ANTIBIOTIC SCREENING OF PLANTS USED TO TREAT INFECTIOUS DISEASES IN KENYA

by

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ABSTRACT

This thesis presents a documentation of plants used in traditional medicine for infectious diseases in Kenya, followed by an analysis of antimicrobial activities of their methanolic extracts. In the first part of this study discussions were held with herbalists from around the Arabuko Sokoke forest in Kilifi District and various other parts in Kenya. A total of 56 species belonging to 32 families were documented to treat infections of the gastrointestinal tract, skin and sexually transmitted diseases. This documentation effort will contribute towards preservation of the fragile indigenous knowledge currently threatened by influences of modernization.

In the second part, a total of 60 extracts from 54 species were tested against selected pathogenic bacteria i.e. the acid fast bacterium - *Mycobacterium phlei,* four strains of gram positive bacteria -*Bacillus subtilis, Staphylococcus aureus* K147, *S. aureus* MR P0017 and *Streptococcus faecalis,* four strains of gram negative bacteria - *Escherichia coli, Pseudomonas aeruginosa* H187, *P. aeruginosa* H188, *Salmonella typhimurium* and two strains of yeast fungi *Candida albicans* and *Saccharomyces cerevisiae.* A total of 43 extracts of 39 nine species were active against at least one microorganism most of them having a strong link between the disease they are used to treat traditionally and the impact on the responsible bacteria and fungi. This linkage provides evidence for the presence of antibiotic substances and establishes, to some extent, the efficacy of the herbal remedies used for infectious diseases.

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DEDICATION

I dedicate this thesis to my lovely daughter Noelle Chao Mutta

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CHAPTER ONE

INTRODUCTION

Focusing attention on those plants used as medicines by indigenous peoples is the most efficient way of identifying the plants that contain bioactive compounds because traditional medicine practice has been developed over many successful generations. This thesis presents research on medicinal plants, used to manage infections, documented from various rural communities in Kenya. The research targets plant uses for bacterial and fungal infections as leads for sources of antibiotic substances and aims at providing some insights into how herbal remedies work.

1.1 Research on medicinal plants

Plants have fed the world and cured its ills since time immemorial. A vast knowledge of medicinal plants must therefore have accumulated, especially in the tropics where the large majority of all higher plant species are found. But most of this knowledge only exists as verbal tradition and only a fraction is yet available to science. Among the approximately 250 000 known flowering plant species (Heywood, 1978) (the total number of existing species is estimated to be 500 000 - 700 000) (Hostettmann, 1991), less than 10 % of all species have been subjected to investigations of secondary metabolites and their biological or pharmacological effects (Hedberg, 1987). Furthermore , the present trend is to concentrate screening on relatively few species or groups of special interest. Since people in the tropics will remain dependent on herbal medicines for many years to come, the growing interest in those regions is of utmost importance. In this connection it is alarming that it has become difficult to find young people willing to train as traditional practitioners, and that many of the plants used are threatened by extinction through exploitation of natural vegetation due to increasing demographic pressures. The most urgent tasks must therefore be documentation of the knowledge held by traditional practitioners and biochemical evaluation of indigenous medicinal plants to provide a basis for conservation of habitats and ecosystems that support medicinal plants.

Research on plants used in traditional medicine is of paramount importance to the developing world since these still play an enormous role in the health care systems. Whilst industrialized countries of temperate regions have gradually reduced the use of plant remedies during the last hundred years in tropical developing countries about 80 % of the rural population depend for their health care on traditional practitioners who mainly use medicinal plants. This fact, together with the WHO program launched in 1976 for the "Promotion and Development of Traditional Medicine", provides strong reasons for devoting considerable resources to research on medicinal plants in the tropics.

History of Research on Medicinal Plants

In order to evaluate the prospects of medicinal plants research we must know something about the results already obtained. History is important since the past gives us the key to the present and should help in planning for the future. Already many hundred years ago a vast knowledge had accumulated on plant species used for medicinal purposes. It is a matter of definition to state the time when the <u>scientific research</u> started on plants used in traditional medicine. But it would probably be safe to date back to the late 18th century when "scientific" investigations were carried out on the effects of *Digitalis* (Scrophulariaceae) by Dr. William Withering (Hedberg, 1987; Lewington, 1990).

Up to early 1800 plant drugs were used raw , crude or as simple extracts. A new epoch was initiated when for the first time morphine was isolated from opium (*Papaver somniferum, P. setigerum* Papavaraceae) and from then on the interest seems to have gradually diverged from <u>research on medicinal plants</u> to <u>research on plant medicines.</u> In other words, the research became increasingly oriented towards the chemical aspects of the medicines and the isolation and manufacturing of pure compounds like strychnine, caffeine and quinine.

The steady improvement of methods in synthetic chemistry meant that the searching of the plant kingdom for remedies diminished. More research was instead being directed towards the synthesizing of new products. This downward trend was seen in the continuous decrease in the importance of medicinal drugs of plant origin. In this era many scientists often forgot that the starting materials for their research were nearly always natural compounds from plants known to be used in traditional medicine, and that their success in creating new medicines were attributable to such model substances.

This trend would have continued were it not for a widespread tropical plant, extensively used in traditional medicine but until about 1950 ignored by the scientists. The discovery of the potent alkaloids in *Catharanthus roseus,* in Apocynaceae, with marked oncolytic properties in 1957 (Bernard, 1967) turned the tide. Although not explicitly stated , this discovery was probably a major reason for the changes in attitudes towards research on plants used in traditional medicine. In the nearly 40 years since the discovery, hundreds of scientific reports have been written and the search for other antitumour agents of plant origin has been stimulated.

In this context it is notable that the first report on *Catharanthus roseus* dates back to more than 300 years. The first printed information on the species is given in 1658 in De Flacourt's "Histoire de la Grand Ile de Madagascar" by Boiteau (Hedberg, 1987). The case of C. *roseus* is by no means unique. As mentioned earlier, most of our modern medicines are based or modeled on compounds occurring in plants which have been used for hundreds or thousands of years in traditional medicine. In China attempts have been made for many years to integrate traditional and modern medicine, and the screening of plants for medical use is restricted to those used in folk - medicine; according to Chinese researchers random screening is not frequently used "since it requires much sowing but yields little harvesting" (Xiao Piegen, 1981).

It has also been shown by Perdue (1970), and many others since, that screening of plants used in traditional medicine gives significantly higher proportions of interesting substances than random screening.

The Current Status of Research on Medicinal Plants.

Literature on medicinal plants used in the tropics has proliferated during recent years, ranging from exhaustive books on practically all scientific and traditional aspects in a country or an area to those based mainly on information about traditional use. Examples of the first kind are the renowned "Medicinal and poisonous plants of Southern and Eastern Africa" (Watt and Breyer Brandwijk, 1962), "Spices, condiments and medicinal plants in Ethiopia" (Jansen, 1981), "Medicinal plants in tropical West Africa" (Oliver-Bever, 1986), and encyclopedias like "The wealth of India" (1948 - 1976). Examples of less extensive surveys, usually giving only the scientific and local names and accounting for reported local uses are "Medicinal plants of West Africa" (Ayensu, 1978), "Medicinal plants of East Africa" (Kokwaro, 1976, 1993) and "The traditional medical practitioner in Zimbabwe" (Gelfand et al., 1985). Furthermore, there are several journals dealing largely or exclusively with medicinal plants like for example, "The Journal of Natural Products" (formerly Lloydia). This publication started in 1938 as "A quarterly journal of biological science", to be changed in 1961 (Vol. 24) into " A quarterly journal of pharmacognosy and allied sciences" and in 1970 (Vol. 33) into "A journal of natural products" . Another relevant publication is the "Journal of Ethnopharmacology", the first volume of which appeared in 1980. A comprehensive survey of the present situation as regards research on medicinal plants in the tropics is given in "A world survey on medicinal plants and herbs" (Marini - Bettolo, 1980).

The Future of Research on Plant Medicines

Judging from the large number of useful substances already obtained from plants, and in view of the fact that only 7 % (Hedberg, 1987) of those species now known to science have been properly investigated pharmacologically, research in this area offers a wide scope for the future. An expansion of screening programs will provide a valuable source for new therapeutics in the future, a reservoir which should be sustainably utilised before the large scale destruction of many plant species occurs. The dwindling plant species of the world must soon be biologically evaluated and conserved before many become extinct. Programs to identify these species have been or are being elaborated in most developing countries and collaboration is now established between scientists in such countries and in developed ones. The fact that WHO encourages and supports such programs is stimulus towards extended research in this area.

1.2 Indigenous Knowledge and Plant Medicines

The first part of this study is based upon indigenous knowledge which is a rich source of information on medicinal plants. Since screening of plants used in traditional medicine yields a much higher output of interesting substances than do plants sampled at random (Hedberg, 1987), it is obvious that a very important issue would be to inventorize the vast knowledge of traditional practitioners in the tropics and to document it in an easily available system. This is an urgent task since with the present rapid acculturation most of the present day practitioners seem to be unable to find successors. This means that when they die their knowledge is lost forever. To quote a scientist who worked for many years in South America: "Each time a traditional healer dies it is as if a library has burnt down". It is frightening that in most developing countries the half - life of existing knowledge of traditional healers is probably not more than ten years (Hedberg, 1987).

All rural communities in Kenya abound with a wealth of knowledge about medicinal plants. But the advent of modern medicine, culturally insensitive education programs, sophistication and urbanization have led to the continuing erosion of this knowledge base. For example colonial rule and the spread of Christian missions in Africa posed an unprecedented challenge to the integrity and character of indigenous religions and their associated systems of traditional healing. Several generations of

Africans educated in colonial government and mission schools and colleges were taught that indigenous religions and traditional healers were savage and primitive (Good, 1987). In Kenya for instance, widespread adoption of Christianity was probably delayed because the missionaries - especially Protestants - demanded rapid, radical changes in African social and cultural practices, including elimination of traditional religious ceremonies in sacred groves and consultations with traditional healers (Good, 1987). Aided by the missions, colonial authorities vigorously repressed and officially banned some organized religious therapy systems.

Since the current formal education system does not recognize indigenous knowledge systems there has been a diminishing interest among the youth in traditional medicine. The current rural urban migration of the youth is also breaking family links through which the much guarded knowledge is passed on to close family members. As a result the traditional practioners age and pass away with the information.

The Role of Indigenous Knowledge in Health, Nutrition and Industry

The majority of the world's peoples rely on traditional knowledge of plants, animals, insects and farming systems for either food or medicines or both. The Rural Advancement Foundation (RAFI - UNDP) estimates that 80 percent of the world's people, about 3.5 billion people (WHO), continue to rely upon indigenous knowledge for their medical needs and possibly two thirds of the world's people could not survive without the foods provided through indigenous knowledge of the biodiversity in their ecosystems and landscapes. For example some 150 drugs from North American indigenous communities have been incorporated into the modern US pharmacopoeia (Kloppenburg, 1988).

Peoples who live in or near tropical forests represent libraries of information on uses of plants for medicinal purposes. This traditional knowledge of plant use by the gene - rich developing world is valuable to all of humanity as scientists from gene - poor industrialized world use it for leads in therapeutic drug discovery. Of the 120 active compounds found in plants and used in Western medicine, 74 % have the same therapeutic use in traditional societies (Moran, 1994). Thus indigenous communities have made and continue to make important contributions to industrial agriculture, the pharmaceutical industry and biotechnology. Among the most famous examples are the skeletal muscle relaxant d -tubocurarine, which is derived from the Amazonian arrow poison known as curare made from barks of mainly *Chondodendron tomentosum* (Menispermaceae) (Heywood, 1978)or *Strychnos* sp. (Loganiaceae) , and the antimalarial drug quinine, which is extracted from the bark of *Cinchona* spp (Rubiaceae).

This wealth of knowledge is embedded in forest peoples' cultural systems and is due to the fact that indigenous peoples, at least in the tropics, inhabit the most diverse ecosystems of the world. Indigenous and rural communities possess the substantial majority of agricultural and medical biodiversity that continues to exist *in situ*. They have discovered, developed and or protected almost all biodiversity in traditional land and waters. They have a sophisticated understanding of the species they use and make important contributions as innovators, sometimes taking care of 200 to 300 different species. Farmers' fields and forests are laboratories, farmers and healers researchers, and every season an experiment that yields results that are passed on to succeeding generations. It is through these processes that knowledge of the use of plants, animals and microbials has been acquired, and continues to accumulate wherever indigenous peoples are free to determine their own destinies.

However, this knowledge as well as the cultures are threatened with disapearance. Since 1900, due to outside encroachment, introduced diseases and loss of habitat, extinction has been the fate of an average of one indigenous culture each year in the Amazon region alone (Cultural Survival, 1991). It thus apparent that we should recognize the existing ethnomedical systems as sources of useful information on medicinal plants with biological activity. Such exploration involves interactions with indigenous peoples through medical ethnobotany, to identify and document valuable plant species, for instance those used for the management of infectious diseases.

Recognizing Indigenous People as Innovators

In recognizing the contributions made by indigenous people towards research on medicinal plants, it is important to consider the ethical implications before beginning an ethnopharmacological project. It is often ethnic minorities or rural people whose knowledge stimulates the selection and screening of specific plants. Local people must be compensated for their intellectual contribution to discovering novel, plant derived commodities. Researchers, and every one else involved in prospecting useful plants, share in the responsibility to ensure that the benefits get to the right people.

In the past, collecting has been largely uncontrolled, with sample material being taken for analysis to Europe, Japan or North America. Drug development and patenting has taken place without the knowledge of people in the country of origin, with no recompense for use of regional natural substances and often without any contractual obligation. Local professionals such as botanists or foresters are paid privately to collect samples for industrial companies or other sponsoring organizations. These people often do not understand the full implications of their work and their payment bears little relation to the potential value of the resource. As many developing countries pay them relatively little and hard currency is hard to get, it is understandable that this occurs. Nevertheless, it has important implications for regional development and conservation. From the point of view of national and local interests, these sponsoring organizations should not be allowed to treat a country's natural resources as global common property, especially considering that the natural resources may later be privatized by the same organization. Indigenous people must benefit equitably from the development of products that their knowledge has revealed. Governments of developing nations should put up institutions to educate the local people of their intellectual rights and protect them. Concrete arrangements to share the outcome of research on indigenous knowledge are recommended and should be developed in consultation with the local resource people. It is through benefiting from the natural resources that people will realise the importance and urgency of conserving the resources.

1.3 Biological Diversity

The second part of this study is devoted to adding biological value to the plants through laboratory screening of plants for antimicrobial activity. This exercise offers the public, policy makers and developing agencies a greater understanding of traditional herbal remedies. This information is vital for the sustainable use of biodiversity that supports such plants, so that decisions made on natural resources have a sound basis. In order to appreciate this role it is imperative to discuss the current isssues on biodiversity.

Issues and trends in biodiversity

Over 90 % of the earth's remaining biological diversity is in the tropical and sub tropical regions of Africa, Asia and South America. Seven percent of the earth's surface hosts between half and three quarters of the world's biological diversity (RAFI, 1994). It is estimated that between 35, 000 and 70, 000 different plant species have been used as medicines by various peoples of the world (Lewington, 1990). More than two thirds of the world's plant species - at least 35,000 of which are estimated to have medicinal value - come from developing countries in the tropics (RAFI, 1994). Example after example illustrates how much more biodiversity can be found in developing than in developed countries.

There is more diversity on a tiny island off the coast of Panama than there is in the entire British Isles. Panama, in fact, is less than one third the size of the United Kingdom, yet it has more than five times as many vertebrate species alone. Costa Rica is less than a tenth the size of France, but has almost three times more vertebrate species (RAFI, 1994). A single hectare near Kuala Lumpur in Malaysia holds half as many plant species as can be found in all of Denmark (UNEP, 1992). A small volcano near the International Rice Research Institute (IRRI) in the Philippines has more tree species than Canada (Prescott-Allen and Prescott-Allen, 1986), and a 15 hectare plot in Borneo has more woody species than in all of North America (Kloppenburg, 1988). Per square kilometer, Mexico and Indonesia both have more than five times the plant diversity of the United States; Peru has seven times the plant diversity of the United States; South Africa, nine, and Colombia, nineteen. The largest plant diversity is believed to exist in Southern Africa.

Even these figures underestimate the true disparity between developing and industrialized countries, since far larger proportions of the total number of species are recorded in developed than in developing countries. By universal consensus , the largest concentration of plant species lies in South America - a region with comparatively few ecologists. In contrast, the largest concentration of ecologists is in North America - a region notable for its lack of botanical diversity (RAFI, 1994).

The Value of Biological Diversity to Agriculture and Pharmaceutics

The sometimes random, sometimes systematic collection of indigenous peoples' agricultural genetic diversity has yielded considerable economic benefit to the world community, including industrialized countries. Genes from the fields of developing countries for only 15 major crops contribute more than $50,000 million in annual sales in the United States alone (RAFI, 1994). RAFI estimates that the contribution of the IARC - held germplasm to developed country crop production is at least $5,000 million per annum; almost all of this germplasm has been collected in developing countries.

One fourth of the prescription drugs on the marketing in the U. S. today are plant derived. It is estimated that in 1990, American consumers spent over $15.5 billion on prescription drugs which contained active ingredients extracted from plants (Moran, 1994). At least 7,000 medical compounds in the Western pharmacopoeia are derived from plants. According to an intergovernmental meeting of developing - country experts in Tanzania in 1990, the estimated annual value of developing - country germplasm to the pharmaceutical industrial could be as high as $47, 000 million by the year 2000 (Prescott-Allen and Prescott-Allen, 1986). At the beginning of the 1990s, worldwide sales of all pharmaceuticals amounted to more than $130,000 million annually; a conservative estimate would be that $32, 000 million of these sales are based upon traditional medicines. However we are currently faced with imminent loss of plant species due to human influenced deforestation activities.

The Problems of Deforestation and Medicinal Plants

Every second of every day, a tropical forest the size of a football field (Moran, 1994); 50 acres every minute - or more than 100 000 square kilometers per year (Hedberg, 1987) is destroyed with cumulative consequences that cross national borders and affect us all. Deforestation erodes the biological diversity of life, itself, since tropical forests are the habitat of almost half the plant and animal species on our planet. In Kenya with a population increase of 4.1 % per year (Anon, 1987) means increasing pressure on forest land for agriculture and products. The annual natural forest loss stands at 360 km^2 because of deforestation (Redfern, 1992). At loss is the diversity of life forms that hold promise for scientists to discover new medicines, crops and industrial applications (Fowler et al., 1988). In this simple fact lies one of the main threats for future development of research on and use of medicinal plants in the tropics. Forest peoples lose their homelands and humanity loses generations of their traditional knowledge of the use of forest resources. Deforestation diminishes forests' ability to moderate climate and the loss of forest cover exacerbates soil erosion and flooding, increases siltation in rivers and estuaries, and disrupts regional hydrological cycles. A vicious cycle of poverty, destructive population and consumption practices, poor land use and land tenure policies and inappropriate development has doubled the rate of tropical deforestation in the past decade (Moran, 1991). Unfortunately the day has yet to come when governments and aid agencies realize the disastrous consequences of the present devastation of nature in the tropics.

Species loss/ erosion

Indigenous communities are losing the biodiversity essential to their survival, as approximately 100 species per day are becoming extinct (Dalrymple, 1986). More species are lost per week now than were lost in total during the preceding centuries (Prescott-Allen and Prescott-Allen, 1986). Nowhere is the loss greater than in industrialized countries. For example since the turn of the century, 97 percent of the varieties of 75 vegetable species in the United States have become extinct; 86 percent of apple and 88 percent of pear species have also disappeared (RAFI, 1994). Similar losses have been estimated for pears and apples in Belgium.

Losses of medicinal plants in industrialized countries are estimated to be significant. The destruction of cultures and agriculture in industrialized countries makes it unlikely that these countries will find many more traditional medicines. In the mid -1980s , industry analysts warned that each medicinal plant lost in the rainforests could lose drug firms sales of more than $200 million(RAFI, 1994). The net effect of species and genetic erosion in developed countries is to leave them almost entirely dependent on the biodiversity of the developing countries, where loss and erosion are also dramatic. In 1990, RAFI estimated that more than 70 percent of the genetic diversity of the world's 20 major food crops had been lost from farmers' fields. Virtually all of those farmers are members of indigenous communities in Africa, Asia, and South and Meso-America.

Applying Biological and Cultural Diversity

The fact that conservation of vegetation and species is impossible without scientific studies on their social and economic uses still seems difficult to grasp in most countries, be they developed or developing. The situation is already alarming in , for example, some parts of India where plants used for centuries in traditional medicine are on the verge of extinction (Jain and Mehar, 1980). Without comprehensive efforts to conserve the vegetation over large areas in the tropics not only species already known to be useful, but also many species not yet known to science, will become extinct in the near future.

The sustainable use of biological resources for medicinal purposes was addressed in the Biodiversity Convention and could begin with bioassays or chemical screening of plant species. Bioassays are tests in which organisms or their parts, typically in the form of chemical extracts, are assessed for their effects on diseases or disease organisms. They are a form of inventory and should be included in the cataloguing process. Bioassays are typically carried out in laboratories of industrialized countries, but increased screening in developing countries offers many benefits. Screening is labor intensive, yet non - invasive, so it can generate jobs and be compatible with local conservation programs. Labs near forests can use fresh samples in the search for chemical activity that may be seasonal. Also it is more vigorous to study source organisms when they are sporadically variable at different times in different places (US Congress, Office of Technology Assessment, 1993)

Rather than random screening of species, organisms can be chosen for bioassays through leads unique to the area and cultures where they are located. In this project, plants used in traditional medicine for the management of infectious diseases are documented and biologically evaluated for antibacterial and antifungal activity though bioassays. Historically, traditional communities have utilized the relationship of local flora and epidemiology as traditional healers have based the selection of their medicinal plant use on observation of the therapeutic effects of local plants on humans and animals. For pharmaceuticals, concentrating on the traditional uses of plants focuses on leads for screening and results in a more timely and less expensive drug discovery process. Likewise, leads from the traditional process of plant preparation for healing provide clues to the type of chemical compounds in plants under investigation. Combining industrialized countries' technology with knowledge of the use of local species in traditional medicine—merging ancient and modern knowledge systems --- offers a powerful methodology for more efficient drug discovery and a pragmatic reason for countries to protect their biodiversity.

CHAPTER TWO

BACKGROUND INFORMATION

Field study in a tribal area gives first hand information (Rao & Hajra, 1986) because the local herbalists are the resource people whose knowledge on herbal medicine is based on practical experiences . In my study I interacted with the Giriama of the Kenyan coast. They belong to the broader tribal group Mijikenda to which I (Rabai) also belong.

2.1 The people of Kenyan coast

Ranging over 12,950 km^2 of the Kenyan coast and its immediate hinterland and also south for a little way along the Tanzanian coast are the Mijikenda people as shown in Appendix IV, and V pages 138 - 139. The Mijikenda or Midzikenda, as they are called in the local vernaculars, number at least 350, 000 and comprise nine sub - groups : the Kauma, Chonyi, Jibana, Giriama, Kambe, Ribe, Rabai, Duruma, and Digo. They are closely related but distinct peoples who share a common linguistic and cultural heritage, but who have each developed their own distinctive dialect and culture over the past three and half centuries. Prior to the mid - 19th century each lived within its own hilltop kaya or village, on the ridge behind the southern Kenya coast from Kilili to Vanga. Each kaya was a large cleared circular glade surrounded by a fortified palisade and thick woods as defenses against the pastoral Oromo who lived on the plains below. During the day, people left the kaya to farm sorghum, millet, and later, corn in their fields below, but all returned to the security of the kaya at night where each person lived in the section set aside for his or her clan, a group of people who traced their common descent from one of the founders of the kaya (Spear, 1982).

During the last century, the villages moved outside the forest patches and the Kayas have come to mean the forest patches which have survived and been protected by the traditions and customs of elders who used the old Kaya clearings for ceremonies. Over the past few decades an increasing disregard for traditional values and a decline in respect for the elders has led to damage to these small forests and associated sacred groves (Robertson, 1992).

2.1.1 The Giriama,

This study was carried out among the Giriama, the largest cluster of the Mijikenda (Brantley, 1981). Numbering approximately 150, 000 in 1969 and occupying almost 6,475 km^2 - mostly in scattered patrilineal, patrilocal homesteads - today they are the major population in Kilifi District, Coast Province (Brantley, 1981; Parkin, 1972).

The Mijikenda all share a common and in many ways remarkably consistent tradition of origin: that they came from Singwaya, a place in the north, in Somalia whence they were driven by a war with the Galla, a pastoral group who play the role of destructive villains in many historical traditions and written histories of the East African coast. From Singwaya, the Mijikenda came south and settled in the Kenya coast hinterland in Kilifi and Kwale districts (Parkin, 1991). Around Mombasa, they found refuge from the Galla in kayas, settlements in clearings within dense stands of forests, only entered by narrow pathways.

Giriama homesteads are linked primarily by footpaths. A network of dirt roads joins small administrative centers such as Ganze, Hadu, Kinarani and Vitengeni. The only semiurban population is at Kaloleni in the southwest, where cash crops foster a concentrated residence pattern. Their economy is based on their own grain production, and agricultural labor is primarily women's work. They are agriculturists and cattle keepers, and traders who dominate the woodland plateau in Kenya's immediate coastal hinterland between the town of Mombasa and the Malindi/ Mambrui complex. They cultivate the traditional staple crops of millet (*mawele*), sorghum (*mtama*), eleusine (*wimbi*), cassava, beans (*kunde*), sweet potatoes, pulses (*pojo*) and yams and they also grow tobacco and castor beans. Cotton is grown in a few areas; at Kaloleni and in the government settlements coconut trees are cultivated for *tembo* (palm wine) or *copra* (for oil) and scattered orange and cashew trees offer cash income. The Giriama are also hunters and trappers, using special pits and snares as well as bows and arrows. Most families keep goats, sheep, and chickens and some cattle which are tended by young boys. Formerly each family made its own pottery and baskets as well as bows and arrows and arrow poison; blacksmiths produced hoes, knives, axes, and arrow tips. The majority of the population speak kiGiriama rather than kiSwahili, though the languages are extremely close linguistically. Although some of the younger generation have adopted western dress, most Giriama still wear imported cloth wrappers; the elders wear a waist cloth and carry a walking stick; Giriama women still wear the traditional short, layered skirts which resemble ballet tutus (Once made of grass, these are now made of cotton cloth). Today the Giriama are represented in local government by appointed chiefs, but most daily government is still conducted by local councils of elders (Brantley, 1981). They are pastoralists, farmers, laborers and fishermen who rely on the Arabuko Sokoke forest for medicine, food, firewood, construction timber, poles and wild fruits.

2.2 Traditional medicine

Traditional medicine is the sum total of all the knowledge and practices, whether explicable or not , used in the diagnosis, prevention, and elimination of physical, mental and / or social imbalance. It relies exclusively on practical experience and observations handed down from generation to generation, verbally or in writing. Most of the world's population relies entirely on local medicines made almost exclusively from plants and, as western drugs continue to be unaffordable or in many instances inappropriate, this pattern of dependence on local herbal cures is set to rise (Lewington, 1990).

In 1976, 70 - 80 percent of the population in the African region, as designated by the World Health Organization, did not have access to such basic modern health care services as: protective immunization, assistance to mothers during pregnancy and childbirth, post natal and infant care, health and nutrition education, safe water supplies, and first aid / emergency care. This means that up to 1976, most of the African population relied on traditional healing systems for their day to day health care needs (Anokbonggo, 1992). The World Health Organization lists 10,000 species of medicinal value commonly used by a majority of households in Africa (Anon, 1987).

The expansion of traditional medicine is a significant trend in African urban areas. Traditionally based therapies are thriving in towns and cities because they fill a void for services that are in demand, they are accessible and they offer culturally recognized responses to illness. As confirmed by the Nairobi case study by Good (1987) as well as studies in African cities (International Development Research Center, 1980) instead of diminishing, traditional medicine displays a remarkable resilience and capacity to adapt to the needs of town dwellers. Traditional medical practitioners are among the largest categories of self employed persons in the vast "informal" urban economy. Traditional medicine therefore forms an integral part of the primary health care systems of most developing countries.

2.2.1 Traditional Medicine in Kenya

Traditional healers are still viewed by Westerners and many educated Africans , at least publicly, as the incarnation of a shameful legacy of paganism, barbarism, and black magic. The activities of traditional medical practitioners are often held up as "examples of irrationality and malpractice, a mixture of superstition, deliberate deception and ignorance...." (Good, 1987). While nations such as Europe and Japan developed their traditional medicine to the present modern medicine; and China and India developed their traditional healing systems alongside modern medicine, Kenya belongs to the category of those nations which started off with traditional medicine and later adopted modern medicine. However nations in this group did not take the appropriate steps to develop their traditional medicine systems to a level where they can be used effectively alongside modern medicine. These nations have had no capacity to develop and maintain modern medicine to cater for their healthcare structure . As a result of this drawback, modern medicine, continues to be lacking in its capacity to provide health care coverage to the people of these countries and traditional healing systems continue, in their undeveloped form, to provide the majority of the population of these nations with the day to day health-care.

Because of the enormous burden of ill-health, and the continuing - even increasing - dependence of Africa's people on traditionally based therapies, it makes little sense for traditional medicine to remain compromised and discredited because the official health establishment denies its worth or scientific intelligibility. This low status is inconsistent with evidence emerging from expanding literature on theoretical and applied aspects of traditional medical systems. Studies of traditional medical systems in tropical Africa over the past two decades reflect increasing conceptual sophistication and sensitivity to the gains in knowledge and understanding that are possible through interdisciplinary approaches in research.

2.3 Primary Health Care

Traditional medicine essentially forms an integral part of the primary health care systems of most developing countries. As delineated by WHO comprehensive primary health care should include "among others treatment against major infectious diseases, prevention and control of locally endemic diseases, appropriate treatment of common diseases and injuries, and provision of essential drugs" (WHO, 1978). WHO has laid down several fundamental principles for primary health care: (1) the use of appropriate technology with a minimum of costly drugs and equipment; (2) a maximum use of village health workers;(3) sensitivity to the traditions of indigenous healers and midwives, with an active community role both in planning and developing the program; and (4) an intersectoral or holistic approach to the improvement of health in the community. This may include attention to a broad range of interconnected issues, from animal husbandry, horticulture, afforestation or small scale irrigation to prenatal care, dialogue with traditional healers and midwives, and family nutrition education

In Kenya, where the rural communities are served by only 15% of trained medical doctors and poor transportation infrastructure, the reliance on traditional medicine is immense. Traditional medicine is beneficial because it is cheap, accessible and efficacious. Traditional medicine therefore meets the WHO criteria and by focussing research efforts towards it my study will contribute towards the achievement of better primary health care delivery in Kenya. In the provision of health for all by the year 2000 WHO recommends the integration of traditional medicine into the health care mainstreams of the developing worlds (Goldsmith, 1989). Traditional medicine has been documented to manage problem diseases such as epilepsy, diabetes, sterility, etc, but my study focuses on herbal remedies used in the management of infectious diseases.

2.4 Infectious Diseases

Infectious diseases are important because we live in a microbe filled world and every day we are faced with challenges of fighting new types of infections. Infection is the result of invasion of the body by a microorganism which destroy its tissues. Communicable disease indicates that the infection is contracted by contact with a source of the microorganism. Microorganisms colonize animals including humans, food, water and soil and human infection can be acquired from any of these sources (Bannister, 1983). Infections still persist as the single most frequent reason why people seek medical care. One reason for this, despite all the advances in therapy, is the diversity of organisms; another is the development of antibiotic resistance as a result of genetic mutation, or gene transfer from an antibiotic - resistant organism to an antibiotic - sensitive one.

Infectious diseases are prevalent in the tropical environment because the wealth of plant, animal, microbial species and human population assures an abundance of opportunities for multiple exposure and frequent infection. To this one must add the special problems of sewage disposal, water sanitation problems, intense poverty and crowding. Widespread malnutrition, especially protein deficiency, significantly exacerbates hyporesponsiveness to parasitic infection. An early age of exposure to parasites may also play a role in nonresponsiveness, including development of tolerance to the parasite's growth and maturation (Goldsmith, 1989). In Tanzania and Kenya infectious diseases comprise more than 50 % of all admissions and deaths in hospitals and clinics (Petit & Ginneken, 1995). An analysis of hospital records in Kenya, Zambia, Tanzania and Ghana between 1975 and 1990 shows that about 75% of all admissions in children below 15 years of age were due to infections and infection related diseases; for adults this figure was 31%. Bacterial infections, in particular gastroenteritis, pneumonia, meningitis and tuberculosis are important diseases in terms of both admissions and deaths (Petit & Ginneken, 1995).

These figures are particularly relevant to the present study, which identifies a number of the plant medicines traditionally used to combat these problems in Kenya. Some of these may, through broader applications, help to alleviate these major health problems in Africa.

Bacteria that cause diseases to humans

Bacteria are ubiquitous, inhabiting virtually every ecological niche capable of supporting life. Most skin and mucosal surfaces are occupied by a variety of bacteria which cause no harm to the host tissues. Normal flora is only harmless when confined to body surfaces. If surface organisms enter the tissues or circulation, however, they are quite capable of causing serious disease. Numerous species of bacteria can cause human disease but those included here represent the spectrum of bacterial pathogens pertinent to this study i.e. skin and intestinal infections and sexually transmitted diseases.

A wide variety of pathogens can infect the skin and mucous membranes. *Staphylococcus epidermitis (albus)* and *S. aureus,* Gram-positive cocci, are colonists of skin (Bannister, 1983). *S. aureus* is highly pathogenic, and enters the tissues easily through skin defects. It is a common cause of wound infections, boils and abscesses in bones and other tissues. Moreover certain strains cause food poisoning, and some apparently are responsible for toxic shock syndrome. *Streptococcus pyogenes* is a Gram-positive coccus which is found on skin and in the pharynx. It enters skin defects, and passes from person to person by contact, as does *S. aureus.* It can also be transmitted by droplet infection and, sometimes by food. *S. pyogenes* is the cause of "strep throat", scarlet fever, wound infections, and infections of the skin, ear and lung.

Intestinal infection results from the consumption of organisms which become established in the bowel and attack the mucosa. Food poisoning is the illness which follows consumption of food contaminated by bacteria, bacterial toxins or toxic chemicals. *Escherichia coli,* a Gram negative bacteria, is a resident of the bowel and is responsible for sporadic disease and for epidemics in nurseries and hospital wards. Some *E. coli* strains produce a toxin which is thought responsible for many cases of 'travellers's diarrhea while some are responsible for meningitis and urinary tract infections (Nester et al., 1983) . *Salmonella enteritis* often referred to as 'food 'poisoning is the commonest food-borne infection. It can be aquired from all kinds of meat and fowl, sometimes from fish and from food contaminated by handlers'(Bannister, 1983). *Salmonella enteriditis* causes gastroenteritis while *S. typhi* causes enteric fever (Nester et al., 1983).

Sexually transmitted diseases are acquired through intimate contact of mucous membranes and are caused by bacteria, viruses, fungi, protozoa and ectoparasites (Osoba, 1989). The bacterial pathogens include *Neisseria gonnorrhoeae* and *Treponema pallidum*. The genus *Neisseria* includes the species of Gram-negative cocci of greatest medical importance (Nester et al., 1983). *N. gonnorrhoeae* the 'gonococcus' causes gonorrhea, the acute infection of the epithelium of the genitourinary tract. Gonorrhea is usually transmitted by sexual intercourse and is one of the most communicable diseases in the world, estimated at about 200 million new cases annually (Osoba, 1989). The spirochete *Treponema pallidum* is the cause of the venereal disease syphilis. Early disease occurs in children and is characterised by mucous membrane and skin lesions. In late disease gummatous lesions of the skin and bones persist, ulcerate and are destructive.

The Gram negative bacterium *Pseudomonas aeruginosa* is a common cause of hospital acquired infections. *P. aeruginosa* is found in many environmental sources, on raw vegetables, and in the normal human intestine. It is not highly invasive, usually infecting only individuals with impaired host defenses. Treatment is often difficult because most strains are resistant to many antimicrobial medicines (Nester et al., 1983).

The acid fast bacteria in the genus *Mycobacterium* are also important human pathogens. *M. tuberculosis* is the cause of human tuberculosis and the routes of infection include the commonest, airborne transmission, ingestion, through blood and inoculation. The infection affects the respiratory system but any organs may be affected.

Fungi that cause diseases to human

Fungi cause diseases in human and other animals as well as plants. They are ubiquitous and well adapted to using a wide range of substrates for their carbon, nitrogen and energy source. Many fungi can be especially difficult to control because of their ability to grow on almost anything.

Plant fungal diseases include potato late blight caused by *Phytophthora infestans* which in 1845 destroyed 40 % of potato crop in Ireland (Hostettman, 1991); tobacco blue mould which in 1960 caused losses of more than $30 million in Europe (Hostettman, 1991); hop downy mildew which between 1924 and 1926 reduced hop yields by 80%; Dutch elm disease which in 1930 caused the death of 25, 000 trees within 8 years in New Jersey; Ergot of rye caused by *Claviceps purpurea* which in 1951 caused the death of five people and made 300 sick in Pont - Saint - Esprit; cereal rusts caused by *Puccinia graminis* which in 1935 caused the loss of 3.7 million tons of wheat in northern US; corn blight caused by *Helminthosporium maydis* which in 1970 swept through the United States causing losses of over $1 billion; and Grape downy mildew (Hostettman, 1991).

Fungi also cause numerous diseases, of serious concern in human and other animals (Bulmer, 1979). In addition fungi produce toxins in foods. Another problem caused by fungi is that their spores give rise to allergies. Athletes' foot, caused by *Trichophyton mentagrophytes,* is probably the most commonly recognized fungal infection in humans and fortunately, one that is seldom incapacitating, unlike many fungal diseases in the tropics. Aspergillosis and actinomycosis are common problems that have been studied since 1841 when they were first recognized. Histoplasmosis and coccidiodomycosis are estimated to affect over 100 million people in the US. Most of these diseases are difficult to treat and this problem is compounded by the increasing use of immunosuppressants in medicine, diabetes, and the spread of AIDS all of which increase human susceptibility to these stubborn fungal infections. A major problem is to control these fungi without negative effects on the animals, including humans, who use farm and food products or are affected by the diseases.

Another important use for fungicides is the preservation of wood, cloth, leather, paper products and other organic materials. This can present a serious challenge in the tropics, where there may be long periods of high humidity and temperature. A serious challenge is in wood construction in contact with the ground, which is teeming with organisms that use wood as a source of nutrients.

2.5 Antibiotics

Antibiotics are low - molecular weight organic substances that in very low concentration inhibit the growth of microorganisms. We do not include among the antibiotics those enzymes , such as lysozyme, and other complex protein molecules such as colicins which also display antibacterial properties. Inhibition of the growth of microorganism means either temporary or permanent inhibition of the ability of the microorganism to reproduce and, consequently, inhibition of growth of the bacterial population rather than that of an individual cell (bacteriostatic). Some antibiotics actually kill the bacterial cell (bacteriocidal). "At low concentration" is added to the definition as even essential and normal cell components can cause damage at excessive concentrations. For example, glycine, one of the constituents of every protein, has a strong bactericidal effect on some bacteria if it is present in the culture medium in high concentrations. A low concentration generally means values well below 1 mg/ml.

Antibiotics may be either natural or synthetic compounds. Some of them show marked and selective biological activity against microorganisms, and if they show low toxicity, they may be used to destroy microbes *in vivo*. The primary medical and industrial importance of antibiotics is in their use as chemotherapeutic agents against pathogenic microbes. Chemotherapy, the drug treatment of infectious diseases, is based on the ability of antibiotics (and of some other chemical substances) to inhibit the multiplication of the infecting microorganism without an intolerable toxic effect on the cells or the metabolic functions of the human organism. The inhibition makes it easier for the body's defenses to overcome infection (Lancini et al., 1995) . Many antibiotics have rapidly found practical application in combating infectious diseases, including socially and epidemiologically important ones such as tuberculosis, syphilis, gastrointestinal infections and communicable diseases of childhood (Korzybski et al., 1967).

2.5.1 Antibiotics and Infectious Diseases

Antibiotics may be divided into classes with broad or narrow antibacterial spectra, or on the basis of toxicity. Due to toxicity only about 5 % of the antibiotics discovered to date can be used clinically. Most of the investigated antibiotics are active against gram - positive microorganisms, and a smaller number against gram - negative and acid fast micro - organisms. Some antibiotics are active against protozoa, spirochaetes and plant and animal viruses, and a few possess anthelmintic or insecticidal properties. Germination of seeds is inhibited by certain unpurified antibiotics. Others are growth factors for animals, their mode of action consisting in quantitative and qualitative changes in the intestinal bacterial flora, that is an antibiotic mechanism. The fermentation broths of *Actinomycetes*, which produce the greatest number of antibiotics, often contain vitamin B12 (Korzbyski et al, 1967).

Despite the wide availability of clinically useful antibiotics and semisynthetic analogues, a continuing search for new anti-infective agents remains indispensable. Some of the major antibiotics have indeed considerable drawbacks in terms of a limited antimicrobial spectrum or serious side-effects. Moreover, the combination of the genetic versatility of microbes and widespread overuse of antibiotics has led to increasing clinical resistance of previously sensitive microorganisms and the emergence of previously uncommon infections. An example of this pattern is the chromosomal resistance of many strains of *Neisseria gonorrhoeae* to penicillin conferred through the accumulative effect of a sequence of single mutations. Even at the time of introduction of penicillin to the clinic, there were strains that required relatively high (but clinically achievable) concentrations of penicillin to inhibit their growth (Fekete, 1995). With the increased use of penicillin for the treatment of gonorrhea, the fraction of these relatively resistant strains has increased. Efforts to use very high doses of penicillin to forestall the spread of such resistant strains have been unsuccessful (Fekete, 1995).

The discovery of new molecules exhibiting prominent activities against infectious microorganisms such as toxogenic *Staphylococci*, anaerobes, *Pseudomonas*, *Legionellae*, various fungi and others, showing no cross resistance with the existing antibiotics would therefore be more than welcomed. With regard to topical anti -

infective agents, there is a need for developing new antiseptics and disinfectants, which are less toxic to human skin and tissues, biodegradeable and less harmful to the environment, viz animals and plants , than many of the existing antiseptic preparations.

One of the possible strategies for finding new anti - infective drugs could involve the search for compounds with chemotherapeutic activities supplementary to and structures widely different from those in use. These compounds could be extracted from sources which have, for various reasons, been explored considerably less than the currently used microorganisms, including among others, higher plants (Mitscher and Rao, 1984). Taking into account the enormous number and the amazing structural diversity of the currently available antimicrobially and antivirally active plant constituents, one might hope that promising systemic and / or locally acting anti - infective agents might be discovered in the plant kingdom (Vlientick, 1987).

2.5.2 Review of Natural sources of Antibiotics

Most antibiotics are products of the secondary metabolism of three main groups of microorganisms: eubacteria, actinomycetes, and filamentous fungi. Only a few antibiotics are produced by higher fungi, algae, lichens, animals and plants as shown in Table 2.5.2 (Lancini et al, 1995).

More than one - half of the antibiotic principles discovered to date are produced by *Actinomycetes* (*Streptomyces*). This group includes among others streptomycin, the tetracyclines, chloromycetin, the macrolide family of compounds of which erythromycin, magnamycin and spiramycin are members, and the antifungal polyene compounds, one of which is nystatin. The first extensively studied and least toxic antibiotic , penicillin, is found in the group produced by *Fungi imperfecti.* Antibiotics produced by bacteria (*Eubacterials,* mostly of the genus *Bacillus*), are predominantly polypeptides and, in spite of marked toxicity, are of some practical importance. Green plants produce about 10 percent of the known antibiotics, although their activity, as a rule, is weak and none has achieved practical importance. About 4 % of antibiotics are produced by Basidiomycetes, and a small number by lichens.

Table 2.5.2 Taxonomic Distribution of Antibiotics (Korzybski et al., 1967 and Lancini et al., 1995)

Organism	Antibiotics
Bacteria (Actinomycetes)	> 50 % more than 6000 substances isolated e.g. Tetracycline
Fungi	from lower fungi 1500 show antibiotic activity. e.g. Penicillin from *Penicillium chrysogenum*
Lichens	V. few e.g. Usnic acid
Higher Plants	10 % e.g. Quinine from *Cinchona*
Animals	e.g. Anstipin

2.5.3 Higher Plants as Sources of Antibiotics

Up till now all antimicrobial substances from higher plants have been found to be either toxic to animals or not competitive therapeutically with the products of microbial origin, due to their low potency and narrow spectrum of activity. In fact no antimicrobial compound from a higher plant has yet come into significant clinical use.

Research, however, continues in the hope of finding plant antimicrobials that are effective for the systemic or topical treatment of human or infections in animals.

Despite their low use in systemic medicine antibiotics from higher plants are widely used in ethnomedical systems for the management of infectious diseases all over the world (Watt and Breyer-Brandwijk, 1962; Kokwaro, 1976; 1993; Turner, 1975; Gelfand et al., 1985). Vascular plants have a long history of medicinal and antibiotic usage, dating back to 4000 B. C. (Nickell, 1959). In spite of this long history, it was not until the discovery of penicillin that large scale screening of higher plants for antibacterial substances was begun. Most of the antibiotic substances from higher plants have been found to be toxic to animals or not competitive therapeutically with products of microbial origin (Nickell, 1959). Research however continues with the hope of finding antibiotics that are effective. The discovery of various antifungal substances in plants has aided in the understanding of resistance to decay in certain trees such as cedar (*Thuja occidentalis* and *T. plicata* (Nickell, 1959) and *Chlorophora excelsa* (Korzybski, 1962); and to disease resistance in certain crop plants such as young corn (Korzybski,1962). Chemists continue their interest in plants because of the array of compounds with unique structures which occur in them.

As a natural antibiotic, garlic *Allium sativum*, a member of the lily family Liliaceae, has been used in many parts of the world to treat and very often prevent all manner of infections, especially those affecting the nose, ears, chest and throat. Colds, flu, chest congestion, sinus problems, tonsil infections, whooping cough and bronchitis as well as intestinal disorders, high blood pressure, indigestion, acne, asthma and diphtheria have all been relieved with the help of garlic. The active ingredient which is responsible for the tenacious smell, is the chemical allicin. It effectively kills the bacteria causing infection, but unlike more powerful commercial antibiotics, which tend to destroy 'friendly' bacteria as well the dangerous ones, allicin kills selectively (Lewington, 1990).

Sphagnum moss (*Sphagnum* species), able to absorb sixteen times its own weight in liquids, and more than twice as much moisture as cotton, helped staunch the bleeding of injured soldiers during both World Wars. Long famous for its antibiotic activity and wound healing capacity, analyses of the moss have revealed several associated micro organisms, including *Penicillium* which seems to be responsible for its activity (Lewington, 1990).

Eucalyptus oil which has powerful antiseptic properties is distilled from the fresh leaves of a number of *Eucalyptus* species, particularly *Eucalyptus globulus*, grown especially for the purpose in Australia, as well as Brazil, the Congo, and parts of the Mediterranean. The main constituent of the oil, accounting for some 70 percent of its volume, is eucalyptol, also known as cineol. It is much used as a counter irritant in throat pastilles and cough syrups, as an antiseptic in gargles, ointments and liniments and as an ingredient of inhalants used to relieve bronchitis and asthma.

About 100 tonnes of ipecac are produced each year from *Ipecac ipecacuanha* mainly grown in Nicaragua, Brazil and India for treating coughs, bronchitis and amoebic dysentery and as a powerful emetic. The bark of the thickened, annulated roots, which should be collected when the plant is in flower, contains most of the active ingredients, the alkaloids emetine, cephaline and psychotrine. These same alkaloids cured Loius XIV of dysentery in the seventeenth century and today are valued for the treatment of other parasitic infections such as bilharziasis and guinea worms (Lewington, 1990).

An oil from the fruit shells of the tropical tree *Anacardium occidentale* has long been used in Brazil as a remedy for leprosy and as an anthelmintic. In 1946, Eichbaum reported that the oil has beneficial action in the treatment of infected wounds. These properties of the oil are due to the presence of anacardic acids which are strongly bactericidal for many gram - positive bacteria *Streptococcus pyogenes* and gram - negative genera *Neisseria, Brucella and Pasteurella,* as well displaying activity against nematodes.

In 1949 Grubdon and King (Korzybski et al., 1967) isolated a substance chlorophorin from the timber of *Chlorophora excelsa* which makes timber resistant to decay.

Phaseolin is an antifungal antibiotic produced by the bean plant (*Phaseolus vulgaris* L.)

Virtanen and Hietala (Korzybski et al., 1967)isolated an antifungal factor from wheat and corn. Smissman et al.(Korzybski, 1967) isolated from corn plants a substance active against the European corn borer and identified it as the 6 - methoxy derivative of 2 (3) - benzoxalinone. Loomis et al.(Korzybski et al., 1967) found that corn contains factors active against *Pyrausta nubialis* (Hubn.), *Penicillium chrysogenum* and other organisms. Extracts from young corn stalks inhibit the growth of *Fusarium moniliforme* Sheld., *Giberella zeae* (Schw.) Petch., *Pyrenochaeta terrestris* (Hanson) *and Diploidia zeae* (Schw.) Lev. From these findings it can be concluded that the fact that young corn stalks are not attacked by *Fusarium moniliforme* and *Giberella zeae* is due to the antifungal substances present in them (Whitney and Mortimore) (Korzybski et al., 1967).

Spencer, Topps and Wain (Korzybski, 1967) described the antibiotic properties of the stems and roots of *Vicia faba* against *Aspergillus niger*. The isolated substance was active against *Bortrys cinerea, B. fabae, Alternaria solani* and *Monilia fructigena*. This may be the explanation of the natural immunity of *Vicia faba* to infection by fungi which are pathogenic for other plants.

Lin and Tsai isolated a tuberculostatic substance from the fruit of the Chinese tree *Gingko biloba* (Korzybski et al., 1967). The substance gingkolic acid, inhibited the growth of tubercle bacilli.

The above examples are but a few of a large number of natural antibiotics and antibiotic activities reported from higher plants.

2.5.4 Antifungals from higher plants

Antifungal metabolites can be preformed in the plant as the so called ' constitutive antifungal substances' or they may be induced after the plant is infected. The latter which involves *de novo* enzyme synthesis, are known as 'induced antifungal constituents' or phytoalexins. Since the latter compounds can also be induced by means of abiotic factors, e.g. UV irradiation, Ingham (Grayer and Harborne, 1994) defines phytoalexins as 'antibiotics formed in plants via a metabolic sequence induced either biotically or in response to chemical or environmental factors'. Some 250 new antifungal metabolites have been characterized in plants since 1982 (Grayer and Harborne, 1994). About half of these are constitutive phytochemicals, whereas the remainder are induced as phytoalexins. They are all typically secondary metabolites, mainly being of terpenoid or phenolic origin.

Constitutive antifungal compounds found in taxa surveyed in the last decade belong to a very wide range of chemical classes, and even closely related species produce their own specific antifungal substances. Thus, although the antifungal compounds newly isolated from Compositae (Asteraceae) are all phenolic , they belong to different chemical subclasses. Even in the two species of *Helichrysum* investigated two types of phenolic were recorded: phloroglucinol derivatives from *H. decumbens* (Tomas-Lorente et al.,1989) and methylated flavonoids from *H. nitens* (Grayer and Harborne, 1994). On the other hand species belonging to the same genus generally contain related antifungal substances, the two *Helichrysum* species being an exception. Examples include *Scutellaria violacea* and *S. woronowii* (Labiatae) which contain closely related antifungal neo-clerodane diterpenoids (Cole et al.,1991). *Glycosmis cyanocarpa* and *G. mauritiana* (Rutaceae) both produce antifungal sulphur - containing amides (Grayer and Harborne, 1994).

New phytoalexins reported since 1982 have been found in *ca* 60 species representing 24 families. Families which have received special attention for the first time include Compositae (Asteraceae), Cruciferae, Dioscoreaceae, Gramineae and Rosaceae (Grayer and Harborne, 1994). Much work has continued on families where the phytoalexin response is well characterized, e.g. the Leguminosae and Solanaceae. Positive phytoalexin identifications were recorded by Bailey and Mansfield (Grayer and Harborne, 1994) in 15 families. The present data extend this to 31 plant families. At the species level, it is more difficult to estimate the extent of phytoalexin coverage. The only family which has been surveyed extensively is that of the Leguminosae (Fabaceae), where an excess of 600 species have been examined (Grayer and Harborne, 1994), the great majority of which have yielded one or more phytoalexins on fungal inoculation. Otherwise, relatively few species have been examined in the remaining families.

At one time it appeared that within a given family, a particular class of phytoalexin was produced, so that for example legumes provided isoflavanoids, and solanaceous plants sesquiterpenoids. Recent research has now shown that several different classes of phytoalexin may be produced within the same family. This is true of the Asteraceae (or Compositae), Gramineae and Rosaceae.

One source of useful information on medicinal plants is the folk knowledge . Ethnopharmacological investigations plants used in traditional medicine may lead to the discovery of unusual biological activities or unique chemistries, which may in turn, lead to the development of analogues suitable for pharmaceutical development (Harvey, 1993). In my study, information on plants used in the management of infectious diseases by the Giriama people of Kenya coast, the Luo, Kamba and Maasai of Kenya has been documented. Works of Kokwaro, the Kenyan ethnobotanist, was also used as a source of information on plants which may contain antibiotics. (Kokwaro, 1993).

2.6 Detecting Antibiotics

Antibacterial and antifungal activity can be demonstrated by observing growth responses of various microorganisms to those plant tissues or extracts which are placed in contact with them. The activity of an antibiotic is defined and measured in terms of its ability to inhibit the growth of a microbial population (bacteria, fungi and protozoa). In order to detect antimicrobial activity in plant extracts, three conditions must be fulfilled. First, the plant extract must be brought into contact with the cell wall of the microorganisms which have been selected for the test. Second, conditions must be adjusted so that the microorganisms are able to grow when no antimicrobial agents are present. Third, there must be some means of judging the amount of growth, if any, made by the test organism during the period of time chosen for the test (Hostettman, 1991)

2.6.1 Screening Methods

Existing methods for detecting antifungal and antibacterial activities, nearly as numerous as the compounds being tested, can be categorised roughly into: (1) diffusion - the inhibition of radial growth on an agar medium in a Petri plate; (2) dilution - growth in liquid culture (which can be measured as increase in dry weight or increase in optical density at a given wavelength); and (3) autobiographic methods. All the available testing methods will only give an idea of the presence or absence of substances with antimicrobial activity in the extract. The potency of the active ingredients can only be determined on pure compounds using a standardised methodology. This is a subject of future study.

The commonly used test methods can be also be classified by whether or not they require sterile samples. Sterilisation by gamma - irradiation is very effective and inexpensive, but rather time consuming. A good alternative is to prepare all samples in an aseptical way (sterilised tubes and flasks, laminar flow hood) and to use aqueous ethanol as extraction solvent for the plant material.

The radial growth method is the most popular, corresponding roughly with the ease of performing this assay (all you need is a ruler) (Hostettman, 1991). Antimicrobial activity is the only property of the diverse compounds that is important in these tests. It is important always to measure the response compared to standards under identical conditions for comparison of relative toxicity.

For preliminary screening methods a simple diffusion test is often best. Diffusion methods are the most commonly used of all biossays. These give a clear zone where no growth occurs. In most studies inhibition zones are compared with those obtained for antibiotics (Hosttetman, 1991) This is useful in establishing the sensitivity of the test organism, but a comparison of the antimicrobial potency of the samples and antibiotics cannot be drawn from this since a large inhibition zone may be caused by a highly active substance present in quite small amounts or by a substance of comparatively low activity but present in high concentration in the plant extract. In any case solvents other than water should always be tested simultaneously with the extracts to make sure that they have no antimicrobial properties in the test system.

Other screening methods that have been used include those by Haleblain (Hosttetman, 1991) who discussed induced experimental *Microsporum lanosum* infections in dogs, cats and rabbits in screening for antifungal compounds. *Trichophyton mentagrophytes* in infected epidermal scales obtained from guinea pigs also proved useful for testing antifungal compounds. Other *in vitro* assays for antifungal compounds used stratum corneum stripped off with translucent adhesive tape. Humans have been used to test control of *T. mentagrophytes* on arms. One arm was used to test the fungicide while the other arm served as control. Experimental cutaneous

Candida albicans infections have been attempted in dogs, mice, guinea pigs, rabbits and humans.

2.6.2 Screening medicinal plants of Kenya and East Africa

Many Kenyan and East African plants have been studied for their biological and pharmacological activities. Timothy Johns et al. (1995) studied the anti - giardial activity of gastrointestinal remedies of the Luo of East Africa, A. J. Vlietinck et al. (1995) screened hundred Rwandese medicinal plants for antimicrobial and antiviral properties and Belachew Desta (1993) studied the antimicrobial activity of 63 Ethiopian medicinal plants. Such evaluation provides the essential evidence for the presence of antibiotics.

CHAPTER THREE

ETHNOBOTANY

3.1 Introduction

Collecting and analyzing plants which are used as medicines by local people is a useful approach to identifying biologically active substances. It is also the most efficient way of testing if the safety and effectiveness of local medicines can be corroborated through phytochemical and pharmacological analysis (Martin, 1995). In this study, candidate species for antibiotic screening - those used to manage infectious diseases, were identified through medico - ethnobotany. Selecting plants used for management of infections is a possible lead to plants with antimicrobial activity.

Ethnobotany is that part of ethnoecology which concerns plants. Ethnoecology is the broader discipline which describes local people's interaction with the natural environment, including subdisciplines such as ethnobiology, ethnobotany, ethnoentomology and ethnozoology. Ethnobotany therefore explores local people's perception of cultural and scientific knowledge of plants.

There are four major interrelated endeavors in ethnobotany: (1) basic documentation of traditional botanical knowledge; (2) quantitative evaluation of the use and management of botanical resources; (3) experimental assessment of the benefits derived from plants, both for subsistence and for commercial ends; and (4) applied projects that seek to maximize the value that local people attain from their ecological knowledge and resources.

This study focussed on documentation of medical botanical knowledge of traditional healers. The processes of gathering ethnobotanical data from a tribal group involves participatory rapid appraisal; interviews and discussions; field surveys ; and collections guided by the traditional healers. The first part of this study therefor involved discussions with ***'Waganga'***, the traditional herbalists practicing around the Arabuko Sokoke forest. Interactions with the administration around the Arabuko Sokoke forest in Kilifi District of Kenyan coast, led to the identification of resource persons with expertise. With the help of locals, four practicing traditional herbalists were interviewed and asked to identify medicinal plant species they use for the management of skin infections such as scabies, ringworm, sores and wounds; gastrointestinal infections such as diarrhea and; sexually transmitted diseases such as syphilis and gonorrhea. This data on local uses of plants was recored in Gyriama, the local language and Swahili, the national language and later translated into English. The name, habit, part used and preparation was recorded for 56 different plant species belonging to 32 families (see Appendix II p 127). Literature sources such as "Medicinal plants of East Africa" (Kokwaro, 1976, 1993) were a useful source of ethnobotanical information that expanded the coverage of the project to the Luo, Luhya, Kamba, Kikuyu and Tugen communities (see.Table 3.1 on page 55). Such documentation contributes towards preservation of the threatened fragile indigenous knowledge as well as highlighting the research value of indigenous species.

The search for biological activity may be strengthened by comparing the plants used to treat specific health condition by different ethnic groups in the region. Literature from other parts of Africa was included and indicated similar uses but often provided a broadened range of medicinal uses of these particular species. Species used in a similar way by a majority of local peoples are more likely to contain a physiologically active substance than species which are used only by one ethnic group or in a single community. Many researchers argue that commonality of use, whether arising through independent discovery or interaction between peoples of different cultures, is directly related to the degree of effectiveness of a remedy (Martin, 1995)

3.2 The project area : Arabuko Sokoke forest

The Giriama people today continue to rely upon the Arabuko Sokoke forest for their supplies of medicinal plants. Arabuko Sokoke forest is the largest stand of indigenous coastal forest in Kenya (Fanshawe, 1994). It is situated in Kilifi district between latitudes 3° 10'S and 3° 25' S and longitudes $39^{\circ}40$ ' E and 40° 00' E and lies at an altitude of 10 to 25 m above mean sea level (see Appendix VI page 140)(Moomaw, 1960). Spreading over 400 km^2 (Moomaw, 1960), 372 km^2 (Fanshawe, 1994) it is nationally and internationally known for its rare bird species (Fanshawe, 1994). About 0.32 km^2 is under silica sand while 0.4 km^2 is on research plots. This forest has 43 km^2 existing as a nature reserve and is one of the key areas for protecting forest diversity (see Appendices VI and VII pages 140,141) (IUCN, 1992). For management purposes the area is divided into 8 outposts each with a forest guard, they are Gede, Arabuko, Sokoke, Dida, Jilore, Kararacha, Mida and Kakuyuni.

The forest derives it name from the Giriama word for dense shady thicket, *sokoke,* which describes the vegetation characteristics of the dark red soils that dominate inland. *Arabuko* means place of the thin elephants because elephants visit pools of water in the forest at night, especially during the dry season. This forest supports a diverse flora and contains many rare and endemic plant species (Robertson, 1992).

Collar and Stuart (Fanshawe, 1994) consider Sokoke the second most important forest for birds on continental Africa. Two bird species are endemic: the Sokoke scops owl *Otus ireneae* and Clarke's weaver *Ploeus golandi* and six species are rare or threatened. The golden - rumped elephant - shrew *Rhynchocyon chrysopygus* is an almost endemic small mammal (IUCN, 1992). The Kayas, which are relict forests on limestone are also significant biodiversity areas.

Four forest habitats are distinguished as *Cynometra manilkara* forest, *Brachystegia* woodland, *Afzelia* forest and lowland rainforest.

More than half (220 km^2) of the forest reserve at Arabuko Sokoke is above 60m contour on Magarini sand soils. The closed canopy evergreen forest occupying these extremely infertile dark red loams is termed *Cynometra - manilkara* forest by Moomaw (1960). Over a distance of less than 20 km this habitat changes from rich forest over 15 m high in the south to impoverished thicket (4 m or lower) in the comparatively arid northwest. *Cynometra wescheri, Manilkara sulcata* and *Brachyleana hutchinsii* are dominant throughout; the last is probably the most conspicuous tree species in undisturbed stands, reaching a height of 20 m or more. Smaller trees include species of *Pavetta, Crenaspora* and *Canthium.* Cycads (*Encephalartos hildebrantii)* are numerous and very impressive in higher rainfall areas, and their virtual absence from northern areas of low rainfall west of Jilore is noteworthy. The understory of tangled saplings and lianas, extending from near ground level to the canopy, is of variable density being thinnest in the tallest stands. The heavy red soil beneath the moderate leaf litter holds water well.

Eighteen percent (70 km^2) of the forest reserve is occupied by open woodland dominated by *Brachystegia spiciformis* trees up to 18m high. *Brachystegia* (or miombo) woodland is one of Africa's important vegetation types. In the Sokoke forest, *Brachystegia* occupies deep, loose, light grey to buff, medium to coarse sands according to Moomaw (1960). Rainfall ranges from 600 to 1000 mm per annum, and in most situations there is evidence of ground water at depth for part of the dry season, especially along the western boundary of the forest reserve where rainfall is lowest. The overwhelming dominance of *B. spiciformis* is well illustrated by Moomaw (1960) where 71 out of 99 trees are of this species, at a mean distance of 16. 4 m apart. The canopy has a coverage rarely exceeding 50%. Adequate sunlight permits a diverse shrub layer to develop. This occurs in patches or thickets which may be quite dense, and includes numerous cycads. Ground cover is of varying density including areas of knee - high grasses, though the sandy substrate permits rapid percolation, leaving little water in the soil to promote plant growth. Demarcation between these light soils and the heavier Magarini sands is usually very abrupt, typically in the form of a drainage line with seasonal pools. Here the woodland is particularly open often including Baobabs (*Adonsonia digitata*).

Thirteen percent (50 km^2) of the forest reserve is occupied by a considerably more dense generally evergreen forest characterized by *Afzelia cuanzensisi, Trachylobium verrucosum* and *Julbernadia magnistipulata.* The nearly continous canopy is as low as 10 - 12 m with its tangled understory of shrubs and small trees and moderate leaf litter, it is structurally similar to parts of the *Cynometra - manilkara* forest. This distinct vegetation type occupies areas of more compact buff - grey sands receiving less than 1000 mm of rainfall.

The final vegetation type is lowland rainforest, which replaces *Afzelia* forest in areas of higher rainfall (more than 1000 mm per annum) on similar soils. The small area (less than 20 km^2) remaining under this habitat is close to Gede forest station and is referred to as the Mida - Gede forest by Moomaw (1960) and it continues to be systematically destroyed. Apart from a higher canopy and a less tangled understory it is structurally similar to the *Afzelia* forest. The composition of this remnant habitat differs from stand to stand in coastal Kenya; Moomaw (1960) has grouped them together using the term *Sterculia - Chlorophora Memacylon* forest. Early logging of valuable trees like *Sterculia appendiculata* has resulted in a modified composition. At Mida - Gede, characteristic trees include *Combretum schumanii, Sorindeia obtusifoliata, Lannea stuhlmanii, Lecaniodiscus fraxinifolius* and species of *Diospyros.*

There are two major soil types; red loam sands (latosols) derived from tertiary sediments on higher ground to the North east at Sokoke, Dida, Jilore, Mida, Kararacha, Nature reserve and Arabuko. The tree species prevalent on these red sands are *Cynometra wescheri, Manilkara sulcata* and *Brachyleana hutchinsii* ; and deep loose white sands derived from coastal sands. Quaternary sediments are found on lower ground at Gede, Kakuyuni, Arabuko, Kararacha and Mida. On these soils the tree species prevalent are *Afzelia cuanzensis, Trachylobium verrucosum* and *Manilkara sulcata.*

The mean annual rainfall ranges from 880 mm at Jilore to 1050 mm at Gede. Mean annual temperature at 19.8 ^{0}C in August is the minimum while the maximum temperature is 31 ^{0}C in March (Mtwapa agricultural research station report, 1987).

Human encroachment is noteworthy. Having depleted the forest reserve of valuable timber, the sawmills at Arabuko, Dida and Kararacha ceased operations a long time ago. Natural regeneration has not occurred. Felled trees are an increasingly common sight in all forest habitats often involving great wastage in all the four habitats.

All the four habitats continue to be modified by the cutting of saplings and small trees for use as poles in the building industry. No cutting is allowed in the 43 km^2 Nature Reserve established by the Forestry Department of the Ministry of Environment and Natural Resources. The Nature reserve occupies an area of diverse soils and vegetation types. Within the forest reserve, plantations of exotic trees are confined to the vicinity of the forest stations and outposts. Indigenous forest continues to be destroyed to make way for these expanding plantations, especially in the vicinity of the forest stations at Gede and Jilore. The whole area to the east, of the Mida - Jilore tract is potentially threatened and especially high rainfall areas occupied by lowland rain forest. Within the forest reserve this beautiful habitat might eventually survive as a mere strip beside the Mombasa - Malindi road, though the remnant coral rag at the nearby 44 ha Gede Historical Monument has a reasonably secure future. In Ripley and Bond, A. D. Forbes - Watson stated that about half of the Sokoke forest has been destroyed by man in the last ten years. Based on extensive ground coverage and a flight over the forest, Britton (1975) reported that most of the 400 km^2 forest reserve was still intact. Areas referred to by Forbes - Watson are south and east of the gazetted forest reserve. Similar areas to the west continue to be cut and settled. This unchecked deforestation is leading to loss of important plant species including medicinal plants. This reduction in the supply of medicinal plants means that herbalists have to travel farther and farther across district boundaries to find plant species that were earlier easily available in the forest.

3.3 MATERIALS AND METHODS

3.3.1 Interviews and Discussions

The term "interviews" here refers to asking people about their beliefs and lifestyles. In open-ended or semi-structured interviews, respondents give extensive responses to a series of general questions, some of which have been prepared in advance and some which arise naturally during the course of the conversation. In-depth interviews were held with traditional healers and discussions held on the plant species they use or employ to manage infectious diseases namely; ringworm, scabies, diarrhea, dysentery, gonorrhea and syphilis.

The study was carried out among the Giriama people living around the Arabuko Sokoke forest from May to August, 1994. Successful fieldwork is dependent upon gaining entry and establishing rapport with an indigenous group. In order to create an atmosphere of trust, the fieldworker must exhibit a genuine sense of warmth. This necessitates treating the traditionals as respected equals and understanding them in terms of their ideas and values rather than in terms of the researcher. The researcher should cast aside any mask or 'professional role' that may create barriers between the healer and the researcher (Lipp, 1989).

An initial survey included discussions with the Gede Forest management of the Ministry of Environment and Natural Resources, and Research Departments of the Kenya Forestry Research Institute (K. E. F. R. I.), local administration and village elders to identify and gain access to the traditional herbalists locally known as *'Mganga'* (singular) and establish a rapport. These are resourceful entry points because they allow for the interaction with the people; they have a sound knowledge of potential resource persons and are respected by the villagers.

Discussions and interviews were conducted with four *'Waganga'* (plural) Mzee Kiti Masha, Bi Dama Kitsao, Mzee Jumaa Kombe and Bw. Jumaa Garama and information was documented concerning indigenous species. The local name, habit, medicinal use, part used, and method of preparation were recorded in the format detailed by Lipp (1989) in his guidelines for ethnopharmacological field work. The information was recorded in Giriama, the local dialect, and Swahili, the national language, and later translated into English. For lack of exact English words, some of the local terms are being maintained alongside approximate English terms.

It was essential to involve local people who acted as field guides as well as translators. The field guides Mzee William Ngome and Bwana Kazungu Masha helped translate the objectives of the study to the healers and also information given by the herbalists to me.

A total of 56 plant species were documented to be used for the management of infections by the Giriama. Most of the species are collected from the Arabuko Sokoke forest while some were readily available within the villages. The healers also observed that the supply was sometimes inadequate for some species and that they have to cross district boundaries to collect them. The ethnobotanical information recorded included: (1) the local plant name used by the informant; (2) the lifeform, or global category into which the plant is placed by the Giriama, i. e. whether a tree, shrub, herb, vine or grass;

(3) the characteristics used by the Giriama to identify the plant such as the taste of the berries, feeling of the cutting edge of the grass, color of the flowers, smell of the crushed leaves or even the sound of the foliage rustling in the wind; (4) medicinal uses, part used and preparation of the plant such as whether the root, bark, leaves, fruit or seed is applied fresh, boiled, steeped in cold or hot water or rubbed, and whether the preparation is administered internally (taken into the body) in drink or food or externally (applied outside the body in the form of a massage, bath or topically) used as a wash; and (5) data on the traditional healer such as name, age, gender place of residence, occupation and specialty.

3..3.2 Field collection

Based on a compiled list of species, discussions with the *Waganga* followed in the forest where the herbalists would identify the species used. Voucher specimen were prepared, field data recorded and the plant part used collected. Herbarium specimens were collected for later taxonomic identification with the help of taxonomists at the East African Herbarium who established the scientific name.

Voucher specimens are valuable because they serve as permanent records of the plants that are known to the community. "...the voucher specimen is the link between two bodies of information, that of Western biological science and that of the ethnoscience of the native culture the ethnobiologist seeks to document. For example, Sahaptin - speaking Indians of the Columbia Plateau employ a plant they call *chaluk'sh* for a variety of purposes, nutritional, medicinal and as a fish poison. This fact remains an ethnographic particularity, however, until it can be established that *chaluk'sha* means *Lomatium dissectum* (Apiaceae or Umbelliferae). On the basis of this equation it is possible to compare a segment of Sahaptin ethnoscientific knowledge with a corresponding segment of Western botanical systematics, phenology, ecology, and pharmacology. The resulting synthesis is of greater value than the sum of its parts, the disconnected bits of ethnographic detail we would otherwise have to deal with" (Hunn, 1992).

Voucher specimens facilitate the identification of the plants' family, genus and species and permit colleagues to review results of the study. Proper documentation of any new phytochemical information requires that a voucher specimen is deposited in a public herbarium, so that the determination can be checked whenever required. In some studies vouchers act as reference specimens, the samples used in naming , sorting and other tasks carried out with local participants. To serve this purpose the material chosen as a voucher must: (1) have diagnostic characters which are easily recognizable; (2) be preserved and maintained in good condition; (3) be thoroughly documented by taking field notes on the collection locality and the appearance of the organism as well as its classification and use by the local people; and (4) be readily accessible in an institution that is clearly identified in research reports and publications.

As far as was possible, with the help of the herbalists, good quality voucher specimens were collected. A good quality specimen contains a representative sample of the plant, including stems, leaves, roots, flowers, fruits and other plant parts which are characteristic of the species. Whenever possible, whole plants or entire branches are included so that the overall architecture of the plant can be observed. Where adequate four specimens were collected to be deposited at the Kenya Forestry Research Institute (KEFRI), the University of British Columbia, the East African Herbarium and one set for personal reference. The specimens were labeled and field information tagged to each one of them. The field data include (1) District, (2) Names : vernacular and if known, scientific (3) locality (4) habitat (5) Description of plant (6) medicinal uses, (7) date collected (8) names of collectors and (8) voucher number (see appendix VIII). The specimen were pressed flat in between absorbent papers , in this case old newspapers, and dried in the field.

3.3.3 Ethics

In recognizing the hebarlists who willingly shared their knowledge of herbal medicine discussions on property rights were held with them and an agreement developed. The agreement, written in Swahili and English, gave me consent to undertake research on the plant species and to share the outcome of any research that will be done on these plants with them.

This agreement recognizes the fact that secrecy is part of the ethics of many African healing systems that protects the society against indiscriminate use of secret medicinal plants by certain individuals. Therefore by sacrificing this right calls for obligatory recognition. When respect for their integrity and genuine desire to learn are communicated traditional healers are more willing to share their professional knowledge.

3.4 Field Data results

Ethnomedical information was documented on a total of 56 species belonging to 32 families. Four Giriama herbalists including three men and one woman were interviewed (see Table 3.0 page 54) from whom information was recorded for 41 species in 25 plant families (see Appendix II page 127). Limited discussions with the Luo of Western Kenya and the Kamba of Eastern Kenya yielded information on five more species in five families. Information on ten species in eight families used in the management of infectious diseases by the Luo and Luhyas of Western Kenya; Kikuyus of Central and Rift Valley of Kenya ;and the Tugens of North Rift Valley of Kenya was included from literature surveys (see Table 3.1 page 55) Literature from other parts of Africa indicated similar uses but often provided a broadened range of medicinal uses of these particular species.

Table 3.0 The Resource persons and their specialities

Name of Resource person	**Location**	**Specialty**
Mzee Kiti Masha	Gede	General practitioner, Diviner
Bi Dama Kitsao	Gede	Female and childrens' conditions
Mzee Jumaa Kombe	Gede	General practitioner
Bw. Jumaa Garama	Gede	General practitioner

Table 3.1 A summary table showing the number of species and families collected from the different sites

Collection site	**# of species**	**# of Families**
Arabuko Sokoke forest	41	25
Kokwaro's ref	11	8 (4 families not found in Arabuko Sokoke forest)
Siaya	6	6 (4 families not in Arabuko S. forest)
Kitui	4	0 (all have been found in Arabuko Sokoke forest)

CHAPTER FOUR

ANTIMICROBIAL SCREENING

Numerous investigations have been carried out on antimicrobial agents from plants. In my research the aim was to test antimicrobial activity of crude methanolic extracts of the species collected and identified from the Arabuko Sokoke forest and other parts of Kenya. Chemical investigations of the active antimicrobial agents will be a subject of future studies. From studies by, Nickell, (1959) and Mitscher (1975), it is clear that the chemical structures of the antimicrobial agents belong to the most commonly encountered classes of higher plant secondary metabolites. In many cases, investigation with modern methodology has confirmed folkloric accounts of the use of higher plant preparations for the treatment of infections (Hosttetman, 1991)

4.1 Disk Diffusion Assay

The most common, simpler and cheaper methods for determining the susceptibility of pathogenic microbes to test extracts is the diffusion method known as disk diffusion or agar diffusion assay.

Through the disk diffusion assay method crude methanol extracts of 56 different plants' used to manage infectious diseases by various peoples of Kenya were tested against eleven microorganisms including gram positive, gram negative and acid fast bacteria. The microorganisms selected include acid fast bacteria *Mycobacterium phlei* ; gram positive bacteria: *Bacillus subtilis, Staphylococcus aureus* K147. *S. aureus* MR P0017, *Streptococcus faecalis*; gram negative bacteria : *Escherichia coli, Salmonella typhimurium, Pseudomonas aeruginosa* H187, *P. aeruginosa* H188 and; yeast fungi *Candida albicans* and *Saccharomyces cerevisiae*.In this technique, a reservoir, filter paper disk, containing a measured amount of the plant extract to be tested is brought into contact with an inoculated agar medium, a gel derived from various algae. The plant extract diffuses from the disk into the agar. The plate is incubated for 24 hours - left in a warm place that stimulates the microorganism to grow, forming a turbid surface of confluent or semiconfluent colonies. All these procedures must be done under sterile conditions to ensure that no undesired bacteria or fungi are introduced onto the plates. In a positive test we find that in the zone around the disk, where the concentration of the extract is higher, the bacterium cannot grow and a transparent inhibition halo is visible. The diameter of this halo relates to the susceptibility of the microorganism to the extract. The inhibition diameters are measured and the microorganism is generally classified as sensitive, intermediate or resistant according to how large the inhibition halo is.

4.2 The Test Microbes

The microbial world is a very competitive one. The intricate and complex warfare among organisms is reflected by the many strategies used to achieve predominance in an environment. Some strains are prototrophic - they can survive on a few and simple nutrients. While these strains may not be the most efficient users of natural energy supplies, they can outlast other strains that are more fastidious and require a more specific set of environmental conditions. *E. coli* is a strain that can live on very simple sugars, a nitrogen source, and some trace elements, but it possesses the capacity to utilize complex substrates effectively. Other strains secrete toxins that inhibit or discourage competitors from occupying their niche. An example of this strategy is the production of colicins by enteric bacteria. Colicins, secreted by bacteria, are toxic to other bacteria - frequently to strains closely related to the toxin producers. Other naturally occurring antibiotics are more broadly active and suppress the growth of a large number of possible competitors.

Escherichia coli, the most well known intestinal commensal, exists comfortably in animals and the environment, as well as in a variety of settings of human health and disease. In other cases, such as *Mycobacterium tuberculosis,* the organisms are totally adapted to coexist with humans and have no natural environmental habitat.

The choice of test organisms depends greatly on the purpose of the investigation. For an investigation of a general character, the test organisms selected should be as diverse as possible and preferably representative of all important groups of pathogenic bacteria and yeasts according to their physical and chemical composition and resistance pattern. Many combinations of test microorganisms can be envisaged, but ideally a complete battery should contain about 11 groups of pathogens as shown in Table 4.2.1 (Hosttetman., 1991). Such a microbial battery contains a representative of most human pathogenic bacteria and yeasts causing diseases of skin, eyes, wounds, nervous, respiratory, digestive, urinary and genital systems. Furthermore, it covers all bacteria causing food infections and intoxications. If one is interested in finding new products which are selectively active against problem microorganisms causing certain diseases, e.g. resistant *Pseudomonas aeruginosa,* it is clearly appropriate to employ the corresponding isolated pathogenic microorganisms.

Most bacteria and yeasts can be cultivated on standard Mueller - Hinton agar. Although organisms may be purchased from the American type culture collection (ATCC) the organisms used in this study were available through the University of British Columbia collections.

4.2.1 Prototype of a microbial battery for screening for plant extracts

Group of bacteria	Microorganism	Optimal incubation conditions	Medium
Gram-positive cocci	*Staphylococcus aureus* *Streptococcus pyogenes*	36°C, aerobic	Standard medium
Gram-negative cocci	*Neisseria gonorrhoeae*	36°C, aerobic (capnophilic) (5–10% CO_2)	Enriched medium
Gram-positive spore-forming rods	*Bacillus cereus*	36°C, aerobic	Standard medium
Gram-positive spore-forming rods	*Clostridium novyi*	36°C, anaerobic	Standard medium
Gram-positive asporogenous rods, acid fast	*Mycobacterium fortuitum*	36°C, aerobic	Standard medium
Gram-negative rods	*Escherichia coli* *Klebsiella pneumoniae* (encapsulated) *Proteus vulgaris* *Salmonella paratyphi* B	36°C, aerobic facultatively anaerobic	Standard medium
Gram-negative rods	*Pseudomonas aeruginosa*	36°C, aerobic	Standard medium
Gram-negative rods	*Bacteroides fragilis*	36°C, anaerobic	Standard medium
Gram-negative curved rods	*Campylobacter fetus*	36°C, micro-aerophilic	Enriched medium
Gram-negative obligate intracellular parasites	*Chlamydia trachomatis*	36°C, aerobic	Tissue culture cells in virological medium
Yeasts	*Candida albicans*	36°C, aerobic	Standard yeast medium

4.3 MATERIALS AND METHODS

4.3.1 Plant preparation

Bulk collections of plant parts used were collected in the field where the herbalists harvest, and usually in the same manner as the voucher specimen. The major differences were that, in addition to making a voucher specimen, I collected a larger amount , about two kilograms, of material from each species designated for the laboratory and the sample was prepared in a way that alters as little as possible the chemical composition of the plant. Care was taken to avoid diminishing a stand of plants, especially rare ones, that are being used by local people. Plants free of infestation with bacteria, fungi or small insects were selected. These organisms could alter the results of subsequent chemical analysis. Levels of certain compounds, such as alkaloids and terpenoids, often increase in response to attack by insects or herbivores (Martin, 1995).

The roots and the trunk were debarked and chopped into smaller pieces using secateurs. The materials were then thoroughly air dried. They were turned several times a day to ensure that drying was uniform and the material did not turn moldy. When completely dried the materials were ground into a powder with a blender, packed in plastic bags and shipped to the phytochemistry laboratory at the University of British Columbia. 500 grams of each plant material were soaked overnight in methanol solvent for extraction. The crude extracts obtained were clarified by filtration and then concentrated *in vacuo*. This often resulted in the precipitation or coprecipitation of possibly active substances during the testing procedure. It is advisable to extract the plants and to evaporate the extracts at low temperature in order not to destroy any thermo - labile antimicrobial agents present. 100 mg of the dried crude extracts were redissolved in 1ml methanol to make a concentration of 0.1g/ml. 20μl of the extract for each species was impregnated onto filter paper disks.

4.3.2 Screening

Mueller - Hinton for bacteria and Sabaroud for fungi agar media was sterilized by autoclaving and dispensed in sterile petri dishes. The agar plates were homogeneously inoculated with 100 μl of an inoculum and plant extract impregnated filter paper disks placed on in predetermined order. Filter paper disks with 10μl gentiamycin and 10μl fungizone were also placed as positive controls for bacteria and fungi respectively. A filter paper disk with 20μl methanol solvent was also included as a control to make sure that the test system did not have any antimicrobial properties. 10μl 8 - Methoxy psoralen a photosensitizer was used as a reference for positive light activity of the plant extracts. This treatment was replicated 6 times under dark conditions. All these procedures were done in a sterilized fume hood with laminar flow to ensure that no undesired bacteria or fungi were introduced into the plates.

All the plates were incubated for 30 minutes to allow the extract to diffuse into the agar. One set of three was covered in aluminium foil, inverted and incubated for a total of 24 hours, the other set was exposed to UV (320 - 400nm) radiation for 2 hours, inverted and incubation resumed for a total of 24 hours. At the end of the incubation period, zones of inhibition were measured in mm around the filter paper disks and recorded in Tables 4.1,. 4.2 and 4.3 as mean values for each plant extract under dark conditions and under UV light conditions. A total of 60 plant extracts of 54 different species were tested for their activity against the 11 different microbes.

4.3.3 Light activity

The effects of light must be taken into consideration in order to detect antibiotics whose activity is light mediated. Examples of natural plant photosensitizers are furanocoumarins e.g. 8 - Methoxypsoralen, quinones e.g. hypericin (Hudson and Towers, 1993); and polyynes, e.g. phenylheptatriyne

4.4 RESULTS

A total of 60 different extracts of fifty - four species were tested against a strain of acid fast bacterium : *Mycobacterium phlei;* four strains of gram positive bacteria : *Bacillus subtilis, Staphylococcus aureus* K147, S. *aureus* MR P0017, and *Streptococcus faecalis;* four strains of gram negative bacteria : *Escherichia coli, Salmonella typhimurium, Pseudomonas aeruginosa* H187 and *P. aeruginosa* H188 ; and two strains of yeast fungi : *Candida albicans* and *Saccharomyces cerevisiae.*

Table 4.1 : Measurements of zones of inhibition (Activity), in mm, of crude methanol extracts of plants from Arabuko Sokoke forest, Siaya, Kitui and the Rift Valley of Kenya against acid fast and gram positive bacteria

* The figures are the measurements of the zones of inhibition in mm, read 24 hours after inoculation of the microbes.

Family, Species Name, local Name		**A. fast Bacteria**		**Gram +ve Bacteria**									
	Part	*M. phlei*		*Bac. subtilis.*		*S. aureus* K147		*S. aureusr* MR P0017		*S. faecalis*	
		UV	Dark	UV	Dark	UV	Dark	UV	Dark	UV	Dark
Anacardiaceae *Lannea stuhlmanii* (Engl.) Engl. KUOGO (Luo)	Stem bark	11	11	9	9	12	11	16	8	-	-
Annonaceae *Annona senegalensis* Pers. MUTAKUMA (Gir)	Root	-	-	10	8	-	-	8	8	-	-
Artabotrys sp MUDZALA SIMBA (Gir)	Root	17	18	10	9	12	9	10	9	9	9
Artabotrys monteiroae MUBULUSHI (Gir)	Root	-	-	9	-	-	-	-	-	-	-

Uvaria acuminata Oliv. MURORI (Gir)	Root	-	-	13	13	16	14	16	13	17	16
Xylopia arenaria Engl. MUBARAWA (Gir)	Root	-	-	7	8	-	-	-	-	-	-
Apiaceae *Steganotaenia araliaceae* Hochst. NYANGNYANG - LIECH (Luo)	Stem bark	-	8	-	-	8	-	8	-	8	-
Apocynaceae *Carisa edulis* (Forsk.) Vahl OCHUOGA (Luo)	Root	10	9	6	-	9	-	8	6	9	-
Araceae *Zamioculus zamiifolia* Lodd. Engl. MCHACHAKE (Gir)	Root	10	10	-	-	9	-	-	-	-	-
	Stem base	12	-	-	-	9	-	-	-	-	-
Asteraceae *Tridax procumbens* NDONGI (Kam)	Root	12	9	-	-	11	-	-	-	11	-

Bignoniaceae *Kigelia africana* (Lam.) Benth. YAGO (Luo)	Stem bark	17	10	12	11	12	15	12	12	-	-
Connaraceae *Connarus* sp. MUVIVIRA (Gir)	Root	-	-	13	7	-	-	-	-	-	-
Curcubitaceae *Coccinia* sp. MRIA (Gir)	Leaves	-	-	-	-	8	8	-	8	-	-
Fabaceae *Abrus precatorius* L. MTHURITHURI (Gir)	Root	-	-	13	15	19	15	-	14	20	16
Acacia nilotica (L.) Del. CHEBIIWO (Tugen)	Stem bark	-	-	12	13	22	15	21	13	11	11
Acacia nilotica (L.) Del.	Root	-	-	11	12	20	15	16	12	8	9
Albizia anthelmintica Brongh. MUOWA (Kam)	Stem bark	-	-	-	-	9	-	-	-	-	-
Dalbergia melanoxylon Guill. &Perr. MUHINGO (Gir)	Root	-	-	13	12	14	14	12	13	12	12

Dichrostachys cinerea (L.) Wight &Arn. MUKINGIRI (Gir)	Root	-	-	7	-	-	-	-	-	-	-
Mundulea sericea (Willd.) A. Chev MUTUPA (Gir)	Root	17	11	-	-	7	-	8	-	-	-
Guttiferae or Clusiaceae *Vismia orientalis* Engl. MWEMBETSAKA (Gir)	Root	-	-	10	8	9	9	7	7	-	-
Lamiaceae *Hoslundia opposita* Vahl. MTSERERE (Gir)	Root	13	-	8	8	10	8	11	10	-	-
	Leaves	-	-	15	8	13	10	11	9	-	-
Plectranthus barbatus Andr.	Leaves	-	-	-	-	8	7	-	-	-	-
Malpighiaceae *Acridocarpus zanzibaricus* MUBOHOBOHO (Gir)	Root	-	-	8	8	11	8	9	9	-	-

Malvaceae *Gossypium barbadense* L. MPAMBAMWITU (Gir)	Root	10	11	10	9	10	9	11	9	9	7
Meliaceae *Trichilia emetica* Vahl. *synonym T. roka*	Stem bark	-	-	12	10	15	11	12	8	8	-
Menispermaceae *Cissampelos pareira* L. *var orbiculata* KASIKIROPAKA (Gir)	Whole plant	10	11	-	-	10	-	-	-	-	-
Rubiaceae *Gardenia volkensii* ssp. *volkensii* K. Schum. MKIMWEMWE (Gir)	Root	9	10	-	8	9	7	8	9	-	-
Heinsia crinita (Afz.) G. Tayl. MCHOCHO (Gir)	Root	-	-	10	-	-	-	-	-	-	-
Rutaceae *Fagara chalybeum* (Engl.) Engl MDUNGU (Gir)	Root	10	-	8	-	9	-	8	-	8	-

Tiliaceae *Grewia plaghiophylla* K. Schum. MKONE (Gir)	Root	-	-	12	11	15	11	14	12	-	-
Triumfetta rhomboidea Jacq.	Leaves	-	-	9	9	9	9	10	8	-	-
Vitaceae *Cyphostemma* sp KAKIRA KALUME (Gir)	Root	-	-	11	11	16	13	18	11	9	9
Cyphostemma adenocaule. MGANGALUNGO (Gir)	Root	-	-	13	10	14	11	13	10	10	9
Rhoicissus revoilli Planch. MUNYWAMADZI (Gir)	Root	-	-	13	12	14	10	12	10	8	8
Pristimera sp. KADZIPO KATITE (Gir)	Root	10	11	10	8	12	11	11	10	7	8
MUVA (Kam)		13	19	11	14	15	12	18	10	10	9
MUVINITHIA MBUI (Kam)		18	12	15	18	16	15	16	14	16	15

Methanol		-	-	-	-	-	-	-	-	-	-
Gentiamycin		26	26	26	26	26	26	26	26	26	26
8- Methoxypsoralen		13	-	13	-	13	-	13	-	13	-

Table 4.2 : Measurements of Zones of inhibition(Activity), in mm, of the crude methanolic plant extracts from Arabuko Sokoke forest, Siaya, Kitui and the Rift Valley of Kenya against gram negative bacteria and yeast fungi

Family, Species Name	**Part Used**	**Gram -ve Bacteria**		**Yeast Fungi**			
		P. aureg. **H188**		*C. alb*		*Sacch. cer*	
		UV	**Dark**	**UV**	**Dark**	**UV**	**Dark**
Annonaceae *Artabotrys* sp. MUBULUSHI (Gir)	Root	-	-	-	-	16	13
Xylopia arenaria MUBARAWA (Gir)	Root	-	-	-	-	9	-
Apiaceae *Steganotaenia araliaceae* Hochst. NYANGNYANG - LIECH (Luo)	Root	10	-	-	-	-	-
Apocynaceae *Carisa edulis* (Forsk.) Vahl. OCHUOGA (Luo)	Root	-	-	-	-	10	-

Euphorbiaceae *Croton dichogamus* Pax. MUYAMA (Gir)	Root	-	-	-	-	-	-
Fabaceae *Abrus precatorius* L. MTHURITHURI (Gir)	Root	-	-	-	-	-	9
Albizia anthelmintica Brongh. MUOWA (Kam)	Bark	10	-	-	-	10	10
Dolichos oliveri YIEND ARUSI (Luo)	Root	-	-	-	-	9	10
Malvaceae *Gossypium barbadense* L. MPAMBAMWITU (Gir)	Root	10	8	-	-	-	-
Rutaceae *Fagara chalybeum* MDUNGU (Gir)	Root	-	-	-	-	10	10
MUVA	Root	10	10	-	-	-	
MUVINITHIA MBUI	Root	12	-	-	-	-	

Methanol		-	-	-	-	-	-
Fungizone		19	19	19	19	19	19
8-Methoxypsoralen		13	-	13	-	13	-

Table 4.3 Plant Species extracts from Arabuko Sokoke forest, Siaya, Kitui and the rift Valley of Kenya which did not exhibit any activity against any of the test microbes.

Family	**Species**	**Part tested**
Amaranthaceae	*Psilotrichum scleranthum* Thw.	Root
Asteraceae	*Vernonia lasiopus* O. Hoffm.	Leaves
Capparidaceae	*Maerua triphylla* A. Rich.	Root
Caricaceae	*Carica papaya* L.	Root
Euphorbiaceae	*Croton dichogamus* Pax	Root
Euphorbiaceae	*Drypetes natalensis* (Harv.) Hutch.	Root
Fabaceae	*Crotolaria laburnifolia* L	Root
Fabaceae	*Milletia usaramensis* Taub	Root
Linaceae	*Hugonia castaneifolia* Engl.	Root
Loganiaceae	*Strychnos spinosa* Lam.	Root
Ranunculaceae	*Clematis (hirsuta) brachiata* Guill & Perr	Root, leaves
Rubiaceae	*Rytignia oligacantha* (K. Schum) Robyns	Root
Tiliaceae	*Corchorus olitorius* L.	whole plant

Table 4.4 : A summary table showing the test microbes and the number of species that each microbe was suceptible to

Test microorganism		# of extracts the microbe was susceptible to
Acid fast bacteria	*Mycobacterium phlei*	19 spp
Gram positive bacteria	*Bacillus subtilis*	33 spp
	Staphylococcus aureus K147	39
	Staphylococcus aureus MR 0017	29
	Streptococcus faecalis	18
Gram negative bacteria	*Escherichia coli*	0
	Salmonella typhimurium	0
	Pseudomonas aeruginosa H187	1
	Pseudomonas aeruginosa H188	6
Yeast Fungi	*Candida albicans*	0
	Sacharomyces cerevisiae	7

No plant extract showed any activity against gram negative bacteria; *Escherichia coli* and *Salmonella typhimurium* and the fungus *Candida albicans* so have not been included in the tables.

Table 4.5 : A table showing the correlation between the traditional medicinal use of each species documented, the pathogen responsible for the condition treated and the the antimicrobial activity of the extracts

*** Disease terms are described in detail in Glossary of Some medical terms in Appendix I p 124**

#	**Name** **Family** **Botanical species Name**	**Medicinal use**	***Pathogen responsible** **(Bacteria, fungi, protozoa, virus)**	**Biological Activity**
1	AMARANTHACEAE *Psilotrichum scleranthum* Thw. Oliv.	Roots : child's asthma in complement with *Aganthisanthemum bojeri* Roots & leaves: ***'upele'*** scabies	Scabies :contagious disease caused by the itch mite (*Sarcoptes scabiei)*	No activity
2	ANACARDIACEAE *Lannea stuhlmanii* (Engl.) Engl.	Stem bark: dysentery, open ulcers, venereal diseases	Dysentery : Intestinal inflammation caused by bacteria, protozoa,	*M. phlei* UV & D; *B. subt* UV &D; *S. aur*. K147 UV & D; *S. aur* MR P0017. UV & D;

			parasites or chemical irritants <u>Ulcers</u> are lesions resulting from an infectious.process. <u>Venereal disease</u>	
3.	ANNONACEAE *Annona senegalensis* Pers.	Roots : stomachache with diarrhoea	<u>Diarrhea</u> may be a symptom of a viral or bacterial infection (mild or severe), food poisoning.	*B. sub.* UV & D; *S. aur* MR P0017 UV & D
4	ANNONACEAE *Artabotrys* sp.	Roots : mixed with *Gossypium barbadense* for stomach pains, swollen stomach, ***"kusikia mibamiba"***, pins and needles like pain, and diarrhea.	<u>Diarrhea</u>	*M. phlei* UV & D; *B. sub.*UV & D; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D; *S. faec.* UV & D

5	ANNONACEAE *Artabotrys* sp	Roots : stomachache with diarrhea in complement with *Xylopia arenaria* Amenorrhea in complement with *Carissa edulis* , *Vernonia hildebradtii.* and *Gossypium barbadense*	Diarrhea	*B. sub.* UV & D; *S. aur* K147 UV only.
6.	ANNONACEAE *Artabotrys monteiroae* Oliv.	Roots: mixed with *Flueggia virosa* for dysmenorrhea ; mixed with *Xylopia arenaria, Premna chrysoclada, Uvaria acuminata, Croton dichogamus and Uvaria lucida* for stomach pains with diarrhea.	Diarrhea	*B. sub* UV only; *S. cer.* UV & D
7	ANNONACEAE *Uvaria acuminata* Oliv.	Roots : incomplement with *Gossypium barbadense* for children's diarrhea with vomiting; mixed with *Artabotrys monteraoe, Xylopia arenaria, Premna chrysoclada Croton dichogamus* and *Uvaria lucida* for stomach	Diarrhea	*B. sub.*UV & D; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D; *S. faec.* UV & D

		pains with diarrhea.		
8	ANNONACEAE *Xylopia arenaria* Engl.	Root: chewed to clear cough , decoction for male impotence,; stomachache with diarrhea in complement with *Artabotrys sp.* (MWANGAJENI); decoction mixed with *Artabotrys monteraoe, Uvaria acuminata, U. lucida, Premna chrysoclada* and *Croton dichogamus* . for stomach pains with diarrhea.	Cough asymptom of a cold, respiratory infection, of bronchitis, pneumonia, tuberculosis or other upper lung disease.. Diarrhea may be a symptom of a viral or bacterial infection	*B. sub* UV & D; *S. cer* UV only.
10	APOCYNACEAE *Carissa edulis* (Forsk.) Vahl	Root decoction : stomach ulcers, venereal diseases, dysuria, body sores and. boils. Amenorrhea in complement with *Artabotrys sp* (MWANGAJENI), *Vernonia hildebrandtii* and *Gossypium barbadense.*	Ulcers are lesions of the skin resulting from an infectious process. Venereal disease : Boils : lump in the skin	*M. phlei* UV & D; *B. sub.* UV only; *S. aur.* K147 UV only; *S. aur.* MR P0017 UV & D; *S. faec.* UV only; *E. coli* UV only; *S. cer* UV only.

			surrounding inflammation caused by bacterial (*Staphylococcal*) infection.	
11	ARACEAE *Zamioculus zamiifolia* Lodd. Engl.	Stem base : juice from roasted stem base is applied to earache with pus.	Earache is pain in tha ear caused by infection	*M. phlei* UV & D; *S. aur.* K 147 UV only
			Pus is thick fluid containing dead white blood cells, bacteria and dead tissue, formed at an infection site.	*M. phlei* UV only; *S. aur* K 147 UV only
12	ASTERACEAE *Tridax procumbens* L.	Leaves : Together with *Perotis patens*, used for stomach troubles in children, also chewed for malaria and stomachache (Kokwaro, 1993).	Malaria is serious infection caused by *Plasmodium* protozoa	*M. phlei* UV & D; *S. aur* K147 UV only; *S. faec.* UV only;

13	ASTERACEAE *Vernonia lasiopus* O. Hoffm.	Root: decoction most effective for stomachache and sex stimulant for men (Kokwaro, 1993).		No activity
		Leaves : decoction for stomachache, also as a purgative; paste used to treat sores on cattle, it keeps maggots away (Kokwaro, 1993)		*B. sub.* UV only; *S. aur.* K147 UV only
14	BIGNONIACEAE. *Kigelia africana* (Lam.) Benth	Stem bark : tropical ulcers, dysentery, oedema and syphilis	Tropical ulcers, tropical sore, oriental sore: is a skin disorder caused by the *Leishmania tropica* parasite.	*M. phlei* UV & D; *B. sub* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D;. *P. aureg.*188 UV only.
15	CAPPARIDACEAE *Maerua triphylla* A. Rich.	Root : headache, vertigo, aphrodisiac; fresh roots are chewed for snake bite or infusion	Wound : injury or break in the skin which lead to	No Activity

		drunk and some infusion used to wash wound.	infection.	
16	CARICACEAE *Carica papaya* L.	Roots : Used in complement with *Pristimera sp.,Abrus precatorius, Dalbergia melanoxylon* and *Heinsia crinita* to treat ***"kisonono"*** syphilis	Syphilis : caused by *Treponema palidum* spirochete.	No activity
17	CONNARACEAE *Connarus* sp	Root decoction : a very strong remedy for stomachache.		*B. sub* UV & D
18	CURCUBITACEAE *Coccinia* sp.	Leaves : used to treat ringworm in complement with *Balanites sp.*	Ringworm : fungal infections of the skin.	*S. aur* K147 UV & D; *S. aur*. MR P0017 D only.
19	EUPHORBIACEAE *Croton pseudopulchellus* Pax *C. dichogamus* Pax	Root : used for ***"ugonjwa wa mshipa, mishipa ya tumbo kukaza"***. Used in complement with *Uvaria acuminata, Uvaria*	Diarrhea may be a symptom of a viral or bacterial infection .	No Activity

		lucida, Xylopia arenaria , *Artabotrys monterae* and *Premna chrysoclada* for stomachache with diarrhea.		
20	EUPHORBIACEAE *Drypetes natalensis* (Harv.) Hutch.	Root : decoction used to treat wounds.	Wound : injury or break in the skin, which may lead to infection	No Activity
21	FABACEAE *Abrus precatorius* L.	Root : Chest problems. Used in complement with *Carica papaya, Pristimera* sp., *Dalbergia melanoxylon* and *Heinsia crinita* to treat ***"kisonono".***	Syphilis : caused by *Treponema palidum* spirochete.	*B. sub* UV & D; *S. aur* K147; *S. aur.* MR P0017 D only; *S. faec.* UV & D; *S. cer* D only.
22	FABACEAE *Acacia nilotica* (L.) Del.	Root : indigestion or stomach upset, as an aphrodisiac, gonorrhea, chest diseases and impotence. Stem bark: sore throat, coughs, children's fever, indigestion, or as a	Pneumonia : Inflammation of lungs caused by infection with bacteria (esp. *Pneumococcus*)	*B. sub* UV & D; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D; *S. faec* UV & *P. aureg.* UV only;

		powerful stimulant. Leaves : chest pains or pneumonia.	viruses, fungi or rickettsiae.	
				B. sub. UV & D; *S. aur.* K147 UV & D; *S. aur* MR P0017 UV & D; *S. faec.* UV & D.
23	FABACEAE *Albizia anthelmintica* Brongh.	Stem bark: malaria and worms	Malaria serious infection caused by *Plasmodium* protozoa .	*S. aur.* K 147 UV only; *P aureg.* 188 UV only; *S. cer* UV & D.
24	FABACEAE *Crotolaria laburnifolia* L.	Root : aphrodisiac, snake bite , gonorrhea and severe dysuric ailments.	Gonorrhea : caused by bacterium *Neisseria gonorrhoea*	No Activity
25	FABACEAE *Dalbergia melanoxylon*	Root : Used in complement with *Carica papaya, Pristimera sp, Abrus precatorius* and	Syphilis : caused by *Treponema palidum*	*B. sub* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV

	Guill & Perr	*Heinsia crinita* to treat ***"kisonono"***.	sprochete	
26	FABACEAE *Dichrostachys cinerea* ssp. *africana* var. *tanganyikensis* (L.) Wight & Arn	Root :Used in complement with *Strychnos spinosa* and *Milletia usaramensis* *for skin diseases.	Ringworm : fungal infections of the skin.	*B. sub* UV only
27	FABACEAE *Dolichos oliveri*	Root tuber : anthrax, boils, thrashes, venereal diseases and poultry diseases.	Anthrax : Bacterial (*Bacillus anthracis*) disease of cattle and other farm animals that can be transmitted to humans Boils : lump in the skin	*S. cer.* UV & D

			surrounding inflammation caused by bacterial (*Staphylococcal*) infection. Thrush : = candidiasis : Infection caused by a *Candida* species of fungus (e.g. *C. albicans*), affecting the skin, mouth and vagina. Venereal disease :	
28	FABACEAE *Mundulea sericea* (Willd.) A. Chev	Seeds, leaves, bark : fish poison in India and some parts of Africa. Bark, roots : insecticides (Dale & Greenway, 1962).		*M. phlei* UV & D; *S. aur,*. K147 UV only *S. aur* MR P0017 UV only

	syn. *M. suberosa* (DC) Benth.	Roots : when fresh used as an aphrodisiac. Bark and seeds cotain "rotenone" toxic principle hence use as fish poison (Kokwaro, 1993).		
29	FABACEAE *Milletia usaramensis* Taub	Root : used in complememt with *Dichrostachys cinerea* and *Strychnos spinosa* for skin disease.with sores. Decoction is drunk and also used as a wash.	<u>Ringworm</u> : fungal infections of the skin	No activity
30	GUTTIFERAE *Vismia orientalis* Engl. syn. *V. mguwe* Bullock ex Dale	Root : peeled, ground to powder may be cooked or mixed with coconut oil and used as wash for ***'upele'*** scabies.	<u>Scabies</u> : contagious disease caused by the itch mite (*Sarcoptes scabiei*) characterized by itching, often leading to secondary	*B. sub* UV & D; *S. aur* K147 UV & D; *S. aur*. MR P0017.

			infection	
31	LAMIACEAE *Hoslundia opposita* Vahl.	Root : cough remedy, boiled with beans and eaten for stomach pains. Leaves :cooling wash for fever in children, fresh wound. Roots and leaves for colds and fever. It is mixed with *Indigofera emarginella* for fits in children.	<u>Cough</u> is a common symptom of a cold, respiratory infection, of bronchitis, pneumonia, tuberculosis . <u>Fever :</u>, fever is most often a sign of infection (bacterial, viral or other) or other disease <u>Wound</u> : break in the skin, may lead to infection <u>Colds</u> : Infection involving the nasal passages.caused by one of many different	*M. phlei* UV only; *B. sub.* UV & D; *S. aur.* K147 UV & D;

			viruses (mainly rhinoviruses)	
		Leaves		*B. sub.* UV & D; *S. aur.* K147 UV & D; *S. aur* MR P0017 UV & D.
32	LAMIACEAE *Plectranthus barbatus* Andr.	Leaves : stomachache, as a purgative,. bath for measles in babies.	<u>Measles :</u> Acute, contagious, viral disease occuring in chldren.	
33	LINACEAE *Hugonia castaneifolia* Engl. syn. *H. holtzii* Engl.	Root : crushed and extract taken for snake bite.		No Activity

34	LOGANIACEAE *Strychnos spinosa* Lam.	Root: in complement with *Dichrostachys cinerea* and (MSIMARIBARA) *Lonchocarpus* sp. or *Milletia usaramensis* for skin disease with sores. Young fruit induces abortion	Ringworm : fungal infections of the skin.	No Activity
35	MALPHIGIACEAE *Acridocarpus zanzibaricus* (Loud) A. Juss	Root : ***"tego"***syphilis in complement with *Rhoicissus revoilli* ; swollen stomach, pains ***"mibamiba"***, with watery discharge for digestive tract. .	Diarrhea may be a symptom of a viral or bacterial infection (mild or severe).	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D.
36	MALVACEAE *Gossypium barbadense* L.	Root : used in complement with *Uvaria acuminata* for children's diarrhea with vomiting. Used in complement with *Artabotrys* sp. (MWANGAJENI) *Carissa edulis* and *Vernonia hildebrandtii* to treat amenorrhea. Used in complement with	Diarrhea may be a symptom of a viral or bacterial infection (mild or severe).	*M. phlei* UV & D; *B. sub.* UV & D; *S aur.* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV & D.

		Artabotrys sp. (MDZALA SIMBA) for swollen stomach, pain ***"mibamiba"*** with diarrhea.		
37	MELIACEAE *Trichilia emetica* Vahl. syn. *T. roka* (Forsk) Chiov.	Bark : used as an emetic (Dale &Greenway, 1962); pounded bark used to treat pneumonia, as a purgative. Root : colds, as a diuretic or induce labour in pregnant women. Seeds : oil from seed is applied to sores from which jiggers have been removed as a treatment and to prevent infection.	Pneumonia : Inflammation of lungs, caused by infection with bacteria (esp. *Pneumococcus*) viruses, fungi or rickettsiae. Wound : break in the skin, usually caused but may lead to infection.	*B. sub* UV & D; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D; *S. faec* UV only.
38	MENISPERMACEAE *Cissampelos pareira* L. var *orbiculata* (DC) Miq.	Root :sore throat, colds, cough, snakebite. Leaves and roots for stomach pains, pregnancy pains; when burnt used for	Colds : Infection involving the nasal passages caused by one of many different	*M. phlei* UV & D; *S. aur.* K147 UV only

		wounds (Kokwaro, 1993).	viruses(mainly rhinoviruses) .. <u>Cough</u> is a common symptom of a cold, respiratory infection, of bronchitis, pneumonia, tuberculosis . <u>Wound</u> : break in skin, but may lead to infection	
39	RANUNCULACEAE *Clematis (hirsuta) brachiata* Guill & Perr	Leaves : gonorrhea, syphilis and sore throat. Roots : yaws, malaria, a purgative, headaches and colds in the head. Flowers : clear stuffy nose.	<u>Gonorrhea :</u> caused by bacterium *Neisseria gonorrhoea* <u>Syphilis</u> : caused by *Treponema palidum* sprochete	No Activiy

			<u>Sore throat :</u> <u>Yaws</u> : Infection caused by the spirochete *Treponema pertenue*,. <u>Malaria</u> serious caused by *Plasmodium* protozoa. <u>Colds</u> : Infection involving the nasal passages caused by one of many different viruses(mainly rhinoviruses).	
40	RUBIACEAE *Gardenia volkensii* ssp. *volkensii* K. Schum			*M. phlei* UV & D; *B. sub* D only; *S. aur* K147 UV & D; *S. aur* MR P0017 UV & D

41	RUBIACEAE *Heinsia crinita* (Afz.) G. Tayl. ssp *parvifolia* (K. Schum & K. Krause) Verdc. syn *H. jasminiflora* Dc	Root : in complement with *Carica papaya* , *Abrus precatorius* ,*Dalbergia melanoxylon,*and *Pristimera* sp. for ***"kisonono "*** syphilis.	Syphilis : caused by *Treponema palidum* spirochete	*B. sub.* UV only
42	RUBIACEAE *Rytignia oligacantha* (K. Schum) Robyns.	Root : cold infusion indigestion, swollen stomach.		No activity
43	RUTACEAE *Fagara chalybeum* Engl.	Root : used in complement with *Cyphostemma adenocaulis* for boils and wounds.	Wound : break in the skin, but may lead to infection. Boils : lump in skin	*M. phlei* UV only, *B. sub.* UV only; *S. aur* K147 UV only; *S. aur* MR P0017 UV only.

			surrounding inflammation caused by bacterial (*Staphylococcal*) infection .	*S. faec* UV only; *S. cer* UV & D.
44	SAPINDACEAE *Lecanodioscus fraxinifolius* Bak. ssp *vaughanii* (Dunkley) Friis	Bark : froth used to increase milk flow and assist puify milk in the breast (Kokwaro, 1993).		*M. phlei* UV only; *B. sub* UV & D; *S. aur.* K147 UV & D; *S. aur.* MR P0017 UV only
	TILIACEAE *Corchorus olitorius* L.	Root : tooth ache		No Activity
46	TILIACEAE *Grewia plaghiophylla* K. Schum	Root : in complement with *Cyphostemma* sp. (KAKIRA KALUME) and *Cyphostemma adenocaulis* for boils. Bark : construction	Boils : lump in the skin surrounding inflammation caused by bacterial	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D

		rope and used to be used as a soap.	(*Staphylococcal*) infection .	
47	TILIACEAE *Triumfetta rhomboidea* Jacq.	Leaves : burns. Root : toothache, circumcision wounds, headache. Leaves ; abscesses and yaws.	Wound : injury or break in the skin, but may lead to infection. Abscesses : Accumulation of pus. Toothache : Yaws : Infection caused by the spirochete *Treponema pertenue,* destruction of underlying tissue. Treatment is by penicillin	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D

48	VITACEAE *Cyphostemma* sp.	Root : used in complement with *Cyphostemma adenocaulis* and *Grewia plaghiophylla* for boils.	Boils : lump in the skin surrounding inflammation caused by bacterial (*Staphylococcal*) infection.	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV
49	VITACEAE *Cyphostemma adenocaulis* A. Rich. Wild & Drum.	Root : used in complement with *Cyphostemma sp* (KAKIRA KALUME) and *Grewia plaghiophylla* for boils.	Boils : lump in skin surrounding inflammation caused by bacterial (*Staphylococcal*) infection.	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV & D.
50	VITACEAE *Rhoicissus revoilli* Planch	Root : boils ;used in complement with *Acridocarpus zanzibaricus* for ***"tego"*** syphilis.	Boils : lump in skin surrounding inflammation caused by bacterial (*Staphylococcal*) infection. Syphilis : caused by *Treponema palidum* sprochete	*B. sub.* UV & D; *S. aur* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV & D.

51	*Pristimera* sp.	Root : in complement with *Carica papaya, Abrus precatorius Dalbergia melanoxylon* and *Heinsia crinita* for ***"kisonono "*** syphilis.	Syphilis : caused by *Treponema palidum* sprochete	*M. phlei* UV & D; *B. sub.* UV & D; *S. au* K147 UV & D; *S. aur.* MR P0017 UV & D; *S. faec.* UV
52	MUVA	Root bark : tuberculosis, asthma, ,malaria, headache, joint pains and open ulcers.	Tuberculosis : infection with bacteria *Mycobacterium tuberculosis* Malaria serious infection by *Plasmodium* protozoa. Ulcers lesions of the skin resulting from an infectious.	.

CHAPTER FIVE

DISCUSSION

5.1 Ethnobotany

All the four herbalists interviewed were very resourceful. Mzee Kiti Masha is a famous traditional healer in Gede who combines herbal medicine and divination and is consulted for all kinds of diseases. Bi Dama Kitsao is an upcoming woman herbalist. She specializes in women's and children's diseases and also practices divination. Mzee Jumaa Kombe and Bw. Jumaa Garama are father and son herbalists respectively. Mzee Jumaa Garama gained his knowledge through working with his aging father. They are general herbalists with a wealth of experience in traditional medicine. They all live in Gede Location close to the Arabuko Sokoke forest. They collect their plants from around the villages, the forest and occasionally from beyond the forest in other districts like Kwale. These herbalists were identified by the local authorities including Forestry Department in the Ministry of Environment and Natural Resources; and colleagues at the Kenya Forestry Research Institute Gede National Research Station. Local staff in these public organizations were instrumental in easing the development of rapport with the herbalists. Their being forest managers and researchers as well as locals was an asset to this study . Messrs William Ngome and Kazungu Masha helped translate the objectives of this study to the herbalists in a culturally acceptable approach thus building on the Waganga's trust. This atmosphere encouraged the herbalists to freely express their views and feelings on issues about traditional medicine research. They pointed out the need to be recognized and appreciated for giving out valuable information which they stated is the practice during apprenticeship. For instance Mzee Jumaa Garama had to give his father Mzee Jumaa Kombe a goat as payment for teaching him traditional medicine. Negotiations followed during which a modest sum of money or goods was to be paid to compensate for time that he took out to give information. This led to respect on both sides of the discussions and a relaxed atmosphere.

The target for this study was information on plants used to manage infectious diseases only. However due to the multiple uses of some species a few other diseases have been included. Fifty six species in 32 families were documented to manage skin and stomach infections and sexually transmitted diseases as shown in Appendix II, page 127.

The five most common families include Annonaceae, Asteraceae (Compositae), Fabaceae, Rubiaceae and Vitaceae (see Appendix II). The species reported from the Annonaceae are *Annona senegalensis* , *Artabotrys* sp (MUDZALASIMBA), *Artabotrys* sp. (MWANGAJENI), *Artabotrys monteiroae, Monathotaxis formcata, Uvaria acuminata, Uvaria lucida ssp lucida* and *Xylopia arenaria.* Seven out of these eight species are used by the Giriama people to manage stomach complaints and diarrhea and are prepared as mixtures, suggesting that this family contains substances that inhibit the growth of bacteria.

The species reported from Asteraceae (Compositae) are: *Crassocephalum picridifolium, Vernonia hildebrandtii* and *Vernonia lasiopus.* The diseases managed by the species in this family ranged from wounds and amenorrhea to stomachache.

The species reported from the Fabaceae are *Abrus precatorius, Acacia nilotica, Albizia anthelmintica, Crotolaria laburnifolia, Dalbergia melanoxylon, Dichrostachys cinerea* ssp *africana* var *tanganyikensis, Mundulea sericea* and *Milletia usaramensis.* The diseases treated by species in this family are mostly skin infections and sexually transmitted diseases most of them being prepared as mixtures of at least two species. These uses therefore suggest the occurrence of antifungal and antibacterial substances in this family. The species reported from Rubiaceae are: *Gardenia volkensii* ssp *volkensii, Heinsia crinita ssp parvifolia* and *Rytignia oligacantha.* The diseases treated by the species range from asthma to syphilis and stomach complaints. The species recorded from Vitaceae are *Cyphostemma* sp., *Cyphostemma adenocaulis* and *Rhoicissus revoilli.* These species are used in the management of boils and syphilis as mixtures of two species. This therefore suggests that this family contains antibacterial substances.

The diseases recorded in this survey can be grouped into three major groups : skin infections, stomach infections, and sexually transmitted diseases. Skin problems include open ulcers, smallpox, ringworm, wounds, skin disease, scabies and boils. Stomach problems include stomach ache, swollen stomach, diarrhea, dysentery and stomach ulcers. Sexually transmitted diseases include gonorrhea and syphilis. Laboratory examinations of patients with the skin infections reveal parasitic associations with pathogenic fungi, for example ringworm, lesions on exposed, glabrous skin is a superficial mycoses caused by the fungus *Trichophyton rubrum. T. rubrum* is most common in the tropics and is transmitted from person to person by skin contact. Stomach problems associated with diarrhea or dysentery are most commonly caused by bacteria and protozoa. Important human pathogens include *Salmonella* *enteritidis, S. typhi, S. shigelli, Campylobacter jejuni* and *Escherichia coli.* Sexually transmitted diseases have in most countries become the commonest communicable diseases caused by bacteria, viruses, fungi, protozoa and ectoparasites. Gonorrhea and syphilis are caused by the bacteria *Neisseria gonorrhoeae* and *Treponema pallidum* respectively.

In modern medicine these infections are clinically managed by the application of antibiotics. Diagnosis of diseases include laboratory examinations of infected tissues with the pathogen responsible being isolated and identified. When evidence shows the invasion of pathogenic bacteria or fungi, chemotherapy is advised and antibiotics prescribed as the treatment. These antibiotics act on the pathogen by inhibiting either its growth or reproduction to a level that the host's immune system is able to fight or tolerate the infection.

In traditional medicine when a patient visits a *Mganga* with any complaint, in some instances the Mganga will merely treat the patient with herbs without divining. If the patient suspects that his complaint is abnormal or if it is prolonged and does not respond to the treatment being applied, he may request divination to be performed. Diviners hold a key position in the traditional medical system, for it is they who determine whether the client has been bewitched or poisoned, has broken a taboo or dishonored ancestral spirits. The findings of diviners are believed and followed without question. What they reveal through their divination is believed to be absolute fact. The ***'Waganga'*** have three basic and important principles of treatment : prevention, finding the cause, and curing the illness. These fundamental principles are precisely the same as those followed by scientific practitioners, who look for an objective cause, such as bacteria, virus or fungi, which is responsible for the disease found in the body. The *Mganga* on the other hand, believes that the cause of illness may frequently be of spiritual origin. The cause, be it bacteria, virus or other agency, can, according to their belief, be introduced into an individual by an evil spirit. The treatments involve herbal preparations of single or mixtures of plant species. For example for the treatment of stomachache with diarrhea decoctions are prepared of either *Artabotrys* sp (MUDZALASIMBA) and *Gossypium barbadense* ; *Artabotrys* sp (MWANGAJENI) and *Xylopia arenaria; or Artabotrys monteiroae, Xylopia arenaria, Preman chrysoclada, Uvaria acuminata, U. lucida* and *Croton dichogamus* are employed for a specific period of time. In most cases these herbal preparations are efficacious in the management of infectious diseases. Chemical analysis of crude plant extracts have revealed a variety of biologically active compounds including antibacterial and antifungal substances.

Recovery from infections must be related to the reduction of growth of the pathogenic microorganism. The herbal preparation must therefore contain antibacterial and antifungal substances, evidence of which can be detected through antibacterial and antifungal assays. In my research assays were conducted on crude methanolic extracts of 54 species in 28 families documented in the ethnobotanical survey

5.2 Antimicrobial testing

Eight out of the 11 strains of the test microorganisms were susceptible to one or more of the 60 plant species extracts.The gram negative bacteria : *Escherichia coli* and *Salmonella typhimurium* and fungus *Candida albicans* were not susceptible to any of the extracts (see Tables 4.1, 4.2, 4.3 and 4.4). The susceptible microbes were *Staphylococcus* *aureus* K147 , 39 out of 60 species extracts were active against it, *Bacillus subtilis* was susceptible to 33 of the extracts, *S. aureus* MR P0017 to twenty nine, *Mycobacterium phlei* to nineteen, *Saccharomyces cerrevisiae* to seven, *Pseudomonas aeruginosa* H188 to six and *Pseudomonas aureginosa* H187 to one extract. The gram negative bacteria *Escherichia coli* and *Salmonella typhimurium* and the yeast *Candida albicans* were not susceptible to any of the extracts.

E. coli is an enterobacterium that causes urinary tract infections, meningitis, wound and intra - abdominal infections , and diarrhea. *Salmonella* spp are also entero-bacteria that inhabit the intestine of a large number of warm- and cold-blooded vertebrate species (e.g. *S. typhi* causes enteric fevers).While *Annona senegalensis, Artabotrys* sp (MUDZALA SIMBA), *Artabotrys* sp (MWANGAJENI), *Artabotrys monteiroae, Uvaria acuminata, Xylopia arenaria, Croton dichogamus* and *Gossypium barbadense* are used to treat diarrhea none of them showed any activity against *E, coli* or *Salmonella typhimurium.* All the species are prepared as mixtures while the test was on preparations from a single species. The activity of the mixtures could be due to synergies of all the contributing species. It would therefore be useful to test the species activity as mixtures rather than as single species to confirm their use. The species *Vernonia lasiopus, Maerua triphylla, Drypetes natalensis, Milletia usaramensis, Strychnos spinosa, Trichilia emetica, Cissampelos pareira, Fagara chalybeum* and *Triumfetta rhomboidea* are used to manage wound infections. But none of them showed any activity against *E. coli.* Three of the nine species are used as mixtures of at least two species suggesting synergy. It is also possible that the species contain substances that enhance the host's ability to fight the invading bacteria, making the patient have a feeling of well being rather than inhibiting the growth of the invading bacteria. The method of extraction may also contribute. In the experiment, methanol extracts were used while traditionally hot water extractions are mostly used. While methanol dissolves many of the biologically active compounds it can miss some important ones e.g. peptides. It would be worthwhile to test the extracts as traditionally prepared. *Candida albicans* is a fungus responsible for candidiasis, infection of the skin or mucous membranes. The species used to manage skin infections are *Coccinia* sp, *Dichrostachys cinerea, Dolichos oliveri, Milletia usaramensis* and *Strychnos spinosa.* However none of them had any impact on the growth of *Candida albicans*. Two of the species are used as mixtures suggesting possible synergistic enhancement. Only *Dolichos oliveri* showed activity against the fungus *Saccharomyces cerevisiae.* All the rest did not have any impact on the other fungus tested. Since only two test fungi were used I cannot make a fair antifungal analysis and conclusion of the species used to treat fungal infections until more fungi are tested.

A total of 42 extracts from 39 species were active against at least one of the susceptible microorganisms (see Table 4.4). Most (33/39) species were active against gram positive bacteria ; 19/93 against acid fast bacteria ; 7/39 active against fungus ; and 6/39 active against gram negative bacteria. The species *Steganotaenia araliaceae, Kigelia africana, Acacia nilotica, Albizia anthelmintica, Gossypium barbadense*, MUVA, and MUVINITHIAMBUI which were active against gram negative bacteria were also active against gram positive bacteria. *Albizia anthelmintica* was also active against the fungus *Saccharomyces cerevisiae.* The species *Artabotrys* sp (MUDZALASIMBA) , *Xylopia arenaria, Carissa edulis, Abrus precatorius* , *Dolichos oliveri* and *Fagara chalybeum* which were active against the fungus *Saccharomyces cerevisiae* were also active against gram positive bacteria. These species have shown activity against different types of pathogens and could contain useful antibiotic compounds with broad spectrum activity. Chemical analysis of these extracts to isolate and identify the active compounds is recommended.

The most common families noted in the ethnobotany section, i.e. Annonaceae, Fabaceae, Asteraceae, Rubiaceae and Vitaceae were also prominent in the antimicrobial testing (see Tables 4.5). In the Annonaceae, five of the six species i.e. *Annona senegalensis, Artabotrys* sp (MUDZALA SIMBA), *Artabotrys* sp (MWANGAJENI), *Artabotrys monteiroae* and *Uvaria cuminata* showed activity against at least one strain of gram positive bacteria; and two species *Artabotrys monteiroae* and *Xylopia arenaria* showed antifungal activity.

Six of the nine species of the Fabaceae i.e. *Abrus precatorius, Acacia nilotica, Albizia anthelmintica , Dalbergia melanoxylon, Dichrostachys cinerea* and *Mundulea sericea* showed activity against gram positive bacteria. two species *: Acacia nilotica* and *Albizia anthelmintica* were active against gram negative bacteria ; three species *: Abrus precatorius , Albizia anthelmintica* and *Dolichos oliveri* against fungi; and the two species *Crotolaria laburnifolia* and *Milletia usaramensis* did not have any impact on any of the microbes..

In Asteraceae, two species i.e. *Tridax procumbens* and *Vernonia lsiopus* were active. *Tridax procumbens* was active against three gram positive bacteria while *Vernonia lasiopus* leaf extract was active against two gram positive bacteria. Most of the activity, against *B. subtilis , S. aureus* K147 and *S. faecalis,* was light mediated. This family must therefore contain antibiotic compounds whose biological activity is either initiated or enhanced by exposure to UV radiation.*Tridax* and *Vernonia* species are known to contain phototoxic polyynes (acetylenes) in roots and leaves (Bohlmann et al., 1973)

In the Rubiaceae three species : *Gardenia volkensii ssp volkensii, Heinsia crinita* and *Rytignia oligacantha,* were tested. *Heinsia crinita* and *Gardenia volkensii ssp volkensii* showed activity against one and four gram positive bacteria respectively. *Rytignia oligacantha* did not show any activity at all.

In Vitaceae, three species, *Cyphostemma sp, Cyphostemma adenocaulis* and *Rhoicissus revoilli,* were tested. All three showed activity against the same four strains of gram positive bacteria, *Bacillus subtillis, Staphylococcus aureus K147, S. aureus* MR P0017 and *Streptococcus faecalis* .

5.3 Linking Traditional Use to Biological Activity

In this study I have shown that most of the species used to traditionally manage bacterial and fungal infections show strong biological activity against the test pathogens as demonstrated in Table 4.5 page 75. Nine out of the ten species used to manage gastrointestinal bacterial infections such as diarrhea and dysentery, are active against at least one gram positive bacterial species. The most prominent plant species include *Lannea stuhlmanii , Artabotrys sp* (MUDZALASIMBA), *Artabotrys monteiroae, Uvaria acuminata, Xylopia arenaria* and *Gossypium barbadense. Lannea stuhlmanii* is used by the Luo to treat , among other diseases, dysentery. Dysentery is an intestinal inflammation caused by bacteria, parasites or even chemical irritants. Methanol extract of the roots was active against four strains of bacteria: *Mycobacterium phlei, Bascillus subtilis, Staphylococcus aureus* K147 and *S. aureus* MR P0017. *Artabotrys* sp (MUDZALA SIMBA) is used in conjunction with *Gossypium barbadense* by the Giriama to manage diarrhea, frequent passage of loose watery stools which may contain mucus, blood or excessive fat, sometimes accompanied by nausea, vomiting, abdominal cramps, and feelings of malaise and weakness. Diarrhea may be a symptom of a viral or bacterial infection, food poisoning, disorder of the colon, gastrointestinal tumor, metabolic disease or other disease. Methanol extracts of both species were very active against one strain of acid fast bacteria: *Mycobacterium phlei* ; and four strains of gram positive bacteria : *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *Streptococcus faecalis. Artabotrys monteiroae* in conjunction with *Uvaria acuminata* and four others are also used by the Giriama to treat diarrhea.A methanol extract of the root of *Artabotrys monteiroae* was active against gram positive *B. subtillis* and the yeast *Saccharomyces cerevisiae* . *Uvaria acuminata* was active against four strains of gram positive bacteria - *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *S. faecalis.* We can therefore conclude that there is a strong relationship between the traditional uses of plants for bacterial infections and their ability to have an impact on the population growth of pathogenic microbes.

Eight out of ten species traditionally used to treat sexually transmitted diseases were active against at least one test pathogen. Seven of these were active against four or more strains of the test pathogens. These are *Lannea stuhlmanii, Steganotaenia araliaceae, Carissa edulis, Abrus precatorius, Dalbergia melanoxylon, Rhoicissus revoilli* and *Pristimera* sp. *Lannea stuhlmanii* is also used by the Luo to treat venereal disease, a communicable disease caused by bacteria and transmitted through sexual contact. Methanol extracts of *L. stuhlmanii* were active against four strains of gram positive bacteria. *S. araliaceae* is also used by the Luo to treat venereal diseases. A methanol extract of *S. araliaceae* was active against one strain of acid fast bacterium, *M. phlei* ; two strains of gram positive bacteria : *S. aureus* K147, *S. aureus* MR P0017 and *S. faecalis* and ; one strain of gram negative bacterium, *Pseudomonas aeruginosa* H188. *Carissa edulis* is also used by the Luo to treat venereal disease.A methanol extract of *C. edulis* was active against one strain of acid fast bacterium,: *M. phlei*; four strains of gram positive bacteria : *B. subtilis, S. aureus* K147, *S. aureus* MR P0017, *S. faecalis*; one strain of gram negative bacteria *Escherichia coli* ; and the yeast *S. cerevisiae*. *Abrus precatorius* is used by the Giriama to treat syphilis, a venereal infection caused by the spirochete, *Treponema palidum*. It is transmitted by sexual contact or through the placenta to an infant. Methanol extracts of *A. precatorius* roots were active against four strains of gram positive bacteria : *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *S. faecalis* and one strain of fungi *S. cerevisiae*. *Dalbergia melanoxylon* is used in conjunction with *Carica papaya, Pristimera* sp, *Abrus precatorius* and *Heinsia crinita* by the Giriama to treat syphilis. Methanol extracts of the root were active against four strains of gram positive bacteria - *B. subtilis, S. aureus* K147, *S. aureus* MR P0017, and *S. faecalis* - while *Pristimera* sp was active against also *M. phlei*. *Rhoicissus revoilli* is used in conjuction with *Acridocarpus zanzibaricus* to treat syphilis by the Giriama. A methanol extract of the root was active against four strains of gram positive bacteria.

Seventeen out of 21 species of plants used to treat skin related infections were active against at least one test microbe. Fifteen showed antibacterial activity while only three were antifungal. The prominent species in this category include *Carissa edulis, Kigelia africana* and *Fagara chalybeum*. *Carissa edulis* is also used to treat ulcers; circumscribed lesions of the skin or mucous membrane of an organ formed by necrosis of tissue resulting from an infectious, malignant or inflammatory process; and boils (small, painful lumps in the skin that have cores of dead tissue and surrounding inflammation caused by bacterial, *Staphylococcal,* infections through a sweat gland or hair follicle. It produces pain, redness and swelling). A methanol extract of the root was active against one acid fast bacterium, four strains of gram positive bacteria including *Staphylococcus aureus* ; one gram negative bacteria and one fungus strain. *Kigelia africana* is used by the Luo to treat tropical ulcers, a cutaneous form of Leishmaniasis, a skin disorder caused by the trypanosome *Leishmania tropica* occuring in Africa and is characterised by ulcerative skin lesions. Methanol extracts were active against one strain of acid fast bacterium *M. phlei,* four strains of gram positive bacteria, *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *S. faecalis* and the gram negative *P. aeruginosa* H188. *Fagara chalybeum* is used by the Giriama in conjuction with *Cyphostemma adenocaulis* to treat boils and injury or break in the skin, usually caused by an accident and not disease leading to an infection. Methanol extracts of *Cyphostemma adenocaulis* were active against the gram positive bacteria, *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *S. faecalis. Fagara chalybeum* was also active against acid fast bacteria *M. phlei* and yeast *S. cerevisiae.*

Five out of six species used traditionally to treat chest and related infections were active against at least one test pathogen. The prominent species include *Acacia nilotica* and *Trichilia emetica.* Both species are used traditionally to treat pneumonia, inflammation of the lungs, usually caused by infection with bacteria especially *Pneumococcus*), viruses, fungi or rickettsiae. A methanol extract of *T. emetica* was active against the gram positive bacteria: *B. subtilis, S. aureus* K147, *S. aureus* MR P0017 and *S.*

faecalis. Trichilia is a species in the Meliaceae, a family well known for bioactive limonoids. *A. nilotica* was also active against a strain of gram negative bacterium *P. aeruginosa* H187.

Triumfetta rhomboidea, traditionally used to treat wounds, abscesses and yaws, was also prominent. Yaws is an infection caused by the spirochete, *Treponema pertenue,* transmitted by direct contact cheifly among children, living in unsanitary conditions in tropical and subtropical areas. A methanol extract of this species was active against the gram positive bacteria, *B. subtilis, S. aureus* K147 and *S. aureus* MR P0017.

CHAPTER SIX

CONCLUSION

From the bioassay results I can conclude that there is a biological relationship between the plant used traditionally to treat infectious diseases and the activity of the components of the plants against pathogenic bacteria and fungi. Although methanol extracts were used rather than plant decoctions or infusions (water extracts) there is enough evidence for the presence of antibiotics in most of the species. Most of the species have been subjects of chemical analysis and many compounds have been isolated and identified from them. However, they had not been subjected to antibacterial and antifungal screening. These species are in forest areas that are under the threat of destruction to provide for agricultural land for the ever increasing population. Some of the species are endangered, yet their full potential has not been realized. These species need to be further studied for the their chemical potential before they become extinct.

Indeed, many scientific groups are currently exploring the African flora for new compounds with pharmacological activities. Such efforts have led to the isolation of several biologically active molecules that are in various stages of development as pharmaceuticals (Iwu, 1993). When the medicinal potential of species is known, Governments and people will place a greater value on the forest resource that supports these plants, and thus will be of value to conservation efforts.

This project has therefore brought together two systems of innovation : the traditional medicine system as a source of leads for antibiotics from plants; and laboratory techniques as a tool for advancing the understanding of traditional uses of plants as well as isolating and identifying useful antibiotics. The two systems therefore are complementary.

Folk medicine has been a pointer towards many of the drugs used today and it is certainly a very useful indicator of biologically active substances. The advent of high throughput, mechanism based *in vitro* bioassays coupled with candidate plants derived from ethnomedical research has resulted in the discovery of new pharmaceuticals such as prostratin, a drug candidate for the treatment for human immunodeficiency virus, as well as a variety of novel anti-inflammatory compounds. We are aware that if we do not do something about preserving the available indigenous knowledge now, it will be too late because of the unfortunate acculturation of tribal peoples around the world.

Indigenous knowledge systems must be recognized and respected as innovation systems. Although indigenous communities have carefully nurtured and developed biological diversity, they have seldom received the benefits from its commercial applications. Often drugs developed from plants used traditionally end up in pharmacies in the developing countries sold at exorbitant prices. This imbalance in equity has resulted in essence to disregard for the need to conserve natural resources by the indigenous people because they see that it will only benefit the developed world. The involvement of the traditional healers in research and benefits accrued will enhance their participation in conservation of the natural resources. Participatory approaches in conservation and development programs is the key to success.

Dissemination of the results to the people of Kenya and, in effect to the policy makers is essential for developing an appreciation of ethnobotany. The current education system does not recognize traditional knowledge systems as important which has led to a diminishing interest among youth. There is need to stimulate interest among young people by incorporating ethnobotany into the school curriculum. When the youth and the public start to see traditional systems as a source of appropriate nutrition and health then we will make wiser use of our natural resources including cultures.

The results of this study, one of the first done among the Giriama, will contribute to the development of a pharmacopoeia of medicinal plants of the Giriama community and to Kenya as a whole. This initiation will also serve as an impetus for research on traditional knowledge of the coastal peoples who are well known in Kenya for their traditional medicine. The results of this study will be shared with the herbalists who contributed their knowledge to this research in a forum that will involve interactions with government officials, health workers, conservation workers and researchers. Discussions will include conservation, nutrition, research and will aim at opening up dialogues between the herbalists, researchers and development agencies that will eventually deliberate on issues of intellectual property rights and conservation.

The results of this study point towards potential sources of potent antibiotics. but the process of development into drugs will involve many years of research and considerable financial investments. But at the local level there is scope for the development of herbal preparations into standardised formulations that can be cost effective as well as income generating.

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APPENDICES

APPENDIX I

Glossary of some medical terms

Anthrax : Bacterial (*Bacillus anthracis*) disease of cattle and other farm animals that can be transmitted to humans from infected animals and animal products. The disease causes skin lesions, fever, mucle pain, nausea and internal haemorrhage; in a serious often fata, form, it ialso attacks the lungs. Treatment is by penicillin or tetracycline.

Boils : Small, painful lump in the skin that has a core of dead tissue and surrounding inflammation caused by bacterial (*Staphylococcal*) infection through a sweat gland or hair follicle, it produces pain, redness and swelling. Treatment is by antibiotics, applications of moist heat and surgical incision and drainage if necessary

Colds : Infection involving the nasal passages and upper part of the breathing system (not including the lungs) and including such symptoms as a runny nose, watery eyes and a sore throat. Caused by one of many different viruses(mainly rhinoviruses) a cold may be treated with rest, decongestants, and increased fluids, but usually not with antibiotics which do not affect viruses.

Cough is sudden , forceful, and audible expulsion of air from the lungs that clears the air passages of irritants and helps to prevent aspiration of foreign particles into the lungs. It is a common symptom of a cold, respiratory infection, of bronchitis, pneumonia, tuberculosis or other upper lung disease, and of some forms of heart disease.

Diarrhea is frequent passage of loose, watery stools (the stools may contain mucus, blood or excessive fat) sometimes accompanied by nausea, vomiting, abdominal cramps, and feelings of malaise and weakness. Diarrhea may be a symptom of a viral or bacterial infection (mild or severe), food poisoning, disorder of the colon (e.g. colitis) gastrointestinal tumour, metabolic disorder or other disease

Dysentery : Intestinal inflammation caused by bacteria, protozoa, parasites or chemical irritants and marked by abdominal pain, frequent bloody stools and rectal spasms.

Earache is pain in tha ear; it may be caused by ear disease or by onfection or disease of the nose, mouth region, throat and other nearby areas; also called otalgia.

Fever : Rise intemperature of the body to greater than 37 ^{0}C (98.6 ^{0} F). A temperature rise can sometimes be caused by severe stress, strenous exercise or dehydration, but fever is most often a sign of infection (bacterial, viral or other) or other disease

Foot and mouth disease : Common viral disease of farm animals in Europe, Asia and Africa that is sometimes transmitted to humans who come in contact with the animals and their products. Symptoms include headache, fever, malaise and small blisters on the oral membranes, tongues, hands and feet.

Gonorrhea : a sexually transmitted diseases caused by bacterium *Neisseria gonorrhoea*
Malaria is serious infection illness characterised by recurrent episodes of chills ,fever, headache, anemia, muscle ache and enlarged spleen. It is caused by *Plasmodium* protozoa transmitted from human to human through the bite of an infected *Anopheles* mosquito or through blood transfusions or hypodermic needles. it is largely confined to tropical and subtropical areas. Treatment is by chloroquine or in resistant cases, a combination of quinine, sulfonamides an dother drugs.

Measles : Acute, contagious, viral disease, occuring primarily in children who have not been immunised and involving the respiratory tract and a spreading rash. Treatment includes pain relievers, fever reducers, rest, and lotions (e.g. calamine) to soothe the skin and relieve itching. prevention is by vaccine.

Pus is thick yellowish or greenish fluid, containing dead white blood cells, bacteria and dead tissue, formed at an infection site.

Ringworm : Any of several fungal infections of the skin often characterized by ringlike skin lesions, including athlete's foot and jock itch.

Scabies : contagious disease caused by the itch mite (*Sarcoptes scabiei*) and characterized by itching and skin irritation, often leading to secondary infection. Treatment is includes scabicides and antihistamines to relieve itching. All contacts, bedding, and clothing must be treated to prevent spread and reinfestation.

Smallpox : Highly contagious viral disease characterised by fever, weakness and a pustular rash that may result in permanent scarring.

Syphilis : a sexually transmitted diseases or passed on unborn baby by mother caused by *Treponema palidum* sprochete.

Thrush = candidiasis : Infection caused by a *Candida* species of fungus (e.g. *C. albicans*), affecting most often the skin, mouth and vagins, and causing itching, peeling, whitish exudate, and sometimes easy bleeding. Common forms of candidiasis include thrush and some types of vaginitis and diaper rash. treatment is by oral and topical antifungal drugs (e.g. nystatin) and sometimes use of gentian violet.

Tropical ulcers, tropical sore, oriental sore: Cutaneous form of Leishmaniasis; a skin disorder caused by the *Leishmania tropica* parasite, occuring in Africa, Asia and areas around the Mediterrenean sea; it is cahracterised by ulcerative skin lesions. treatment usually onvolves the use of antimony preparations.

Ulcers are circumscribed lesions of the skin or mucous membrane of an organ formed by necrosis of tissue resulting from an infectious, malignant or inflammatory process.

Venereal disease : Communicable disease transmitted by sexual intercourse or genital contact. VD include gonorrhea, syphilis and granuloma inguinala

Wound : injury or break in the skin, usually caused by accident, not disease but may be infected.

APPENDIX II

List of species traditionally used by the Giriama, Luo, Luhya, Kamba, Kikuyu and the Tugens to treat infectious diseases

The species are arranged alphabetically by family and within each family. Information is listed as follows Latin names (Author)/ **local names** (tribal group)/brief description/ part used/ medicinal use (specimen voucher number); other uses in rest of Africa (country or people) (reference). Gir stands for the Giriama dialect. Species from other parts of Kenya are also listed e.g. Luo, Luhya, Kikuyu (Kik), Kamba (Kam.), Maasai (Maa) and Tugen. Local terminologies are in ***"italics bold "***within quotation marks; single quotation marks are used where an ***'approximate English translation'*** is known and double marks used where a ***"direct translation"*** follows.

Amaranthaceae

Psilotrichum scleranthium Thw / **Kabarutitsaka** (Gir) / shrub to 1 m / roots, leaves / used to treat ***'upele'*** (scabies) and children's asthma in complement with *Aganthisanthemum bojeri*. (G27/ 94). Waist joint pains (Mutta, 1988). Ash from burnt leaves is applied to hernia. The ash is also rubbed into cuts to reduce swelling or pain. Poultices with hot water are made from leaves and used to reduce swelling (Kokwaro, 1993).

Anacardiaceae

Lannea stuhlmanii (Engl.) Engl. / **Kuogo** (Luo) / a savanna shrub or tree up to 13.5 m; stem bark; decoction is used to treat dysentery, venereal diseases and open ulcers (S3/94).

Annonaceae

Annona senegalensis Pers. Syn.s *Annona chrysophylla, A. senegalensis* var *latifolia. A. senegalensis* var *chrysophylla* (Boj.) R. Sillans / **Mutakuma** (Gir) / tree up to 5 m / roots / decoction is taken for stomachache with symptoms of diarrhea (G22/94). Gastrointestinal disorders (Dalziel, 1949). Chest complaints and heart burn (Irvine, 1961). The roots and leaves are used to treat abdominal upsets in Uganda (Anokbonggo, 1974). Labor pains, children's fever (Mutta, 1988). A decoction of the roots is taken as a remedy for chest colds. The gum is applied to cuts and wounds to seal them. Fruits cure diarrhea, dysentery and vomiting (Kokwaro, 1993). Chalazion and eyelid swelling (Klauss and Adala, 1994).

Artabotrys sp. / **Mudzala simba** (Gir) / woody climber up to 3.5 m/ roots/ decoction is mixed with Gossypium barbadense and drank for swollen stomach, stomachache ***'kusikia mibamiba'*** pin and needles like pain with diarrhea (G21/94).

Artabotrys sp. / **Mwangajeni** (Gir) / tree up to 4 m/ roots/ used in complement with *Xylopia arenaria* to treat stomachache with diarrhea and in complement with *Carissa edulis, Vernonia hildebrandtii* and *Gossypium barbadense* for amenorrhea (G2/94)

Artabotrys monteroae Oliv. / **Mubulushi** (Gir) / tree / roots / decoction is taken for stomachache with diarrhea symptoms in complement with other species namely *Xylopia arenaria, Uvaria acuminata* and *Croton dichogamus* (G3/ 94). Blenorrhagia (Tonga) (Watt and Breyer - Brandwijk, 1962).

Monathotaxis formcata (Baill.) Verdc./ **Muzimu** (Gir)/ shrub to 4 m tall/root/ (G42/94); decoction is drunk to treat miscarriage (Mutta, 1988). Decoction of the leaves which are aromatic is taken as a remedy for headache by the Digo (Kokwaro, 1993)

Premna chrysoclada/ **Muvuma** (Gir)/ shrub/ root/ for stomachache with diarrhea (G5/94). Anemia (Mutta, 1988). Decoction of root is drunk by women for painful menstruation and also taken for snakebite and pectoral (breast) diseases (Kokwaro, 1993).

Uvaria acuminata Oliv. / **Murori** (Gir) / shrub / root / decoction taken by children for diarrhea with vomiting; used in complement with *Gossypium barbadense* for amenorrhea and with *Artabotrys monteiroae, Uvaria lucida, Xylopia arenaria, Croton dichogamus and Uvaria lucida* Benth. ssp *lucida* / **Mdzaladowe** (Gir) /shrub to 6 m/ root/ used in complement with *Croton dichogamus, Xylopia arenaria, Artabotrys monteiroae, Premna chrysoclada* and *Uvaria. acuminata* to treat stomachache with diarrhea (G37/94).

Xylopia arenaria Engl. / **Mubarawa** (Gir) / tree to 5m / root / chewed to clear cough; decoction is taken for stomachache with diarrhea symptoms in complement with other species namely *Artabotrys monterae, Uvaria acuminata, Uvaria lucida, Croton dichogamus* and *Premna chrysoclada* (G1/94). Decoction is taken for male impotence and to chase evil spirits in women (Mutta, 1988).

Apiaceae or Umbelliferae

Steganotaenia araliaceae Hochst. synonym *Peucedanum fraxinifolium* Hiern. / **Nyang Nyang - Liech** (Luo) / savannah tree to 3 - 5m / stem bark / decoction is taken to treat venereal disease, East Coast Fever, Foot and mouth disease, stomach ulcers and small pox (S1/94). In Zimbabwe it is used as an abortifacient, to ease calving, convulsions and sore eyes (Gelfand et al., 1985). Roots are used for snake bite, sore throat; bark decoction for dysentery and excess gas in stomach (Kokwaro , 1993). Sore throat, asthma (Zigula and Sukuma) Watt and Breyer - Brandwijk, 1962). Malaria, rheumatism, bilharzia, gonorrhea (Haerdi,1964) Snake bite (Kokwaro, 1976). Abdominal pains (Hedberg, 1983). Abortifacient, to ease calving, convulsions and sore eyes (Zimbabwe) (Gelfand et al, 1985). Menstrual problems (Pare) (Chhabra, 1993).

Apocynaceae

Carissa edulis (Forsk.) Vahl / **Vujeyatsi** (Gir) **Ochuoga** (Luo) / branched scrambling shrub to 3.5m.; root; decoction is taken to treat body sores, boils, venereal diseases, stomach ulcers and dysuria (S2/94. Chest complaints (Nyamwezi, Kamba), gastric ulcer (Maasai), ***"msanti"*** plague like disease (Chagga), abortifacient, tonic, cough (E. Africa), anthelmintic, venereal disease (Tanzania)(Watt & Breyer - Brandwijk, 1962). Abdominal pains, asthma, boils, cataract, chest pains, ***"chidyiso"*** pain in alimentary canal , cough, tonic for pregnant mothers and suckling babies, painful uterus, pneumonia, headache, gonorrhea, women infertility, abscess, dysponea (Gelfand, 1985). Antimetazoal (Oliver - Bever, 1986). Severe abdominal upsets (Uganda) (Anokbonggo, 1992). Headache (Ethiopia) (Tadesse & Demissew, 1992). Indigestion, lower abdominal pain when pregnant, chest pains, malaria, polio symptoms (Kokwaro, 1993).

Araceae

Zamioculus zamiifolia Lodd. Engl. / **Mchachake** (Gir)/ herb/ stem base/ is warmed in hot ash and juice applied for earache (G27/94)

Asteraceae or Compositae

Crassocephalum picridifolium (DC) S. Moore / **Bunimkubwa** (Luhya) / Leaves/ (6/94) : chewed and sprayed over wound to heal it.

Vernonia hildebrandtii Vatke. / **Mlazakoma** (Gir) / Root : amenorrhea in complement with *Artabotrys* sp **(MWANGAJENI)**, *Carissa edulis* and *Gossypium barbadense* (G44/94).

Vernonia lasiopus O. Hoffm. / **Muchatha** (Kik) / woody herb to 2.5 m/ leaves, root/ (1/94) the leaves are either chewed or boiled and decoction drunk for stomachache. However the root decoction is said to be the most effective treatment for stomachache, and sex stimulant. The leaves also as a purgative also pounded and the paste used to treat sores on cattle, as the paste keeps maggots away (Kokwaro, 1993).

Balanitaceae

Balanites sp. / **Andari** (Gir) / Leaves/ are crushed and applied on to ringworm in complement with *Coccinia sp* (G40/94).

Bignoniaceae

Kigelia africana (Lam.) Benth. / **Yago** (Luo) / tree; stem bark; it is used to treat tropical ulcers, dysentery, syphilis and oedema (S4/94). Rheumatism and dysentery (Oliver, 1959; Dalziel ,1937). Intoxicant, sexual excitant, wounds, ulcers, abscesses (Tanzania), purgative, dysentery, syphilis, gonorrhea (Nigeria), constipation, haemorrhoids, sores, rheumatism, dysentery, (Ghana), boils, sore throat (E. Africa), ulcers dressing (S. Africa) (Watt & Breyer - Brandwijk, 1962). Abortifacient, aphrodisiac (Kokwaro, 1981). Tropical ulcers, pneumonia, backache, toothache, epilepsy, snake bite (Zimbabwe) (Gelfand et al., 1985). Post parturition haemorrhage, spleen infection, dizziness, malaria fever, gonorrhea, syphilis, regularise menstrual flow, retained placenta and infertility (FAO, 1986). Women's remedy (Ghana), breast development in young girls (Cape

Verde) (Oliver - Bever, 1986). Skin diseases (Taita, Kikuyu, Marakwet, Luo) (Kokwaro, 1988). Measles, headache, malaria, abortion (Kokwaro, 1993).

Capparidaceae

Maerua triphylla A. Rich. / **Chokowa** (Pokot) / tree up to 2.5 m high/ roots/ (4/94) fresh roots are chewed or pounded, soaked in water and infusion given to a patient to drink for snake bite while some is used to wash the wound. (Kokwaro, 1993).

Caricaceae

Carica papaya L. / **Mupapayu mulume** (Gir) / tree with softwood to 3.5m high / roots / decoction is taken to treat gonorrhea (G9/94). In Zimbabwe its used for depressed fontanella (Chipande), warts (Tanzania), purgative (W. Africa), piles (Ghana), oedema (Ivory Coast), toothache (Zaire) (Gelfand, 1985). depressed Dysentery, anthelmintic (East Africa) enlarged spleen, boils, insecticide (Sierra Leone) (Watt and Breyer - Brandwijk, 1962). Anthelmintic diuretic, bilious conditions (Oliver - Bever, 1986).

Celastraceae

Salacia madagascariensis (Lam.) DC / **Mdzipo** (Gir) / Root : ***"mshipa"*** stomach pains (G41/94)

Connaraceae

Connarus sp./ **Muvivira** (Gir)/ forest liane to 35m / root / decoction is a very strong remedy for stomach pains (G25/94).

Cucurbitaceae

Coccinia sp. / **Mria** (Gir)/ climbing plant / leaves / in complement with *Balanites* sp. leaves are crushed and juice applied to ringworm (G6/94).

Euphorbiaceae

Croton dichogamus Pax / **Muyama** (Gir)/ savannah shrub or tree to 13.5 m / roots / when mixed with *Artabotrys monterae* Oliv. **Mubulushi** (Gir), *Xylopia arenaria* **Mubarawa** (Gir), *Uvaria acuminata* Oliv. **Murori** (Gir) a root decoction is taken for stomachache with diarrhea (G8/94). Fever, chest ailments, stomach diseases, stomach ache and tonic (Kokwaro, 1993).

Drypetes natalensis (Harv.) Hutch./ **Mugandamwa** (Gir)/ small tree to 10 m / root / decoction is taken for treatment of wounds (G24/94).

Fabaceae or Leguminosae

Abrus precatorius L./ **Mthurithuri** (Gir)/ climber / root / decoction is taken to treat syphilis (G13/94). Other uses include blood purification (Zimbabwe), eye remedy (Tanzania), aphrodisiac (Zaire), purulent eye infections (Eritrea), infertility in women, vomiting blood and as a poison (Gelfand, 1985). Chest pain (Zulu), inflamed eyes (Luvale), emetic(Eritrea), stomach complaints, aphrodisiac, snakebite (E. Africa), ophthalmia, ulcers, oral contraceptive, (Central Africa) arrow poison (E. Africa, SW Africa) (Watt and Breyer - Brandwijk, 1962).

Acacia nilotica (L.) Del./ **Chebiiwo** (Tugen) / single bole tree up to 3 - 5 m/ stem bark, root, leaves/ (8/94) the stem bark is chewed for treating sore throat and coughs; roots are used for the treatment of gonorrhea and chest diseases; leaves are boiled and taken in tea or coffee for chest pains, pneumonia. (Kokwaro, 1993)

Albizia anthelmintica Brongh. / **Muowa** (Kam) / decidious bush or tree to 8 m ; stembark, root; decoction of bark or root is used as an anthelmintic mainly for tape worm. It is also used for treating malaria. Roots are said to be used to treat fever and gonorrhea (Kokwaro, 1993)

Crotolaria laburnifolia L. / **Mihi'hro** (Luhya, Kakamega) / leguminous much branched herb up to 1 m high/ root, leaves/ (3/94) root extract is drunk for treatment of gonorrhea and pounded leaves applied to afflicted area of snake bite (Kokwaro, 1993)

Dalbergia melanoxylon Guill. & Perr. / **Muhingo** (Gir) / deciduous savanna tree or shrub

3 - 11m high / root / when mixed with *Heinsia crinita* (Afz.) G. Tayl. Mchocho (Gir),

Abrus precatorius L. **Mthurithuri** (Gir) and *Carica papaya* **Mupapayu mlume** (Gir) decoction is taken to treat 'kisonono' (syphilis) (G 11/94). Emetic (S. Africa), aphrodisiac (Zambia) (Watt & Breyer - Brandwijk, 1962). Abdominal pains, gonorrhea, mouth wash for tooth ache (Kokwaro, 1976). Cleaning wounds, abdominal pains, anthelmintic and gonorrhea (Zimbabwe)(Gelfand et al., 1985).Cleaning wounds (Meru) (Kokwaro, 1988). Anthelmintic, joint pains (Kokwaro, 1993).

Dichrostachys cinerea (L.) Wight & Arn / **Mukingiri** (Gir) / acacia like shrub or tree usually 3 - 5m high / root / when mixed with *Strychnos spinosa* **Mjaji**(Gir), *Lonchocarpus* sp **Msimaribara** (Gir) decoction is used to treat skin diseases (G20/ 94). Other uses include pneumonia (Zimbabwe), Foot and mouth disease (Tanzania), leprosy (eastern Sudan), depressed fontanella, influenza, cough, scabies, nose bleeding, diarrhea with blood, backache, scorpion bites, oedema (Gelfand, 1985). Conjuctivitis, stomachache, gonorrhea, (Kokwaro, 1993). Toothache (Tonga), stomach troubles (Pedi), chest complaints (Zigula), gonorrhea, syphilis (Chaga) (Watt and Breyer - Brandwijk, 1962). Elephantiasis, circumcision wound, catarrh, sore throat, colic, diarrhea (Liberia), urethral complaints,, anthelmintic (Eastern Sudan), bronchitis, antidysenterica (Senegal, French Guinea), snakebite antidote (Nyamwezi) (Watt and Breyer - Brandwijk, 1962).

Milletia usaramensis Taub./ **Msimaribara** (Gir) / Root : used in complememt with *Dichrostachys cinerea* and *Strychnos spinosa* for skin disease with sores. Decoction is drunk and also used as a wash.

Mundulea sericea (Willd.) A. Chev / **Mutupa** (Gir) / root/ used to treat infertility (G29/94). Other uses include constipation (Ghana), dysentery (Nigeria), diuretic (Ivory Coast) (Gelfand 1985) Swollen stomach (Mutta, 1988). Fish poison (E and W. Africa) (Oliver - Bever, 1986, Watt and Breyer -Brandwijk, 1962). Insecticidal (Dale and Greenway, 1961).

Guttiferae or Clusiaceae

Vismia orientalis Engl. / **Mwembetsaka** (Gir) / small tree to 8m / root / root bark peel is sundried, crushed to powder, mixed with coconut oil and applied topically for scabies (G 19/94). Pimples, acne, smallpox, chickenpox and primary syphilis (Kokwaro, 1993).

Lamiaceae or Labiatae

Hoslundia opposita Vahl. / **Mutserere** (Gir) / perennial woody herb to 1m high / roots / leaves / root decoction is taken for stomach problems (10/ 94) . Gonorrhea, cystitis, blenorrhagia (Haya), chest pains (Shambala), poisonous (Watt and Breyer - Brandwijk, 1962). Snakebite antidote (Nigeria), stomachic (W. Africa) cataract, diarrhea in infants, sore throat, epilepsy fits (Zimbabwe) (Gelfand et al, 1985). Conjuctivitis (Uganda) (Anokbonggo, 1992). Cough, fresh wound, children's fever, colds, stomach pains (Kokwaro, 1993).

Plectranthus barbatus Andr. / **Maiya** (Kam) / woody herb/ leaves/ (5/94) are crushed and the juice drunk as a remedy for stomachache and as a purgative. The leaves are also pounded, soaked in warm water and used to bathe babies suffering from measles (Kokwaro, 1993).

Linaceae

Hugonia castaneifolia Engl. / **Mkuro** (Gir) / scandent shrub / root / decoction is used to treat snakebite (G7/94). Intestinal worms (Kokwaro, 1993).

Loganiaceae

Strychnos spinosa Lam. / **Mjaji** (Gir) / savannah shrub or tree usually 5 - 7 m high / roots/ in complement with *Lonchocarpus sp.* Msimaribara(Gir) root decoction is used to treat skin disease. The young fruit is used to induce abortion (G18/94). Other uses include syphilis (Nigeria) colds, snake bite remedy (East Africa) (Gelfand ,1985). Febrifuge, emetic, sore eyes (Zulu), dysentery, syphilitic sores (Tonga), snakebite (E. Africa), conjuctivitis (Nyamwezi), jiggers (Tanzania) (Watt and Breyer - Brandwijk, 1962). Colitis, enterocolitis, diarrhea, stomachic (Tropical W. Africa) (Oliver - Bever, 1986).

Malphigiaceae

Acridocarpus zanzibaricus (Bojer ex Loud.) A. Juss. / **Mubohoboho** (Gir) / showy scandent shrub / root / decoction is taken for the symptoms swollen painful stomach, ***"mibamiba"*** (pins and needles like pain in stomach) and watery discharge from digestive tract (G23/94).

Malvaceae

Gossypium barbadense L. / **Mpambamwitu** (Gir) / root / when mixed with *Uvaria acuminata* Oliv. Murori (Gir) decoction is taken by children for diarrhea and vomiting symptoms; in complement with *Artabotrys sp.* Mwangajeni (Gir) decoction is taken for amenorrhoea to stop prolonged blood flow during menstruation (G26/94).

Emenagogue, dysentery, sores, wound dressing (Nigeria), abortion (African Americans), amenorrhea (Senegal) (Oliver - Bever, 1986).

Meliaceae

Trichilia emetica Vahl. synonym *T. roka* / **Ekuyen** (Turkana) / tree usually 5 -13m high/bark, seeds/ (9/ 94) infusion of bark is used as a remedy for pneumonia; seeds are fried and the oil thus extracted applied to sores from which jiggers have been removed as a treatment. The oil is also rubbed on toes to prevent jigger infection (Kokwaro, 1993).

Menispermaceae

Cissampelos pareira L. var. *orbiculata* (DC) Miq. / **Kasikiropaka** (Gir) / root, leaves/ root for sore throat, colds, cough, snakebite. Leaves and roots for stomach pains, pregnancy pains; when burnt used for wounds (Kokwaro, 1993). Stomach pains, cough, snakebite and in pregnancy (Tanzania) (Watt & Breyer - Brandwijk, 1962). Constipation, palpitation, mental disturbance (Mutta, 1988).

Moraceae

Flueggia virosa (Willd.) Pax & Hoffm / **Mkwamba** (Gir) / Root : dysmenorrhea, amenorrhea and miscarriage (G34/94).

Ranunculaceae

Clematis hirsuta Guill. & Perr. / **Mugayangandu** (Kik) / much branched climber/ leaves, root/ (2/94) infusion from leaves is drunk for the treatment of gonorrhea, syphilis and sore throat; infusion form roots is used for treating yaws (Kokwaro, 1993).

Rubiaceae

Aganthisanthemum bojeri Klotzch / **Mkaithima** (Gir)/ shrub/ when mixed with *Scleranthum psilotrichum* Thw. **Kabarutitsaka** (Gir) it is used to treat asthma (G30/94). Chest conditions, cough (Karanga), snakebite (Nyamwezi) (Watt and Breyer - Brandwijk, 1962). Sore throat, syphilis, toothache (Kokwaro, 1993).

Heinsia crinita (Afz.) G. Taylor synonym *H. jasminiflora* DC / **Mchocho** (Gir) / scandent shrub to 5m / root / decoction is used to treat syphilis when mixed with *Dalbergia melanoxylon* Guill & Perr. **Muhingo** (Gir), *Carica papaya* **Mupapayu mulume** (Gir) and *Abrus precatorius* **Mthuri thuri** (Gir) (G12/94) Injured neck (Kokwaro, 1993).
Rytignia oligacantha (K. Schum) Robyns / **Mfrange** (Gir)/ much branched shrub to 4 m/ root bark/ cold infusion of bark is remedy for indigestion and swollen stomach (G32/94).

Rutaceae

Zanthoxylum chalybeum Engl. *Fagara chalybeum* / **Mdungu** (Gir) / Root : used in complement with *Cyphostemma adenocaulis* for boils and wounds (G40/94). Tooth brush, swellings, fever with vomitting, (Nyamwezi) (Watt & Breyer - Brandwijk, 1962). Oedema in kwashiorkor, ***"litaragu"*** a chest pain and creeping disease (Hehe), children's appetite (Maasai and Sunjo), malaria, cold, cough, dizziness, toothache,diarrhea in goats (Kokwaro, 1976, 1993). Snake bite, bile emesis, diarrhea (Zimbabwe) (Gelfand et al., 1985). Oedema swellings, cough, dysmenorrhea and constipation (Mutta, 1988).

Sapindaceae

Lecanodioscus fraxinifolius Bak. ssp. *vaughanii* (Dunkley) Friis / **Loch mattress** (Luo)/ Bark/ (S5/94) froth used to increase milk flow and assist purify milk in the breast (Kokwaro, 1993).

Tiliaceae

Corchorus olitarius L. / **Therian** (Tugen) / single stemmed herb up to 1 m high/ root/ (7/94) scrapings from the root are put into hollow teeth to stop them from aching (Kokwaro, 1993).

Grewia plaghiophylla K. Schum. / **Mkone** (Gir) / small tree / root / when mixed with *Cyphostemma adenocaulis* decoction is used to treat boils (G16/94). Bubonic plague (Taita) (Watt and Breyer - Brandwijk, 1962). Stomachache with diarrhea (Mutta, 1988). Stomacha aches, kidney troubles and gonorrhea (Kokwaro, 1976, 1993). Mental illness (Tanzania) (Hedberg et al., 1983) Stomachache with diarrhea (Giriama) (Mutta, 1988), (Zaramo) (Chhabra, 1993).

Verbanaceae

Premna chrysoclada (Boj.) Guerke / **Muvuma** (Gir) / Root : used in complement with *Uvaria acuminata, Uvaria lucida, Xylopia arenaria , Artabotrys monterae* and *Croton dichogamus* for stomachache with diarrhea (G36/94). Ulcerations, inflammation of the male organ (Swahili) (Watt & Breyer - Brandwijk, 1962). Venereal diseases, kidney troubles, dysentery and snake bites (Kokwaro, 1976). Mental illness (Herdberg et al., 1983) Indigestion, elephantiasis (Mutta, 1988). Abdominal pains, asthma, fever, psychiatric disorders, convulsions (Chhabra et al, 1993). Dysentery, purgative (Kokwaro, 1993).

Vitaceae

Cyphostemma sp. / **Kakira Kalume** (Gir) / Root : used in complement with *Cyphostemma adenocaulis.* and *Grewia plaghiophylla* for boils (G15/94).

Cyphostemma adenocaulis (A. Rich.) (Wild and Drum) / **Mgangalungo** (Gir) / climber / root / crushed and applied on boils to speed up ripening (G14/94). To prevent abortion (Watt & Breyer - Brandwijk, 1962). Syphilis (Kokwaro, 1976). Stomach ache, migraine, mental disease (Hedberg, 1983). Amenorrhea, remove retained placenta (Uganda) (Anokbonggo, 1992). Hernia, appendicitis, uvulitis, enlarged spleen (Zigua) (Chhabra et al., 1993). Swellings, pneumonia, purgative, abdominal pain during pregnancy, syphilis and ***"tambazi"*** (Swahili) (Kokwaro, 1993).

Rhoicissus revoilli Planch. / **Munywamadzi** (Gir) / climbing lianas / root / decoction is taken for treatment of syphilis and boils (G4/94). Stomachache, diarrhea and fever (Mutta, 1988). Cuts, sores, burns, (Kokwaro, 1976). To prevent abortion (Hedberg, et al., 1983) Stomachache, diarrhea and fever (Mutta, 1988). Hernia, prevents abortion (Chhabra et al., 1993). Wounds and bloody constipation (Kokwaro, 1993).

Pristimera sp. / **Kadzipo katite** (Gir) / Root : in complement with *Carica papaya, Abrus precatorius Dalbergia melanoxylon* and *Heinsia crinita* for ***"kisonono "*** syphilis (G10/94).

APPENDIX III

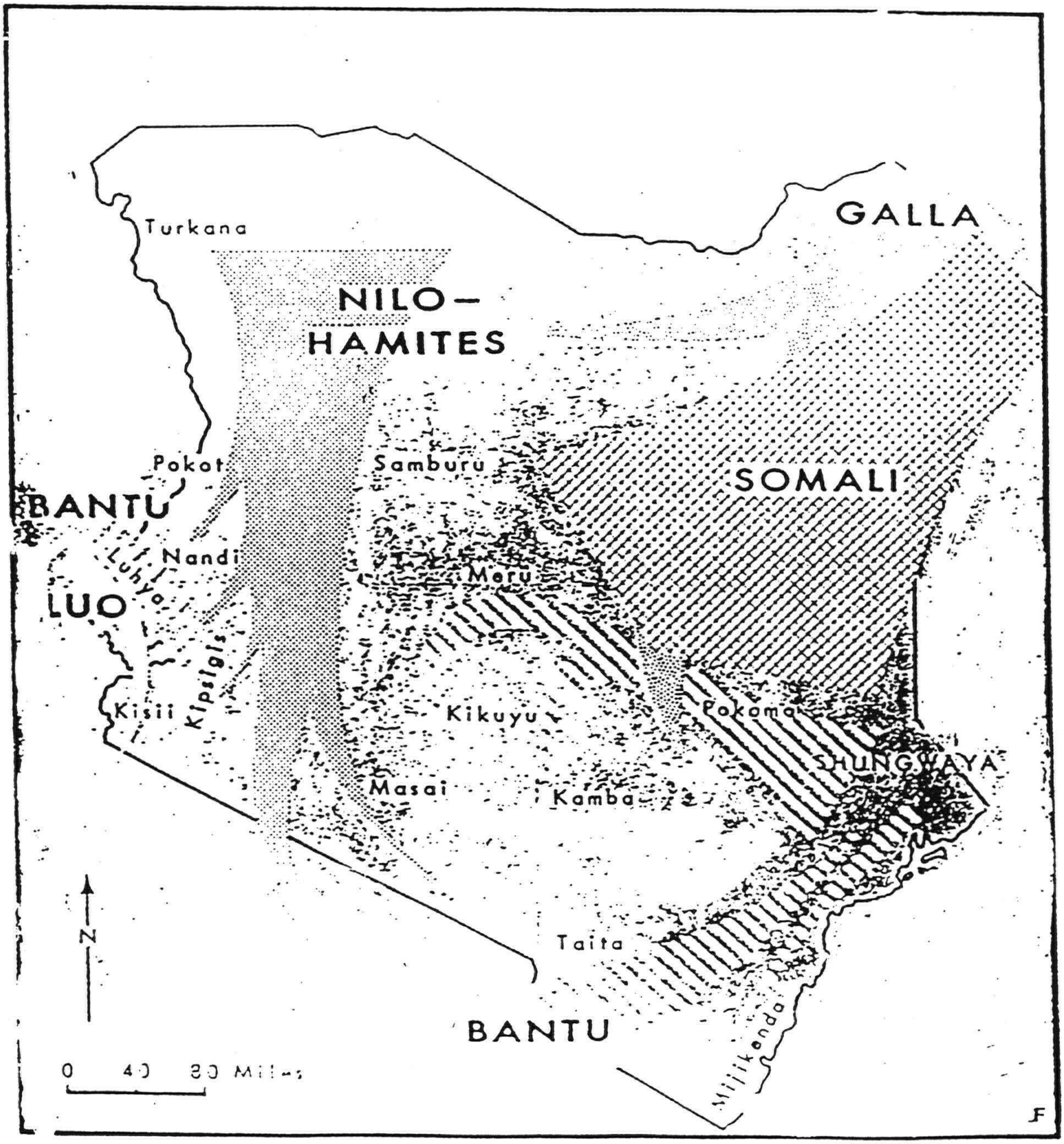
A table showing the test microbes and a listing of the species that each microbe was susceptible to.

Pathogen group	Spectum of activity	Species active
Acid fast, Gram positive, Gram negative bacteria, fungi	o	(13 spp) : *Psilotrichum scleranthum* Thw (Amaranthaceae), *Vernonia lasiopus* O. Hoffm (Asteraceae), *Maerua triphylla* A. Rich. (Capparidaceae), *Carica papaya* L (Caricaceae) *Croton dichogamus* Pax. (Euphorbiaceae), *Drypetes natalensis* (Harv.) Hutch. (Euphorbiaceae), *Crotolaria laburnifolia* L (Fabaceae), *Milletia usaramensis* Taub. (Fabaceae), *Hugonia castaneifolia* Engl. (Linaceae), *Strychnos spinosa* Lam. (Loganiaceae), *Clematis (hirsuta) brachiata* Guill & Perr. (Ranunculaceae), *Rytignia oligacantha* (K. Schum) Robyns. (Rubiaceae), *Corchorus olitorius* L. (Tiliaceae),
Gram positive bacteria	1	(9 spp.) *Artabotrys monteiroae* Oliv.(Annonaceae), *Xylopia arenaria* Engl. (Annonaceae), *Connarus sp.* (Connaraceae), *Coccinia sp.* (Curcubitaceae), *Albizia anthelmintica* Brongh. (Fabaceae), *Dichrostachys cinerea* (L.) Wight & Arn. (Fabaceae), *Hoslundia opposita* Vahl. (Lamiaceae), *Heinsia crinita* (Afz.) G. Tayl. (Rubiaceae), *Tridax procumbens* L. (Asteraceae).
	2	(4 spp.) *Annona senegalensis* Pers. (Annonaceae), *Artabotrys sp.* (MWANGAJENI) (Annonaceae), *Zamioculus zamiifolia* Lodd. Engl. (R & SB) (Araceae), *Cissampelos pareira* L. *var orbiculata* (DC) Miq. (Menispermaceae).
	3	(7 spp.) *Tridax procumbens* L. (Asteraceae), *Abrus precatorius* L. (Fabaceae), *Mundulea sericea* (Fabaceae), *Vismia orientalis* Engl. (Guttiferae), *Acridocarpus zanzibaricus* (Loud) A. Juss (Malphigiaceae), *Grewia plaghiophylla* K. Schum (Tiliaceae), *Triumfetta rhomboidea* Jacq. (Tiliaceae)
	4	(14 spp.)*Lannea stuhlmanii* (Engl.) Engl. (Anacardiaceae), *Uvaria acuminata* Oliv. (Annonaceae), *Carisa edulis* (Forsk.) Vahl. (Apocynaceae), *Kigelia africana* (Lam.) Benth. (Bignoniaceae), *Acacia nilotica* (SB & R) (L.) Del. (Fabaceae), *Dalbergia melanoxylon* Guill. & Perr (Fabaceae), *Hoslundia opposita* Vahl. (Lamiaceae), *Trichilia emetica* Vahl. (Meliaceae), *Gardenia volkensii ssp volkensii* K. Schum (Rubiaceae), *Lecaniodiscus fraxinifolius* Bak. *ssp vaughanii* (Dunkley) Friis (Sapindaceae), *Cyphostemma sp.* (Vitaceae), *Cyphostemma adenocaulis* A.(Vitaceae), *Rhoicissus revoilli Planch.* (Vitaceae).
	5	(7 spp) *Artabotrys sp* (MUDZALA SIMBA) (Annonaceae) ,*Steganotaenia araliaceae* Hochst (Apiaceae), *Gossypium barbadense* L. (Malvaceae), *Pristimera sp.* (?), *Fagara chalybeum* (Engl.)Engl.

		(Rutaceae), MUVA, MUVINITHIAMBUI.
Gram negative bacteria	1	(7 spp.) *Steganotaenia araliaceae* Hochst. (Apiaceae), *Kigelia africana* (Lam.) Benth. (Bignoniaceae), *Acacia nilotica* (L.)Del. (SB) (Fabaceae), *Albizia anthelmintica* Brongh.(Fabaceae), *Gossypium barbadense* L. (Malvaceae), MUVA, MUVINITHIA MBUI
Fungi	1	(7 spp.) *Artabotrys monteiroae* Oliv. (Annonaceae), *Xylopia arenaria* (Annonaceae), *Carissa edulis* (Forsk.) Vahl. (Apocynaceae) *Abrus precatorius* L. (Fabaceae), *Albizia anthelmintica* Brongh. (Fabaceae), *Dolichos oliveri* (Fabaceae) (Fabaceae), *Fagara chalybeum* (Engl.) Engl.
Gram positive and Gram negative bacteria		(7 spp.) *Steganotaenia araliaceae* Hochst. (Apiaceae), *Kigelia africana* (Lam.) Benth. (Bignoniaceae), *Acacia nilotica* (SB) (L.) Del. (Fabaceae), *Albizia anthelmintica* Brongh. (Fabaceae), *Gossypium barbadense* L. (Malvaceae). MUVA, MUVINITHIAMBUI.
Gram positive and fungi		(6 spp.) *Artabotrys monteiroae* Oliv (Annonaceae), *Xylopia arenaria* Engl. (Annonaceae), *Carissa edulis* (Forsk.) Vahl. (Apocynaceae), *Abrus precatorius* L. (Fabaceae), *Albizia anthelmintica* Brongh. (Fabaceae), *Fagara chalybeum* (Engl.) Engl. (Rutaceae)
Gram negative and fungi		*Albizia anthelmintica* Brongh. (Fabaceae)
Gram positive and Gram negative and fungi		*Albizia anthelmintica* Brongh. (Fabaceae)

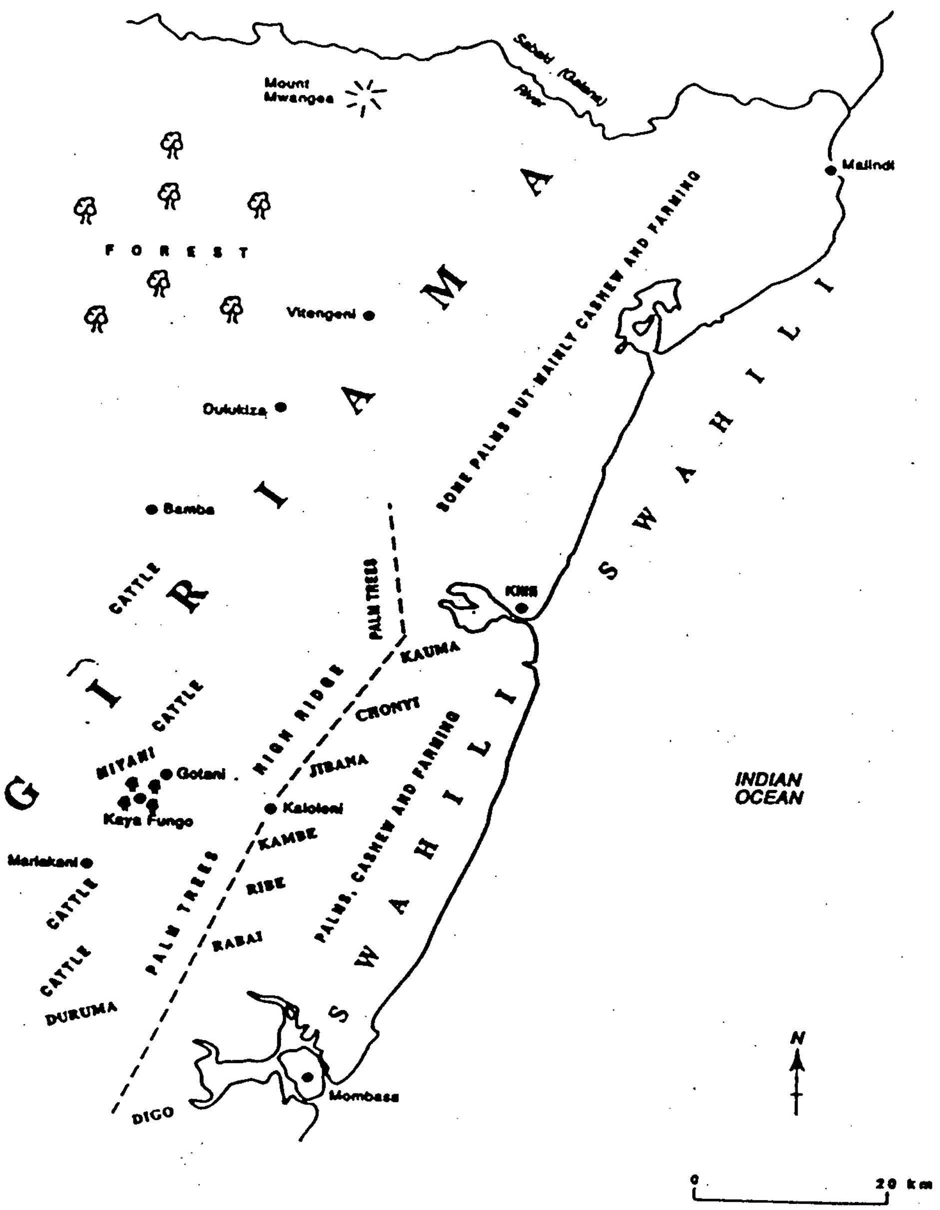
APPENDIX IV

Map showing location of the People of Kenya.



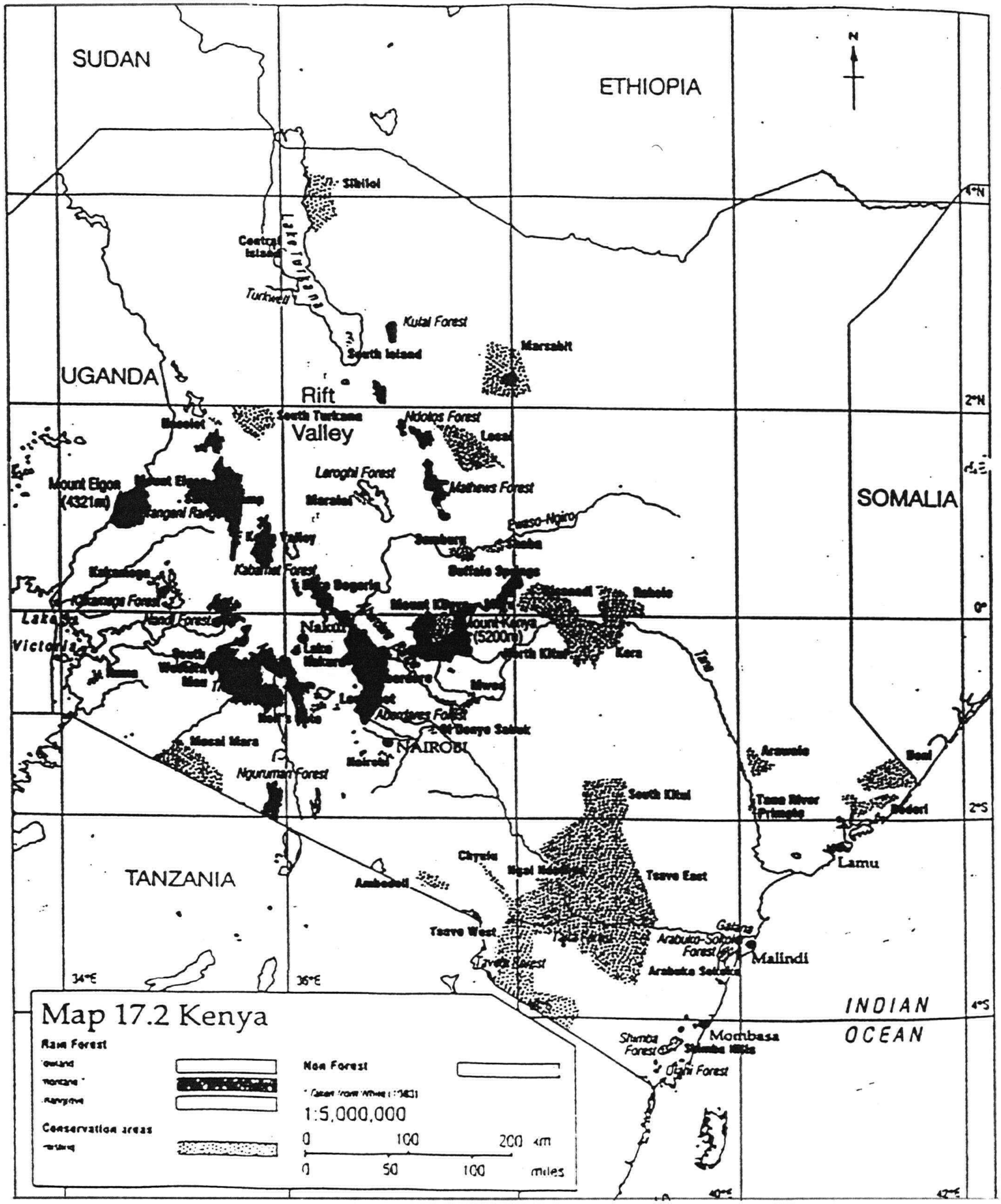
APPENDIX V

Giriamaland and the Kenyan Coast



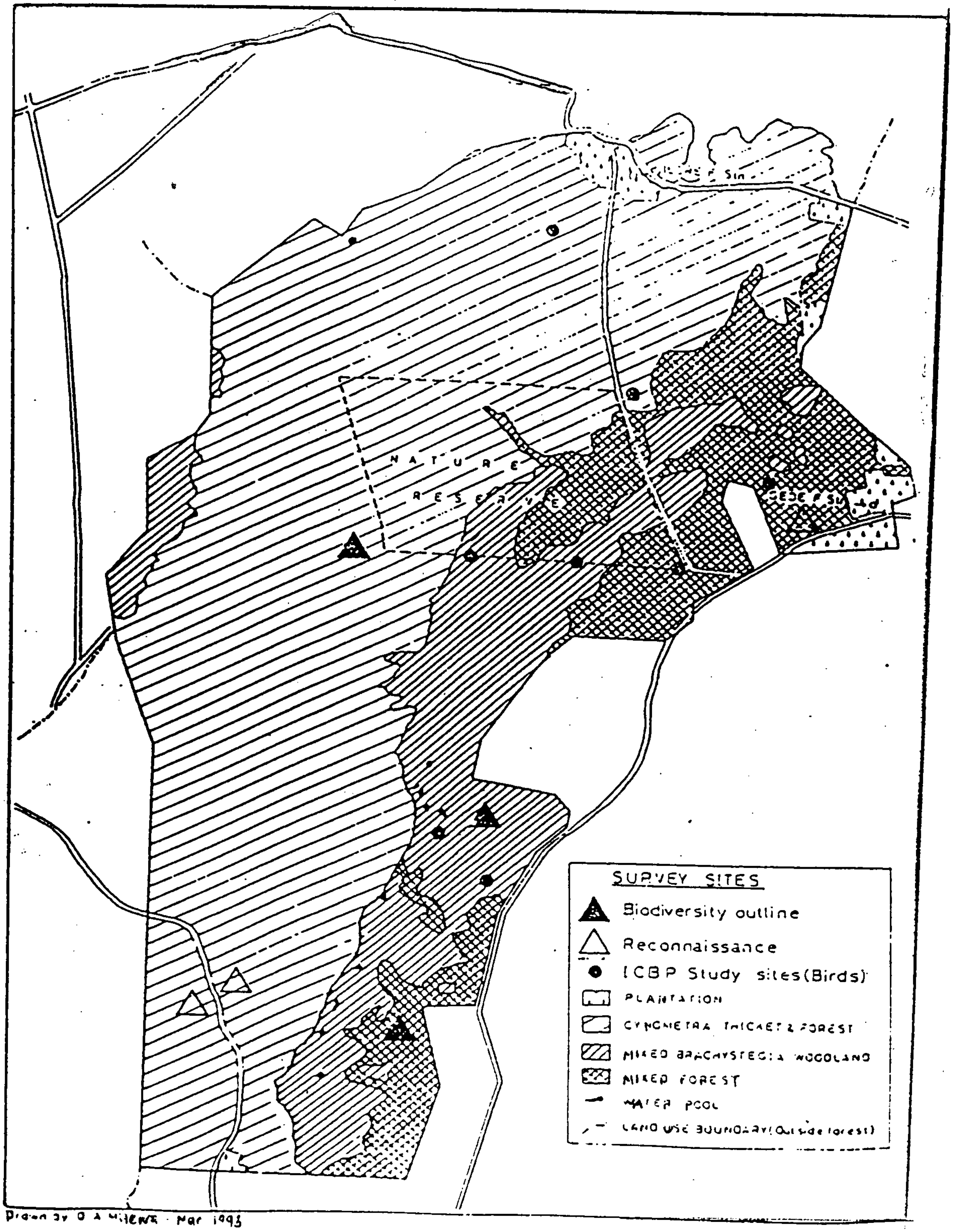
APPENDIX VI

Conservation areas in Kenya



APPENDIX VII

Arabuko Sokoke Forest Nature Reserve and Vegetation



APPENDIX VIII

Field Data Collection format

✓F6 ✓

NAIROBI UNIVERSITY HERBARIUM

FLORA OF Kilifi District

Name Rhoicissus revoilii Planch.

*Vern. Name Munywamadzi

Locality Gede-Mida roadside
5m from road main

Alt.

Habitat Forest among mubuthi
Mururuku

Description Climbing tree, red bark
roots has like potato, running root, v. common
leaves - trifoliate, alt, roundish apex
smooth, bark rough root bark v. red peel
roots fibrous

Economics alone syphilis, boils root

Date 16.06.94

Collector
Mutis Mbwi, Ngome
Kasiki K., Kasiki Ki

No. 44/94

N. U. HERB.

No. 46/94

N. U. HERB.

No. 44/94

N. U. HERB.

No. 44/94

N. U. HERB.

No. 44/94