, within a complex of other vegetation types. Extensive botanical and zoological collections were undertaken and an ornithological check-list was compiled. Four transects were set up to identify the vegetation types and physiognomy, and brief comparisons were made with Kiwengoma Forest Reserve.

During this period four members of the camp traveled to Kazimzumbwi Forest Reserve, Kiserawe District (39°02′E - 39°04′E, 6°55′S - 7°02′S) to undertake an ornithological survey. The east coast akalat was found to be abundant in this forest, and uluguru violet-backed sunbird and southern banded snake eagle were also recorded.

Towards the end of the expedition phase reconnaissance visits were made to coastal thicket and thicket/forest on the eastern seaboard of Mafia Island (39°35'E - 39°55'E, 8°07′S - 8°37′S) and to a coastal forest remnant at Kilindoni (07 55 S, 39 40 E). Suitable sites for further work were identified.

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The global biological importance of the coastal forests of Tanzania has been reviewed in several recent publications (eg. Bensted-Smith & Msangi-Msangi 1989; Burgess *et al.*, 1992; Kingdon, 1990).

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2.0 Study sites

Eight sites (mainly Forest Reserves) were visited during the expedition. Their location is presented in Figure 2.1 and the length of time spent in each of these sites is presented in Table 2.1, below.

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Kazimzumbwi Forest Reserve	10/08/90-24/08/90	15
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2.1 MCHUNGU FOREST RESERVE

Location:

Mchungu Forest Reserve lies in Rufiji District just north of the Rufiji Delta between 39°15'E, 39°18'E and 7°46'S, 7°42'S (see Figure 2.1).

The Forest Reserve stretches for some 10km north along the coast, and contains a wide variety of habitats including mangrove swamps, various kinds of terrestrial forest, *Barringtonia* swamp and wet edaphic (natural) grasslands. A vegetation map of the entire reserve, derived from combining the Ordnance Survey map with ground observations, is given in Figure 2.2

Topography, Geology and Soils:

The whole reserve lies at less than 15m asl. Recently deposited deltaic sediments flank the coastline supporting a rich mangrove ecosystem. Inland from the mangroves, mud flats and salt pans produce a distinct break in the vegetation. The coastal plain topography is dominated by 10m high Quaternary sand-terraces with their long axes running approximately parallel to the coastline.

Areas of ground-water swamp and open fresh water pools follow north to north-east drainage lines that reach the sea at tidal inlets.

Thick deposits of dark mud occur in the wetland areas. Elsewhere the soils comprise fine to coarse sands of clean quartz. Soil horizons are absent down to a depth of 2m. A few thin (2-20mm) mud lenses occur at various levels throughout this profile.

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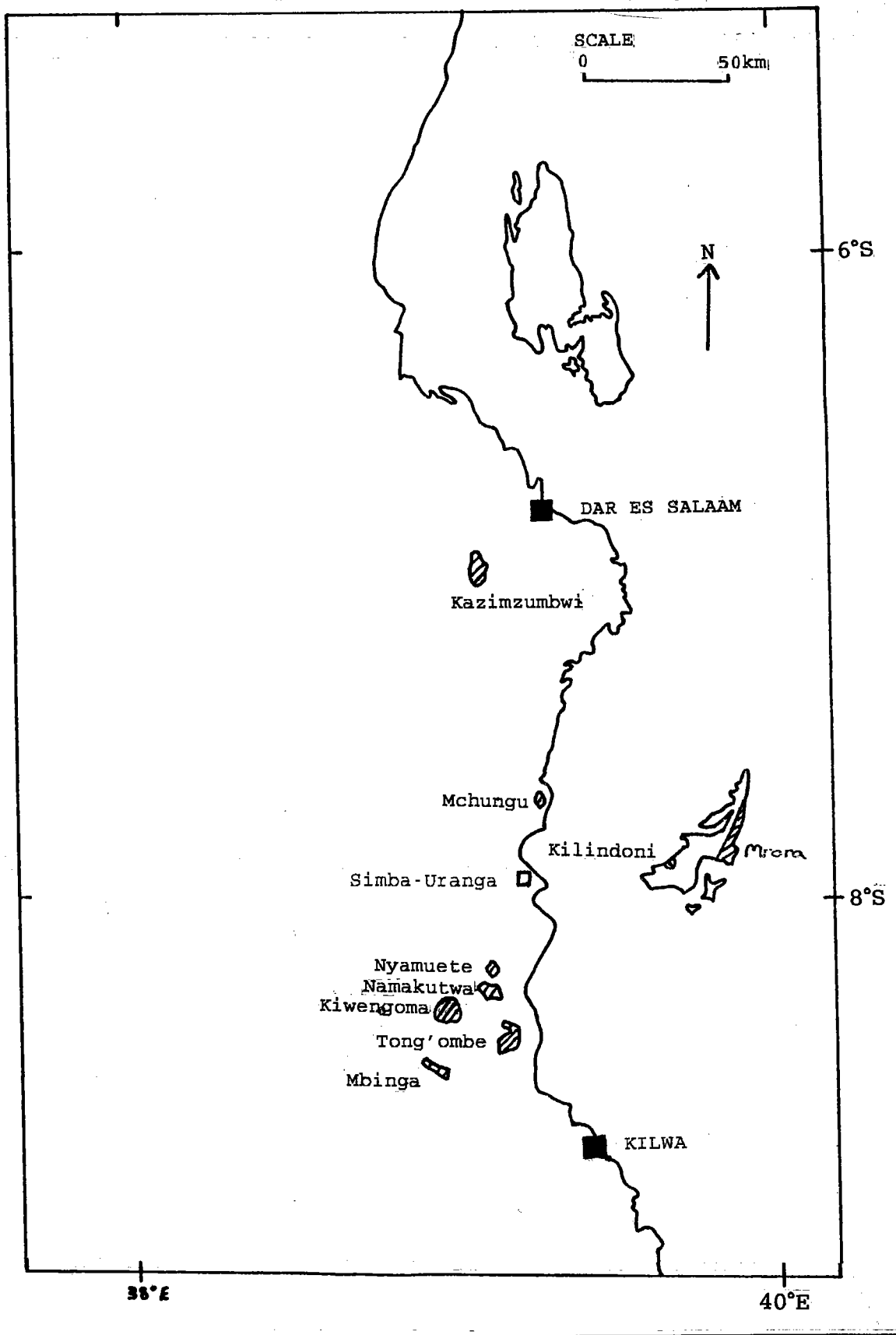

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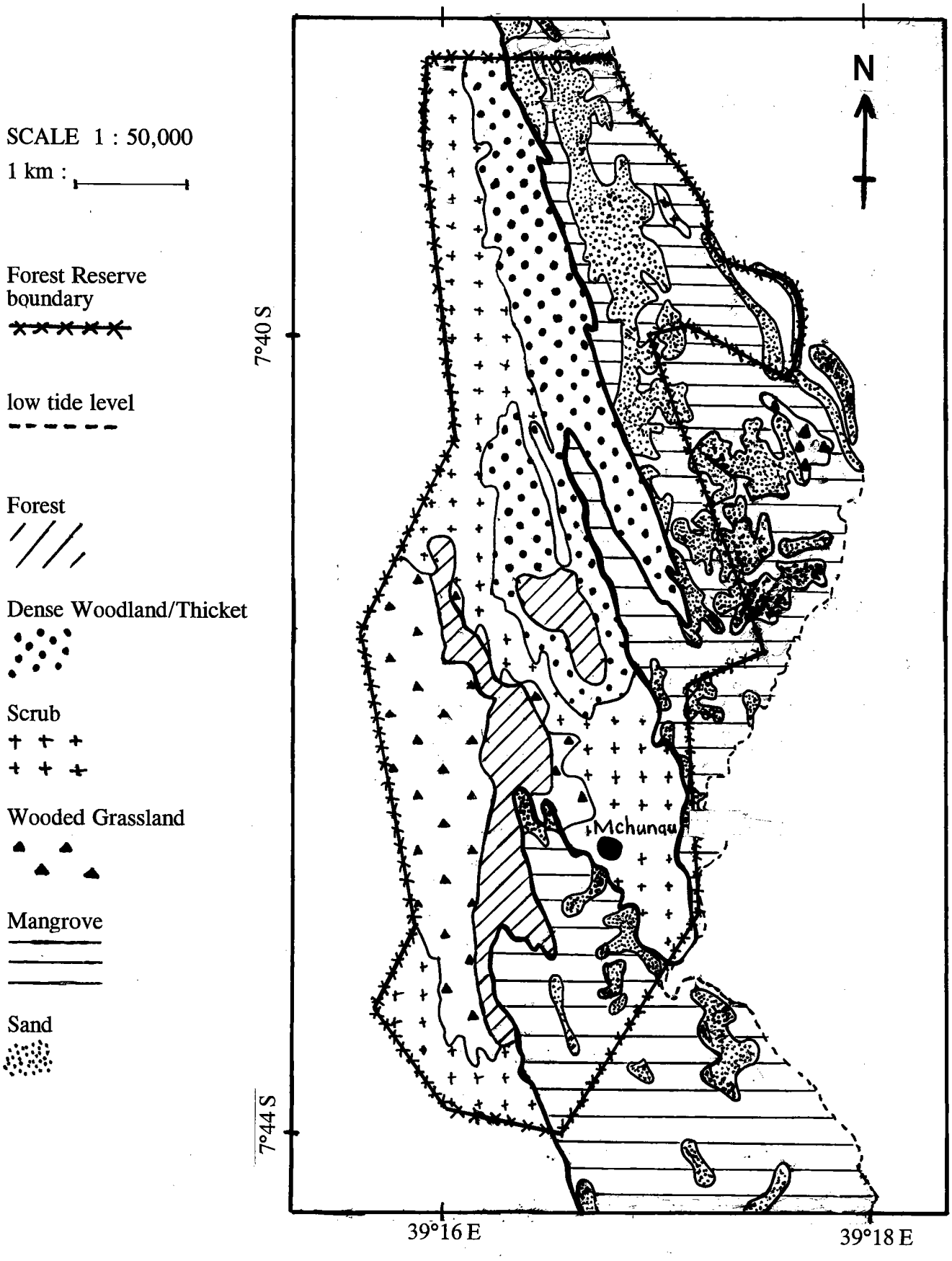

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Full descriptions of this site are given in Kingdon (1989) and Sheil & Burgess (1990).

Further to these earlier Frontier reports, it was discovered that there was local confusion over the location of the Regional boundaries in this area. Discrepancies between local opinion and official boundary locations (ie. according to government maps and gazettement papers) are illustrated by comparing Figures 2.3 and 2.4. These discrepancies had led in the past to the assumption that the forest lies largely within the Kiwengoma Forest Reserve, whereas in fact the forest lies mostly outside and to the south of Kiwengoma Forest Reserve (at the location of the word "Matumbi" on Figure 2.3), and is thus mainly on unreserved land in Lindi Region.

2.3 KAZIMZUMBWE FOREST RESERVE

Four of the expedition party spent two weeks conducting an ornithological survey of Kazimzumbwe forest. The forest is adjacent to the Pugu Hills Forest Reserve, which is known as one of the richest forests in Africa for rare bird life and also of great importance for other groups, containing 11 endemic plant species. Though Kazimzumbwe could be assumed to contain most or all of the rare species of Pugu, its precise conservation importance had not been assessed.

Location:

Kazimzumbwe Forest Reserve lies in Kiserawe District just 20km south-west of Dar es Salaam in the Pugu Hills, from 6°55' and 7°02'S and 39°02' and 39°04'E.

The forest covers 28.5km^2, of which 80% lies within the Kazimzumbwe Forest Reserve. Kazimzumbwe, with the neighbouring Pugu Forest Reserve (24km^2) includes the remainder of what was once a much larger forest extending to within 10km of Dar es Salaam. The forest is severely disturbed due to logging for timber in the past and charcoal at present: only 9km^2 of Kazimzumbwe has a canopy cover of 40% or greater

A variety of vegetation types are present in the Reserve, with distinct "wet" valley bottom, "dry" ridge-top and "intermediate" valley side communities characterise the undisturbed forest. Other vegetation types correspond to the intensity of forest disturbance, with evergreen thicket being present in the most disturbed areas. Savannah woodland and swamp vegetation are also present within the Forest Reserve.

Topography, Geology and Soils:

The Pugu Hills reach 280m asl, with forest present from 120m upwards. The hills are kaolinitic sandstone overlain by red sandy-clay soils and receive an average of 1,236mm of rain annually (data from the weather station at Kisarawe). Red to brown soils of pH range 5-6 predominate.

2.4 RECONNAISSANCE VISITS

During the expedition brief reconnaissance visits were made to investigate the presence of forest in several Forest Reserves and other areas: Mbinga, Ton'gombe and Namakutwa-Nyamuete Forest Reserves, Nan'goma Caves and Mafia Island (see Figure 2.1). Descriptions of these sites are presented in Appendix A. A small vertebrate collection was also made from Simba-Uranga, an inhabited island in the Rufiji Delta. This island has no terrestrial forest but was studied to determine what vertebrate species were utilising the mangroves and associated habitats.

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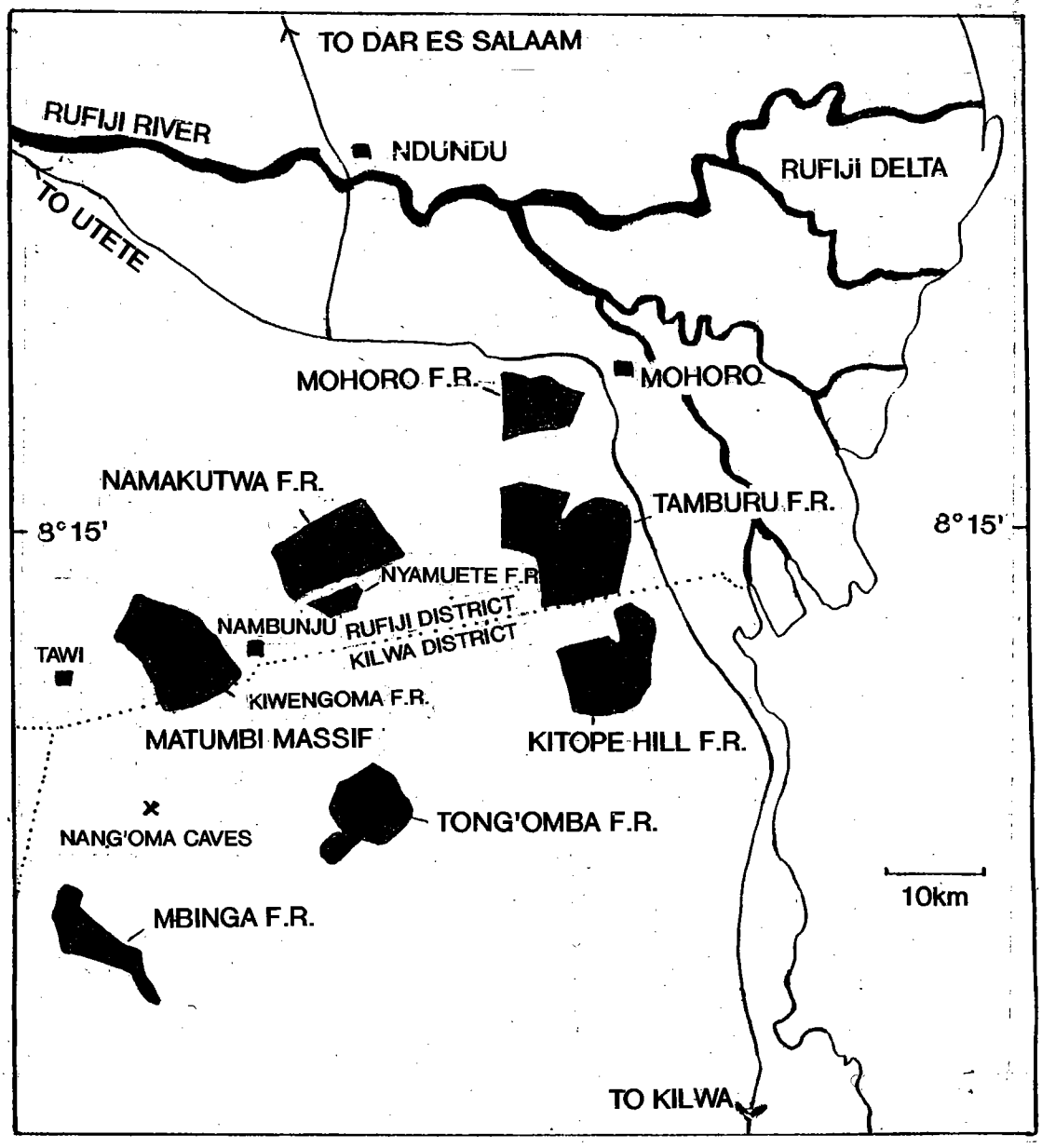

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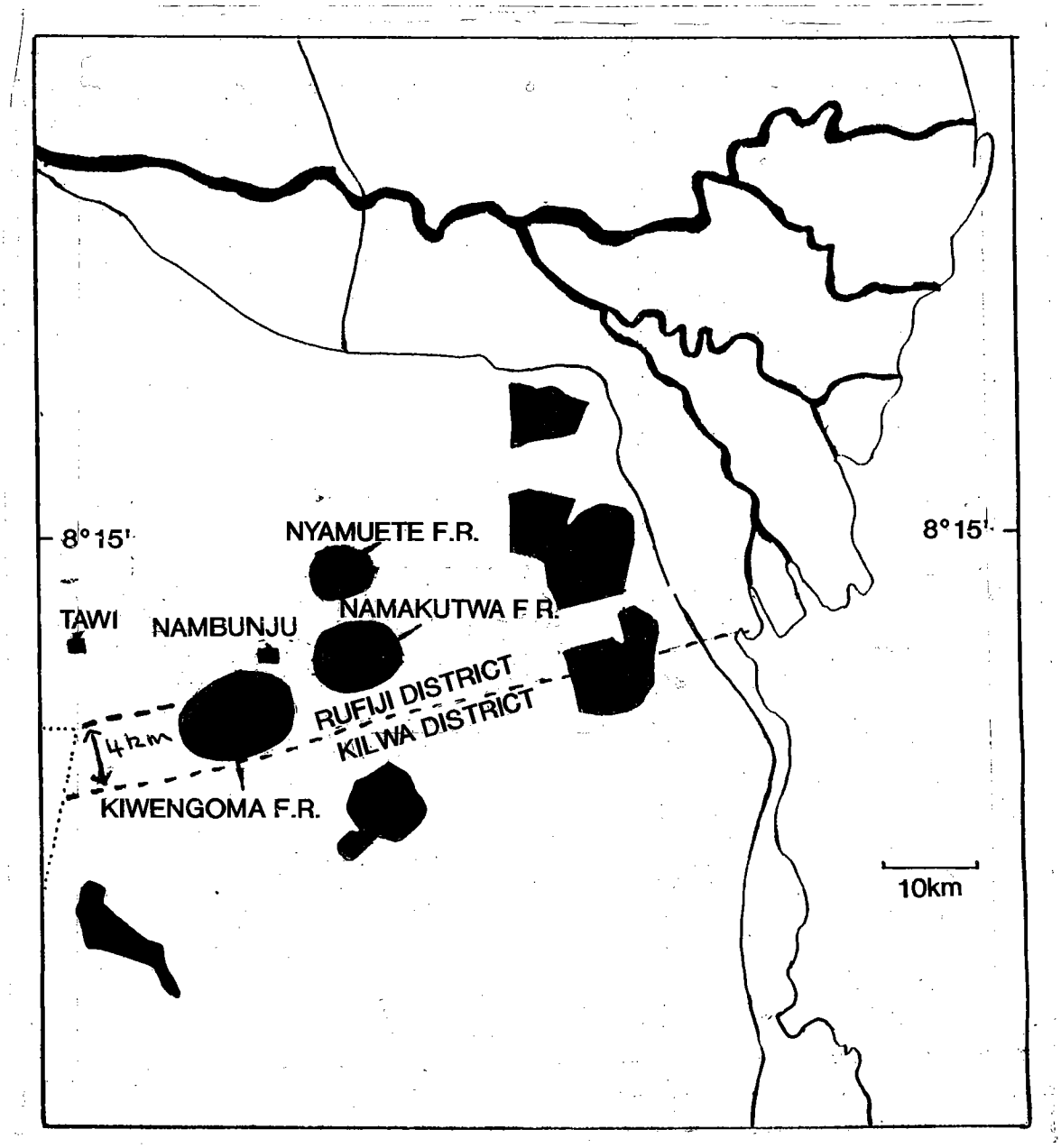


3.0 Personnel

Scientific work was coordinated by Tertia Waters (Zoological), Dr. Alexander Chepstow-Lusty, Frank Mbago and Kanissius Kayombo (Botanical), and Charles Mlingwa and Mark Huxham (Ornithological). Alex Dickinson was responsible for reconnaissance, planning and logistical support.

Medical staff were Alison Thompsett R.C.N. and Caroline Gratwick, R.C.N.

Voluntary support in all aspects of the work was provided by: Anna Christie, Jake Davies, Julie Granger, Caroline Gratwick, Tim Hellen, Charlotte Jenkins, Mark Lawrence, Rachel McCaffrey, Simon Ogle, Richard Selman, Nick Smith and Alison Thompsett.

Nasorro Salim and Costa Andrew acted as drivers and interpreters.

4.0 Project reports: Botanical

4.1 MCHUNGU FOREST RESERVE

The botanical work at Mchungu involved: a) Mapping and describing habitats and vegetation types, b) Describing the threats to the forest, c) Using transects to present details of the vegetation profile and vegetation composition, d) Collecting data on vegetation structure within plots located along transects, e) Collecting herbarium specimens to produce species-lists for the reserve, particularly the forest component.

4.1.1 Survey and Mapping

The vegetation types recognised in Mchungu Forest Reserve display many of the characteristics assigned to the Zanzibar-Inhambane regional mosaic of White (1983). There is a complex interdigitation of vegetation types, reflecting the influence of both environmental conditions and human pressures. The distribution of broad habitat types within the Reserve is shown in Figure 2.2. Terrestrial forest was limited to the southern half of the Reserve, and the vegetation of this area was mapped in greater detail: see Figure 4.1.

Forest was present as several small patches consisting of a variety of vegetation communities; these and the other terrestrial habitats and vegetation types are described briefly below.

Coastal Forest:
The small patches of forest (about 2km^2 in total), may be classified as Zanzibar - Inhambane regional mosaic undifferentiated forest (White, 1983). They also exhibit certain moist semi-evergreen forest characteristics, such as the presence of buttressed trees, *Syzygium* sp., and the abundance of *Ficus* sp.

Swamp Forest:
In Kiboko forest permanent muddy pools colonised by *Barringtonia* sp. are present. These areas are about 5 to 20 meters wide, and 100-500m long running north-eastwards. They are regularly used by hippos migrating to the edaphic grasslands where they graze at night.

Scrub Forest:
In this vegetation type the understorey is 1 to 2 meters tall, with larger trees of up to 15 meters tall forming a broken canopy. Many lianes and ferns are present. The best area for this vegetation is Mpiripiri, which is the local name for *Sorindeia* sp. which dominates the evergreen understorey, along with many Euphorbias. This area was cultivated in 1974 and has since been allowed to regenerate. The ground level has a thin leaf-litter, lying on a sandy soil of low humus content.

Bushland or thicket:
This is present as an ecotone between forest and wooded grasslands. It is characterised by a 50-60% ground cover of bushes up to 5 meters in height. The dominant plants are multi-stemmed Leguminaceae. Grasses occur, though they are subordinate. The soil is sandy, with a very thin, poor humus layer.

Wooded Grassland:
This is the most widespread vegetation in the reserve. Dominant tree species are *Parinari curatellifolia* and *Strychnos* sp. They form up to 40% ground cover and stand 6 to 7 meters tall. There is a well-developed herbaceous layer. Fringing palms *Hyphaene coriacea* occur throughout the wooded grasslands, and are concentrated at ecotones. *Ochna* sp., *Pteleopsis* sp., *Annona senegalensis* and *Syzygium* sp. are also present.

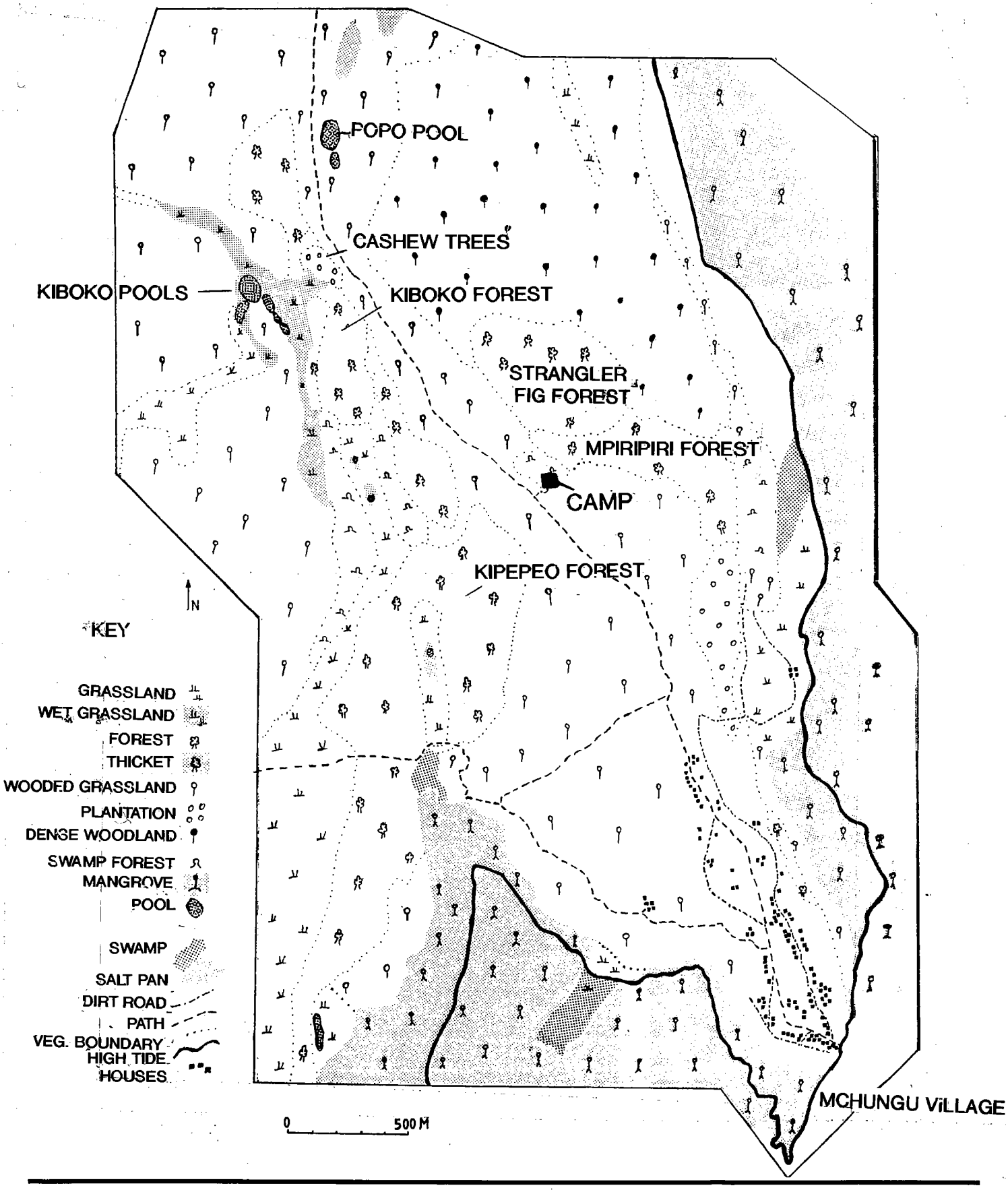
Herbaceous fresh-water swamp and aquatic vegetation:
This habitat is sustained by the year round supply of ground-water. Sedges and *Mimosa pudica* are abundant. *Hypocis* sp. is also present, and species from the family Scrophulariaceae dominate the flowering herbs. An ecotone dominated by *Hyphaene coriacea* exists at forest boundaries.

Dense Woodland:
This habitat covers a large part of the reserve, and dominates the closed-canopy vegetation. The type area is Dugiza Woodland, which is dominated by leguminous trees. The majority of trees are deciduous woodland species, forming a closed canopy of between 10 and 12 meters in height.

An evergreen understorey exists in many places in the woodland, which is dominated by *Sorindeia* sp, along with large numbers of Euphorbias.

Others
Other vegetation and habitat types present in the Reserve (and shown on the map) which do not warrant further detail here are: (i) tidal mud and sand flat; (ii) intertidal mangrove forest; (iii) salt-pans with halophytic vegetation; and (iv) anthropic mango and cashew-nut plantation.

Figure 4.1: Detailed vegetation map of south Mchungu Forest Reserve, showing the forested areas



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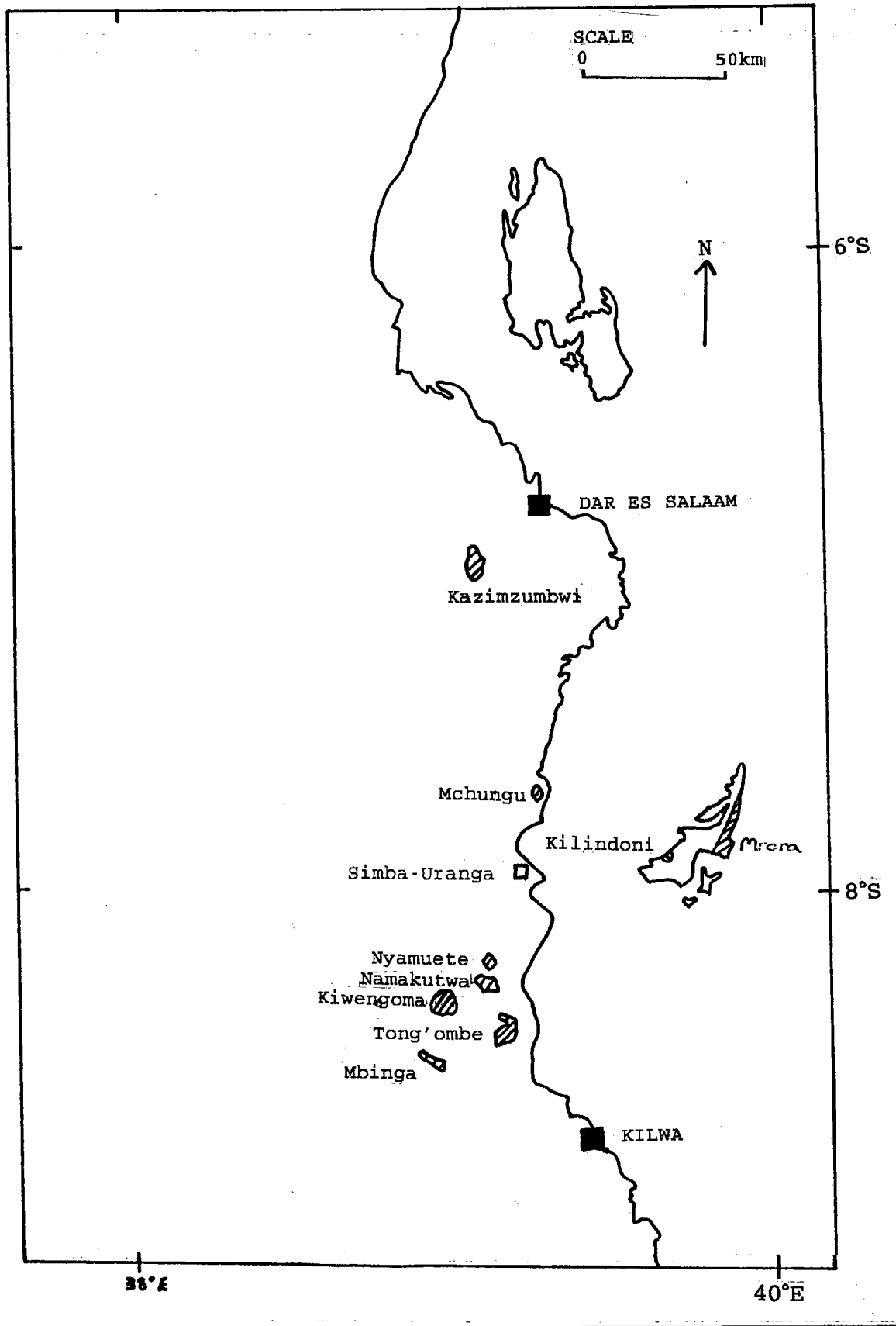

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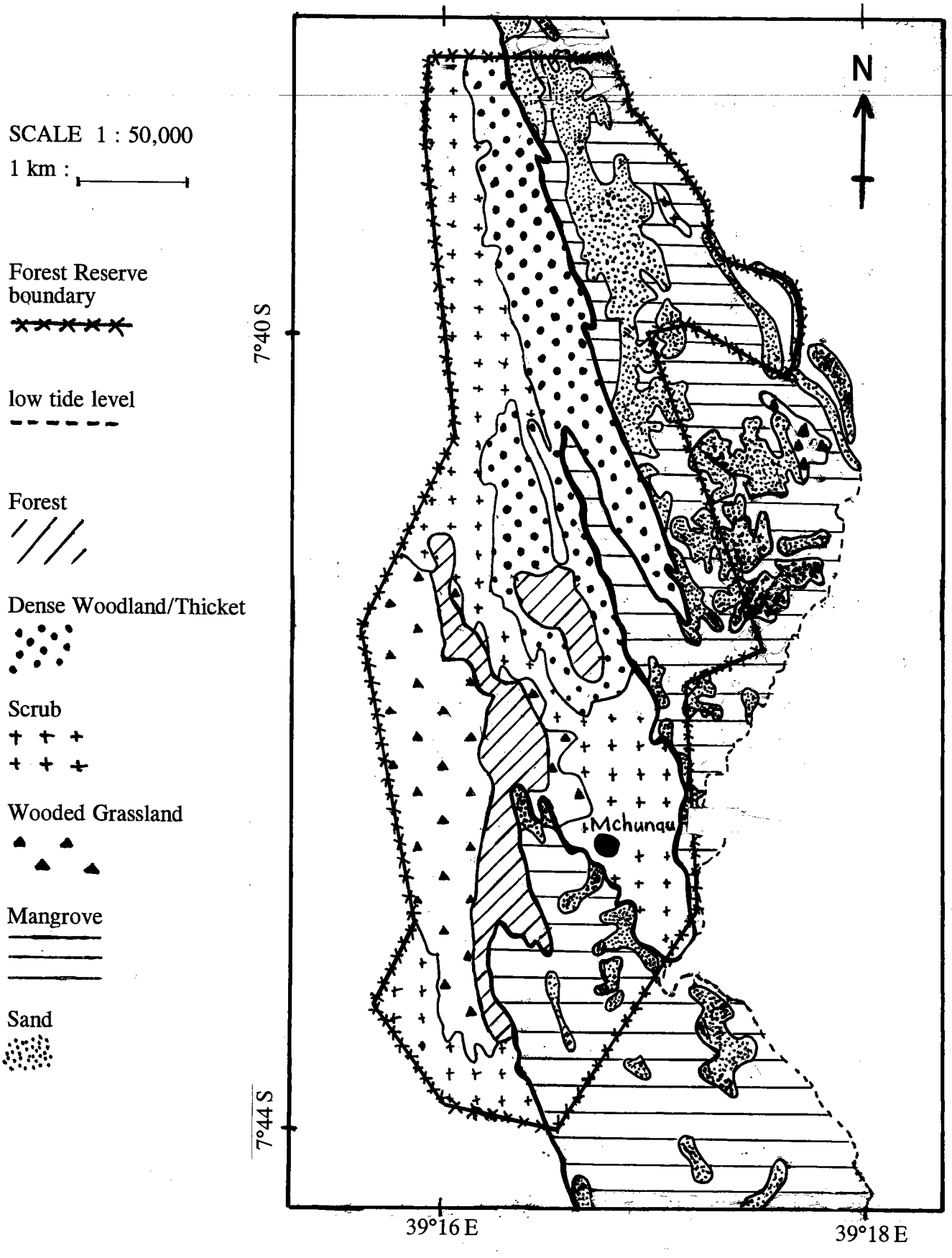

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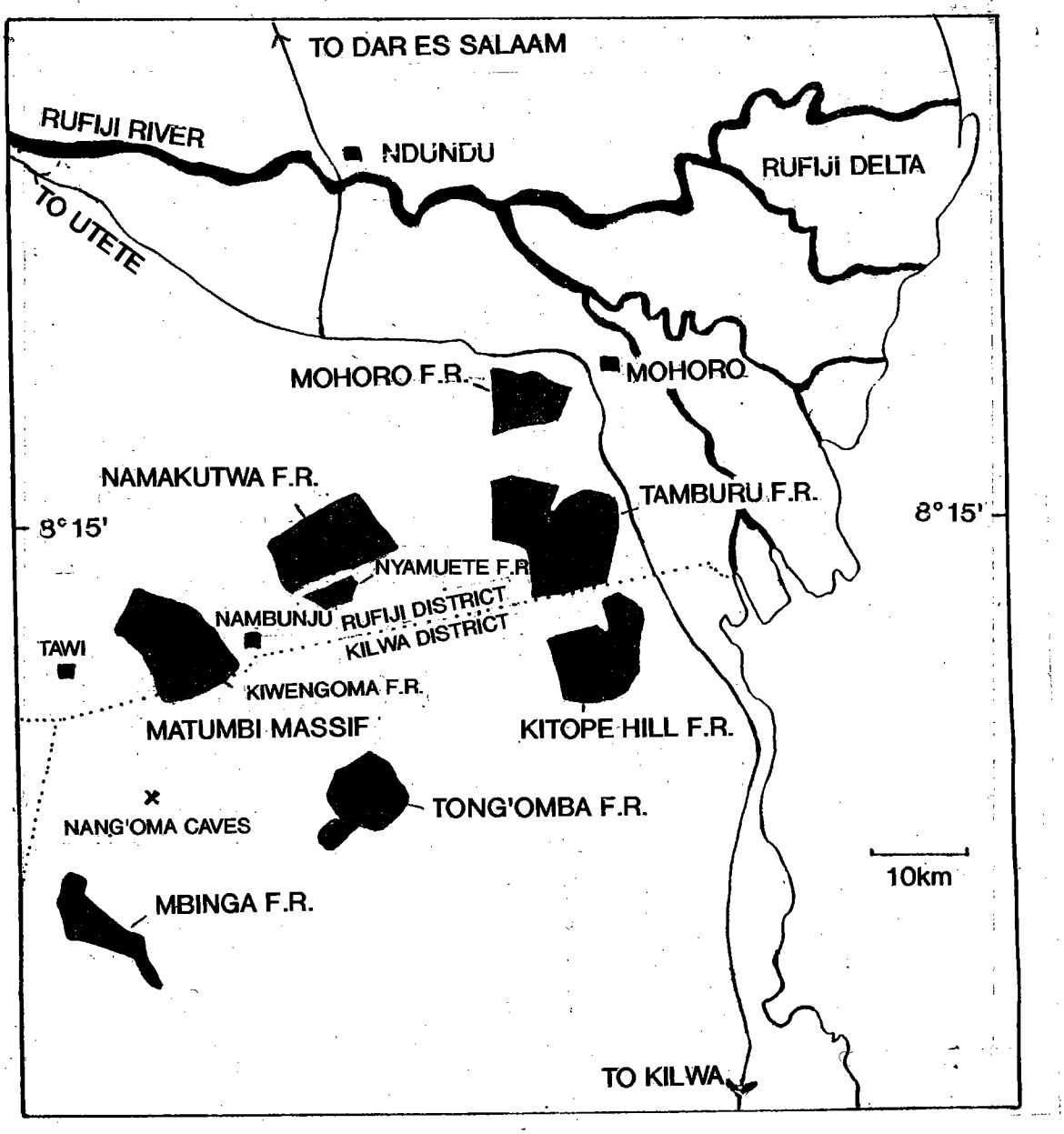

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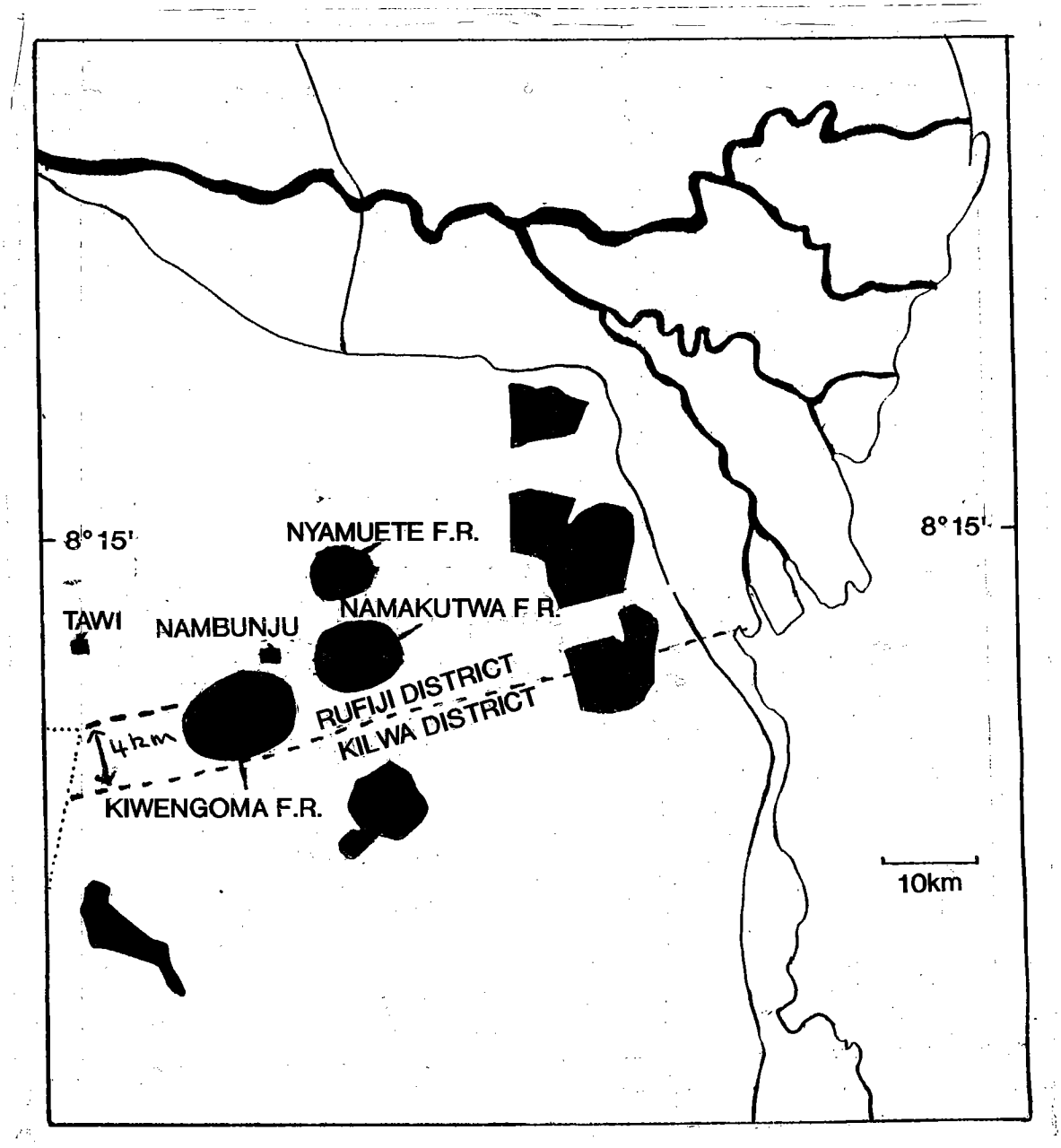


3.0 Personnel

Scientific work was coordinated by Tertia Waters (Zoological), Dr. Alexander Chepstow-Lusty, Frank Mbago and Kanissius Kayombo (Botanical), and Charles Mlingwa and Mark Huxham (Ornithological). Alex Dickinson was responsible for reconnaissance, planning and logistical support.

Medical staff were Alison Thompsett R.C.N. and Caroline Gratwick, R.C.N.

Voluntary support in all aspects of the work was provided by: Anna Christie, Jake Davies, Julie Granger, Caroline Gratwick, Tim Hellen, Charlotte Jenkins, Mark Lawrence, Rachel McCaffrey, Simon Ogle, Richard Selman, Nick Smith and Alison Thompsett.

Nasorro Salim and Costa Andrew acted as drivers and interpreters.

4.0 Project reports: Botanical

4.1 MCHUNGU FOREST RESERVE

The botanical work at Mchungu involved: a) Mapping and describing habitats and vegetation types, b) Describing the threats to the forest, c) Using transects to present details of the vegetation profile and vegetation composition, d) Collecting data on vegetation structure within plots located along transects, e) Collecting herbarium specimens to produce species-lists for the reserve, particularly the forest component.

4.1.1 Survey and Mapping

The vegetation types recognised in Mchungu Forest Reserve display many of the characteristics assigned to the Zanzibar-Inhambane regional mosaic of White (1983). There is a complex interdigitation of vegetation types, reflecting the influence of both environmental conditions and human pressures. The distribution of broad habitat types within the Reserve is shown in Figure 2.2. Terrestrial forest was limited to the southern half of the Reserve, and the vegetation of this area was mapped in greater detail: see Figure 4.1.

Forest was present as several small patches consisting of a variety of vegetation communities; these and the other terrestrial habitats and vegetation types are described briefly below.

Coastal Forest:
The small patches of forest (about 2km^2 in total), may be classified as Zanzibar - Inhambane regional mosaic undifferentiated forest (White, 1983). They also exhibit certain moist semi-evergreen forest characteristics, such as the presence of buttressed trees, *Syzygium* sp., and the abundance of *Ficus* sp.

Swamp Forest:
In Kiboko forest permanent muddy pools colonised by *Barringtonia* sp. are present. These areas are about 5 to 20 meters wide, and 100-500m long running north-eastwards. They are regularly used by hippos migrating to the edaphic grasslands where they graze at night.

Scrub Forest:
In this vegetation type the understorey is 1 to 2 meters tall, with larger trees of up to 15 meters tall forming a broken canopy. Many lianes and ferns are present. The best area for this vegetation is Mpiripiri, which is the local name for *Sorindeia* sp. which dominates the evergreen understorey, along with many Euphorbias. This area was cultivated in 1974 and has since been allowed to regenerate. The ground level has a thin leaf-litter, lying on a sandy soil of low humus content.

Bushland or thicket:
This is present as an ecotone between forest and wooded grasslands. It is characterised by a 50-60% ground cover of bushes up to 5 meters in height. The dominant plants are multi-stemmed Leguminaceae. Grasses occur, though they are subordinate. The soil is sandy, with a very thin, poor humus layer.

Wooded Grassland:
This is the most widespread vegetation in the reserve. Dominant tree species are *Parinari curatellifolia* and *Strychnos* sp. They form up to 40% ground cover and stand 6 to 7 meters tall. There is a well-developed herbaceous layer. Fringing palms *Hyphaene coriacea* occur throughout the wooded grasslands, and are concentrated at ecotones. *Ochna* sp., *Pteleopsis* sp., *Annona senegalensis* and *Syzygium* sp. are also present.

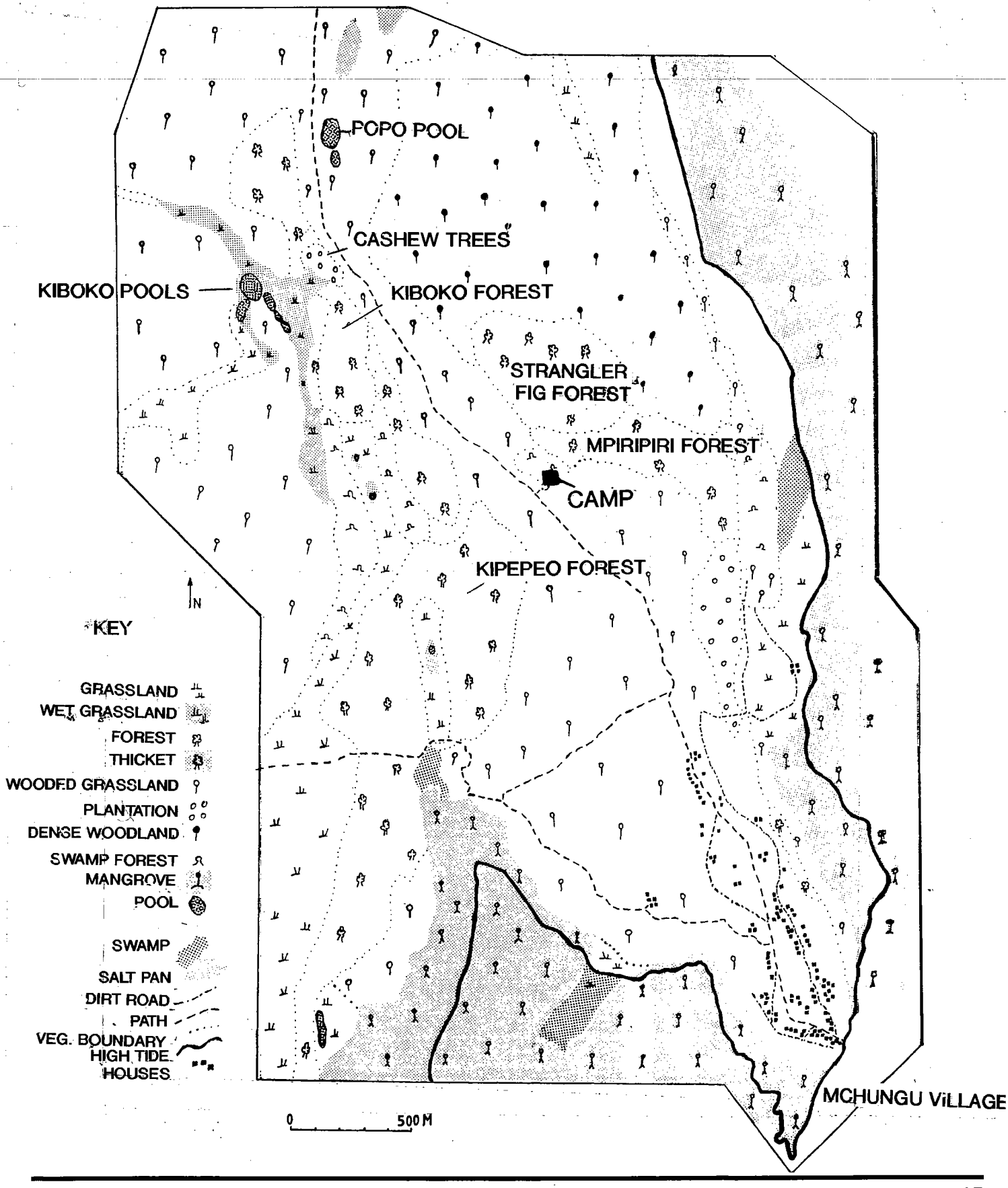
Herbaceous fresh-water swamp and aquatic vegetation:
This habitat is sustained by the year round supply of ground-water. Sedges and *Mimosa pudica* are abundant. *Hypocis* sp. is also present, and species from the family Scrophulariaceae dominate the flowering herbs. An ecotone dominated by *Hyphaene coriacea* exists at forest boundaries.

Dense Woodland:
This habitat covers a large part of the reserve, and dominates the closed-canopy vegetation. The type area is Dugiza Woodland, which is dominated by leguminous trees. The majority of trees are deciduous woodland species, forming a closed canopy of between 10 and 12 meters in height.

An evergreen understorey exists in many places in the woodland, which is dominated by *Sorindeia* sp, along with large numbers of Euphorbias.

Others
Other vegetation and habitat types present in the Reserve (and shown on the map) which do not warrant further detail here are: (i) tidal mud and sand flat; (ii) intertidal mangrove forest; (iii) salt-pans with halophytic vegetation; and (iv) anthropic mango and cashew-nut plantation.

Figure 4.1: **Detailed vegetation map of south Mchungu Forest Reserve, showing the forested areas**



4.1.2 Description of Coastal Forest Vegetation

The areas of coastal forest are described in more detail below.

Forest Canopy:
The forest has a broken canopy over 30m in height, the structure of which is illustrated by the transect profile diagrams (Figures 4.2 to 4.5). The canopy is dominated by *Hymenaea verrucosa* and *Baphia* sp, and is *c*.50% evergreen. Other canopy trees include *Borassus* sp, *Sideroxylon* sp., *Afzelia quanzensis*, *Manilkara* sp., *Ficus* sp., and other species belonging to the families Fabaceae, Rubiaceae, Apocynaceae and Annonaceae. Lianes and climbers are common throughout, and include *Saba florida*, *Paullinia* sp, *Cissus* sp, *Strychnos* sp, and *Flagellaria guineensis* sp. (a climbing grass). Epiphytes are present, although uncommon, such as the orchid *Eulophia* sp.

Forest Understorey:
The understorey is well developed and predominantly evergreen. *Polysphaeria* sp. and *Chassalia* sp. dominate. Also abundant are *Haplocoelum* sp., *Allophylus* sp., *Pancovia* sp. and *Diospyros verrucosa*. Succulent euphorbias occur in most areas.

Herbaceous Layer:
The herbaceous layer is sparse throughout most of the forest, and is best developed in areas where trees have fallen. The dominant species are *Flagellaria guineensis*, and *Sanseviera conspicua*. In moist areas, ferns are present.

Ground and Leaf Litter:
In most areas the leaf-litter covers 80-100% of the ground. There is also a high density of damp rotting logs supporting bracket fungi.

4.1.3 Disturbance to Forested Areas

The forest is subjected to many pressures from both human and animal activities. Effects of these fall into 4 main categories which are described below.

(i) Clearance by humans for cultivation:
The coastal towns of Msindaji and Mchungo are reliant on the fishing trade and cash crops (mango and cashew nut) for income. Large areas of the forest reserve have been cleared and re-planted with these cash crops. The 'shamba' style of shifting agriculture is little used locally and vegetables such as tomato and cassava are bought from Nyanjati to the South. Mpiripiri forest was cleared in 1974, and has since had 16 years to regenerate into an area of low scrub-forest. Kiboko forest on the other hand has escaped cultivation due to its proximity to hippo pools.

(ii) Selective logging of forest species:
Signs of commercial logging are at present few around Mchungu: only 5 to 6 felled trees were seen in the whole study area. This is despite relatively easy access from Mchungu to Dar es Salaam by road or sea, and may be because most commercially valuable trees are now scarce in the area.

Forest hardwoods are used however for boat construction. Three species were named as used for making dug-out canoes: "Msandaleusi", Mtanga", and Mkongo". The canoes are completed within one and four weeks after felling, and are sold locally or in Dar es Salaam. A canoe has a working life of 6-7 years; there were at least 25 such canoes in Mchungo. Simba-Uranga, Kiomboni, and Nyamasati are also supplied with timber from this forest, mainly for canoes.

Unusually, cutting of forest saplings for use as poles for house construction does not occur to any great degree at Mchungu; instead poles are obtained from the mangrove forests on the island of Simba-Uranga.

Permission for the removal of forest and mangrove species is granted locally by a forest ranger, whose jurisdiction covers Mchungu and Nyamasati. No yearly limit exists for local demands. Local information suggested that no official commercial logging occurs here.

(iii) Animal disturbance:
Damage to the forest vegetation from hippo and elephant is visible throughout the forested areas. In particular, Kiboko forest has a dense network of well trodden paths cutting through it. Elephants were seen feeding in the cashew nut plantations next to Kiboko forest, and droppings of varying ages are abundant throughout the area.

The existence of permanent pools of fresh water makes the area a refuge for many large animals during the dry season. Duiker, bush-pig, lion, leopard, black and white colobus, blue monkey and vervet monkey were all present in the reserve.

(iv) Fire:
The wooded grasslands were heavily burnt at the time of study. This may be indicative of the important role played by fire in reducing the regeneration of forest species.

Kiboko Forest was found to be the least disturbed area of forest remaining. It covers a very small area of about 750m^2 and borders onto the *Barringtonia* swamp forest and is therefore generally moister than other areas of forest. The canopy is flat-topped, of about 80% cover and reaches a height of about 35m. The canopy trees branch at around 15 to 20m, and the understorey reaches about 8m. The herb layer is sparse and a thick leaf litter exists. Lianes, climbers, buttress root trees, and epiphytic orchids were all found in this area of forest.

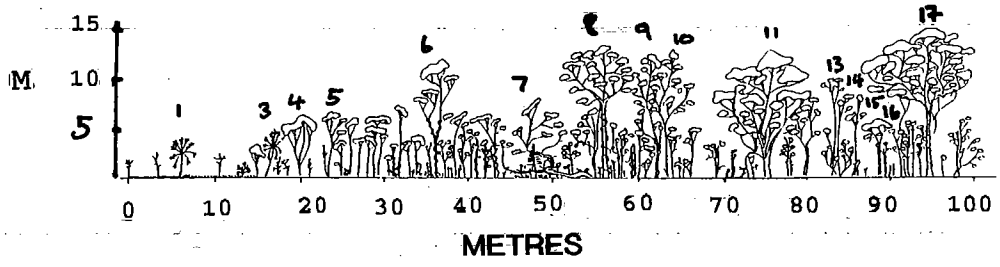
Kiboko Forest is protected from clearance for cultivation due to extensive use by hippos at night. It is however very small, and is under pressure from logging.

4.1.4 Description of Vegetation Profile, Structure and Physiognomy using Transects

Four 100m transects were established in Mchungu Forest Reserve sampling each of the terrestrial forest types present, plus wooded grassland and scrub woodland. For each transect structural and botanical data were collected and profile diagrams were drawn to scale (see Figures 4.2 to 4.5).

Species identities for numbered trees (Diameter at Breast Height > 10cm) and shrub and herb species encountered on the transects are summarised beneath each transect diagram. Species identifications are provisional and were made in the field by Mr. Frank Mbago of the Department of Botany, University of Dar es Salaam.

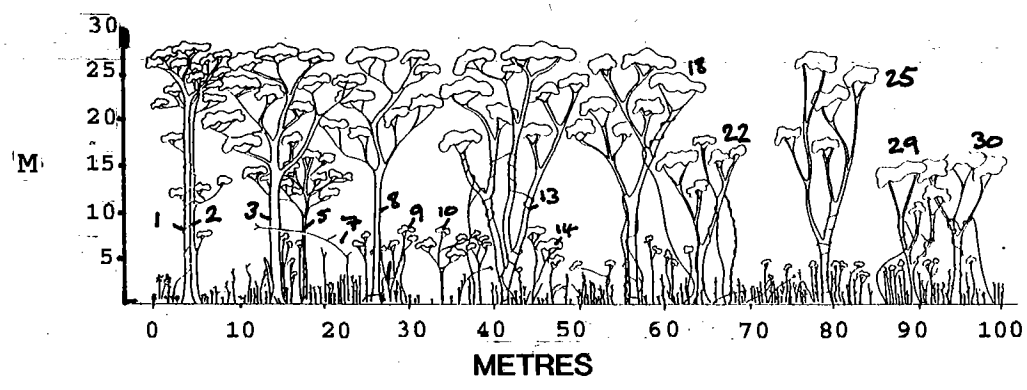
Figure 4.2: Vegetation profile diagram of Transect 1: "Kiboko" forest area into forest/woodland ecotone then wooded grassland, Mchungu Forest Reserve



TREES: 1. *Borassus* sp., 3. *Borassus* sp. 4. *Baphia* sp., 5. *Sideroxylon* sp., 6. *Baphia* sp., 7. *Afzelia quanzensis,* 8. *Baphia* sp., 9. *Baphia* sp., 10. *Baphia* sp., 11. Fabaceae ?, 12. *Sideroxylon* sp., 13. *Trachylobium* sp., 14. *Trachylobium* sp., 15. *Trachylobium* sp., 16. Rubiaceae ?, 17. *Trachylobium* sp.

GROUND LAYER: The herb layer consisted of *Flagellaria, Sanseviera, Panicum, Landolphia, Dracaena.* There were various shrub species.

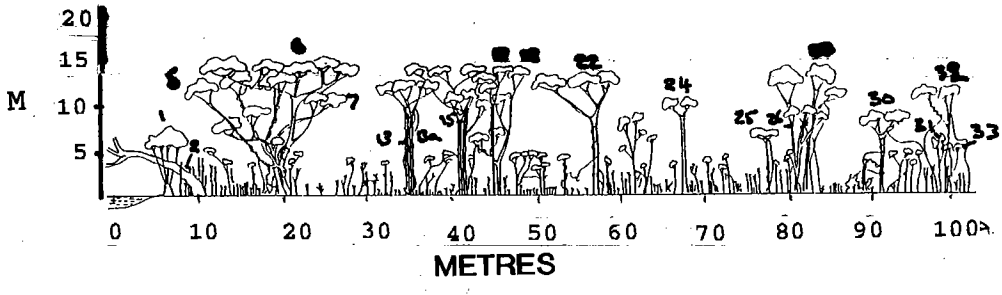
Figure 4.3 : Vegetation profile diagram of Transect 2; "Kiboko" area, Mchungu Forest Reserve



TREES: 1. *Barringtonia* sp., 2. *Barringtonia* sp., 6. *Trachylobium* sp., 7. Baphia sp., 8. *Afzelia* sp., 13. *Trachylobium* sp., 13a. *Trachylobium* sp., 15. *Trachylobium* sp., 16. *Baphia* sp., 17. *Trachylobium* sp., 18. *Baphia* sp., 22. *Trachylobium* sp., 24. *Trachylobium* sp., 25. *Baphia* sp., 26. *Baphia* sp., 27. *Trachylobium* sp., 30. *Trachylobium* sp., 31. *Baphia* sp., 32. Sapindaceae, 33. *Manettia* sp.

GROUND LAYER: The ground layer was sparse, with some *Dracaena,* but very few other species. There was a thick layer of decaying leaves and twigs. The shrub layer was dense. Lianes and climbers were abundant.

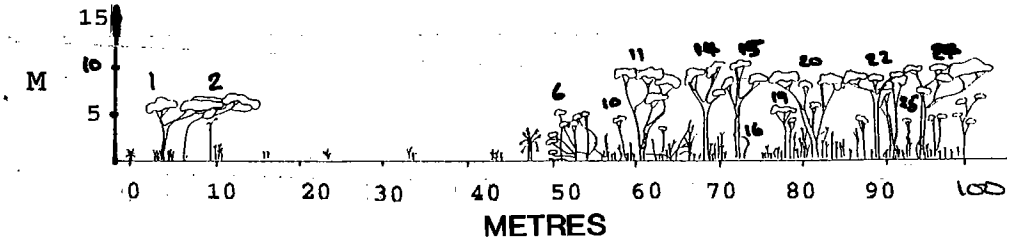
Figure 4.4: Vegetation profile diagram of Transect 3: Barringtonia swamp forest into low canopy coastal forest, Mchungu Forest Reserve



TREES: 1. *Trachylobium* sp, 2. *Trachylobium* sp, 3. *Trachylobium* sp, 5. *Baphia* sp., 7. Dead, unknown?, 8. *Trachylobium* sp, 9. Apocynaceae ?, 10. *Annonaceae* ?, 13. *Trachylobium* sp, 14. Annonaceae, 18. *Trachylobium* sp, 22. *Baphia* sp., 25. *Trachylobium* sp., 29. Annonaceae ?, 31. *Trachylobium* sp.

GROUND LAYER: The ground layer consisted of *Panicum, Sanseviera, Landolphia, Asparagus, Strychnos,* ferns and *Euphorbia* species.

Figure 4.5: Vegetation profile diagram of Transect 4: wooded grassland into scrub woodland, Mchungu Forest Reserve



TREES: 1. *Sclerocarpa* sp., 2. *Euclea* sp., 5. *Borassus* sp., 6. *Borassus* sp., 10. *Trachylobium* sp., 11. *Trachylobium* sp., 14. *Trachylobium* sp., 15. *Trachylobium* sp., 16. *Trachylobium* sp., 19. *Balanites* sp., 20. *Trachylobium* sp., 22. *Trachylobium* sp., 25. *Sorindeia* sp., 26. *Baphia* sp., 27. *Trachylobium* sp.

GROUND LAYER: In the grassland, grassy species were abundant, and as the transect passed into forest there was less of a ground layer with species such as *Sanseviera, Panicum, Flagellaria* and a few *Euphorbia* species.

4.1.5 Forest Vegetation Structure

Data on the three-dimensional vegetation structure of Mchungu Forest Reserve was collected for comparison with other forests using standardised methods. Thirty measurements were taken at random a 50m x 50m plot located along each of the vegetation transect. Average figures for the entire reserve (combining data from all four plots/transects) is presented in Table 4.1. Vertical shrub and canopy density were recorded by looking through a tube containing a fine grid and counting the number of grid squares occluded. Ground cover density was similarly estimated using a quadrat marked off with a grid. "Half-sightings" are a measure of horizontal vegetation density, and indicate the distance at which 50% of the squares on a "checkerboard" become occluded by vegetation. Full details of these methods are given in Burgess and Dickinson (in prep.).

Table 4.1: Vegetation structure of the forest and woodland of Mchungu Forest Reserve (figures are the average of 30 measurements from each of four plots covering several vegetation types).

Mean shrub height (m)	1.6
Mean canopy height (m)	15.1
Mean tree diameter (m)	0.3
Mean vertical shrub density (%)	34.3
Mean vertical canopy density (%)	61.2
Mean ground cover density (%)	18.0
Mean half sightings - at 0.5m (m)	7.1
- at 1.0m (m)	8.4
- at 1.5m (m)	9.0

4.1.6 Collection of Herbarium Specimens

231 fertile and non-fertile herbarium plant specimens were collected throughout Mchungu Forest Reserve using standard methods (Frontier collection Nos. 1192-1423). All plant specimens were collected in sets of 6 replicates; one complete set was passed to Dr. Kaj Vollesen in Kew Gardens for identification, and another retained at the herbarium in the Department of Botany, University of Dar es Salaam.

4.2 KIWENGOMA FOREST

Botanical work at Kiwengoma concentrated on a) Collection of plants to augment previous collections from different seasons, b) A logging census and c) Recording structural characteristics of the vegetation in plots. Other data on the site can be found in Kingdon (1989) and Sheil & Burgess (1990).

4.2.1 Plant Collection

During the study period, 66 plant specimens (Frontier collection Nos. 1125-1191) were collected in sets of 6 copies and one set has been sent to Kew Gardens for identification. Most specimens were sterile and were collected from the coastal forest areas, particularly along the Mwengei and Nambunju valleys.

4.2.2 Logging Census

Methods

Data on tree species of commercial logging value were recorded in the Mwengei river valley. For the logging census, six line transects 50m long and *c*.5m wide were established. The transects ran approximately East-West, perpendicular to the river valley which crossed each transect at the 25m point. The transects were placed along a N-S gradient with altitude decreasing southwards and Transect 6 the northernmost and highest altitude. All trees above 3m in height were counted along each transect.

Results

There were found to be four commercially exploited tree species present: *Milicia excelsa*, *Khaya nyasica*, and *Dalbergia melanoxylon* (hardwoods) and *Pterocarpus* sp. (softwood). Summarised data are displayed in Table 4.2.

Table 4.2: Results of a logging survey in the Mwengei river valley, Kiwengoma forest

Transect number	No. of trees	No. commercial species (%)	Mean height (m)	Mean DBH (cm)
1	15	6 (40)	17.7	190.5
2	15	6 (40)	16.5	174.5
3	22	10 (46)	14.6	164.7
4	25	13 (52)	12.4	74.7
5	18	4 (28)	16.0	176.0
6	24	5 (21)	10.4	187.0
Mean (1-6)	19.8	7.3 (37.7)	14.6	161.2

The table displays the change in physiognomic structure of the forest with increasing altitude more clearly than the effects of logging. Transects 4-6 show a marked decrease in mean height and DBH (diameter at breast height) with increasing altitude, a characteristic which becomes clearly visible at the head of the valley. The number of trees per transect does, however, decline in the more accessible southern transects, which probably indicates removal over an extended time-period.

Logging is currently concentrated along the valley bottom. During the study period 193 tree stumps were counted, 15 of which were recent. The canopy over the valley floor is destroyed in many places, which is leading to a local loss of humidity-dependent species such as the African Violet *Saintpaulia* sp.. It was found that parts of the forest were composed of up to 40% commercially valuable species; removal of all of these would lead to a general increase in air movement and decrease in humidity in the forest which could prove catastrophic to sensitive species such as the African Violet.

Axes and fire are used to fell the trees; pit-sawyers then cut the wood into planks of 200cm x 20cm x 8cm. Licences are purchased to enable the loggers to fell 5 trees per season per licence. When the licence has been used, a new one may be purchased in order to continue. Thus there is no effective means of restricting logging intensity.

A local forester has the job of monitoring all logging (legal and illegal) over the whole area of the Matumbi Massif, some 7 to 10 isolated forested areas. He has no transport and is very poorly paid. During the period of study three local groups had felling licences operating.

Commercial tree species are listed below with details of their uses and the licence price:

Milicia excelsa. Kiswahili name: Mvule. This is a high quality hardwood, used for cabinet making and construction. The bark is used to make charcoal. The licence costs 400 TZS per tree.

Khaya nyasica. Kimatumbi and Kiswahili name: Mkangazi. This East African mahogany is used for mortars and other utensils. It is the most commonly logged tree, being the most abundant commercial hardwood in the Mwengei Valley. It is usually felled when over 30 years old, the licence costs 250 TZS per tree.

Dalbergia melanoxylon. Kimatumbi and Kiswahili name: Mpingo. This dense, black wood is used for 'Makonde' carvings. It is relatively uncommon in the Mwengei Valley, but is abundant in the Nambunju Valley, which has yet to be extensively logged. The licence costs 600 TZS per tree.

Pterocarpus sp. Kimatumbi name: Mwingamaji. This tree is very common in the Mwengei Valley. The licence costs 200 TZS per tree.

There is no restriction on the size of tree that may be logged, although larger trees are obviously more profitable. The timber from these trees is sold in Dar es Salaam, and is also exported to Mozambique, China and Japan.

4.2.3 Forest Vegetation Structure

Vegetation structural data for the forest were recorded as for Mchungu (above). in this case a single plot and transect was used. Summarised results are presented in Table 4.3. Comparison with data from Mchungu Forest Reserve (Table 4.1) shows the area sampled at Kiwengoma to have fewer and shorter trees with a sparser canopy. The Kiwengoma plot also has a denser shrub layer and denser ground cover, which could be a result of the sparser canopy allowing more light to reach the ground.

Further comparison of the vegetation structure of other coastal forests in Tanzania, especially with respect to the distribution of bird species, is presented in Ogle (1990).

Table 4.3: Vegetation structure of Kiwengoma forest

Mean shrub height (m)		2.4
Mean canopy height (m)		10.8
Mean tree diameter (m)		0.2
Mean vertical shrub density (%)		44.0
Mean vertical canopy density (%)		55.0
Mean ground cover density (%)		26.0
Mean half sightings	- at 0.5m (m)	4.4
	- at 1.0m (m)	5.3
	- at 1.5m (m)	5.3

5.0 Project reports: Zoological

The Zoological projects undertaken during this expedition phase were: a) general invertebrate collection from Mchungu and Kiwengoma, b) comparison of invertebrate morphospecies diversity in pitfalls located in two different habitats at Mchungu, c) general collection and sight records of mammals from Mchungu and Kiwengoma, and d) ornithological investigations at Kazimzumbwi and Mchungu Forest Reserves.

5.1 GENERAL INVERTEBRATE COLLECTION: MCHUNGU AND KIWENGOMA FORESTS

Methods

Techniques for collection were chosen so as to sample as many biotopes as possible. The main biotopes studied were: ground and low vegetation, tree trunks, dead wood and leaf litter, with the addition of the fresh water biotope present in the swamp forest and swamp grasslands at Mchungu.

A wide array of collection techniques was used, including pitfall-trapping, Ultra-Violet light-trapping, beating, insecticide sprays, hand-netting, sweep-netting, intercept trap, pond-netting and hand collection. These methods are described in detail in Burgess and Dickinson (in press). Processing of specimens, including sorting of invertebrates to order level, was carried out at the field camp.

Results

Many thousands of invertebrate specimens of various orders were obtained. Specimens have been distributed to a number of different taxonomists for study. The majority of the invertebrate groups are poorly known for East Africa and identification takes some time, hence no species lists from this work can be presented here. Appendix E presents a species list for butterflies collected on a previous Frontier expedition to Kiwengoma (TZ03: January to March 1990).

5.2 COMPARATIVE MORPHOSPECIES DIVERSITY OF PITFALL CATCHES FROM WOODLAND AND FOREST AT MCHUNGU

This study aimed to compare the species diversity of the woodland and forest vegetation at Mchungu.

Methods

Pitfall traps with 2m drift fences arranged in a star pattern were located in a standardised grid pattern and placed in the ground for a standard length of time. These were used to collect invertebrates from the forest floor. Invertebrates were identified to morphospecies level in the field and a collection of representative specimens was made. Numbers of morphospecies within Invertebrate Orders were counted in the field and the relative composition and species-richness of the woodland and forest ground invertebrate communities were assessed.

Results

Summarized results of this study are presented in Table 5.1.

A simple diversity index of number of species divided by total number of individuals was calculated for both samples:

Woodland = 0.04
Forest = 0.15

The higher diversity of the forest sample may largely be attributed to the occurrence of 1632 individuals of one species of Dipteran in the woodland sample, lowering its overall diversity value. The Dipteran responsible was attracted to a species of dung beetle that floated in the pitfall traps and started to decay. If this error is corrected for, the diversity indexes for both samples are fairly similar; 0.2 in the woodland against 0.15 in the forest.

It is notable that only 28% of the species are common to both habitats. Obvious differences between the samples are the absence of many predatory Arachnids in the forest sample: *Arthroleptis* sp., a moisture dependant ground predator occurs instead. Also, soil and rotting vegetation loving insects such as the Dermapterans, and Isopterans are absent from the woodland sample the ground in this area was hot and dry during the sampling period.

To some extent the assemblages reflect the contrasting characters of the two ecosystems from which they came, with largely distinct faunas occurring in each location. This study may also indicate the depauperate nature of this particular site in comparison with other coastal forests in Tanzania.

This method was preliminarily tested at Mchungu to assess its suitability for comparing the many coastal forest sites being visited by the Frontier-Tanzania Coastal Forest Research Programme. It was found, however, that there are immense problems with standardising the assignation of invertebrates to morphospecies even at a single locality. Hence, determining whether the same species are being recorded at another locality in another period is extremely difficult, especially given the incomplete taxonomy of the invertebrates in the tropical region generally. However, the method is a valuable way to assess major (at level of Order) changes in the invertebrate assemblages of different forests, and especially of different habitats within a single forest.

5.3 GENERAL VERTEBRATE COLLECTION: KIWENGOMA AND MCHUNGU FORESTS, PLUS SIMBA-URANGA AND MAFIA ISLANDS

Methods

Vertebrate collection and observation was undertaken to produce a species list for Mchungu Forest Reserve, and to augment existing lists for Kiwengoma forest. Surveys were also carried out in non-forest habitats at Simba-Uranga (cropland amongst mangroves) and Mafia (cropland/scrub) to determine the extent to which "forest" vertebrates were using these non-forest habitats in these areas, and to document utilisation of mangroves by terrestrial vertebrates in general as this remained a poorly-known subject for Tanzania.

A variety of standardised methods were employed in order to sample all groups present: mist nets for bats; pitfalls and hand capture for reptiles and amphibians; live-traps, break-back traps and observation for mammals; and fish traps. These methods are described in detail in Burgess and Dickinson (in press).

Table 5.1: Invertebrate composition of pitfall-assemblages from forest and woodland habitats in Mchungu Forest Reserve

HABITATS:	FOREST		WOODLAND	
	No. of Species	No. of Individuals	No. of Species	No. of Individuals
INVERTEBRATE ORDERS:				
Diplopoda	1	1	2	10
Chilopoda	0	0	1	2
Isopoda	2	5	3	16
Araneae	13	57	19	54
Scorpiones	0	0	1	1
Solifugid	0	0	1	2
Opiliones	0	0	1	2
Acarina	5	20	6	29
INSECT ORDERS:				
Collembola	5	22	5	15
Orthoptera	8	63	7	18
Coleoptera	23	104	19	163
Hymenoptera	11	124	11	85
Hemiptera	3	5	5	13
Psocoptera	1	1	1	1
Diptera	16	176	9	1667
Dermoptera	2	3	0	0
Isoptera	1	30	0	0
VERTEBRATES:				
Arthroleptis sp.	1	3	0	0
TOTALS	93	618	91	2078

Results

Species lists are presented in Appendix B.

Mchungu was found to have a healthy mixed forest/woodland fauna, with notable species present being black-and-rufous elephant-shrew, African elephant, leopard and lion. In addition an entirely new species of worm snake (*Leptotyphlops* sp. nov.) was collected. To-date this species has been found at two further sites (Mkwaja and Kambai, both in Tanzania) and is still undescribed.

Some interesting new species records were obtained for Kiwengoma forest, including the first recording of fish (catfish) in the temporary streams.

The species lists of the other sites visited are discussed under the individual forest descriptions in Appendix A. However, of particular note was the discovery of a new species of "writhing skink" (*Lygosoma* sp. nov.) on Mafia. This species has subsequently been found at Kisiju forest on the mainland. Also a very rare toad (*Spaeleophryne methneri*) was found surviving in the tiny forest at Nan'goma, which was the site of the species original discovery.

5.4 ORNITHOLOGICAL STUDIES AT KAZIMZUMBWI AND MCHUNGU FOREST RESERVES

These investigations aimed to produce comprehensive species-lists for the birds present in these two forest reserves, to assess the relative abundance of the various species, and to determine their habitat preferences.

Methods

The majority of the ornithological investigation was undertaken in Kazimzumbwi Forest Reserve near Dar es Salaam, between 10/8/90 and 24/8/90. At this site both mist-netting and direct observation were employed to determine bird species present. One week was also spent compiling a species-list for the birds of Mchungu Forest Reserve, using direct observation only.

The principal investigators at both sites were Charles Mlingwa and Mark Huxham.

Results

The bird species-list for Kazimzumbwi is presented in Appendix C, and that for Mchungu in Appendix D.

In total 55 birds were netted at Kazimzumbwi and 12 of these were re-trapped. A total species-list of 68 species was produced for Kazimzumbwi Forest Reserve.

The globally 'rare' (Collar & Stuart, 1985) species east coast akalat was found to be abundant at Kazimzumbwi, the 'near-threatened' species southern banded snake eagle, uluguru violet-backed sunbird and were also recorded, as well as the 'candidate' red data book species Kretschmer's longbill, tiny greenbul, little yellow flycatcher and chestnut-fronted helmet shrike.

A total of 95 species were recorded in Mchungu Forest Reserve. None of these species are of particular conservation significance, although the 'candidate' Red Data Book species tiny greenbul and chestnut-fronted helmet shrike were both recorded.

These results are written up in greater in detail in Mlingwa *et al.* (1993) and the interested reader is referred there for further information.

6.0 Discussion

These investigations in Kiwengoma and Mchungu Forest Reserves (allied with data collected by Sheil & Burgess, 1990) have tended to indicate that coastal forests situated on higher ground inland from the Indian Ocean (Kiwengoma and Kazimzumbwi) possess considerable importance for the conservation of biological diversity and scarce species, including species new to science. This may be because forest vegetation has been present in these locations for anything up to 30 million years (Burgess *et al.*, 1992). On the other hand, the relatively young (probably only a few thousand years of age: Hamilton, 1982) patches of forest close to the Indian Ocean (e.g. Mchungu) support rather few species of conservation concern and it would appear that their biological diversity is lower than the more ancient forests. It thus seems reasonable to suggest that it is the coastal forests located on higher ground that are of highest conservation concern and that these should be the priority of any conservation plan to safeguard representative examples of this forest type.

Further reading on the conservation of the coastal forests of Tanzania may be found in Bensted-Smith and Msangi-Msangi (1989), Burgess *et al.* (1992), Burgess *et al.* (1993), Hawthorne (1984), Sheil & Burgess (1990) and Sheil (1992).

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Details of the later full surveys of the sites reconnoitred in this report are presented in the following:

Clarke, G.P. (submitted). *Site description and conservation evaluation: Namakutwa-Nyamuete forest, Rufiji District, Tanzania.*

Dickinson, A. (in prep). *Site description and conservation evaluation: coastal forest and thicket of Mafia Island, Tanzania.*

Dickinson, A. and Burgess, N.D. (in prep). *Site descriptions and conservation evaluations: Kazimzumbwi and Ruvu South Forest Reserves, Kiserawe District, Tanzania.*

Msuya, C.A. and Mlingwa, C.O.F. (1992). *Bird study on Mafia Island, Tanzania Part 1: a report of May 1992 expedition.* Unpublished.

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Stubblefield, L.K. and Brewin, M.S. (submitted). *Site description and conservation evaluation: Ton'gomba Forest Reserve, Kilwa District, Tanzania.*

APPENDIX A :

Preliminary visits to Forest Reserves and other forested sites

1. Nan'goma Caves

Nan'goma village is situated on the south-western margin of the Matumbi Massif at the co-ordinates 38°54'E, 8°30'S at an altitude of approximately 500m above sea level.

The cave mouth is situated in a sink hole 30m in diameter. The rock strata consists of interbedded fine grained sandstones, limestones, and mudstones. The entrance to the cave faces westwards and is 20m wide and 10m in height. The front chamber of the cave reaches a height of 10m and a width of 15m. In the mouth several vertical shafts leading down to horizontal chambers were seen. A 2m stalagmite known as the "Drum of God" was situated a short way inside. The cave floor was covered in a deep layer of compact bat faeces.

The cave has religious significance in Nan'goma and Nandembo villages and is therefore protected from disturbance. This may explain the presence of forest growing in the sink hole. A few large trees of up to 20m in height remain with high- branching crowns, as well as a dense network of lianes and climbers. *Euphorbia* species and ferns grow in the shaded damp area around the cave mouth.

A brief zoological collection was made, finding 6 species of millipede, which were comparable with species found in Kiwengoma.

The toad *Spaeleophryne methneri* occurs at Nan'goma and is known from only a few other sites in the world. The toad was originally discovered at Nan'goma, in a "rotting log in a cave mouth" (K. Howell, pers. comm.). We found the toad in exactly the same habitat at the same site, but its future survival at this site has to be in question owing to the tiny habitat size. It is of note that numerous rotting logs in damp locations were searched in the neighbouring Kiwengoma forest without finding any of these toads.

2. Ton'gomba Forest Reserve

Ton'gomba Forest Reserve is situated between 38°58' - 39°02'E and 8°26' - 8°32'S, some 15km South-East of Kiwengoma Forest Reserve, between the villages of Kibata and Pungutini. The Forest Reserve covers an area of 36km^2 (approx) and lies between 200m and 600m asl. The topography consists of steep ridges and gullies.

The ridges appear to act as rain traps, obtaining at least 5 minutes rainfall every morning according to local villagers. Vegetation to the West of the forested ridges is very dry Miombo woodland - possibly due to the effects of a rain shadow caused by Ton'gomba.

The forest is restricted to areas of above 300m. The canopy is closed and varies from 20m high on the ridge sides, declining to 5m high with a broken canopy on the ridge tops. There are many lianas, and an evergreen understorey. A noticeable element of the understorey is a plant known locally as Mton'gomba (Kimatumbi name), after which the reserve was named. This evergreen shrub reaches a height of 2m and is abundant throughout the forest. No herbaceous ground layer exists. A well-developed mixed-age leaf litter is present. The soil is a fine brown muddy laterite.

Access to the reserve is very poor, the road being impassable to our vehicle in August (dry season). This may contribute to the apparently pristine state of the forest seen. The reserve is listed as a protective reserve, for catchment preservation use only, no commercial logging being permitted.

3. Mbinga Forest Reserve

Mbinga Forest Reserve, lying between 38°47' - 38°52E, 8°32' - 8°29'S, is an area of dense, impenetrable Miombo woodland, thicket tangles and some forest. The area is very dry, possibly in the rain shadow of the ridges to the East.

4. Namakutwa Forest Reserve

Namakutwa Forest Reserve is situated 4km North East of Nambunju village on the Matumbi Massif. The slopes have deciduous woodland vegetation, with intermediate forest/woodland growing higher up. The vegetation is similar to that in Kiwengoma Forest Reserve, with a deciduous understorey and low broken canopy, of approximately 5m with many lianes. The vegetation is characteristic of dense woodland/forest. A smaller forest reserve, Nyamuete, exists to the North according to local information, although shown bordering Namakutwa to the South on the official 1 : 50,000 map.

5. Mafia Island

The evergreen coastal thicket, which grows on the eastern coast of the Island, was thought to approach forest structure in places and was targeted for investigation as all original coastal forest has been cleared on Mafia. Characteristic forest mammals still survive on Mafia (eg. duiker *Cephalopus sp.*, black & rufous elephant shrew *Rhynchocynon petersi adersi*, Syke's monkey *Cercopithecus albogularis*), and it was hoped that coastal forest invertebrates and small vertebrates would be surviving in the evergreen coastal thicket (Howell, *pers. comm.*).

Towards the end of the phase, 2 members of the forest team deployed to Mafia Island to investigate the potential for work in the coastal thicket and any remaining forest on the island, and to prepare the way for a full camp during the next expedition phase (TZ06). Visits were made to patches of evergreen coastal thicket, and to the tiny forest remnant in Kilindoni town (07 55 S, 39 40 E).

A forest refugium was identified at Mlola/Mrora (7°52'S, 39°50'E). the site was suffering encroachment but the local authorities had plans to make it a protective forest reserve.

Research objectives were identified, a camp-site located, and the relevant permissions obtained. Extensive research was subsequently carried out on these sites the following phase, the results of which will be presented in a later report (Dickinson, in prep.).

Two specimens of the fruit bat *Pteropus comoroensis* were also taken. Mafia holds the only population of these bats in Africa, and only two specimens were known previously. A check can now be made on the specific status of these bats.

A new species of skink (*Lygosoma* sp. nov.) was found. This has subsequently been found at Kisiju forest on the mainland. On Mafia the skink is not restricted to forest areas, occurring in open cashew plantation and farmland.

A new species of toad *Stephopaedes* sp. nov. was also found, which is only known from this one tiny site.

6. Simba-Uranga

Simba-Uranga is an island on the seaward margin of the Rufiji Delta, at 7°45'S,39°20'E. The island contains no terrestrial forest and is comprised mainly of mangroves. The small part of the island which is non-tidal supports a small village and coconut and cashew plantations. The forest is sand with no fresh water.

APPENDIX B :

Mammals, Reptiles and Amphibians of the forests (Collected or observed July-September 1990)

Key to vertebrate species list annotations:

Column 1: Method

spec. = specimen obtained
obs. = observation

Column 2: Frequency[1]

1 = seen once
2 = seen a few times
3 = seen regularly

[1] Where relevant, frequency of observation is included as a rough indicator of the species' abundance in the area.

KIWENGOMA: forest and surrounding farmland/scrub

Fish			
(Unidentified catfish)	spec.	2	(new record)
Reptilia			
Hemidactylus platycephalus Baobab gecko	spec.		
Chamaeleo dilepis Flap-necked chamaeleon	obs.	2	
Varanus niloticus Nile monitor	obs.	3	
Crotaphopeltis hotamboeia Herald snake	spec.		
Philothamnus macrops Usambara green snake	spec.		(new record)
Philothamnus hoplogaster Southeastern green snake	spec.		
Mammalia			
Rousettus aegyptiacus leachi Egyptian rousette bat	spec.		
Mus minutoides Minute mouse	spec.		(new record)
Rattus rattus Common rat	spec.		
Rhynchocyon petersi Black & rufous elephant shrew	obs.	3	F
Papio cynocephalus Yellow baboon	obs.	2	
Cercopithecus albogularis Syke's monkey	obs.	3	F
Mungos mungo Banded mongoose	obs.	2	
Cephalopus sp. (duiker)	obs.	1	F
Potamochoerus porcus Bush pig	obs.	1	F

MCHUNGU FOREST RESERVE: forest and woodland

Amphibia			
Hylarana galamensis (frog)	spec.		
Hyperolius nasutus (treefrog)	spec.		
Hyperolius parkeri (treefrog)	spec.		
Hyperolius argus (treefrog)	spec.		
Hyperolius tuberilinguis (treefrog)	spec.		
Afrixalus fornasini (treefrog)	spec.		
Kassina senegalensis Running frog	spec.		
Ptychadena anchietae Ridged frog	spec.		
Phrynobatrachus acridoides Puddle frog	spec.		
Arthroleptis stenodactylus (leaf-litter toad)	spec.		F/S
Xenopus muelleri (clawed toad)	spec.		
Reptilia			
Hemidactylus mabouia Moreau's tropical house gecko	spec.		
Panaspis wahlbergi Savannah snake-eyed skink	spec.		F/S
Chamaeleo dilepis Flap-necked chamaeleon	obs.	1	
Leptotyphlops sp. nov. (worm snake)	spec.		NEW SPECIES
Hemirhagerris nototaeniata Mopane snake	spec.		
Mammalia			
Epomophorus wahlbergi Epauletted fruitbat	spec.		
Grammomys (Thamnomys) dolichurus Narrow footed thicket rat	spec.		F/S
Paraxerus palliatus Red bush squirrel	obs.	2	
Rhynchocyon petersi Black & rufous elephant-shrew	spec.	3	F
(Unidentified Galago)	obs.	3	
Cercopithecus albogularis Syke's monkey	obs.	3	F
Cercopithecus aethiops Vervet monkey	obs.	1	
Colobus polykomos Black & white colobus	obs.	3	
Papio cynocephalus Yellow baboon	obs.	2	
Herpestes paludinosus Marsh mongoose	obs.	1	
Panthera leo Lion	obs.	1	
Panthera pardus Leopard	obs.	1	F
Loxodanta africana African elephant	obs.	1	
Hippopotamus amphibius Hippopotamus	obs.	3	

MAFIA ISLAND: farmland/scrub

Amphibia		
Hyperolius sp. (treefrog)	spec.	
Afrixalus fornasini (treefrog)	spec.	
Kassina senegalensis Running frog	spec.	
Hemisus marmoratus Marbled burrowing frog	spec.	
Reptilia		
Hemidactylus platycephalus Baobab gecko	spec.	
Hemidactylus mabouia Moreau's tropical house gecko	spec.	
Mabuya striata Striped skink	spec.	
Lygosoma sp. nov. (writhing skink)	spec.	NEW SPECIES
Mammalia		
Pteropus seychellensis comoroensis Comoros flying fox	spec.	

NAN'GOMA

NANGOMA CAVE ENTRANCE (MATUMBI HILLS): forest in sinkhole

Reptilia		
Hemidactylus platycephalus Baobab gecko	spec.	
Amphibia		
Arthroleptis stenodactylus (leaf-litter frog)	spec.	f/s
Spaeleophryne methneri cave toad	spec.	F?
Mammalia		
Cercopithecus albogularis Syke's monkey	obs.	F

SIMBA URANGA (RUFIJI DELTA): farmland in mangroves

Amphibia		
Ptychadena sp. Ridged frog	spec.	
Reptilia		
Hemidactylus platycephalus Baobab gecko	spec.	
Panaspis wahlbergi Savannah snake-eyed skink	spec.	
Naja melanoleuca Forest cobra	spec.	f/s
Philothamnus punctatus Spotted bush snake	spec.	
Mammalia		
Rattus rattus Common rat	spec.	
Cercopithecus albogularis Syke's monkey	obs.	F

APPENDIX C :

Birds of Kazimzumbwe Forest Reserve

→ Species follows Britton (1980).

Key to Kazimzumbwe bird species list annotations:

Column 1: Frequency	Column 2: Method
1 = seen/heard once	N = netted
2 = seen/heard a few times	
3 = seen/heard regularly	

Accipitridae (eagles and hawks)	
Palm-nut Vulture *Gypohierax angolensis*	2
Southern Banded Snake Eagle *Circaetus fasciolatus*	2
Bateleur *Terathopius ecaudatus*	1
Little Sparrowhawk *Accipiter minullus*	1
African Goshawk *A. tachiro*	2
Crowned Eagle *Stephanoaetus coronatus*	2
Numididae (guineafowl)	
Kenya Crested Guineafowl *Guttera pucherani*	3
Columbidae (pigeons and doves)	
Emerald-spotted Wood Dove *Turtur chalcospilos*	2
Tambourine Dove *T. tympanistria*	3
Musophagidae (turacos)	
Livingstone's Turaco *Tauraco livingstonii*	2
Cuculidae (cuckoos and coucals)	
Yellowbill *Ceuthmochares aereus*	2
White-browed Coucal *Centropus superciliosus*	2
Strigidae (owls)	
African Wood Owl *Ciccaba woodfordii*	3
Pearl-spotted Owlet *Glaucidium perlatum*	2
Caprimulgidae (nightjars)	
Fiery-necked Nightjar *Caprimulgus pectoralis*	2

Apodidae (swifts)		
Palm Swift *Cypsiurus parvus*	3	
Boehm's ~~Bodini~~'s Spinetail *Neafrapus boehmi*	3	
Trogonidae (trogons)		
Narina's Trogon *Apaloderma narina*	2	
Alcedinidae (kingfishers)		
Brown-hooded Kingfisher *Halcyon albiventris*	2	
Striped Kingfisher *H. chelicuti*	2	
Woodland Kingfisher *H. senegalensis*	2	
Pygmy Kingfisher *Ispidina picta*	3	N
Meropidae (bee-eaters)		
Boehm's Bee-eater *Merops boehmi*	1	
Phoeniculidae		
Green Wood Hoopoe *Phoeniculus purpureus*	2	
Bucerotidae (hornbills)		
Trumpeter Hornbill *Bycanistes bucinator*	2	
Crowned Hornbill *Tockus alboterminatus*	3	
Capitonidae (barbets)		
White-eared Barbet *Buccanodon leucotis*	1	
Yellow-rumped Tinkerbird *Pogoniulus bilineatus*	3	
Green Tinkerbird *P. simplex*	3	N
Indicatoridae (honeyguides)		
Lesser Honeyguide *Indicator minor*	1	
Scaly-throated Honeyguide *I. variegatus*	1	
Picidae (woodpeckers)		
Little Spotted Woodpecker *Campethera cailliautii*	2	
Eurylaimidae (broadbills)		
African Broadbill *Smithornis capensis*	3	N
Hirundinidae (swallows, martins, rough-wings)		
Striped Swallow *Hirundo abyssinica*	2	
Dicruridae (drongos)		
Square-tailed Drongo *Dicrurus ludwigii*	3	N
Oriolidae (orioles)		
African Golden Oriole *Oriolus auratus*	2	
Black-headed Oriole *O. larvatus*	2	
Timaliidae		
Pale-breasted Illadopsis *Trichastoma rufipennis*	3	N
Campephagidae (cucko-shrikes)		
Black Cuckoo Shrike *Campephaga ~~flava~~ sulphurata*	3	

Pycnonotidae (bulbuls)		
Little Greenbul *Andropadus virens*	3	
Yellow-bellied Greenbul *Chlorocichla flaviventris*	3	
Nicator *Nicator chloris*	3	N
Tiny Greenbul *Phyllastrephus debilis*	3	N
Fischer's Greenbul *P. fischeri*	2	
Yellow-streaked Greenbul *P. flavostriatus*	2	
Common Bulbul *Pycnonotus barbatus*	2	
Turdidae (thrushes, robins etc.)		
White-browed Scrub Robin *Cercotrichas leucophrys*	2	
Eastern Bearded Scrub Robin *C. quadrivirgata*	3	N
Red-capped Robin Chat *Cossypha natalensis*	3	N
Red-tailed Ant Thrush *Neocossyphus rufus*	3	N
East Coast Akalat *Sheppardia gunningi*	3	N
Sylviidae (warblers)		
Black-headed Apalis *Apalis melanocephala*	2	
Grey-backed Camaroptera *Camaroptera brachyura*	3	N
Kretschmer's Longbill *Macrosphenus kretschmeri*	2	
Muscicapidae (flycatchers)		
Little Yellow Flycatcher *Erythrocercus holochlorus*	3	
Paradise Flycatcher *Terpsiphone viridis*	3	N
Crested Flycatcher *Trochocercus cyanomelas*	3	N
Malaconotidae (bush-shrikes)		
Black-backed Puffback *Dryoscopus cubla*	3	
Tropical Boubou *Laniarius ferrugineus*	3	
Prionopidae (helmet shrike)		
Chestnut-fronted Helmet Shrike *Prionops scopifrons*	3	
Sturnidae (starlings)		
Black-breasted Glossy Starling *Lamprotornis corruscus*	2	
Nectariniidae (sunbirds)		
Collared Sunbird *Anthreptes collaris*	3	
Uluguru Violet-backed Sunbird *A. neglectus*	2	N
Olive Sunbird *Nectarinia olivacea*	2	
Ploceidae (weavers)		
Dark-backed Weaver *Ploceus bicolor*	3	N
Estrildidae (waxbills etc.)		
Waxbill *Estrilda astrild*	1	
Peter's Twinspot *Hypargos niveoguttatus*	3	N
Green-backed Twinspot *Mandingoa nitidula*	3	

(68 species)

APPENDIX D :

Birds of Mchungu Forest Reserve

Key to Mchungu bird species list annotations:

Column 1: Frequency

1 = seen/heard once
2 = seen/heard a few times
3 = seen/heard regularly

Column 2: Habitat

F = forest
W = woodland
M = marsh / "hippo pool"

Pelicanidae (pelicans)		
White Pelican *Pelecanus onocrotalus*	2	M
Ardeidae (herons, egrets and bitterns)		
Squacco Heron *Ardeola ralloides*	2	M
Little Egret *Egretta garzetta*	2	M
Scopidae (hamerkop)		
Hamerkop *Scopus umbretta*	2	M
Ciconiidae (storks)		
Woolly-necked Stork *Ciconia episcopus*	2	M
Marabou Stork *Leptoptilos crumeniferus*	1	W
Threskiornithidae (ibises)		
Hadada Ibis *Bostrychia hagedash*	3	F,M
Sacred Ibis *Threskiornis aethiopica*	2	M
Accipitridae (eagles and hawks)		
Harrier Hawk *Polyboroides radiatus*	2	W
Brown Snake Eagle *Circaetus cinereus*	1	M
Bateleur *Terathopius ecaudatus*	2	W
Little Sparrowhawk *Accipiter minullus*	2	W
African Goshawk *A. tachiro*	2	W,F
Crowned Eagle *Stephanoaetus coronatus*	2	F
Fish Eagle *Haliaeetus vocifer*	2	M
Black Kite *Milvus migrans*	3	W
Bat Hawk *Macheiramphus alcinus*	2	W

Falconidae (falcons, kestrels)		
Dickinson's Kestrel *Falco dickinsoni*	1	W
Phasianidae (francolins)		
Crested Francolin *Francolinus sephaena*	2	W
Numididae (guineafowl)		
Kenya Crested Guineafowl *Guttera pucherani*	2	F
Helmeted Guineafowl *Numida meleagris*	1	W
Rallidae (crakes)		
Black Crake *Limnocorax flavirostra*	3	M
Purple Gallinule *Porphyrio porphyrio*	3	M
Jacanidae (jacana)		
Jacana *Actophilornis africanus*	3	M
Columbidae (pigeons and doves)		
Ring-Necked Dove *Streptopelia capicola*	3	W
Red-Eyed Dove *S. semitorquata*	3	W
Emerald-Spotted Wood Dove *Turtur chalcospilos*	2	W
Tambourine Dove *T. tympanistria*	3	F,W
Green Pigeon *Treron australis*	3	F,W
Psittacidae (parrots)		
Brown-Headed Parrot *Poicephalus cryptoxanthus*	3	W
Musophagidae (turacos)		
Livingstone's Turaco *Tauraco livingstonii*	3	F
Cuculidae (cuckoos and coucals)		
Yellowbill *Ceuthmochares aereus*	2	F,W
White-Browed Coucal *Centropus superciliosus*	2	M
Strigidae (owls)		
African Wood Owl *Ciccaba woodfordii*	3	F,W
Caprimulgidae (nightjars)		
Fiery-Necked Nightjar *Caprimulgus pectoralis*	3	W
Apodidae (swifts)		
Palm Swift *Cypsiurus parvus*	3	W
Colidae (mousebirds)		
Speckled Mousebird *Colius striatus*	2	W
Blue-Naped Mousebird *Urocolius macrourus*	2	W
Trogonidae (trogons)		
Narina's Trogon *Apaloderma narina*	2	F

Alcedinidae (kingfishers)		
Pied Kingfisher *Ceryle rudis*	2	M
Brown-Hooded Kingfisher *Halcyon albiventris*	2	W
Woodland Kingfisher *H. senegalensis*	2	W
Mangrove Kingfisher *H. senegaloides*	1	W
Pygmy Kingfisher *Ispidina picta*	3	F
Meropidae (bee-eaters)		
Little Bee-Eater *Merops pusillus*	2	W
Coraciidae (rollers)		
Lilac-Breasted Roller *Coracias caudata*	2	W
Phoeniculidae		
Scimitarbill *Phoeniculus cyanomelas*	2	W
Bucerotidae (hornbills)		
Trumpeter Hornbill *Bycanistes bucinator*	3	F
Crowned Hornbill *Tockus alboterminatus*	3	F
Capitonidae (barbets)		
Brown-Breasted Barbet *Lybius melanopterus*	3	W
Yellow-Rumped Tinkerbird *Pogoniulus bilineatus*	3	F
Green Tinkerbird *P. simplex*	3	F
Indicatoridae (honeyguides)		
Lesser Honeyguide *Indicator minor*	1	W
Scaly-Throated Honeyguide *I. variegatus*	2	F
Picidae (woodpeckers)		
Little-Spotted Woodpecker *Campethera cailliautii*	2	W
Eurylaimidae (broadbills)		
African Broadbill *Smithornis capensis*	3	F
Dicruridae (drongos)		
Drongo *Dicrurus adsimilis*	2	W
Square-Tailed Drongo *D. ludwigii*	1	F
Oriolidae (orioles)		
Black-Headed Oriole *Oriolus larvatus*	2	F,W
Campephagidae (cucko-shrikes)		
Black-Cuckoo Shrike *Campephaga flava*	3	F,W
Pycnonotidae (bulbuls)		
Zanzibar Sombre Greenbul *Andropadus importunus*	3	W
Little Greenbull *A. virens*	2	F
Yellow-Bellied Greenbul *Chlorocichla flaviventris*	3	F,W
Nicator *Nicator chloris*	2	F
Tiny Greenbul *Phyllastrephus debilis*	2	F
Fischer's Greenbul *P. fischeri*	1	F
Common Bulbul *Pycnonotus barbatus*	3	F,W

Turdidae (thrushes, robins etc.)		
Red-Capped Robin Chat *Cossypha natalensis*	3	F
Sylviidae (warblers)		
Yellow-Breasted Apalis *Apalis florida*	1	W
Grey-Backed Camaroptera *Camaroptera brachyura*	3	F,W
Tawny-Flanked Prinia *Prinia subflava*	3	W
Muscicapidae (flycatchers)		
Black-Headed Batis *Batis minor*	1	F,W
Forest Batis *B. mixta*	1	F
Paradise Flycatcher *Terpsiphone viridis*	3	F,W
Crested Flycatcher *Trochocercus cyanomelas*	2	F
Malaconotidae (bush-shrikes)		
Black-Backed Puffback *Dryoscopus cubla*	3	F
Grey-Headed Bush Shrike *Malaconotus blanchoti*	1	F
Brown-Headed Tchagra *Tchagra australis*	2	W
Tropical Boubou *Laniarius ferrugineus*	2	F
Prionopidae (helmet shrike)		
Chestnut-Fronted Helmet Shrike *Prionops scopifrons*	2	F
Sturnidae (starlings)		
Violet-Backed Starling *Cinnyricinclus leucogaster*	3	F
Black-Breasted Glossy Starling *Lamprotornis corruscus*	3	F
Nectariniidae (sunbirds)		
Collared Sunbird *Anthreptes collaris*	3	F,W
Amethyst Sunbird *Nectarinia amethystina*	3	W
Little Purple-Banded Sunbird *N. bifasciata*	3	W
Mariqua Sunbird *N. mariquensis*	2	W
Olive Sunbird *N. olivacea*	3	F,W
Scarlet-Chested Sunbird *N. senegalensis*	3	W
Mouse-Coloured Sunbird *N. veroxii*	2	F
Ploceidae (weavers)		
Yellow-Throated Petronia *Petronia superciliaris*	2	W
Estrildidae (waxbills etc.)		
Waxbill *Estrilda astrild*	3	W
Peters' Twinspot *Hypargos niveoguttatus*	3	F,W
Green-Backed Twinspot *Mandingoa nitidula*	2	W
Bronze Mannikin *Lonchura cucullata*	3	W
Yellow-Fronted Canary *Serinus mozambicus*	1	W

(95 species)

APPENDIX E :

Checklist of the Lepidoptera (Rhopalocera) of Kiwengoma forest, Matumbi Hills.

The following identifications are of specimens collected during an earlier expedition to Kiwengoma forest (February 1990; expedition phase TZ03). Owing to the time required to confirm invertebrate identifications this species list was not available for the report of the expedition in question (Sheil and Burgess, 1990) and is presented here. The list by no means includes all butterfly species present in the forest but includes most of the more conspicuous species which a visitor might notice. The list is by no means a record of all butterfly species present in the forest: the full butterfly fauna would number 300 species or more (68 are listed here), and a list of all Lepidoptera (ie. including moths) would number several thousand species.

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

PIERIDAE
Appias lasti
Belenois thysa
Belenois creona
Nepheronia argia
Nepheronia thalassina
Leptosia alcesta
Eurema floricola
Mylothris yulei ertli
Dixeya orbone
Colotis antevippe

ACRAEIDAE
Bematistes epaea epitellus
Acraea satis
Acraea quirina rosa
Acraea eponina

SATYRIDAE
Bicyclus safitza
Bicyclus campus

DANAIDAE
Amauris niavius damoclides

LYCAENIDAE
Pentila pauli nyassana
Pentila rodgersi
Baliochila minima
Baliochila stygia
Teriomima micra
Teriomima puella
Hemiolaus coeculus
Epamera ssp.
Azanus moriqua

HESPERIIDAE
Tagiades flesus
Sarangesa motozi
Gorgyra subflavidus
Andronymus caesar philander
Teniorhinus herilus

NYMPHALIDAE
Euphaedra orientalis
Euphaedra neophron neophron
Bebearis mardania
Hypolimnas dubius wahlbergi
Hypolimnas deceptor
Hypolimnas usambarae
Salamis cacta amaniensis
Pseudacraea boisduvali trimeni
Pseudacraea lucretia
Sallya boisduvali
Sallya pseudotrimeni
Neptis saclava marpessa
Neptis carcassoni
Harma theobene blassi
Cyrestis camillus sublineata
Aterica galenus
Junonia natalica
Charaxes 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
Euxanthe wakefieldi
Euxanthe tiberius tiberius