Mkomazi Research Programme

PROGRESS REPORT - JULY 1995

The Mkomazi Research Programme is a joint venture by the Department of Wildlife (Ministry of Tourism, Natural Resources and Environment, Tanzania), Oxford University and the Royal Geographical Society, London, to undertake an ecological survey of the Mkomazi Game Reserve in Tanzania. On 2nd August 1993 the Director of Wildlife, Mr Ndolanga and Dr Malcolm Coe signed the Memorandum of Understanding at the FOC Ibaya Research Centre in the Mkomazi Game Reserve. It is planned that the final report for the programme will be published in 1998 and will be available to assist the Department of Wildlife in the future management of this East African Savannah.

Further copies of interim reports, such as this, are available from:
Nigel Winser, Deputy Director, Royal Geographical Society (with The Institute of British Geographers), 1 Kensington Gore, London SW7 2AR, UK.

Report printed by Speedprint, 143-145 Uxbridge Road, Ealing, London WI3 9AU

Acknowledgements

The Directors of the Mkomazi Research Programme wish to thank and acknowledge the following Corporate Patrons, sponsors and associates for their commitment and practical support to this study.

Corporate patrons

Friends of Conservation - Foundation Sponsor
British Airways
British Council
BP Tanzania
CMC Land Rover, Tanzania
Land Rover, UK
Sheraton Hotel (Dar es Salaam)

Research & Development Associates

Cambridge University, Department of Zoology
Department of the Environment, Darwin Initiative
Durrell Institute of Conservation & Ecology (DICE), Kent University
Natural History Society, London
Natural Resources Institute, Chatham
Oxford University, Department of Zoology
Overseas Development Administration (ODA)
Royal Botanic Gardens, Kew
Royal Society
Tropical Pesticides Research Institute, Arusha
University Museum, Oxford

Sponsors and Trusts

Abercrombie and Kent, Arusha
Appledore Trust
Baring Foundation
Booker plc
Mr Edward de Courcy-Bryant
Coopers and Lybrand, Tanzania
DHL International, Tanzania
George Adamson Wildlife Preservation Trust
GreenCard Trust
Group 4 Security, Tanzania
Mansons Ltd, Tanzania
River Island Clothing Company

The programme also wishes to acknowledge the very many individuals in Same, in Arusha, in Tanzania, in the UK and elsewhere who have done so much to help launch the programme. Their commitment has meant a great deal to all members of the programme and we remain indebted to them all.

Mkomazi Research Programme

PROGRESS REPORT - JULY 1995

CONTENTS

PART I

PART II

PART I

A Preliminary Report on the Field Research of the Mkomazi Research Programme

Introduction

An overview

Over the last 20 years the Mkomazi Game Reserve has been subject to considerable pressure, as the human population around its periphery has continued to rise. In particular, the presence of areas with agricultural and forestry potential in the surrounding hills has added another dimension to the equation of anthropogenic disturbance. Small game reserves such as Mkomazi retain little standing water over much of the year, which means that they are unlikely to provide a viable (big-game viewing) market for tourism, yet its position at the southern end of the great Tsavo ecosystem makes it vital for the future survival of the large mammal populations of this area. The Mkomazi Game Reserve (MGR) lies at the southern extremity of that great arc of semi-arid savanna - the Sahel, into which many Somalian species of plants and animals are funnelled, but beyond which they are unable to extend their range. This concentrating effect, coupled with high local physiographic diversity, is responsible for the number of plant and bird (and probably insects) species present, making this one of the richest savanna's in Africa and possibly the world.

The continuing aim of our studies will be to describe the distribution, abundance and diversity of the Mkomazi flora and fauna in order that the Project Manager for Mkomazi and the Department of Wildlife may plan for the future management and utilisation of this fascinating region. Coupled with our ecological studies within the MGR boundary, we must not forget the human components of the Mkomazi equation (described in their own chapter in this report), for without the incorporation of some of their needs into the planning procedure, most attempts at conservation are doomed to failure. Nonetheless, while those who plan the future of Wildlife Conservation areas must incorporate the needs of the local population into their programmes, so local social aspirations must consider the sensitivity of savanna environments to disturbance. Without careful planning they will be degraded by fire, domestic animals and subsistence agriculture as experienced by many other regions of Africa, some of which are apparently almost beyond repair. Without the will to tackle these difficult questions in the long term, neither the natural flora and fauna or the human population will benefit from what these natural environments have to offer in the near or distant future.

Beginnings: 1989-90

In 1989 the Royal Geographical Society was asked to mount an ecological inventory study of the Mkomazi Game Reserve by the Tanzanian Ministry of Tourism, Natural Resources and Environment, Wildlife Department. This request came as a result of the very successful outcome of the Society's Kora Research Project in eastern Kenya, between 1982 and 1985 (Coe 1985, Coe and Collins 1986). This Project undertook a programme to describe the flora and fauna of the Kora National Reserve, with a view to providing the information that would be necessary for the Kenya Government to plan the future utilisation and management of this little disturbed area of Acacia-Commiphora bushland.

The response of the RGS to this invitation was to ask Dr Malcolm Coe, who led the Kora Research Project, to plan a new venture in collaboration with the

Tanzanian Widlife Department in 1990. The aim was to mount a joint Mkomazi Research Programme (MRP), which would provide research and training opportunities for UK-based scientists and their Tanzanian counterparts. For this collaborative programme the University of Dar-es-Salaam (Department of Zoology) and the African College of Wildlife Management, Mweka, were identified as suitable bodies to provide the young Tanzanian scientists to collaborate in our work.

In July 1991 Dr Coe signed a Memorandum of Understanding, later revised in July 1993, between the Department of Wildlife and the Royal Geographical Society/University of Oxford, Department of Zoology, which laid out the relative roles of the participating bodies. Subsequent to obtaining this Memorandum, the RGS set up a Planning Committee and Malcolm Coe and Nigel Winser (RGS) visited the Mkomazi Game Reserve from 30th March - 5th April, 1992 to conduct a brief ground and aerial reconnaissance and to select a Base Camp, with the assistance and advice of the Mkomazi Reserve Program Manager.

The Study Area

The Mkomazi Game Reserve lies between Kilimanjaro and the coast, adjacent to the Kenya border and the Tsavo (West) National Park, covering an area of about 3600km2 (3° 50' - 4° 25' South, and 37° 35' - 38° 45' East). Its altitude varies between 630 - 1594m, sloping mainly in a northerly direction, though, over much of the region the surface is broken by a large number of steep-sided hills which reach altitudes of 411m (Kibondo) to 1594 m (Kinondu). Rainfall estimates, based on local records and altitude, suggest that precipitation is likely to range between 300 and 900mm per annum, although the "mist forest" zones on hill tops may well be elevated to 1500mm. The area experiences a bimodal rainfall pattern, which may be expected between March and mid-May ("long rains"), and late October to December ("short rains"). Harris (1972) recorded a mean annual temperature of 23.1°C, mean minima of 9.4 - 17.5°C, and mean maxima of 29.0 - 37.8°C, at two sites in the north-west of the Reserve.

Despite its small area, the MGR has a rich fauna and flora. The savanna vegetation is greatly influenced along its central and north-western limits by the Usambara and Pare Mountains, which lie adjacent to its southern boundary. Both are centres of endemism for animals and plants. Erosion of the montane massifs has led to a marked altitudinal stratification of vegetation down the major slopes, resulting in a great diversity of habitat and vegetation types. Heavy clay soils ("Mbugas") in the valley bottoms develop a lush grass community, virtually devoid of trees. These depressions are seasonally inundated, and bear dense stands of grass well into the dry season. There are a range of bushland types, making up a mosaic (see separate chapter on vegetation). The plant community structure of these is strongly influenced by local soil conditions and anthropogenically induced burning.

Although almost insignificant in terms of their total areas (*c*.4%), hills rising above about 1000m, support an unusual upland dry forest on their summits, or as hanging stands in valley heads, where fire has reduced the tree cover on the open slopes. These areas are frequently enveloped in cloud, which leads to the development of profuse epiphytic growths on tree trunks. There is also a rich shrub understorey, and vigorous stands of tall grass develop in forest clearings. This habitat is seriously endangered, especially around the periphery, where the effects of fire have been the most severe within the Reserve. Riparian woodland along the course of the Umba River, the only permanent water source in the Reserve, and the ground water forest in the vicinity of Kisiwani and the Pangaro Valley, west of Ibaya, comprise important dry season refuges for many large herbivores.

Rock outcrops, pavements and rocky slopes bear rich xerophytic flora, and as in Kora, these isolated rocky islands are likely to support numerous species that are rare, or even new to science. Acacia-Commiphora bush is the commonest habitat constituent of the MGR, its great physiographic diversity results in a mosaic of smaller habitat types interspersed within it, which are rich both in terms of their floral diversity and their frequently, plant-specific fauna. Bearing in mind that these habitats are being steadily degraded throughout the Sahel, the need to study the diversity and inter-relationships of its flora and fauna have never been greater.

During the last 20 years the Mkomazi Game Reserve has experienced utilisation from local pastoralists with their domestic stock, and the fires that have accompanied their activities. Within the last four years pastoralists have been almost entirely excluded from the Reserve as a pre-requisite to rehabilitating this conservation area. Many of the habitats are already showing encouraging signs of regeneration. In the south western and western areas, fire generated by agriculturalists and charcoal burners are still causing large-scale regular fires. This has resulted in most of the area now being occupied by open fire-derived grassland, which may encoulrage increases in the numbers of grazing large herbivores, but decreases the habitat and scenic diversity.

Additionally, the high levels of elephant poaching in Tsavo to the north and in Mkomazi, are also beginning to be reflected in the re-establishment of woody vegetation. Mkomazi comprises a vital part of the greater Tsavo ecosystem, and has traditionally provided a, largely, wet season dispersal area for elephants from the Tsavo (West) National Park, across the Kenya border. This pattern of movement is largely mediated by the shortage of standing water in Mkomazi during the dry season. Regular aerial counts of elephants by Kenya Wildlife Services, within the whole ecosystem have indicated a reduction in elephant numbers of up to 80% since the early 1970's. Although hunting has been banned in Kenya for many years, sport hunting of elephants continued in Mkomazi until two years ago, at which time elephant numbers were very low. In the last year however, herds exceeding 100 elephants have been regularly observed in Mkomazi, indicating that the area is showing a marked recovery of its mega-herbivore fauna, adding to its future potential for education, research and tourism.

In studying the flora and fauna of a savanna area like Mkomazi, it is important that any research programme undertaken should not fail to recognise the activities and development aspirations of the local human population, for without their co-operation and understanding, efforts directed at the future utilisation of this rich area are bound to fail. To this end we consider that liaison with local people and the establishment of an Educational Extension Programme, must comprise an important adjunct to our investigations. Funds have already been promised to finance such a programme. Dr Katherine Homewood, who has spent many years studying pastoralism in Tanzania, is currently supervising two students in a study of the local human population, along the southern boundary of the Reserve, especially in the vicinity of Kisiwani. This research, along the MGR periphery is being closely correlated with our own studies within the Reserve.

The Scientific Programme

The following sections provide an overview of the development of the scientific programme. The progress of the principal research areas is then described in more detail in separate chapters.

Aims of the study

To describe the habitats of the Mkomazi Game Reserve in both floral and faunal terms, in order to generate models which will delineate the factors responsible for their observed patterns of distribution, abundance and species diversity.

1. To integrate our observations on the environmental effects of human intrusion into the Reserve, and the severe reduction of elephant numbers on natural habitats, into a Management Plan for the areas future utilisation.
2. To provide baseline data, against which disturbance and change in surrounding areas, which are subject to human activities, may be studied.

In an intensely seasonal environment like Mkomazi, it seemed inappropriate to attempt, as we did in Kora, to solely use small parties of specialists who could carry out their work during a vacation or a period of sabbatical leave. We have, therefore, aimed at raising the funds for at least one senior scientist with previous African savanna experience, who would be resident in the MGR for up to three years, to carry out the major theme of habitat description, in terms of both their distribution and diversity and to act as an on-site supervisor for Tanzanian and overseas students. This scientist would be assisted by a Tanzanian counterpart, and an administrative manager. Such plans are, of course entirely dependent on adequate funding, which in the present climate of recession, has not been forthcoming. Themes not covered by the senior scientist(s) and the post-graduate students, including some arthropod groups and the smaller vertebrates, would be covered by short-term specialists, who would be recruited to cover briefer periods during the main rainy and dry seasons.

The first season: 1993

Refurbishment of an existing camp at Ibaya (see map, inside front cover) began after four years of planning, meetings and reconnaissance visits to Tanzania by Malcolm Coe and Nigel Winser (Deputy Director, RGS). Hugh Watson arrived to act as the RGS representative for the summer at Ibaya and the first repairs began in July 1993. Several scientific studies got successfully underway during this first field season.

Dr Peter Lack (British Trust for Ornithology) and a group of six undergraduates from St Peter's College, Oxford (Jackson *et al.* 1994) recorded 260 species in relation to their dry season habitat distribution before they returned to the UK in September. It is probable that at least 100 more species remain to be added to this inventory.

Dr Malcolm Coe began his work on plant phenology and seed / fruit dispersal and initiated the plant collecting programme with the able assistance of Raphael Abdullah from the National Herbarium (Tropical Pesticides Research Institute, Arusha) (please see separate chapter in this report). A fundamental part of this work was the establishment of eight, one hectare permanent vegetation plots allowing detailed surveying of species richness in different habitats, and providing baseline data for longer term studies of change.

Dr Mark Ritchie (Natural Resources Institute, UK) commenced the insect sampling programme in August and confirmed the great species richness of Mkomazi with a multitude of orthopteran species (grasshoppers) - many new to science. Julie Cox, also from the NRI, arrived at the same time to start mapping Mkomazi vegetation types and habitats. By combining an examination of patterns on the ground with satellite images she was able to show how much the vegetation in the west-central areas had become fragmented as a result of frequent fires between the 1970's and the mid 1980's - perhaps a central theme in the ecology of Mkomazi.

By the end of 1993 we were satisfied that with alteration and renovation, the FOC Ibaya Research Centre would make an ideal headquarters. In addition to building work, the principal concern lay in provision of water supplies, dependent on repair of a damaged existing bore hole shaft and provision of an adequate pump. In spite of many difficulties new sponsorship was obtained, largely by Nigel Winser and his team, and developments were free to continue.

Establishment: 1994

In July 1994 Angus Jackson travelled to Ibaya to start the major renovation work. Hugh Watson was replaced by Tim Morgan as the RGS representative. Tim has a long background of East African experience and as a result of his lively presence and the release of more funds from our Corporate Sponsors, the FOC Ibaya Research Centre changed beyond all recognition. A new pump has been installed in the refurbished bore-hole, with a generous grant from the George Adamson Wildlife Preservation Trust. As a result, for the first time in many years, there is good water for drinking, cooking and toilet purposes. Accommodation has been refurbished throughout, allowing everyone to live in reasonable safari-comfort. A kitchen and a dining area have been built and the rain-water tank refurbished. Two generators have been installed in their own purpose-built shelters to power the bore-hole pump and for camp generator. New building projects will be directed at constructing a Conservation Centre (meeting room, small lab and accommodation facilities) with funds generously donated by Friends of Conservation (FOC). FOC will also assist with the "Information Centre", to be constructed at the Zange Gate (see map, inside front cover) and to be run by the Project Director Issai Swai and his staff.

1994 also saw extension of the scientific programme. Dr Mark Ritchie (NRI) and Dr Nigel Stork (the Natural History Museum) were awarded a generous grant from the (British Government sponsored) Darwin Initiative to study insect diversity in the MGR (please refer to separate chapter in this report). Malcolm Coe and Dr George McGavin (University Museum, Oxford, and part of the Darwin Initiative group) undertook further work on the vegetation and initiated studies of the insects associated with the commoner tree species.

The integration of biological concerns with human issues in the reserve area was enormously strengthened when Dr Katherine Homewood (University College, London) joined the research project. With a long experience of issues of human ecology in East Africa, Dr Homewood agreed to spearhead a study of the people living around the periphery of the MGR, with a view to examining the way in which the human population might, in the future, be integrated into the management strategies of small game reserves. Her field assistant Daniel Brockington is currently working in the Same and Kisiwani regions (see map, inside front cover). Their work is funded by the Overseas Development Administration of the British Government.

The nomination of Paul Marenga by the Department of Wildlife as our Counterpart Liaison Officer has added another strength to our team, for his experience with the Planning and Assessment for Wildlife Management group and his training as a biologist ideally suit him for this task. He has already proved to be a tower of strength in our dealings with

Government Departments and Officials in Dar-es-Salaam and elsewhere. As we get established and our administrative problems decrease we hope that he will play a larger part in the science programme, in order that at the completion of our studies in 1997 at least one experienced Tanzanian scientist / administrator will be in a position to continue this work into the future.

Up to Date: 1995

The scientific work is gathering increasing momentum, and much is already in progress for 1995.

1. Geographical Information System (GIS) and mapping.

This system relies on accurate description of positions on the ground using satellite fixes from a mobile GPS receiver. Using the programme's Land Rover Defender vehicles, donated by Land Rover, the location of key features such as road junctions, have been recorded to allow the preparation highly accurate base maps. These will allow preparation of detailed environmental maps of the reserve to include description of habitat types and recordings of distributions of animals and plants. A grid of rain gauges has been established at major road junctions, in order that rainfall distribution maps can be generated for the whole area. This work is being coordinated by Dr Shaun Russell and colleagues at the Durrell Institute of Conservation Ecology, University of Cantebury, in the UK. In addition a further GIS input will come from the secondment of Fay Hercod to the Programme by the Royal Geographical Society.

2. Soil minerals / plant nutrients and geomorphology

A series of sediment collections made in 1994 were screened for rare soil nutrients essential to plant growth and correlated with the abundance of some large animal species, such as elephants. This work will continue when Dr Peter Abrahams (University of West Wales, Aberystwyth, U.K.) goes out to Mkomazi in September to carry out a further sampling programme, based on the GIS grid. We hope he will be accompanied by Dr Andrew Agnew (an eminent East African botanist) early in the new year. Funds permitting, they intend to initiate a detailed study of the effects of fire on both soils and vegetation. Both are currently seeking financial support from the UNEP for this aspect of desertification research.

Although the areas of black cotton soil have not been previously examined, the persistence of ground water in many of these, well into the dry season, suggests that pollen may well be sufficiently preserved in them to initiate palynological studies of these deposits. This would enable an investigation of climatically mediated changes in vegetation over the last 10 - 20,000 years.

Reports that many of the hills show signs of early human occupation (Fitzjohn pers. comm.), holds out the possibility that an archaeological survey would add much to our understanding of the human history of the region.

3. Vegetation studies

The excellent rains in December 1994 - February 1995 (still falling intermittently in May) have facilitated an active continuing programme of field work on the vegetation (Raphael Abdullah, Dr Malcolm Coe, Professor Leonard Mwasumbi, and Kaj Vollesen). The number of permanent 1 hectare vegetation plots has now been extended to 13. Kaj Vollesen (Royal Botanical Gardens, Kew) is collecting in Mkomazi with Raphael Abdullah, and will spend a further week at the TPRI in Arusha identifying material. Both will then proceed to Kenya with Raphael to work on the more difficult material at the National Herbarium in Nairobi. Malcolm Coe will be in Mkomazi from mid-July to August and again from early November to mid-January when he will continue his work on the phenology of woody plants and the dispersal of their propagules by animals, accompanied by Raphael Abdullah.

4. Insects and other invertebrates.

Insects and spiders are the main foci of the invertebrate work, which can be divided into two distinct but overlapping research areas:

1. The Darwin Initiative group are examining large scale patterns of biodiversity associated with particular tree species and habitat types (Dr Mark Ritchie, Dr Anthony Russell-Smith, Dr George McGavin, Jonathan Davies, Ramadani Makusi, Paul Marenga, Bruno Nyundo). Substantial collections have already been made over Easter 1995, and further collections are planned over Christmas 1995-6 to carry on the large-scale sampling programme initiated in 1994 (Jonathan Davies, Ramadani Makusi, Bruno Nyundo, Mark Ritchie, Anthony Russell-Smith).

2. A smaller group, seeking funding from the National Geographic Society, are working on the pollination of Acacia trees in the Mkomazi reserve, and the use of acacia flowers as food and water resources (Graham Stone, Pat Willmer, Francis Gilbert, Ramadani Makusi, Bruno Nyundo). Collection of flower visitors commenced over Christmas 1994-5, and will continue from November 1995.

The Darwin Initiative insect diversity study has been responsible for sponsoring Bruno Nyundo from the University of Dar-es-Salaam, to work with the team in the field and to undertake taxonomic training in London and Oxford during 1995. His work on visitors to acacia flowers joins the two main avenues of insect research. New insect cabinets are being constructed which will improve the specimen storage capacity of the National Insect Collection at the TPRI in Arusha. The deposition of reference collections of specimens in Tanzania is an important contribution to the longer term aims of the MRP.

We are exploring the possibility of a UK-based graduate student undertaking post-graduate work on the association between ants and Acacia trees. Funding allowing, our attempts to understand the insect diversity of this rich savanna region will be enriched by visits by Hamish Robertson (Ants) and Simon van Noort (Parasitic wasps, Hymenoptera) of the South African Museum, Cape Town .

5. Ornithological Studies.

The birds have been censussed by Neil and Liz Baker, with additional short visits by Stan Davies and Myles Turner. Further work is in preparation by Dr Peter Lack (please see separate chapter).

6. Reptiles and Amphibians

Dr Mike Cherry of the Department of Zoology, University of Stellenbosch, South Africa has been working to organise a Herpetological Programme in the MGR. Discussions are now well advanced and (finance willing) we hope that he will visit Ibaya for the first time at the end of the year to collect in the short rains. He will be accompanied by Alex Flemming of the National Museum, Bloemfontein.

7. Mammal Studies

Professor Larry Harris (Department of Wildlife and Range Sciences, University of Florida) obtained much of the important baseline data on mammal distributions and abundance on transects he established in Mkomazi in the 1960's. He returned to Mkomazi in May with a small party to initiate large mammal counts on these same transects. He is accompanied by his student, Deborah Epperson, who may return for a longer stay if this brief reconnaissance proves successful.

The RGS have received a welcome grant from the Green Card Trust to support studies of elephant movements in the MGR, for although we believe that they move seasonally from the Tsavo National Park in Kenya into Mkomazi we have no detailed knowledge of these local migrations. Dr Keith Eltringham (Cambridge University, U.K.) will be assisted by Tony Fitzjohn in carrying out aerial counts of large herbivores across the reserve. A volunteer, Ken Ferguson, is expecting to join Dr Eltringham for a longer period, to press ahead with studies of elephant numbers, their distribution and movement in Mkomazi.

Robert Morley (University of Reading) arrived in Mkomazi in mid-June 1995 to spend two months trapping small mammals on the western end of the Reserve on the Simba, Nyati, Mwasumbi, Pangaro, Cadaba and Ubanyi one-hectare permanent vegetation plots. This will be a preliminary investigation establishing a species list for the MGR. We are fortunate that, at the time Robert is in the field, Jonathan Kingdon (expert both as an artist and as a biologist, particularly of mammals) will also be visiting Mkomazi as *Artist in Residence*, generously funded by the British Council. He has kindly offered to give us some help with the identification of the mammals that Robert Morley catches.

It is not appropriate to single out single discoveries as being exciting when we have so far to go before our task is even partially complete, but I will however indulge myself by mentioning the discovery of the delightful highland Pygmy Chameleon [*Rampholeon (Brookesia) kersteni*] at Ibaya and the ground dwelling montane Tree Hyrax (*Dendrohyrax validus terricola*) at Pangaro. Although it seems likely that these animals are outliers of a fauna that is happier at higher (or wetter) levels it does indicate that the Tanzanian game wardens in Mkomazi really are guardians of a valuable faunal refuge.

Dr Malcolm Coe
Dr Graham Stone
27 June 1995

Botanical Studies in the Mkomazi Game Reserve

Dr Malcolm Coe, St Peter's College, Oxford

Introduction

The flora of the Mkomazi Game Reserve (MGR) is particularly rich, which is a reflection of its geographical position and its great geomorphological diversity. The general land surface slopes from S-N and W-E, falling from about 1000m in the West to less than 350m in the East. Outlying hills of the Pare and Usambara Mountains, which lie within the MGR may exceed 1500m.

The botanical studies in the MGR have been designed to provide information on local floral biodiversity. This will be used by researchers conducting the faunal studies, to assist the Department of Wildlife in planning the areas future management and utilisation and to contribute to our understanding of the ecology of the severely threatened savanna habitats of Africa.

Plant collections from the vicinity of the MGR already exist at the National Herbarium (Tropical Pesticides Research Institute - TPRI) in Arusha, the African College of Wildlife Management at Mweka, the Forest Herbarium (Tanzanian Forestry Research Institute) at Lushoto and the Herbarium of the Department of Botany, University of Dar-es-Salaam. All plant material collected during the MERP will have their identities confirmed by Dr Leonard Mwasumbi (University of Dar-es-Salaam), Dr William Mziray and Raphael Abdullah (TPRI) and Drs Roger Polhill and Kaj Vollesen at the Royal Botanic Gardens, Kew. Pressed material will be later distributed to local and overseas collaborators by the Tanzanian researchers.

Aims of the botanical studies

The current botanical investigations are being conducted under the following headings.

i. The flora of the Mkomazi Game Reserve

In order to understand the vegetation of the MGR, it is necessary for us to establish a flora for the area, which will tell us which species occur within the Reserve. Multiple collecting will provide us with an accurate description of "which species occurs where, in company with which other species", whilst the availability of GPS equipment makes it possible to locate major collecting sites for input into a geographical information system (GIS).

ii. Habitat structure, composition and plant diversity

Plant collecting will provide basic data on the overall patterns of plant species distribution. Transects will continue to be periodically conducted in all major habitats, using the "point centred quarter" method to provide information on the density of woody plants over 1.5m and herbaceous perennials under 1.5m in height. Additionally we have recorded canopy cover, bole cover and local species richness. To date 13 x 1 hectare plots have been established in all habitats, which will provide sites for the study of invertebrates and small mammals, but will also be utilised in the study of plant species diversity, their phenology and the ecological effects of periodic anthropogenically induced fire regimes. The information obtained on species composition of habitats and their distribution, in relation to local physical factors will enable us to use the GIS data being accumulated at the Durrell Institute of Conservation and Ecology (University of Kent) to produce a vegetation map of the MGR.

iii. The phenology of woody plants, fruit and seed dispersal

In order to understand the patterns of plant species successions (changes in species composition with time), it is necessary that we should know a great deal more about the phenology (temporal patterns) of leafing, flowering and fruiting in major components of the flora. To a large extent, dispersal of edible fruits and seeds by birds and mammals is strongly associated with woody plant species, which in savanna habitats may commonly make up as much as 80% of the flora.

These studies will be associated with the multiple collecting activities, but will also be conducted on the hectare plots and at random locations throughout the MGR. This aspect of the plant studies will be closely co-ordinated with the pollination studies of Dr Graham Stone and his colleagues.

TABLE 1
Predicted plant species numbers in Mkomazi and its environs

Group	Total Potential Mkomazi spp.	Harris spp. not found in Greenway ('69)	Harris spp. found in Greenway ('69)	Total spp. recorded by Harris ('72)
Ferns	11	0	0	0
Dicots	773	107	58	165
Monocots	242	49	46	95
Totals	1026	156	104	260

iv. The effects of fire on habitat structure and plant succession

The central and western areas of the Mkomazi Game Reserve have been badly affected by fire over the last 15 years. As a result, much of the original *Acacia-Commiphora* vegetation cover has been converted to low scrub and grassland. Although the source of some of these fires may be natural, most of them are generated by pastoralists within the Reserve or (more commonly today) by agriculturalists beyond and on the edge of the MGR boundary. Currently, serious problems exist at Ibaya and Igire, where itinerant cultivators have begun farming and charcoal-burning several kilometres inside the Reserve.

We shall initiate studies of plant succession and development on "known-age" burnt areas in the western half of the MGR. These will be carried out on the hectare plots and on transects laid out specifically for this purpose. This study will be conducted in conjunction with the intended reserach on geomorphological aspects of desertification processes, currently under discussion with UNEP in Nairobi by Dr Peter Abrahams. A primary approach will be through soil studies, with an integral vegetation component to be directed by Dr Andrew Agnew.

Preliminary results

The flora of the Mkomazi Game Reserve

Plant collections have been taking place since 1993 on all habitats but earlier problems with transport have meant that the central and western areas of the MGR are currently better represented. The eastern areas are now being collected more regularly, although we should remember that at least 80% of the physiographic diversity of the MGR is located in the main collecting area. Our programme has to date provided a good level of cover for the major habitats, but due to the great between-year variation in respect of rainfall, we do not expect to have completed our collections before the end of 1996.

We expect that the final flora recorded in Mkomazi will approach 1500 species, compared with the other savanna sites of Tsavo (East) National Park, Kenya (937 spp.; 13,000 km^2: Greenway 1969), Kora National Reserve, Kenya (717 spp.; 1788 km^2: Kabuye, Mungai and Mutangah 1986), and Meru National Park, Kenya (605 spp.; 870 km^2: Ament 1975 and Gillett 1983).

It will be observed that there is no obvious relationship between the number of species and land area. The predicted high number of species for the MGR is based upon the area's great physiographic diversity. Since the above sites lie in an almost contiguous arc from the north, when our MGR collections are complete, we shall learn a great deal more about the manner in which genera and species in the Sahel savanna change over their whole range. The Usambara and Pare mountains act as a barrier, beyond which most essentially Sahel animal and plant species do not pass. As this aspect of the work progresses we expect to make some very interesting phytogeographic observations in this area, into which both the Sahel and Somalian species from the Horn of Africa are channelled.

Although Greenway's (1969) flora of Tsavo covers a generally drier environment 65 km to the north of the MGR, it is probable that in excess of 70% of the species recorded by that author will also be found in Mkomazi. The only previous published plant collections from the MGR are those of Harris (1972) who worked there in the late 1960's. If we combine the above records (Coe and Windsor 1993) (Table 1) we observe that the current potential flora is 1026 species, while of the 269 species recorded by Harris (op.cit.) 156 are not present in Greenway's (op. cit.) records, while 104 species recorded by Harris were also observed by Greenway.

The species which will largely contribute to the rich flora of this area are those associated with the isolated hilltops which are capped by vegetation. These areas are rich in lower montane species and a rich epiphyte flora, due to the frequent cloud cover observed on these peaks. These isolated forest patches are not only areas in which we might expect to find local endemic species, but they are also not influenced by the plants introduced by humans; introduced species are having serious ecological effects on the indigenous vegetation of the nearby South Pare Mountains.

It is difficult to separate particular plant genera that are of significance to the Mkomazi ecosystem, but a glance at our tentative Flora (Coe and Windsor 1993) does indicate the species richness of the woody genera *Acacia* (?18spp.), *Commiphora* (?16spp.) and *Grewia* (?20spp.). The two first-named genera appear to have radiated in the Somalian region of North eastern Africa, an arid Regional Centre of Endemism, as defined in the phytogeographical studies of White (1979) and Coe and Skinner (1993).

Habitat composition, structure and plant diversity

To a large degree our designation of habitat types may be related to the percentage composition of woody species in the flora and the nature of the substrate. The presence of large montane outliers from the Usambara and Pare mountains are responsible for the very varied relief of the MGR. Slow weathering of these rocky massifs has led to the formation of broad valleys, many of which are closed, resulting in very large areas which form seasonally inundated "mbugas". Black cotton soils make these areas completely impassable during the rains. In many areas of open weathered quartz we observe round-oval patches of dark red soil which bear a distinctive flora and frequently possess water holes on their surfaces. These appear to represent the iron-stained remains of old inselbergs that have now been weathered to the level of the surrounding terrain.

Harris 1972 (and Harris and Fowler 1975) described the major habitats he observed in the MGR between late-1964 and mid-1967, which he classified according to rainfall, altitude and substrate. These were the *Acacia-Commiphora* habitats receiving <500 mm of rain per annum, which he estimated covered 70% of the total area of the MGR and comprised numerous *Acacia spp.* including *A. bussei* and *A. etbaica*. The genus *Commiphora* is represented by a number of species (*C. africana*, *C. campestris*, *C. edulis* and *C. schimperi*) which often represent over 50% of the canopy cover. Areas with rainfall >500 mm per annum are similar to the above structurally, but their species composition differs markedly, containing far fewer *Commiphora spp.* but *Acacia tortilis*, *A. etbaica*, *Boscia salicifolia*, *Platycelyphium voense* and *Melia volkensii* are common. The seasonally inundated mbugas are dominated largely by grasses and bulbous monocotyledones, but their margins are frequently occupied by dense stands of *Acacia seyal var. fistula*, while their central areas commonly bear robust stands of *Acacia drepanolobium*.

The only permanent river in the MGR is the Umba in the extreme east, whose marginal forest, in common with ground water forests in the vicinity of Kisiwani and Kisima are dominated by a very distinctive forest flora including *Afzelia cuanzensis*, *Albizia harveyi*, *A. petersiana*, *Newtonia hildebrandtii*, *Tamarindus indica*, *Terminalia prunioides*. Although they only comprise a very small percentage of the total area (c.4%) the dry upland forests of the isolated hills of Mkomazi represent probably one of the most important reasons why these areas should be preserved. In the West of the Reserve, the summit forests of Igire contain the valuable timber trees *Spirostachys africana* and *Brachylaena huillensis*, but many of these have already been felled by charcoal-burners who are now resident within the MGR boundary. Other notable habitats can be recognised in the comparatively rich flora of rocky habitats and the species poor alkaline or saline environments.

Transects measured by the Point Centred Quarter method (Curtis 1959) in the major habitats (Table 2) in 1993 revealed that tree (>1.5 m in height) densities varied between 70.3 and 1298.7 per hectare, while canopy cover ranged from under 1% to 93% in the densest *Acacia-Commiphora* habitats in the vicinity of Ndea and on the hill-slopes from Njoro and Kisima. The mean height of trees on these transects exhibited a very small range from 2.59 to 3.97 m which represented between 3 and 16 tree species out of the 40 trees examined at 10 metre intervals on a 100 transect.

TABLE 2
Point Centred Quarter data for trees >1.5 m high on 100 m transects in the Mkomazi Game Reserve

Transect No.	Tree >1.5 m Density	% Canopy Cover	% Bole Cover x 10^4	Mean Height (m)	No. Tree Species in Transect
1a	30.86	0.87	0.05	2.82	8
1b	333.67	26.18	0.40	3.43	9
1	70.26	3.56	0.90	3.11	9
2	151.01	7.18	0.23	3.03	16
3	70.62	6.11	1.15	3.47	5
4	995.02	73.20	3.68	3.37	7
5	296.03	45.44	2.06	3.97	16
6	214.68	9.88	0.30	2.59	9
7	1298.70	93.06	8.45	3.49	11
8	816.33	9.54	0.70	2.67	3

Transect description and coordinates

1a Acacia tortilis woodland - recently burnt - Zange.
1b Acacia tortilis woodland - unburnt - Zange. S 4_ 03.588' E 37_ 48.344'
2 Fire-derived grassland with scattered *A. tortilis* - Zange. S 4_ 02.881' E 37_ 48.683'
3 Open *Commiphora campestris* woodland near Ndea. S 3_ 53.446' E 37_ 53.927'
4 Dense *Commiphora campestris* woodland near Ndea. S 3_ 53.654' E 37_ 56.636'
5 *Acacia-Commiphora* woodland valley at Ngurunga. S 4_ 01.361' E 37_ 54.677'
6 Recently severely burnt woodland below Mandi Hill. S 4_ 01.046' E 37_ 52.872'
7 Dense species-rich woodland below Njiro gate. S 4_ 08.605' E 38_ 08.607'
8 *Combretum* woodland on Ibaya - Pangaro road. S 3_ 55.380' E_ 47.467'

In August 1993 Julie Cox arrived from the Natural Resources Institute (UK) to map habitats in the Central and Western areas of the MGR (Cox 1993). She spent four weeks walking transects and recording releves in all the major habitats listed above. Dr Chris Justice of the Goddard Space and Flight Centre (NASA) in Washington kindly provided prints of MGR satellite images taken in 1975 and 1987.

The habitat maps produced using these photographs, demonstrate the great local importance of fire in modifying habitat distribution. At the earlier date the woody habitats were observed as distinct blocks, many of which are more or less contiguous over quite large areas, while by 1987 these had been to a large degree fragmented, and in many cases replaced by grassland. Apart from the seasonally inundated grasslands in valley bottoms, also subject to regular burning, it is mainly the lower and intermediate hill-slopes that have been affected by these largely anthropogenically induced burning regimes. Since 1987 annual fires in the western end of the MGR have led to a further reduction in woody plant cover, resulting in the establishment of a ground flora that is largely dominated by grasses and fire resistant shrubs.

The phenology of woody plants, fruit and seed dispersal

The MERP study of phenology has only just started, but its importance cannot be overestimated, for to-date we know little about the factors governing the patterns of growth and reproduction in African vegetation. We might naturally assume that most leafing, flowering and fruiting activity is associated with one, or both of the rainy seasons, which may be expected in the MGR between March and May ("long-rains") and October and early January ("short-rains"). A study by Tyrell and Coe (1974) in the nearby Tsavo National Park, Kenya demonstrated that the amount of rain falling in these rainy seasons was more or less equal, but that the "short-rains" were statistically more predictable than the "long-rains". Interestingly, they also showed that local herbarium records indicated that far more species flowered in the more predictable "short-rains" than they did in the "long-rains".

The coincidence of growth and flowering activity with the rains may well be associated with processes of the decomposer sub-system, rather than simply with the availability of water. In these savanna environments, the dry season is a period of great importance, for at this time dead organic matter (DOM) accumulates as litter, which will not be comminuted or decomposed until the rains begin. Additionally, the availability of nutrients to a plant's roots is dependant on the depth to which the rain has penetrated, since until the soil-water column has been completed many deep rooted plants will obtain neither water nor nutrients. It is worth remembering that since the dry season falls between the long and short rains, the greater accumulation of DOM during the former period may be responsible for the release of a larger nutrient pulse, which may well explain why more plants flower in the short than in the long rains.

When the rains arrive, it is common to initially record a number of small showers which barely penetrate more than a few centimetres into the soil, while later precipitation may be heavier, even torrential, when the water column may be completed. Decomposer activity in these soils is severely water-limited, but once the water column is complete nutrients may be transported rapidly towards the water table. It is observed that shallow rooted bulbous plants flower early in the rains, while herbaceous perennials and shrubs flower later and many of the deeper rooted trees flower quite late in the rain. This may be associated with the movement of such a nutrient pulse downwards through the soil during the course of the rains. Such a view seems to be supported by Scholes and Walter (1993) who have recently suggested that savanna environments are dependent upon current decomposition as their major source of nutrients for plant metabolic activities, since a nutrient-pool is, to all intents and purposes, absent.

The phenological studies promise a new insight into the way savanna ecosystems function and, above all, will indicate the manner in which disturbance to these fragile systems can lead to a severe reduction in their productivity and perhaps even their survival. There are no easy answers to the evolutionary questions as to why plants vary so much in their patterns of growth and reproduction. Preliminary observations indicate that species which flower before, or at the beginning of the rains, either have large nutrient reserves (bulbous plants) or need to ripen their seeds early. Thus i they may be incorporated onto the surface of the bare soil to germinate as soon as the rains begin. The Mkomazi amaryllid *Crinum macowanii* adopts this strategy. Not only do they flower before the rains start but the seeds have already begun to germinate in their brilliant scarlet fleshy capsules (whose function is unclear but must be attributed to some obscure form of animal dispersal) in order that they can begin to grow as soon as they fall.

The pattern of flowering is very variable, with some species flowering in only one rainy season while others flower in both. Additionally we have noted that the timing of flowering varies, irrespective of flower and/or fruit and seed size A woody species may be observed to develop buds which persist on the plant for weeks after the rains have started. Then, after especially heavy precipitation, all plants in the area complete their flowering in a few days (*Securinega virescens, Grewia spp.*). Other species seem to have several attempts at flowering. When, after a few showers, the plant produces large numbers of flowers, some are pollinated, but will abort if the rain fails to continue (*Lannea schweinfurthii*). Another rain pulse stimulates a further set of buds to produce flowers. In this case we observe that the plant has all of its buds fully developed and ready to open, but only a small percentage of these do actually open in any one flowering interval. By contrast, other species begin to flower at the beginning of the rains and continue to do so until they are finished (most capparaceous species - *Thylachium africanum, Cadaba* and *Maerua spp.*).

In studying the patterns of growth and flowering it is important to look at the nature of seed dispersal. In most species it is these syndromes that are vital to understanding the manner in which these areas are re-colonised once they have been disturbed, whether through physical, human or other animal agency. During the course of evolution all species have developed patterns of reproduction which fit into their environment and ecological role. A "decision" the plant has made during evolutionary time is whether it is going to invest its accumulated reserves in large numbers of small seeds or small numbers of big ones. One might imagine that the small seed bodies will be much quicker to develop than their larger counterparts, but in nature the plant is probably investing as much energy in a capsule with many small seeds as it does in a large one with only one. Such a view fits closely with the authors' observations on the animal dispersed indehiscent *Acacia spp.*, which although often produces massive pods, take just as long to develop as their much smaller but much more abundant dehiscent counterparts (Coe 1989). Bearing in mind that up to 80% of the woody plant species are animal dispersed, our studies have a long way to go before we can say anything meaningful about the relationship between animal dispersal syndromes and successional phenomena.

The effects of fire on habitat structure and plant succession

The one hectare plots cover all the major habitat types, whose cover characteristics vary from open tree-less grassland on areas of seasonal inundation through scattered tree grassland to the almost closed canopies of the *Acacia-Commiphora* woodlands or the *Spirostachys-Brachylaena* forests on hill summits. These plots will be used to observe the effects of fire and their regeneration capacity either directly or by experimental manipulation.

Preliminary observations in areas that have been regularly burnt in the vicinity of Ibaya indicate that most species of *Commiphora* are very sensitive to fire with the larger trees of *C. campestris* surviving far better than smaller specimens. Indeed scattered large specimens of this species are virtually the only trees surviving on lower hill-slopes between Ibaya and the Zange Gate. The shrubs, herbaceous perennials and climbers, which presumably have big nutrient reserves stored in their below-ground biomass (which may exceed 80% of the total), survive burning regimes very well and sprout within a few days of rain falling. These plants comprise a rich flora, which includes:- Trees; *Boscia salicifolia*, *Dalbergia melanoxylon*, *Platycelyphium cynanthum*, *Zanthoxylum* (*Fagara*) *chalybeum* and *Ziziphus mucronata*:: Shrubs; *Cadaba farinosa*, *Dolichos uniflorus*, *Indogofera spp.*, *Maerua spp.*, *Ormocarpum kirkii* and *Thylachium africana*:: Climbers and scramblers; *Asparagus spp.*, *Citrullus colocynthis*, *Cyphostemma adenocaulis*, *Ipomoea hildebrandtii*, *Momordica boivinii*, *Pergularia daemia* and *Tylosemma fassoglense*.

Studies on the habitat plots will assist us in the important task of understanding the way in which savanna vegetation functions. By comparing areas that have and have not recently been disturbed by human activity, we should be able to make more practical recommendations on how these unique natural treasures can be managed and preserved for posterity.

Acknowledgements

I should like to express my thanks to the Royal Botanic Garden, Kew, the Tropical Pesticides Research Institute, in Arusha and the Department of Botany of the University of Dar-es-Salaam who have allowed their staff to work with us in the field and back in their laboratories. In Mkomazi we have been supported by my very good friend Raphael Abdullah, who never stops working and always stays cheerful. Daniel Mafunde our Ranger, to whom we owe a great debt, has protected and nurtured us in the ways of the Mkomazi bush. The University of Oxford granted me my last period of sabbatical leave before I retire, which has enabled me to devote more time to getting the science and administration of the MRP on-track. Lastly but by no means least Nigel Winser, who begs finance from sponsors and other donors while we have the much less stressful task of working in the bush - we all owe him a great debt of gratitude.

References

Ament, J.G. & Gillett, J.B. 1975. The vascular plants of Meru National Park, Kenya: Part 2. Checklist of the vascular plants recorded. Journal of the East African Natural History Society and National Museum. **154**: 11-34.

Coe, M. 1989. Large herbivorous mammals, vegetation and seed dispersal in African savannas. Zoological Society of Southern Africa Symposium - "African Savannas". Held in the Etosha National Park, Namibia - July 1989. (Abstract only published).

Coe, M. & Windsor, N. (Eds). 1993. **Introduction, Flora & Fauna Species Lists and Bibliography for Mradi wa Utafiti, Mkomazi (Mkomazi Ecological Research Programme 1993-1996**. Dept of Wildlife, Tanzania; RGS; Dept Zoology, University of Oxford. 63pp.

Coe, M.J. & Skinner, J.D. 1993. Connections, Disjunctions and Endemism in the Eastern and Southern African Mammal faunas. Trans. Roy. Soc. S. Afr. **48(2)**: 233-255.

Cox, J.A. 1993. **Mkomazi Ecological Research Programme Pilot Study: Remote Sensing/Vegetation Survey/Mapping.** Report to the Royal Geographical Society. Natural Resources Institute, Chatham, UK.

Curtis, J.T. 1959. The vegetation of Wisconsin. Madison.

Greenway, P.J. 1969. A check-list of plants recorded in Tsavo National Park, East. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **27(3)**: 162-209.

Gillett, J.B. (1983). The vascular plants of the Kora Research area in East Central Africa. In **The Flora and Fauna of the Kora National Reserve.** (Ed. M. Coe). Nat. Mus. Kenya/Royal Geographical Society. 47pp. (Mimeographed)

Harris, L.D. 1972. **An ecological description of a semi-arid East African ecosystem.** Science Series No. 11, Colorado State Univ, Range Science Dept. 81pp.

Harris, L.D. & Fowler, N.K. 1975. Ecosystem analysis and simulation of the Mkomazi Reserve, Tanzania. E. Afr. Wildl. J. **13(3 & 4)**: 325-346.

Kabuye, C.H.S., Mungai, G.M. & Mutangah, J.G. 1986. Flora of Kora National Reserve. In Kora: **An ecological inventory of the Kora National Reserve, Kenya.** (Eds. M. Coe & N. M. Collins). 57-104pp.

Scholes, R.J. & Walker, M.H. 1993. **An African Savanna: synthesis of the Nylsvley study.** Cambridge: Cambridge University Press. 306pp.

Tyrell, J. & Coe, M. 1974. The phenological significance of the rainfall regime of the Tsavo National Park, Kenya. J. Biogeog. **1**: 187-192.

Pollination Studies on the Acacia Trees of the Mkomazi Game Reserve

Dr Graham N.Stone and Dr M.J.Coe, Oxford University Department of Zoology
Bruno Nyundo, Department of Zoology, University of Dar es Salaam, Tanzania
Dr Pat Willmer, Department of Biology, St. Andrews University
Dr Francis Gilbert, Department of Biological Sciences, Nottingham University

Introduction

Acacia trees are important and characteristic components of many African ecosystems (Coe, Beentje, and Wise 1991). Their wood, leaves, pods and seeds provide resources for a wide variety of organisms (Coe 1985; Coe, Beentje, and Wise 1991; Janzen 1967; New, T.R. 1984). Although acacia flowers are essential sources of food and moisture for many animals in other habitats (Dutoit 1990; Nagy and Knight 1994; Tybirk 1989), their ecological role in East Africa is almost completely unknown. This study will examine the community level effects of ecologically important differences between acacia species in the study area listed in Table 1.

1. To what extent do differences between acacia species in flower colour and the form of their inflorescences effect the communities associated with their flowers?
2. What are the community consequences of the fact that some acacias produce nectar and pollen, and others only pollen?
3. What is the functional significance of the infertile flowers, unable to give rise to fruit (Tybirk 1989), characteristically found in the inflorescences of certain acacia species and not others?
4. In what ways do the ants which inhabit pseudogalls on some acacia species in the study site (Table 1) effect flower visitors? While these ants effectively repel many herbivores (Janzen 1967), do they adversely effect pollinators too?

The animals which visit the flowers of almost all of the acacia species to be studied, and the roles of the differences between species in structuring the communities which exploit acacia flowers are entirely unknown. Despite its small size (3700 square km^2) the MGR contains 37% of Tanzania's *Acacia* species, and 14.5% of those found in Africa, making the reserve an ideal site in which to carry out this study.

Permanent vegetational plots have been established in several of the savannah, lower montane and riverside habitats in which the *Acacias* and their flower visitors will be studied. All areas can be reached by 4WD vehicle throughout the proposed study seasons.

Aims of this study

1. To examine patterns of flowering in time and space, including patterns of pollen and nectar availability and production of sterile flowers, and so characterise the resources available to flower visitors.
2. To assess how important the flowers are as a resource through the year to mammals and birds (e.g. Nagy and Knight 1994).
3. To collect and identify invertebrate flower visitors and determine which species are effective pollinators.
4. To identify the extent to which season, habitat and plant community composition determine the pool of available pollinators active at a given tree species.
5. By comparison between *Acacia* species to determine the effects of flower structure, colour and ant pseudogalls (Table 1) on flower visitor behaviour.
6. To identify the other plant species on which pollinator species depend, and so identify the links between *Acacias* and other plant species in the studied range of habitats and seasons.

TABLE 1.
Species of *Acacia* to be studied in the Mkomazi Game Reserve.
For each species inflorescence type and colour have been classified and presence/absence of ant-galls noted.

Species	Inflorescence form	Ant galls	Inflorescence colour
A. ancistroclada	globular	absent	bright yellow
A. brevispica	globular	absent	yellow-white
A. bussei	elongate	present	creamy white
A. drepanolobium	globular	present	creamy white
A. etbaica	globular	absent	creamy white
A. horrida	elongate	present	creamy white
A. mellifera	elongate	absent	yellow-cream
A. nilotica	globular	absent	bright yellow
A. reficiens	globular	absent	creamy white
A. senegal	elongate	absent	white
A. seyal	globular	present	bright yellow
A. stuhlmanni	globular	absent	pink-white
A. thomasii	elongate	absent	yellow-white
A. tortilis	globular	absent	yellow-white

Methods

1. Flowering phenology:
The flowering phenology of at least five individuals of each species will be studied in detail. The progress of flower development and the distribution of fertile and infertile flowers within trees and inflorescences will be determined by dissection under a binocular microscope. This will establish the longevity of each flower, the timing and duration of pollen release, and the timing and duration of stigma receptivity. The progress of flowering in each tree will be observed either from the ground or from a lightweight scaffolding tower (maximum height five metres), enabling us to observe the canopy.

2. Pollination mechanisms:
Pollination mechanisms will be examined using bagging experiments (a section of branch bearing flowers is contained within netting bag) to test for self compatibility, and gauze of varying mesh sizes to allow wind borne pollen and invertebrates of particular size ranges to reach the inflorescence. The fate of flowers from which all but specific visitor types have been excluded will be followed by bagging before and after the specified visit, and following the fate of the flower to examine whether seed are subsequently set.

3. Ecological roles of flower visitors.
Large animals visiting the flowers (e.g.Nagy and Knight 1994) will be identified using available field guides. Insects visiting or feeding on the flowers will be collected and specimens identified at the collaborating institutions. Battery powered red lights (invisible to insects) will be used to observe night-time visitors. The role of each type of visitor will be established by close observation at the inflorescences (Willmer and Stone 1988; Stone and Willmer 1989). Temporal activity patterns of visitor types will be obtained by recording numbers arriving at a given number of flowers over time. These activity distributions, when related to the flowering patterns of each *Acacia* species, will also provide a guide to role of the visitor in pollination. Ecological links between acacias and other plants resulting from pollinator behaviour will be established in three mutually supporting ways.

a. Pollen samples will be taken from insects visiting *Acacia* flowers and compared with a reference collection taken from all other flowering plants in the habitat, allowing identification of other plants visited by the insects.

b. Individuals of selected insect species will be captured and marked (Stone 1994) and individual insects followed. This will quantify insect movements within and between individual acacias, and between plant species.

c. Nests of significant bee species will be located, cells excavated and pollen stores identified. Data on the masses and proportions of different pollen types in the cells, the mass of loads collected by bees on each flight and the ways in which bees move within and between trees, can be used to estimate the value of bees as pollinators (Stone and Willmer 1989; Willmer and Stone 1988)

Results to date

Collections from several *Acacia* species were made during the Easter of 1995 by Bruno Nyundo. Supported by the Darwin Initiative, he worked on the specimens he obtained at the Hope department of Entomology, Oxford University. The bee fauna of Mkomazi is rich, particularly in leaf cutter bees of the family *Megachilidae* and mining bees of the family *Anthophoridae*. The most obvious visitors to *Acacia* flowers so far are megachilids, including large species in the genus *Megachile*.

This work is still at an early stage, and detailed studies are planned for the forthcoming short rains, when the full team will be in the field.

References

Bowers, J.E. and Dimmitt, M. A. (1994). Bulletin of the Torrey Botanical Club. **121**, 215-229.

Coe, M. (1985). International Zoo News **193**, 5-11.

Coe, M., Beentje, H and Wise R.(1991). **A field Guide to the Acacias of Kenya**. OUP.

Dutoit, J.T. (1990).African Journal of Ecology **28**, 63-68.

Janzen, D.H. (1967). Coevolution of mutualism between ants and acacias. Evolution **20**, 249-275.

Nagy K.A. and Knight, M.H. (1994). Journal of Mammalogy **75**, 860-872.

New, T.R. (1984). **The Biology of Acacias**. Oxford University Press. Melbourne.

Sedgley M. *et al.* (1994). Australian Journal of Botany **41**, 37-48.

Stone G.N. and Willmer P.G. (1989). Journal of Apicultural Research **28**, 228-237.

Stone, G.N. (1994). Ecological Entomology, **19**,177-189.

Tybirk, K. (1989). Nordic Journal of Botany **9**, 375-381.

Willmer P.G. and Stone G.N. (1988). Entomologia Experimentia et Applicata **50**, 113-124.

Mkomazi Game Reserve Invertebrate Biodiversity Project (funded by the Darwin Initiative)

Dr J Mark Ritchie (Project Coordinator), Natural Resources Institute, UK
Dr Anthony Russell-Smith, Natural Resources Institute, UK
Dr George C. McGavin, Hope Entomological Collections, Oxford University Museum, UK
Mr Jonathan Davies, Dept of Entomology, The Natural History Museum, London, UK
Mr Paul Marenga, Dept of Wildlife, Ministry of Tourism and Wildlife, Tanzania
Mr Bruno Nyundo, University of Dar es Salaam, Tanzania
Mr Elias Kihumo, Tropical Pesticides Research Institute, Arusha, Tanzania
Mr Ramadhani Makusi, formerly of TPRI, Arusha, Tanzania

Introduction

The overall purpose of this project, funded by the Darwin Initiative, is to describe in quantitative terms the diversity of the terrestrial invertebrate fauna of Mkomazi and to assess the influence upon it of natural and human-induced factors. The project aims to conduct a baseline inventory for selected invertebrate groups (currently spiders, grasshoppers, beetles and plant sucking-bugs) and to assess variation in species numbers and diversity within and between habitat types. The effects of burning and other disturbance on diversity are being investigated by sampling in burnt and unburnt hillside bush and valley grassland habitats. Sampling methods include sweep-netting (grassland), malaise and pitfall trapping (for flying and surface-active species respectively) and non-persistent insecticidal spraying of trees (for guilds of canopy-living species).

Training and Institution building

A major emphasis of the Darwin Initiative-funded project is training of Tanzanian scientists and technical personnel. Mr Bruno Nyundo (Dar es Salaam University) began a study of the diversity of insect pollinators associated with shrubs and trees in Mkomazi in April 1995 supervised by Dr Graham Stone (Oxford University). Mr Nyundo is visiting the UK from 20 June to 30 July as a Darwin Scholar to continue his work with Dr Stone and Dr McGavin at Oxford and subsequently to attend a training course in insect taxonomy at the Natural History Museum, London. A further opportunity for a Tanzanian professional to undertake longer term training in the UK has been created by the provision of a nine month Darwin Fellowship.

In 1996 technical training will be provided for Mr Elias Kihumo (Insect Museum technician, TPRI, Arusha) in insect collection management in UK. Mr Kihumo is already receiving training in field sampling techniques during visits to Mkomazi. The insect museum facilities at TPRI are being upgraded by provision of new insect cabinets (already supplied) and the return of identified project specimens to form a valuable biodiversity reference collection for Tanzania.

Field sampling methods

Pitfall trapping

Activity of ground living beetles and spiders was studied with pitfall traps constructed from plastic coffee beakers each 7 cm in diameter and 10 cm deep. Traps were spaced at a minimum of 2 metres apart and filled to a quarter of their depth with water to which a trace of household detergent was added. To reduce disturbance resulting from daily emptying, two plastic cups were placed one inside the other and only the inside cup was removed from the ground. All catches were sorted at camp and transferred to 75% ethanol for return to the UK.

During August 1993, a total of 30 traps were placed in burnt and unburnt *Acacia / Commiphora* bushland on the hillside immediately behind the FOC Ibaya Research Centre and operated over a six day period. In the footslope grassland below FOC Ibaya Research Centre 50 traps were placed in burnt and unburnt grassland and operated over the same period. More extensive pitfall trapping was carried out in six different habitat types over a period of three weeks in November, 1994. In each of the four habitats situated near to the FOC Ibaya Camp (burnt hillside, unburnt hillside, burnt grassland and unburnt grassland) 30 traps were serviced for six days at the beginning of the trip, followed by a further three days at the end of the trip. The second spell of sampling, to study beetle emergence, was carried out in response to the first major rain of the season which fell on November 24th (there was a smaller burst on the 15th). In each of the two other sites, *Acacia senegal* parkland and an *Acacia drepanolobium* vlei, located near to Ndea hill, 60 traps were serviced for three days. This provided a total of 180 trap days, equivalent to the first trapping period at Ibaya in August 1993. In April 1995 a further series of samples was taken which are still being analysed. A summary of pitfall trap data gathered up to April 1995 is given in Annex 1.

Canopy sampling

Tree canopy sampling was carried out in November 1994 and April 1995 using a *Hurricane Minor* petrol-driven, mist blower (Cooper-Pegler Ltd.) fitted with an ultra low volume delivery nozzle and charged with undiluted Pybuthrin 216 (Roussel Uclaf). The advantage of this method over other mass collection techniques such as fogging is the degree to which the mist can be directed accurately into the canopy from ground level. Pybuthrin 216, a pyrethroid formulation synergised with piperonyl butoxide, is ideal for use in the field and gives fast knockdown with non-persistency. As for other knock-down collection methods, wind is an important factor and, wherever possible, sampling was carried out in still conditions. Winds due to ground heating are common and can be quite strong in the MGR and sometimes conditions became unsuitable during the sampling period. Sampling was also avoided when rain or dew was present on leaf surfaces. As the power output of the mistblower is such that foliage above 10m high cannot be effectively or reliably sprayed very large trees were not sampled. The maximum height of trees sampled was 9m.

Insects knocked down were collected on purpose built, lightweight funnel-shaped trays ($1m^2$). The trays, which were made from rip-stop nylon balloon fabric, braced with 16 gauge aluminium tube, were fixed to nylon lines strung between or fastened to stakes by strips of inner tube. The latter method proved the most efficient. For small trees whose foliage was too low and/or spinous to permit the use of suspended trays, plastic washing up bowls ($0.16m^2$) were used instead.

Trees whose canopies were isolated from surrounding trees were used for sampling and the calculation of canopy cover area assumed a near-circular canopy. As far as was possible trees were sampled in areas that were also being used for pitfall trap sampling. Collecting trays or bowls were placed below the tree in positions likely to maximise samples (branches which were bare or did not appear healthy were avoided).

On the first trip foliage immediately above the collecting trays was sprayed for a total of 15 seconds in three five-second bursts from different directions. On the second trip the spray interval used was longer (30 seconds in three bursts) to allow for the greater volume of foliage present and to ensure thorough spray penetration through the canopy. For the larger trees one hour was used as the standard drop time period as most invertebrates were knocked down in the first 15 minutes and nothing was collected after 45 minutes.

For some trees, such as those less than 3m or with a small or low canopy cover, the sample time was reduced to a little over 30 minutes. Again the vast majority of the total catch was obtained during the first quarter. During the sampling period GPS coordinates, tree height, canopy cover and tree girth measurements were recorded. The height of trees over 2.5m were estimated, by visual comparison against measured heights. Canopy depth was not estimated. Other factors such as the presence or absence of flowers, seed pods and leaves were also recorded. At the end of the sampling period all material and fallen foliage was gently brushed into the collecting jars and pooled. Catches were examined, separated from debris and plant material and transferred to 70% alcohol.

Other samples

Opportunistic collecting of grasshoppers by hand-netting was undertaken in the vicinity of Ibaya Camp and in a range of woodland, bush and grassland habitats in the western third of the Reserve (west of Kisiwani). Fixed-time collecting was not used to compare habitats since ease of access varied due to vegetation structure and time availability in many habitats was dependent on priorities of other team members.

Other methods of sampling included sweeping vegetation with a net, litter sorting and hand-collecting. Originally it had been hoped to carry out systematic net samples of known numbers of sweeps in different grassland habitats. However, the very dry state of the grasslands in November 1994 resulted in few spiders being present and only non-systematic samples were taken. Hand collecting was carried out in a variety of habitats and in dry montane forest on the summit of Igire ridge litter was collected and sorted for spiders at Ibaya camp. In July/August 1994 additional invertebrate sampling was done using a sweep net. Six grass areas (various locations) were swept (50 sweeps) and the invertebrates stored in alcohol. A number of other insect samples were taken on an *ad hoc* basis. For example, three or four species of water bug were collected from a kettle hole in the rocks by Ngurunga Dam and an ant-attended plataspid (*Hemiptera: Plataspidae*) species was collected from old termite galleries on the trunk of a species of *Balanites* at Zange Gate. Galls from three branches of an *Acacia seyal* var *fistula* and three small *Acacia drepanolobium* trees were plugged and the contents removed and preserved for examination. A number of other insect samples were taken on an *ad hoc* basis especially from lights around the Ibaya camp site after dark. In April 1995 two adjacent areas, one dominated by a *Combretum* species and the other by *Dichrostachys cinerea* were studied in depth. Pitfall sampling (Davies) and canopy sampling was augmented by 200 ground cover sweep samples.

Results

Pitfall trapping of spiders and beetles

a) Activity of ground living spiders

Initial analysis of the data from the pitfall traps has concentrated on comparisons of family composition and species richness between sites, seasons and burning treatments. More detailed analysis of species diversity will be presented at a later date.

Seasonal comparisons:

In the hillside *Acacia-Commiphora* bushland, greater numbers of spiders were trapped in the early rainy season (Nov. 1994) than in mid-dry season (August 1993) but the reverse was true in the footslope grassland (Figs 1-4). The most abundant families in both habitats on both sampling occasions were Salticidae (18% - 48% of all spiders trapped), Zodariidae (10% - 37%) and Gnaphosidae (6% - 40%) (Figs 1-4). On the hillside, Salticidae and Zodariidae were equally abundant in the traps in both seasons but Gnaphosidae were more abundant in the dry season. In the footslope grassland, Salticidae were more abundant in the dry season, Zodariidae more abundant in the early rains and Gnaphosidae almost five times more abundant in the dry season.

There was over 60% more spider species trapped in the early wet season than in the dry season in *Acacia-Commiphora* bushland but only a small difference between wet and dry season in species numbers trapped in the footslope grassland (Figs 5-8). There were more than twice the numbers of species of Zodariidae and Salticidae but slightly fewer species of Gnaphosidae trapped in the wet season than in the dry season in the bushland. In the grassland, there were 80% more species of Salticidae and 40% more species of Zodariidae trapped in the early rains but 20% less species of Gnaphosidae. In both habitats, the mygalomorph family Cyrtauchenidae was only trapped in the early wet season.

Effects of burning:

In the dry season of 1993, spiders were more abundant in traps from the unburnt than burnt habitats in both the *Acacia/Commiphora* bushland and the grassland. The same was also true for all of the three most important families except for Zodariidae in the footslope grassland which were slightly more abundant in the burnt area (Figs 1-4). In the early short rains in 1994, spiders were considerably more abundant in the burnt areas of both bushland and grassland than in the unburnt grassland. This was true for most of the principle families represented except that Gnaphosidae were more abundant in the unburnt bush habitat.

In the dry season of 1993 there was virtually no difference in the total species numbers trapped in burnt and unburnt grassland and only three more species trapped in unburnt bushland than burnt bushland (Figs 5-8). In both bushland and in grassland, species numbers in the three major families were identical in burnt and unburnt sites. In the early wet season (Nov. 1994), 60% more species were trapped in unburnt bushland than in the burnt site, but species numbers in burnt and unburnt grassland were almost identical. In the bushland, there were more species of Salticidae and fewer species of Gnaphosidae trapped on the burnt than on the unburnt site. In the grassland, the species numbers in the three principle families were identical in burnt and unburnt sites.

b) Overall diversity of spider species

Up to the end of 1994, a total of 230 morpho-species of spiders have been sorted from all sites in Mkomazi, excluding those collected from tree canopies by Dr

McGavin. Allowing for some duplication as a result of unmatched males and females, this would suggest an overall total of over 200 species. It is difficult to make direct comparisons with estimates of species richness from other studies, since both sampling effort and methods differ. However, it is certain that overall diversity is not lower than that from the Okavango region of Botswana (Russell-Smith, 1981) or Kora National Reserve in Kenya (Russell-Smith, Ritchie & Collins, 1987). A notable feature of the Mkomazi samples was the richness in mygalomorph spiders which were hardly represented in the Kora or the Okavango collections.

c) Habitat type and beetle diversity

All of the beetles from the pitfall sampling have been pinned, labelled and sorted to morphospecies at the Natural History Museum in London. A total of 1,997 beetles were collected, and have been assigned to 202 species. A number of families dominate the beetle fauna in the ground and low herb layer. In the open grassland and hillside habitats at Ibaya the assemblage is dominated by large numbers of predatory ground beetles (Carabidae) and tiger beetles (Cicindelidae), and in particular species of the genera *Cypholoba*, *Oodes*, *Cicindela*, *Megacephala*, and *Dromica*. Dung beetles (Scarabeidae), blister beetles (Meloidae) and jewel beetles (Buprestidae) are also present in significant numbers. The sandy soil of the *Acacia senegal* parkland supports a very different fauna in which sand swimmers (Tenebrionidae: zophosini) are the only abundant group. All other species occur in very low numbers, with the exception of one species of *Mylabris* (Meloidae). The only large predatory species present is *Thermophilum binotata*, a very powerful Carabid that was found in no other habitat type. The fauna associated with the *Acacia drepanolobium* vlei is very different again, with only one species of *Brachinus* (Carabidae) and two species of *Mylabris* occurring in significant numbers. Indeed, the Meloidae, most of them belonging to the genus *Mylabris*, are the most consistently abundant family in all six sites.

Figure 9 illustrates the differences between the six sites in terms of species richness and abundance. The two graphs demonstrate a marked increase in the number of species and individuals following the rain at Ibaya, despite there being only half the sampling effort in the second trapping period. This suggests that the first rain after the dry season, as might be expected, triggers a rapid emergence of beetles in anticipation of a plentiful supply of food. Further analysis of the data will reveal which groups are responding to rain in this way, and which are present during the dry season, when resources are more scarce.

The graphs also indicate that burning results in a decrease in species richness and abundance, with both burnt hillside and burnt grassland found to be impoverished in comparison with their corresponding unburnt sites. Monthly sampling for a full year, which started in April 1995 and is due to finish in April 1996, will enable us to investigate how much the burnt areas recover over time. Faunal similarity analysis of beetle communities will demonstrate to what extent burning enables new species to colonise an area.

Another interesting result is the marked difference between the hillside site and the grassland plain. Although only separated by a distance of about half a kilometre, the grassland is noticeably richer and more productive than the hillside, particularly after the rain. Faunal similarity analysis will again be employed to compare the composition of the assemblages, and a detailed survey of the vegetation, soils, topography and drainage in the two habitats will be required to help identify any factors that might be causing the differences. Similarly, the beetle communities from the two *Acacia* sites will be compared with those from the hillside and grassland to assess the degree of faunal overlap between different habitats located in different parts of the reserve.

In April 1995 the four habitats at Ibaya were sampled again to coincide with the long rains. As before, six days of trapping at the beginning of the trip were followed by a further three days at the end to study post-rain emergence. Six more habitat types were also sampled: *Dichrostachys* bush, *Combretum* bush, *Spirostachys* forest, *Setaria* grassland, riverine bush, and *Commiphora* woodland. Processing of all of the beetles from this sampling trip is currently being undertaken at the Natural History Museum in London.

Canopy sampling

The invertebrate species associated with canopies of selected tree species were sampled during July and August 1994 and April 1995. On the first trip sampling from *Commiphora* species was not considered worthwhile as none were in leaf and beating branches did not produce anything of interest. Most of the *Acacia* trees sampled were in leaf and some were flowering. During the second trip samples were obtained from three different *Commiphora* species (including the white, paper-barked, *C. hoseana*). In addition to *Acacia* species, samples were also obtained from *Combretum molle*, *Dichrostachys cinerea* and a species of *Boswellia*. Quantitative invertebrate samples were obtained from the canopies of 110 trees. Details of the canopy samples are listed at Annex 2.

The material collected has not, as yet, been fully sorted or identified but preliminary samples from the first trip indicate a negative correlation between the diversity of insect groups recorded in *Acacia* canopies and ant attendance. Species diversity and abundance in non ant-attended trees was found to be much greater than previously recorded in a study carried out between 1982-85 in Kora National Reserve, Kenya. A large part of the phytophagous guild was represented by species of Coleoptera, Hemiptera, Phasmatodea and Thysanoptera. The most abundant carnivorous invertebrate species collected were spiders and mantids. Sweep samples of grassland areas during the dry season reveal a surprisingly diverse insect fauna.

Samples obtained during April 1995 were more diverse than that obtained during the dry season. One or two taxa are perhaps worthy of note even at this early stage. Silverfish and woodlice appear to be very common inhabitants of certain tree canopies. The samples appear to be particularly rich in mantid, beetle and parasitoid wasp species. Perhaps due to the very hot and dry conditions, trees sampled near the Umba River had markedly less diverse canopy faunas.

Grasshopper sampling

A total of approximately 50 species of grasshoppers (Acridoidea), represented by more than 800 specimens, were collected over 62 separate collecting occasions. This collection is likely to represent between one third and one half of the true acridoid species inventory of the Reserve, bearing in mind the more humid lowland climate in the eastern section of the Reserve, the presence of riverine woodland on the Umba River and the penetration inland of a distinctive coastal endemic faunal element. A full assessment of the collections of Acridoidea is in progress and an annotated list with ecological notes is in preparation. Several species are new to science and descriptions of these are in preparation and in press.

Other invertebrate records

The second known collection record of *Necperissa tinglei* (Disney, 1990) (Diptera, Phoridae, Termitoxeniinae), a termite-associated scuttle fly previously only known from a single collection from Zimbabwe, was made in pitfalls near FOC Ibaya Research Centre in August 1993 (identified by R.H.L. Disney). Larvae of the corn earworm *Mussidia nigrivenella* Ragonot (Lepidoptera, Pyralidae, Phycitinae) (identified by M. Shaffer, BMNH) were collected from seed pods of *Afzelia cuanzensis*, a new host record, near Ibaya in August 1993.

Discussion

The abundance of spiders caught in pitfall traps is influenced by a wide range of factors, among which differences in behaviour of individual species, the type of vegetation cover and seasonal changes in activity are of particular importance. Attempts to deduce the effects of fire on abundance of ground living spiders from catches in pitfall traps is therefore difficult without a detailed knowledge of the behaviour of the species concerned. This is particularly true when trapping is carried out over very short periods (as at Mkomazi) since adult male spiders are known to have discrete seasonal peaks of activity which can give a biased picture of their abundance when results from pitfall traps are used. By contrast, pitfall traps are useful for obtaining a approximate idea of species richness in different habitats since, unlike most other sampling methods, they operate continuously day and night over the period of sampling.

The results to date suggest that burning had relatively little effect on the species richness of ground living spiders in the footslope grassland at Ibaya but that species richness was reduced in the burnt *Acacia/Commiphora* bushland and that this reduction was greater in the early rains in 1994 than in the dry season. Confirmation or otherwise of these results will require considerably more sampling in the habitats concerned. Regular monthly sampling in both the bushland and the grassland are planned for 1995.

The family composition of the ground living spider fauna in Mkomazi is similar to that from other semi-arid habitats in Africa. The same dominant families, Salticidae, Gnaphosidae and Zodariidae, have also been found to be important in semi-arid habitats in Botswana and in Kora Reserve in Kenya, confirming the authors observations from hand collecting in the Sahel (Senegal) and the semi-arid rift valley region of Ethiopia. However, the relative species richness in different families varies between regions. Thus, in Botswana Zodariidae were poorly represented in traps while in both Kora and Mkomazi they are both abundant and diverse. By contrast, Gnaphosidae are abundant and highly diverse both in Botswana and throughout much of southern Africa.

Figure 1. Spider abundance: pitfalls
Footslope grassland, Ibaya Mkomazi, 1993

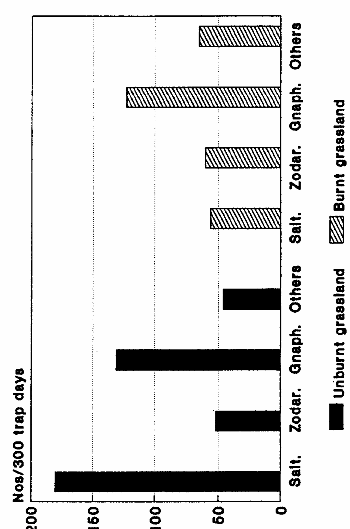


Figure 2. Spider abundance: pitfalls
Footslope grassland, Ibaya Mkomazi, 1994

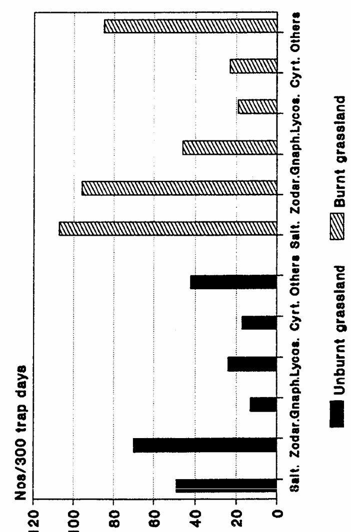


Figure 3. Spider abundance: pitfalls
Hillside bushland, Ibaya, Mkomazi, 1993

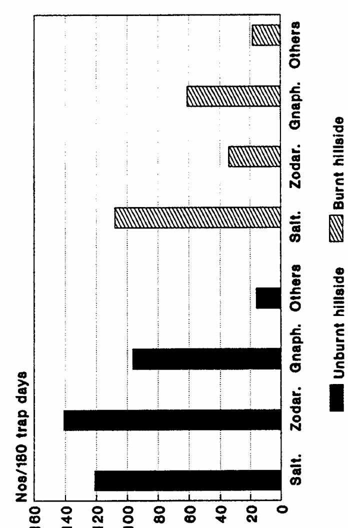


Figure 4. Spider abundance: pitfalls
Hillside bushland, Ibaya, Mkomazi, 1994

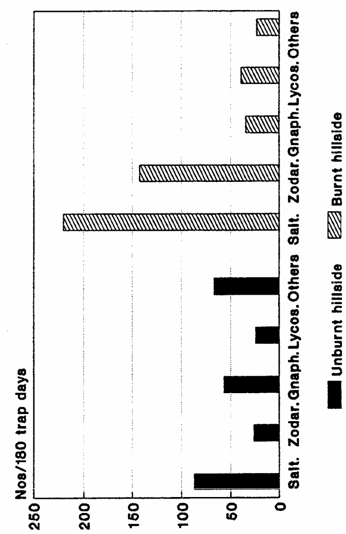


Figure 5. Species richness of spiders Ibaya, Mkomazi, August 1993

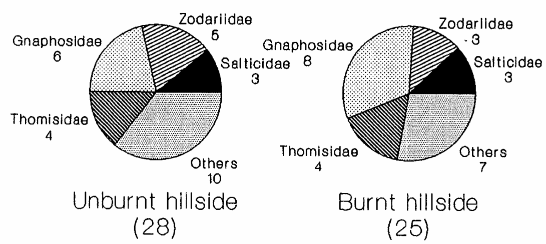


Figure 6. Species richness of spiders Ibaya, Mkomazi, August 1993

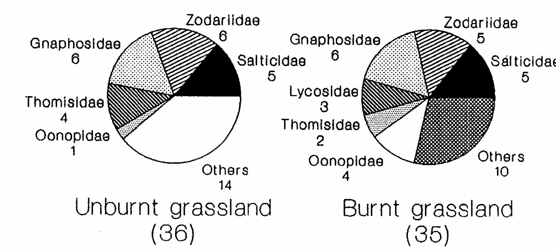


Figure 7. Species richness of spiders Ibaya,Mkomazi, November 1994

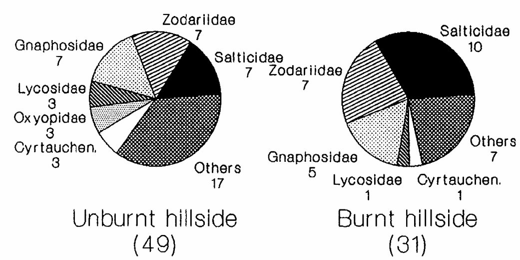


Figure 8. Species richness of spiders Ibaya, Mkomazi, November 1994

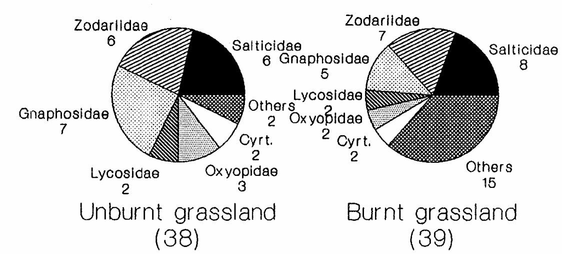
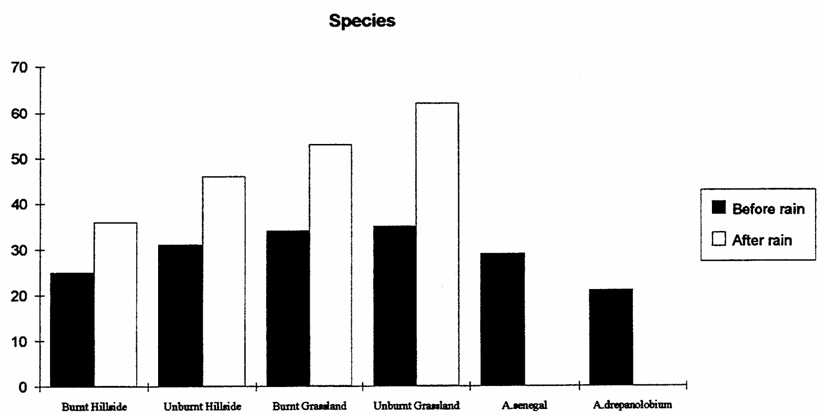
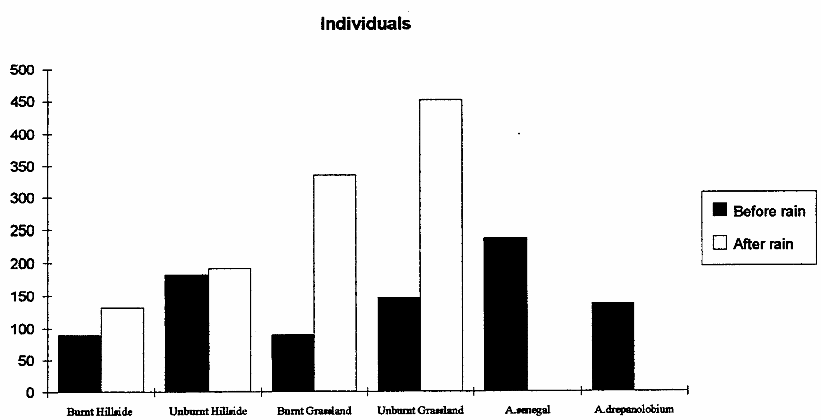


FIGURE 9.

The number of beetle species and individuals collected by pitfall trapping in six different habitat types in Mkomazi Game Reserve at the onset of the rainy season (Nov 1994).





Notes:

1. Owing to their location several kilometres from Ibaya, it was not possible to know for certain whether or not the two *Acacia* sites received the rain that fell on Ibaya. The indications were, however, that there had been no rain.
2. Black bars are the result of 180 trap days of sampling; white bars correspond to only 90 trap days.

ANNEX 1

Summary of pitfall trap samples: Mkomazi Game Reserve, August 1993 - May 1995

Site	Vegetation type	Status	Trap days	Date
Ibaya	valley grassland	Unburnt	50x6=300	August 1993
Ibaya *	valley grassland	Unburnt	30x6+3=270	Nov 1994
Ibaya	valley grassland	Unburnt	30x6+3=270	April 1995
7kms SE of Ibaya	valley grassland	Burnt	50x5=250	August 1993
Ibaya *	valley grassland	Burnt	30x6+3=270	Nov 1994
Ibaya	valley grassland	Burnt	30x6+3=270	April 1995
Ibaya	Hillside bush	Unburnt	25x6=150	August 1993
Ibaya	Hillside bush	Burnt	25x6=150	August 1993
Ibaya *	Hillside bush	Unburnt	30x6+3=270	Nov 1994
Ibaya *	Hillside bush	Burnt	30x6+3=270	Nov 1994
Ndea	*Acacia senegal* woodland	Unburnt	60x3=180	Nov 1994
Ndea	*Acacia drepanolobium* vlei	Unburnt	60x3=180	Nov 1994
Ibaya Hill	Forest	Unburnt	60x3=180	April 1995
Ibaya Hill	*Setaria/Panicum* Grassland	old clearing	60x3=180	April 1995
Dindera	*Dichrostachys* bush	Unburnt	60x3=180	April 1995
Dindera	*Combretum* bush	Unburnt	60x3=180	April 1995
Umba River	Riverine bush	Unburnt	60x3=180	April 1995
Umba River	*Commiphora* woodland	Unburnt	60x3=180	April 1995

* Samples of 30 traps x 6 days are being repeated at these locations monthly from May 1995 to April 1996.

Total sample size from all sites is 3,910 trap days or 10.7 trap years from a total of 13 sites

ANNEX 2

Summary of tree species sampled for insects by mist-blower, July-August 1994 and April 1995

Tree number: species; time and date sampled; GPS location or equivalent; maximum height; canopy circumference; canopy area; collection area / percentage of canopy sampled; notes.

July / August 1994

Tree 1: *Lannea stuhlmanii*; 08.45 28/7/94; Ibaya Camp S3°57.996 E37°8.128; 6m; 35m; 97.5m^2; 4m^2/3.9%; sample stopped after 40 minutes due to wind, possible bad sample due to nozzle misalignment.

Tree 2: *Lannea stuhlmanii*; am 29/7/94; Ibaya Camp by Rangers's block; 5m; 24m; 45.84m^2; 2m^2/4.36%; possible bad sample due to nozzle misalignment.

Tree 3: *Terminalia* sp.; am 29/7/94; Ibaya Camp by Rhino block S3°57.996 E37°48.128; 10m; 25m; 49.74^2; 2m^2/4.02%; possible bad sample due to nozzle misalignment.

Tree 4: *Melia volkensii*; am 29/7/94; Ibaya Camp behind ranger's toilet block; 6-8m?; 24m; 45.84m^2; 2m^2/4.36%; possible bad sample due to nozzle misalignment.

Tree 5: *Acacia tortilis*; 11.00 29/7/94; left of road 4km from Zange Gate; 13m; 75m; 447.6m^2; 4m^2/0.89%; bad sample - stopped after 50 minutes due to wind - foliage just out of effective range of sprayer.

Tree 6: *Albizia anthelmintica*; 07.15 30/7/94; left side of road 3.5 km from Zange Gate; 8m; 30m; 71.62m^2; 4m^2/5.58%

Tree 7: *Acacia reficiens*; 07.45 30/7/94; 100m further from Zange Gate than tree 6; 7m; 24m; 45.84m^2; 2m^2/4.36%; sampled stopped after 50 minutes due to wind.

Tree 8: *Acacia senegal*; 12.30 1/8/94; 1km from Zange Gate S4° 03.365 E37° 47.758; 8m; 32m; 81.49m^2; 2m^2/2.45%

Tree 9: *Acacia senegal*; 12.40 1/8/94; 1km from Zange Gate S4° 03.365 E37° 47.758; 8m; 26m; 53.79m^2; 2m^2/3.72%

Tree 10: *Acacia tortilis*; 12.40 1/8/94; 1km from Zange Gate S4° 03.365 E37° 47.758; 10m; 30m; 71.62m^2; 2m^2/2.79%

Tree 11: *Acacia drepanolobium*; 13.30 3/8/94; Vitawine area S3° 53.042 E37° 52.468; 2m?; 8m; 5.09m²; 0.32m²/6.29%

Tree 12: *Acacia drepanolobium*; 13.50 3/8/94; Vitawine area S3° 53.042 E37° 52.468; 2m; 4m; 1.27m²; 0.32m²/25.19%

Tree 13: *Acacia drepanolobium*; 13.55 3/8/94; Vitawine area S3° 53.042 E37° 52.468; 1.75m; 5m; 1.99m²; 0.32m²/16.08%; gusty last 15 mins.

Tree 14: *Acacia drepanolobium*; 14.00 3/8/94; Vitawine area S3° 53.042 E37° 52.468; 1.6m; 4.4m; 1.54m²; 0.32m²/20.77%

Tree 15: *Acacia seyal* var. *fistula*; 10.30 4/8/94; S3° 58.882 E37° 50.471; 3m; 11m; 9.63m²; 0.64m²/6.65%

Tree 16: *Acacia seyal* var. *fistula*; 11.30 4/8/94; S3° 58.882 E37° 50.471; 3.5m; 14m; 15.60m²; 0.64m²/4.10%

Tree 17: *Acacia seyal* var. *fistula*; 12.30 4/8/94; S3° 58.686 E37° 50.719; 7m; 18m; 25.78m²; 0.64m²/2.48%;

Tree 18: *Acacia seyal* var. *fistula*; 13.40 4/8/94; S3° 58.902 E37° 50.321; 5m; 17m; 23.00m²; 0.64m²/2.78%; some windy gusts.

Tree 19: *Acacia drepanolobium*; 14.20 4/8/94; S3° 59.084 E37° 49.689; 1.5m; 2m; 0.32m²; 0.32m²/100%

Tree 20: *Acacia mellifera*; 06.50 5/8/94; S4° 02.710 E37° 48.923; 4m; 20m; 31.83²; 2m²/6.28%; some windy gusts.

Tree 21: *Acacia mellifera*; 07.10 5/8/94; S4° 02.732 E37° 48.842; 5m; 20m; 31.83²; 2m²/6.28%

Tree 22: *Acacia drepanolobium*; 08.35 7/8/94; S3° 52.960 E37° 52.440; 1.5m; 6m; 2.86m²; 0.32m²/11.19%

Tree 23: *Acacia drepanolobium*; 08.35 7/8/94; S3° 52.960 E37° 52.440; 2m; 5m; 1.99m²; 0.32m²/16.08%

Tree 24: *Acacia drepanolobium*; 08.35 7/8/94; S3° 52.960 E37° 52.440; 1.5m; 5m; 1.99m²; 0.32m²/16.08%

Tree 25: *Acacia senegal*; 10.50 7/8/94; S3° 54.113 E37° 52.679; 3m; 4m; 1.27m²; 2m²/157%; this tree might have been very spindly or the circumference is incorrect.

Tree 26: *Acacia mellifera*; 06.50 10/8/94; S4° 03.300 E37° 48.044; 2.2m; 12m; 11.46m²; 0.96m²/8.38%

Tree 27: *Acacia bussei*; 09.15 10/8/94; S4° 02.978 E37° 48.665; 3m; 14m; 15.60m²; 2m²/12.82%.

Tree 28: *Acacia bussei*; 09.15 10/8/94; S4° 02.978 E37° 48.665; 3m; 18m; 25.78m²; 2m²/7.76%.

Tree 29: *Acacia tortilis*; 07.20 12/8/94; S4° 06.577 E38° 01.379; 2.25m; 10m; 7.96m²; 0.96m²/12.06%; sampled period 2 hours due to logistic difficulties.

Tree 30: *Acacia ancistroclada*; mid am 12/8/94; S4° 07.479 E38° 01.129; 10m; 41m; 133.77m²; 4.96m²/3.71%; some windy gusts during sampling period.

Tree 31: *Acacia tortilis*; 11.30 13/8/94; GPS? road to Ngurunga Dam before junction across plain; 2m; 3.5m; 0.98m²; 0.64m²/65.30%

Tree 32: *Acacia tortilis*; 09.15 14/8/94; S4° 56.442 E37° 48.005; 3m; 7m; 3.90m²; 0.96m²/24.6%

Tree 33: *Acacia nilotica*; am 14/8/94; S3° 57.059 E37° 48.203; 5m; 11m; 9.63m²; 0.96m²/9.97%

Tree 34: *Acacia tortilis*; 12.00 14/8/94; S3° 57.059 E37° 48.203; 2m; 8m; 5.09m²; 2m²/ 39.29%

Tree 35: *Acacia nilotica*; 12.30am 14/8/94; S3° 57.059 E37° 48.203; 2m; 13m; 13.45m²; 0.96m²/7.14%

April 1995

Tree 1: *Acacia senegal*; 09.30 4/4/95; S3°55.17 E37°49.17; 2m; 7m; 3.89m²; 0.32m² / 8.23%

Tree 2: *Acacia tortilis*; 09.30 4/4/95; S3°55.17 E37°49.17; 2m; 8.5m; 5.75m²; 0.64m² / 11.13%

Tree 3: *Acacia senegal*; 10.35 4/4/95; S3°54.63 E37°50.06; 2.5m; 4m; 1.27m²; 0.32m² / 25.20%

Tree 4: *Acacia thomasii*; 10.35 4/4/95; S3°54.63 E37°50.06; 4m; 8m; 5.09m²; 0.64m² / 12.57%

Tree 5: *Acacia brevispica*; 17.30 4/4/95; S3°56.70 E37°48.05; 3.5m; 8m; 5.09m²; 0.64m² / 12.57%

Tree 6: *Acacia brevispica*; 17.30 4/4/95; S3°56.70 E37°48.05; 2.5m; ..m; 12.43m²; 0.64m² / 5.15%

Tree 7: *Commiphora* sp. A; 10.20 5/4/95; S4°03.33 E37°47.69; 10m; 26m; 53.79m²; 4m² / 7.44%

Tree 8: *Dichrostachys cinerea*; 12.40 5/4/95; S4° 02.72 E37° 48.93; 6m; 70m; 389.9m²; 1.28m² / 0.33%

Tree 9: *Grewia* sp.; 16.30 5/4/95; S4° 02.37 E37° 49.34; 3m; 10m; 7.95m²; 1.28² / 16.1% [sample stopped after 15 minutes due to wind]

Tree 10: *Lannea stuhlmannii*; 17.20 5/4/95; S4° 01.33 E37° 50.12; 3.5m; 10m; 7.95m²; 1.28m² / 16.1%

Tree 11: *Lannea stuhlmannii*; 09.30 6/4/95; GPS as Ibaya Camp; 6m; 35m; 97.48m²; 4m² / 4.10% [same as tree 1 sprayed July 1994]

Tree 12: *Acacia brevispica*; 11.25 6/4/95; 1.3 miles from Ibaya on road to Dindera; 3m; 10m; 7.95m²; 1.28m² / 16.1%

Tree 13: *Commiphora* sp. A; 11.55 7/4/95; Zange Gate S4° 03.44 E37° 47.5?1; 6m; 25m; 49.73m²; 4m² / 8.04% [some gusts of wind]

Tree 14: *Commiphora* sp. A; 11.55 7/4/95; Zange Gate S4° 03.44 E37° 47.5?1; 5m; 22m; 38.52m²; 4m² / 10.38%

Tree 15: *Grewia* spp; 11.55 7/4/95; Zange Gate S4° 03.44 E37° 47.5?1; 3m; 13+10m; 13.45+7.95m²; 1.28m² / 5.98%

Tree 16: *Commiphora* sp. A; 16.00 7/4/95; Zange Gate S4° 03.44 E37° 47.5?1; 50.471; 8m; 33m; 86.66m²; 4m² / 4.62%

Tree 17: *Commiphora* sp. A; 16.00 7/4/95; Zange Gate S4° 03.44 E37° 47.5?1; 50.471; 8m; 35m; 97.48m²; 4m² / 4.10%

Tree 18: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 5m; 3m; 0.716m²; 1.0m² / 139.7% [tall, spindly growth form]

Tree 19: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 3.5m; 3m; 0.716m²; 1.0m² / 139.7% [tall, spindly growth form]

Tree 20: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 4.5m; 3m; 0.716m²; 1.0m² / 139.7% [tall, spindly growth form]

Tree 21: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 3.5m; 3m; 0.716m²; 1.0m² / 139.7% [tall, spindly growth form]

Tree 22: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 4m; 4m; 1.27m²; 1.0m² / 78.7% [tall, spindly growth form]

Tree 23: *Combretum molle*; 09.50 8/4/95; S3° 54.75 E37° 48.58; 3.5m; 5m; 1.99m²; 1.0m² / 50.25% [tall, spindly growth form]

Tree 24: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 5m; 5m; 1.99m²; 1m² / 50.25%

Tree 25: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 5m; 6m; 2.86m²; 1m² / 35.0%

Tree 26: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 6m; 12m; 11.46m²; 1m² / 8.73%

Tree 27: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 5m; 9m; 6.45m^2; 1m^2 / 15.50%
Tree 28: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 4.5m; 8m; 5.09m^2; 1m^2 / 19.65%
Tree 29: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 5m; 7m; 3.90m^2; 1m^2 / 25.64%
Tree 30: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 5m; 5m; 1.99m^2; 1m^2 / 50.25%
Tree 31: *Combretum molle*; 09.55 9/4/95; S3° 54.75 E37° 48.50; 4.5m; 7m; 3.90m^2; 1m^2 / 25.64%
Tree 32: *Dichrostachys cinerea*; 14.45 9/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 33: *Dichrostachys cinerea*; 14.45 9/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 34: *Dichrostachys cinerea*; 10.00 10/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 35: *Dichrostachys cinerea*; 10.00 10/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 36: *Dichrostachys cinerea*; 10.00 10/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 37: *Dichrostachys cinerea*; 10.00 10/4/95; S3° 55.00 E37° 49.12; 1.5m; 3m; 0.716m^2; 0.64m^2 / 89.39%
Tree 38: *Commiphora* sp. A; 09.05 12/4/95; S3° 57.64 E37° 51.71; 7m; 39m; 121m^2; 4m^2 / 3.31%
Tree 39: *Commiphora* sp. A; 09.05 12/4/95; S3° 57.64 E37° 51.71; 9m; 44m; 154m^2; 4m^2 / 2.60%
Tree 40: *Acacia seyal* var *fistula*; 09.15 12/4/95; S3° 57.64 E37° 51.71; 3.5m; 14m; 15.6m^2; 1.28^2 / 8.21%
Tree 41: *Acacia seyal* var *fistula*; 09.15 12/4/95; S3° 57.64 E37° 51.71; 3.5m; 9m; 6.45m^2; 0.64m^2 / 9.92%
Tree 42: *Acacia seyal* var *fistula*; 09.15 12/4/95; S3° 57.64 E37° 51.71; 3.5m; 8m; 5.09m^2; 0.64m^2 / 12.57%
Tree 43: *Acacia seyal* var *fistula*; 10.55 12/4/95; S3° 57.56 E37° 51.83; 4m; 19m; 28.73m^2; 1.28m^2 / 4.46%
Tree 44: *Commiphora* sp. A; 16.25 12/4/95; S3° 58.62 E37° 50.51; 6m; 37m; 108.9m^2; 4m^2 / 3.67%
Tree 45: *Commiphora* sp. A; 16.25 12/4/95; S3° 58.62 E37° 50.51; 6m; 39m; 121.0m^2; 4m^2 / 3.31%
Tree 46: *Acacia seyal* var *fistula*; 10.00 13/4/95; S3° 58.89 E37° 50.41; 4m; 18m; 25.78m^2; 1m^2 / 3.88%
Tree 47: *Acacia seyal* var *fistula*; 10.00 13/4/95; S3° 58.89 E37° 50.41; 3m; 12m; 11.46m^2; 1m^2 / 8.73%
Tree 48: *Acacia seyal* var *fistula*; 10.00 13/4/95; S3° 58.89 E37° 50.41; 3m; 10m; 7.96m^2; 1m^2 / 12.56%
Tree 49: *Acacia seyal* var *fistula*; 10.00 13/4/95; S3° 58.89 E37° 50.41; 5m; 16m; 20.37m^2; 1m^2 / 4.91%
Tree 50: *Acacia seyal* var *fistula*; 10.00 13/4/95; S3° 58.89 E37° 50.41; 4m; 10m; 7.96m^2; 1.28m^2 / 16.08%
Tree 51: *Acacia senegal*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 4m; 15m; 17.9m^2; 1m^2 / 5.59%
Tree 52: *Acacia tortilis*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 6m; 36m; 103.1m^2; 2m^2 / 1.94%
Tree 53: *Acacia senegal*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 5m; 31m; 76.47m^2; 2m^2 / 2.62%
Tree 54: *Acacia senegal*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 4m; 24m; 45.84m^2; 1m^2 / 2.18%
Tree 55: *Acacia senegal*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 5m; 25m; 49.74m^2; 2m^2 / 4.02%
Tree 56: *Acacia senegal*; 16.45 13/4/95; S3° 54.57 E37° 52.80; 3m; 15m; 17.90m^2; 1.28m^2 / 7.15%
Tree 57: *Acacia tortilis*; 10.15 15/4/95; S3° 54.56 E37° 52.72; 5m; 12m; 11.46m^2; 2m^2 / 17.45%
Tree 58: *Acacia tortilis*; 10.15 15/4/95; S3° 54.56 E37° 52.72; 4.5m; 20m; 31.83m^2; 2m^2 / 6.28%
Tree 59: *Acacia tortilis*; 10.15 15/4/95; S3° 54.56 E37° 52.72; 6m; 15m; 17.9m^2; 2m^2 / 11.17%
Tree 60: *Acacia senegal*; 10.15 15/4/95; S3° 54.56 E37° 52.72; 3m; 14m; 15.59m^2; 1.28m^2 / 8.21%
Tree 61: *Acacia senegal*; 10.15 15/4/95; S3° 54.56 E37° 52.72; 4m; 20m; 31.83m^2; 2m^2 / 6.28%
Tree 62: *Commiphora* sp. A; 10.05 18/4/95; S4° 29.67 E38° 32.50; 4m; 25m; 49.74m^2; 2m^2 / 4.02%
Tree 63: *Commiphora* sp. B; 10.05 18/4/95; S4° 29.67 E38° 32.50; 3.5m; 11m; 9.63m^2; 1m^2 / 10.38%
Tree 64: *Commiphora* sp. A; 10.05 18/4/95; S4° 29.67 E38° 32.50; 5m; 22m; 38.52m^2; 2m^2 / 5.22%
Tree 65: *Commiphora* sp. A; 10.05 18/4/95; S4° 29.67 E38° 32.50; 4m; 16m; 20.37m^2; 1m^2 / 4.91%
Tree 66: *Commiphora* sp. A; 10.05 18/4/95; S4° 29.67 E38° 32.50; 5m; 32m; 81.49m^2; 2m^2 / 2.45%
Tree 67: *Commiphora* sp. A; 09.00 19/4/95; S4° 27.86 E38° 33.47; 3m; 12m; 11.46m^2; 1m^2 / 8.72%
Tree 68: *Boswellia* sp.; 09.00 19/4/95; S4° 27.86 E38° 33.47; 4m; 24m; 45.84m^2; 1m^2 / 2.18%
Tree 69: *Boswellia* sp.; 09.00 19/4/95; S4° 27.86 E38° 33.47; 3m; 15m; 17.90m^2; 1m^2 / 5.59%
Tree 70: *Commiphora* sp. B; 09.00 19/4/95; S4° 27.86 E38° 33.47; 4m; 12m; 11.46m^2; 1m^2 / 8.72%
Tree 71: *Commiphora* sp. A; 09.00 19/4/95; S4° 27.86 E38° 33.47; 4m; 25m; 49.74m^2; 2m^2 / 4.02%
Tree 72: *Commiphora* sp. B; 09.00 19/4/95; S4° 27.86 E38° 33.47; 5m; 30m; 71.62m^2; 2m^2 / 2.79%
Tree 73: *Commiphora hoseana*; 11.55. 21/4/95; S4° 05.72 E38° 01.63; 9m; 25m; 49.74m^2; 2m^2 / 4.02%
Tree 74: *Commiphora hoseana*; 11.55. 21/4/95; S4° 05.72 E38° 01.63; 6m; 15m; 17.90m^2; 2m^2 / 11.17%
Tree 75: *Commiphora hoseana*; 11.55. 21/4/95; S4° 05.72 E38° 01.63; 6.5m; 13m; 13.45m^2; 2m^2 / 14.87%
Tree 76: *Acacia tortilis*; 11.55. 21/4/95; S4° 05.72 E38° 01.63; 6m; 37m; 108.94m^2; 2m^2 / 1.84%

The Birds of the Mkomazi Game Reserve

Dr Peter C. Lack, British Trust for Ornithology

Introduction

To date the project has information on the birds of Mkomazi Game Reserve from four sources: a visit of three and a half weeks in July-August 1993 by myself accompanied by Agustino Peter as driver and helper and for some of the time by wife Diane Ridgley; an eight week visit by six students from St Peter's College, Oxford also in July-August 1993; two overnight stays by Don Turner and Miles Coverdale in February 1994; and Neil Baker and others have made several visits during 1994 and 1995. In addition there are many earlier records compiled by Larry Harris in the 1960s (summarised in his 1972 paper). As far as is known, only myself and the Oxford students have done more than compile lists of the species recorded.

The general area of 'Mkomazi' was visited many times in the 1930s by Reg Moreau, who was stationed as an agriculturalist at the Amani Station in the Usambaras. At the time he thought that the area was one of the richest savannas for bird life in Africa. However it is unclear exactly which area or areas he was referring to. It is likely that he was mainly, if not entirely, referring to the area around Mkomazi Village and by the Pangani River, in the gap between the South Pare and Usambara Mountains which he reached on foot or horseback from the railway station at Mkomazi Village. Certainly it is this area where David Lack did his study of the bishop-bird *Euplectes hordeaceus* (Lack 1935) while he was staying with Moreau.

Species List

A preliminary list of species for the Game Reserve is included in the appendix to this report. This includes 376 species seen by myself, the Oxford students, Don Turner and Miles Coverdale, or Neil Baker and others and another 13 seen by Harris (1972). There are also likely to be several more migrants which will appear in greater or lesser numbers in the wet seasons and northern winter. I consider the species list for the reserve is likely to reach 450-500 which makes it a very rich area for its size and habitat range.

Among these there are already five species not previously recorded in Tanzania - Three-streaked Tchagra *Tchagra jamesi* (Lack 1994), Violet Wood Hoopoe *Phoeniculus granti*, Friedmann's Lark *Mirafra pulpa*, Yellow-vented Eremomela *Eremomela flaviventris* and Somali Long-billed Crombec *Sylvietta isabellina*. A sixth new species, the Barbary Falcon *Falco peregrinoides*, was recorded just to the south of the reserve boundary in circumstances in which it could only have passed over the reserve. (It must be noted that as yet not all these have been accepted by the East African Rarities Committee.) Several other records are worthy of special note either for being at the southernmost part of their range - Pigmy Batis *Batis perkeo* and Pringle's Puffback *Dryoscopus pringlii*, or for their overall general uncommonness - Blue Quail *Coturnix chinensis*, Black-bellied Bustard *Eupodotis melanogaster* and White-headed Mousebird *Colius leucocephalus*, and a Eurasian Swallow *Hirundo rustica* seen on 18 July 1993 was exceptionally early in the year for a land-bird migrant from the Palaearctic. Most of these are not too unlikely in view of the reserve forming the southernmost extension of the Somali semi-arid belt which encompasses a wide area of southeastern Kenya, including the Tsavo National Parks, and that up to now very few experienced birdwatchers have ventured into the area.

Bird Census Work

The following is a brief description of the results from my own census work, carried out during July-August 1993 (2-3 months into the dry season). This will be written up more fully in due course after a comparative visit in the wet season.

Bird censuses were conducted along reserve roads. Ten minute stops were made every kilometre (or sometimes 2 km) during which time all birds seen and/or heard were recorded. Each census point was allocated into one of 12 major habitat types. These were:

Grassland (G) - no bushes or trees present, area usually with thick unburnt grass. Bushed Grassland

(BG) - no trees, bushes less than 10% canopy cover, grass cover either very thick or burnt. Wooded Bushed Grassland type A (WBGa) - trees mainly *Acacia tortilis* of less than 10% canopy cover, bushes less than 10% canopy cover and of variable height, grass as above. (Censuses in this were only done along the road towards Ngurunga Dam and near Zangi Gate.) Wooded Bushed Grassland type B (WBGb) - trees of various species and often of mixed species in one area, bushes and grass as above. Bushland (B) - (rather limited areas) no trees, bushes more than 10% canopy cover, grass usually present but variable amount. Wooded Bushland (WB) - (also rather limited areas) as bushland but with some trees present. Acacia Woodland type A (AcWa) - trees dominated by Acacia typically *A. tortilis* of more than 10% canopy cover, bushes very dense and up to 3 m high, grass amounts variable. (This was restricted to censuses taken along the Zangi Gate to Kisiwani road which were adjacent to border of reserve and Forest Reserve.) Acacia Woodland type B (AcWb) - similar to above but in other parts of the reserve. Ngurunga Thicket (NgT) - very dense trees and bushes (mixed species) close to the watercourse leading to the Ngurunga Dam. Commiphora Woodland type A (CoWa) - woodland as above but dominated, often nearly exclusively, by *Commiphora* spp. (This type was the area from Njiro Gate towards Kisima Camp which contained generally richer vegetation than elsewhere and with the trees up to 12-15 m in places.) Commiphora Woodland type B (CoWb) - other woodland dominated by *Commiphora* spp, mostly in very dry areas and with trees often only up to 5 m and sometimes a near closed canopy at about 3-4 m. Forest (F) - a small area of ground water/riverine forest near the village of Kisiwani with trees up to 20 m and impenetrable bush layer.

A total of 326 10-minute counts were made with the number in each habitat ranging from 7 to 55. For the present purposes the commoner bird species (those recorded at least 6 times in censuses) have divided into six ecological categories depending on the their main foods. Table 1 records the numbers of each of these seen per hour in each habitat, together with totals and numbers of species.

TABLE 1
The numbers of birds of different ecological categories seen per hour in each of the 12 main habitat types in Mkomazi Game Reserve, July-August 1993.

Food Type	**G**	**BG**	**WBG**	**WBG**	**B**	**WB**	**AcW**	**AcW**	**NgT**	**CoW**	**CoW**	**F**	**Total**
			a	**b**			**a**	**b**		**a**	**b**		
Insects only	10	40	36	36	12	39	15	32	18	13	23	20	27
Insects+Fruit	0	4	8	9	5	6	12	8	9	7	7	24	8
Insects+Seeds	4	12	12	5	18	17	5	9	19	11	7	2	10
Insects+Nectar	0	x	5	2	2	5	11	1	3	9	3	5	4
Fruits only	0	1	2	4	0	4	7	6	5	5	4	11	4
Seeds only	9	3	17	4	2	8	10	3	21	5	4	11	6
TOTAL	23	59	80	60	40	78	60	59	75	50	47	73	58
Total no.spec.	20	89	82	96	46	73	87	79	45	85	86	39	177
No. 10m counts	7	50	28	55	16	17	24	22	9	44	46	8	326

NOTES:
The numbers in the main part of the table are the number of each ecological type seen per hour's censusing in each habitat. Only those species of which at least 6 were recorded in all censuses are included in this total.
The TOTAL line is the total number of birds per hour (including all species).
The Total number of species is that recorded in all censuses.
The last line is the number of 10 minute counts carried out in that habitat.; habitat abbreviations are as in text.

Inspection of the table shows that the total numbers seen did not vary very much or very consistently between habitats. However it must be remembered that these are not actual density figures, and indeed the counts in more open habitats were over a larger area than in the thicker ones. The proportions of the different ecological types of bird, however, show a few more interesting patterns. The pure insectivores were more dominant in the more open habitats. All frugivores were commonest in Forest and next most in Acacia Woodland type A which was in the same geographical area. This is typical of elsewhere in Africa as forest areas always hold many fruiting trees. Seed eaters were most common in the Ngurunga Thicket, followed by

Wooded Bushed Grassland type A. This was probably due to the presence of Ngurunga Dam within a few kilometres as seed eaters are one of the few groups of birds which need to drink nearly every day. Finally, nectarivores were especially common in Acacia Woodland type A and Commiphora Woodland type A. Both these habitats contained a higher proportion of mature trees than other savanna habitats, some of which were flowering. It was especially noticeable that sunbirds congregated around flowering trees of *Albizia*.

It is clear from the penultimate line of the table that the habitats richest in species were Acacia Woodland (both types) and Wooded Bushed Grassland type A followed by Wooded Bushland. (Note that a direct comparison must take into account the total time spent in each habitat.) All these were dominated by Acacia trees and it is clear that *Acacia* is preferred to *Commiphora* as a bird habitat. Further analyses involving individual species and their habitat preferences will be carried out in due course.

A comparison with my earlier studies in Tsavo East National Park (Lack 1980, 1985, Lack et al. 1980) indicates that there is a much greater diversity in Mkomazi. This is partly due to the wider range of habitat types in Mkomazi within a fairly small area but also the much larger number of Acacia trees. There is also a rather higher rainfall and one of the most visually obvious differences between the areas was that Mkomazi had much more grass present and that a fair amount was being burnt. All these points will be investigated further.

There were also some interesting individual species differences from Tsavo East. A few examples are set out in Table 2. Some of these can be attributed to the rather higher rainfall in Mkomazi. However there were also some species which were about equally common in both areas and showed almost identical habitat preferences, for example Black-throated Barbet *Lybius melanocephalus* (common) and Bare-eyed Thrush *Turdus tephronotus* (fairly common but elusive) occurring almost exclusively in Commiphora Woodland.

These and other similarities and differences will be investigated in greater detail in due course.

TABLE 2

A few examples of differences in commonness (rarity) and habitat preferences between Mkomazi (this study) and Tsavo East National Park in Kenya about 100 km to the northeast (data from Lack 1980, 1985).
Scientific names are in the species list in appendix.

Species	**Mkomazi**	**Tsavo East N.P.**
Yellow-necked Spurfowl	Commonest in open habitats	Commonest in Wooded
Black-faced Sandgrouse	Rare, only in thicker habitats	Common, especially in open habitats
Orange-bellied Parrot	Common in all habitats with trees	Restricted to thick Commiphora
Pink-breasted Lark	Uncommon in wooded areas	Common everywhere
Rattling Cisticola	Widespread	Very rare
Black-headed Tchagra	Widespread	Rare and only in Commiphora woodland
Long-tailed Fiscal	Very common in open habitats	Only in damper parts
Taita Fiscal	Very rare and only in driest areas	Very common
Hildebrandt's Starling	Very common	Very rare
Superb Starling	Much less common than Hildebrandt's	Much commoner than Hildebrandt's
Sunbirds (all species)	Fairly common	Uncommon

Acknowledgements

I am grateful to the Royal Society for providing the grant which enabled me to go to Tanzania to carry out the study.

References

Harris, L.D. 1972. An ecological description of a semi-arid East African ecosystem. *Range Sci, Depr,. Sci. Ser.* **11**: 89pp. Colorado State University.

Lack, D. 1935. Territory and polygamy in a bishop-bird, *Euplectes hordeacea hordeacea* (Linn.). *Ibis* **1935**: 817-836.

Lack, P.C. 1980. **The habitats and feeding stations of the birds in Tsavo National Park, Kenya**. Unpublished D.Phil. thesis, Oxford University.

Lack, P.C. 1985. The ecology of the land-birds of Tsavo East National Park, Kenya. *Scopus* **9**: 2-23, 57-96.

Lack, P.C. 1994. Three-streaked Tchagra *Tchagra jamesi*: a new record for Tanzania. *Scopus* **17**: 140-141.

Lack, P.C., Leuthold, W. & Smeenk, C. 1980. Check-list of the birds of Tsavo East National Park, Kenya. *Jl. E. Afr. Nat. Hist. Soc. natl. Mus.* **170**: 1-25.

GIS and Habitat Mapping

Shaun Russell, Durrell Institute of Conservation and Ecology,
University of Kent at Canterbury

Introduction

Ground truthed aerial photography has traditionally been used for vegetation survey, and less frequently for animal census in protected areas in Africa. Satellite imagery has also been used for the mapping of habitat types, particularly in the larger parks and reserves. Increasing human pressure on protected areas and commitments to the Biodiversity Convention, are leading many African countries to seek more rapid and efficient means of inventorying and mapping their biodiversity resources. Image analysis and GIS techniques are thus becoming more frequently used for this purpose in Africa, and the Mkomazi Ecological Research Programme (MERP) has adopted these methods for providing base mapping and the capacity to integrate the results of Programme sub-projects into a spatially referenced database of value for ecologists and wildlife managers at the Reserve.

Objectives of the GIS sub-project

1. Establish a GIS grid for the Mkomazi Game Reserve (MGR) using commonly available software.
2. Include in the database, topographic data, the infrastructure network of roads and buildings and gross vegetation boundaries derived from remote sensing data.
3. Produce hard-copy and digital base mapping for Mkomazi, at scales required by the Reserve managers and scientists working on MERP sub-projects.
4. If funds permit, to digitize the existing 1:50 000 topographic maps of the Reserve, and overlay detailed habitat classes derived from remote-sensing and ground survey work..
5. Train staff of the Tanzanian Department of Wildlife in the further development and use of the GIS at Mkomazi, and secure resources for a permanent GIS facility at the Reserve.

Progress to date (September 1995):

1993

Field survey was carried out in August 1993 by Julie Cox, to ground truth gross vegetation zone data interpreted from satellite images of the western MGR. Results of this study are given in Cox (1993). Hardcopy Landsat MSS single band images (non-colour) from 1975 and 1987 were acquired for the pilot study, giving a scale of 1:250 000 with a X4 enlargement. Interpretation allowed the designation of nine land cover classes, and the areas of these were calculated using a dot grid. Vegetation types were classified according to percentage cover of shrub and tree components, following the physiognomic scheme widely used in East African ecological studies (Fig 1). Manually-prepared colour maps of major vegetation zones in the West of the MGR have resulted from this study, and copies are kept in the Reserve, at RGS headquarters and at Oxford and Canterbury. Gross vegetation changes between the two dates as interpreted from the satellite images are indicated in Table 1. Major trends that emerged from this study were fragmentation of the denser bush and woodland types in the West of the Reserve, possibly due to anthropogenic factors such as fire, and an increase in the density of bush and thicket types, possibly influenced by the fall in numbers of browsers such as Elephant. Such questions are being addressed by the MERP sub-projects examining vegetation dynamics and large mammal ecology.

1994

In 1994, Kent Cassels continued the field work by conducting a GPS survey of the road network with Angus Jackson. Roads, tracks, water points and drainage-lines, camps, prominent topographic points, scientific transects and plots, were fixed and entered into the Mkomazi database at DICE. Vehicle-mounted GPS equipment was programmed and calibrated for this study, and 1000 coordinates were obtained. A commercially available database is being used (Microsoft "ACCESS") and the data entry format is shown in Figure 2. 200 coordinates of game observations were also obtained and additional local data was collected for updating of the topographic maps.

1995

A GIS unit has been established at DICE and comprises a PC-based system with A0 digitizing board and colour printer. The Central Processing Unit includes a CD-ROM drive and tape streamer for accommodating the large amounts of data that will accrue as the GIS develops. State-of-the-Art software (PC-ARC/INFO for Windows) and low-cost software (IDRISI for Windows) have been obtained, and will be used to produce high quality detailed mapping output, but also to form the basis of a low-cost system that can be donated to the Reserve and/or used at other field stations in protected areas in Tanzania.

Two sets of air photos of the MGR at 1:60 000 scale have been obtained; one set is temporarily on loan from the Reserve for use by DICE in a preliminary interpretation of vegetation classes. In addition to geomorphic and vegetation information, these photographs show clearly the distribution of fire scars in the Reserve, and will be of considerable value in providing vegetation history and habitat management data to workers on the ground. This work was assisted by a two week ground reconnaissance at the Reserve, carried out by Shaun Russell in August 1995. A short training session in GIS techniques was provided for Wildlife Department staff at the MGR during this visit, and planning was undertaken for further training opportunities in the UK and in the Reserve at a later stage of the project.

The 1:50 000 topographic maps of the MGR have been scanned into digital (raster) format and read into CD storage media. Print-outs of selected areas of the Reserve at requisite scales can now be provided to workers on MERP sub-projects.

TABLE 1
Changes in land cover 1975-1987 (% study area/West Mkomazi)
(after Cox, J. 1993)

Image Interpretation Class	% Area 1975	% Area 1987	Change
1. Grassland	2	5	+
2. Bush-Grassland Wood-Grassland Wood-Bush-Grassland	27	22	-
3. Hill or Mountain Brushland and Bush-Grassland	2.5	3	
4. Hill or Mountain Woodland, dense Bushland and Bush-Thicket	13	8	-
5. Montane Forest - dense Bushland	≤1	≤1	
6. Burnt area	≤1	≤1	
7. Ill-drained Bushland/Swamp	13.5	8	-
8. Bushland	37	31	-
9. Woodland, dense Bushland and Bush-Thicket	5	23	+
10.Water bodies	≤1	≤1	

Future work

It is intended to extend the results of the 1993 remote-sensing pilot study, by obtaining up-to-date and higher resolution satellite imagery, and by carrying out a more detailed interpretation using image analysis software in cooperation with the Tala Research Group in the Zoology Department at Oxford University.

As the GIS is developed, input of data from other sub-projects will be invited, in order to produce tailored mapping and interpretive overlays of ecological information at MGR. During 1996, two staff from the College of African Wildlife Management in Tanzania will complete M.Sc degrees at DICE, and will carry out their field projects in the MGR funded by the British Council, the RGS and DICE. These study-fellows will carry forward the ground-truthing of air-photo and satellite imagery interpretation, to allow a detailed habitat class map to be prepared for the Reserve.

Reference

Cox, J.A. (1993). **Mkomazi Ecological Research Programme Pilot Study: Remote Sensing/Vegetation Survey/Mapping**. Typescript Report, December 1993. Royal Geographical Society, London.

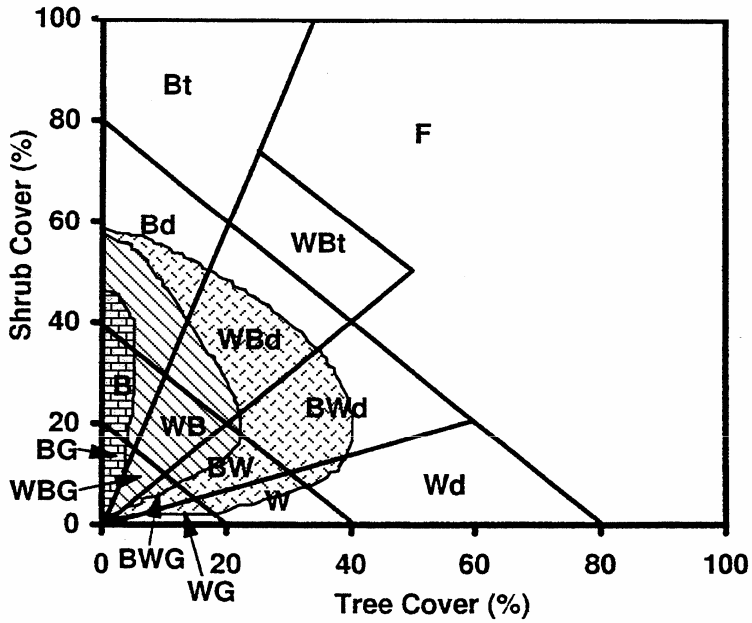


FIGURE 1
Variation in structure classes of the three major groups of vegetation represented at the Mkomazi Game Reserve (after Cox 1993)

Commiphora-Lannea group of communities, on well-drained, rather acid soils

Commiphora-Acacia group of communities, on well to imperfectly drained, neutral to alkaline soils

Acacia-Schenfeldia group of communities, on poorly drained, alkaline and often saline soils

Vegetation Structure Classes

G	Grassland	**B**	Bushland
WG	Wood-Grassland	**Wd**	Dense Woodland
BWG	Bush-Wood-Grassland	**BWd**	Dense Bush Woodland
BG	Bush-Grassland	**Bd**	Dense Bushland
W	Woodland	**Wbt**	Wood Bush-Thicket
BW	Bush-Woodland	**Bt**	Bush-Thicket
WB	Wood Bushland	**F**	Forest

Mkomazi Game Reserve : Conservation with Development in East African Rangelands

Dr Katherine Homewood and Daniel Brockington, Anthropology, University College London
Hilda Kiwasila, Anthropology, Institute of Resource Assessment, Dar es Salaam

Tanzania is a poor country with a growing population. Around 25% of its land area is game conservation estate of one sort or another. Tanzania cannot afford to set aside land for conservation without at the same time considering the implications for development . The case of Mkomazi has emerged at a time when the context of conservation is changing throughout the developing world. In ecological terms, patterns of local natural resource use are coming to be understood as often playing an important part in broader ecosystem processes. Conservation areas are no longer seen as areas from which all local community use must necessarily be excluded. Community -based management, both of natural resources in general and of conservation areas in particular, is in many cases coming to be seen as the only possible viable long term option. The present project is carrying out research into resource use by local communities around Mkomazi. It is gathering baseline information that will help defuse actual and potential conflicts and foster conservation with development in the long term in this and other savannah areas. This research is collecting data necessary to investigate community use of resources around Mkomazi, and to evaluate the possibility of participatory management in Mkomazi.

The study of community use of natural resources requires data on:

1. What resources are available.
2. What is used and how.
3. Environmental implications of the observed patterns of use.
4. Implications for community health and welfare of observed patterns of use.
5. Social structure of decision-making over resource use.

MRP is making available data on the soils, water, vegetation and wildlife which constitute the available resources. This study therefore focuses on the categories 2-5 above, for Maasai, Pare and other reserve-adjacent dwellers. Broadly speaking the contested resources are water, grazing, and fuelwood. The study is also looking at access to agricultural land. The easier the access to cultivable land, the more effective the alternatives to pastoralist use of reserve grazing. Construction poles, fibres, food plants and medicinal plants may prove to be major issues as well.

What is used and how

Dan Brockington working on the pastoralists and Hilda Kiwasila focusing on the reserve-adjacent farming communities are both using household survey techniques to collect data on:

1. Access to agricultural land.
2. Livestock holdings.
3. Local habitat/ vegetation/ plant classifications.

Both field researchers are also using recall data plus direct observation to map and quantify variation for different households across different seasons and localities in:

1. Grazing areas and routes.
2. Water points and their use.
3. Fuelwood and other wild plant use.
4. Ecological, cultural and economic determinants of wild resource use.

Environmental implications

Conservation concerns have centred on the effects of pastoralists and cultivators around Mkomazi on overgrazing (soil erosion, vegetation change); burning (vegetation change, loss of biodiversity); and competition with wildlife (declining wildlife populations; wildlife exclusion) as well as direct effects (e.g. hunting). This section is using MRP data to analyse the nature of long term trends in vegetation patterns and wildlife populations, and the extent to which they correlate with climatic fluctuations on the one hand and with livestock and human numbers in and around Mkomazi on the other. Mkomazi is not an isolated system and it is also necessary to take note of other changes affecting the history of the area: for example, the excision of areas along the western border for irrigation schemes, the construction of water points in Mkomazi substituting for the water sources lost to irrigation agriculture, and the changing conservation policies and wildlife population numbers in neighbouring Tsavo.

The approach in this part of the project is to test competing hypotheses as to the relative importance of human-induced versus climate-driven and other sources of change by relating vegetation and wildlife population trends to:

1. Climate trends.
2. Livestock numbers.
3. Elephant numbers.
4. Policy changes on e.g.: Tsavo poaching control, fire, exclusion of pastoralists.

This should set in context the ecological implications of different communities' resource use of the Mkomazi ecosystem, and bring the impact of different interventions into perspective.

Implications of changing resource use for community health and welfare

This section of the project is looking at

1. Livestock/ land holdings.
2. Livestock and crop performance:
    - livestock fertility/ crop yields
    - livestock mortality/ crop loss
    - milk production/ other sources of income
    - offtake/ sale and consumption
3. Diet and nutritional status:
    - 24-hour recall
    - dietary adequacy
    - anthropometry
4. Microeconomics:
    - production system
    - market value of wild resources
    - potential tourist revenue sharing
    - costs and benefits of exclusion
5. Extent of dependence on wild resources:
    - nutritional and economic dependence
6. Demography - if time/resources allow:
    - fertility
    - in- and out- migration

These measures help evaluate the impact of exclusion on the reserve-adjacent communities and on their production systems. This can form the basis of an economic analysis of the costs and benefits of different management options. It can also correlate inter-household variation with access to cultivable land, wealth, education etc.

The social structure of decision-making over resource use

Conservation management often comes up against difficulties because the policies that have been devised and the structure which is expected to implement them take no account of the way in which local communities operate resource management. At the same time any attempt to incorporate local systems of decision-making and conflict resolution can be manipulated by particularly powerful and/or vocal subgroups. This section of the project is making use of participant observation and social network analysis to investigate:

1. Change in traditional structures of decision-making and conflict resolution.
2. Potential for co-management between government, Maasai, Pare and NGO groups.
3. Representation of weaker/ less vocal subgroups within the reserve-adjacent communities. This component of the study will foster a management system that is viable in the long term.

Acknowledgements

This research is being funded by ODA-ESCOR . It has also been given support by the London University Central Research Fund, the University College London Graduate School Research Fund, the Emslie Horniman Fund, the Boise Fund, the Parkes Foundation and the Kathleen and Margery Elliot Trust.

References.

Behnke, R. 1993 **Natural Resource management in pastoral Africa**. Presented to the workshop: Listening to People: Social aspects of dryland management. UNEP, Nairobi

Behnke, R., Scoones, I. and Kerven, C. 1993. **Range ecology at disequilibrium**. ODI, Regents Park, London.

Berkes F. (ed) **Common Property Resources: Ecology and Community-based sustainable Development** Belhaven Press, London

Bromley, D.W. and Cernea, M.M. 1989 **The management of Common Property Resources**. Some conceptual and operational fallacies. World Bank Discussion Papers 57. The World Bank, Washington DC

Coe, M. 1993. **Introduction, Flora and Fauna Species Lists and Bibliography for Mradi Wa Utafiti, Mkomazi, Mkomazi Research Programme 1993-1996**. Unpublished paper.

Heine, B., I. Heine and C. Köenig 1988 Plant concepts and plant use: an ethnobotanical survey of the semi-arid and arid lands of East Africa. Part V: **Plants of the Samburu (Kenya)**. Verlag Breitennbach. Saarbrücken . Fort Lauderdale.

Homewood, K. 1992 Development and the ecology of Maasai food and nutrition. Ecology of Food and Nutrition **29**: 61-81

Homewood K (1992) Patch production by cattle. Nature **359** **(6391)** 109-110

Homewood, K. 1993 **Methods in the study of African land use** Proceedings of the African Studies Association, Boston, December 1993

Homewood K. (in press) Ecological outcomes of boundary formation in Maasailand. Africa

Homewood K. (in press for 1994) Pastoral production systems and climate change. Ch. 12 In R. Chen, T. Downing, R. Kates and M. Parry, eds. **Climate change and world food security**. Springer Verlag

Homewood K. (1994) Pastoralists, environment and development in African rangelands in B. Zaba and J. Clarke (eds.) **Environment and Population Change**. IUSSP/BSPS Symposium volume. Ordina Editions

Homewood K. and Rodgers W. 1984 Pastoralism and conservation. Human Ecology **12**, 431-441

Homewood, K., and Rodgers, W. 1991 **Maasailand Ecology.** Pastoralist development and wildlife conservation in Ngorongoro , Tanzania. Cambridge University Press, Cambridge.

Kangwana, K. 1993 **Elephants and Maasai Conflicts and Conservation in Amboseli, Kenya.** PhD Thesis, Cambridge University (Zoology).

Mduma, S.R. 1988. **Mkomazi Game Reserve: Dangers and Recommended Measures for its Survival**. Miombo Dec: 1-5. Mkomazi Research Programme 1994-6 1994 Fund-raising document, available from RGS.

Moris, J. 1981 A case in rural development: the Maasai Range development project. In J. Moris: **Managing induced rural development** Bloomington, Indiana. International Development Institute.

Mentis, M.T. and Tainton, N.M. 1984 The effects of fire on forage production and quality. In P. de V. Booysen and NM Tainton (eds.) Ecological effects of fire in South African ecosystems. Ecological Studies **48** Springer- Verlag, Berlin.

Murphree, M. 1993 **Communities as resource management institutions.** Gatekeeper Series 1 IIED, London

Mwalyosi R 1992 Influence of livestock grazing on range condition in south west Maasailand - northern Tanzania. Journal of Applied Ecology **29**

Ndagala, D. 1982 Operation Imparnati: the sedentarisation of the pastoral Maasai in Tanzania. Nomadic Peoples **10**: 28-39

Ndagala, D. 1990 Pastoral territoriality and land degradation in Tanzania. In G. Palsson (ed.) **From Water to World making**. Scandinavian Institute of African Studies, Uppsala, Sweden.

Ndagala, D. 1992 **Territory, pastoralists and livestock: resource control among the Kisongo Maasai.** Acta Universitatis Uppsaliensis, Uppsala.

Oba, G. 1990 Changing property rights among settling pastoralists: an adaptive strategy to declining pastoral resources. In P. Baxter and R. Hogg (eds.) **Property, poverty and people. Changing property rights and problems of pastoral development.** Department of Social Anthropology and International Development Centre, Manchester University.

Parkipuny, L, Ole. 1993 Pastoralism, Conservation and development in the Greater Serengeti Region. Drylands Issues Papers **26** IIED, London

Rodgers W. and Homewood K. 1986 Cattle dynamics in a pastoralist community in Ngorongoro, Tanzania during the 1982-83 drought. Agricultural Systems **22**, 33-51

Sandford, S. 1982 Pastoral Strategies and Desertification: Opportunism and Conservatism in Dry Lands. In B. Spooner and H. Mann (eds.) **Desertification and Development** Academic Press, London.

Scoones, I. and Thompson, J. 1993 Rural People; knowledge, agricultural research and extension practise: overview papers. **Research Series 1** IIED, London

Sobania, N. 1990 Social relationships as an aspect of property rights: Northern Kenya in the pre-colonial and colonial periods. In P. Baxter and R. Hogg (eds.) **Property, poverty and people. Changing property rights and problems of pastoral development.** Department of Social Anthropology and International Development Centre, Manchester University.

Spear, T. and Waller, R. (eds.) **Being Maasai**. James Currey. London.

Talle, A. 1988 Women at a loss. Changes in Maasai pastoralism and their effects on gender relations. Stockholm Studies in Social Anthropology no **19**

Watson, R. 1991. Mkomazi, Restoring Africa. Swara **14**: 14-17

Western, D.1992. **Conserving savannah ecosystems through community participation. The Amboseli case study**. Presented at the Liz Claiborne Art Ortenberg Foundation Workshop in Community-based Conservation.

Western, D. and Dunne, T. 1979 **Environmental aspects of settlement site decisions among pastoral Maasai**. Human Ecology

Mkomazi Research Programme Members

As of October 1995

Members

Raphael Abdullah
Botany
Herbarium Assistant
Tropical Pesticides Research
P.O.Box 3024
Arusha, Tanzania

Dr Peter Abrahams
Soils hydrology, nutrient content
Institute of Earth Sciences
University of Wales
Llandinian Building
Aberystwyth
Dyfed SY23 3DB

Mr Neil Baker
Ornithology
P.O.Box 9601
Moshi
Tanzania

Mr Chris Caldicott
Programme Photographer
71 Cobbold Road
London W12 9LA

Mr Kent Cassels
Mapping
Durrell Institute of Conservation
Ecology (DICE)
University of Kent
Canterbury, Kent CT2 7PD

Dr Michael Cherry
Amphibians
Department of Zoology
University of Stellenbosch
Matieland 7602
South Africa

Dr Malcolm Coe
Programme Director
Phenology of woody plant species
Department of Zoology
University of Oxford

Ms Julie Cox
Mapping, remote sensing ,GIS
21 Albany Road
Rochester, Kent ME1 3ET
Tel 01634 840256

Mr Jonathan Davies
Entomology
Department of Entomology
Natural History Museum
Cromwell Road
London SW7 5BD

Dr Keith Eltringham
Large mammals
Department of Zoology
University of Cambridge
Downing Street
Cambridge CB2 3EJ

Dr Alexander Fleming
Reptiles
National Museum
P.O.Box 266
Blomfontein 9300
South Africa

Dr Francis Gilbert
Flower visiting communities of hover flies
Department of Life Science
Nottingham University
Nottingham NG7 2RD

Professor Larry Harris
Large mammal counts
Dept Wildlife Ecology
University of Florida
303 Newins-Ziegler Hall
P.O.Box 110430
Gainesville
FL 32611-0430
USA

Fay Hercod
Expedition Advisory Centre
Royal Geographical Society
1 Kensington Gore
London SW7 2AR

Ms Jeannette Kayes
Geographical Magazine visitor
5 Maple Drive
Witham
Essex CM8 2LH

Mr Elias Kihumo
Invertebrate biodiversity sampling
Insect Museum
Tropical Pesticides Research
P.O.Box 3024
Arusha, Tanzania

Dr Jonathan Kingdon
Artist in Residence
The Elms, The Walk
Islip
Oxon OX5 2SD

Mr Elias Jengo
Artist in Residence
Tanga
Tanzania

Dr Peter Lack
Ornithology
British Trust for Ornithology
The Nunnery
Thetford
Norfolk IP24 2PU

Daniel Mafunde
Programme Ranger
Mkomazi Research Programme
P.O.Box 81
Same
Tanzania

Ramahdani Makusi
Invertebrate sampling (ex TPRI)
P.O.Box 11734
Arusha
Tanzania

Mr Paul Marenga
Mkomazi Progamme Manager
Department of Wildlife
P.O. Box 1994
Dar es Salaam, Tanzania

Mr B.N.N Mbano
Deputy Director
Department of Wildlife
P.O.Box 1994
Dar es Salaam
Tanzania

Dr George McGavin
Entomology
Hope Department of Entomology
University Museum
South Parks Road
Oxford OXI 3PW

Mr Nicholas McWilliam
Scientific Assistant
Mkomazi Reserach Programme
P.O.Box 81
Same
Tanzania

Mr Tim Morgan
Field Director
Mkomazi Research Programme
P.O.Box 81
Same
Tanzania

Mr M.A. Ndolanga
Programme Director
Director of Wildlife
Department of Wildlife
P.O.Box 1994
Dar es Salaam
Tanzania

Mr Bruno Nyundo
Entomology
Dept Zoology & Marine Biology
University of Dar es Salaam
P.O.Box 35064
Dar es Salaam
Tanzania

Dr Mark Ritchie
Entomology
Natural Resources Institute
Central Avenue
Chatham Maritime
Chatham
Kent ME4 4TB

Dr Shaun Russell
Mapping
Durrell Institute of Conservation Ecology (DICE)
University of Kent
Canterbury, Kent CT2 7PD

Dr Antony Russell-Smith
Entomology
Natural Resources Institute
Central Avenue
Chatham Maritime
Chatham, Kent ME4 4TB

Venetia Simonds
Tanzania Programme Manager
Royal Geographical Society
1 Kensington Gore
London SW7 2AR

Dr Graham Stone
Insect pollinators on major tree species
Department of Zoology
University of Oxford
South Parks Road
Oxford
OX1 3PS

Dr Nigel Stork
Entomology
Department of Entomology
Natural History Museum
Cromwell Road
London SW7 5BD

Mr Issai Swai
Project Manager
Mkomazi Game Reserve
P.O.Box 41
Same
Tanzania

Dr Hamish Robertson
Entomology
Life Sciences Division
P.O.Box 61
Cape Town 8000
South Africa

Dr Rudi van Aarde
Mammal Research Institute
University of Pretoria
Pretoria 0002
South Africa

Dr Simon van Noort
Entomology
Life Sciences Division
South African Museum
P.O.Box 61
Cape Town 8000
South Africa

Dr Kaj Vollesen
Botany
Herbarium
Royal Botanic Gardens, Kew
Richmond
Surrey TW9 3AB

Dr Pat Willmer
Pollination mechanisms
Dept Biology & Preclinical Med
Bute Medical Buildings
St Andrews
Fife KY16 9TS

Mr Nigel Winser
Deputy Director
Royal Geographical Society
1 Kensington Gore
London SW7 2AR

Associate Members

Mr Daniel Brockington
Department of Anthropology,
Unversity College
Gower Street,
London WC1E 6BT

Dr Katherine Homewood
Department of Anthropology
University College London
Gower Street
London WC1E 6BT

Hilda Kiwasila
Institute of Resource Management
Dar es Salaam
Tanzania

Mkomazi Research Programme Sponsors and Supporters

As of July 1995

Corporate Patrons

British Airways
Coronation House, Samora Ave
P.O.Box 2439
Dar es Salaam
Tanzania

Ms Diane Pilot,
Manager, Tanzania

British Council
Samora Avenue
P.O.Box 9100
Dar es Salaam
Tanzania

Mr Robert Sykes, Director

BP Tanzania Ltd
P.O.Box 9043
Dar es Salaam
Tanzania

Mr Stuart K. Johnston,
Managing Director

CMC Land Rover (T) Ltd
Maktaba Street
P.O.Box 1852
Dar es Salaam
Tanzania

Mr Abdul Haji,
Managing Director

Friends of Conservation
Sloane Square House
Holbein Place
London SW1W 8NS

Mrs Jorie Kent

Land Rover Ltd
Lode Lane
Solihull
West Midlands B92 8NW
Richard Fox

Sheraton / Mansons Ltd
P.O.Box 529
Dar es Salaam
Tanzania

Mr Emmanuel Mantheakis,
Managing Director

Sponsors

Appledore Trust
c/o 8 Church lane
Middleton, Banbury
Oxon OX17 2NR

Baring Foundation
8 Bishops Gate
London EC4 4AE

Booker PLC
Portland House
Stag Place
London SW1E 5AY

Cambridge University
Downing Street
Cambridge CB2 3EJ

Darwin Intitiative
Department of Environment
Room A303
Romney House
43 Marsham Street
London SW1P 3PY

George Adamson Wildlife Protection Trust
c/o 16a Park View Road
London N3 2JB

Green Card Charitable Trust
33 Blagrave Street
Reading
Berks RG1 1PW

Long Distance Walking Association
c/o 97 Ringwood Road
Totton
Southampton SO4 3DX

River Island Clothing Co Ltd
Chelsea House
West Gate
London W5 1DR

Royal Society
6 Carlton House Terrace
London SW1Y 5AG

Supporters

Abercrombie & Kent (Tanzania) Ltd
AICC Serengeti Wing, Room 348
P.O.Box 427
Arusha, Tanzania

Mr Sandy Evans

Aims Group
P.O.Box 20066
7th Floor, Sukari House
Cnr. Ohio/Sokoine Street
Dar es Salaam, Tanzania

Mr Jeetu Patel, Chairman

Coopers & Lybrand
8th Floor
IPS Building
Maktaba Street
P.O.Box 45
Tanzania

Mr Godfrey Urasa, Partner

DHL International
Tanganyika Motors Building
36 Upanga Road
P.O.Box 3405
Dar es Salaam
Tanzania

Mr Max Shaw,
Managing Director

Group 4 Security (T) Ltd
Plot No 120 AA, Sea View
P.O.Box 9390
Dar es Salaam
Tanzania
Tel 00 255 51 32135
Fax 00 255 51 46856
Mr David Sutton,
Managing Director

PART II

Tentative Flora & Fauna Species List and Bibliography for the Mkomazi Game Reserve

Introduction

The Flora and Fauna of the Mkomazi Game Reserve, Tanzania is not well known, although Harris (1972) has listed the commoner elements, encountered during his studies there between late 1964 and mid 1967. The African College of Wildlife Management, Mweka have used the area extensively for field studies, but no systematic lists exist.

Across the adjacent Kenya border, the Tsavo National Park has been the object of considerable study by the Tsavo Research Project, and as a result the flora, mammals, birds, dung beetles and termites are relatively well known.

A common problem, faced by most ecologists working in African conservation areas, is the absence of floral and faunal lists which may be used as an introduction to species that should, or might be present in the area. In 1983 the Royal Geographical Society and the National Museums of Kenya published a tentative Flora and Fauna of the Kora National Reserve, for the benefit of scientists working with the Kora Research Project. This publication is intended to fulfil a similar role for the Mkomazi Research Programme.

The sources of all the information included, is indicated at the beginning of each section. MJC is indebted to Drs. Bennun, Lack and Ritchie, and Mr Alec MacKay, who have kindly looked over the lists, with a view to improving their accuracy.

The extensive bibliography includes references to scientific research and historical exploration, carried out in Mkomazi, Tsavo and surrounding areas. This information has been collated by Malcolm Coe, Alex Walters and Nicholas Windsor, with the able assistance of Shane and Nigel Winser, and the libraries of the University of Oxford, Royal Geographical Society and the Natural History Museum, London.

This species list and bibliography has been compiled for the use of members of the Mkomazi Research Programme. As the Programme proceeds, further additions will be included. Amendments should be sent to Dr Malcolm Coe, Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS
310447). Information contained in this section should not be quoted without reference to Malcolm Coe.

FLORA

This list comprises the plant species recorded by Greenway (1969), in the Tsavo East National Park, Kenya. These represent species found in a somewhat more arid region than Mkomazi, but Greenway (op cit.) considers that a large percentage will also be found in Tsavo West, adjacent to Mkomazi. Additional species have been added, that have been recorded by Harris (1972) in Mkomazi, but not by Greenway (op. cit), which are marked *, while common species to both lists are indicated thus **. Those species which have definitely been identified within MGR are indicated with a ✓ , whilst those species which have been introduced to the MGR are contained within *[ ]*. The more recent list of Kabuye, Mungai and Mutangah (1986) for the Kora National Reserve, also in an arid eastern Kenya environment, have not been included, but many that are not common to the lists of Greenway (op cit.) or Harris (op cit.) are very likely to be found in the drier habitats of Mkomazi. Although our MERP collections are now extensive, none of these records are indicated below.

FERNS AND FERN ALLIES

Adiantaceae
Adiantum incisum
Dryopteris concolor
Pellaea adiantoides
P. doniana ✓
P. viridis

Aspleniaceae
Ceterach cordatum
Asplenium rutifolium ✓

Equisetaceae
Equisetum ramosissimum

Marsileaceae
Marsilea diffusa
M. minuta

Pteridaceae
Actiniopteris dimorpha ✓
A. radiata
A. semiflabellata

Selaginellaceae
Selaginella dregei ✓

DICOTYLEDONS

Acanthaceae
Adhatoda schimperana ✓
Anisotes parvifolius
Asystasia charmian
A. gangetica ✓
A. schimperi ✓
A. somalensis
Asystasia sp.
* *Barleria diffusa* ✓
B. eranthemoides ✓
* *B. ramulosa* ✓
B. submollis
B. taitensis ✓
* *Barleria* sp.
** *Blepharis integrifolia* ✓
B. linariifolia ✓
B. maderaspatensis ✓
B. fruticulosa
B. sp.
Crabbea velutina ✓
* *Crossandra mucronata* ✓
C. stenostachya
C. subaucaulis
Dicliptera mossambicensis
Dousperma kilimandscharica ✓
D. sp.
** *Dyschoriste hildebrandtii* ✓
D. perrotteii
Ecbolium amplexicaule
E. hamatum
E. revolutum
E. subcordatum
Hypoestes hildebrandtii ✓
Justicia betonica ✓
J. fischeri
* *J. flava* ✓
* *J. glabra* ✓
J. heterocarpa ✓
J. matammensis ✓
J. sansibarensis
J. striata
J. uncinulata
J. whytei
J. sp.
Lepidagathis scariosa
Monechma debile ✓
Monechma sp. ?
Neuracanthus ukambensis ✓
Neuracanthus sp.
Peristrophe bicalyculata
** *Pseuderanthemum hildebrandtii* ✓
Rhinacanthus nasutus
Ruellia amabilis ✓
R. patula ✓
Ruttya fruticosa ✓
Thunbergia alata
** *T. affinis* ✓
T. holstii ✓
T. guerkeana ✓
Thunbergia sp.

Aizoaceae (Ficoidaceae)
Corbichonia decumbens
* *Gisekia pharnaceoides* ✓
Glinus setiflorus ✓
Hypertelis bowkerana
Limeum viscosum var. *kenyense* ✓
Mollugo cerviana var. *spathulifolia* ? ✓
M. nudicaulis
Trianthema ceratosepala
T. portulacastrum
Zaleya pentandra ✓

Amaranthaceae
Achyranthes aspera ✓
* *Achyranthes* sp.
* *Aerva lanata var. elegans* ✓
** *A. persica* ✓
Alternanthera pungens
** *A. sessilis* ✓
Amaranthus aschersonianus
A. graecizans ? ✓
Celosia acroprosoides
C. trigyna
* *Centemopsis rubra* ✓
** *Cyathula erinaceae* ✓
** *Digera muricata* ✓
Gomphrena celosioides ✓
Pleuropterantha ?
Psilotrichum boivinianum
P. scleranthum
* *Pupalia lappacea* ✓
** *Sericocomopsis grisea*
S. hildebrandtii ✓
** *S. pallida* ✓

Anacardiaceae
* *Lannea alata* ✓
* *L. (stuhlmannii) =schweinfurthii* ✓
L. triphylla ✓
Lannea sp.

Apocynaceae
Acokanthera sp.?
* *Adenium obesum* ✓
Carissa edulis ✓
[Catharanthus roseus] ✓
Holarrhena (febrifuga) =pubescense
Strophanthus mirabilis ✓
Taberaemontana sp.? ✓

Asclepiadaceae
Baseonema gregorii
Calotropis procera ✓
Caralluma priogonium
C. russelliana
C. speciosa ✓
C. turneri
Cynanchum defoliascens
C. hastifolium
C. omissum
C. tetrapterum
C. validum
Diplostigma canescens
Dregea stelostigma
D. sp. ?
Echidnopsis dammanniana
Edithcolea grandis
Glossonema revoilii
Kanahia laniflora ✓
Oxystelma bornuense
Pergularia daemis ✓
Sacleuxia newii
Sarcostemma viminale ✓
S. sp. ?
Schlechterella africana
Secamone punctulata var. *stenophylla*
S. sp. ? ✓
Stathmostelma pedunculatum

Balanitaceae
Balanites orbicularis (=rotundifolia) ✓
* *B. glabra* ✓
B. pedicellaris ? ✓

Bignoniaceae
Kigelia africana ✓

Bombacaceae
* *Adansonia digitata* ✓

Boraginaceae
Bourreria teitensis
Coldenia procumbens
Cordia (gharaf) quercifolia/sinensis ✓
* *C. ovalis*
Cordia sp
** *Ehretia amoena* ✓
E. cymosa ✓
* *E. teitensis*
Heliotropium albohispidum
** *H. eduardii*
H. indicum ✓
H. ? marifolium ✓
H. ovalifolium ✓
H. steudneri ✓
H. strigosum ✓
H. subulatum
H. supinum
H. sp. ✓
Trichodesma zeylanica ✓

Burseraceae
Boswellia hildebrandtii ✓
Commiphora africana ✓
C. (boiviniana) edulis ✓
** *C. caerulea (=holtziana)* ✓
* *C. campestris(=scheffleri)*✓
C. mildbraedii (=riparia) ✓
** *C. schimperi (=trothae)* ✓
** *Commiphora mollis*
C. habessinica
C. merkeri
* *C.* sp.
C. sp.

Cactaceae
Rhipsalis sp.

Caesalpiniaceae
** *Afzelia cuanzensis* ✓
Bauhinia taitensis ✓
B. tomentosa ✓
Caesalpinia trothae ssp. *erlangeri* ✓
C. trothae ssp. *trothae*
* *Cassia abbreviata* ssp. *kaessneri* ✓
C. absus ✓
C. bicapsularis
C. fallacina ✓
* *C. longiracemosa*
C. occidentalis ✓
* *C. mimosoides* ✓
** *C. singueana* ✓
* *Delonix elata* ✓
* *Tamarindus indica* ✓
* *Tylosema fassoglensis* ✓

Capparidaceae
** *Boscia angustifolia* ✓
B. coriacea ✓
** *B. salicifolia* ✓
* *Cadaba farinosa* spp. *adenotricha (=farinosa)* ✓
C. glandulosa
C. heterotricha ✓
C. stenopoda ✓
* *Cadaba* sp.
Capparis sepiaria ✓
* *C. tomentosa* ✓
Cleome briquetii
C. hirta ✓
C. macrophylla ✓
** *C. stenopetala*
C. tenella ✓
Gynandropsis gynandra ✓
Maerua angolensis ✓
M. crassifolia ✓
M. denhardtiorum
M. edulis (=decumbens) ✓
** *M. grantii* ✓
M. holstii ✓
* *M. kirkii* ✓
M. macrantha
M.subcordata (=decumbens) ✓
M. triphylla ✓
** *Thylachium africanum* ✓
T. thomasii

Celastraceae
Cassine aquifolium
Catha edulis
Hippocratea africana ✓
Maytenus senegalensis ✓

Chenopodiaceae
Chenopodium ambrosioides ✓
Suaeda monoica ✓

Combretaceae
* *Combretum aculeatum* ✓
C. exalatum ✓
* *C. molle* ✓
C. ukambensis (=mossambicense)
C. sp.
* *C.* sp.
* *Terminalia kilimandscaharica* ✓
T. orbicularis
T. parvula ✓
* *T. prunioides* ✓
* *T. spinosa* ✓

Compositae
Acanthospermum hispidum
* *Aspilia mossambicensis* ✓
Athroisma psyllioides ✓
Bidens incumbens ✓
B. sp. ? ✓
B. sp. ? ✓
Blepharispermum (fruticosum) lanceolatum
B. guebaricum ✓
Blumea aurita ✓
** *Brachylaena (hutchinsii) huillensis* ✓
Conyza aegyptiaca ✓
Dicoma tomentosa
Eclipta prostrata ✓
Erlangea boranensis
E. marginata
Erythrocephalum longifolium ✓
Galinsoga parviflora ✓
Geigeria acaulis
Grangea maderaspatana
Gutenbergia polycephala ✓
** *Haarera alternifolia*
* *Helichrysum glumaceum* ✓
Hirpicium diffusum
Kleinia kleinoides ✓
** *Lactuca capensis* ✓
Launaea cornuta ✓
L. intybacea
* *Microglossa oblongifolia*
Notonia sp. ? ✓
Osteospermum vaillantii ✓
Pegolettia senegalensis
Pluchea dioscoridis ✓
P. ovalis ✓
P. sordida ✓
Sclerocarpus africanus
Senecio discifolius ✓
S. stuhlmannii ✓
Sphaeranthus napierae
S. ukambensis
Spilanthes mauritiana ✓
Tridax procumbens ✓
Vernonia aemulans
V. cinerascens
V. cinerea
V. colorata
V. hildebrandtii
V. pauciflora
V. wakefieldii

Convolvulaceae
* *Astripomoea hyoscyamoidea* ✓
Convolvulus rhyniospermus
Evolvulus alsinoides ✓
Hildebrandtia sepalosa ✓
Ipomoea arachnosperma
I. bullata
I. cairica ✓
I. cicatricosa
I. eriocarpa ✓
I. garckeana ✓
I. hartmannii
I. hildebrandtii ✓
I. irwinae
I. kituiensis ✓
I. longituba ✓
I. obscura
I. ochracea
I. oenotherae
I. mombassana ✓
* *I. pes-tigridis* var. *pes-tigridis*
I. sinensis ssp. *blepharosepala*
I. transvaalensis ssp. *orientalis*
** *I. wightii*
I. sp
Jacquemontia tamnifolia ✓
Merremia ampelophylla
M. pinnata ✓
M. tridentata ssp. *angustifolia*
Seddera hirsuta var. *gracilis*
Stictocardia incomta
Turbina stenosiphon

Crassulaceae
Kalanchoe crenata ✓
K. lancolata ✓
K. lateritia var lateritia ✓

Cruciferae
Farsetia longisiliqua ? ✓
Rorippa madagascariensis ✓

Cucurbitaceae
Cephalopentandra ecirrhosa
Citrullus lanatus ✓
Coccinia grandis ✓
C. microphylla
C. trilobata ✓
Corallocarpus epigaeus ?
C. schimperi ?
Cucumella engleri ✓
Cucumis aculeatus ✓
C. dipsaceus ✓
C. figarei
C. prophetarum ssp. *dissectus*
C. sativus
Cyclantheropsis parviflora
Gerrardanthus lobatus ✓
Kedrostis foetidissima
K. gijef
K. hirtella ✓
K. leloja
K. pseudogijef
Lagenaria sphaerica ✓
Momordica rostrata
M. trifoliolata ✓
M. spinosa ✓
Peponium vogelii ✓
Trochomeria sp. ?
Zehneria pallidinervia
Zehneria sp.

Ebenaceae
Diospyros consolatae
D. cornii
D. sp. (+2?)

Euphorbiaceae
* *Acalypha ciliata* ✓
* *A. fruticosa* ✓
A. indica ✓

Bridelia taitensis
Cephalocroton nudus
Croton confertus
* *C. dichogamus* ✓
Dalechampia scandens ✓
D. scandens var. *cordafana*
D. trifoliata ✓
Erythrococca atrovirens ✓
Euclea divinorum ✓
Euphorbia acalyphoides ✓
E. agowensis var. *pseudoholstii* ✓
E. cryptospinosa
E. cuneata ✓
E. cuneata var. nov
E. engleri ✓
E. espinosa
E. gossypina var. *gossypina* ✓
E. grandicornis
E. heterochroma ✓
E. hirta ✓
E. jatrophoides
E. kibwezensis (=bussei) ✓
E. ndurumensis
E. nyikae ✓
E. polyantha ✓
E. quinquecostata
E. robecchii
E. scheffleri
E. schinzii
E. spinescens
** *E. systyloides(=crotonoides)*
E. tirucallii
Euphorbia sp.
E. uhligiana ✓
E. sp.
Excoecaria madagascariensis
E. venifera
Givotia gosai
Jatropha dichtar ✓
J. parvifolia
J. spicata
J. stuhlmannii
J. sp
Monadenium invenustum
** *Phyllanthus amarus*
* *P. maderaspatensis* ✓
P. niruri ✓
P. somalensis
P. sp.
** *[Ricinus communis]*
Securinega virescens ✓
Spirostachys africana ✓
Synadenium (? molle) ✓
Tragia arabica
T. brevipes
T. hildebrantii ✓
T. subsessilis
T. sp.

Flacourtiaceae
Trimeria grandifolia ssp tropica ✓

Gentianaceae
Enicostema hyssopifolia

Geraniaceae
Monsonia senegalensis ✓

Guttiferae
Garcinia livingstonei ✓

Hernandiaceae
Gyrocarpus americanus

Hydnoraceae
Hydnora abyssinica ✓
H. bogosensis

Icacinaceae
Apodytes dimidiata ✓
* *Pyrenacantha malvifolia* ✓

Labiatae
** *Acolanthus repens* ✓
* *Basilicum polystachion* ✓
Becium sp. ✓
Capitanya otostegioides
Coleus ambionicus
C. ignarius
C. tenuiflorus ✓
C. teitensis
C. sp.
Endostemon tenuiflorus
E. tereticaulis
Erythrochlamys spectabilis
* *Hemizygia fischeri*
* *Hoslundia opposita* ✓
Iboza multiflora ✓
Leonotis nepetifolia ✓
** *Leucas glabrata* ✓
L. neuflizeana
L.nubica
L. oligocephala
L. pratensis ✓
Lencas sp.
Ocimum basilicum ✓
O. hadiense
O. sp.
** *Orthosiphon parvifolius* ✓
O. sp.
Plectranthus barbatus
P. cylindraceus
P. longipes
P. prostratus
* *Pycnostachys umbrosa* ✓
Tinnea aethiopica

Lobeliaceae
Lobelia anceps var. anceps
L. holstii

Loganiaceae
Buddleia polystachya ✓
Strychnos decussata ✓
S. madagascariensis ✓
* *Strychnos henningsii*

Loranthaceae
Amyena panganensis
Erianthemum occulatum
Helixanthera kirkii
Loranthus triplinervius
L. schimperi var. *schimperi*
Oliverella hildebrandtii
Plicosepalus curviflorus
P. sagittifolius
Tapinanthus sansibarensis
Tapinanthus sp.

Lythraceae
Ammannia auriculata ✓
Lawsonia inermis ✓

Malpighiaceae
* *Acridocarpus zanzibaricus*
Caucanthus albidus ✓
C. auriculatus
Triaspis erlangeri ✓
T. niedenzuiana

Malvaceae
Abutilon fruticosum ✓
A. grandiflorum
** *A. guineense* ✓
A.hirtum ✓
A. mauritianum ✓
Hibiscus aponeurus
H. calyphyllus
H. cannabinus ✓
H. greenwayi ✓
* *H. micranthus* ✓
H. palmatus ✓
H. susattensis ✓
* *H. vitifolius* ✓
Pavonia arabica ✓
P. elegans ✓
P. grewioides
P. patens ✓
Pavonia urens ✓
P. zeylanica ✓
P. zeylanica var. *microphylla*
** *Sida cordifolia* ✓
S. ovata ✓
S. rhombifolia ✓
Thespesia danis

Meliaceae
** *Melia volkensii* ✓
Trichilia emetica (=roka)
* *T.* sp. ?

Menispermaceae
Tiliacora sp. or *Tricalisia* sp. ✓

Mimosaceae
** *Acacia ancistroclada* ✓
* *A. brevispica* ✓
* *A. bussei* ✓
A. clavigera ssp. *usambarensis*
* *A. etbaica* sp. *platycarpa* ✓
A. horrida ssp. *benadirensis* ✓
* *A. mellifera* ssp. *mellifera* ✓
A. nilotica ssp. *subalata* ✓
A. polyacantha spp. *campylacantha* ✓
A. rovumae
** *A. senegal* var *senegal*
** *A. seyal* var *fistual* ✓
* *A. stuhlmannii* ✓
A. reficiens ssp. *misera* ✓
A. thomasii ✓
* *A. tortilis* ssp. *spirocarpa* ✓
** *A. zanzibarica*
* *Acacia* sp.
* *Albizia anthelmintica* ✓
** *A. harveyi* ✓
A. glaberrima
** *A. petersiana*
A. zimmermannii ✓
* *Albizia* sp.
* *Dichrostachys cinerea* ssp. *africana* ✓
Entada leptostachya ✓
Neptunia oleracea
Newtonia buchananii ✓
* *N. hildebrandtii* var. *hildebrandtii*

Moraceae
Dorstenia ? crispa
Ficus ingens ✓
F. mucuso
F. populifolia
** *F. pretoriae*
F. sonderi
F. sycomorus ✓
* *Ficus thonningii*

Moringaceae
Moringa sp.

Nyctaginaceae
Boerhavia coccinea ✓
B. diffusa ✓
B. erecta ✓
B. repens ✓
Commicarpus pedunculosus
C. plumbagineus
C. stellatus

Nymphaeaceae
Nymphaea capensis ✓

Ochnaceae
Ochna inermis ✓
O. ovata ✓

Olacaceae
Ximenia americana ✓

Oleaceae
Jasminum grahamii
J. (parvifolium) =streptopus
J. fluminense ✓

Onagraceae
Ludwigia pubescens ssp. *brevisepala* ✓
L. stolonifera

Papaveraceae
Argemone mexicana ✓

Papilionaceae

* *Abrus schimperi* ssp. *africana* ✓
Aeschynomene indica ✓
Alysicarpus sp. ✓
Clitoria ternatea ✓
* *Craibia brevicaudata* var. *brevicaudata* ✓
C. glauca ✓
C. laburnifolia ✓
C. laburnifolia ssp. *tenuicarpa*
C. patula
C. polysperma
C. scassellatii
C. tsavoana
C. zimmermannii
C. ukambensis
* *Crotalaria* sp.
* *Dalbergia melanoxylon* ✓
Dolichos uniflorus var. *stenocarpa* ✓
Erythrina burttii ✓
E. melanacantha ✓
* *Erythrina* sp.
Indigofera arrecta
I. costata ssp. *goniodes*
I. hirsuta var. *hirsuta* ✓
I. hochstetteri
I. malindiensis
I. schimperi var. *schimperi*
* *I. schimperi* var. *baukeana*
I. sesilis
* *I. spinosa* ✓
I.tanganyikensis f. formapaucijuga
I. trita var. *subulata*
I. vohemarensis
I. volkensii ✓
Indigofera sp
I. microcharoides var. *latestipulata*
** *I. zenkeri*
* *Indigofera* sp.
* *Lonchocarpus eriocalyx* ✓
* *Lonchocarpus* sp.
Neorautenenia mitis
** *N. pseudopachyrhiza*
Ormocarpum kirkii ✓
O. (mimosoides) =trachycarpum
Ophrestia hedysaroides
** *Ostryoderris stuhlmanni* ✓
* *Platycelyphium voense* ✓
Rhynchosia minima ✓
R. pulchra
R. sennarensis ✓
R. sublobata
R. velutina ✓
Sesbania quadrata ✓
* *S. sericea*
S. sesban var. *nubica* ✓
Spathionema kilimandscharicum ✓
Stylosanthes fruticosa ✓
Tephrosia lortii ✓
T. ? interrupta
T. nociflora ✓
T. pentaphylla ✓
* *T. pumila* var. *pumila* ✓
T. purpurea var. *pubescens*
T. subtriflora ✓
T. uniflora ✓
* *T. villosa* ssp. *ehrenbergiana* ✓
Vatovaea pseudolablab ✓
Vigna membranacea ssp. *caesia* ✓
** *V. fragrans*
V. kirkii ✓
V. praecox ✓
** *V. reticulata*
V. unguiculata ssp. *cylindrica* ✓
Zornia glochidiata ✓

Passifloraceae
* *Adenia globosa* ✓
A. gummifera ✓
A. keramanthus
A. scheffleri
Adenia sp. (*=venenata?*)
Tryphostemma hanningtonianum
T. lanceolatum
Tryphostemma sp.

Pedaliaceae
Josephinia africana ? ✓
Pedalium murex ✓
Pterodiscus ruspolii
Sesamothamnus busseanus
S. rivae ? ✓

Piperaceae
Peperomia arabica ✓

Plumbaginaceae
Plumbago zeylanica ✓

Polygalaceae
Polygala erioptera
P. kilimandscharica
P. liniflora
P. petitiana
P. sphenoptera
Polygala sp.

Polygonaceae
Oxygonum atriplicifolium
** *O. sinuatum* ✓
O. stuhlmannii ✓
Polygonum senegalensis ✓

Portulacaceae
Calyptrotheca somalensis
** *C. taitensis*
Portulaca oleracea ✓
P. pilosa ✓
P. quadrifida
P. sp.
* *Talinum caffrum* ✓
T. portulacifolium ✓

Ranunculaceae
Clematis simensis var. *dentata* ✓

Rhamnaceae
Berchemia discolor ✓
Helinus integrifolius ✓
* *Ziziphus mucronata* ✓

Rhizophoraceae
** *Cassipourea malosana*
Cassipourea ? celastroides

Rubiaceae
Borreria scabra
Dirichletia glaucescens
Gardenia(jovis-tonantis) lernifolia ✓
* *Gardenia* volkensii ✓
Hymenodictyon parvifolium ✓
Kohautia caespitosa var. *amaniensis* ✓
Meyna tetraphylla ✓
Oldenlandia herbacea var. *holstii* ✓
O. somala
O. wiedermannii
Paederia pospischilii
* *Pentanisia auranogyne* ✓
Pentas bussei
* *P. parvifolia* ✓
Pentodon pentander var. *minor*
* *Psychotria kirkii* ✓
Psychotria sp.
Rochmannia fischeri ✓
* *Rytigynia* sp.
R. loranthifolia
Tarenna graveolens
Tricalysia ovalifolia
Xeromphis keniensis

Rutaceae
** *Calodendrum capense* ✓
Vepris eugeniifolia ✓
** *V. uguenensis*
Vepris sp.
Zanthoxylum chalybeum var. chalybeum ✓
* *Zanthoxylum* sp.

Salvadoraceae
Azima tetracantha ✓
Dobera glabra ✓
** *D. loranthifolia*
* *Salvadora persica* ✓

Sapindaceae
Allophylus rubifolius
Aphania senegalensis
Cardiospermum corindum✓
C. halicacabum
Deinbollia borbonica ✓
Dodonaea angustifolia
* *Haplocoelum foliolosum* ✓
Lecaniodiscus fraxinifolius

Sapotaceae
Manilkara mochisia ✓
M. sulcata?
Mimusops (schliebenii) =somaliensis
M. sp.

Scrophulariaceae
Alectra vogelii ✓
Craterostigma sp. ✓
Buttonia hildebrantii
Harveya obtusifolia ✓
Illysanthes pusilla
Pseudosopubia sp. ✓
Rhamphicarpa veronicifolia ✓
Stemodiopsis buchananii
S. humilis
** *Striga asiatica* ✓
S. gesnerioides
** *S. latericea* ✓

Simaroubaceae
Harrisonia abyssinica
Kirkia tenuifolia

Solanaceae
[Capsicum frutescens]
Datura metel ✓
Lyctum europaeum
Solanum dubium ✓
S. hastifolium ✓
S. incanum ✓
S. nigrum ✓
S. renschii ✓
S. somalense var. *planifrons*
* *S. taitense* ✓
Withania somnifera ✓

Sterculiaceae
Dombeya (praetermissa) =taylorii
D. umbraculifera (=kirkii)
* *Hermannia exappendiculata* ✓
H. fischeri ✓
H. glanduligera
* *H. oliveri* ✓
* *H. uhligii* ✓
** *Melhania ferruginea* ✓
M. ovata ✓
M. parviflora (=taylorii)
M. velutina ✓
* *Sterculia africana* ✓
** *S. appendiculata* ✓
S. rhynchocarpa (=africana) ✓
S. stenocarpa (=africana)
Waltheria indica ✓

Thymelaeceae
Gnidia latifolius ✓

Tiliaceae
Corchorus baldaccii
C. olitorius ✓
* *C. trilocularis* ✓
C. sp.
* *Grewia bicolor* ✓
G. densa ✓

G. ectasicarpa ✓
* *G. fallax* ✓
G. forbesii ✓
G. glandulosa ✓
G. holstii ✓
G. lilaciina ✓
G. micrantha ✓
G. mollis ✓
G. nematopus ✓
* *G. tembensis var. kakothamnos* ✓
* *G. tenax* ✓
G. trichocarpa ✓
G. tristis ✓
G. truncata ✓
G. vaughanii ✓
* *G. villosa* ✓

Triumfetta flavescens

Turneraceae
Wormskioldia sp. ✓

Umbelliferae
Berula erecta ✓
Steganotaenia araliacea ✓

Verbenaceae
Chascanum hildebrandtii
Clerodendrum eriophyllum ✓
** *C. hildebrandtii* ✓
C. makanjanum
Cyclocheilon eriantherum
[Lantana camara] ✓
Lantana sp.
* *L. rhodesiensis*
Lippia kambensis ✓
Phyla nodiflora
Premna hildebrandtii
** *P. oligotricha*
* *P. resinosa* ✓
* *P.* sp.
Priva cordifolia var. *abyssinica* ✓
Svensonia laeta
Vitex domiana
V. payos
* *V. strickeri*

Violaceae
Hybanthus danguyanus
H. enneaspermus var. enneaspermus
Rinorea elliptica ✓

Vitaceae (Ampelidaceae)
Ampelocissus africana ✓
Cissus aphyllantha ✓
C. cactiformis
C. quadrangularis ✓
C. rotundifolia ✓
Cyphostemma adenocaule ✓
Cyphostemma sp. (+4 spp.?)

Zygophyllaceae
Tribulus cistoides ✓
** *T. terrestris* ✓

MONOCOTYLEDON

Agavaceae
Sansevieria arborescens
S. caulescens
S. ehrenbergiana ✓
S. intermedia ✓
S. powellii
S. singularis
Sansevieria sp.

Amaryllidaceae
Ammocharis tinneana
Crinum kirkii ✓
Crinum sp.
Cryptostephanus haemanthoides
Haemanthus multiflorus ✓
Pancratium trianthum

Araceae
Amorphophallus gallaensis
A. gregoryana ? ✓
Stylochiton angustifolius
S. salaamicus

Commelinaceae
** *Aneilema aequinoctiale* ✓
A. hockii ✓
A. johnstonii
A. petersii ✓
A. rendlei ✓
A. sp.
Anthericopsis sepalosa ✓
Ballya zebrina
Commelina albescens
C. benghalensis ✓
C. erecta ssp. *livingstonii* ✓
C. forskalei
C. imberbis
C. latifolia ✓
C. ? petersii
C.subulata
* *Commelina* sp.

Cyperaceae
Bulbostylis sp. ✓
Coelochloa setifera
** *Cyperus alopecuroides*
C.alternifolius ssp. *flabelliformis* ✓
C. articulatus
C. compressus
** *C. bulbous*
* *C. distans* ✓
** *C. exaltatus* ✓
C. giolii
C. grandibulbosus
C. immensus var. *taylori*
C. kaessneri
C. laevigatus ✓
C. longus ssp. *tenuiflorus*
C. maculatus
* *C. obtusiflorus*
Fimbristylis bisumbellata
F. exilis
Kyllinga alba
** *K. oblonga*
K. triceps var. *obtusiflora*
Lipocarpha chinensis
Mariscus aristatus
** *M. circumclusus*
* *M. leptophyllus*
M. mollipes
M. obsoletenervosus
** *M. pseudovestitus*
* *M.taylori var. taylori*
Mariscus sp

Gramineae
Arachne racemosa
* *Andropogon schinzii*
* *Aristida adscensionis*
A. barbicollis
A. coerulescens
A. lommelii
A. mutabilis
A. stenostachys
* *Bothriochloa radicans*
** *B. glabra* ✓
* *Brachiaria deflexa* ✓
** *B. eruciformis*
* *B. lachnantha*
B. leersioides
* *B. leucacrantha*
B. nigropedata
* *B. serrifolia*
Brachiaria sp.
* *Cenchrus ciliaris* ✓
C. setigerus
Chloris barbata
C. gayana ✓
** *C. mossambicensis*
* *C. roxburghiana* ✓
** *C. virgata* ✓
Chrysopogon aucheri var. *quinqueplumis*
Coix lacryma-jobi
** *Cymbopogon afronardus* ✓
C. pospischilii
** *Cymbosetaria sagittifolia*
* *Cynodon dactylon* ✓
** *C. plectostachyus*
* *Dactyloctenium aegyptium* ✓
D. giganteum
D. scindicum
D. sp.
** *Dichanthium pappilosum* ✓
Digitaria aridicola
D. milanjiana ✓
** *D. macroblephara*
** *D. mombasana* ✓
** *D. setivalva*
** *D. remotigluma*
** *D. retroflexa*
* *D. rivae*
D. pennata ✓
Diplachne caudata
D. velutina
* *Echinochloa haploclada*
Eleusine indica ✓
* *Enneapogon cenchroides* ✓
** *E. elegans*
** *E.* sp.
* *Enteropogon macrostachys*
E. rupestris
Eragrostiella bifaria
* *Eragrostis aethiopica*
E. aspera ✓
* *E. caespitosa*
E. cilianensis
E. ciliaris ✓
E. ciliaris var. *brachystachya*
E. exasperata
E. horizontalis
* *E. superba*
** *E. rigidior*
** *Eriochloa meyeriana* ? ✓
* *E. nubica*
Eulalia sp.
E. ferruginea
* *Eustachys paspaloides*
Harpachne racemosa
Hemarthria natans
** *Heterocarpa haareri*
* *Heteropogon contortus* ✓
Holcolemma canaliculatus
Hyparrhenia filipendula var. *pilosa* ✓
* *Ischaemum afrum* ✓
* *Latipes senegalensis*
Leersia hexandra
* *Leptocarydion vulpiastrum*
* *Leptochloa obtusiflora*
L. ? panicea
** *Lintonia nutans*
Oropetium thomaeum
Oropetium sp.

** *Microchloa kunthii*
Panicum chusqueoides
** *P. coloratum* ✓
* *P. deustum*
P. heterostachyum ✓
* *P. infestum*
* *P. maximum* ✓
P. meyerianum
P. repens
* *Panicum* sp.
Paspalidium geminatum
Paspalum vaginatum ✓
Pennisetum massaicum ✓
* *P. mezianum* ✓
Perotis patens
Phragmites karka
P. mauritianus ✓
* *Rhynchelytrum repens* ✓
** *R. setifolium*
* *R. villosum*
* *Rottboellia exaltata*
* *Schmidtia bulbosa*
* *Schoenefeldia transiens*
** *Setaria homonyma* ? ✓
S. incrassata
S. pallidefusca
** *S. sphaeelata* ? ✓
** *S. versicolor* ? ✓
Sorghum brevicarinatrum var. *swahelorum*
* *S. verticilliflorum*

** *Sporobolus consimilis*
* *S. festivus* ✓
** *S. filipes* ✓
** *S. fimbriatus*
S. helvolus
S. gemiratus
S.pellucidus ✓
** *S. pyramidalis* ✓
S. spicatus ✓
S. virginicus
Stipagrostis hirtigluma
S. uniplumis
Tetrachaete elionuroides
* *Tetrapogon bidentatus*
T. cenchriformis
* *T. tenellus* ✓
** *Themeda triandra* ✓
* *Tragus berteronianus* ✓
Tricholaena eichingeri
** *Tripogon abyssinicus*
** *Urochloa mosambicensis* ✓
** *U. sclerochiaena*
** *Urochloa* sp.

Hydrocharitaceae
Lagarosiphon tenuis

Iridaceae
Acidanthera candida

Liliaceae
Albuca wakefieldii
Aloe deserti
A. lateritia
A. ruspoliana ✓
A. secundiflora ✓
* *Aloe* sp.
Anthericum brehmerianum
A. suffruticosum ✓
A. sp
** *A. moniliforma* ✓
* *Asparagus asiaticus*
A. falcatus
A. ? *nudicaulis*
** *A. racemosa* ✓
Chlorophytum gallabatense ✓
C. tenuifolium ✓
C. tuberosum
C. viridescens
Dasystachys debilis ✓
Dipcadi viride ✓
Drimiopsis sp. ✓
Gloriosa abyssinica var *graminifolia*
* *G. simplex* ✓
* *Ornithogalum donaldsonii*
** *Ornithogalum* sp.
Scilla kirkii
U. indica
U. sp.

Najadaceae
Najas graminea

Orchidaceae
Aerangis ? *kotschyana*
Angraecopsis sp.
Eulophia orthoplectra
E. petersii
E. wakefieldii
Habenaria ndiana
Microcoelia sp. ✓
Oberonia disticha ✓
Polystachya spp. ✓
Rangaeris sp. ?

Palmae
Hyphaene coriacea ✓

Typhaceae
Typha domingensis ✓

Velloziaceae
* *Xerophyta aequatorialis* ✓
** *X. spekei* ✓

Zingiberiaceae
Kaempferia aethiopica
Siphonochilus aethiopicus

REFERENCES

Greenway, P.J. 1969. A Check-list of plants recorded in Tsavo National Park East. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **27(3)**:169-209.

Harris, L.D. 1972. **An ecological description of a semi-arid East African ecosystem.** Range Sci. Dept. Sci. Ser. **11.** 89pp.

Kabuye, H.S., Mungai, G.M. & Mutangah, J.G. 1986. Flora of the Kora National Reserve. **In Kora: An ecological inventory study of the Kora National Reserve, Kenya.** (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. 57-114pp.

FAUNA

ARTHROPODS

Our knowledge of the arthropods in the Mkomazi region is very incomplete, although there is an extensive (mainly taxonomic) literature on many groups, and especially on the insects. The following tentative species lists are based upon research conducted in the Tsavo National Park by Kingston (1976) on dung beetles, and Buxton (1976) on termites. Additional information is based upon lists prepared for the Kora Research Project's studies in Kenya 1982-95 (Duff-MacKay 1983, Ritchie and Clifton 1983), which have, where possible been brought up to date. The original lists were scored for definite, probable and possible species, but these annotations are here excluded.

SCORPIONS

(After Duff MacKay 1983)

Buthidae
Babycurus sp.
Buthotus trilineatus
Isometrus maculatus
Lychas burdoi
Parabuthus liosoma
P. liosoma
Uroplectes fischeri

Scorpionidae

Scorpioninae
Pandinus cavimanus.
P.gregoryi

Ischnurinae
Iomachus politus

ARACHNIDA (SPIDERS)

(Dr A. Russell-Smith)

Note: Most of the major groups of spiders listed here are currently being studied by specialists in those families. This list should not be quoted in publications and is for internal use by the Mkomazi Research Project only.

Cyrtauchenidae
Ancylotrypa spp.

Idiopidae
Ctenolophus sp.
Idiops spp.

Dipluridae
Thelechoris karschii

Nemesiidae
Nemesiidae indet

Barychelidae
Cyphonisia sp.

Theraphosidae
Harpactira sp.
Pisenor sp.
Pterinochilus sp.
Theraphosidae spp.

Scytodidae
Scytodes spp.

Caponiidae
Caponia natalensis

Pholcidae
Smeringopus cf pallidus
Pholcidae spp.

Ochyroceratidae
Ochyroceratidae sp.

Dysderidae
Ariadna spp.

Oonopidae
Oonopidae spp.

Palpimanidae
Palpimanidae spp.

Mimetidae
Mimetidae sp.

Hersiliidae
Hersilia sp.

Uloboridae
Uloborus sp.

Theridiidae
Dipoena sp.
Enoplognatha sp.
Episinus sp.
Euryopis spp.
Latrodectus rhodesiensis
L. geometricus
Steatoda spp.
Theridion spp.
Theridiidae spp.

Theridiosomatidae
Theridiosomatidae

Linyphiidae
Callitrichia sp.
Ceratinopsis sp.
Meioneta prosectes
Metaleptyphantes ovatus
M. perexiguus
Nereine sp.

Tetragnathidae
Leucauge spp.

Araneidae
Araneus sp.
Argiope cf trifasciata
Caerostris sp.
Chorizopella sp.
Cyrtophora citricola
Drexelia sp.
Gasteracantha sanguinolenta
Gea sp.
Hyposinga spp.
Isoxya stuhlmanni
Neoscona sp.
Singa sp.
Araneidae spp.

Lycosidae
Hippasa spp.
Lycosa spp.
Pardosa spp.
Zenonina sp.
Lycosinae indet spp.

Pisauridae
Eupresthenops sp.
Maypacius sp.
Tetragonophthalma sp.

Agelenidae
Agelenidae sp.

Dictynidae
Dictyna sp.

Amaurobidae
Amaurobidae indet

Oxyopidae
Oxyopidae spp.

Clubionidae
Castaneriinae spp.
Cheiracanthium spp.
Clubiona sp.
Graptartia sp.
Clubionidae spp.

Zodariidae
Akyttara akagera
Chariobas sp.
Diores initialis
D. nr. strandi
D. nr. murphyorum
Dusmadiores sp.
Mallinella sp.
Palfuria sp.
Ranops spp.
Systenoplacis spp.
Zodariidae indet.

Gnaphosidae
Aphantaulax sp.
Asemesthes spp.
"Camillina" sp.
Echeminae spp.
Gnaphosa sp.
Haplodrassus sp.

Micaria sp.
Prodidomus sp.
Zelotes spp.
Gnaphosidae spp.

Ctenidae
Ctenidae spp.

Selenopidae
Selenops sp.

Heteropodidae
Heteropodidae spp.
Olios sp.

Philodromidae
Philodromus sp.
Tibellus sp.

Thomisidae
Monaeses spp.
Ozyptila sp.
Parasmodix sp.
Runcinia flavida
Simorcus sp.
Synaema sp.
Thomisus spp.
Thomisops spp.
Tmarus sp.
Thomisidae spp.

Salticidae
Aelurillus spp.
Enoplomischus sp.
Euophrys sp.
Habrocestum spp.
Hyllus spp.
Myrmarachne sp.
Natta horizontalis
Paramodunda thyenoides
Stenaelurillus spp.
Salticid spp.

INSECTS

(After Ritchie & Clifton 1983)

ORTHOPTERA: ACRIDIDAE (GRASSHOPPERS)

Eumastacidae

Thericleinae
Plagiotriptus hippiscus
Thericles degodea

Euschimidtinae
Auschmidtia tanaensis

Pamphagidae
Xiphoceriana atrox

Pyrogomorphidae
Chrotogonus senegalensis sudanicus
C. tuberculatus
Dictyophorus griseus
Phymateus aegrotus
P. morbillosus
Pyrgomorpha conica/cognata/bispinosa group

Acrididae

Tratodinae
Acrostegastes sp.
Family uncertain?
Merehana gharrei

Tropidopolinae
Afroxyrrhepes procera
Hemiacridinae
Xenipella sp.

Oxyinae
Oxya hyla

Calliptaminae
Acorypha ornatipes

Catantopinae
Abisares depressus
Brachycatantops emalicus
Catantops momboensis
Ischansis curvicerca
Ixalidus sp.
Phaeocatantops decoratus
Sauracris striolata

Cyrtacanthacridinae
Anacridium wernerellum
Cyrtacanthacris tatarica
Orthacanthacris humilicurus
Schistocerca gregaria

Eyprepocnemidinae
Cataploipus cognatus
C. tanaensis
Heteracris coerulescens
Taramassus spp.

Euryphyminae
Phymeurus bigranosus

Oedipodinae
Acrotylus blondeli
A. longipes
A. patruelis
Aiolopus longicornis
A. meruensis
A. t. thalassinus
Calephorus compressicornis
Chloe ora dimorpha turanae
Gastrimargus determinatus vitripennis
G. verticalis
Heteropternis spp.
Humbe tenuicornis
Jasomenia sansbara
Locusta migratoria migratorioides
Morphacris fasciata
Oedaleus inornatus
O. instillatus
O. miniatus
O. senegalensis
Paracinema tricolor
Pycnodictya galinieri
P. kelleri
P. gracilis zinae
Scintharista notabilis lateritia
Sphingonotus canariensis
S. savignyi
S. turkanae
Trilophidia conturbata

Acridinae
Acrida bicolor
A. crassicollis
A. suphuripennis
Coryphosima stenoptera
Duronia chloronota
Gymnobothrus sp.
Odontmelus sp.
Orthochtha dasycnemis

Truxalinae
Truxalis bolivari

Gomphocerimae
Afrohippus sp.
Aulocobothrus emalicus
Brachycrotaphus sp.
Leva/Stenohippus spp.
Ochrilidia harterti salfiana
Pnorisa squalus
Rhapotittha nyuki

ISOPTERA (TERMITES)

(After Buxton 1979)

Kalotermitidae
Bifiditermes azaniae
Cryptotermes havilandi
Cryptotermes sp. *1*
Epicalotermes kempae
Neotermes meruensis

Rhinotermitidae

Coptopermitinae
Coptotermes amanii

Termitidae

Termitinae
Amitermes lonnbergianus
A. sciangallorum
A. messinae
A. somaliensi
Cubitermes glebae
C. umbratus
Microcerotermes parvus
Promirotermes bellicosi
P. massaicus

Nasutitermitinae
Trinervitermes gratiosus
T. ispar
T. bettonianus

Macrotermitinae
Macrotermes subhyalinus

Microtermes allaudanus
M. vadschaggae
Microtermes sp. *1*
Odontotermes badius
O. zambesiensis
O. mediocris
Synacanthotermes zanzibarensis

ODONATA (DRAGONFLIES)

(After Ritchie & Clifton 1983)

Lestidae
Lestes plagiatus
L. tridens
L. simulans
L. pallidus

Protoneuridae
Ellattoneura glauca

Coenagriidae
Ceriagrion suave
C. moorei
C. glabrum
Enallagma nigridorsum
E. elongatum
Ischnura senegalensis
Pseudagrion kersteini
P. acaciae
P. nigerimum
P. pseudomassaicum

Agriidae
Phaon iridipennis

Chlorocyphidae
Playcyopha caligata

Gomphidae
Paragomphus cognatus
P. elpidius

Aeschnidae
Acanthagyna mandarica
Anax imperator

Libellulidae
Acisoma paorpoides
Arthetrum f. falsum
Brachythemis leucosticta
Crocothemis erythraea
C. sanguinolenta
Diplacodes lefebvrei
Hadrothemis scabrifrons
Hemistigma albipunctata
Olopogastra lugubris
O. fuelleborni
Orthetrum stemmale kalai
O. chrysostigma
O. trinacria
Palpopleura lucia
P. deceptor
Pantala flavescens
Philonomon luminans
Rhyothemis semihyalina
separata
Thyolymis tillarga
Trapezostigma basilaris
T. limbata
Trithemis annulata
T. pluvialis
T. kirbyi
T. werneri
T. arteriosa
T. stictica
Urothemis assignata
U. edwardsi

LEPIDOPTERA: RHOPALOCERA

(After Ritchie & Clifton 1983)

Papilionidae
Papilio d. demodocus

Pieridae
Appias sabina phoebe
A. epaphia contracta
Belenois creona severina
B. gidica
B. t. thysa
Catopsilia florella
Colotis antevippe exole
C. aurigineua
C. c. calais
C. chrysonome
C. creona severina
C. danae pseudacaste
C. enenina sipylus
C. e. eris
C. evagore antigone
C. evippe omphale
C. ione
C. incretus
C. halimede maxima
C. h. hetaera
C. hildebrandti
C. phisadia rothschildi
C. pleione heliocausta
C. protomedia
C. venosus
C. vestalis casalis
Dixeia charina liliana
Eronia cleodora dilitata
Eurema brigitta
E. hecabe solifera
Mylothris y. yulei
Pinacopterys eriphia melanarge

Acraeidae
Acraea acrita pudorina
A. braesia
A. cabira
A. lygus
A. mirabilis
A. onacea
A. terpsicore neobule
Paradopsis punctatissima

Danaidae
Danaus cyrysippus aegyptius

Satyridae
Bicyclus s. safitza
Melanitis leda helena

Nymphalidae
Byblia ilithyia
Charaxes brutus alcyone
C. ethalion littoralis
C. ethalion littoralis
C. jalhusa kenyensis
C. jasius saturnus
C. varanes vologeses
C. viola kirki
C. z. zoolina
Euphaedra neonphron
ellenbecki
Eurytela dryope angulata
Hypolimnas dubius wahlbergi
H. misippus
Junonia hierta cebrene
J. n. natalica
J. octavia sesamus
Phalanta p. aethiopica

Lycaenidae
Anthene opalina
Aphnaeus neavei
Axiocerses harpax kadugli
Baliochilia fragilis
Castalius m. melaena
Chloroselas minima
C. vansomereni
Epamera tajorica
Freyeria trochilus
Lachnoptera bibulus
Lampides boeticus
Leptotes pirithous
Myrina silenus ficedula
Spindasis nairobiensis
S. somalina
Tarucus grammicus
Virachola livia
Zizeeria knysna
Zizina antanossa
Zizula hylax

COLEOPTERA; SCARABAEIDAE; SCARABAEINAE (DUNG BEETLES)

(After Kingston 1977)

Tribe Coprini
Heliocopris alatus
H. andersoni
H. densissa
H. dilloni
H. hamadryas
H. japetus
Catharsius furculatus
C. heros
C. jacksoni
C. mirabilis
C. pansion

C. playcerus
Metacatharsius tubifrons
Metacatharsius A
Metacatharsius B
Copris bornemisszai
C. diversus
C. elphenor
C. evanidus
C. harrisi *Copris A*

Tribe Dichotomiini
Pedaria sp.

Tribe Scarabaeinae
Kheper aegyptiorum
K. aeratus
K. laevistriatus
K. platynotus
K. catenatus
Scarabaeus ebenus
S. fraterculus
S. isidis

Tribe Gymnopleurini
Gymnopleurus laevicollis
G. umbrinus
Garetta nitens

Tribe Sisyphini
Sisyphus nr. aramatus
S. caffer
S. infuscatus
S. seminulum
S. spinipes
S. trochantericus

Tribe Canthonini
Anachalcos covexus

Tribe Onthophagini
Caccobius ferruginens
Milichis jugatus
M. rhodesianus
Mimonthophagus nr. apicehirtus
Onthophagus alcyon
O. bicallosus
O. carbobarius
O. extensus
O. flexicollis
O. gazella
O. gerstaeckeri
O. kingstoni
O. loricatus
O. nimbatus
O. obliquus
O. pictipodex
O. polyodon
O. prostans
O. quadriarmatus
O. revoili
O. rufobasilis
O. tibialis
O. tumidulus
O. variegatus
O. xanthopterus
Onthophagus sp. *nov.*
Phalops aurifrons
P. lutatus

Tribe Oniticellini
Drepanocerus abyssinicus
D. laticollis
D. parallelus
D. saegeri
Oniticellus egregius
O. intermedius
O. kawanus
O. pictus
O. planatus
Tiniocellus spinipes
Tragiscus dimidiatus

Tribe Onitini
Aptychonitis anomalus
Cheironitis bennigseni
Heteronitis castelnaui
Onitis aerarius
O. alexis
O. fulmineus
O. granicollis
O. inversidens
O. kenisensis
O. kingstoni
O. pseudojanssenii
O. trochantericus
Platyonitis oberthuri
P. smeenkorum

Sub-family Aphodinae
Aphodius circumdatus
A. fiechteri
A. infinitus
A. koshantschikovi
A. massaicus
Aphodius A
Aphodius B
Sybax sp.

Sub-family Hybosorinae
Hybosorus illigeri

Family Histeridae
Hister calidus
H. tropicanus
Macrolister maximus

Family Hydrophilidae
Sphaeridium spp.

REFERENCES

Buxton, R. 1979. **The Role of Termites in the Ecology of the Tsavo National Park, Kenya**. DPhil Thesis, University of Oxford.

Duff-MacKay, A. 1983. Scorpions. In **Flora and Fauna of the Kora National Reserve**. National Museums of Kenya/RGS. 39p.

Kingston, T. J. 1977. **Natural Manuring by Elephants in the Tsavo National Park, Kenya**. DPhil Thesis, University of Oxford.

Ritchie, M. & Clifton, M. 1983. Insects. In **Flora and Fauna of the Kora National Reserve** National Museums of Kenya/Royal Geographical Society. 40-47pp.

AMPHIBIANS

The lack of abundant seasonal waterholes in Mkomazi must severely limit the anuran fauna. The presence however, of somewhat more mesic habitats in the east, towards the coast and the persistence of small forest refuges close to the southern boundary, may well be responsible for the presence of a number of forest species. The species in this tentative list include those which are essentially coastal or montane endemics recorded on the Usambara and Pare mountains. This list has been prepared using information from Cheptumo, Madsen, Duff-MacKay, Hebrard, Rotich & Loman (1986), Duff-MacKay (1983), Loveridge(1957), Passmore & Carruthers (1979), Poynton (1964).

Pipidae
Xenopus borealis

Bufonidae
Bufo carens
B. garmani
B. gutteralis
B. lughensis
B. maculatus
B. taitanus

Ranidae

Arthroleptinae
Arthroleptides martiensseni
Arthroleptis stenodactlyus

Hemisinae
Hemisus marmoratus

Raninae
Hildebrandtia ornata or (H. macrotympanum)
Hylarana galamensis
Ptychadena anchietae
P. floweri
P. mascareniensis
P. mossambica
P. oxyrhynchus
Pyxicephalus adspersus
P. flavigula
P. marmoratus
Rana fasciata
R. fuscigula
Tomopterna delalandii
T. marmorata

Phrynobatrachinae
Phrynobatrachus acridioides
P. kreffti
P. natalensis

Rhacophorinae
Chiromantis xerampelina
C. petersi

Hyperolinae
Afrixalus brachycnemis
A. fornasini
A. pygmaeus
A. uluguruensis
Hyperolius argus
H. mitchelli
H. nasutus
H. parkeri
H. punctulatus
H. pusillus
H. sheldricki
H. spinigularis
H. tuberilinguis
H. viridiflavus
Kassina maculatus
K. senegalensis
Leptopelis argenteus
L. barbouri
L. flavomaculatus
L. parkeri
L. uluguruensis
L. vermiculatus

Phrynomeridae
Phrynomerus bifasciatus

Microhylidae
Breviceps mossambicus
Hoplophryne rogersi
Parahoplophryne usambarica
Probreviceps macrodactylus
Spelaeophryne methneri

REFERENCES

Cheptumo, M. Madsen, T. Duff-MacKay, A. Henrard, J. Rotich, D. & Loman, J. 1986. A survey of the reptiles and amphibians of the Kora National Reserve, in **Kora: An Ecological Inventory Study of the Kora National Reserve, Kenya**. Royal Geographical Society, London. 235-239pp.

Duff-MacKay, A. 1983. Amphibians, in **Flora and Fauna of the Kora National Reserve**. (Ed. M. Coe). National Museums of Kenya/Royal Geographical Society. pp 33. (Mimeographed).

Loveridge, A. 1957. Check list of the Reptiles and Amphibians of East Africa (Uganda; Kenya; Tanganyika; Zanzibar). Bull. Mus. Camp. Zool. Harv. **117(2)**:362 + xxxvi.

Passmore, N.I. & Carruthers, V.C. 1979. **South African Frogs** Witwatersrand University Press, Johannesburg. 270pp

Poynton, J.C. 1964. The Amphibia of Southern Africa. Ann. Nat. Mus. **17**:1-334.

Schiotz, A. 1975. **The Treefrogs of Eastern Africa**. Steenstrupia, Copenhagen. 232pp.

REPTILES

The reptiles of the Mkomazi area are poorly known, but the following list has been compiled with the help of information in Duff-MacKay (1983) and Cheptumo, Madsen, Duff-MacKay, Hebrard, Rotich & Loman(1986) for the Kora National Reserve, Kenya and Loveridge (1957). Vesey Fitzgerald (1975) has described the snakes of the Tanzania and Kenya borderlands. Species recorded from the Tanzanian coast and adjacent montane forests of Usambara and Pare have been included, where appropriate, since these species may befound in the east of the MGR, or in highland forest remnants.

CROCODILES, TORTOISES AND TERRAPINS

Crocodylidae
Crocodylus niloticus

Testudinidae
Kinyxis belliana
Malacocersus tornieri
Testudo pardalis

Pelomedusidae
Pelomedusa subrufa
Pelusios sinuatus

LIZARDS

Agamidae
Agama agama
A. ruppelli

Chamaeleonidae
Ramphoieon (Brookesia) kersteni
B. brevicaudata
Chamaeleo dilepis
C. fischeri
C. gracilis *C. tenuis*

Gekkonidae
Cnemaspis africana
Hemidactylus platycephalus
H. mabouia
H. squamulatus
H. brooki
Lygodactylus picturatus
Pachydactylus sp. (*cf. bibronii*)

Scincidae
Ablepharus wahlbergi
Acontias percivali
Mabuya brevicollis
M. maculilabris
M. planifrons
M. quinquitaeniata
M. striata
Riopa sundevallii
Scelotes eggeli

Cordylidae
Chamaesauria anguina
Cordylus cordylus
Gerrhosaurus major
G. nigrolineatus

Lacertidae
Bedriagala moreaui
Eremias spekii
Holaspis guentheri
Latastia longicaudata

Varanidae
Varanus exanthematicus
V. niloticus

Amphisbaenidae
Geocalamus scutus

SNAKES

Typhlopidae
Typhlops puncatus
T. braminus
T. sp. ? *obtusus*
Rhinotyphlops schlegelii
R. unitaeniatus

Leptotyphlopidae
Leptotyphlops conjuncta

Boidae
Python sabae
P. natalensis ?
Eryx colubrinus

Colubrinae
Boedon fuliginosus
Coluber florulentus
Crotaphopeltis hotamboeia
Dipsadoboa aulicus
D. typus
Hemirhagerrhis kelleri
H. nototaenia
Lycophidion depressirostre
Mehelya nyassae
Meizodon semiornatus
Philothamnus semivariegatus
Psammophis biseriatus
P. petersi
P. punctulatus
P. subtaeniatus
Prosymna ambigus
Rhamphiophis oxyrhynchus
R. rubropunctatus
Scaphiophis albopunctatus
Telescopus dhara
T. semiannulatus

Aparallactinae
Aparallactus jacksoni
A. lunulatus
Atractaspis microlepidota
Micrelaps bicoloratus

Dasypeltinae
Dasypeltis scabra

Elapidae
Naja pallida
N. melanoleuca
N. mossambica
N. nigricollis
Dendroaspis angusticeps
D. polylepis

Viperidae
Bitis arietans

References

Chaptumo, M., Madsen, T., Duff-Mackay, A., Hebrard, J., Rotich, D. & Loman, J. 1986. A survey of the reptiles and amphibians of Kora National Reserve. In **Kora: An Ecological Inventory of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. 235-239pp.

Duff-MacKay, A. 1983. Reptiles. In **Flora and Fauna of the Kora National Reserve**. (Ed. M. Coe) National Museums of Kenya/Royal Geographical Society. 29-32pp. (Mimeographed).

Loveridge, A. 1957. Check list of the Reptiles and Amphibians of East Africa (Uganda; Kenya; Tanganyika; Zanzibar). Bull. Mus. Comp. Zool. Harv. **117(2)**:362 + xxxiv.

Vesey Fitzgerald, D.F. 1975. A guide to the snakes of the Tanzania and Kenya borderlands. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **149**:1-26
.

BIRDS

The following lists those species of birds claimed for Mkomazi Game Reserve by Peter Lack and the students from St Peter's College, Oxford in July-August 1993, those by Don Turner and Miles Coverdale in February 1994 and those by Neil Baker and others during 1994. In addition those marked ➳ were recorded by Harris (1972) but have not since been seen for certain although it is likely all or most still occur at times.

This list must be considered preliminary. Some records still await acceptance by local Rarities Committees and some are considered doubtful for various reasons. There will also be many more migrant and vagrant species to be recorded in the wet seasons and northern winter, and it is likely that more species will be recorded from the small patches of montane forest on top of the various hills. Nomenclature follows Britton (1980).

	Struthionidae	**Ostriches**
	Struthio camelus	Ostrich
	Podicipitidae	**Grebes**
➳	*Tachybaptus ruficollis*	Little Grebe
	Pelecanidae	**Pelicans**
	Pelecanus onocrotalus	White Pelican
	Pelecanus rufescens	Pink-backed Pelican
	Phalacrocoracidae	**Cormorants**
➳	*Phalacrocorax carbo*	Cormorant
	Ardeidae	**Herons**
➳	*Nycticorax nycticorax*	Night Heron
➳	*Ardeola ralloides*	Squacco Heron
	Bubulcus ibis	Cattle Egret
	Butorides striatus	Green-backed Heron
	Egretta alba	Great White Egret
	Egretta intermedia	Yellow-billed Egret
	Egretta garzetta	Little Egret
	Ardea cinerea	Grey Heron
	Ardea melanocephala	Black-headed Heron
➳	*Ardea purpurea*	Purple Heron
	Scopidae	**Hammerkop**
	Scopus umbretta	Hammerkop
	Ciconiidae	**Storks**
	Ciconia ciconia	White Stork
	Ciconia nigra	Black Stork
	Ciconia abdimii	White-bellied or Abdim's Stork
	Ciconia episcopus	Woolly-necked Stork
	Ephippiorhynchus senegalenis	Saddle-billed Stork
	Anastomus lamelligerus	Open-billed Stork
	Leptoptilos crumeniferus	Marabou
	Mycteria ibis	Yellow-billed Stork
	Threskiornithidae	**Ibises, Spoonbills**
	Threskiornis aethiopica	Sacred Ibis
	Bostrychia hagedash	Hadada Ibis
	Plegadis falcinellus	Glossy Ibis
	Platalea alba	African Spoonbill

	Phoenicopteridae	**Flamingoes**
	Phoenicopterus minor	Lesser Flamingo
	Anatidae	**Ducks, Geese**
	Dendrocygna viduata	White-faced Whistling Duck
	Alopochen aegyptiacus	Egyptian Goose
	Plectopterus gambensis	Spur-winged Goose
➳	*Sarkidiornis melanotos*	Knob-billed Goose
	Anas erythrorhynchos	Red-billed Teal
	Anas capensis	Cape Wigeon
	Anas hottentota	Hottentot Teal
	Anas querquedula	Garganey
	Netta erythrophthalma	Southern Pochard
	Accipitridae	**Vultures, Eagles, Hawks**
	Gypohierax angolensis	Palm-nut Vulture
	Torgos tracheliotus	Lappet-faced Vulture
	Trigonoceps occipitalis	White-headed Vulture
	Gyps ruepellii	Ruppell's Vulture
	Gyps africanus	White-backed Vulture
	Neophron percnopterus	Egyptian Vulture
	Neophron monachus	Hooded Vulture
	Gypaetus barbatus	Lammergeyer
	Circus macrourus	Pallid Harrier
	Circus pygargus	Montagu's Harrier
	Circus aeruginosus	Marsh Harrier
	Polyboroides radiatus	Harrier Hawk
	Terathopius ecaudatus	Bateleur
	Circaetus gallicus pectoralis	Black-chested Harrier-Eagle
	Circaetus cinereus	Brown Harrier-Eagle
	Accipiter badius	Shikra
	Melierax poliopterus	Pale Chanting Goshawk
	Melierax gabar	Gabar Goshawk
	Kaupifalco monogrammicus	Lizard Buzzard
	Bustastur rufipennis	Grasshopper Buzzard
	Buteo augur	Augur Buzzard
	Buteo buteo vulpinus	Steppe Buzzard
	Lophaetus occipitalis	Long-crested Eagle
	Polemaetus bellicosus	Martial Eagle
	Stephanoaetus coronatus	Crowned Eagle
	Hieraaetus pennatus	Booted Eagle
	Hieraaetus spilogaster	African Hawk Eagle
	Aquila pomarina	Lesser Spotted Eagle
	Aquila rapax belisarius	Tawny Eagle
	Aquila nipalensis orientalis	Steppe Eagle
	Aquila verreauxii	Verreaux's Eagle

Aquila wahlbergi	Wahlberg's Eagle
Haliaaetus vocifer	Fish Eagle
Milvus migrans	Black Kite
Elanus caeruleus	Black-shouldered Kite
Falconidae	**Falcons**
Polihierax semitorquatus	Pigmy Falcon
Falco biarmicus	Lanner Falcon
Falco peregrinus	Peregrine Falcon
Falco subbuteo	Hobby
Falco naumanni	Lesser Kestrel
Falco tinnunculus	Kestrel
Falco eleonorae	Eleonora's Falcon
Sagittariidae	**Secretary Bird**
Sagittarius serpentarius	Secretary Bird
Phasianidae	**Game Birds**
Francolinus shelleyi	Shelley's Francolin
Francolinus sephaena	Crested Francolin
Francolinus hildebrandti	Hildebrandt's Francolin
Francolinus leucoscepus	Yellow-necked Spurfowl
Coturnix chinensis	Blue Quail
Coturnix delegorguei	Harlequin Quail
Numididae	**Guinea-Fowl**
Numida meleagris	Helmeted Guineafowl
Guttera pucherani	Kenya Crested Guineafowl
Acryllium vulturinum	Vulturine Guineafowl
Turnicidae	**Button Quails**
Turnix sylvatica	Button Quail
Rallidae	**Crakes, Rails**
Crex crex	Corncrake
Crex egregia	African Crake
Limnocorax flavirostra	Black Crake
Fulica cristata	Red-knobbed Coot
Heliornithidae	**Finfoots**
Podica senegalensis	African Finfoot
Otididae	**Bustards**
Otis kori	Kori Bustard
Eupodotis ruficrista	Buff-crested Bustard
Eupodotis senegalensis	White-bellied Bustard
Eupodotis melanogaster	Black-bellied Bustard
Eupodotis hartlaubii	Hartlaub's Bustard
Rostratulidae	**Painted Snipes**
Rostratula benghalensis	Painted Snipe
Charadriidae	**Plovers**
Vanellus armatus	Blacksmith Plover
Vanellus lugubris	Senegal Plover
Vanellus coronatus	Crowned Plover
Charadrius pecuarius	Kittlitz's Sandplover
Charadrius tricollaris	Three-banded Plover
Scolopacidae	**Waders**
Tringa nebularia	Greenshank
Tringa stagnatilis	Marsh Sandpiper
Tringa glareola	Wood Sandpiper
Tringa ochropus	Green Sandpiper
Actitis hypoleucos	Common Sandpiper

Calidris ferruginea	Curlew Sandpiper
Calidris minuta	Little Stint
Philomachus pugnax	Ruff
Recurvirostridae	**Stilts, Avocets**
Himantopus himantopus	Black-winged Stilt
Burhinidae	**Thicknees**
Burhinus capensis	Spotted Thicknee
Glareolidae	**Coursers, Pratincoles**
Cursorius temminckii	Temminck's Courser
Rhinoptilus africanus	Two-banded Courser
Rhinoptilus cinctus	Heuglin's Courser
Laridae	**Terns**
Gelochelidon nilotica	Gull-billed Tern
Chlidonias hybridus	Whiskered Tern
Pteroclididae	**Sandgrouse**
Pterocles decoratus	Black-faced Sandgrouse
Columbidae	**Pigeons, Doves**
Streptopelia semitorquata	Red-eyed Dove
Streptopelia decipiens	Mourning Dove
Streptopelia capicola	Ring-necked Dove
Streptopelia senegalensis	Laughing Dove
Oena capensis	Namaqua Dove
Turtur tympanistria	Tambourine Dove
Turtur chalcospilos	Emerald-spotted Wood Dove
Treron australis	Green Pigeon
Psittacidae	**Parrots**
Poicephalus rufiventris	Orange-bellied Parrot
Poicephalus meyeri	Brown Parrot
Musophagidae	**Turacos**
Corythaixoides leucogaster	White-bellied Go-Away Bird
Cuculidae	**Cuckoos**
Clamator glandarius	Great Spotted Cuckoo
Clamator jacobinus	Black and White Cuckoo
Cuculus solitarius	Red-chested Cuckoo
Cuculus clamosus	Black Cuckoo
Cuculus canorus	Eurasian Cuckoo
Cuculus gularis	African Cuckoo
Cuculus poliocephalus	Lesser Cuckoo
Chrysococcyx klaas	Klaas' Cuckoo
Chrysococcyx caprius	Didric Cuckoo
Ceuthmochares aereus	Yellowbill
Centropus grillii	Black Coucal
Centropus superciliosus	White-browed Coucal
Strigidae	**Owls**
Otus scops	Scops Owl
Otus leucotis	White-faced Scops Owl
Bubo africanus	Spotted Eagle Owl
Bubo lacteus	Verreaux's Eagle Owl
Glaucidium perlatum	Pearl-spotted Owlet
Caprimulgidae	**Nightjars**
➛ *Caprimulgus europaeus*	Eurasian Nightjar
Caprimulgus donaldsoni	Donaldson-Smith's Nightjar
Caprimulgus inornatus	Plain Nightjar
Caprimulgas tristigma	Freckled Nightjar
➛ *Caprimulgus fossii*	Gabon Nightjar
Caprimulgus clarus	Slender-tailed Nightjar
Apodidae	**Swifts**
Apus aeqatorialis	Mottled Swift
Apus apus	Common Swift
Apus niansa	Nyanza Swift

Apus caffer	White-rumped Swift
Apus affinis	Little Swift
Cypsiurus parvus	Palm Swift
Schoutedenapus myoptilus	Scarce Swift
Coliidae	**Mousebirds**
Colius striatus	Speckled Mousebird
Colius leucocephalus	White-headed Mousebird
Urocolius macrourus	Blue-naped Mousebird
Trogonidae	**Trogons**
Apaloderma narina	Narina's Trogon
Alcedinidae	**Kingfishers**
Ceryle rudis	Pied Kingfisher
Ceryle maxima	Giant Kingfisher
Alcedo cristata	Malachite Kingfisher
Halcyon chelicuti	Striped Kingfisher
Halcyon albiventris	Brown-hooded Kingfisher
Halcyon leucocephala	Chestnut-bellied Kingfisher
Meropidae	**Bee-eaters**
Merops apiaster	Eurasian Bee-eater
Merops superciliosus	Madagascar Bee-eater
Merops persicus	Blue-cheeked Bee-eater
➤ *Merops nubicus*	Carmine Bee-eater
Merops albicollis	White-throated Bee-eater
Merops pusillus	Little Bee-eater
Coraciidae	**Rollers**
Coracias garrulus	Eurasian Roller
Coracias caudatus	Lilac-breasted Roller
Coracias naevia	Rufous-crowned Roller
Eurystomus glaucurus	Broad-billed Roller
Upupidae	**Hoopoes**
Upupa epops	Hoopoe
Phoeniculidae	**Wood Hoopoes**
Phoeniculus purpureus	Green Wood Hoopoe
Phoeniculus granti	Violet Wood Hoopoe
Phoeniculus minor	Abyssinian Scimitarbill
Phoeniculus cyanomelas	Scimitarbill
Bucerotidae	**Hornbills**
Tockus nasutus	Grey Hornbill
Tockus erythrorhynchus	Red-billed Hornbill
Tockus deckeni	Von der Decken's Hornbill
Tockus flavirostris	Yellow-billed Hornbill
Tockus alboterminatus	Crowned Hornbill
Bycanistes brevis	Silvery-cheeked Hornbill
Bycanistes bucinator	Trumpeter Hornbill
Bucorvus cafer	Ground Hornbill
Capitonidae	**Barbets**
Lybius melanopterus	Brown-breasted Barbet
Lybius melanocephalus	Black-throated Barbet
Lybius leucocephalus	White-headed Barbet
Lybius lacrymosus	Spotted-flanked Barbet
Pogoniulus pusillus	Red-fronted Tinker-Bird
Pogoniulus bilineatus	Yellow-rumped Tinker-Bird
Trachyphonus darnaudii	D'Arnaud's Barbet
Tachyphonus erythrocephalus	Red and Yellow Barbet
Indicatoridae	**Honey-Guides**
Indicator indicator	Black-throated Honeyguide
Indicator minor	Lesser Honeyguide
Picidae	**Woodpeckers**
Campethera nubica	Nubian Woodpecker

Dendropicos fuscescens	Cardinal Woodpecker
Thripias namaquus	Bearded Woodpecker
Alaudidae	**Larks**
Mirafra cantillans	Singing Bush Lark
Mirafra hypermetra	Red-winged Bush Lark
Mirafra rufocinnamomea	Flappet Lark
Mirafra africanoides	Fawn-coloured Lark
Mirafra poecilosterna	Pink-breasted Lark
Mirafra pulpa	Friedmann's Lark
Eremopterix leucopareia	Fischer's Sparrow Lark
Eremopterix leucotis	Chestnut-backed Sparrow-Lark
Hirundinidae	**Swallows, Martins**
Riparia riparia	Sand Martin
Riparia paludicola	African Sand Martin
Riparia cincta	Banded Martin
Psalidoprocne pristoptera	Black Rough-wing
Hirundo rustica	Eurasian Swallow
Hirundo smithii	Wire-tailed Swallow
➤ *Hirundo senegalensis*	Mosque Swallow
Hirundo daurica	Red-rumped Swallow
Hirundo abyssinica	Striped Swallow
Hirundo fuligula	African Rock Martin
Motacillidae	**Wagtails, Pipits**
➤ *Motacilla flava*	Yellow Wagtail
Motacilla aguimp	African Pied Wagtail
Anthus novaeseelandiae	Richard's Pipit
Anthus trivialis	Tree Pipit
Anthus novaeseelandiae	Richard's Pipit
Tmetothylacus tenellus	Golden Pipit
Macronyx aurantiigula	Pangani Longclaw
Macronyx croceus	Yellow-throated Longclaw
Campephagidae	**Cuckoo Shrikes**
Campephaga flava	Black Cuckoo Shrike
Pycnonotidae	**Bulbuls**
Pycnonotus barbatus	Common Bulbul
Andropadus importunus	Zanzibar Sombre Greenbul
Chlorocichla flaviventris	Yellow-bellied Greenbul
Phyllastrephus strepitans	Northern Brownbul
Nicator chloris	Nicator
Laniidae	**Shrikes**
Eurocephalus rueppelli	White-crowned Shrike
Prionops plumata	Helmet Shrike
Prionops retzii	Retz's Helmet Shrike
Prionops scopifrons	Chestnut-fronted Helmet Shrike
Nilaus afer	Brubru
Dryoscopus cubla	Black-backed Puffback
Dryoscopus pringlii	Pringle's Puffback
Tchagra jamesi	Three-streaked Tchagra
Tchagra australis	Brown-headed Tchagra
Tchagra senegala	Black-headed Tchagra
Rhodophoneus cruentus	Rosy-patched Shrike
Laniarius ferrugineus	Tropical Boubou
Laniarius funebris	Slate-coloured Boubou
Malaconotus sulfureopectus	Sulphur-breasted Bush Shrike
Malaconotus blanchoti	Grey-headed Bush Shrike
Lanius collurio	Red-backed Shrike
Lanius isabellinus	Red-tailed Shrike
Lanius minor	Lesser Grey Shrike
Lanius cabanisi	Long-tailed Fiscal
Lanius dorsalis	Taita Fiscal
Timaliidae	**Babblers, Chatterers**
Turdoides rubiginosus	Rufous Chatterer
Turdoides aylmeri	Scaly Chatterer
Turdidae	**Thrushes, Chats**

Oenanthe oenanthe	Northern Wheatear
Oenanthe pleschanka	Pied Wheatear
Oenanthe isabellina	Isabelline Wheatear
Oenanthe pileata	Capped Wheatear
Cercomela familiaris	Red-tailed Chat
Thamnolaea cinnamomeiventris	Cliff Chat
Monticola saxatilis	Rock Thrush
Cercotrichas leucophrys	White-browed Scrub Robin
Cichladusa guttata	Spotted Morning Thrush
➳ *Neocossyphus rufus*	Red-tailed Ant Thrush
Luscinia luscinia	Sprosser
Irania gutturalis	Irania
Cossypha natalensis	Red-capped Robin Chat
Turdus tephronotus	Bare-eyed Thrush
Sylviidae	**Warblers**
Acrocephalus palustris	Marsh Warbler
Schoenicola platyura	Fan-tailed Warbler
Hippolais olivetorum	Olive-tree Warbler
Hippolais languida	Upcher's Warbler
Hippolais pallida	Olivaceous Warbler
Hippolais icterina	Icterine Warbler
Sylvia nisoria	Barred Warbler
Sylvia borin	Garden Warbler
Sylvia communis	Whitethroat
Phylloscopus trochilus	Willow Warbler
Cisticola chiniana	Rattling Cisticola
Cisticola galactotes	Winding Cisticola
Cisticola cinereola	Ashy Cisticola
Cisticola erythrops	Red-faced Cisticola
Cisticola nana	Tiny Cisticola
Cisticola brachyptera	Siffling Cisticola
Cisticola aridula	Desert Cisticola
Cisticola juncidis	Zitting Cisticola (probable)
Prinia subflava	Tawny-flanked Prinia
Apalis flavida	Yellow-breasted Apalis
Spiloptila rufifrons	Red-fronted Warbler
Camaroptera brevicaudata	Grey-backed Camaroptera
Camaroptera simplex	Grey Wren Warbler
Sylvietta brachyura	Northern Crombec
Sylvietta whytii	Red-faced Crombec
Sylvietta isabellina	Somali Long-billed Crombec
Eremomela icteropygialis	Yellow-bellied Eremomela
Eremomela flaviventris	Yellow-vented Eremomela
Muscicapidae	**Flycatchers**
Muscicapa striata	Spotted Flycatcher
Muscicapa caerulescens	Ashy Flycatcher
Melaenornis pammelaina	Southern Black Flycatcher
Bradornis microrhynchus	Grey Flycatcher
Bradornis pallidus	Pale Flycatcher
Batis molitor	Chin-spot Batis
Batis perkeo	Pigmy Batis
Batis minor	Black-headed Batis
Terpsiphone viridis	Paradise Flycatcher
Paridae	**Tits**
Parus afer	Grey Tit
Parus albiventris	White-bellied Tit
Remizidae	**Penduline Tits**
Remiz musculus	Mouse-coloured Penduline Tit
Remiz caroli	African Penduline Tit
Nectariniidae	**Sunbirds**
Anthreptes orientalis	Eastern Violet-backed Sunbird
Anthreptes collaris	Collared Sunbird
Nectarinia amethystina	Amethyst Sunbird
Nectarinia hunteri	Hunter's Sunbird
Nectarinia venusta	Variable Sunbird
Nectarinia bifasciata	Little Purple-banded Sunbird
Nectarinia nectarinioides	Smaller Black-bellied Sunbird
Nectarinia pulchella	Beautiful Sunbird
Nectarinia mariquensis	Mariqua Sunbird
Zosteropidae	**White-eyes**
Zosterops abyssinica	Abyssinian White-eye
Emberizidae	**Buntings**
Emberiza poliopleura	Somali Golden-breasted Bunting
Emberiza tahapisi	Cinnamon-breasted Rock Bunting
Fringillidae	**Finches**
Serinus atrogularis	Yellow-rumped Seed-eater
Serinus mozambicus	Yellow-fronted Canary
Estrildidae	**Waxbills**
Hypargos niveoguttatus	Peter's Twin-spot
Pytilia melba	Green-winged Pytilia (Melba Finch)
Estrilda rhodopyga	Crimson-rumped Waxbill
Estrilda astrild	Waxbill
Estrilda erythronotus	Black-cheeked Waxbill
Uraeginthus ianthinogaster	Purple Granadier
Uraeginthus bengalus	Red-cheeked Cordon-Bleu
Uraeginthus cyanocephalus	Blue-capped Cordon-Bleu
Lagonosticta rhodopareia	Jameson's Firefinch
Lagonosticta rubricata	African Firefinch (probable)
Lagonosticta senegala	Red-billed Firefinch
Ortygospiza atricollis	Quailfinch
Amadina fasciata	Cut-throat
Lonchura malabarica	Silver-bill
Lonchura griseicapilla	Grey-headed Silver-bill
Lonchura cucullata	Bronze Mannikin
Lonchura bicolor nigriceps	Rufous-backed Mannikin
Ploceidae	**Weavers, Sparrows**
Vidua macroura	Pin-tailed Whydah
➳ *Vidua fischeri*	Straw-tailed Whydah
Vidua paradisaea	Paradise Whydah
Ploceus velatus	Vitelline Masked Weaver
Ploceus cucullatus	Black-headed Weaver
Ploceus rubiginosus	Chestnut Weaver
Ploceus nigricollis	Black-necked Weaver
Anaplectes rubriceps	Red-headed Weaver
Quelea quelea	Red-billed Quelea
Quelea erythrops	Red-headed Quelea
Quelea cardinalis	Cardinal Quelea
Euplectes albonotatus	White-winged Widowbird
Euplectes diadematus	Fire-fronted Bishop
Euplectes capensis	Yellow Bishop
Euplectes nigroventris	Zanzibar Red Bishop
Euplectes hordeaceus	Black-winged Red Bishop
Bubalornis niger	Red-billed Buffalo Weaver
Dinemellia dinemelli	White-headed Buffalo Weaver
Plocepasser mahali	White-browed Sparrow Weaver
Passer domesticus	House Sparrow (in Same Town)
Passer griseus gongonensis	Parrot-billed Sparrow
Passer griseus griseus	Grey-headed Sparrow
Passer eminibey	Chestnut Sparrow
Petronia pyrgita	Yellow-spotted Petronia
Sturnidae	**Starlings**
Onychognathus morio	Redwing Starling
Lamprotornis chalybaeus	Blue-eared Glossy Starling
Cinnyricinclus leucogaster	Violet-backed Starling
Spreo fischeri	Fischer's Starling
Spreo hildebrandti	Hildebrandt's Starling
Spreo superbus	Superb Starling
Cosmopsarus regius	Golden-breasted Starling
Creatophora cinerea	Wattled Starling
Buphagus erythrorhynchus	Red-billed Oxpecker
Buphagus africanus	Yellow-billed Oxpecker

Oriolidae	**Orioles**	*Dicrurus adsimilis*	Drongo
Oriolus oriolus	Golden Oriole		
Oriolus auratus	African Golden Oriole	**Corvidae**	**Crows**
Oriolus larvatus	Black-headed Oriole	*Corvus albus*	Pied Crow
		Corvus albicollis	White-necked Raven
Dicruridae	**Drongos**		

REFERENCES

Harris, L D. 1972. An ecological description of a semi-arid East African ecosystem. Range Sci, Depr., Sci. Ser. **11**:89pp. Colorado State Univ.

Lack, P C., Leuthold, W & Smeenk, C. 1980. Check-list of the Birds of Tsavo East National Park, Kenya. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **170**:25pp.

Mackworth-Praed, C W & Grant, C H B. 1952. **Birds of Eastern and North-Eastern Africa**. Longman, Green & Co., London 836pp.

Mackworth-Praed, C W & Grant, C H B. 1952. **Birds of Eastern and North Eastern Africa**. Longman, Green & Co., London. 1099pp.

MAMMALS

The following tentative list is after Harris (1972), with additional species added where they have been recorded, or predicted in similar habitats to the north, in Tsavo National Park and the Kora National Reserve (Aggundey 1983, Alibhai & Key, 1986). Scientific names have been updated or corrected, following Kingdon (1971-1982) and Corbet & Hill (1991).

INSECTIVORA

Macroscelidae
Elephantulus rufescens
Rhynchocyon cirnei

Erinaceidae
Erinaceus (Atelerix) pruneri

Soricidae
Crocidura bicolor
C. hildegardeae
C. hirta
C. voi

CHIROPTERA

MEGACHIROPTERA

Pteropidae
Epomophorus wahlbergi
Lissonycteris angolensis?

Microchiroptera

Emballonuridae
Taphozous hildegardeae
T. mauritianus
T. (Liponycteris) nudiventris

Hipposideridae
Hipposideros caffer
H. ruber

Megadermidae
Cardioderma cor
Lavia frons

Molossidae
Platymops setiger
Tadarida bivitata
T. cistura
T. condylura
T. pumila

Nycteridae
Nycteris aethiopica
N. hispida
N. schlieffeni

Rhinolophidae
Rhinolophus clivosus
R. hildebrandti
R. landeri

Vespertilionidae
Eptisecus rendalli
E. somalicus
Glauconycteris argentata
G. variegata
Kerivoula smithi
Mimetillus maloneyi
Miniopterus schreibersi
Pipistrellus nanus
P. ariel ?
P. kuhli
Scotoecus hirudo
Scotophilus leucogaster
S. nigrita

PRIMATES

Lorisidae
Galago senegalensis

Ceropithecidae
Papio anubis
P. cynocephalus
Cercopithecus aethiops
C. mitis

PHOLIDOTA

Manidae
Manis temminckii

LAGOMORPHA

Leporidae
Lepus capensis

RODENTIA

Bathyergidae
Heliophobius spalax

Hystricidae
Hystrix galeata

Sciuridae
Paraxerus ochraceus
Xerus rutilus

Gliridae
Graphiurus murinus

Muridae
Arvicanthus niloticus
Acomys cahirinus
A. dimidiatus
A. percivali
A. wilsoni
Aethomus chrysophilus
Gerbillus harwoodi
G. pusillus
Grammomys dolichurus
Lemniscomys barbarus
L. griselda
Praomys (Mastomys) natalenis
Mus minutoides
M. bufo
Steatomys purvus
Tatera robusta
T. nigricauda
Taterillus emeni
T. lowei
T. osgoodi
Thallomys paedulcus

CARNIVORA

Canidae
Canis adustus
Lycaeon pictus
Otocyon megalotis

Viverridae
Ictonyx striatus
Mellivora capensis

Mustelidae
Civettictis civetta
Genetta genetta
Helogale parvula
Herpestes ichneumon
H. sanguineum
Ichneumia albicauda
Mungos mungo

Hyaenidae
Crocuta crocuta
Hyaena hyaena
Proteles cristatus

Felidae
Acinonyx jubatus
Felis caracal
F. lybica
F. serval
Panthera pardus
P. leo

TUBULIDENTATA

Orycteropidae
Orycteropus afer

PROBOSCIDEA

Elephantidae
Loxodonta africana

HYRACOIDEA

Procaviidae
Dendrohyrax validus
Heterohyrax brucei
Procavia johnstoni

PERRISSODACTYLA

Equidae
Equus burchelli

Rhinoceratidae
Diceros bicornis

Artiodactyla

Suidae
Phacochoerus aethiopicus
Pomatochoerus porcus

Giraffidae
Giraffa camelopardalis

Bovidae
Aepyceros melampus
Alcelaphus buselaphus
Gazella granti
Kobus ellipsiprymnus
Litocranius walleri
Oryx beisa
Oreotragus oreotragus
Raphicerus campestris

Redunca redunca	*Sylvicapra grimmia*	*Taurotragus oryx*	*T. scriptus*
Rhynchotragus kirkii	*Syncerus caffer*	*T. imberbis*	*T. strepsiceros*

REFERENCES

Aggundey, I. 1983. Mammals in, **The Flora and Fauna of the Kora National Reserve** (Ed. M. Coe). National Museums of Kenya/Royal Geographical Society. 47pp. (Mimeographed).

Alibhai, S.K. & Key, G. 1986. Biology of small mammals in the Kora National Reserve,. In **Kora: An Ecological Inventory of the Kora National Reserve, Kenya** (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. 303-317pp.

Corbet, G.B. & Hill, J.E. 1991 (3rd Ed.). **A World Atlas of Mammalian Species**. Oxford University Press. 243pp.

Kingdon, J. 1971-1982. **East African Mammals: An Atlas of Evolution in Africa**. Academic Press, London. 7 Volumes.

Bibliography of the Mkomazi Game Reserve and its environs

MKOMAZI

Anstey, D. 1956. Mkomazi Game Reserve. Oryx **3**:183-5 (In RGS Library).

Harris, L.D. and Fowler, N.K. 1975. Ecosystem analysis and simulation of the Mkomazi Reserve, Tanzania. E.Afr.Wildl.J. **13(3&4)**:325-346 *(Photocopy held in EAC).*

Hemingway, P., Cormack, A. & Robinette, W.L. 1966. Appraisal of range condition on the Kalimawe controlled area. In **Kalimawe in relation to Mkomazi Game Reserve**. (Ed. D.C. Anstey): 7-9. Reg. Devlt. Comm, Kilimanjaro Region, Moshi, Tanzania. Ref. No. TA/G/GR/MR.

Miller, R.I. 1978. An island biogeographic theory on an East African reserve. Environmental Conservation **5(3)**:191-195.

Moluma, S.R. 1988. Mkomazi Game Reserve: Design and reconstruction measures(?) for its survival. Miombo. **1**:17-19.

Parker, I.S.C. and Archer, A.L. 1970. **The status of elephants, other wildlife and cattle in the Mkomazi Game Reserve, Tanzania**. Wildl. Serv., Nairobi.

Watson, R. 1991. Mkomazi;-restoring Africa. Swara. **14(5)**:14-16.

CONSERVATION AND DEVELOPMENT

Anderson, D. and Grove, R.H. (Eds.),1989. **Conservation in Africa: Peoples, Policies and Practice**. CUP pp.300 (Argues for radical reappraisal of conservation strategies in Africa, with conservation forming an integral part of the economic and social set-up of rural African communities).

Anon. 1993. **Report of the Regional Conference on the Coordination of Elephant Conservation in Eastern Africa**. Arusha, Tanzania. 24-27 August 1993. 33pp.

Bensted-Smith, R. and Msangi, T.H. 1989. **Report on the conservation of ecosystems and genetic resources**. Tropical Forestry Action Plan, United Republic of Tanzania. *Unpublished* report for the Forest and Beekeeping Division of The Ministry of Lands, Natural Resources and Tourism.

Bohlen, E. 1978. **Crop pests in Tanzania and their control**. Paul Parey, Berlin. 142pp.

Corfield, T. 1984. **The Wilderness Guardian: a practical guide to fieldwork related to wildlife conservation**. David Sheldrake Memorial Appeal, Box 48177, Nairobi, Kenya. 621pp. (Practical tips on detailed operational aspects of park management in East Africa).

Dar-es-Salaam: Tanzania Society. 1978. The Human Environment in Tanzania. Tanzania Notes and Records No. **83**. 170pp Maps. Bibliogs.

FAO 1981. **Forest Resources of Tropical Africa**. II.Country Briefs.

Homewood, K.M. and Rodgers, W.A. 1991. **Maasailand Ecology: pastoralist development and wildlife conservation in Ngorongoro, Tanzania**. CUP 298pp. (In Cambridge studies in applied ecology and resource management).

Horrobin, D.F. 1971. **A guide to Kenya and northern Tanzania**. Scribners NY.304pp.

IIED 1991. **Wetlands in Drylands: The Agroeconomy of Savanna Systems in Africa. Part 1: Overview - ecological, economic and social issues**. Drylands Programme, London. 82pp.

IIED 1991. **Wetlands in Drylands: The Agroeconomy of Savanna Systems in Africa. Part 2: Soil and water processes**. Drylands Programme, London. 69pp.

IIED 1992. **Pastoral Land Rights in Tanzania: A review**. Drylands Programme, Pastoral Land Tenure Series, London. 24pp.

IIED 1994. **Who should own the Range? New thinking on pastoral resource tenure in Drylands Africa**. Drylands Programme, Pastoral Land Tenure Series No. 3, London. 34pp.

IIED 1994. **Whose Eden? An Overview of Community Approaches to Wildlife Management**. ODA Report, Russell Press, Nottingham. 124pp.

IUCN Tropical Forest Programme, 1988. **Tanzania: conservation of biological diversity and forest ecosystems. A briefing document**. Available from IUCN Publications Unit, 219(c) Huntingdon Rd., Cambridge CB3 ODL.

IUCN 1987. **Action strategy for protected areas of the Afrotropical realm**. IUCN, Gland, Switzerland and Cambridge, UK.pp.47-49.

IUCN 1987. **Directory of Afrotropical Protected Areas**. IUCN pp.1034.

IUCN 1989. **Forest conservation in the east Usambara mountains, Tanzania**. IUCN, Gland. 392pp.

IUCN 1993. **The Eastern Africa Programme: An overview.**

IUCN (date unknown). **Sharing The Land: Wildlife, people and development in Africa**.

Isack, H.A. 1976. An African ethic of conservation. Nat.Hist. **85(9)** pp.90-95.

Laws, R.M. 1969. The Tsavo Research Project. J.Reprod. Fertil. Suppl. **6**:495-53.

Laws, R.M. 1970. Elephants as agents of landscape change in East Africa. Oikos. **21**:177-8.

Leopold, A.S. 1970. **Research Policy in Tanzania National Parks**. Tanzania National Parks.

Luk, S.H. 1975. Soil erosion with special reference to agriculture in Tanzania. J. Geol. Association Tanzania (Dar-es-Salaam). **13**: 64-86 (In RGS Library).

MacKinnon, J. and MacKinnon, K. 1986. **Review of the protected areas system in the Afrotropical Realm**. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. pp.244-246

Mangubuli, M.J.J. 1992. Mkomazi Game Reserve - A Recovered Pear. Kakakuona. **14**: 1

Mence, A.J. 1974. The College of African Wildlife Management, (MWEKA), Tanzania after eleven years. Biol. Cons. **6**:73-76.

Miller, R.I. and Harris, L.D. 1977. Isolation and extirpation in wildlife reserves. Biol. Cons. **12**:311-6.

Miller, R.I. and Harris, L.D. 1979. Predicting species changes in isolated wildlife preserves. In: **Proceedings of the First Conference on Scientific Research in the National Parks, New Orleans, Louisiana, 1976**.

Mshigeni, K.E. 1979. **Exploitation and conservation of biological resources in Tanzania**. In Hedberg, I.(Ed.)(1979). pp.140-143. Almquist and Wiksell Int. 157pp.

Mwalyosi, R.B.B. 1986. **Tanzania, Natural Resources Expertise Profile**. Conservation for Development centre - International Union for the Conservation of Nature and Natural Resources, (IUCN) Gland, Switzerland. 71pp.

Ndagala, D.K. Pastoral territoriality and land degradation in Tanzania, in Palsson, G. (ed.) **From water to world making** (item 583). 175-89

Ndagala, D.K. 1990. Pastoralists and the state in Tanzania. Nomadic peoples, **25-27**. 51-65

Nieuwolt, S. 1977. The influence on rainfall on rural population in Tanzania. J.Trop.Geog. [Singapore] **44**:43-56 (In RGS Library).

Planning & Assessment for Wildlife Management, Wildlife Department, 1992. **Mkomazi Game Reserve, Status Report March 1992**.

Pratt, D.J. & Gwynne, M.D. (Eds.) 1977. **Rangeland Management and Ecology in East Africa**. Hodder and Stoughton, London. 310pp.

Selous Conservation Programme Publications: Community Wildlife Management around the Selous Game Reserve 1991; Selous Project Progress Review 1990; Planning for Phase II October 90 to September 92, 1990; Planning for Phase III October 92 to September 95, published 1992; Selous Census; Veterinary & Virological aspects associated with driving cattle on foot via a stock route through the Selous Game Reserve, 1990; Rogers, W.A., The Ecology of Large Herbivores in the Miombo Woodlands of South East Tanzania vols 1 & 2; Selous Game Reserve General Management Plan, March 1995.

Stuart, S.N. and Adams, R.J. 1990. **Biodiversity in sub-Saharan Africa and its islands: conservation, management and sustainable use**. IUCN, Gland, Switzerland. 204-214.

Tanzania Wildlife Protection Fund, Kakakuona Magazine; vol **3**:1, vol **4**:1

Thomas, I.D. 1970. **Some notes on population and land use in the North Pare Mountains**. Research notes, Bureau Resource Assessment (Dar-es-Salaam) 9 :v & 61 (In RGS Library).

Watson, J.R. 1972. Conservation problems, policies and the origins of the Mlalo basin rehabilitation scheme, Usambara Mounts.,Tanzania. Geogr. Ann. Ser. A. **54A(3-4)**:221-226.

Williams, J.G.1967. **A Field Guide to the National Parks of East Africa**. Collins, London. 352pp.

Williams, J.G. 1981. **A Field guide to the national parks of East Africa**. Collins.

ECOLOGY

Agnew, A.D.Q. 1966. The use of game trails as a possible measure of habitat utilisation by larger mammals. E. Afr. Wildl. J. **4**:38-46.

Beentje, H.J. (Ed.). 1988. An ecological and floristic study of the forests of the Taita Hills, Kenya. Utafiti. **1(2)**:23-66.

Beentje, H.G., Ndiang'ui N. 1988. Ecology of the forests. (Taita Hills). Utafiti. **1(2)**:23-42.

Bourliere, F. 1965. Ecological notes on the Tsavo. Afr. Wildl. **19**:47-107.

Bowker, R.G. & Bowker, M.H. 1979. Abundance and distribution of anurans in a Kenya pond. Copeia. **1979**:278-85.

Cambridge Tanzania Expedition, 1975. Ecological survey of West Usambara Mountains. (In Cambridge Expeditions Journal - Held in RGS/MAP ROOM, Ref **357** :27-30).

Coe, M. and Collins, N.M. (Eds.). 1986. **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. Royal Geographical Society, London. 340pp.

Harris, L.D. 1972. **An ecological description of a semi-arid East African ecosystem**. Science Series no. 11, Colorado State Univ., Range Science Dept. 81pp. *(Photocopy held in EAC)*

Kabuye, C.H.S., Mungai, G.M. and Mutangah, J.G. 1986. Flora of the Kora National Reserve; in **Kora: An ecological inventory of the Kora National Reserve,Kenya**. (Eds.M.Coe and N.M.Collins) Royal Geographical Society, London. pp.57-104

Moreau, R.E. 1963a. Vicissitudes of the African biomes in the late Pleistocene. Proc. Zool. Soc., Lond. **141**:395-421.

Oxford Expedition to Tanzania, 1979. Visited Usambara and Uzungwa mountains. Ornithological, mapping and botanical projects. (Full Report held at the RGS/MAP ROOM, ref. **1121**. 95pp).

Pomeroy, D. 1987. **Tropical Ecology: A Textbook for Africa**. Longman 240pp.

Rogers, D.J.(Compiler),1979. **A Bibliography of African ecology**. (A geographically and topically classified list of books and articles). Greenwood Press,London. 500pp.

Sinclair, A.R.E. 1980**. Serengeti: Dynamics of an Ecosystem**. Chicago UP 390pp.

Stuart, S.N. and van der Willigen, S.T. (eds.),1978. **Report on the Cambridge ecological expedition to Tanzania, 1978**. [Cambridge Expedition Group] 77pp.

University College London Zoology Department Expedition to Tanzania, 1985. Collection of frogs and bats, behavioural study of chameleons and distribution survey of small mammals, around Amani in E. Usambaras. (Held in RGS/MAP ROOM. 12pp. ref. **1610**).

ZOOLOGY

MAMMALS

Alibhai, S.K. & Key, G. 1986. Biology of small mammals in the Kora National Reserve. **In Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M.Collins). Royal Geographical Society, London. pp303-317.

Anderson, J.M. & Coe, M.J. 1974. Decomposition of elephant dung in an arid tropical environment. Oecologia (Berl). **141**:111-125.

Anon. 1970. **A note on age groups of elephants which died in Tsavo National Park (East) during the dry period of 1970**. Tsavo Research Project. 7pp. (Mimeographed).

Afolayan, T.A. 1975. Distribution and relative abundance of Haartebeest in 4 range land habitats. Mammalia **40(2)**:245-256.

Ansell, W.F.H. 1989. **African Mammals 1938-1988**. Trendrine Press.77pp.

(A bibliographical reference to the names of African mammals published between 1938 and 1988, updating Allen's "A checklist of African Mammals", Publ.1939.)

Ayeni, J.S.O. 1975. Periodicity of African wildlife at water holes in Tsavo East National Park, Kenya. Bull. Anim. Health Prod. Afr. **23(2)**:131-137.

Ayeni, J.S.O. 1979. Big game utilisation of natural mineral licks. In **Wildlife Management in Savannah Woodland**. (Eds. S.S. Ajayi & L.B. Halstead). Taylor and Francis, London. pp.85-95.

Ayeni, J.S.O. 1975. Utilisation of water-holes in Tsavo National Park (East). E. Afr. Wild. J. **13**:305-23.

Beekman, J.H. and Prins, H.H.T. 1989. Feeding strategies of sedentary large herbivores in East Africa, with emphasis on the African buffalo, *Syncerus caffer*. E.Afr.Wildl.J. **27(2)**:129-149.

Borner, M. (ed.) 1995. **Ngorogoro Rhino Conservation Project: Status Report**. Ngorogoro Conservation Area Authority and Frankfurt Zoological Society. 89pp.

Boshe, J.I. 1984. Effects of reduced shrub density and cover on territory size and structure of Kirks dikdik in Arusha National Park, Tanzania. E.Afr.Wildl.J. **22(2)**:107-117.

Cobb, S. 1976. **The distribution and abundance of the large herbivore community of Tsavo National Park, Kenya**. DPhil Thesis. University of Oxford. 208pp.

Coe, M. 1972. Defaecation in the African Elephant (*Loxodonta africana* Blum.) E. Afr. Wildl. J. **10**:165-174.

Coe, M. 1977. The role of termites in the removal of elephant dung in the Tsavo (East) National Park, Kenya. E. Afr. Wildl. J. **15**:49-55.

Coe, M. 1078. The decomposition of elephant carcases in the Tsavo (East) National Park, Kenya. J. Arid. Envir. **1**:71-86.

Coe. M. 1980. The natural history of the unmentionable. Swara. **2(3)**:8-13.

Corfield, T.F. 1973. Elephant mortality in Tsavo National Park, Kenya. E. Afr. Wildl. J. **11**:339-68.

Cunningham-van Someren, G.R. 1986b. The larger mammals of the Kora National Reserve, with notes on the *Sciuridae* and *Bathyergidae*. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp 287-300.

Dorst, J. and Dandelot, P. 1972. A Field guide to the larger mammals of Africa. Harper Collins. 287pp.

Dougall, H.W. 1963. On the chemical composition of elephant faeces. E. Afr. Wildl. J. **1**:123.

Dougall, H.W., Drysdale, V.M. & Glover, P.E. 1964. The chemical composition of Kenya browse and pasture herbage. E. Afr. Wildl. J. **2**:86-121.

Dougall, H.W. & Sheldrick, D.L.W. 1964. The chemical composition of a day's diet of an elephant. E. Afr. Wildl. J. **2**:51-59.

Estes, R. (Illus. by Otte, D.),1991. **The Behaviour guide To Africa's Mammals**. California UP 660pp. (Covers: Ruminant hoofed mammals, non-ruminant hoofed mammals, carnivores and primates)

Estes, R.D. The comparative behaviour of Grant's and Thomsons's gazelle's. J. Mammal. **48**:189-209.

Foster J.B. 1965. Mortality and ageing of black rhinoceros in East Tsavo National Park, Kenya. E. Afr. Wildl. J. **3**:118-119.

Goddard, J. 1969. Aerial census of black rhinoceros using stratified random sampling. E. Afr. Wildl. J. **7**:105-114.

Goddard, J. 1970a. Age criteria and vital statistics of a black rhinoceros population. E. Afr. Wildl. J. **8**:105-22.

Goddard, J. 1970b. Food preferences of black rhinoceros in the Tsavo National Park. E. Afr. Wildl. J. **8**:145-162.

Glover, J. 1963. The elephant problem in Tsavo. E. Afr. Wildl. J. **1**:30-39.

Glover, P.E. 1970. The Tsavo and the elephants. Oryx. **X(5)**:323-25.

Glover, P.E. & Sheldrick, D. 1964. An urgent research problem in the elephant and rhino population of the Tsavo National Park in Kenya. Bull. epizoot. Dis. Afr. **12**:33-38.

Glover, P.E. 1970a. **Tsavo Research Project, Progress Report (June 1968-June 1970)**. Kenya National Parks. (Mimeographed).

Glover, P.E. 1970. The Tsavo and the elephants. **Oryx X(5)**:323-325.

Glover, P.E. 1971. **Tsavo Research Project, Progress Report for the Year 1972**. Kenya National Parks. (Mimeographed).

Glover, P.E. 1972. **Tsavo Research Project, Progress Report for the Year 1972**. Kenya National Parks. 73pp (Mimeographed).

Glover, P.E. 1973. **Tsavo Research Project, Progress Report for the Year 1973**. Kenya National Parks. 61pp (Mimeographed).

Glover, P.E. 1975. **Tsavo Research Project, Progress Report for the Period 1.1.74 - 30.6.75**. Kenya National Parks. 73pp (Mimeographed).

Haltenorth T. & Diller, H. 1980. **A Field Guide to the Mammals of Africa, including Madagascar**. Collins, London. 400pp.

Harris, L.D. 1970. **Some functional and structural attributes of a semi-arid East African ecosystem**. PhD Diss. Michigan State University.

Harris, L.D. & Francis, R.C. 1972. **AFCONS, a dynamic simulation model of an interactive herbivore community**. USIBP Grassland Biome Tech. Rept. 158.

Harthoorn, A.M. 1966. The Tsavo elephants. Oryx. **VIII(4)**:233-236.

Jewell, P.A. and Maloiy, G. (Eds.),1989. **The biology of large African mammals in their environment**. OUP 356pp.

Jamrozy, G. 1977. Fauna of large mammals of Mkomazi Game Reserve, N.E.Tanzania. Przeglad Zoologiczny **21(4)**:358-373.

(Paper in Polish- abstract in English held in EAC, RGS)

(examines connections between nutritive value of pastures,trace element occurrence and animal movements, with particular reference to okapi and buffalo. Chaps. also on Grevy's zebra, elephant, spotted hyena, hippo and antelope.)

Kenya Wildlife Service. 1991a. **Tsavo Elephant Count**. Kenya Wildlife Service. 9pp. (Mimeographed for internal use).

Kenya Wildlife Service. 1991a. **Draft Executive Report: Total Elephant Count-1991**. Kenya Wildlife Serrvice. 15pp. (Mimeographed for internal use),

Kingdon, J. 1971. **East African Mammals: An Atlas of Evolution in Africa**. *Vol. 1*. Academic Press, London. 446pp.

Kingdon, J. 1974a. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 2a*. (Insectivores and bats). Academic Press, London. 341pp.

Kingdon, J. 1974b. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 2b*. (Hares and rodents). Academic Press, London. 704pp.

Kingdon, J. 1977. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 3a*. (Carnivores). Academic Press, London. 476pp.

Kingdon, J. 1979. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 3b*. (Large mammals). Academic Press, London. 436pp.

Kingdon, J. 1982a. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 3c*. (Bovids). Academic Press, London. 393pp.

Kingdon, J. 1982b. **East African Mammals: An Atlas of Evolution in Africa**. *Vol 3d*. (Bovids). Academic Press, London. 746pp.

Kingston, T.J. 1977. **Natural Manuring by Elephants in the Tsavo National Park, Kenya**. DPhil Thesis. University of Oxford.

Kortlandt, A. 1976. Tree destruction by elephants in Tsavo National Park and the role of man in African ecosystems. Neth. J. Zool. **26(3)**:449-451.

Laws, R.M. 1971. The Tsavo elephants. Oryx **11(1)**:32-34.

Laws, R.M. 1966. Age criteria for the African elephant, *Loxodonta a. africana*. E. Afr. Wildl. J. **4**:1-37.

Laws, R.M. 1967a. Eye lens weight and age in African elephants. E. Afr. Wildl. J. **5**:46-52.

Laws, R.M. 1967b. Occurence of placental scars in the uterus of the African elephant *(Loxodonta africana)*. J. Reprod. Fert. **14**:445-449.

Laws, R.M. 1968. Interactions between elephant and hippopotamus populations and their environments. E. Afr. Agr. For. J. (Spec. Issue). **33**:140-147.

Laws, R.M. 1969a. The Tsavo Research Project. J. Reprod. Fert., Suppl **6**:495-531.

Laws, R.M. 1969b. Aspects of reproduction in the African elephant, *Loxodonta africana*. J. Reprod. Fert. Suppl. **6**:193-217.

Laws, R.M. 1970. The Tsavo Research Project. Oryx. **X(6)**:355-361.

Laws, R.M. 1989. Development of research on large mammals in East Africa. **In The Biology of Large African Mammals in their Environment**. (Eds. P.A. Jewell & G.M.O. Maloiy). Symp. Zool. Soc. Lond. 61:267-298.

Laws, R.M., Parker, I.S.C. & Archer, A.L. 1968. Estimating live weights of elephants from hind leg weights. E. Afr. Wildl. J. **5**:106-111.

Laws, R.M. & Parker, I.S.C. 1968. Recent studies of an elephant population in East Africa. Symp. Zool. Soc. Lond. **21**:319-55.

Leuthold, B.M. 1979. Social organisation and behaviour of Giraffe in Tsavo East National Park. Afr. J. Ecol. **17**:19-34.

Leuthold. B.M. & Leuthold W. 1972. Food habits of giraffe in Tsavo National Park, Kenya. E. Afr. Wildl. J. **10**:129-41.

Leuthold, B.M. & Leuthold, W. 1978a. Daytime activity patterns of gerenuk and giraffe in Tsavo National Park, Kenya. E. Afr. Wildl. J. **16**:231-43.

Leuthold, B.M. and Leuthold, W. 1978b. Ecology of giraffe in Tsavo East National Park, Kenya. **16**:1-20.

Leuthold, W. 1970a. Preliminary observations on food habits of gerenuk in Tsavo National Park, Kenya. E. Afr. Wildl. J. **8**:73-84.

Leuthold, W. 1970b. Observations on the social organisation of impala *(Apyceros melampus)*. Z. Tierpsychol. **27**:693-721.

Leuthold, W. 1970d. Some breeding data on Somali ostrich. E. Afr. Wildl. J. **8**:206.

Leuthold, W. 1971a. Studies on the food habits of lesser kudu in Tsavo National, Park, Kenya. E. Afr. Wildl. J. **9**:35-45.

Leuthold, W. 1971b. A note on the formation of food habits in young antelopes. E. Afr. Wildl. J. **9**:154-56.

Leuthold, W. 1971c. Observations on the mother-young relationship in some antelopes. E,. Afr. Wildl. J. **9**:152-154.

Leuthold, W. 1971d. Freilandbeobachtungen an Giraffengazellen *(Litocranius walleri)* in Tsavo National Park, Kenya. Z. Saugetierkunde. **36**:19-37.

Leuthold, W. 1971e. On association between antelopes and baboons. Bull. E. Afr. Nat. Hist. Soc. December 1971.

Leuthold, W. 1972a. Home range, movements and food of a buffalo herd in Tsavo National Park, Kenya. E. Afr. Wildl. J. **10**:237-43.

Leuthold, W. 1972b. Queleas and attendant predators. Bull. E. Afr. Nat. Hist. Soc. May 1972. 77-78.

Leuthold, W. 1973a. **Recent elephant counts in Tsavo National Park: A report to the Trustees of Kenya National Parks. Tsavo research Project**; 5th March 1973. 17pp + 6 Figs. (Mimeographed).

Leuthold, W. 1976a. Age structure of elephants in Tsavo National Park. J. Appl. Ecol. **13**:435-444.

Leuthold, W. Group size in elephants of Tsavo National Park and possible factors influencing it. J. Anim. Ecol. **45**:425-439.

Leuthold, W. 1977a. **African ungulates. A comparative review of their ethology and behavioural ecology**. Springer Verlag, Berlin. 8.

Leuthold, W. 1977b. Spatial organisation and strategy of habitat utilisation of elephant in Tsavo National Park, Kenya. Z. Saugtierk. **42**:358-79.

Leuthold, W. 1978a. On the ecology of gerenuk *Litocranius walleri*. J. Anim. Ecol. **47**:561-80.

Leuthold, W. 1978b. On the social organisation of the gerenuk *Litocranius walleri* (Brooke 1978). J. Tierpsych. **47**:194-216.

Leuthold, W. 1978c. Ecological separation among browsing ungulates in Tsavo National Park, Kenya. Oecologia (Berl.). **35**:241-252.

Leuthold, W. 1979. The lesser kudu, *Tragelaphus imberbis* (Blyth 1869). Ecology and behaviour of an African antelope. Saugetierk. Mitt. **27**:1-75.

Leuthold, W. & Leuthold B.M. 1973. **Ecological studies of ungulates in Tsavo National Park (East), Kenya. Tsavo Research Project, Kenya National Parks**. August 1973. 67pp + 21figs. (Mimeographed).

Leuthold, W. & Leuthold B.M. 1975. Patterns of social grouping in ungulates of Tsavo National Park, Kenya. J. Zool., Lond. **175**:405-20.

Leuthold, W. & Leuthold B.M. 1976. Density and biomass of ungulates in Tsavo East National Park, Kenya. E. Afr. Wildl. J. **14**: 49-58.

Leuthold, W. & Sale, J.B. 1973. Movements and patterns of habitat utilisation of elephants in Tsavo National Park, Kenya. E. Afr. Wildl. J. **11**:369-84.

Leuthold, W. 1970. Field observations on gerenuk (*Litocranius walleri*) in Tsavo National Park, Kenya. Zeitschrift fur Saugetierkunde. **36(1)**:19-37.

Leuthold, W. and Leuthold, B.M. 1975. Temporal patterns of reproduction in ungulates of Tsavo East National Park, Kenya. East Afr. Wildl. J. **13(3-4)**:159-169.

Leuthold, W. 1977. Notes on the breeding biology of the ostrich (*Struthio camelus*) in Tsavo East National Park,Kenya. Ibis **119(4)**:541-544.

Leuthold, W. 1981. Contact between formerly allopatric subspecies of Grant's Gazelle (*Gazella granti*) owing to vegetation changes in Tsavo National Park,Kenya. Zeitschrift fuer Saeugetierkunde **46(1)**:48-55. (In English)

Lee, P., Thornback, J. and Bennet, E. (Eds.),1988. **"Threatened Primates of Africa": The IUCN Red Data Book**. IUCN 150pp.

McCullagh, K.G. 1973. Are elephants deficient in essential fatty acids?. Nature. **242**:267-268.

Mitchell, A.W. 1977. Preliminary observations on the daytime activity patterns of lesser kudu in Tsavo National Park, Kenya. East Afr. Wildl. J. **15(3)**:199-206.

Mloszewski, J. 1983. **"The Behaviour and Ecology of the African Buffalo"**. CUP 270pp.

Myers, N. 1973. Tsavo National Park, Kenya, and its elephants; An interim appraisal. Biol. Conserv. **5(2)**: 123-132.

Napier Bax, P. & Sheldrick, D.L.W. 1963. Observations on the food of elephants in the Tsavo Royal National Park (East) of Kenya. E. Afr. Wildl. J. **1**:40-53.

Ndumo, N.G. (No date). **The effects of micro-meteorology and status of vegetation on the diurnal behaviour of free-ranging elephants in Tsavo National Park East, Kenya**. Seminar on "Vegetation Studies in Tsavo National Park". (Study carried out, mid 1975-76). 48pp. (Mimeographed).

Olang, M.O. 1986. Plant biomass production and large herbivore utilisation in the Kora National Reserve. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya.** (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp129-134.

Ottichilo, W.F. 1981. **Population studies of elephant (*Loxodonta africana*) in the Tsavo ecosystem, Kenya**: 1975-1980. MSc Thesis, University of Nairobi.

Ottichilo, W.F. 1986. Age structure of elephants in the Tsavo National Park, Kenya. Afr. J. Ecol. **24**:69-75.

Ottichilo, W.F., Kufwafura, J.W. & Stelfox, J.F. 1987. Elephant population trends in Kenya 1977-81. Afr. J. Eol. **25(1)**:9-18.

Ottichilo, W.K. 1986. Population estimates and distribution patterns of elephants in the Tsavo ecosystem. E.Afr.Wildl.J. **24(1)**:53-59.

Ottichilo, W.K. 1987. The causes of recent heavy elephant mortality in the Tsavo ecosystemm, Kenya 1975-80. Biol. Conserv. **41(4)**:279-290.

Root, A. 1972. Fringe-eared oryx digging for tubers in Tsavo National Park, Kenya. E. Afr. Wildl. J. **11**:155-157.

Round, H.C. 1964. A new species of *Stephanofilaria* in skin lesions from the black rhinoceros (*Diceros bicornis*). J. Heminthol. **38**:87-96.

Schenkel, R. & Schenkel-Hulliger,L. 1969. **Ecology and behaviour of the Black Rhinoceros**. Paul Parey, Hamburg.

Sikes, S.K. 1966. The African elephant: the background to its present day ecological status in the Murchison Falls (Uganda) and Tsavo (Kenya) National Parks and environs. Rev. Zool. Bot. Afr. **74**:255-72.

Sinclair, A.R.E. 1977. **The African Buffalo; A study of resource limitations of populations**. Chicago UP 356pp. illus.

Smith, S.J. 1988. **The atlas of Africa's principal mammals**. Frandsen. 272pp.

Swynnerton, G. H. & Hayman, R.W. 1950. A checklist of the land mammals of the Tanganyika Territory and the Zanzibar Protectorate. J. E. Afr. Nat. Hist. Soc. **20**:274-392.

Tieszen, L.L., Boutton, T.W., Ottichilo, W.K., Nelson, D.E., Brandt, D.H. 1989. An assessment of long-term food habits of Tsavo elephants,based on stable carbon and nitrogen isotope ratios of bone collagen. Afr. J. Ecol. **27(3)** pp.219-226

Tremlett, J.G. 1964. **Observations on the pathology of lesions associated with *Stephanofilaria dinniki* Round 1964, from black rhinoceros (*Diceros bicornis*)**.

Tyrrell, J.G. 1985. The distribution of elephants in the Tsavo region during the late 19th century. Afr. J. Ecol. **23(1)**:29-34.

Watson, R.M., Parker, I.S.C. and Allan, T. 1969. A census of elephant and other large mammals in the Mkomazi Region of N.Tanzania and S.Kenya. E.Afr.Wildl.J. **(7)**:11-26.

Wijngaarden, W. van. 1985. **Elephants-Trees-Grass-Grazers**. Int. Inst. Aerpsp. Surv. & Earth Sci. (ITC). 159pp.

Wildlife Department. 1991. **Elephant conservation plan** - Tanzania.Wildlife Division, Ministry of Tourism, Natural Resources and the Environment, Dar-es-Saalam. 152pp.

Willoughby, Capt. Sir J.C., 1886. **East Africa and its big game**. London; Longmans, Green and Co.(1889). Contains an appendix of biological sightings et.c., compiled largely by H.C.V.Hunter. *RGS lib. [ref.611 E]*

Zucker, E.L. (Ed.),1987. **Comparative behaviour of African monkeys**. (Monographs in primatology Vol.10) Liss 342pp.

(Behavioural data for several species of African monkeys, especially those in the genera *Cercopithecus* and *Erythrocebus*, are analysed and interpreted.)

BIRDS

Backhurst, G.C. 1969. Bird ringing report. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **XXVII(3)**:217-225.

Backhurst, G.C. 1970. Bird ringing report-1968-69. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **XXVIII**:16-26.

Backhurst, G.C. 1971. East African bird ringing report-1969-70. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **28(123)**:1-14.

Backhurst, G.C. 1972a. East African bird ringing report-1970-71. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **126**:16pp.

Backhurst, G.C. 1972b. East African bird ringing report-1971-72. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **144**:15pp.

Backhurst, G.C. 1973. East African bird ringing report-1971-72. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **144**:?pp.

Backhurst, G.C. 1974. East African bird ringing report-1972-73, 73-74. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **146**:9pp.

Backhurst, G.C. 1977. East African bird ringing report-1974-77. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **163**:16pp.

Backhurst, G.C. 1981. East African bird ringing report. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **174**:19pp.

Backhurst, G.C., Britton, P.L. & Mann, C.F. 1973. The less common Palaearctic migrant birds of Kenya and Tanzania. J. E. Afr. Mt. Soc. & Nat. Mus. **140**:38pp.

Backhurst, G.C. & Pearson, D.J. 1977a. Ethiopean region birds attracted to the lights of Ngulia Safari Lodge, Kenya. Scopus. **1**:98-103.

Backhurst, G.C. & Pearson, D.J. 1977b. Southward migration at Ngulia 1976-77. Scopus. **1(1)**:12-17.

Backhurst, G.C. & Pearson, D.J. 1979. Southward migration at Ngulia, Tsavo, Kenya. 1978/79. Scopus. **3(1)**:19-25.

Backhurst, G.C. & Pearson, D.J. 1980., Southward migration at Ngulia, Tsavo, Kenya-1979-1980. Scopus. **4(1)**:14-20.

Backhurst, G,C. & Pearson, D.J. 1981. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **5(1)**:28-30.

Backhurst, G.C. 1982. Checklist of the birds of Tanzania. Nairobi: Ornithological sub-committee. E. Afr. Nat. Hist. Soc. & Nat. Mus. 33pp.

Backhurst, G,C. & Pearson, D.J. 1983. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **5(5)**:166-167.

Backhurst, G,C. & Pearson, D.J. 1983. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **6(5)**:144-145.

Backhurst, G,C. & Pearson, D.J. 1984. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **7(5)**:136-138.

Backhurst, G.C. 1984. The timing of the southward night migration of Palaearctic birds over Ngulia, south-east Kenya. Proc. 5th Pan Afr. Ornith. Cong. pp361-369.

Backhurst, G.C. 1986. Checklist of the birds of Kenya (2nd Ed.). Ornithological sub-committee. E.Afr. Nat. Hist. Soc. 30pp.

Backhurst, G,C. & Pearson, D.J. 1987. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **9(5)**:160-162.

Backhurst, G,C. & Pearson, D.J. 1988. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **10(5)**:133-136.

Backhurst, G,C. & Pearson, D.J. 1989. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus. **11(5)**:120-122.

Backhurst, G,C. & Pearson, D.J. 1990. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **12(5)**:127-128.

Backhurst, G,C. & Pearson, D.J. 1991. Ringing and migration at Ngulia, Tsavo, Kenya. Scopus **13(3)**:181-183.

Britton, P. and Britton, H. 1971. Somali bee-eater in Tsavo East National Park. E. Afr. Nat. Hist Soc Bull. No. **5** (1971) 71pp.

Britton, P.L. & Britton, H.A. 1977. An April fall of palaearctic migrants at Ngulia. Scopus. **1(4)**:109-111.

Britton, P.L. 1978. The Andersen collection from Tanzania. Scopus. **2(4)**:71-85.

Brown, L.H., Urban, E.K. and Newman, K.B. (eds.),1982. **"The Birds of Africa" (vol.1) - Ostriches To Falcons**. Academic Press.pp. 521 (*see below for further vols.*)

Collar, N.J. and Stuart, S.N. 1984. **Threatened birds of Africa**. IUCN/ICBP Red Data Book. Part 1.

Cunningham-van Someren, G.R. 1986a. Avifauna of the Kora National Reserve. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp 247-284.

Fry, S., Keith, S. and Urban, E.K. (eds.),1988. **The Birds of Africa (vol.3) - Parrots To Woodpeckers**. Academic press. 611pp.

Forbes-Watson, A.D. 1971. **Skeleton checklist of East African Birds**. National Museum, Nairobi, Kenya. 32pp. (Mimeographed).

Fuggles-Couchman, N.R. 1957. The habitat distribution of birds of northern, eastern and central Tanganyika. Tanganyika Notes Recs.(Dar-es-Salaam) **46**:32-68 (In RGS Library).

Guggisberg, C.A.W. and illus. by Ellis, M. 1986/1988. **Birds of East Africa**. (638 species described and illustrated - available as 2 vol.pbk. or single vol.hdbk.)

Keith, S., Urban, E. and Fry, H. (eds.,due summer 1992) **The Birds of Africa (vol.4) - Broadbills To Chats**. Academic press.

(3 further volumes expected. The completed series will cover all breeding species in full with non-breeding visitors treated more briefly, and includes information on range and status as well as behaviour, identification and breeding biology).

Kelsey, M.G., Backhurst, G.C. and Pearson, D.J. 1989. Age differences in the timing and biometrics of migrating marsh warblers in Kenya. Ringing and Migr. **10(1)**:41-47 (Edward Grey Inst. Field Ornithology).

Lack, P.C., Leuthold, W. and Smeenk, C. 1980. Checklist of the birds of Tsavo East National Park, Kenya. J.E.Afr.Nat.Hist.Soc., No.170 pp.1-25 *(Photocopy held in EAC).*

Lack, P.C. 1975a. Range expansion of the quail plover. E. Afr. Nat. Hist Soc. Bull. 110.

Lack, P.C. 1975b. **Records of less common palaearctic migrants in Tsavo National Park East, Kenya**. E. Afr. Nat. Hist. Soc. Bull. 87-88.

Lack, P.C. 1975c. Dietary notes on some kenyan birds. Scopus. **2**:89-91.

Lack, P.C. 1977. The status of Friedmann's bush-lark Mirafra pulsa. Scopus. **1(1)**:34-39.

Lack, P.C. 1980. **Habits and feeding stations of birds in Tsavo National Park, Kenya**. DPhil Thesis. University of Oxford. pp333.

Lack, P.C. 1983. The movements of Palaearctic landbird migrants in Tsavo East National Park, Kenya. J. Anim. Ecol. **52**:513-524.

Lack, P.C. 1985. The ecology of landbirds on Tsavo East National Park, Kenya. Scopus. **9**:2-23; **9**:57-96.

Lack, P.C. 1986a. Diurnal and seasonal variation in biomass of arthropods in Tsavo East National Park, Kenya. Afr. J. Ecol. **24**:47-51.

Lack, P.C. 1986b. Ecological correlates of migrants and residents in a tropical African savanna. Ardea. **74**:111-119.

Lack, P.C. 1987. The structure and seasonal dynamics of the bird community in Tsavo East National Park, Kenya. Ostrich. **58**:9-23.

Leuthold, W. 1971. Somali bee-eater in Tsavo National Park. E. Afr. Nat. Hist. Soc. Bull. (June 1971) 97pp.

Leuthold, W. 1973. Is the Somali bee-eater extending its range? E. Afr. Nat. Hist. Soc. Bull. (July 1973) 101pp.

Leuthold, W. 1973a. Less common palaearctic migrants. Bull. E. Afr. Nat. Hist. Soc. August 1973. 111-112.

Leuthold, W. 1970c. Albino buffalo weaver. E. Afr, Wildl. J. **8**:205.

Mackworth-Praed, C.W. & Grant, C.H.B. 1952. **Birds of Eastern and North-Eastern Africa**. Longman, Green & Co., London. 836pp.

Mackworth-Praed, C.W. & Grant, C.H.B. 1955. **Birds of Eastern and North-Eastern Africa**. Longman, Green & Co., London. 1099pp.

Moreau, R.E. & Moreau, E.M. 1931. The bird population of a settled valley in the west Usambaras, Tanganyika Territory. J. Ecol. **XIX(1)**:64-74.

Moreau, R.E. 1993. Pleistocene climatic changes and the distribution of life in East Africa. J. Ecol. **21**: 421-?

Moreau, R.E. 1935a. A synecological analysis of Usambara, Tanganyika Territory, with particular reference to birds. J. Ecol. **23**:1-43.

Moreau, R.E. 1935b. A critical analysis of the distribution of birds in a tropical African area. J. Anim. Ecol. **23**:167-191.

Moreau, R.E. 1947. A contribution to the faunistics of Tanganyika Territory. Ibis. **1947**:216-231.

Moreau, R.E. 1948. Ecological isolation in a rich tropical avifauna. J. Anim. Ecol. **17(2)**:113-126.

Moreau, R.E. 1963b. The distribution of tropical African birds as an indicator of past climatic changes. In: **African Ecology and Human Evolution** (Eds. F.C. Howell & F. Bouliere). Methuen. pp28-42.

Moreau, R.E. 1966. The bird communities of some African vegetation types. Ostrich. **6**:265-270.

Moreau, R.E. 1966. **The Bird Faunas of Africa and its Islands.** Academic Press, London.

Pearson, D.J. 1978. The genus Sylvia in Kenya and Uganda. Scopus. **2**:63-71.

Pearson, D.J. 1980. Northward spring passage of palaearctic passerines across Tsavo. Scopus. **4(2)**:25-28.

Pearson, D.J. & Backhurst, G.C. 1978. Southward migration at Ngulia, Tsavo, Kenya 1977/78. Scopus. **2(2)**:42-47.

Pelchen, H. 1977. The Taita Falcon *Falco fusciinucha* in Tsavo. Scopus. **1**:83-84.

Rasa, O.A.E. 1987. Patterns of intra-African small raptor species migrations in the Taru Desert, Kenya. Afr. J. Ecol. **25(3)**:165-172.

Ruffo, C.K. et al. (in press). **Plant species recorded from the East Usambara forests.** (IUCN Project)

Schippers, R.R. (in press). Observations on the pteridophytes of the Pare and Usambara mountains in north Tanzania.

Short, L.L., Horne, J.F.M. and Muringo-Gichuki, 1990. An Annotated Checklist of the Birds of East Africa. Proceedings of the Western Foundation of Vertebrate Zoology **4(3)** Western Foundation 185pp.

(Each entry provides English and Latin names,countries where recorded, status, distribution, accepted records and habitat preferences.)

Smeenk, C. 1974. Comparative ecological studies of some east African birds of prey. Ardea. **62**:1-97.

Smeenk, C. and Smeenk-Enserink, N. 1975. Observations on the Pale Chanting Goshawk (*Melierax poliopterus*) with comparative notes on the Gabar Goshawk (*Micronisus gabar*). Ardea **63(3-4)**:93-115.

van Someren, G.R.C. 1986. Avifauna of the Kora National Reserve in **Kora: An ecological inventory of the Kora National Reserve, Kenya**.(Eds. M.Coe and N.M.Collins).Royal Geographical Society, London.pp.247-284.

Strecker, P. *et al.* 1994. **Mkomazi '93: Oxford University Expedition to the Mkomazi Game Reserve, Tanzania.** RGS Map Library, Report No. 2695.

Stronach, B. 1966. The feeding habits of the yellow-necked spurfowl (*Pternistis leucoscepus*) in northen Tanzania. E. Afr. Wildl. J. **4**:76-81.

Stuart, S.N. and Hutton, J.M.(eds.) 1977. **The avifauna of the East Usambara Mountains, Tanzania.**_Compiled by The Cambridge Ornithological Expedition to East Africa, 1977. 90pp.

Stuart, S.N. 1981. A comparison of the avifauna of seven African forest islands. Afr. J. Evol. **19**:133-151.

Stuart, S.N. & Turner, D.A. 1980. Some range extensions and other notable records of forest birds from eastern and north-eastern Tanzania. Scopus. **4(2)**:36-41.

Stuart, S.N. & Jenson, F.P. 1981. Further range extensions and other notable record of forest birds from Tanzania. Scopus. **5(4)**:106-115.

Turner, D.A. 1977. Status and distribution of the East African endemic birds. Scopus **1(1)**:2-11.

Urban, E.K., Fry, C.H. and Keith, C.H. (eds.), 1986. **The Birds of Africa (vol.2) - Gamebirds to Pigeons**. Academic press. 600pp.

Williams, J.G. 1963. **A Field Guide to the Birds of East and Central Africa**. Collins, London. 288pp.

Williams, J. and Arlott, N (Illus.) 1977. **A Field guide to the birds of E.Africa**. Harper Collins. 351pp.

Williams, J.G. 1980. **A Field Guide to the Birds of East Africa**. Collins, London. 415pp.

REPTILES AND AMPHIBIANS

Cheptumo, M., Madsen, T., Duff-MacKay, A., Hebrard, J., Rotich, D. & Loman, J. 1986. A survey of reptiles and amphibians of Kora National Reserve. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp 235-239..

Loveridge, A. 1930. A list of Amphibians of the British Territories of East Africa, together with keys for the diagnosis of the species. Proc. Zool. Soc. Lond. **(1)**:7-32.

Loveridge, A. 1957. Check list of the reptiles and amphibians of East Africa (Uganda; Kenya; Tanganyika; Zanzibar). Bull. Mus. Comp. Zool. Harv. **117(2)**:362 + xxxvi.

MacKay, A. & MacKay, J. 1985. **Poisonous snakes of Eastern Africa, and the treatment of their bites**. A & J MacKay, Nairobi, Kenya. 95pp.

Duff-MacKay, A. & Schiotz, A. 1971. A new *Hyperolius* from Kenya. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **29**:1-3.

Schiotz, A. 1975. **The Treefrogs of Eastern Africa**. Steenstrupia, Copenhagen. 232pp.

Schiotz, A. 1981. The amphibia of the forested basement hills of Tanzania: a biogeographical indicator group. Afr. J. Ecol. **19**:205-207.

Vesey-Fitzgerald, D.F. 1975. A guide to the snakes of the Tanzania and Kenya borderlands. J. E. Afr. Nat. Hist. Soc. & Nat. Mus. **149**:1-26.

Welch, K.R. 1982. **Herpetology of Africa**. Krieger 314pp.(A checklist and bibliography of the orders Amphisbaena, Sauria and Serpentes.)

INVERTEBRATES

Buxton, R.D. 1981. Termites and the turnover of dead wood in an arid tropical environment. Oecologia(Berl.) **51(3)**:379-384.

Buxton, R.D. 1981. Changes in the composition and activities of termite communities in relation to changing rainfall. Oecologia(Berl.) **51(3)**:371-378.

Buxton, R. 1979. **The Role of Termites in the Ecology of the Tsavo National Park, Kenya**. DPhil Thesis. University of Oxford.

Coe, M. 1988. The ecology of dung beetles in a xeric African environment. In **The Ecophysiology of Desert Vertebrates**. (Eds. I. Prakash & P. Ghosh). Scientific Publishers, Jodhpur, India. pp 1-33.

Crosskey, R.W. 1980. **Catalogue of the diptera of the Afrotropical region**. British Museum(Natural History) 1437pp.

Hathell, G.W. 1959. Resettlement in areas reclaimed by the Tsetse fly. Tanganyika Notes & rec.(Dar-es-Salaam) **53** :243-249 (In RGS Library).

Kielland, J. 1990. **Butterflies of Tanzania**. Hill House. 363pp.

Kingston, T.J. & Coe, M. 1977. The biology of a giant dung beetle (Heliocopris dilloni)(Coleoptera: Scarabeidae). J. Zool., Lond. **181**: 243-263.

Larsen, T.B. 1991. **The Butterflies of Kenya and their Natural History**. OUP 600pp. (Comprehensively illustrated. Detailed species accounts which cover appearance, field characters, Kenyan and African distribution, subspecies, habitats larval food plants and additional life history information when known).

Larsen, T.B. 1990. The hazards of butterfly collecting. Tsavo, Kenya (May,1988). Entomol. Rec. and J. Var. **102(1-2)**:39-40. (358 Coldharbour Lane, London, SW9 8PL).

Parsons, B.T. & Sheldrick, D.L.W. 1964. Some observations on biting flies (Diptera; Muscidae; sub-fam. Stomoxydinae) associated with the black rhinoceros. (Diceros bicornis) (L.)). E. Afr. Wildl. J., **2**: pp 78-85

Pickford, M. 1986. Mollusca of Kora National Reserve. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp 225-232.

Skaife, S.H. 1953. **"African Insect Life"**. Longmans 387pp.

West, C. 1986. Insect comunities in tree canopies. In **"Kora: An ecological inventory study of the Kora National Reserve,Kenya"**. (Eds. M. Coe and N.M. Collins). Royal Geographical Society, London. pp. 209-222.

BOTANY

FLORA

Greenway, P.J. 1943. **A Provisional Classification of East African Vegetation** Amani, Tanzania. iv + 84. (Mimeographed).

Greenway, P.J. 1969. A checklist of the plants collected or recorded in the Tsavo National Park East. J.E.Afr.Nat.Hist.Soc.& Nat.Mus. **27(3)**:169-210. *(Photocopy held in EAC)*

Polhill, R.M. (current ed) 1949-. **Flora of Tropical East Africa**. Available from Royal Botanical Gardens Kew.(So far 158 out of 225 parts have been published)

Polhill, D. 1991. **Flora of Tropical East Africa:Index of collecting localities**. Royal Botanic Gardens, Kew. pp.399.2 Maps.Pbk.

VASCULAR PLANTS

Agnew, A.D.Q. 1968. Observations on the changing vegetation of Tsavo National Park (East). E. Afr. Wildl. J. **6**:75-80.

Agnew, A.D.Q. 1974. **Upland Kenya Wild Flowers: A Flora of the Ferns & Herbaceous plants of Upland Kenya**. Oxford University Press. ix + 827pp.

Ament, J.G. 1975. The vascular plants of the Meru National Park, Kenya. E. Afr. Nat. Hist. Soc. & Nat. Mus. **154**:1-34.

Bogdan, A.V. 1958. **A Revised List of Kenya Grasses**. Government Printer, Nairobi, Kenya. 73pp+8 figs.

De Luca, P., Stevenson, D.W. & Moretti, A. 1989. ***Encephalartos sclavoi*** De Luca, D. Stevenson and Moretti (Zamiaceae), **a new species from Tanzania**. Delpinoa. 29-30:3-5.

Edwards, D.C. & Bogdan, A.V. 1951. **Important Grassland Plants of Kenya**. Pitman, Nairobi, Kenya. 124pp.

Faden, R.B., Beentje, H.G. & Nyakundi, D.O. 1988. Checklist of forest plant species (Taita Hills). Utafiti. **1(2)**:43-66.

Faden,.R.B. & Beentje, H. J. 1989. *Encephalartos kisambo*, a new cycad from Kenya, with a note on *E. tegulaneus*. Utafiti. **2(1)**:7-10.

Ghazanfar, S. 1988. **Savannah Plants: An illustrated guide**. Macmillan 240pp.

Gillett, J.B. 1983. The vascular plants of the Kora Research area in East Central Africa. In **The Flora and Fauna of the Kora National Reserve**. (Ed. M. Coe). Nat. Mus. Kenya/RGS. 47pp. (Mimeographed).

Ivens, G.W. 1967. **East African Weeds and their control**. OUP(Nairobi) 245pp.(pbk.)

Iversen, S.T. 1991. The Usambara mountains, N.E.Tanzania: Phytogeography of the vascular plant flora. Uppsala, Uppsala University. Symbolae Botanicae Uppsalienses. **29(3)**:234.

Lind, E.M. and Morrison, M.E.S. 1974. **East African vegetation**. Longman.

Piers, F. 1959. **Orchids of East Africa**. Nairobi, Kenya. 147pp. (Mimeographed).

Napper, D.M. 1966. **Grasses of Tanganyika with keys**. Govt. printer, Dar-es-Salaam.

White, F. 1983. **The Vegetation of Africa**. Natural Resources Research: XX. UNESCO: Paris. 356pp.

TREES AND SHRUBS

Agnew, A.D.Q., Payne, R. & Waterman. P.G. 1986. The structure of Acacia-Commiphora woodland in the Kora National Reserve, Kenya. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp107-134.

Agnew, A.D.Q. 1989. Drought resistant woodland in Kora National Reserve, Kenya. Afr. J. Ecol. **27**:53-62.

Belsky, A.J., Amundsen, R.G., Duxbury, J.M., Riha, S.J., Ali, A.R. and Mwonga, S.M. 1989. The effects of trees on their physical, chemical and biological environments in a semi-arid savannah in Kenya. Cornell Plantations, Cornell Univ. J. Appl. Ecol.**26(3)**:1005-1024.

Bogdan, A.V. & Pratt, D.J. 1961. **Common Acacias of Kenya**. Government Printer, Nairobi, Kenya.

Brenan, J.P.M. and Greenway, P.J. 1949. **Checklist of the trees and shrubs: Tanganyika Territory**. I.F.I.,Oxford.

Coe, M. and Beentje, H. 1992. **A Field Guide to the Acacias of Kenya**. OUP 160pp.

Corfield, T.F. 1975. **Woody vegetation in Tsavo National Park (East)**. Tsavo Resarch Project Progress Report. pp1-5. (Mimeographed).

Dale, I.R. & Greenway, P.J. 1961. **Kenya Trees and Shrubs**. Buchanan's Kenya Estates, in association with Hatchards.

Fenner, M. 1982. Aspects of the ecology of *Acacia-Commiphora* woodland, near Kibwezi, Kenya. J. E. Afr. Nat. Hist. Soc & Nat. Mus. **175**:1-11.

Gillett, J.B. & McDonald, P.G. 1970. **A Numbered Check-list of the Trees, Strubs and Noteworthy Lianes Indigenous to Kenya**. Government Printer, Nairobi, Kenya. 67pp.

Hora, F.B. 1940. **Check-lists of the forest trees and shrubs of the British Empire-Tanganyika Territory**. Imperial Forestry Inst., Oxford. pp.660.

Leuthold, W. 1977c. Changes in tree populations in Tsavo East National Park. E. Afr., Wildl. J. **15**:19-39.

McDowell, P.G., Lwande, W, Deans, S.G. & Waterman, P.G. 1988. Volatile resin exudate from stem bark of Commiphora rostrata: Potential role in plant defence. Phytochemistry. **27(8)**: 2519-2521.

McQuade, H.A., Cumbie, B.G. & Sheldrick, D.L.W. 1970. The wool-like covering of the roots of *Lannea alata*. I. The origin and morphology of the wooly coat. Amer, J. Bot. **57**:1240-1244.

Noad, T. and Birnie, A. 1989. **Trees of Kenya: A fully illustrated field guide**. Noad 308pp. (Covering over 300 indigenous and introduced species).

Nshubemuki, L. Tree-species for the semi-arid parts of Tanzania: the Dodoma experience, **in Trees for development in sub-saharan Africa** (item 38). 291-298

Provan, G.J., Alexander, I.G. Waterman, P.G. 1987a. Sesquiterpenes from the Myrrh-rich resins of some Kenyan *Commiphora* species. Flavour and Fragrance J. **2**:109-113.

Provan, G.J., Gray, A.I. & Waterman, P.G. 1987b. Monoterpene-rich resins from some Kenyan Burseraceae. Flavour and Fragrance J. **2**:115-118.

Waterman, P.G. 1986. Resins and other exudates in the flora of the Kora National Reserve. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp129-134.

ECONOMIC BOTANY AND ETHNOBOTANY

Gray, R.F. 1974. **The Sonjo of Tanganyika: an anthropological study of an irrigation based society**. Greenwood Press, Westport, Conn. 181pp.

Lock, J.M. 1989. **Legumes of Africa: A Check List**. Kew (pbk.) pp.619. (Provides summary of current information viz. economic importance to Africa of Leguminosae. Highlights objectives for further work, prompted by the International Legume Database and Information Service project, it covers all the 5825 taxa).

Tanzania National Scientific Research Council. 1990. **Bibliography of agricultural research in Tanzania**. Uppsala, SAREC 24, 686PP.

GEOLOGY AND GEOGRAPHY

Anon. 1972. Records of rainfall-Tsavo National Park 1969-1971. Tsavo Research Project. 15pp. (Mimeographed).

Anon. 1970a. Data from Meteorological station, Tsavo National Park, Voi, Kenya. For the year 1970. 3pp. (Mimeographed).

Anon. 1970b. Rainfall, Tsavo East. Tsavo Research Project. 6pp. (Mimeographed).

Anon. 1971. Data from Meteorological station, Tsavo National Park, Voi, Kenya. For the year 1971. 5pp. (Mimeographed).

Anon. 1972. Data from Meteorological station, Tsavo National Park, Voi, Kenya. For the year 1972. 7pp. (Mimeographed).

Ayeni, J.S.O. 1977. Water holes in Tsavo National Park, Kenya. J. Appl. Ecol. **14(2)** pp.369-378.

Bagnall, P.S. 1963. The geology of The North Pare Mountains. Rec. Geol. Surv. Tanganyika (Dar-es-Salaam) **10**:7-17 (In RGS Library).

Chesney, C. 1972. Rainfall records-Tsavo East National Park, for the year 1972. 3pp. (Mimeographed).

Cobb, S.M. 1975a. **The effects of roads on habitats and animals in Tsavo National Park**. Tsavo Research Project Report. pp1-6. (Mimeographed).

Cobb, S.M. 1975. **Preliminary Results of the Aerial Monitoring Programme in the Tsavo Region. Report to Trustees, Kenya National Parks**. May 1975. 23pp. (Mimeographed).

Christianssen, C. 1981. **Soil erosion and sedimentation in semi-arid Tanzania: Studies of environmental change and ecological imbalance**. Uppsala, Sweden: Scandinavian Institute of African Studies. 208pp.

Coe, M. 1985. **Islands in the bush**. George Philip, London. 240pp.

Coe, M. 1986. The ecology of rock outcrops in the Kora National Reserve, Kenya. In **Kora: An ecological inventory study of the Kora National Reserve, Kenya**. (Eds. M. Coe & N.M. Collins). Royal Geographical Society, London. pp159-171.

Glover, P.E. (No date: c1971). **Notes on the Geology of Tsavo National Park**. Tsavo Research Project. 24pp. (Mimeographed).

Hamilton, A.C. 1982. **"Environmental history of East Africa: a study of the quaternary**." London, New York: Academic Press. 328pp. Maps. Bibliog.

Jensen, C.L. & Belsky, A.J. 1989. Grassland homogeneity in Tsavo National Park (West), Kenya. Afr. J. Ecol. **27(1)**:35-44.

Phillipson, J. 1973**. Tsavo Park East: Report on primary production and "carrying capacity" in Tsavo East National Park**. Tsavo Research Project Report. 3pp. (Mimeographed), .

Phillipson, J. 1975. Rainfall, primary production and "carrying capacity" of Tsavo National Park (East), Kenya. E. Afr. Wildl. J. **13**:171-201.

Nieuwolt, S. 1974. Seasonal rainfall distribution in Tanzania and its cartographic representation. Erdkunde(Bonn) **28(3)**:186-94 (In RGS Library).

Rodgers, W.A. and Homewood, K.M. 1982. Species richness and endemism in the Usambara mountain forests, Tanzania. Biol. J. Linn. Soc. **18**:197-242.

Saggerson, E.P. 1962. **Geology of the Kasigau-Kurase area**. Ministry of Commerce and Industry; Geol Surv. Kenya. Government Printer, Nairobi, Kenya.

Sanders, L.D. 1959. **Geology of the Voi-South Yatta area**. Ministry of Commerce and Industry; Geol. Surv. Kenya. Government Printer, Nairobi, Kenya.

Tyrrell, J. 1972. Report on the analysis of rainfall data for the Tsavo region. 3pp. (Mimeographed).

Tyrrell, J. & Coe, M. 1974. The phenological significance of the rainfall regime of the Tsavo National Park, Kenya. J. Biogeog. **1**:187-192.

Walsh, J. 1960. **Geology of the area south of the Teita Hills**. Ministry of Commerce and Industry; Geol, Surv. Kenya. Government Printer, Nairobi, Kenya.

Wijngaarden, W. van & Van Engelen, V.W.P. 1985. **Soils and vegetation of the Tsavo area**. Recconaisance Soil Survey Report No. R7, Kenya Soil Surv., Nairobi.

MAPS

Berry, L. 1971. **Tanzania in maps**. London University Press.

As above, 1972. **Tanzania in maps: Graphic perspectives of a developing country**. Africana Publ.172pp.

East Africa 1:250 000 Series Y503 (Dar-es-Salaam) SMD (Surveys and Mapping Division, of the Min. of Lands,Housing and Urb.Devel.) 63 sheets, 47 publ. (Sheets most relevant-SA-37, SB-37).

Geological Map of Tanzania 1:200 000. Dodoma: MEM(Ministry of Energy and Minerals), 1985.

Geological Survey Dept.(Dodoma) Bulletins nos.17,18,29,52 may provide relevant 1 deg.(1:250,000) maps.

Gillman, C. 1949. A Vegetation-types map of Tanganyika Territory. Geogr.Rev.39(1) pp.7-37 (with coloured map 1:2 000 000).

IMW Series 1:1 000 000 Dar-es-Salaam:SMD (See above) 6 sheets, all publ.

Mkomazi Game Reserve (Same and Lushoto Districts) 1;200 000 Forest Division (Dar-es-Salaam) ref.Jb.2177 (B&W. shows river systems, roads and esp. footpaths in detail) (copy c/o Dep.Dir.RGS).

Tanzania 1:2 000 000 Dar-es-Salaam:SMD(See above) 1968.

Tanzania 1:3 220 000 Washington, DC:CIA,1970 (with 4 thematic ancillary maps on sheet).

Tanzania 1:50 000 Series Y742 Dar-es-Salaam; SMD 1947-1250 sheets(all publ.) Mkomazi covered by sheets 73, 89, 90, 91.

Tanzania: geological map series 1:125 000 Dodoma MEM (See above) 1954-. 330 sheets.(ca.140 publ).Relevant 1/2 deg. sheets; Nos.73, 89, 90, 109, 110, 111.

Tanzania: Vegetation and mean annual rainfall 1:5 000 000. Enschede: ITC,1979.

Tanzania(Northern) Vegetation map 1976. 1:1 000 000. Available at BM(NH) Botany Libr. MAP(676.2)

HISTORY

Map out of **Petermann's Mitteilungen**, from Justus Perthes (a German Publisher) Geographisches Anstallt. Ergaenzungsband XXIV.(Heft 111), 1894. In RGS MAP ROOM [Ref. DIV 1] Pub. on behalf of O.Baumann,1895.

Atlas of Tanganyika Territory, 1948.(2nd.Edition). Shows a chronological map series onwards of c.1500 + a small scale map of Tanzania/Kenya depicting the various routes taken by certain 19th. century explorers. In RGS MAP ROOM [Ref. No. 14 B 294]

l'Ajjemy, Abdullah bin Hemedi. 1962. (ed. Allen J.W.T.) **Habari za Wakilindi**. Nairobi: E. African Literature Bureau 254pp. English Edition, 1963 The Kilindi E African Literature Bureau (q.v.) 238pp.

Baumann, O. (q.v.). 1888. **In Deutschostafrika Waehrend des Aufstandes: Reise der Dr Hans Meyerschen Expedition in Usambara**. Wien and Olmutz, 1890, 224pp. (Narrative + ethnological and linguistic notes. No biology. INDEX w/ refs. to Mkomazi and Umba rivers et.c.) *In RGS library [ref.539 H]*

Baumann, O. 1891. **Usambara und seine Nachbargebiete** (Usambara and its neighbouring zones) Berlin: Reimer. 375pp. (Includes comprehensive set of relevant thematic maps, INDEX, set of Kiswahili songs w/ musical notation. Chaps. on butterflies (schmetterlinge) and skulls (schaedeln)). *In RGS library [ref.539 H]*

Baumann, O. 1894. **Durch Massailand zur Nilquelle**. (Travels 1891-93). Berlin; Dietrich Reimer. 380pp. (Concerned largely w/ anthropology. Of esp. interest may be chap.1, pp.1-17; **Nach Tanga von Aruscha**. Folded map at back. *In RGS lib.[ref.250 H])*

See Also: Fosbrooke, H.A.(annot.) **Ngoro's first visitor** et.c. A translation of Baumann's book. Kampala; E. African Lit. Bur.(1963)

Burton, Sir R.F. 1872. **Zanzibar: city, island and coast**. London; Tinsley. (2 vols.) Reprinted, New York; Johnson Reprint, 1967. Specific page refs; 2:183-235 general description of Usambara and peoples + famous meeting with King Kimwere. P.135; **The Persian tile**. Pp.433-457; meteorological appendices. In RGS library *[ref.540 H]*

Cooley, W.D. 1852. **Inner Africa laid open; the travels of Krapf and Rebmann.**

Corfield, M. 1974. **Historical notes on Tsavo**. Published privately by the Kenya National Parks, **Tsavo Research Project**. Copy held by Dr. M.Coe at Dept. of Zoology, Sth. Parks Rd., Oxford OX1 3PS. Tel.(0865) 271174. Held at Exp. Adv. Cent.(RGS) are photocopies of the contents list/index to this volume. These include RGS lib. refs., where available, to those works featured in this compilation of historical sources.

Darch, C. 1985. **Tanzania**. World Bibliographical series. Vol. 54. Oxford: Clio Press 316pp.

Eick, L. 1896. Bericht ueber meine Reise ins Kwai - und Masumbailand (Usambara), vom 12 bis 16 Marz, 1896. M. Deutsch. Schutzgeb. **9 (1896)**:184-188. (In RGS Library).

Feiermann, S. 1974. **The Shambaa Kingdom: a history**. London: University of Wisconsin Press 235pp.

Fischer, G.A. 1885. **Das Massailand**. *In RGS lib.[ref.251 B].*

Green, E.C. 1963. **The Wambugu of Usambara**. Tanganyika Notes and Records. No.61 (1963).

Hassing and Bennet. 1886. **A Journey across Tanganyika in 1886**. Dar-es-Salaam: Tanganyika Notes and Records, 58-59 (1962), pp 129-47.

Jago, N.D. and Masinde, S.K. 1968. **Aspects of the ecology of the montane evergreen forest near Amani, East Usambaras**. Tanganyika Notes and Records, No.68 (1968).

Kersten, O. (ed), Von der Decken, Baron C.C. 1869-1879. **Reisen in Ost-Afrika in den Jahren 1859 bis 1965**. (Travels in East Africa in the years 1859 to 1865) Leipzig: Winter. (1st 2 vols. narrative. 3 part 3rd vol. and 4th vol. consist of technical drawings and descriptions of fauna and flora + occasional refs. to their precise locations. Also geological and meteorological tables.) Specific page refs.: p.249,vol.1; the outward journey (1861).Point of reaching Mkomazi from Kenya. p312,the return journey (1861). P.12, vol.2 **Travelling towards Usambara** (1862) p.14 **Experiences in Pare and Kisuani** (1862). Also: detailed map of routes taken. *In RGS library [ref. 539 C and D]*

Kimambo, I.N. 1969. **A political history of the Pare of Tanzania, ca.1500-1900**. Nairobi: East African Publishing House, (Peoples of East Africa No.3) 253pp.

Kjekshus, H. 1977. **Ecology control and economic development in East African history: the case of Tanganyika, 1850-1950**. London: Heinemann 215pp.

Krapf, J.L. 1860. **Travels, researches and missionary labours during an eighteen year residence in Eastern Africa, 1837-1855**. London, Trubner. 566pp. Reprint: Frank Cass, London. (Ref. Usambara pp 266-408).

Leuthold, W. (No date). Early description and notes on the Tsavo region. Translation of J.L.Krapf. 1858. **Reisen in Ostafrika, ausgefuehrt in den Jahren 1937-1855**. Tsavo Research Project. 7pp. (Mimeographed).

Meyer, H. 1900. **Der Kilimandsharo. Reisen und Studien**. Berlin; Reimer. 436pp. Good INDEX, ref. to Usambara pp.6-70. BM; RCS; SOAS and *RGS lib. [ref.610 G]*

Mihalyi, L.J. 1970. Land alienation and forest conservation in the Usambara highlands of German East Africa in the period, 1885-1914. California G. (Northridge) **11(1970)**:29-33.

Perham, M. and Bull, M. (eds.) 1959. **The diaries of Lord Lugard**.(1890). London; Faber and Faber. For very detailed biological notes (on Tsavo East esp.) see his entries for 20th Feb. to 3rd Mar. 1890. Starts chap.2 p.109. *N/A in RGS lib.*

Perbandt, C.von, Richelmann, G. and Schmidt, R. 1906. **Hermann von Wissmann: Deutschlands groesster Afrikaner.** Berlin 578pp. (see esp.; Richelmann: River Rufiji - R. Umba 1889. pp 173-251). BM; RCS; SOAS.

Prince, Magdalene von, 1901. **Eine Deutsche Frau im Innern Deutsch-Ostafrikas**. Berlin 239pp. BM; RCS.

Redzich, C. 1913. **Zugvogel: Reise-Erinnerungen und Erlebnisse aus Deutsch-Ostafrika zur Zeit der ersten Landerwerbungen**. Berlin (I, 84-261) ref. Usambara. RCS.

Roberts, A.(ed.) 1968. **Tanzania Before 1900**. Intnl.Publ.Serv.

Roberts, A.D. 1969. **A bibliography of primary sources for Tanzania, 1799-1899**. (Books only) University of Zambia. 45pp. *RGS lib.*

Rowley, H. 1881. **Twenty years in Central Africa**. London. 288,xii pp. (ref Usambara pp 174-279 in extracts of reports and letters on the travels of Tozer, Alington, Farler, Steere, Maples et al. 1865-1876). RGS.

Sheldrick, D. 1972. Tsavo- The hard lessons of history. Africana. **10**:14-15 + 26-28.

Sheldrick, D. 1973. **The Tsavo Story**. Collins & Harvill Press, London.

Speke, J.H. 1864. **What led to the discovery of the source of the Nile**. Edinburgh and London. 372,xii.pp. (ref. Usambara in travels from 1857-1858 pp 155-372) Reprint: Frank Cass, London. DSM; BM?

Thomson, J. 1885. **Through Masai-land**. RGS expeditionary travels 1883-4. (3rd. edition). London; Sampson Low etc. (A purely narrative work, told by the man who was the first to explore the territory of the Masai and live. Folded map at back. *In RGS lib. [ref.249 C]*.

Volkens, G. 1897. **Der Kilimandscharo**. Berlin 338pp. (Travels from Tanga to Kilimanjaro).

Ward, G. (ed E.F. Russell) 1898. **The Life of Charles Alan Smythies**. London. 272pp. (extracts from letters mentioning Usambaras 1884-1894).

Weiss, K. 1886. **Meine Reise nach dem Kilima-Ndjarogebiet**. Berlin. Deutsch Ost-Afrikanishe Gesell-schaft. 42pp.(pamphlet)- ref. Pare. (Shows map of area in which he worked.Routes marked). *In RGS lib. [ref.X 317.16]*

Wohlrab, P. 1915. **Usambara: Werden und Wachsen einer Heidenchristlichen Gemeinde in Deutsch Ost-Afrika**. Bethel bei Bielefeld. 233pp. (ref.Usambara 1894-). RCS.

Wohltmann, F. 1898. **Deutsch-Ostafrika: Bericht ueber die Ergebnisse seiner Reise ausgefuehrt im Auftrage der Kolonial-Abteilung des Auswaertigen Amtes**. Berlin; Winter. 92pp. (refs. to Plantations and colonisation near the coast and in Usambara, 1897-1898.specifically pp.62-68). *In RGS lib. [ref.539 H]*

Index of Major Taxonomic Units