ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

AN ETHNOBOTANICAL STUDY OF MEDICINAL PLANTS USED BY THE MAASAI PEOPLE OF MANYARA- ARUSHA, TANZANIA

BY

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An Ethnobotanical Study of Medicinal Plants Used by the Maasai People of Manyara-Arusha, Tanzania

A thesis submitted to the
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DEDICATION

This work is dedicated to:

My father the late Mwl. Akilei Njau and to my mummy, the late Catherine Lazaro, for inspiring on me the spirit of loving and valuing education and hard working.

May God the Almighty rest their soul in internal Peace AMEN!

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ABSTRACT

An ethnobotanical study was carried out to document information on the use of medicinal plants by the Maasai people living at the vicinity of Lake Manyara National Park, Monduli District in Arusha, Tanzania. Six villages or study sites were chosen randomly: Mto wa Mbu, Moyamayoka, Losirwa, Silale, Selela and Ngo'goro. It was assumed that indigenous knowledge related to biodiversity conservation and use of medicinal plants of this cultural group of people was getting lost or not well documented.

The main method of study was based on semi-structured interviews and discussion with selected informants (Maasai elders and healers). A vegetation survey was conducted to investigate the habitat status of the reported medicinal plants between the protected area inside Lake Manyara National Park and outside the park for conservation and monitoring purposes.

A total of 54 plant species belonging to 33 families and 44 genera were cited as being used by the Maasai of Manyara for their medicinal value. Of these medicinal plants, 49 plant species or 90% were trees and shrubs. Very few grasses and climbers are used. The result from Kruskall-Wallis and Friedman's test shows that there is high significant difference (**P< 0.0001, KW=63.036 and Fr=52.746) between trees and herbs/grasses for the medicinal plants used by the Maasai. Further analysis shows that plant species belonging to the families FABACEAE and EUPHORBIACEAE are the most used in Maasai remedial systems. Family Fabaceae account for 22% of the total medicinal plant species and Euphorbiaceae contributes 13% of the total medicinal cited. Out of these 54 plant species, 25 species are used for treatment of human ailments and 29 species are used for treatment of animal diseases. *Adansonia digitata, Albizia anthelmintica and Warburgia ugandensis* are used for the treatment of both humans' and veterinary diseases.

Barks and roots form the major component of plant parts collected accounting for 61% of the recorded medicinal plants. Most of the remedies are prepared in the form of decoction from single plant or as concoctions involving more than one plant. Seventy six percent of the

reported medicinal plants are taken orally. Some additives such as meat and bone soup are added to improve palatability.

With the exception of *Azadirachta indica* (**mwarobaini**), all other medicinal plants (about 98%) are harvested from the wild, which may indicate that Maasai have little practice of bringing medicinal plants under cultivation. Twenty seven percent of reported medicinal plants that were used to be forest-inhabited species are currently reported to have been rarely encountered in the area. *Leucas martinicensis, Allium ampeloprasum and Pappea capensis* are among the threatened species in the area. Seventy one percent of the recorded medicinal plants that are mostly trees and shrubs are commonly or occasionally encountered.

Habitat degradation and intense deforestation have been the leading cause for depletion of medicinal plants. From the vegetation data it is confirmed that Lake Manyara National Park (LMNP) is very rich in terms of medicinal plants especially those derived from Fabaceae. Thus, a greater emphasis should be given to conserve the park not only for its fauna as it is the case now but also its flora. Maasai are very rich in terms of the ethnoveterinary knowledge; this calls for a further study of their remedial system to taste for pharmaceutical efficacy of their medicines.

1. INTRODUCTION

1.1 General Introduction

The use of plants in indigenous societies are multiple and very diverse. Pastoral Maasai have for long-lived in intimate contact with their immediate environment's biological resources (Galaty, 1993). In the process they have managed to develop socio-economic, ecological and technocultural bodies of knowledge associated with plants and animal species which have been under their stewardship for centuries (Niamier, 1991; Doran, 1993). While primarily herding cattle over generations they have developed a detailed stock of primary knowledge that is technical and its attributes are embedded in its practical nature and capacity to produce sustainable environmental utilities (Warner, 1991). Maasai pastoralists sometimes referred to as "ecosystem people" have a detailed knowledge of forage and poisonous plants (Berger, 1993). They can name and categorize virtually every plant found on their rangelands. These "people of cattle", as Galaty (1982) and Herskovitz (1986) call them, have developed for quite ages a strong ethnophytopharmacopeia. They possess knowledge and experience on toxicity of some plants with such details as what and in what quantities different plants can cause to which sex and age for the treatment of both human and veterinary ailments (Niamier, 1991). From such knowledge, they have depended on their traditional medicinal plants for everyday treatment of their animals, albeit in crude form (Warren 1991; Dean 1990).

It is from this view point that, the environmentally - derived technological wealth of folk knowledge has made pastoral Maasai self-made experts in such fields as ethnobiology, ethnopharmacology, ethnoprophylaxis, ethnotherapeutics and ethnophytotoxicology (McCorkle, 1986). Appreciating plants as nature's chemical factories, providing the richest

source of organic compounds, the Maasai recognize that most plants are effective against various human and veterinary ailments (Muta, 1996; Omulokoli and Khan, 1996).

In pastoral Maasai's mode of treatment, it is recognized that therapy does not simply focus on getting rid of the pathogenic organism but also enhancing immunity of humans as well as animals to diseases (Ole-Lengisugi, 1996). Some of the medicinal plants used are intended to convey or enhance immunity and it turns out that most of them are rich in vitamin C. When the vitamin C rich herbal medicines are administered, they additionally, enable the animal to manage stress in grassland semi-arid climate (Niamier, 1991). Indeed, it is broadly acknowledged that vitamin C forms the basis of pastoral animal disease control systems. For instance, vitamin C counteracts effects of saline water and helps in the metabolization and excretion of environmental pollutants and mycotoxins (Minja, 1998).

Regrettably, the pastoral Maasai's knowledge just described is threatened by the influence of Western science and technology (Ole-Lengisugi, 1996). For instance, the introduced paradigms of modernity are packed with scientific and technological solutions purportedly aimed at complementing or improving the indigenous practices, but unfortunately, this is conducted in a somewhat incompatible fashion. More often than not, the outcome is that the indigenous technologies tend to be over ridden by the introduced ones which nevertheless, proves to be unsuitable under local conditions in the course of time (Minja, 1998). While it is desirable to give introduced technologies a chance, it is considered necessary to take them with caution, just in case they should become absolute. Ethnobotanically these people (the Maasai) become extremely important and therefore there is a need to have a comprehensive account of their traditional medicinal practices.

1.2 OBJECTIVES

1. 2 .1 General Objective

The general objective of this study is therefore, to compile and document the traditional knowledge of the Maasai people on medicinal plants, the status of medicinal plants will be established for comparison between the protected area inside the Lake Manyara National Park and outside the park for conservation and monitoring purposes and taxonomy of the important plants will also be dealt with.

1.2.2 Specific Objectives

(i) To compile and document traditional knowledge of the Maasai people on medicinal plants

(ii) To compile an authentic list of the important medicinal plants of both humans and veterinary importance of the Maasai including the scientific and local names, habit, part used and preparation methods

(iii) To assess the current status and/or abundance of medicinal plants and existing threat in the area based on the information derived from informants, literature observation and from vegetation data

(iv) To provide the baseline information for further detailed ethnobotanical and pharmacognosical studies.

1.3 LITERATURE REVIEW

1.3.1 Indigenous knowledge Systems

Indigenous knowledge systems have evolved through trial and improvement as a natural process of human beings interacting with the environment. The purpose behind this being to ensure survival, progress and preservation of that community (Kipuri, 1983). Local or indigenous knowledge systems have been variously described as ethnoscience, traditional wisdom, etc; but they all refer to a body of knowledge that evolves over time and is communicated orally from one generation to the next (Martin, 1995). Riddles, proverbs, songs and other oral forms are means by which indigenous knowledge is transmitted (Kipuri, 1983). Indigenous knowledge systems refer to sets of concepts, beliefs, and perceptions comprising the stock of knowledge as well as the process by which it is acquired, augmented, stored and transmitted. Like any other knowledge system, indigenous knowledge is dynamic and ever changing through creativity, innovation, and borrowing from other knowledge systems. It holds practical value for mounting cost-effective, sustainable and culturally acceptable options for appropriate development problem solving.

In East Africa, most of what is left of natural resources is located in arid and semi -arid areas occupied primarily by pastoralists (Niamier, 1991). The Maasai being one of these pastoralists groups are particularly known in the region for their extensive knowledge of environmental resources management (Kipuri, 1983). Their knowledge covers the preservation of the ecosystem through extensive ranching and rotational grazing and use of a variety of livestock that utilize different flora (Galaty, 1982).

The importance of Maasai indigenous knowledge systems in the utilization, management and preservation of the natural resource base cannot be over emphasized. The latter are well known to contain indigenous knowledge system in the diagnosis, treatment and control of human and livestock diseases.

1.3.2 Indigenous Knowledge and the Environment

The significance of the natural environment for the daily lives of the Maasai pastoralists is contained in the knowledge of the environment and its resources, as well as the uses to which environmental resources are put (Kipuri, 1983). Trees and shrubs, besides providing fodder to the livestock, have many other uses, the primary one being their medicinal value. This emphasis is contained in the similarity of the word for tree (**ol-chni**, pl.**il-keek**) and the one used for medicine, since the latter is essentially derived from trees and shrubs. Plants used for the treatment of various ailments are numerous and most of them have been very effective (McCorkle, 1986; Muta, 1996; Omulokoli and Khan, 1996). It follows therefore the indigenous knowledge, developed after many years of experiment with the various plants, must be protected and recorded. For example apart from simply preserving records, it is equally important to ensure that the useful ethnomedicinal resources are conserved.

1.3.3 Origin and Development of Ethnobotany

It is rather difficult to tell exactly when the term ethnobotany became part of modern science. However, it can be traced back to the time when man started making conscious interactions with plants and animals. Ethnobotanical work seems to have started with Christopher

Columbus in 1492 that brought tobacco, maize, spices and other useful plants to Europe from Cuba (Cotton, 1996). Other immigrants from the New World documented food, medicine and other useful plants of the Aztec, Maya and Inca peoples (Martin, 1995). The British explorer, Richard Spruce around 1858 for example, noted for the first time the psychoactive properties of the South American vine, *Banisteriopsis caapi* (Cotton, 1996). Following this trend, there has been an ever-increasing interest of botanists, anthropologists and explorers to document plants of economic potential used by indigenous societies. With time, this practice has resulted into officially formulation of the field of science termed Ethnobotany.

The term ethnobotany was proposed for the first time by John Harshberger in 1895 (Balick, 1996). However, this term has been given different interpretations and definitions depending on the interest of workers involved in the study (Cotton, 1996). Harshberger (1896; cited in Cotton 1996), defined ethnobotany as the study of the use of plants by aboriginal people. In 1941, Shultes redefined ethnobotany as the study of the relationship, which exist between human and their ambient vegetation (Castetter, 1944; cited in Cotton, 1996). Martin (1995) defined ethnobotany as the study of people's classification, management and use of plants. From these definition there is a tendency of change in the scope of ethnobotany from a simple listing of traditionally useful plants to the more understanding of how the indigenous people view plants in their own culture. In short, ethnobotany is an interdisciplinary science that combines anthropology and botany (Prance, 1991). Documentation and investigation of medicinal plants as will be done in this thesis is just one aspect of ethnobotany.

1.3.4 Herbal Medicine as a Source of Modern Medicine

Medicinal drugs derived from natural sources make up an important global contribution to health care (WCMC, 1992). According to Levantine and McMahon (1996) about 75 - 90% of the rural population in the World (excluding Western countries) rely on herbal medicine as their only health care. WHO estimates that 70 - 80% of people in developing countries, including Africa, depend on traditional medicine for their health care (Cunningham, 1994). This is not only because of poverty where people cannot afford to buy expensive modern drugs, but traditional systems are also more culturally acceptable, and meet the psychological needs in a way modern medicine does not (Brown, 1994). The integration of modern health system and traditional medicine will provide a better public health service. This on one hand will have truly effective and affordable health care for low - income groups in the developing world (Farnsworth, 1980).

Estimates show that about 25,000 to 75,000 species of higher plants have been used in traditional medicine (Farnsworth, 1980). Evidently, traditional knowledge of medicinal plants is important in development of new modern drugs. Currently there are more that 50 drugs (e.g. aspirin from *Filipendula ulmaria* [ROSACEAE], quinene from *Cinchona pubescens* [RUBIACEAE], morphine from *Papaver somniferum [PAPAVERACEAE]* and ephidrine from *Ephedra sinica*) prescribed in North America and Europe. About 80 drugs prescribed in the industrialized world as a whole, most of them were discovered based on information derived from ethnobotanical investigation (Balick and Cox, 1996).

Some phytochemical studies have demonstrated that there is a better probability of encountering active compounds from plants when an ethnobotanical approach is used rather than a random survey (Balick and Cox, 1996). Preliminary tests of medicinal plants from Central America in which an in Vitro anti- HIV screen was detected as being active, 25% of these plant species were those classified as "powerful plants" by herbal healers, on the other hand only 6% of randomly collected species were active (Balick and Cox, 1996). Another worth mentioning useful medicinal plant collecting method is a phytometric survey where researchers choose close relatives of plants known to produce useful compounds (Balick and Cox, 1996). This approach might increase the probability of encountering active compounds but unlike ethnobotanical information, little is known about their efficacy and safety, as they are not practically tested time and again through years. According to Balick and Cox (1996), the history of drug discovery implies that the ethnobotanical approach is the most productive of the plant survey methods and the recent findings confirm this impression.

1.3.5 Loss of Diversity of Medicinal Plants

The loss of species of medicinal value is greater as there is evidence that extinction of such plant species is obvious. Disturbance and overexploitation by humans are causing major global reduction of plants diversity (Allen and Barnes, 1985; Bownder, 1987; IUCN/UNEP/WWF, 1991; Whitmore and Sayer, 1992; Brown and Brown, 1992; Reid, 1992). According to IUCN (1978) an average of one out of ten of species of vascular plants known are rare or are under severe threat. Wilson (1980; cited in Plotkin 1991) estimated current rate of extinction to be 400 times faster than what happened in the recent geological times. According to WHO/IUCN/WWF (1986), 90% of plant materials used as medicinal plants are

collected from the wild without parallel regeneration programs and as a result many medicinal plants species are driven to extinction or severe genetic loss. However as observed by WHO/IUCN/WWF (1986), detailed information is not available. When a population of given species is reduced beyond a certain thresh hold level the remaining population may suffer both from heterozygosity and allelic diversity loss and if such threats continues genetic drift cannot be avoided (Endashaw, 1986). This is a situation that makes the population susceptible to extinction at times of environmental crisis. The worry about species extinction is with a ground, it is clear that once a species is lost it can never be retrieved.

Different scientists have advanced various reasons and estimates regarding plant species loss today. For example, (Reven 1987; cited in Heywood and Stuart1992), predicted that if the moist forest area is reduced to less than 10% that is likely to happen within few years to come, it is estimated that about 65000 plant species will become extinct in the next few decades. This number corresponds to the quarter of the world's species. It is known that the moist forests contain about half of the world's total species of higher plants. Another prediction discloses that under current trends of habitat loss, up to 60000 plant species may be extinct or may suffer severe genetic erosion by the middle of the next century (IUCN/WWF 1986; cited in Princepe, 1991). Wolf (1988; cited in Ledec and Goodland1992) estimated that under the current trend of habitat destruction, about 15- 20% of species of plants and animal living in 1980 might be extinct by the year 2000. Myers (1988; cited in Whitmore and Sayer 1992) also estimated the percentage of extinction to range between 25 –30 for the same period.

In the same line, Reid (1992), using the species to area relationship estimated that in Madagascar where about 90% of the forest has been lost and conversion of forests to other

uses continues, 50% of plant and animal species are at risk of extinction in the near future. On the other hand, Heywood and Stuart (1992), though they agree that a sizeable number of species become extinct every year, they argue that the numbers estimated are too big to be realistic. However, in the general terms as Plotkin (1991) observed, there exist an agreement among biologist that the current extinction rate is alarming. Some authors, for example Wilson (1980; cited in Plotkin 1991), go as far as considering extinction to be the major tragedy and folly of 1980's. On the same line Ledec and Goodland (1992) consider the rate of reduction of biodiversity in the last quarter of the 20th century to be unprecedented in the history of life on earth.

There are many problems that are associated to loss of species diversity. Some species are ecologically key species (species that play a significant role in ecological processes and sustainability) and some are socio-economic key species (playing a great role in people's socio-economic well being). As Ledec and Goodland (1992) warned the world, not all the consequences that come as a result of extinction of these species are known.

1.3.6 Harvesting of Medicinal Plants

One of the major threats to medicinal plants and associated knowledge is the method by which these plants are harvested. Traditional healers and/ or the indigenous plant users harvest roots, bark, leaves, flowers, fruits and seeds and sometimes the whole plant to make medicines that they use to cure different diseases and conditions (Kokwaro,1976; Anokbbango, 1992; Iwu, 1993). Exploitation of these parts, which include both reproductive and vegetative parts, is not without ecological impact. The negative effects that occur depend on floristic composition,

nature and the intensity of harvesting, the species harvested and the specific plant extracted or compound extracted (Peters, 1994). For examples, Cunningham (1992) observed the fact that, *Faurea macnauglitonii* and *Podocarpus henkelii* cannot survive debarking regardless of how small it may be. Pests usually attack them, whereas there is a complete bark regrowth in species like *Warburgia salutaris* and *Prunus africana* except where the demand exceeds the stock available.

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According to Peters (1994), overharversting may lead to depletion or even local extinction of some plant species, especially in the areas where the plants are rare or endemic to particular habitats. On the other hand, where seeds or fruits are used the survival of the species is reduced. This lies on the unpredictability of the seed dispersal where seeds may get lost through predation and pest attack. Peters (1994) further observed that the seedlings are not quite safe as they are susceptible to diseases, pests and mechanical injury. Harvesting of vegetative parts may result in killing of the individual, wound it fatally or in the few cases the plants may regenerate the lost part through meristematic activities. Root removal or injury, negatively affects the growth and physiology of the plant, resulting in its death in the long run (Kokwaro, 1976).

Overexploitation may lead to scarcity and in case of medicinal plants this means more time will be needed to collect parts of plants required by traditional healers. Cunningham (1996) observed that with increased scarcity, commercial trade develops and prices rise and this means more exploitation. Actually, this is what brings unsustainable models (Brigham *et al.*, 1996).

Another threat to medicinal plants is a result of demand of botanicals locally and/ or at international level which results in overexploitation and lack of regeneration programs. Globally more than 90% of plant species used in the industry are collected from the wild without parallel regeneration programs to replenish the stock (IUCN/UNEP/WWF, 1991). Lange (1997) estimated this amount to be between 70-90%. The ever-increasing demand of botanicals is a threat on itself. In 1994 worldwide leading importers of materials for medicinal purposes namely: Hong Kong, Japan, Germany, France, USA and South Korea imported a total 244,783 tonnes. Three years later (1997) the amount reached 271,071 (Lange, 1997). Chihongo (1992) reported a six times increase of *Cinchona spp.* import from Tanzania which rose from 119.8 tonnes (1981) to 755.92 tonnes (1991). The global annual production of Cinchona is estimated to be about 8000-10000 tonnes (Husain, 1991).

Examples of medicinal plants entering the world market from Tanzania as reported by Farnsworth and Soejarto (1988). *Agave sisalana*, *Cinchona calisaya, C. ledgeriana, C. officinalis, C. pubescens.* Others, which are rare but being ordered in huge amounts for screening purposes is: *Maytenus senegalensis*, *Tabernaemontana elegans* from Usambara mountains and *Strophanthus kombe* from all over the country (Government of Tanzania, 1997).

1.3.7 Documentation of Herbal Medicines in Tanzania

Traditional medicine in Tanzania, like in other developing countries where medical facilities can not satisfy national demands, play a big role in combating both human and animal diseases (Ruffo, 1989). It is estimated that about 80% of the people who live in rural areas rely on traditional healers for their treatments using medicinal herbs (Cunningham, 1994). However, these medicinal plants have not been well studied, tested or documented (Nkunya, 1992). Most of the information is still in the hands of traditional healers (FAO, 1986). Due to the current threat brought by diseases like malaria, cancer, hypertension, AIDS and others, Tanzania in collaboration with other nations has carried an international combined effort from both scientists and traditional healers to do some more research on medicinal plants which might give some positive results. Some of the information which is now available about medicinal plants in Tanzania include the work of Watt and Breyer-Brandwijik (1962) in a book on Medicinal and Poisonous Plants of Southern and Eastern Africa, Medicinal plants of East Africa by Kokwaro (1976) and that of Raimo Harjula (1988) who made some ethnomedicinal studies in Meru, Arusha. The Traditional Medicinal Research Unit at Muhimbili Medical Centre in Dar es Salaam is responsible for this work and is currently undertaking some research on traditional medicine. The Tanzania Forestry Research Institute (TAFORI) at Lushoto has been conducting some botanical surveys in Dodoma , Singida and Eastern Usambara and part of the information has been published by FAO (1986).

1.4 DESCRIPTION OF THE STUDY AREA AND THE PEOPLE

1.4.1 Location

The study was carried out inside and out side Lake Manyara National Park. Lake Manyara National Park here in called (LMNP) is located within the Maasai plateau, an area of about 35,000 km^2 (Loth, 1999), (See Fig.1). LMNP is located 125 km West of Arusha town, in Northern Tanzania (Centre of the Park at 3° 30'S, 35°45'E) is situated between Lake Manyara and the steeply rising escarpment of the Great Rift Valley. The Park is 330 km^2 in size, of which 230 km^2 is covered by Lake Manyara (Conservation of Wildlife and Environment, 1999). The Lake level fluctuates over the years (Loth and Prins, 1986). The escarpment rises to a height of approximately 1200 to 1300 m in the northern part and to more than 1700 m at the south end. In 1990 a strip of land (10 km^2) adjacent to the park to the South that was formally occupied by sugar cane plantations, was added to the park. Recently further extensions have been proposed, including the Marang Forest Reserve. During this study six villages/sites were visited, these include Mto wa Mbu which is adjacent to the park, Moyamayoka in the southern part of the park, Losirwa, Selela and Silalei in the north and Ng'ogoro in the north east (Fig.1).

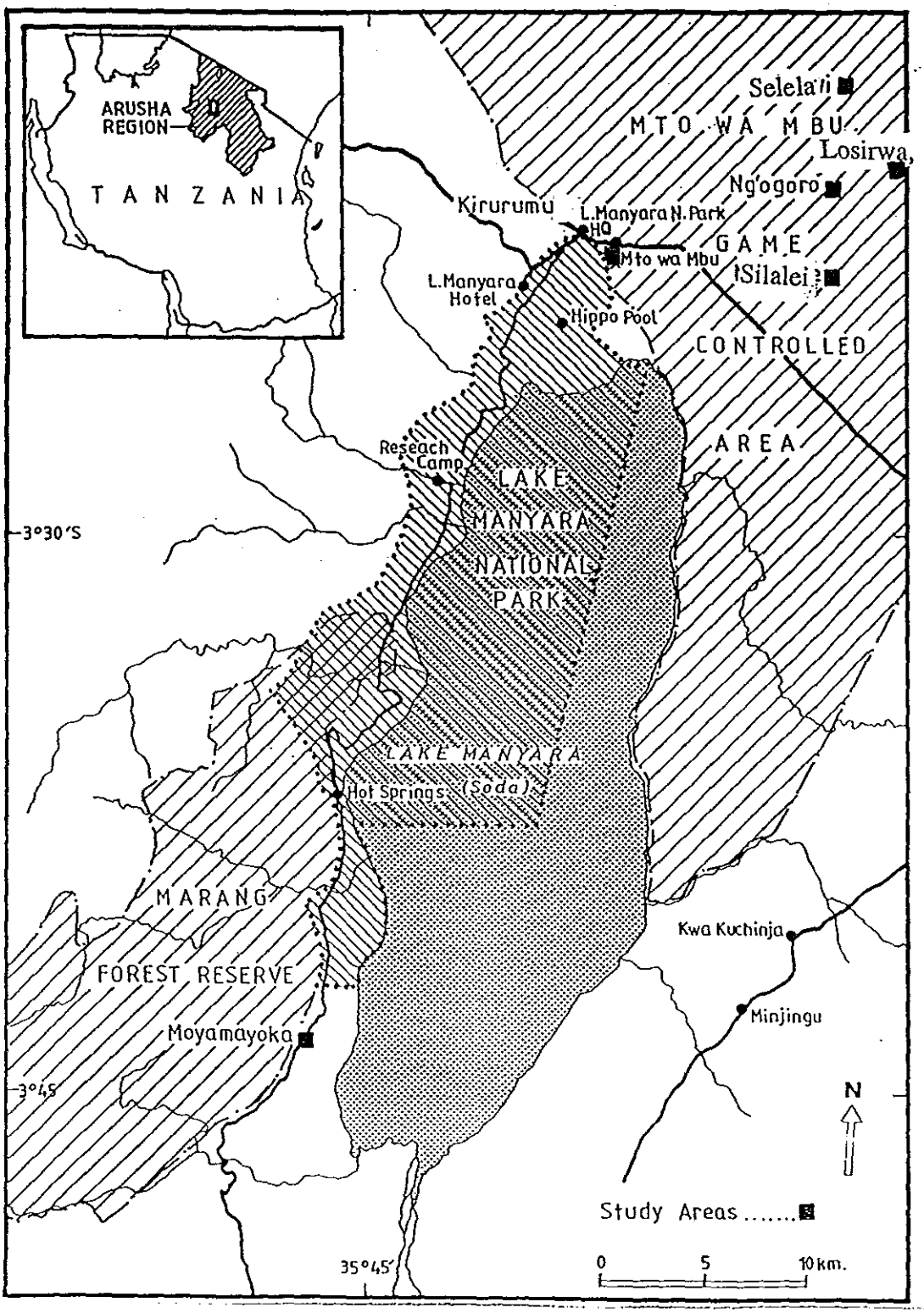


Figure 1. Map of Lake Manyara National Park showing study area and the sampling sites.

1.4.2 Geology

The geology of LMNP and the surrounding area shows that the underlying rocks belong to the Mozambique Belt which is a part of the crystalline basement complex in which a wide variety of sedimentary and volcanic rocks have been subjected to similar metamorphic history (Safferson 1972). On the other hand, crystalline basement complex in the area consists mainly of Precambrian gneisses, banded with quartzo-feldspathics (Mineral Resources Division 1965). The erosion surfaces were formed in the Tertiary (70 to 3 million years ago) (Loth, 1999). Furthermore, whereas the Great Rift Valley at most places are delineated by both western and eastern rift walls, in this area only the western side is boarded by an escarpment. At the eastern side the Maasai steppe gently dips to the west, forming a depression at the foot of the fault scarp where the lake has settled at the lowest point (Safferson 1972; Loth, 1999). On the other hand, volcanic activity is another important event that was associated with the Rift valley formation. Most of the present volcanic forms, however, were formed during the Pleistocene up to recent times (Loth, 1999). In northern Tanzania, Mt. Kilimanjaro, Mt Meru and the Ngorongoro caldera were formed during the Pleistocene (Berry, 1972). This area is still considered to be volcanic active. For instance, areas around Oldonyo Lengai, approximately 100 km north of the park, erupted in 1917, 1942, 1960, and was highly active in 1983 and in 1995. As a result of Pleistocene volcanic activity, the northern part of Mbulu Plateau is covered with lava. The occurrence of volcanic lava and ash also accounts for the high alkalinity of the area. (Safferson 1972).

1.4.3 Soil

Soil is formed as a result of weathering of the parent material. Various studies carried in Lake Manyara National Park (LMNP) shows that the area consists of volcanic rocks that weather easily and release large quantities of sodium, thus soil and ground water alkalinity increases in the proximity of the lake (Loth and Prins, 1986). The soils on the plateau are derived from volcanic lavas and tuffs. They are non-calcareous and the texture ranges between clay-loam and clay. Their moisture-holding capacities usually are quite good; the content of organic matter in many cases is low (Loth, 1999). In general they are suitable for agriculture, if the risk of erosion is taken into consideration. However, big parts of the area are dominated by eroded soils. In the valley of Mto wa Mbu, the soils have developed on a mixture of colluvial and alluvial deposits. The distance from the escarpment influences soil texture as well as soil salinity. The coarser deposits are situated nearer to the escarpment and along the rivers and natural flood plains (Safferson, 1972). The permanent supply of freshwater keeps down soil salinity to a minimum, while it increases quickly towards the drier areas in the east of the valley. Soil texture is constantly clay-loam, probably due to earlier lake deposits and salinity increases drastically towards the lake.

1.4.4 Climate

Areas surrounding Lake Manyara National Park, like the other Rift Valley areas, have a short rainy season (November to January) and a long rainy season (February to May), with prolonged dry period from June to October (Sombroek *et al.,* 1982). Rain in October and November is erratic, sometimes even absent, and the onset of the short rains may be delayed (Mwalyosi, 1990). However, the mean annual rainfall does not exceed 725 mm. Data collected at Mto wa Mbu weather station and at LMNP air strip for ten years (1990-1999) are presented in (Fig. 2) below. The mean annual temperature is approximately 25°C and the mean monthly temperatures do not deviate more then 3^0C from the yearly mean.

Mto wa Mbu/LMNP (960) m 25^0C, [725] mm

[10] Years

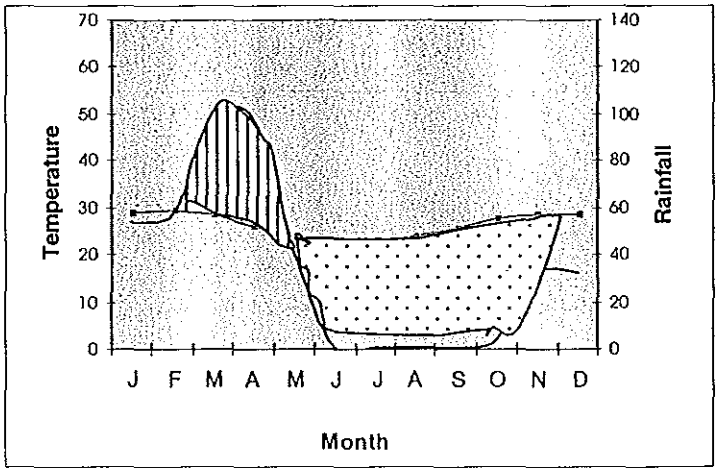


Figure 2. Climatic diagram of the study area.

1.4.5 Vegetation

Vegetation of the Lake Manyara National Park (LMNP) and the surrounding area show remarkable variations (See Fig.3). Detailed studies have been restricted to the principal grassland areas (Greenway and Verssey-Fitz-Gerald, 1969). Douglas- Hamilton (1972) did some quantitative survey of the wood vegetations. Greenway and Verssey-Fitz-Gerald, (1969) observed three major physiognomic vegetation types based on drainage namely:

1. The vegetation related to the land drainage from the plateau above the rift wall.
2. The vegetation which obtains water from the spring emerging from the base of rift wall and
3. The zones of vegetation and shallow alkaline lake flats.

The vegetation of the plateaus has been extensively modified by clearing and burning; but some basin of bad drainage edaphic grassland and woodland on the volcanic soils and evergreen forest covering highest part of the granite mountains of the Marang Forest Reserve probably represents what is left of the natural vegetation of the catchment fire- induced grassland and wooded grassland (Mwaliyosi, 1987). Relic vegetation survives in the gorges; however, the vegetation of the Marang Forest Reserve indicates a dry evergreen forest.

The vegetation on the escarpment face is deciduous woodland and dry thicket, both of which have been modified by fire or replaced by secondary derived wooded grasslands on the less steep slopes (Mwaliyosi, 1990). In the valleys and along streams, cutting and burning have modified these parts. The valley floor, covered with redistributed soils supports ground water (*Acacia*) woodland and grass cover (Loth, 1999). This woodland has been modified by both elephants and fire (Greenway and Verssey-Fitz-Gerald, 1972). At the northern end of the park

a number of springs emerge from among lava bounders at the floor of the escarpment. These springs drain to areas that support the ground water evergreen forest. Within the forest there are fresh water swampland glades of the valley grassland. These are modified by indigenous grazing animals (Greenway and Verssey-Fitz-Gerald, 1972). The lake beds consists of deposited alkaline silts, sand and clays which are exposed during periods of low lake levels and inundated when the lake is high. It supports grassland whose extent and zonation depends on the varying level of the lake. Thus the northern third of the park is covered by evergreen forest made possible by the low precipitation but high water table. Swampy glades of *Typha* and *Cyperus* break the continuity of the forest (Mwaliyosi, 1990). *Acacia* woodland covers the central part of the park. In the southern part, vegetation consists mainly of shrubs, patches of riverine forest and scattered trees. Outside the park is mainly Maasai drylands, dominated by savanna grassland and sparsely vegetated *Acacia* woodlands (Fig.3).

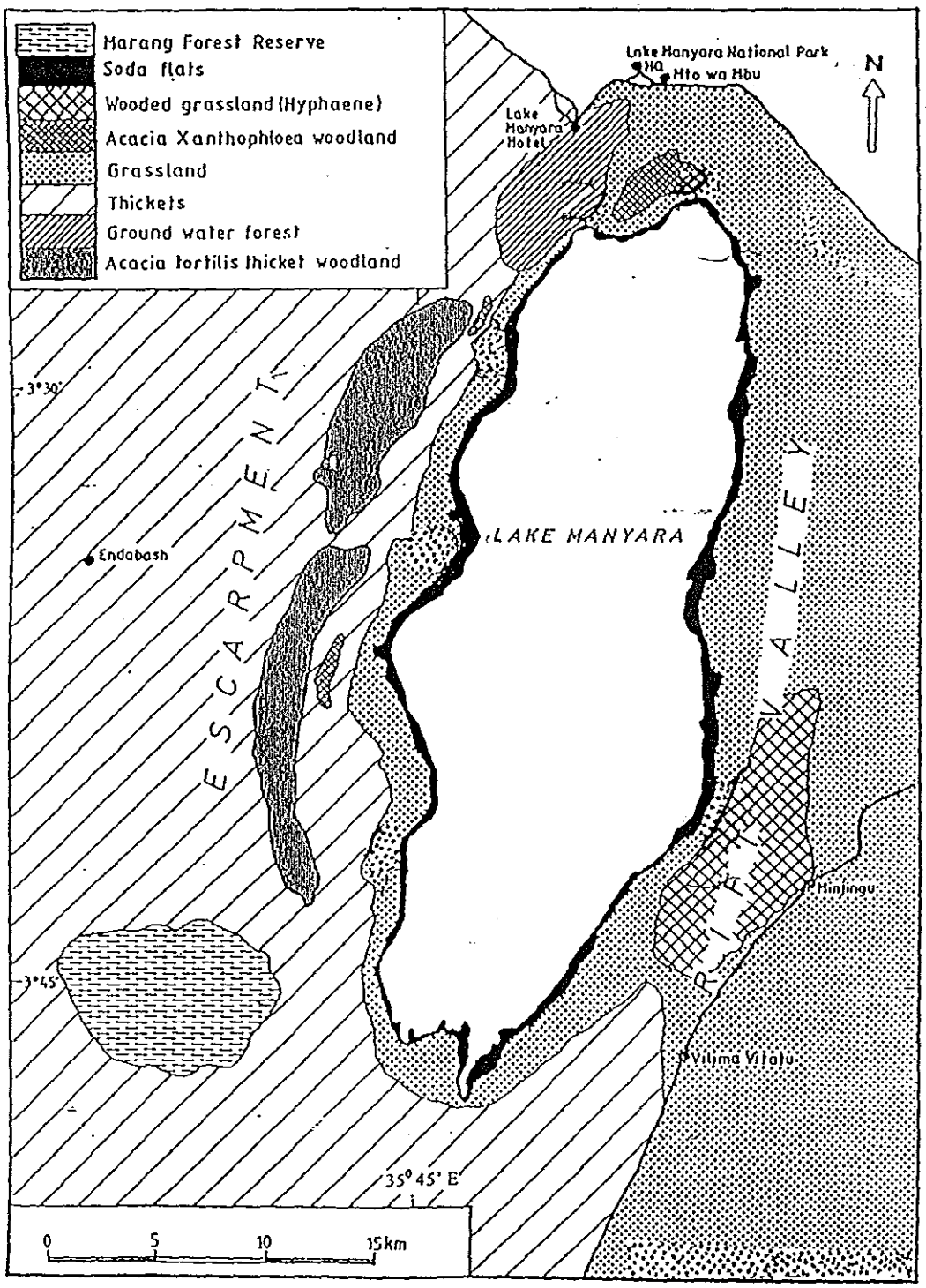


Figure 3. Vegetation map of Lake Manyara National Park

1.5 THE PEOPLE OF THE STUDY AREA

The Maasai people live in the rangelands of East Africa particularly along the Rift Valley occupying parts of Arusha region in Tanzania and Kenyan Rift valley (See Fig.4). They lead a traditional life based on the livestock keeping. Cattle, sheep and goats form the basis of their subsistence (Arhem, 1990). Milk, meat and blood are their dietary ideals (Balick and Cox, 1996), but in reality agricultural foods frequently supplement their pastorals diet, particularly during drought and at the height of the dry season. Maasai are nomadic, and as many nomadic tribes they have close relationship with plants and animals (Grandin, 1991). Livestock means far more than food and economic security to the Maasai. Cattle in particular constitute a key value in Maasai culture. The entire social system is geared to cattle herding (Arhem, 1990). Cattle are multiple purpose resource. The live produce food and the different parts of the carcass are used as medicines, utensils, clothing and adornment.

1.5.1 Settlement Characteristic of the Study Area

Lake Manyara National Park (LMNP) falls under the East African Rift Valley (See Fig.4). It is located in Monduli District, Arusha region, northern Tanzania. According to the 1988 census, the district had a population of about 102,492. In 1998 it was estimated to be 141,896 people at the growth rate of 3.8% (Tanzania Bureau of Statistics, 1998). It is sparsely populated at ten persons per square kilometer, which is lower compared to the regional figure of about 21 people per square kilometer and that of the national average of about 26 people per square kilometer. Immigration is one of the factors affecting population trends in the district.

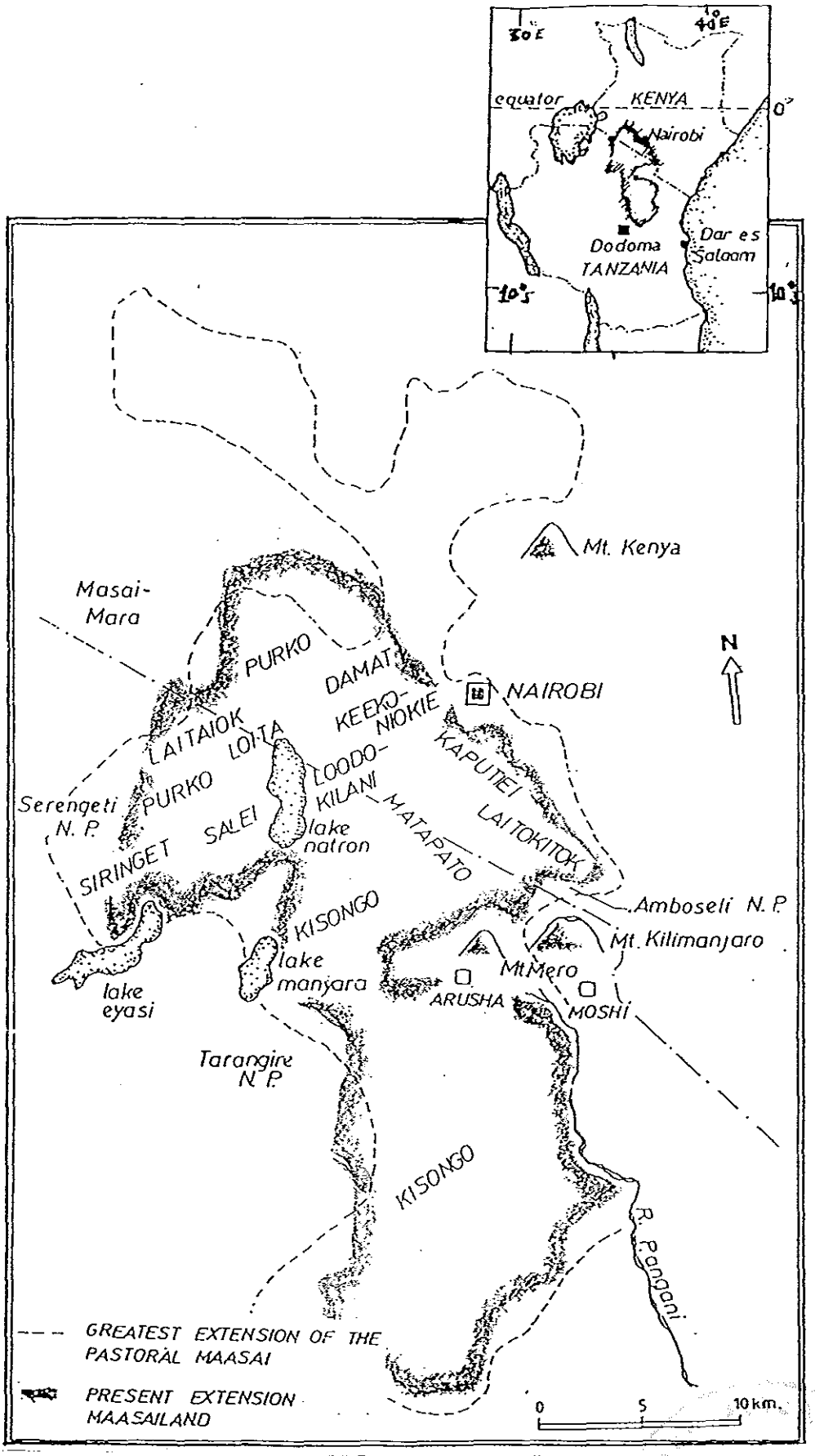


Figure 4. Map showing geographical distributions of Maasai in East Africa. (Adapted and modified from Arhem, 1990).

At the vicinity of LMNP there are townships and villages such as Migombani and Mto wa Mbu, Selela, Silale, Ng'ogoro and Mwinjere Baraka with a total population of 22000 people (Tanzania Bureau of statistics, 1998). The major tribes occupying the areas are the Masaai and Waarusha, together comprising more than 60% of the total population. However, in Mto wa Mbu for example there other tribes such as Wachagga, Wapare, Wambulu and Waberbeigi. During the present study, the Maasai living at the vicinity of LMNP were studied.

1. 5.2 The Maasai Social and Traditional Political System

Maasai social and traditional political system bears out the pastoral adaptations (Ole Lengisugi, 1996). It is flexible and pragmatic and there are no ascribed or hereditary leaders (Arhem, 1990). Authority rests on age set leaders elected on the basis of the moral conduct and personal qualities. Hierarchy and equality are co-existence political principle in Maasai society (Kipuri, 1983). The young men (***ilmuran)*** form the locality – based fellowships stressing sharing and communism. Egalitarian solidarity and generosity are supreme values. Influence however grows with seniority, increased knowledge and wisdom. As men grow older wealth as indicator of herding skills, comes to play an increasingly important role. Thus, elders control the younger age- group and community wide authority rest with leaders. The council of elders (***enkigwana***) is the principle decision body of locality. Such councils of elders were very important during the present study, as they were source of ethnobotanical information

2. MATERIAL AND METHODS

2.1 Ethnobotanical Data

Ethnobotanical information/data were collected from Maasai people around the vicinity of Lake Manyara National Park by use of anthropological method namely semi-structured interviews, participatory rural appraisal (PRA) and group discussion between September and February 2001. In this study the main method was based on open-ended interview according to Martin (1995) where local informants such as herbalists and knowledgeable elderly people were consulted. These approaches, which are often referred to as formal or quantitative methods, yield verbatim answers that can be analyzed using various statistical methods (Martin, 1995).

2.1.1 Semi - Structured Interviews

Semi-structured and structured interactions involve asking group of selected informants to respond to the same set of questions (Martin, 1995). In this study questions were prepared in advance (interview schedule) and other questions were asked promptly depending on the responses (see Appendix-1). The language used was both Kiswahili (the National Language of Tanzania) and Kimasai (the Maasai language) with the help of interpreter. This method was mostly preferred because it allowed the respondents to express their views without being interrupted or contradicted by others as in the case of group interactions.

In this ethnobotanical study, 25 knowledgeable elders (19 men and 6 women) between the ages of 30 and 71 years were involved from the six study sites (5 from Losirwa, 4 from Selela,

3 from Moyamayoka, 4 from Silalei and 3 from Ng'ogoro, 2 from Arusha and served as key informants. (See Appendix- 2). These knowledgeable elders on medicinal plants were chosen from the different sites with the assistance of local administration and community elders (*enkigwana)*. During the course of the study, each informant was visited at least three times in order to verify the reliability of data obtained. If what was said during the first visit concerning the use of a particular medicinal plant by any informants didn't agree with what was told during the second or the third visit, the information was considered unreliable and had to be discarded. Repeated visits also helped to get some additional information that was not mentioned during the early interviews.

2.1.2 Participatory Rural Appraisal (PRA)

It is the most used method in obtaining information on traditional beliefs attached to plants and/or habitats names and meaning of names of plants generally known to be useful (Martin, 1995; Balick and Cox, 1996). As described by Martin (1995), this method was used to explore indigenous knowledge and practices used to conserve plants of medicinal importance. The method was preferred over other methods because it is cost-effective, it allows a good amount of flexibility and one can obtain a lot of information within a short time.

In this study, the PRA involved one technician from the National Herbarium, Arusha who was also a Maasai, and hence helped as a linguistic and interpreter, a taxonomist who was also my supervisor, a veterinary doctor also a Maasai, and group of Maasai elders and ***el-moorani*** (the Maasai youth). During the exercise, data were collected and organized in the data file.

2.1.3 Group Discussion

The method was used once the important medicinal plants have been identified, the name of each plant or plant category was written in Kiswahili (the National Language) or Kimasai (local language). This was written on a large board and the participants encouraged listing all local names of the diseases treated by each species category. On the other hand a separate column listing of the plant parts used and method of preparation was affected. From such information, how frequent a particular medicinal plant (remedy) is mentioned by informants for a given disease/disease category was determined which in turn indicated the (popularity) of the species. Thus the proportion of informants who independently reported the knowledge of a given use was assessed to give the relative importance of different plants. From each study village, two herbalists or knowledgeable elders were selected as key informants). The six sites (villages) were Mto wa Mbu, which is adjacent to the park, Moyamayoka in the southern part of the park, Losirwa, Selela and Silalei in the north and Ng'ogoro in the north east. Other informal discussions were also held from time to time around the Maasai homestead **(bomas)** during evenings to ascertain some information.

2.1.4 Botanical Method

Voucher specimens of plants claimed to be of medicinal value were collected in triplicates, identified and deposited in the National Herbarium in Arusha and Botany Department University of Dar es Salaam. The identification of the voucher specimen was based on three methods: Firstly, experience and/or visual identification of the plant in the field. This was

done by the assistance of technicians from the National Herbarium and from University of Dar-es-Salaam and my supervisor (Dr. H. Lyaruu) who is also an ecologist. Secondly, by comparison with already identified specimens and thirdly by using taxonomical keys

2.2 Vegetation Sampling Method

In order to classify and describe the existing plant communities and assess the abundance and distribution of the reported medicinal plants in the area, a vegetation survey was carried out between 24th November and 15th December 2000. A total of 40 sample plots were established in such a way that 20 plots were inside the protected area, Lake Manyara National Park (i.e. area with very little and/or no human influence (NHI) and another 20 plots were outside the park (area with high human influence (HHI). A modified Whittaker Nested-Quadrat Sampling method by Stohlgren *et al.,* (1994) was adopted in this study. Sampling was done in north-south direction for the orientation of sampling point except when sampling from the lake into the National Park. Whereas trees were sampled in 25 x 20 m plots (A) shrubs and juvenile trees were sampled in

5 x 2 m plots (B). On the other hand grasses and herbs were sampled in 2 x 1 m plots (C) nested on the bigger plot (Fig. 5).

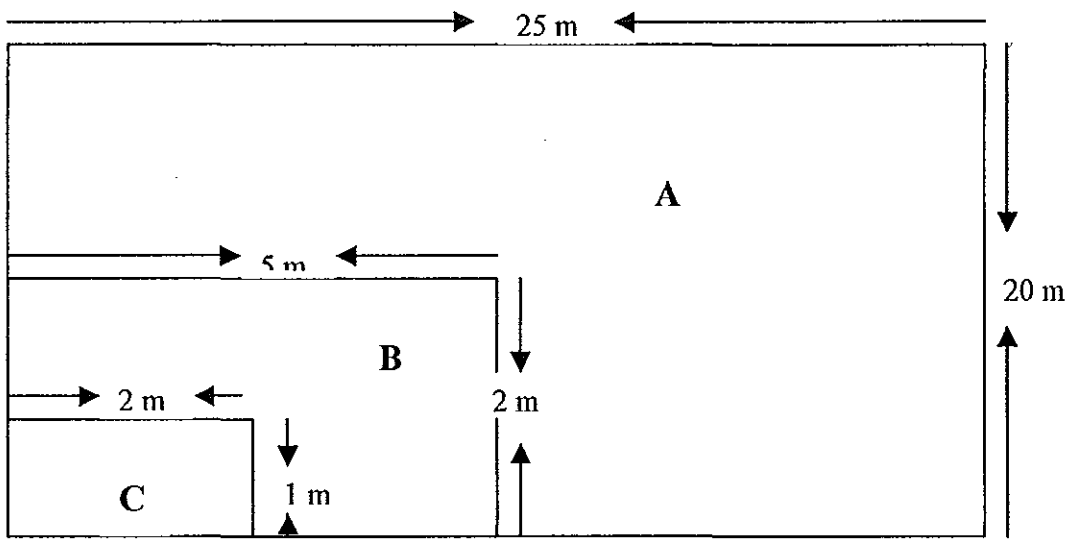


Figure 5. A modified Whittaker Nested-quadrant plots (by Stohlogren *et al.*, 1994) used for sampling of vegetation in the study.

The information collected for trees included the following: Species identity, diameter at breast height (DBH) and heights of individual trees were estimated particularly where it was impossible to measure the tree correctly. A tree in this study is defined as an individual with DBH of 10 cm or more or circumference at breast height of 34 cm and above. (Normally diameter at breast height is considered to be 1.5 m above the ground). For grasses and herbs the individuals were identified and their relative cover of each species occupying recorded. The scale used for relative cover was a modified Braun-Blanquet scale of cover (See Muller Dombois and Ellenberg, 1974). For those individuals that were difficulty to identify in the field, voucher specimens were collected in triplicates and pressed. These were later properly determined at the National Herbarium Arusha and at the University of Dar-es-Salaam. Voucher specimens have been kept in these two herbaria.

2.3 Cluster Analysis (Classification)

Classification, as multivariate technique to analyze ecological communities, groups similar sample stands into types (Whittaker, 1975) and aims at grouping individual stands into categories by producing final groups which are as homogenous in composition as possible (Greig-Smith, 1980). The stands that are closely similar with one another form one class, which is separated from other such classes that also consists of similar stands. The properties common to a group of similar stands in access are then abstracted to serve as a description of that class. Therefore, the abstracted class properties may be compared to the average mean of set of values when combined with a measure of range. For practical and scientific validity, the abstracted class futures should adequately describe the individual members of each class (Greig-Smith, 1983; Mueller-Dombois and Ellenberg, 1974; Kumar, 1981; Digby and Kempton, 1994). Although classification implies discontinuity in composition, in practice it often leads to the concept of vegetation as varying continuously in composition but emphasizes the commoner occurrence of certain variants (Greig- Smith, 1983).

Various technique of vegetation classification have been discussed by several authors such as Whittaker (1962); Mueller-Dombois and Ellenberg (1974); Greig –Smith (1980, 1983); Gold – Smith and Harrisson (1976); Gauch (1982), and Digby and Kempton (1994). According to Gauch (1982), classification techniques are subdivided into three groups. These are tables arrangement; non hierarchical and hierarchical. Detailed considerations of table arrangement are given by Mueller- Dombois and Ellenberg (1974); and Westhoff and Maarel (1978). This subdivision is the earliest classification technique in community ecology. It has an advantage in that it exhibits at once both the general features and fully detailed of data set (Gauch, 1982). The Braun- Blanquet table work pursues to order the sample-by –Species data matrix into the order that could reveal the inherent structure of the data (Mueller-Dombois and Ellenberg,

1974). The aim is to arrange the species that brings together species similar in their distribution in the samples and also, to arrange the sample in sequence that brings sample similar in composition. Besides its advantage, it has certain drawbacks. Some of these are: the results are relatively subjective (Kershaw, 1973; Gauch, 1982) and the application to unfamiliar species and unknown vegetation is difficult (Westhoff and Maarel, 1978).

When there is no particular advantage in the groups or species of sites being arranged in a hierarchy, a non hierarchical method of classification, where groups have no joint structure, may be preferred (Gauch, 1982; Digby and Kempton, 1994). Here samples or species are arranged to clusters, bringing similar samples or species together With this technique it is the structure of the individual groups, which is optimized. Its aim is to produce the most efficient groupings regardless of the route by which they are derived (Greig- Smith, 1983). For those applications in which homogeneity of groups is of prime importance, the non-hierarchical techniques are attractive. This method is however, followed by computational difficulties. (William, 1971; Digby and Kempton,1994). Hierarchical classification techniques arrange similar entities into classes and the classes at any level are subclasses of classes at higher level (1969; Everitt, 1980). Therefore, the groups are themselves arranged into a hierarchy, say K groups are part of a separate grouping into (K-1) groups and so on (Digby and Kempton, 1994). It optimizes a route between the entire population and the set of individual of which they are composed. Hierarchial classification techniques are divided into three namely: Monothetic divisive, polythetic divisive and polythetic agglomerative (Williams *et al.*, 1966; Williams 1971; Gold-Smith and Harrison, 1976; Everitt, 1980; Greig-Smith 1980; Gauch, 1982).

According to Williams and Lambert (1960) Monothetic divisive classification technique begins with all the samples in a single group and then hierarchically into progressively smaller groups on the basis of presence and absence of single species. Williams and Lambert (1960) presented a Monothetic divisive procedure, association analysis, which has long been one of the most frequently used numerical classification methods in plant community studies and is based on similar, early work of Goodall (1953). This procedure has the disadvantage that it is liable to misclassification (Kershaw, 1961; Hill *et al.*, 1975) and it also followed by computational difficulties.

Polythetic divisive classification procedures use information on all species (Williams, 1971; Williams and Lambert, 1960). They begin with all samples together in a single cluster and successively divide the samples into a hierarchy of smaller and cluster until finally, each clusters contain only one sample or some specified smaller number of samples (Digby and Kempton, 1994). Polythetic agglomerative techniques also use information on all species. However, these begins with each sample allotted to a cluster with a single member and agglomerate these in hierarchy of larger and larger clusters until finally a single cluster contains all samples (Gauch and Whittaker, 1981; Digby and Kempton, 1994). Polythetic agglomerative methods proceed by scanning the whole data set and by examining the relationship between possible pairs of individuals (1/2n(n-1) where n= number of samples. At any particular stage the methods fuse individuals or groups of individuals that are most similar (or closest) (Sokal and Sneath, 1963; Goodall, 1978). These methods cluster on the basis of overall similarities (Fig. 9). Because of this they are in general less likely to lead to misclassification (Greig-Smith, 1983). Differences between methods arise because of the different ways of defining similarity (or distance) function are currently in use. These include

single linkage, average linkage, clustering etc. (Everitt, 1980; Greig-Smith, 1983; Digby and kempton, 1994).

According to Digby and Kempton (1994) starting from the fully inter-unit similarity matrix, all agglomerative methods begin by joining the two most similar units into a single group. The similarity of this group and all the other units are calculated. This is where the methods differ. At the second stage the largest remaining similarity, among the two units or the new groups and the other units, determines the next joint. This process repeats until there are only two groups or cluster, which are finally merged (Digby and Kempton, 1994). The final results from any clustering procedure depend both on the initial choice of similarity measure used for comparing units and the choice of criterion for defining group similarity.

2.4 Data Analysis

There are three indices used by Williams and Lambert (1960) as possible measure of association namely chi-square, chi-square corrected for continuity and the chi-square divided by total number of the stands.

(a) Since association analysis can be achieved by qualitative data such as presence and absence data, it has therefore been decided that association analysis based on the corrected chi -square be used in this work.

Further analysis was done by FORTRAN program named SYNTAX, version 3 (Podani, 1988). This analyzes and classifies the vegetation data from the releve's. It classifies groups of similar individual sample stands into categories that are as homogenous as possible (Greig-Smith, 1980).

(b) Instat statistic program was used to compare medicinal plants basing on different life forms. Kruskal-Wallis Non-Parametric ANOVA test was employed. This was further confirmed by Dunn's multiple comparisons test and further still by Friedman's Non-parametric Repeated Measure test.

(c) A descriptive statistical method such as percentages was employed to analyze and summarize the ethnobotanical data from the interview on reported medicinal plants and associated knowledge.

(d) Preference ranking was used for comparison of scarcity of the medicinal plants in the study area.

3. RESULTS

3.1 Ethnobotanical Study

3.1.1 The Medicinal Plants and their Applications

During the present ethnobotanical study, 54 plant species were reported by the informants for their medicinal use by the Maasai people (see tables 1-10). They represent 44 genera and 33 families. Twelve species belong to the family FABACEAE and this is about 22% of the total species reported. Seven species belong to the family EUPHORBIACEAE and this is about 13% of the total species. The families Aloaceae , Boraginaceae, Labiatae, Myrsinaceae and Solanaceae consisted two species each. The rest of 26 families have one species each. About 60% of the medicinal plants were reported with their local names and most of them are known only in Maasai names. Only 40% of plants have names in both Kiswahili and Kimasai.

Of the 54 medicinal plants, 25 species are used against human ailments and the remaining 29 species are used to treat diseases of cattle, sheep and goats. One species (*Aloe secundiflora*) is known to treat newcaste, a disease of poultry. Some of the medicinal plants namely *Albizia anthelmintica, Adansonia digitata, Balanites aegyptiaca, Salvadora persica and Warburgia ugandensis* are used both for humans and veterinary purposes.

Based on the interview and the general consensus, the medicinal plants mentioned could be grouped into two major categories namely those that deal with humans ailments and secondly those that treat animal diseases. Further analysis gave ten groups of plants according to the diseases of humans and animals they are used to treat.

For the treatment of human ailments the following four categories were reported:

- Plants that are used for gastrointestinal diseases
- Plants that are used for health problems connected with gynecological, andrological and urinary tract infections
- Plants that are used for respiratory problems, malaria and fever
- Plants used at meat feasting camps that confer immunity and general body fitness

For the treatments of veterinary diseases the following six groups of plants were reported.

- Plants with anthelmintic activities
- Plants used as fertility regulators and for treatment of prenatal and postnatal diseases in cattle
- Plants with insecticidal , acaricidal and repellant properties
- Plants with anti-inflammatory, anaesthetic and anti-poisoning properties
- Plants used against babesiosis, blackquarter, respiratory diseases and newcaste
- Plants with fungicidal, antprotozoal and ant scour activities.

The above categories are presented in the series of the tables that follows (Tables 1-10).

Table 1: Plants used for Humans' Gastrointestinal Ailments

(Voucher numbers are given in Appendix- 3)

S/N	Scientific Name	Family	Vernacular name	Habit	Part used	Application	Method of preparation	Route
1	*Acacia nilotica* (L.) Willd.*ex* Del.	FABACEAE	Olkiloriti (MAA) Mgunga (Kisw.)	Tree	B	Indigestion	A bark infusion or decoction is used to facilitate digestion incase of indigestion; normally boiled with meat soup.	Oral
2	*Acacia xanthophloea* Benth.	FABACEAE	Olerai(MAA) Mgunga(Kisw.)	Tree	B	Indigestion	Barks are boiled and decoction is used to facilitate digestion incase of indigestion.	Oral
3	*Albizia anthelmintica* (A. Rich.) Brogn.	FABACEAE	Ol-Emugutani (MAA). Mgunga (Kisw.)	Tree	B, R	Anthelmintic, Tapeworms, Roundworms	Barks of the roots are chopped and dried. They are pounded, two to three spoonfuls of the powder are added in a liter of water and boiled.	Oral
4	*Croton macrostachyus* Del.	EUPHORBIACEAE	Olkeparlu (MAA) Mfurufuru(Kisw.)	Tree	R	Anthelminths (Roundworm)	Roots are boiled in water and the resulting decoction taken when cold.	Oral
5	*Ocimum gratissimum* L.	LABIATAE	Olemoran(MAA.)	Herb	L	Stomach upset	Fresh leaves are chewed for treatment of stomach aches.	Oral

(ST=Stem, B=Bark, R= Root, L= Leaves, SD= Seed, FL= Flowers, F= Fruit, Wp=Whole plant, Kisw= Kiswahili, MAA= Maasai language)

Table 2: Plants Used for Gynaecological, Andrological and Urinary Tract Infection in Humans

S/N	Scientific Names	Family	Vernacular Names	Habit	Part Used	Application	Methods of Preparation	Route
1	*Acacia drepanolobium* Harms *ex* Sjostedt	FABACEAE	Eluayi (MAA) Mgunga (Kisw.)	Tree	B, ST	Increase milk production	Barks and stem parts are boiled; little sugar is added and taken as tea	Oral.
2	*Adansonia digitata* L.	BOMBACACEAE	Olmesera (MAA) Mbuyu (Kisw.)	Tree	R, B	Retained placenta	Roots and barks are boiled in water, and then cooled; it can then be stored and taken when needed	Oral
3	*Balanites aegyptiaca* (L.) Del	BALANITACEAE	Olngoswa (MAA)	Tree	F	Bilharzias	The emulsion of fruit is mixed with water to form a decoction used for treatment of bilharzias	Oral
4	*Harrisonia abyssinica* Oliv.	SIMARAUBACEAE	Engiloiloi (MAA)	Shrub	R	Gonorrhea	Roots are boiled and decoction taken when cold	Oral
5	*Indigofera arrecta* Hochst.*ex* A.Rich	FABACEAE	Operelong'o (MAA) Mshushua mbuzi (Kisw.)	Tree	R	Aphrodisiac (for males)	Roots are washed and chewed while fresh, said to increase virility in males.	Oral
6	*Kigelia africana* (Lam.) Benth.	BIGNONIACEAE	Olngoswa (MAA) Mwegea (Kisw.)	Tree	B	Kidney and pancrease	Barks are boiled and decoction is cooled then about one bottle of soda is taken twice a day	Oral
7	*Maerua crassifolia* Forssk.	CAPPARIDACEAE	Oloireroi (MAA)	Shrub	B, L	Stimulate libido. Said to contain progesterone that stimulate libido	Bark fibers and leaves are boiled decoction is taken when cold	Oral

(ST=Stem, B= Bark, R=Root, L=Leaves, SD=Seed, FL=Flowers, F= Fruit, Wp=Whole plant, Kisw. =Kiswahili, MAA= Maasai language).

Table 3: Plants Used for Respiratory Diseases, Malaria and Fever in Humans

S/N	Scientific Name	Family	Vernacular names	Habit	Part used	Application	Method of Preparation	Route
1	*Albizia anthelmintica* (A. Rich.) Brogn.	FABACEAE	Ol-emugutani (MAA.) Mporojo (Kisw.)	Tree	B	Malaria	Barks are macerated and boiled in water, decoction should be concentrated, little sugar may be added and taken as tea	Oral
2	*Azadirachta indica* A. Juss.	MELIACEAE	Arobaini kamili (MAA) Mwarobaini (Kisw.)	Tree	L	Malaria	Leaves are pounded and then boiled; the decoction is taken while warm.	Oral
3	*Salvadora persica* L.	SALVADORACEAE	Oremiti or Eremiti (MAA.) Mswaki (Kisw.)	Tree/ Shrub	R	Cough and /or Fever	Barks of the root are taken while fresh and boiled in water, then resulting decoction is taken when cold	Oral
4	*Warburgia ugandensis* Spague	CANELLACEAE	Sokonoi (MAA.) Omenyakige (Kisw.)	Tree	B	Cough	Fresh or dried barks are pounded and mixed with water and boiled, the resulting solution is taken when cold.	Oral

(ST= Stem, B= Bark, R= Root, L= Leaves, SD= Seed, FL= Flowers, F= Fruit, Wp= Whole plant, Kisw= Kiswahili, MAA= Maasai language)

Table 4: Plants Used for Recreation and Meat Feasting Camps

S/N	Scientific Name	Family	Vernacular name	Habit	Part used	Application	Method of Preparation	Route
1.	*Acacia brevispica* Harms	FABACEAE	Engigiri (MAA) Mgunga (Kisw.)	Tree	R	General body fitness	Roots are chopped and boiled with meat. The amount to be mixed is quite flexible	Oral
2	*Acacia nilotica* (L.) Will.ex Del.	FABACEAE	Ol-kiloriti (MAA) Mgunga (Kisw.)	Tree	ST, B, R	Excitant, digestive	The stem, barks and even roots are boiled with meat, this increases rate of digestion	Oral
3	*Acacia seyal* Del.	FABACEAE	Olchorai (MAA) Mgunga (Kisw.)	Tree	R, ST	Digestive, Purgative	Roots and pieces of stem while fresh are boiled with meat, the amount is quite flexible	Oral
4	*Albizia anthelmintica* (A. Rich.) Brogn.	FABACEAE	Ormukutani (MAA) Mporojo (Kisw.)	Tree	R, ST	Excitant, anthelmintic	Pieces of stems and roots are boiled together with meat, this has two effects, the soup gives excitant and the cocktail will act as anthelmintic	Oral
5	*Croton dichogamus* Pax.	EUPHORBIACEAE	Enjani orpukel (MAA)	Tree	R	Fat emulsifier antibiotic for sexual diseases	Pieces of roots are boiled with soup as fat emulsifier. The soup also serves as antibiotic for sexual diseases	Oral
6	*Cynodon* sp	POACEAE	Embalakae (MAA)	Grass	L	Excitant	Leaves are mixed with meat and boiled	Oral
7	*Euphorbia cuneata* Vahl	EUPHORBIACEAE	Armeme(MAA) Mlimbilimbi (Kisw.)	Shrub/ Tree	R	For general body fitness	Pieces of roots are chopped, washed and boiled with meat.	Oral

Table 4 continued.....

8	*Harrisonia abyssinica* Oliv	SIMAROUBACEAE	Engiloilo (MAA)	Shrub/ Climber	ST, R	Antibiotic for skin disease	Roots and stem pieces are boiled with meat and, the resulting decoction serve as antibiotic	Oral
9	*Maesa lanceolata* Forssk.	MYRSINACEAE	Ilodwa or/ olreteti (MAA).	Tree/ shrub	F	Excitant, Purgative, Stimulant	Fruits (taste like ginger to sweet) eaten during meat feasting party serve as excitant and/or stimulant.	Oral
10	*Pappea capensis* Ecky. & Zeyh.	SAPINDACEAE	Oltimigomi (MAA)	Shrub/ Tree	R, ST	Increase libido	Roots and stem pieces are boiled with meat the resulting soup is taken while hot	Oral
11	*Sclerocarya birrea* A. (Rich.) Hochst.	ANACARDIACEAE	Emangulai (MAA)	Tree	R	General body fitness/ builds immunity	Roots are boiled with meat; the soup is taken while hot.	Oral
12	*Synadenium grantii* Hook. f	EUPHORBIACEAE	Oligorbobi or Engorbobi (MAA)	Shrub/ tree	ST	Tonic	Tonic, mixed with soup for women who have just delivered.	Oral

(ST=Stem, B=Bark, R=Root, L=Leaves, SD=Seed, FL=Flowers, F= Fruit, Wp=Whole plants, Kisw=Kiswahili, MAA=Maasai language)

Table 5: Plants With Antihelmintic Activity in Cattle

S/N	Scientific Name	Family	Vernacular Name	Habit	Part used	Application	Method of Preparation	Route
1.	*Albizia anthelmintica (A.Rich.)* Brogn.	FABACEAE	Olemugutani (MAA) Mporojo (Kisw.)	Tree	ST, B	Anthelmintic Nematodes Trematods Cestodes	Bark& stem pieces are boiled in water and decoction given to cattle	Oral
2	*Croton macrostachyus* Del.	EUPHORBIACEAE	Olpurkey (MAA) Mfuruaji (Kisw.)	Tree	B, R	Anthelmintic	Barks and roots are boiled together in water and decoction given to cattle	Oral
3	*Croton megalocarpus* Hutch.	EUPHORBIACEAE	Armabaiti (MAA) Mfuruanji (Kisw.)	Tree	B, L	Anthelmintic	Barks and leaves are boiled together and decoction given to cattle	Oral
4	*Embelia schimperi* Vatke	MYRSINACEAE	Olchanionyokie (MAA)	Shrub	R, SD	Anthelmintic	Dry seed are pounded and resulting powder added in the animal feed.	Oral
5	*Osyris quadripartita* Decn.	SANTALACEAE	Ol-assiassia (MAA)	Shrub	R, B	Anthelmintic	Roots and barks are boiled and decoction given to cattle	Oral

(ST=Stem, B=Bark, R= Root, L= Leaves, SD= Seed, FL= Flower, F = Fruit, Wp= Whole plant, Kisw =Kiswahili, MAA= Maasai language)

Table 6: Plants with Fertility Regulatory, Prenatal and Post natal Disease Control in cattle

S/N	Scientific Names	Family	Vernacular Name	Habit	Part used	Application	Method of Preparation	Route
1.	*Acacia drepalonobium* Harms & Sjostedt.	FABACEAE	Eluai (MAA) Mgunga (Kisw.)	Tree	ST	Retained placenta	Pieces of stem are boiled in water, decoction is given to cattle when is cold	Oral
2.	*Adansonia digitata* L.	BOMBACACEAE	Ol-mesera (MAA) Mbuyu (Kisw.)	Tree	B, L	Retained placenta	Barks and leaves are boiled and decoction given to cattle for expulsion of retained placenta	Oral
3.	*Cordia monoica* Roxb. (syn= *Cordia ovalis* D.C)	BORAGINACEAE	Oldapoi(MAA) Msasa (Kisw.)	Shrub/ Tree	F, B	Retained placenta	Fruits and barks are boiled together and concoction given to cattle	Oral
4.	*Euphorbia cuneata* Vahl.	EUPHORBIACEAE	Ol-mame (MAA)	Shrub/ tree	B, R	Retained placenta	Both bark and roots are boiled and decoction given to cattle when cold.	Oral
5.	*Euphorbia hirta* L.	EUPHORBIACEAE	Emame (MAA)	Shrub/Tree	L, ST	Stimulates lactation	Leaves and branches are added in the animal fodder	Oral
6.	*Ficus natalensis* Hochst.	MORACEAE	Ol-ngaboli (MAA)	Tree/ shrub	R	Induces lactation	Roots are boiled and decoction given to cattle	Oral
7	*Grewia bicolor* Juss.	TILIACEAE	Ositeti (MAA) Mfukufuku (Kisw.)	Shrub/ tree	B, ST	Mastitis	Bark and stem are boiled together and concoction given to cattle	Oral
8	*Heliotropium indicum* L.	BORAGINACEAE	Alaisikirai (MAA)	Herb/shrub	Wp	Correct uterus post patrum	Whole plant while fresh is added in the animal feed	Oral

(ST=Stem, B=Bark, R= Root, L= Leaves, SD= Seed, FL= Flower, F = Fruit, Wp= Whole plant, Kisw =Kiswahili, MAA= Maasai language)

Table 7: Plants With Insecticidal, Acaricidal and Repellant Properties in cattle

S/N	Scientific Name	Family	Vernacular Name	Habit	Part used	Application	Methods of preparation	Route
1.	*Aloe lateritia Engl Syn=A. volkens*	ALOACEAE	Osukuroi (MAA)	Herb/ shrub	B, R	Ant-inflammatory	Paste from the fresh plant barks and from the roots are massaged on the skin of the animal	Skin surface
2	*Asparagus africanus Lam.*	ASPARAGACEAE	Empere- e-papa (MAA)	Herb	R, ST, L	Ant-inflammatory	Roots, stem and leaves are pounded while fresh and the concoction applied on goat/ cattle skin surface	Skin surface
3	*Combretum schumannii* Engl.	COMBRETACEAE	Ol-maroroi (MAA)	Tree	R, B/fibre	Antpoisoning and Ant-odema	Roots and bark fibre are crushed while fresh, mixed with water and decoction given to cattle	Oral
4.	*Cussonia kirkii* Harms *ex* Engl.	ARALIACEAE	Ol-tumorai (MAA)	Tree/Shrub	R, B	Ant – poisoning& ant-oedema	Roots and bark are pounded while fresh and decoction applied on the skin where the swelling occur.	Skin surface
5.	*Dichrostachys cinerea* (L.) Wight & Arn.	FABACEAE	Endundulo (MAA).	Tree	B	Anaesthetic	Juice prepared from the barks are applied on skin	Skin surface
6.	*Lannea schweinfurthii (Engl.) Engl.*	ANACARDIACEAE	Erupande (MAA)	Tree	ST	Ant-poison	Stem parts are boiled and decoction given to cattle	oral
7.	*Rubia cordifolia* L.	RUBIACEAE	Ol-ngeriandus	Climber	L, B	Ant -poison	Leaves and barks macerated and resulting solution applied externally	Skin surface
8.	*Solanum incanum* L.	SOLANACEAE	Olndulelei/endulelei (MAA) Ndulele (Kisw,)	Shrub	F	Ant-poison	Juice from ripe fruit is applied on the surface after a cut is made on the surface on the affected part.	Skin surface

(ST=Stem, B=Bark, R= Root, L=Leaves, SD=Seed, FL=Flowers, F=Fruit, Wp=Whole plant, Kisw=Kiswahili, MAA=Maasai language)

Table 8: Plants With Anti-Inflammatory, Anaesthetic and Ant- Poisoning Properties

	Scientific Names	Family	Vernacular name	Habit	Part used	Application	Method of Preparation	Route
1	*Azadirachta indica* A. Juss.	MELIACEAE	Arobaini -kamili (MAA) Mwarobaini (Kisw.)	Shrub/ tree	B	Acaricidal	Barks are dried, then pounded, the powder is smeared on the skin	Skin surface
2	*Combretum schumannii* Engl.	COMBRETACEAE	Ol-maroroi (MAA) Mugurure (Kisw.)	Tree	L	Repellant	Infusion made from the leaves is smeared on the skin act as repellant against tsetse flies and bot flies.	Skin surface
3	*Commiphora swynnertonii* B. D. Burtt.	BURSERACEAE	Ol-temwai (MAA)	Shrub/ tree	Fibre-sap	Acaricidal	The sap is watery and slightly scented is obtained from leaves or stem fibre smeared on the skin of animal	Skin surface
4	*Embelia schimperi* Vatke	MYRISINACEAE	Ol-chanionyakie (MAA)	Climb er	Fibre sap	Repellant	The fibre sap is obtained from leaves or stem and is smeared on the surface of goats & cattle, used against tsetse flies	Skin surface
5	*Premna resinosa* (Hochst.) Schauer	VERBENACEAE	Ol-konerei (MAA)	Shrub	ST,	Fumigant	Stem and/ or branches are burnt and the smoke is used as a fumigant against tsetse flies	Skin surface
6	*Cordia monoica* Roxb.	BORAGINACEAE	Oldapoi (MAA) Msasa (Kisw.)	Tree	B, ST	Fumigant	Barks and stem wood are burnt and the smoke is used as a fumigant	Skin surface
7	*Rauvolfia caffra* Sond.	APOCYNACEAE	Ol-chapukelia (MAA)	Shrub/ tree	B, R	Acaricidal	Barks &roots are macerated and the sap is smeared as an acaricide	Skin surface
8	*Ziziphus mucronata* Willd.	RHAMNACEAE	Ol-oilaki (MAA)	Shrub/ tree	R	Acaricidal	Root decoction is used as an acaricide	Skin surface

Table 9: Plants Used Against Bebesiosis, Blackquarter, Respiratory and Newcaster Disease

N/S	Scientific Names	Family	Vernacular name	Habit	Part used	Application	Method of Preparation	Route
1.	*Aloe secundiflora* Engl.	ALOACEAE	Osukuroi (MAA)	Herb	L	Newcaste	Leaves are macerated and mixed with cold water, the decoction given to chicken	Oral
2.	*Balanites aegyptiaca* (L.) Del.	BALANITACEAE	Ol-ng'oswa (MAA)	Tree	B	Babesiosis	Barks are boiled and the decoction is given to cattle while cold	Oral
3.	*Commelina benghalensis* L.	COMMELINACEAE	Engaiteteyai (MAA)	Herb	L	Blackquarter	Leaves constitute ingredients used in the preparation of vaccine against black quarter	Skin surface
4.	*Delonix elata* (L.) Gamble	FABACEAE	Ol-tang'ori (MAA)	Tree	B, ST, L	Babesiosis	Barks, stem pieces and leaves are boiled together and concoction is given to cattle	Oral
5.	*Erythrina brucei* (Schweinf.)	FABACEAE	Ol- ngarooji (MAA)	Shrub	B, L	Babesiosis	Leaves and barks are boiled together and decoction given to cattle	Oral
6	*Leucas martinicensis* (Jacq) R. Br	LABIATAE	Ol-bibiai (MAA)	Herb	Wp	Cough relieve	Whole plant is boiled and then evaporated for sometimes to make decoction concentrated.	Oral
7.	*Warburgia ugandensis* Spraque	CANELLACEAE	Sokonoi (MAA)	Tree	B, R	Respiratory infection	Barks and roots are dried and then pounded, the powder is mixed with water and animal drenched for treatment of minor respiratory infection	Oral

(ST=Stem, B=Bark, R= Root, L=Leaves, SD=Seed, FL=Flowers, F=Fruit, Wp=Whole plant, Kisw=Kiswahili, MAA=Maasai language)

Table 10: Plants With Fungicidal and Antiprotozoal Activity

S/N	Scientific Names	Family	Vernacular Name	Habit	Part used	Application	Method of Preparation	Route
1	*Acacia tortilis* (Forsk.) Hynae	FABACEAE	Osiyamalili (MAA) Mgunga (Kisw.)	Tree	L, B	Calf scours	Leaves and barks are boiled together and decoction is given to calf	Oral
2	*Allium ampeloprasum L.*	ALLIACEAE	Ole kitonya (MAA)	Herb	L	East coast fever	Infusion is made from the leaves	Oral
3	*Aloe secundiflora* Engl.	ALOACEAE	Osukuroi (MAA)	Herb	L	East coast fever	Infusion is made from the leaves	Oral
4	*Senna occidentalis L.*	FABACEAE	Olerai	Tree	L	East coast fever	Infusion from the leaves	Oral
5	*Solanum incanum* L.	SOLANACEAE	Endulelei(MAA) Ndulele (Kisw.)	Herb	F, R	Fungal skin	Infusion from the leaves and roasted fruit is rubbed on the affected part	Skin surface
6	*Solanum nigrum* L.	SOLANACEAE	Endulelei (MAA Ndulele (Kisw.)	Herb	B, F	Fungal skin	Infusion from bark and fruits is rubbed on the skin, this is mixed with sheep tail fats or milk butter fats	Skin surface

(ST=Stem, B=Bark, R= Root, L=Leaves, SD=Seed, FL=Flowers, F=Fruit, Wp=Whole plant, Kisw=Kiswahili, MAA=Maasai language)

3.1.2 Analysis of Data for medicinal plants based on their habits or life forms

Analysis of data using non-parametric ANOVA test for different life forms of the medicinal plants used by the Maasai was carried out. The results based on Kruskal Wallis Non-parametric test (Table 11), showed that there is a significant difference between different habits namely trees, shrubs, grass/herbs and climbers

Table 11: Kruskal-Wallis Non-Parametric Test (KW =63.036, P < 0.0001)

Grass/herb				
Climber	-9.613 P> 0.05			
Shrubs	59.038* P <0.001	56.095* P<0.001		
Trees	63.950* P<0.001	73.563* P<0.001	4.525 P>0. 05	
	Grass/herb	Climber	Shrubs	Trees

Marked mean values are significant at given P-levels

These results were further confirmed by Friedman Non-Parametric test (Table 12).
(Fr = 52.746, P < 0.0001)

Table 12: Friedman Non –Parametric Repeated Measure test

Grass/ herb				
Climber	-8.000 P> 0.05			
Shrubs	59.000* P<0.001	56.000* P<0.001		
Tree	64.000* P<0.001	72.000* P <0.001	2.000 P>0.05	
	Grass/herbs	Climbers	Shrubs	Tree

Marked mean values are significant at given P-levels

The above results as shown in (Tables 11 &12) confirm the hypothesis that most of the Maasai remedies are derived from trees and shrubs rather than herbs and grasses.

3.1.3 Plant Parts Used and Mode of Preparation

Assessment on the different plant parts utilized reveals that barks are the most commonly used and account for (32%) of the total recorded medicinal plants followed by roots (29%), leaves (17%), stem (16%), fruit (4%) and whole plant (2%) (See Fig.6) below.

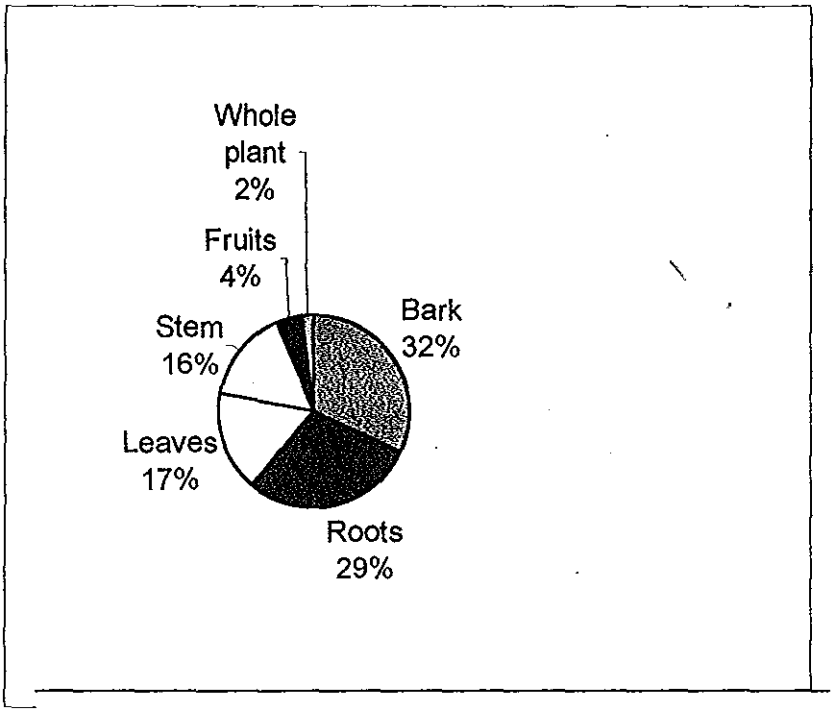


Figure 6. Percentage of medicinal plant parts used in Maasai remedial system.

Most of plant remedies are prepared as a decoction or through boiling the barks, roots or stem pieces either individually or in some cases by having the combination of them. Water is the major medium in which the solutions are made. But one of the interesting feature was may be the plant remedies used in meat feasting camps (Table 4) in this case a number of plant parts most of them from family [Fabaceae] such as *Acacia brevispica, Acacia nilotica, Acacia seyal,*

Albizia anthelmintica are added in the meat cocktail, and the major ingredient is the meat soup. This forms a concoction that is said to give the body general fitness and confer immunity.

3.1.4 Route of Administration and Dosage

As regard to their route of administration, most of the Maasai remedies are taken orally accounting for (76%) of the medicinal plants, followed by external application (applied topically on skin) (20%) and nasal application (6%). The mode of application of two remedies namely *Prema resinosa* (VERBENACEAE) [Olkonerei-MAA], and *Cordia monoica (BORAGINACEAE)*

[Oldapoi-MAA] do not fit into either of the above categories since they are meant to act as fumigants rather than treatment. These are dried and burnt, the smoke is meant to act as fumigant in the animal cages (**bomas**) against tsetse flies that causes trypanasomiasis.

To improve the acceptability of certain remedies that are taken orally some additives are frequently added. For example *Acacia drepalonobium* that is used as remedial to increase milk production in women is added with some sugar and taken as tea. The root of *Pappea capensis* (SAPINDACEAE) that is said to increase libido is boiled with meat to form a soup and this can be taken without much difficulty.

Some of the informants reported that restrictions are imposed when the patients take certain types of remedies. For example, a patient who takes remedy against tapeworm (prepared from *Albizia anthelmintica)* should not take any food the night before the administration and further

still food containing milk are completely forbidden until the proglottids are expelled from the intestine. The drug is thought to be more effective when the proglottids are made to starve.

For most of the remedies, full dose is taken once. However, the dose given to the patient depends on age, physical and health conditions. Lack of agreement among the informants on doses of certain remedies prescribed was sometimes noted. For example, the amount of barks of (*Warburgia ugandensis*) (sokonoi-MAA) used for treatment of cough and other respiratory related diseases, vary from one informant to another. Besides the units such as (handful of roots, some leaves or little amount of barks e.t.c) employed to measure the amount of the plant parts used in the preparation of most remedies are so rough and therefore lacks precision.

3.1.5 Confidently Used Medicinal Plants by Informants Consensus

The result of the study shows that some medicinal plants and their remedial practices are more popular than others. Accordingly, *Albizia anthelmintica* **(olmugutani)** took the lead where it was cited by 20 informants (80%) for its medicinal value in the treatment of worms (Tapeworms, round worms) both in humans and in veterinary, it is also used for treatment of malaria and it is used in meat feasting camps as excitant, and for general body fitness. This is followed by *Warburgia ugandensis* **(sokonoi)** cited by 18 informants (72%), it is well known for its medicinal value in treatment of cough and respiratory diseases. Another well known medicine is *Acacia nilotica* **(ol-kiloriti)** cited by 16 informants (64%) This is commonly used in meat feasting camps, mixed with meat for building proper body immune system and as fatty emulsifier. Those which were cited by at least 60% of informants include the following, *Adansonia digitata* **(olemesera)** for expulsion of retained placenta, *Salvadora persica* **(Oremit)** for teeth brush and for treatment of cough, *Croton machrostachyus* and *Croton*

megalocarpus for treatment of worms, *Harrisonia abyssinica* for treatment of gonorrhea and syphilis, *Kigelia africana* **(ordopoi)** for treatment of kidney and pancrease. *Solanum incanum* **(enduleilei)** *is* well known medicinal plant for treatment of fungal diseases in cattle.

Table 13. List of Medicinal Plants Confidently used for Treatment of More than One Ailment, The % of informants is given

Scientific Name	Ailments	Number of informants
Albizia anthelmintica	Tapeworms, round worms, malaria,	20 (80%)
Warburgia ugandensis	Chest pain, cough, abdominal pain	18 (72%)
Salvadora persica	Tooth aches, tooth brush, cough, purgative	16 (64%)
Acacia nilotica	Build body immune system, as digestive, fat emulsifier	16 (64%)
Harrisonia abyssinica	Gonorrhea, syphilis	15 (60%)
Kigelia africana	Kidney, pancrease	15 (60%)
Solanum incanum	Fungal skin disease	14 (58%)

3.1.6 Habitat, Current Status and Trend of Medicinal Plants

General trend shows that there is little practice of cultivating medicinal plants in the area. Almost all medicinal plants (98%) are harvested from the wild. It was noted that only one species (*Azadirachta indica*) (**Mwarobaini**) of family [MELIACEAE], is the only medicinal plant that is under cultivation. This can be explained from the fact that Maasai are pastoralists and nomadic, as they rarely have permanent homesteads, they do not practice such things like home gardens. But in the case of *Azadiratcha indica*, the plant was introduced, and they grow it near their homesteads for shelter and it turns up to be an important medicinal plant.

However, most of the medicinal plants that are collected from the wild are available in areas not very far from their villages. For example, it was noted that those Maasai around Mto wa Mbu and Losirwa use the forest reserve at Selela for harvesting medicinal plants especially those of *Acacia* spp. As this forest is under management of the village. Those in Moyamayoka use part of Marang Forest Reserve. All in all when the need arise, for those that are not easily found, they can be purchased from nearby townships during the market day (**mnada**).

The interview result shows that more than 29% of the Maasai medicinal plants, which used to be found in the forest are now scarce, being rarely encountered or are found strictly in the preserved area like in Manyara National Park where there is little human perturbations. However, about 71% of the noted medicinal plants that were cited are either commonly or occasionally found in the area (see Table 14). Most of them are wild herbs and shrubs that grow in semi-disturbed and fallowed lands and in roadsides. As Maasai are nomadic when they migrate, they live behind the land to regenerate, thus the medicinal plants also regenerate. Favored by such situation, the medicinal plants and vegetation types are quite dynamic.

Table 14. Three Categories of Medicinal Plants Based on The Degree of Abundance as Reported by Informants

Rarely encountered (27% of the total)	Occasionally encountered (34% of the total)	Commonly encountered (37% of the total)
Warburgia ugandensis	*Albizia anthelmintica*	*Solanum incanum*
Delonix elata	*Acacia nilotica*	*Solanum nigrum*
Maesa lanceolata	*Grewia bicolor*	*Commelina benghalensis*
Pappea capensis	*Ficus natelensis*	*Adansonia digitata*
Commiphora swynnertonii	*Balanites aegyptiaca*	*Acacia tortilis*
Allium ampeloprasum	*Harrisonia abyssinica*	*Rauvolfia caffra*
Leucas martiniicensis	*Euphorbia cuneata*	*Ocimum gratissimum*
Sclerocarya birrea	*Aloe volkensis*	*Kigelia africana*
Synadenium grantii	*Rubia cordifolia*	*Aloe secundiflora*
Osyris quadripartita	*Heliotropium indicum*	*Croton macrostachyus*
Lannea schweinfurthii	*Euphorbia hirta*	*Acacia drepalonobium*
	Salvadora persica	*Maerua crassifolia*
	Asparagus africanus	*Azadirachta indica* *
	Croton dichowegumus	*Sphaeranthus gomphrenoides*
		Cynodon sp.
		Ricinus communis
		Croton megalocarpus

* Under cultivation

From the rarely encountered medicinal plants, which had been reported as scarce by the key informants, preference ranking was used for analysis. This is according to Martin (1995) where the most rare is given the highest value (e.g. 5) and the less rare is given (e.g. 1). Ten informants were chosen coded by letters A to J (See Table 15).

Table 15. Preference Ranking Values (based on the degree of scarcity) of the Ten Selected Medicinal Plants in the Study Area.

List of Medicinal plants	Key Informants (coded A to J)											
	A	B	C	D	E	F	G	H	I	J	Total score	Rank
Warburgia ugandensis	2	2	3	2	1	3	3	2	2	1	21	9th
Delonix elata	3	4	3	3	4	2	1	2	3	1	26	5th
Maesa lanceolata	3	3	2	2	2	2	1	2	4	4	25	6th
Pappea capensis	4	3	3	3	4	4	3	2	2	2	30	3rd
Commiphora swynertonii	1	3	1	2	1	2	3	1	1	1	16	10th
Allium ampeloprasum	5	4	5	5	5	4	4	5	4	5	46	2nd
Leucas martinicensis	5	5	5	5	4	5	4	5	5	5	48	1st
Sclerocarya birrea	3	3	2	3	2	3	3	3	3	3	28	4th
Synadenium grantii	2	2	3	4	1	1	3	4	1	4	25	6th
Osyris quadripartita	4	2	2	1	2	2	2	3	3	2	23	8th

This analysis shows that *Leucas martinicensis* is the most rare of all, followed by *Allium ampeloprasum* (a certain type of wild onions), then *Pappea capensis* whose roots are said to increase libido is rare. However, *Commiphora swynertonii* and *Warburgia ugandensis* scored least (Fig.7). This shows that they are still available at adequate amounts.

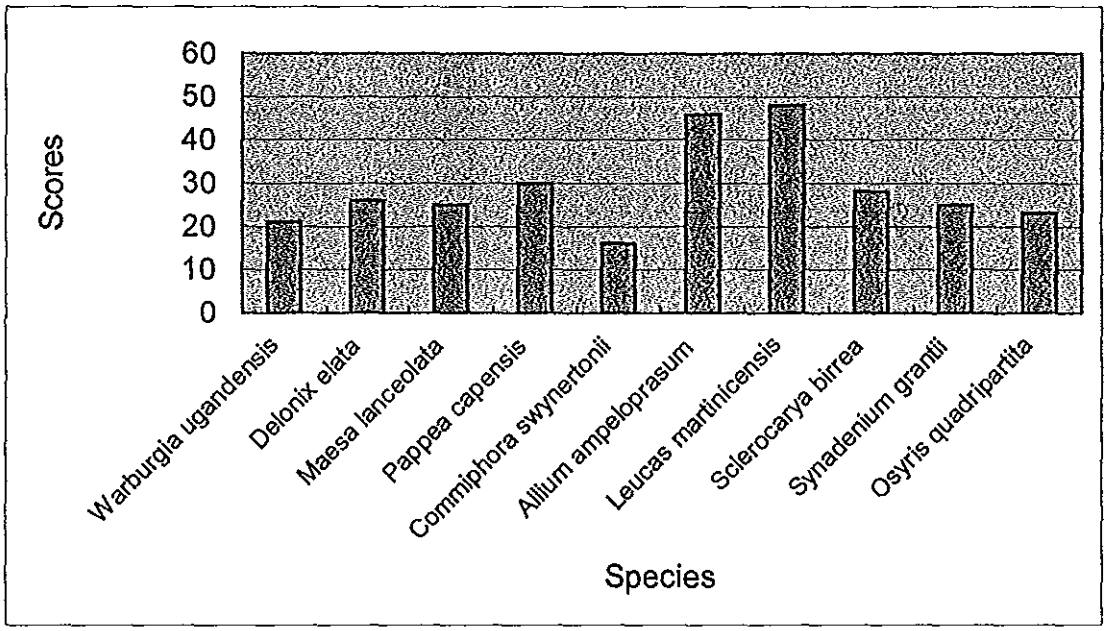


Figure 7. Preference ranking value for selected medicinal plants in the study area based on degree of scarcity by informant consensus.

3.1.7 Maasai Medicinal Plants and Trade

In the past few decades about 98% of the Maasai medicinal plants were used locally within the community for treatment of both human ailments and veterinary diseases. Today, however more than 80% of these medicinal plants are sold in markets in big towns and cities like Dar-es –Salaam, Arusha, Moshi, and Nairobi. One interesting feature is that these medicinal herbs are sold mostly by the Maasai women and serve as remedy to the large community (See Fig.8). The most commonly sold medicinal plants include *Warburgia ugandensis* (sokonoi), *Albizia anthelmintica* (olmugutani), *Acacia nilotica* (olkiloriti), *Maesa lanceolata* (Ilodwa), *Indigofera arrecta* (operelong'o), *Salvadora persica* (oremiti), as a toothbrush and many more.

Figure 8. A picture of a Maasai woman selling herbal medicines in Kariakoo market in Dar-es-Salaam.

3.2 Classification of Vegetation into Community Type and Distribution of Medicinal Plants.

A total of 80 plant species were recorded from 40 releve's (sample plots). Based on the composition, presence and / or absence of species, association analysis of the data was run (See Fig.9). The program was based on Williams and Lambert's long division (adapted and modified by Zerihun Woldu, 1980 and 1985). This is a type of division that keeps dividing until a single stand is obtained unless computer core space is limiting. The alternative technique terminates at maximum chi-square of zero. From this analysis the species association was recognized which was then categorized into nine groups. The Dendrogram for this analysis is given in Fig.9.

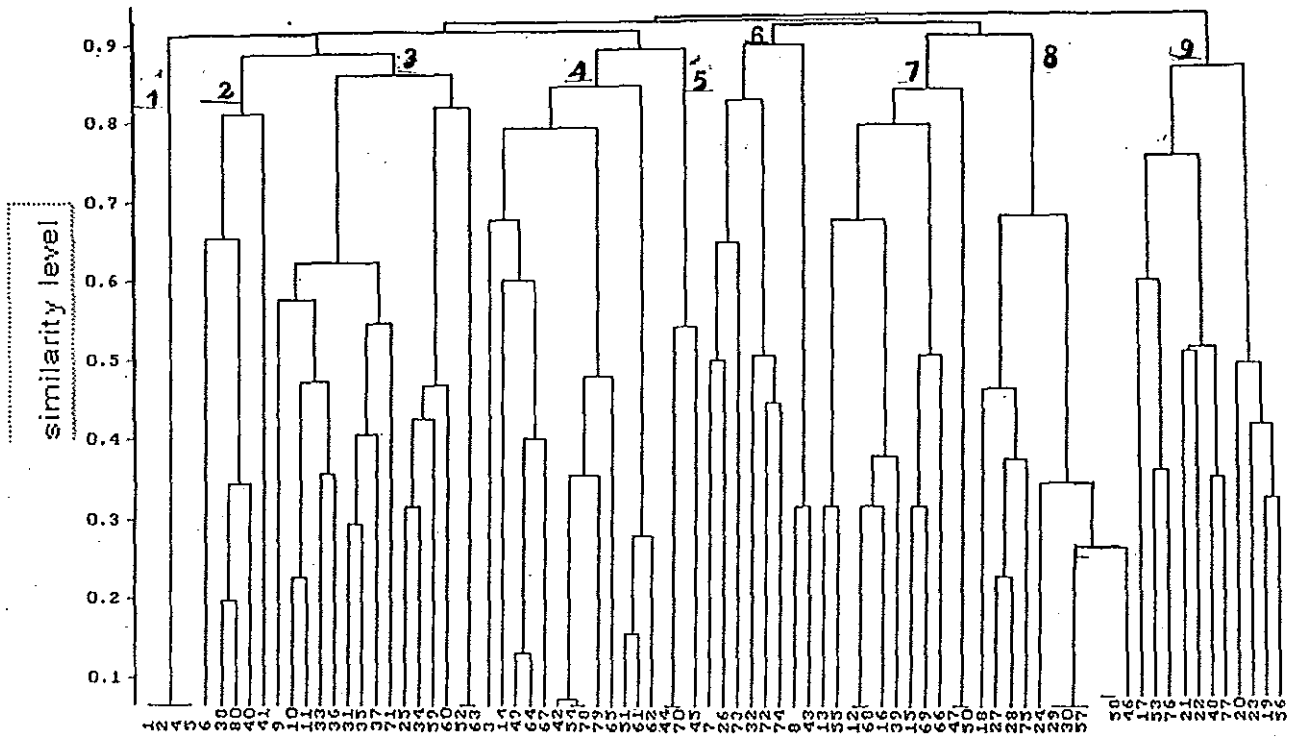


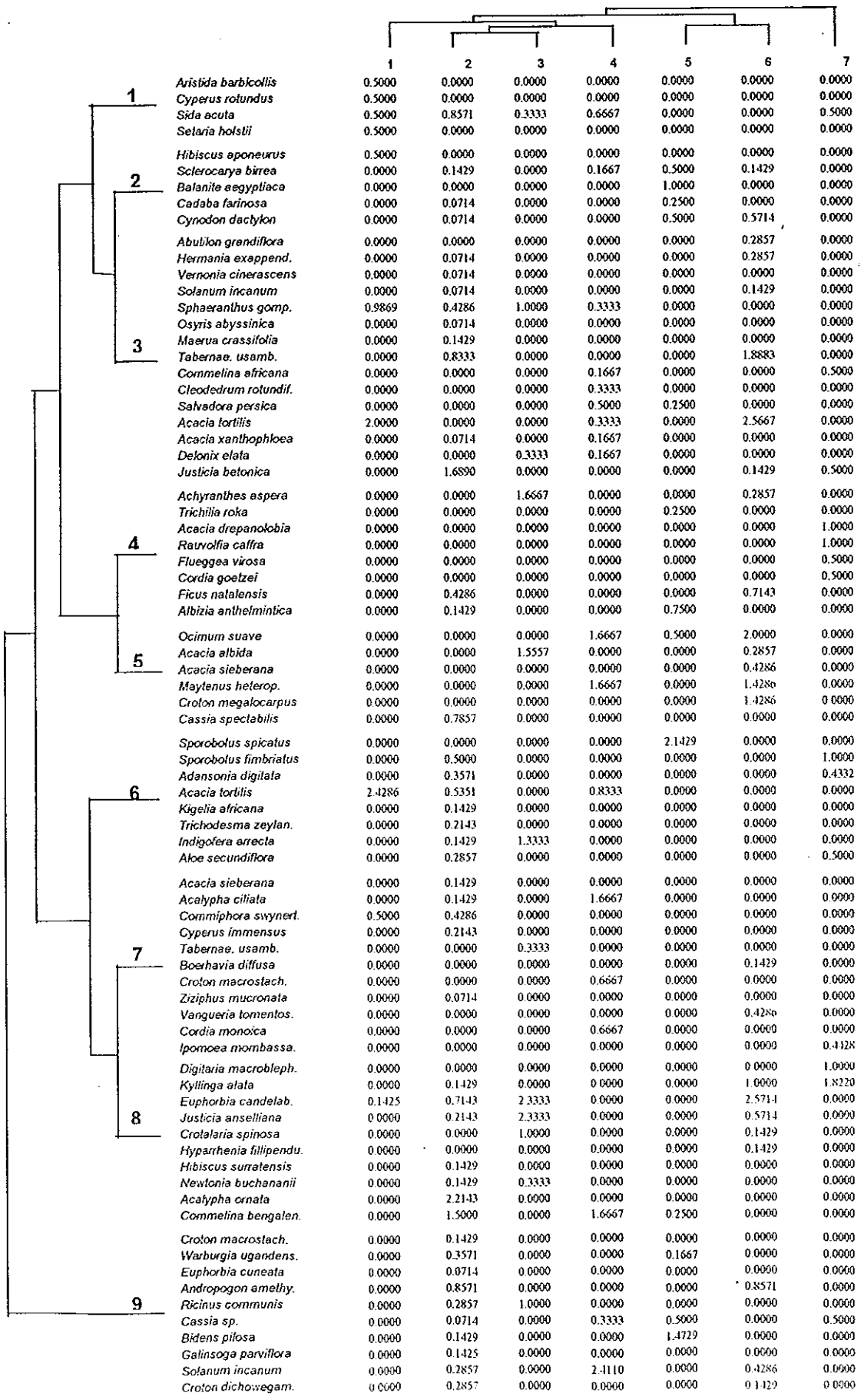
Figure 9. Dendrogram Showing the Classification of stands in Manyara study area using Similarity ratio. (X-axis represents species and Y-axis represents similarity level)

Further analysis using FORTRAN program named SYNTAX, version 3 (Podani, 1988) was used to classify the vegetation data. In here, the average linkage clustering procedure was used. Average linkage clustering is hierarchical polythetic agglomerative procedure in which pairs of stands are fused on the basis of their similarities being highest or dissimilarities being lowest. It progresses by successive fusion until all stands are fused into a single group, building a hierarchy from the bottom. Similarity ratio was used as a resemblances index. The cluster analyses of the quantitative vegetation data produced seven major clusters of vegetation groups at 0.8-similarity level. The homogenous groups that resulted from the analyses were identified as plant community types and designated as 1,2, 3, 4, 5, 6 and 7. The resulting Dendrogram for this analysis is given as (a top Dendrogram) shown in (Fig. 10).

Each community is named by the genus or a combination of genera of the characteristic species, which has the highest mean value.

Table 16. Summary of Data Based on SYNTAX Analysis

Community Type	Releve's or Plots in the Group	Group size
1	1, 21	2
2	8, 9, 10, 18, 15, 16, 11, 19, 20, 24, 25, 14, 31, 12	14
3	17, 23, 32	3
4	27, 28, 33, 30, 29, 34	6
5	3, 4, 35, 36	4
6	5, 6, 7, 26, 2, 37, 40	7
7	38, 39	2



		1	2	3	4	5	6	7
1	*Aristida barbicollis*	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Cyperus rotundus	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Sida acuta	0.5000	0.8571	0.3333	0.6667	0.0000	0.0000	0.5000
	Setaria holstii	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	*Hibiscus aponeurus*	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Sclerocarya birrea	0.0000	0.1429	0.0000	0.1667	0.5000	0.1429	0.0000
	Balanite aegyptiaca	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	Cadaba farinosa	0.0000	0.0714	0.0000	0.0000	0.2500	0.0000	0.0000
	Cynodon dactylon	0.0000	0.0714	0.0000	0.0000	0.5000	0.5714	0.0000
3	*Abutilon grandiflora*	0.0000	0.0000	0.0000	0.0000	0.0000	0.2857	0.0000
	Hermania exappend.	0.0000	0.0714	0.0000	0.0000	0.0000	0.2857	0.0000
	Vernonia cinerascens	0.0000	0.0714	0.0000	0.0000	0.0000	0.0000	0.0000
	Solanum incanum	0.0000	0.0714	0.0000	0.0000	0.0000	0.1429	0.0000
	Sphaeranthus gomp.	0.9869	0.4286	1.0000	0.3333	0.0000	0.0000	0.0000
	Osyris abyssinica	0.0000	0.0714	0.0000	0.0000	0.0000	0.0000	0.0000
	Maerua crassifolia	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000
	Tabernae. usamb.	0.0000	0.8333	0.0000	0.0000	0.0000	1.8883	0.0000
	Commelina africana	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.5000
	Cleodedrum rotundif.	0.0000	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000
	Salvadora persica	0.0000	0.0000	0.0000	0.5000	0.2500	0.0000	0.0000
	Acacia tortilis	2.0000	0.0000	0.0000	0.3333	0.0000	2.5667	0.0000
	Acacia xanthophloea	0.0000	0.0714	0.0000	0.1667	0.0000	0.0000	0.0000
	Delonix elata	0.0000	0.0000	0.3333	0.1667	0.0000	0.0000	0.0000
	Justicia betonica	0.0000	1.6890	0.0000	0.0000	0.0000	0.1429	0.5000
4	*Achyranthes aspera*	0.0000	0.0000	1.6667	0.0000	0.0000	0.2857	0.0000
	Trichilia roka	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000	0.0000
	Acacia drepanolobia	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	Rauvolfia caffra	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	Flueggea virosa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000
	Cordia goetzei	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000
	Ficus natalensis	0.0000	0.4286	0.0000	0.0000	0.0000	0.7143	0.0000
	Albizia anthelmintica	0.0000	0.1429	0.0000	0.0000	0.7500	0.0000	0.0000
5	*Ocimum suave*	0.0000	0.0000	0.0000	1.6667	0.5000	2.0000	0.0000
	Acacia albida	0.0000	0.0000	1.5557	0.0000	0.0000	0.2857	0.0000
	Acacia sieberana	0.0000	0.0000	0.0000	0.0000	0.0000	0.4286	0.0000
	Maytenus heterop.	0.0000	0.0000	0.0000	1.6667	0.0000	1.4286	0.0000
	Croton megalocarpus	0.0000	0.0000	0.0000	0.0000	0.0000	1.4286	0.0000
	Cassia spectabilis	0.0000	0.7857	0.0000	0.0000	0.0000	0.0000	0.0000
6	*Sporobolus spicatus*	0.0000	0.0000	0.0000	0.0000	2.1429	0.0000	0.0000
	Sporobolus fimbriatus	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	1.0000
	Adansonia digitata	0.0000	0.3571	0.0000	0.0000	0.0000	0.0000	0.4332
	Acacia tortilis	2.4286	0.5351	0.0000	0.8333	0.0000	0.0000	0.0000
	Kigelia africana	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000
	Trichodesma zeylan.	0.0000	0.2143	0.0000	0.0000	0.0000	0.0000	0.0000
	Indigofera arrecta	0.0000	0.1429	1.3333	0.0000	0.0000	0.0000	0.0000
	Aloe secundiflora	0.0000	0.2857	0.0000	0.0000	0.0000	0.0000	0.5000
7	*Acacia sieberana*	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000
	Acalypha ciliata	0.0000	0.1429	0.0000	1.6667	0.0000	0.0000	0.0000
	Commiphora swynerl.	0.5000	0.4286	0.0000	0.0000	0.0000	0.0000	0.0000
	Cyperus immensus	0.0000	0.2143	0.0000	0.0000	0.0000	0.0000	0.0000
	Tabernae. usamb.	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000
	Boerhavia diffusa	0.0000	0.0000	0.0000	0.0000	0.0000	0.1429	0.0000
	Croton macrostach.	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.0000
	Ziziphus mucronata	0.0000	0.0714	0.0000	0.0000	0.0000	0.0000	0.0000
	Vangueria tomentos.	0.0000	0.0000	0.0000	0.0000	0.0000	0.4286	0.0000
	Cordia monoica	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.0000
	Ipomoea mombassa.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4128
8	*Digitaria macrobleph.*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
	Kyllinga alata	0.0000	0.1429	0.0000	0.0000	0.0000	1.0000	1.8220
	Euphorbia candelab.	0.1425	0.7143	2.3333	0.0000	0.0000	2.5714	0.0000
	Justicia anselliana	0.0000	0.2143	2.3333	0.0000	0.0000	0.5714	0.0000
	Crotalaria spinosa	0.0000	0.0000	1.0000	0.0000	0.0000	0.1429	0.0000
	Hyparrhenia filipendu.	0.0000	0.0000	0.0000	0.0000	0.0000	0.1429	0.0000
	Hibiscus surratensis	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000
	Newtonia buchananii	0.0000	0.1429	0.3333	0.0000	0.0000	0.0000	0.0000
	Acalypha ornata	0.0000	2.2143	0.0000	0.0000	0.0000	0.0000	0.0000
	Commelina bengalen.	0.0000	1.5000	0.0000	1.6667	0.2500	0.0000	0.0000
9	*Croton macrostach.*	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000
	Warburgia ugandens.	0.0000	0.3571	0.0000	0.0000	0.1667	0.0000	0.0000
	Euphorbia cuneata	0.0000	0.0714	0.0000	0.0000	0.0000	0.0000	0.0000
	Andropogon amethy.	0.0000	0.8571	0.0000	0.0000	0.0000	0.8571	0.0000
	Ricinus communis	0.0000	0.2857	1.0000	0.0000	0.0000	0.0000	0.0000
	Cassia sp.	0.0000	0.0714	0.0000	0.3333	0.5000	0.0000	0.5000
	Bidens pilosa	0.0000	0.1429	0.0000	0.0000	1.4729	0.0000	0.0000
	Galinsoga parviflora	0.0000	0.1425	0.0000	0.0000	0.0000	0.0000	0.0000
	Solanum incanum	0.0000	0.2857	0.0000	2.4110	0.0000	0.4286	0.0000
	Croton dichogegam.	0.0000	0.2857	0.0000	0.0000	0.0000	0.1429	0.0000

Figure 10. Synopsis of the community groups (top Dendrogram) and species association (the Dendrogram on left). The values indicate mean cover value for each species in the communities.

1. Acacia-Aristida-Solanum community

Acacia tortilis, Aristida barbicollis and Solanum incanum are the characteristic species of this community. This community occurs in southern part of LMNP in Moyamayoka area. The area is dominated by open *Acacia* woodland; it is a fairly grazed area. On the other hand is a public land that is fallowed and dominated by *Solanum incanum* and *Sida acuta.* This area occurs at an altitude of 1006 m. Medicinal plants that are common in this area include *Acacia nilotica, Acacia tortilis and Solanum incanum.*

2. Justicia-Tabernaemontana-Trichilia Community

Justicia betonica, Tarbernaemontana usambaraensis and Trichilia roka are the typical characteristic of this community. The plots describing this community occur inside the park in the under ground water forest area. The presence of tall trees of *Trichilia roka* forms a dense canopy that makes the undergrowth more or less bare or with a very little cover. Medicinal plants that occur in this area include *Solanum incanum, Solanum nigrum and Ricinus communis.*

3.Acacia- Achyranthes community

Acacia albida and Achyranthes aspera are characteristics species of this community. This type of community occur in Selela Forest Reserve at an altitude of 1006 m, just outside LMNP.The undergrowth has a lot of juvenile trees and shrubs such as *Rauvolfia caffra* and *Croton macrostachyus*. This forest area is famous for its medicinal plants, such species as

*Acacia nilotica, Acacia tortilis, Albizia anthelmintic*a are found. In here a number of *Acacia* trees were debarked for medicinal use (See Fig. 11 and 12).

4. Bidens- Commelina- Solanum Community

Bidens pilosa, Commelina benghalensis and Solanum incanum are the characteristic species of this community. These plots are outside LMNP at Mto wa Mbu within the disturbed vegetation. The area is at an altitude of 1000m. Most of these plots fall under cultivated land that was fallowed. In terms of medicinal plants *Solanum incanum, Croton macrostachyus, Commelina benghalensis, Ricinus communis, Ocimum gratissimum* are found.

5. Cynodon-Sporobus Community

Cynodon dactylon and Sporobus spicatus are the characteristic species of this community. This type of community occurs in Mabokoni area inside LMNP at an altitude of 990 m. It is an area that is near to the lake. The two grass types are typical alkaline grasses that are highly grazed by wild animals such as buffalos. Outside the park there are some *Cynodon* species occurring with *Adansonia digitata*. In terms of medicinal plants, *Adansonia digitata* and some *Acacia* are found.

6. Acacia-Cynodon-Tabernaemontana community

Acacia tortilis, Cynodon dactylon and Tabernaemontana usambaraensis are the characteristic species of this community. The plots occur inside the park at an altitude of 990 m. It is typical *Acacia* woodland with short grasses of *Cynodon dactylon and Cynodon nlemfluensis*. The

medicinal plants found in this area include *Acacia xanthophloea, Cordia monoica, Salvadora persica and Solanum incanum.*

7. Digitaria-Kyllinga Community

Digitaria macroblepharis and Kyllinga elata are the characteristic species of this community. This community type is found in Losirwa study area outside the park at an altitude of 1000 m. It is an area of short grasses with sparse *Acacia* woodland. These are fallowed areas mainly meant for grazing. In terms of medicinal plants, only few debarked *Adansonia digitata* are found.

4. DISCUSSION

4.1 Traditional Medicines and Associated Knowledge

The number of reported medicinal plants (54 species) as being used by the Maasai of Manyara is not quite small taking into account the small human population size and the other factors such as deforestation, land degradation and acculturalization that has happened in the area through ages.

In similar studies carried in Nomadic society of Somalis in Wajir District of Northern Kenya, 50 species of medicinal plants were recorded (Yusuf et al., 2000). In another study of indigenous drugs of coastal region, Tanzania, 59 plant species were recorded (Kabudi, 1990). Mirutse Giday (1999) recorded 33 species of medicinal plants used by the Zay people in Rift valley of Ethiopia. Zemede Asfaw (1999) also conducted a similar study on Berta people of the Benishagul Gumuz region in Western Ethiopia and their preliminary results showed 24 medicinal plants.

All the informants have agreed that more medicinal plants were in use in the past than those reported now. This is aggravated by the continued deforestation, land degradation and acculturization that took place in the area over several years. This situation gave way to the local loss of some medicinal plants and the associated knowledge. Comparing areas around LMNP and those that are outside the park there is a clear indication that this area was formerly covered by many tree species such as *Acacia tortilis, A. albida, A. xanthophloea, A. nilotica, Adansonia digitata, Cordia africana, Rauvolfia caffra, Salvadora persica, Tabernaemontana usambaraensis and Trichilia emetica* as majority of them are medicinal and are still found

inside the park but few of them are found outside the park. The law conserves the park and thus it has little humans' perturbations.

As regard to the knowledge of medicinal plants among the Maasai, most of it is still well preserved. The Maasai are traditionally educated through an age-set system. **Layonis** (young boys) learn from village elders until they are initiated after which they are sent to **Olpul** (an isolated place where the **layonis** and **morani,** the young men) undergo intensive course on Maasai education and culture including traditional approaches in the treatment of animals, humans, knowledge for motivating human libido, and courage. Not only that but also they are taught basic animal anatomy; traditional ethics and general animal care including knowledge of animal behavior.

In case of women, after circumcision mothers teach the girls varying aspects of household responsibility. Further knowledge on midwifery, or the use of herbs for treating livestock diseases is gained through observation, discussion, consultation and exposure. Husbands teach their newly married wives about the traditional treatment of animals. The senior wife is responsible for imparting knowledge on the whereabouts of the herbs and how the treatments are prepared. For this reason, knowledge on traditional medicines cut across the whole society.

Many of the reported medicinal plants are used for treatment of retained placenta in cattle, treatment of helminthes in humans and in cattle and for indigestions. This may suggest that all those diseases with many alternative ways of medicinal treatment are highly prevalent in the area. According to Chifundera (1985), Kokwaro (1976), Dawit Abebe and Ahadu Ayehu

(1993), a certain complaints with several alternative drugs might indicate a preponderance of that particular health problem.

Two families of plants (FABACEAE) and (EUPHORBIACEAE) are leading for being used as remedies against a variety of complaints for both humans and veterinary diseases in the area. The high diversity of use of these two families of plants with their species in brackets (FABACEAE: *Acacia brevispica, A. drepalonobia, A. nilotica, A. seyal, A. tortilis, Albizia anthelmintica and Indigofera arrecta*). (EUPHORBIACEAE: *Croton machrostachyus, C. dichogamus, C. megalocarpus, Euphorbia cuneata, E. hirta and Synadenium grantii*) could be attributed to their relative abundance in the area. They are also the most cited species for their medical value as compared to other medicinal plants, which is again an indication of their relative abundance. The high salience or familiarity of *Albizia anthelmintica* (cited by 80% of key informants) and *Warburgia ugandensis* (cited by 74%) of key informants for being used against helminthes and respiratory complaints, respectively, might indicate their efficacy. According to Trotter and Logan (1986), pharmacologically effective remedies are expected to have greater informants consensus. However, according to Johns *et al.*, (1990) confirmation is not a single true measure of the potential efficacy of any remedy. There is a greater probability of a common plant being reported to treat a common disease to be cited more frequently than a rare plant that is used to treat a disease of limited occurrence.

Making reference to the literature available, one can learn that most of reported Maasai medicinal plants are also used elsewhere in Tanzania for their medicinal value of which 12 species (*Adansonia digitata, Acacia nilotica, Albizia anthelmintica, Aloe lateritia, A. secundiflora, Azadirachta indica, Balanites aegyptiaca, Harrisonia abyssinica, Indigofera*

arrecta, Kigelia africana, Salvadora persica, Solanum incanum,) are in many instances used in the same way as they are used by the Maasai people.

Maasai also recognize the "Doctrine of Signatures" thus *Kigelia africana* (the sausage tree) is used for treatment of kidney and pancrease. The fact that more than one community is using some medicinal plants for the same purpose might indicate the pharmacological effectiveness of these remedies.

The largest percentage of the plants remedies that were recorded during the course of this study for instance *Albizia anthelmintica* were reported by authors elsewhere to have been used medicinally in other parts of the world (Cunningham,1994, Johns *et al.*, 1990, Kokwaro, 1976, Weimann and Heirich, 1997). The active substances of some of the Maasai medicinal plants are known from other studies that were carried out elsewhere.

4.2 Administrations and Psychosomatic Approach

Pastoral Maasai use woody plants to cure humans as well as livestock diseases and injuries. They have developed modes of administration of medicinal plants that include intranasal, infusion, decoctions and elaborated psychosomatic approach to treatment, for example they hang medicinal plant emulates in animal cages (**bomas**) as sign of good omen with power to whisk away evils.

They have some general procedures for preparation of dosage as follows:

- Either fresh plant are finely chopped, dried, ground and mixed with the feed, or salty soil or drinking water.
- Crushed or chopped plants parts while fresh, spread on a goat skin may be used to sores area of inflammation, for example *Asparagus africanus* mixed with *Eurphorbia cuneata* which serve as a styptic and anti-inflammatory
- Dried, roasted plant part prepared as powder e.g. *Aloe secundiflora* bark in treatment of pneumonia
- Either fumigation by burning dried plant parts as smoke inhalant e.g *Croton megalocarpus* leaves, branches as remedies for flue or as pest repellants
- Ointment for massage, for instance castor oil from *Ricinus communis*, *Croton megalocarpus* oil, in case of sprain and general pain
- Intranasal application as infusion from *Acacia brevispica* fruit, *Albizia anthelmintica* root juice, *Rauvolfia caffra* for treatment of infected nostril, or as passage down to deworm or as a purgative respectively.

Most of these reported preparations in the area are drawn from a single plant; mixtures are rarely used. In other parts of the country, the use of mixture of plant species in treating a particular ailment is fairly common (Mahunnah,1990). Synergic interaction or potential effect of one plant on the other in prescription of multiple sources is well recognized in many traditional medicinal practice (Kokwaro, 1976; Mahunnah, 1990).

Lack of precision in the determination of doses has been noted in the area. According to Dawit Abebe and Ahadu Ayehu (1993), the real drawbacks in traditional medicine stem mostly from lack of precision in dosage.

The majority of the remedies are taken orally. This is in agreement with the result of study carried out with many authors on traditional medicines.

4.3 Habit of the medicinal Plants and Part Used

About 90% of the Maasai remedies were reported to have been obtained from trees and shrubs. Very few are from grasses and climbers. This may be explained from the fact that the Maasai inhabit semi-arid to arid areas where most of the period of the year is dry and therefore difficult to obtain climbers and herb remedies. It is also true that, trees and shrubs especially those of *Acacia* species are quite adapted in this climate, and they live long enough to have high concentrations of active ingredients.

Yusuf *et al* (2000) compiled 50 medicinal plants used by Somalis of Wajir District in Kenyan drylands, of these 90% were trees and shrubs. Chikamani (1998) did similar study among the Mukodo Maasai of Kenya and almost all medicinal plants reported were from trees and shrubs.

The most widely sought after plant parts in the preparation of remedies are the barks, roots and stems parts. The popularity of these parts has grave consequences from both ecological point of view and from the survival of the medicinal species (Dawit Abebe and Ahadu Ayehu, 1993). Costentinos Berhe *et al.*, (1995) reported that some plant species such as *Dracaena*

steudneri, Hagenia abyssinica and Securidaca longepedunculata that are harvested for their roots, barks or whole plants in many parts of Ethiopia have become scarce and so difficulty to find. This is also true for the case of *Leucas martinicensis* (LABIATAE) that is harvested as a whole plant for the treatment of cough reported in this study, it has been very rare and difficult to find. On the other hand, collecting leaves does not pose a greater danger to the existence of an individual plant when compared with the collection of the underground parts, stem or whole part. Studies have shown that removal of up to 50% of tree leaves does not significantly affect the growth of the species studied (Poffenberger, *et al.*, 1992)

4.4 Habitats and Status of the Medicinal Plants

About 99% of the medicinal plants utilized by the pastoral Maasai are harvested from the wild. This is true in many parts of Tanzania. Kabudi (1990) reported that of the 59 medicinal plants used by coastal people of Tanzania, over 90% are harvested from the wild. Kokwaro (1976) gave similar observation. Tesfaye Awas and Zemede Asfaw (1999) reported that 71% of the medicinal plants of the Berta people in Western Ethiopia are obtained from the wild. Zemede Asfaw (1998) reported that only six percent of the plants maintained in home gardens in Ethiopia for example are primarily cultivated for their medicinal value even though many other plants are encountered. The fact that most of the remedies are only found in the wild poses a big threat to their existence as the mass destruction of their habitats continues. As regard to the Maasai rangelands, the continued cutting of trees especially those of *Acacia* for charcoal and for building materials and for other uses has resulted in scarcity of some medicinal plants.

The vegetation data reveals that there is a significant variation in terms of species diversity and the numbers of medicinal plants and other species between plots sampled inside the park and those sampled outside the park.

4.5 Marketability of the Maasai Medicinal Plants

As reported earlier in this study, a majority of the Maasai herbal medicines are now sold in many towns of Tanzania (See Fig. 8). Expansion of market for these remedies means more harvesting. Over harvesting may lead to depletion or even local extinction of some plants especially in the areas where the plants are rare or endemic (Cunningham, 1992). This again may pose serious problems in the future and need to be addressed.

4.6 Meat Feasting Camps and Case of low Cholesterol

Meat feasting camps locally referred to as **olpul** are regularly organized for the youth (**moorani**), the main purpose of which is to make them strong and healthy in the face of formidable task of feeding and protecting Maasai herds. A cocktail (boiled mixture) of number of plants is prepared at meat camps and either mixed with soup before being taken, or taken straight as excitants, digestive or fat emulsifiers as well as enhancing body immunity (see Table 4).

In a study carried among the Batemi and Maasai of Kenya by Timothy John (1990;cited in Balick and Cox, 1996) indicated that though these two tribes feed exclusively on meat, milk and blood, a nutrition regime that the *new scientist* called "the world's worst diet", they do not suffer cholesterol. The addition of barks of *Acacia goetzei* [FABACEAE] and *Albizia anthelmintica* [FABACEAE] was found to be the reason for low cholesterols among the Maasai. When these barks were chemically tested, they were found to contain saponins,

organic compound with a sugar like core that forms soapy foam when they are dissolved in water.

The present study has also been able to show that a number of medicinal plants especially those of *Acacia* are used by Maasai during meat feasting camps. The implication of this research is profound: If new cholesterol-lowering substances can be isolated from these wild-gathered plants, millions of people could reduce their risk of cardiovascular illness, one of the health threats in the Western World.

5. CONCLUSION

Pastoral Maasai rely on selected plants for treatment and control of both humans as well as animal diseases. For this reason plants have become the most revered and treasured friends in the Maasai world. Ethnobotanical knowledge is widespread especially among the Maasai worriers who are charged with task of protecting their herds from enemies, famine and against diseases. However, experienced healers who happen to be aged (above fifty years) and **laibons** are more experienced in this field and are consulted from time to time.

These experienced healers know exactly which part of the plants should be taken and at which time. In some plants active ingredients are concentrated only in the core of the wood, in others it is concentrated in the leaves, stems, flowers or in roots and in few cases in the whole plant. In preparation and administration of the dosages other ingredients such as anthill soil, yeast, animal fat, soot and soup may be added. Thus Maasai pastoralists are able to confidently contain different disease conditions afflicting both humans and animals from time to time.

Loss of medicinal plants and the associated knowledge will, therefore hamper the existing health care system in the area. However, the Maasai knowledge just described is threatened by influence of Western science and technology, as less and less medicinal plants are being utilized as generation goes by. The introduction of modern education has to some extent contributed in making the young generation undermine traditional knowledge and practices on medicinal plants.

Environmental degradation and intense deforestation that have continued for decades as a result of increased needs for farming lands, fuel wood and charcoal, and for construction materials in the area, have been the main cause for reduction of medicinal plants. This is

clearly revealed by the differences shown in terms of plants numbers and diversity for plots sampled between inside the Lake Manyara National Park (LMNP) and those sampled outside the park. With an exception of one species of medicinal plant (*Azadirachta indica*), almost all of the Maasai remedies are harvested from the wild. As they are nomadic Maasai have no practice of bringing medicinal plants under cultivation.

As far as marketability of medicinal plants is concerned, over 60% of the Maasai remedies are sold in towns, this may lead to over harvesting of some of medicinal plants and this may pose a serious threat to some of the species. However, for those plant species that are found all over the country this may not be the case.

There is stereotype in terms of the medicinal value of plants used by Maasai and those used by other tribes in the country. The wide use of these medicinal plants could be attributed to their pharmacological efficacy.

6. RECOMMENDATION

When certain plant species are confirmed as pharmaceutically effective against certain disease conditions, there is the risk that such plants will be over used to the point of total destruction. The aim should therefore be to reduce future harvesting pressure on wild populations of such plants. This may be brought about through the following:

- ✓ Mass production of rooted cuttings and seedling of key species for home gardens
- ✓ Dissemination of information on appropriate cultivation methods for medicinal plants in demand
- ✓ Planting of popular medicinal plants (particularly trees and shrubs)
- ✓ The majority of Maasai herbal medicines comes from family [FABACEAE], Lake Manyara National Park is rich in plant species of *Acacia,* thus priority should be given to conserve this area not only for its fauna but also for its medicinal plants richness.

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8. APPENDICES

APPENDIX- 1

Checklist of Question for Semi-structured Interview

1. Date.....Village.....Ward.....
2. Name of respondent.....
3. Sex: Male..... ...Female.....
4. Occupation.....
5. Do you know disease x, y, z etc, Yes/ no
6. Do you treat it using some herb? Yes/no. If yes,
7. What is the local name of this plant, (In Maasai/ or in Kiswahili language)?
8. What part of the plant do you use e.g. leaves, roots, barks etc.
9. How is it prepared? (Method of preparation).
10. Do you mix some other ingredients such as water, soup, milk or sugar with the medicine? If so, why?
11. How is it taken? (route of administration).
12. What amount do you take? (Dosage e.g. one cup or one spoon etc)
13. Is there any side effect in case of overdose?
14. Does the dose differ among males, females and children?
15. Is there any condition that forbids taking the medicine?
16. Where do you collect these medicinal plants?
17. Is the medicinal plant marketable?
18. How abundant is the medicinal plant, its trend when compared to the past years (Is it increasing or decreasing?)
19. How is the knowledge on the use of these medicinal plants passed from one generation to the

    to the next?
20. What traditional conservation methods are used?
21. Have you attempted to cultivate this medicinal plant near your home?

APPENDIX- 2

List of Key Informants Contacted in the Ethnobotanical Study.

S/N	Name	Sex	Age	Occupation	Village/Site
1.	Karainei Lenekakwa	Male	44	Herder	Losirwa
2.	Losotu Logilaak	Male	32	Herder	Losirwa
3.	Kaimereki Longilaaki	Male	42	Herder	Losirwa
4.	Papayoki Sikao	Male	36	Herder	Losirwa
5.	Lengine Melembuki	Female	60	Housewife	Losirwa
6.	Namitu Saruni	Female	30	Housewife	Selela
7.	Loning'o Njoolay	Male	71	Herder	Selela
8.	Jackson Losira Loishooki	Male	49	Teacher	Selela
9.	Karumbe Oranguti	Male	32	Herder	Selela
10.	Godson Ngala Olonyokie	Male	31	Shopkeeper	Mto wa Mbu
11.	Losiki Loramatu	Male	55	Herder	Mto wa Mbu
12.	Lenana Lenganasa	Male	45	Teacher	Mto wa Mbu
13.	Nasieku Kissila	Female	39	Housewife	Mto wa Mbu
14.	Oltimbau Sanare	Female	51	Housewife	Silalei
15.	Mathias Lowassa	Male	50	Leader	Silalei
16.	Loeku Losira	Female	44	Housewife	Silalei
17.	Lengiteng' Loishinye	Male	52	Herder	Silalei
18.	Sikayoki Papalaak	Male	40	Herder	Moyamayoka
19.	Helena Qororo	Female	30	Teacher	Moyamayoka
20.	Lelioki Loishinye	Male	48	Herder	Moyamayoka
21.	Olengotieki Meshilyeki	Male	70	Herder	Ng'ogoro
22.	Lekinana Loserian	Male	49	Herder	Ng'ogoro
23.	Lokaji Lokweni	Male	36	Herder	Ng'ogoro
24.	Johnson Ole Mollel	Male	53	Veterinary doctor	Arusha
25.	Godson Leliyo	Male	39	Herbarium technician	Arusha

Appendix- 3

List of species of Medicinal plants Encountered

Species	Family	Voucher No.
Acacia brevispica Harms.	FABACEAE	EN 048
Acacia drepalonobium Harms & Sjostedt	FABACEAE	EN 043
Acacia nilotica (L.) Willd.ex Del.	FABACEAE	EN 002
Acacia seyal Del.	FABACEAE	EN 009
Acacia tortilis (Forssk.) Hayne	FABACEAE	EN 007
Acacia xanthophloea Benth.	FABACEAE	EN 004
Adansonia digitata L.	BOMBACACEAE	EN 075
Albizia anthelmintica (A.Rich.) Brogn.	FABACEAE	EN 051
Allium ampeloprasum L.	ALLIACEAE	EN 072
Aloe lateritia Engl.	ALOACEAE	EN 080
Aloe secundiflora Engl.	ALOACEAE	EN 042
Asparagus africanus Lam.	ASPARAGACEAE	EN 088
Azadirachta indica A. Juss.	MELIACEAE	EN 021
Balanites aegyptiaca (L.) Del.	BALANITACEAE	EN 026
Cassia occidentalis L.	FABACEAE	EN 077
Combretum schumannii Engl.	COMBRETACEAE	EN 033
Commelina benghalensis L	COMMELINACEAE	EN 006
Commiphora swynertonni B.D. Burtt.	BURSERACEAE	EN 068
Cordia monoica Roxb.	BORAGINACEAE	EN 064
Croton dichogamus Pax.	EUPHORBIACEAE	EN 017
Croton macrostachyus Del.	EUPHORBIACEAE	EN 054
Croton megalocarpus Hutch.	EUPHORBIACEAE	EN 081
Cussonia kirkii Harms ex Engl.	ARALIACEAE	EN 029
Cynodon sp.	POACEAE	EN 019
Delonix elata (L.) Gamble	FABACEAE	EN 053
Dichrostachys cinerea (L.) Wight & Arn.	FABACEAE	EN 021
Embelia schimperi Vatke	MYRISINACEAE	EN 045

Erythrina burtii L.	FABACEAE	EN 049
Euphorbia cuneata Vahl.	EUPHORBIACEAE	EN 073
Euphorbia hirta L.	EUPHORBIACEAE	EN 006
Ficus natalensis Hochst.	MORACEAE	EN 063
Grewia bicolor Juss.	TILIACEAE	EN 073
Harrisonia abyssinica Oliv.	SIMARAUBACEAE	EN 014
Heliotropium indicum L.	BORAGINACEAE	EN 030
Indigofera arrecta Hochst. ex A. Rich.	FABACEAE	EN 016
Kigelia Africana (Lam.) Benth.	BIGNONIACEAE	EN 042
Lannea schweinfurthii (Engl.)	ANACARDICEAE	EN 025
Leucas martinicensis (Jacq) R. Br.	LABIATAE	EN 076
Maerua crassifolia Forssk.	CAPPARIDACEAE	EN 027
Maesa lanceolata Forssk.	MYRSINACEAE	EN 044
Ocimum gratissimum L.	LABIATAE	EN 017
Osyris quadripartita Decn.	SANTALACEAE	EN 045
Pappea capensis Ecky & Zeyh.	SAPINDACEAE	EN 078
Premna resinosa (Hochst.) Schauer	VERBENACEAE	EN 077
Rauvolfia caffra Sond.	APOCYNACEAE	EN 044
Ricinus communis	EUPHORBIACEAE	EN 016
Rubia cordifolia L.	RUBIACEAE	EN 028
Salvadora persica L.	SALVADORACEAE	EN 071
Sclerocarya birrea A. (Rich.) Hochst	ANACARDIACEAE	EN 065
Synadenium grantii Hook.f.	EUPHORBIACEAE	EN 040
Solanum incanum L.	SOLANACEAE	EN 011
Solanum nigrum L.	SOLANACEAE	EN 022
Synadenium grantii Hook. f.	EUPHORBIACEAE	EN 056
Warburgia ugandensis Sprague	CANELLACEAE	EN 079
Ziziphus mucronata Willd.	RHAMNACEAE	EN 038