A FLORISTIC ANALYSIS AND ETHNOBOTANICAL INVESTIGATION OF THE AWASH RIVERINE VEGETATION

BY

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DEDICATION

THIS THESIS IS DEDICATED TO MY LATE FATHER TIKSA HINSENE AND TO THE AFAR AND OROMO PASTORALISTS.

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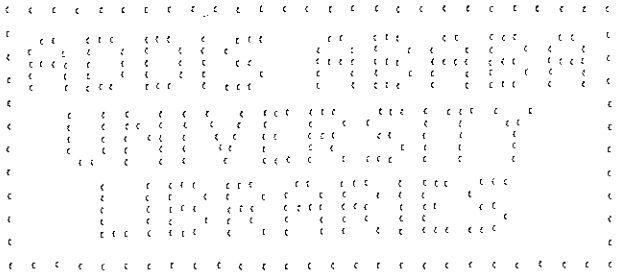

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ABSTRACT

Riverine vegetation along the Awash River between altitudinal gradient extending from 350-1470 m a.s.l. was studied to describe major plant communities and relationships between plant communities, edaphic, climatic and topographic factors. Ethnobotanical information was gathered from key informants and the plants were described briefly. Two field trips were conducted in December 1999-January 2000 to the Awash basin in the East Shoa Zone of Oromia Regional State and the Afar Region. A total of 65 relevés were analysed. In each of the sample plots the floristic composition was quantitatively analysed systematically within a nested belt transect of 100 m laid parallel to the river. Cover/abundance value was estimated for each species based on Braun-Blanquet approach. All woody individuals taller than 2 m. and thicker than 2 cm. were measured for height and diameter at breast height (dbh). Environment variables measured include Altitude, Slope, Soil Texture, Sand %, Silt % and Clay %, pH, Cation Exchange Capacity (CEC), Electrical Conductivity (EC), Organic Carbon (OC), available Sodium (Na), Calcium (Ca), Potassium (K), Magnesium (Mg) and base saturation. Seven vegetation communities were described. *Acacia nilotica* subsp. *leiocarpa (L.) Willd. ex. Del.-Carissa edulis Vahl.* type; *Acacia robusta* Burch. subsp. *usambarensis* (Taub) Brenan,-*Acokanthera schimperi* (A. DC.) Schweinf. type; *Celtis africana-Mimusops laurifolia* type; *Acacia senegal-Acacia mellifera-Dobera glabra* type, *Acacia nilotica* subsp. *indica-Ficus capreaefolia* type, *Lannea schimperi-Glycine wightii* type and *Tamarix nilotica-Acacia hocki* community type. 36 plant species were described as ethnobotanically significant plants as informed by key informants. All plant specimens collected were identified and deposited in the National Herbarium (ETH.).

INTRODUCTION

Phytosociology of the riverine vegetation of the semi arid zones of Ethiopia and other African countries was not studied and not sufficiently represented in literature (Carr, 1998). The science of phytosociology is the mapping of vegetation communities and types, and the study of relationships between plant species distributions and environmental controls (Kent & Coker, 1992).

Within the varying topography and geomorphology of Ethiopia the study of riverine vegetation is a significant task that shows the distribution of different vegetation communities along altitudinal and environmental gradients.

It has been generally noted that variation exists between riverine vegetation mainly due to the differences in environmental factors. FAO (1984) noted that the composition of the riverine vegetation of Ethiopia varies widely. It is possible to see some general links in the riverine vegetation pattern with general links to temperature with reference to altitudinal differentiation. Ethiopian Mapping Agency (1988) noted that riverine vegetation shows variation from region to region depending upon rainfall; altitude and adjacent vegetation region through which the river flows.

Several physicochemical environmental variables could be measured along the altitudianl

gradients, changing geomorphology and landscape, climatic changes (rainfall, temperature, evapo-transpiration, humidity) along river channels. The seasonal flow rates of rivers showing significant variation in the higher altitudes and bottom lands, the shape of the river valleys and slopes, seasonal water logging and period of inundation all contribute to the differences of micro-environments which support different vegetation communities.

Within the semi-arid climate zone, riverine vegetation forms a major contrast with the surrounding environment due to the wet environment around the river corridor and deficiency of water in the semi-arid environment. This makes the riverine ecosystem the centre of attraction of diversified fauna and flora. Springuel (1990) described that the sequence of formations constituting the zonation from the river edge to the adjacent uplands (terraces) is apparently controlled by topographic features governing the surpluses and shortages of water.

Ensermu Kelbessa *et al.* (1992) described the significance of riverine wet sites for Ethiopia. They noted that this is mainly attributed to the large river valleys, which have dissected the plateau and made it possible for species from the lowlands to come far from the parent populations and differentiate. Thus the riparian zone can serve as a corridor for migration and differentiation. The diversified flora and fauna of Ethiopia have a significant opportunity to migrate through the large dissected river valleys of the riverine corridor.

Friis (1992), mentioned that the riverine and riparian forest vegetation of Northeast

Tropical Africa is very variable, and that the floristic composition depends on altitude and geographical locations. In his summary on riverine and riparian vegetation of Ethiopia he recommended the need for further studies and collections of riverine vegetation.

Awash is one of the major rivers of Ethiopia. Awash River starts from an altitude of 2230 m in the western highlands at a place locally called Eela Hunde, where both perennial and seasonal deep headwaters are found in a meadow. There is a site called *Xabala Hawaas*, a water spring used for a cure of different diseases under a *Phoenix* tree shade commencing the Awash as a river, thereafter. The Awash known as *Hawas* from headwaters to the mouth by the Oromo and Afar local people, flows for most of its length in the Rift Valley ending in surface flow into Lake Abe after 1200 kms from headwaters to mouth (Tesfaye Chernet, 1993). The Debis River, joins the contrasting catchment of the Abay starting from a swampy headwater called Chalalaka Bole. This meadow which is seasonally inundated may have hydrological input both for the Awash and the Debis River. The environmental gradient crossed by the Awash River along its channel from the central highlands of Ethiopia to the adverse arid zones in the lowlands is tremendous.

Detailed study of the Awash Valley was carried out by FAO between 1961 and 1965 to assess the potentials for irrigation and hydroelectric power. Sir William Halcrow and Partners in May 1987 studied the Awash Master Plan in agreement with the Ethiopian Valleys Development Studies Authority (EVDSA) (Tesfaye Chernet, 1993), though no quantitative analysis of the Awash basin vegetation was included. The studies mainly focused on the possible resource utilisation within the Awash Basin. This study was

carried out to cover the gap of the need to quantitatively analyse the Awash riverine vegetation and the environmental gradients for the formation of the plant communities and to collect information on the ethnobotanical aspects.

Most of the Awash River channel is within the Rift Valley, the tributaries of the Awash originate from the western and eastern Ethiopian escarpments, the eastern escarpment tributaries are seasonal. The Awash basin in contrast to the other river valleys of Ethiopia is relatively open and accessible for development schemes (FAO 1965). Halcrow (1989) attributed the rich dryland biodiversity of the Awash basin to the biogeographic setting of the river and the vegetation that enabled the survival of the whole-integrated ecosystem.

Far before the implementation of the development schemes within the Awash basin Longhitano & Bavazzano (1973), noted the human influence on the environment. They described the destruction of the vegetation on a wider area with a consequence of easy removal of soil by wind and water in the Middle Awash valley. The Awash riverine vegetation is severely destroyed by overuse and clearing for small scale and large scale irrigation schemes. The conservation of biodiversity within the Awash valley also seems to fall under complicated land use impact.

The more fragile range ecosystems are more easily lost under conditions of overgrazing, especially when combined with drought (EPA, 1998). Heavy over grazing due to confining livestock to limited areas and loss of access to previous rangelands by the pastoralists exacerbated the rate of soil erosion, and has exerted a direct negative impact

on the riverine vegetation. Widespread decline in riverine forests of arid and semi-arid regions have been observed in association with a variety of human water and land use practices, including alteration and heavy cattle grazing (Rood & Mahoney, 1990).

The extensive invasion of the rangelands and the riverine vegetation with low forage value weeds like *Prosopis juliflora* (Sw.) DC. has become a potential threat to the diversity of vegetation in the Middle and Lower Awash Valley. The need to study the remnant patches of vegetation left along the Awash River within the semi-arid environment for the floristic analysis and ethnobotanical investigation was initiated and carried out to highlight the need for the conservation of this disappearing ecosystem.

1. BACKGROUND AND JUSTIFICATION

1:1. Significance of River Corridors

Klosowski & Tomaszewicz (1993) described the riparian vegetation as distinct and specific due to the fact that it forms a specific transition zone between proper terrestrial ecosystems and the aquatic ones. It covers the area through which allochthonous (originated elsewhere) matter is transported from land to water bodies and streams, and on the other hand a place, where this matter can be accumulated and transformed together with local autochthonous (indigenous) matter. Therefore, this zone may be a significant biological filter for various substances, including nutrients.

Tr´emoli´eres *et al.* (1994) studied changes in aquatic vegetation along the Rhine floodplain. This study described that vegetation can change in structure and composition showing an upstream-downstream zonation. This continuum can be related to a succession series if the succession has an autogenous character, i.e. involves a progressive accumulation of locally produced organic matter. Discontinuities in space or time may arise if the change in a specific habitat factor exceeds a certain threshold, which results in a simultaneous change of complex of factors changing at once.

The riverine zone can thus be credited as a zone of transportation of materials that are not local to the zone and the zone of accumulation and transformation of the allochthonous and autochthonous matter. This may imply the development of unique vegetation types

within this dynamic system. This also attracts the consumers at every level making the wet riverine zone a zone of diversification of different life forms.

The stream corridor is exceptionally diverse environmentally and normally supports high species richness, sometimes the highest in the landscape. Riparian corridors in dry areas have been called *"linear oasis"* and contain many rare species. Many animals in the surrounding matrix also depend on these corridors for water, food or shade (Forman, 1995).

The water resource in the semi-arid and arid environment attracts wildlife, which seek the refuge of the diversified riverine habitat (Mitch & Gosselink, 1993). It is also clear that luxurious vegetation within the arid and semi-arid lands (ASALs) are found diversified within the different continuum from headwater to the mouth of the river. Though the 1200 km. long Awash River course with most of its channel in the Rift Valley faced serious channel diversification, damming, intensive irrigation, overgrazing, patches of natural riverine vegetation supporting different life forms are found along the river, mainly along conservation areas.

According to Carr (1998), detailed investigations of riverine vegetation in semi-arid Africa are poorly represented in the literature. Ensermu Kelbessa *et al.* (1992) noted that the riparian and swamp vegetation in Ethiopia is not properly collected though there is a higher probability of finding endemic species.

Human activities throughout the world have caused great concern in the scientific community and among the general public. This disappearance of species has been described as a loss of plants and animals with potential agricultural and economic value, as a loss of medical cures not yet discovered and as a loss of the Earth's genetic diversity (Huston, 1994). According to Finch & Ruggiero (1993), riverine forests represent critical structural habitat in arid and semi-arid landscapes, and are valued for their role in supporting regional biological diversity and a range of human economic and recreational activities.

The semi-arid and arid riverine ecosystems are conspicuous and attractive oasis to wildlife and humans. Some authorities call these ecosystems the *"green ribbons"* within the semi-arid and arid drylands (Mitch & Gosselink, 1993). Wetlands can be also described as *"biological supermarkets"* for the extensive food chain and rich biodiversity they support (Godreau, 1999).

Gregory (1991) noted that small watercourses and larger riparian zones within natural forests are far more significant than their restricted area might suggest. A key characteristic of riparian zones in natural forests is habitat diversity.

The high water table of riverine zones and associated ecosystems are highly influenced by topography, aridity and presence of depositional soils. These ecosystems are uniquely characterised by the combination of high species diversity, high species densities and high

productivity. These water bank ecosystems continuously interact for exchange of energy, nutrients and species between the aquatic and the terrestrial ecosystems (Mitch & Gosselink, 1993).

1:2. Conservation of River Corridors

Preservation of undeveloped areas in floodplain limits the risk of flood damages while providing benefits associated with fish and wildlife habitat, water quality improvement and recreation (Kusler, 1989). The need to conserve some of the natural ecosystem along the Awash River for conservation of biodiversity needs not to be overlooked. Though some land is left beyond the flood protection scheme at the Middle Awash it was not aimed for conservation of biodiversity along the river and it is under human impact.

In the Awash Basin water logging has increased the level of salinity and it has become one of the major threats to the irrigation projects. Several hundred hectares of land has already become unproductive due to salinity hazard and has been already abandoned (Halcrow, 1989). Over flooding has also damaged properties due to lack of integrated watershed management of the whole river basin and the increased rate of flood flushing exacerbated by intensive high slope cultivation and deforestation.

Overgrazing has also exacerbated soil erosion by changing the soil into dust, which is finally carried away as a silt load, by the river. The dust bowls in the arid Afar rangelands and the dust created when a large number of livestock go to the Awash for water also increase the rate of erosion and gully formation.

The conservation of the wildlife in the Awash National Park and other conservation areas along the Awash River needs to be integrated with the proper conservation of the riverine vegetation. Medley (1992) noted that the protection of the diversity of vegetation and key resources like the endangered primates needs to be coupled with the protection of the forest heterogeneity that characterises the dynamic landscape.

According to Soulé (1986), damming up rivers affects the nearby terrestrial habitats. During dam construction the fertile alluvial soil can drown and the soil can loose fertility. There is also a risk of driving away the local inhabitants. Displacing the pastoral society from their traditional pasturelands has led to serious problems and negative attitude for development and research activities among the pastoral society.

Godreau (1999), noted that together with river channelisation or embankments, important modifications of agricultural practices were noticed, i.e. giving up of traditional pastures, agricultural intensification, floodplain drainage and fertilisations. As a consequence, biodiversity in floodplains has seriously declined and emergency actions have to be set up if we want to preserve biodiversity in these floodplains.

The ecological importance of riparian ecosystems and their constituent flora has received growing attention in the last decade (Lyon & Sagers, 1998). Riparian plant communities have been shown to be species rich and highly variable in species composition in both temperate and tropical systems (Pollock *et al.* 1999). It has been summarised that riparian

corridors have also been linked to species flows and exchanges across ecotonal and ecoclinal boundaries (Lyon & Sagers 1998).

Lyon & Sagers (1998), discussed the need to study the ecology of riverine vegetation. Understanding the underlying factors influencing vegetation patterns is critical for modelling vegetation change in these systems and for the management of diversity in the broader riparian landscape. There is expanding knowledge on the structure and composition of riparian vegetation and the role of flooding in riparian zones. However, there is less information on the patterns of plant species diversity from the river's edge beyond the zone of flooding influence and the influence of environmental gradients in this zone. Furthermore, according to Lyon & Sagers (1998), much of the vegetation research in riparian systems has focused exclusively either on woody vegetation or on herb vegetation. Despite a historical precedent, fewer studies have focussed on the interactions between different vegetation layers and the influence of environmental gradients on species richness and composition in riparian systems.

In addition, upstream reservoirs typically decrease peak flow and sediment load, further reducing flood deposition and the rate of channel movement. Such restrictions on channel change and flow variability can greatly decrease the rate of establishment of the riverine vegetation seedlings (Johnson, 1992).

Currently, 35 per cent of the world's land surface is at risk. Each year, 21 million hectares is reduced to near or complete uselessness (Poulsen & Lawesson, 1991). The degradation

of fragile drylands threatens the livelihoods of over 900 million people in some 100 countries and the process affects some 25 percent of the Earth's land area and seems to be occurring at an accelerated rate globally (UNCED, 1992).

Global biodiversity strategy identified the fundamental causes of biodiversity loss among which human population growth and natural resource consumption is the primary issue. The conservation of biodiversity is a multi-dimensional problem. It is a problem which cannot be addressed without recognising the relationship between ecological, social, historical, cultural, economic and political factors at a global, regional, national and local level (Furz *et al.,* 1996). In addition to being the core for irrigation and hydroelectric dam sites the Awash River crosses Awash National Park and Yangudi Rassa Game Reserves, which are areas of high biodiversity conservation for the country. This calls for an investigation of the remnant vegetation and the documentation of indigenous botanical knowledge of the pastoral society.

2. OBJECTIVES OF THE STUDY

The present study was carried out with the following objectives in mind:

- ***To describe vegetation associations and plant community types along the ecological gradient of the Awash River, below the Koka Dam.***

The riverine vegetation which contrasts with the adjacent arid and semi-arid environment is a refuge for wildlife and a corridor of migration for avifauna which necessitates the study of the plant communities along the ecological gradient of the Awash River. The different sanctuaries and national parks along the Awash River can benefit from the information of the plant association and ethnobotanical significance of certain plants.

- ***To study the influence of topographic, climatic and edaphic factors on the riverine vegetation of the study area.***

The vegetation changes along physical features manifest the impact of the environmental gradient on the formation and establishment of different community types. This study had the objectives of defining the different environmental variables that influence of the formation of the plant communities along the river.

- ***To gather data on ethnobotanically significant plants along the Awash River.***

As the pastoralist community members depend on plant products for traditional medicine, food, animal grazing and browsing etc. the research aimed at organising information on ethnobotanically significant plants.

3. DESCRIPTION OF THE STUDY AREA

The study area is the riverine vegetation along the Awash River in the semi-arid and arid climate below the Koka Dam to Logia Bridge (39°10'E- 40°46'E, 9°36'N-11°07'N) from an altitude 1470 m asl at Koka Dam to 350 m a.s.l at Logia Bridge (see figure 1).

The headwaters of the Awash River are found at an elevation of 2320 m a.s.l. west of the small town called Ginchi about 96 km west of the Ethiopian capital Addis Ababa. The river channel extends about 1200 km until it finally ends in Lake Abe at the Ethio-Djibouti border. The river crosses eastern Oromia and Afar Regional States and bends northeast to the Afar Triangle until it finally ends in Lake Abe (see figure 3).

3:1. Geology and Geomorphology

The study area, from the geomorphologic point of view is part of the Rift Valley. The recent alluvial formation, which has been washed with recent Awash River depositing its load in the last season flood peak, is conspicuous. The riverine vegetation stand is along the river channel on the fluvial plain. Mohr (1971), noted that "...more perhaps than in any other country of Africa, the physiography of Ethiopia is an intimate expression of the underlying geology." The two main physiographic components of the Awash Basin are the Ethiopian Plateau, and the Rift Valley that widens to the north into the Afar Triangle. On the Ethiopian plateau are the tertiary volcanics: basalt tufts and agglomerates of the trap series. The volcanic rocks on the floor of the Rift Valley are mainly the basaltic and ignimbrites of the Afar group (Pliocene to Holocene) and Holocene lavas are present near

the active volcanic centres like Fantale, Dofan and Afrera. During the Pleiostocene pluvial period, very large lakes were formed on the floor of the rift valley and the flat plains of Wonji, Metahara and the lower Awash Plains contain thick successions of lacustrine deposits. A series of fault scarps from the plateau to the floor of the rift valley, which slopes northeast from the elevation of nearly 2,000 m. at L. Ziway to less than 400 m. where it becomes the Afar Triangle. The flat floor of the rift valley is frequently broken by fault scarps and the effects of Pleistocene and Holocene volcanic activity. Unlike many Ethiopian rivers the alluvial plains adjacent to the Awash River are relatively wide in parts extending over 25 km. The river is also in part in a levee or elevated formation, particularly in the middle valley area, such that the adjacent lands can be relatively commanded for irrigation as summarised by Halcrow (1989) for the Awash Basin Development.

According to Tesfaye Chernet (1993) the Awash basin is described as having the following main regions: (1), the Upper Basin is from the headwaters to the Koka Dam; (2), the Upper Valley is from Koka Dam to Metahara; (3), the Middle Valley is from Metchara to Tendaho; and (4), lower Plains is from Tendaho to Lake Abe.

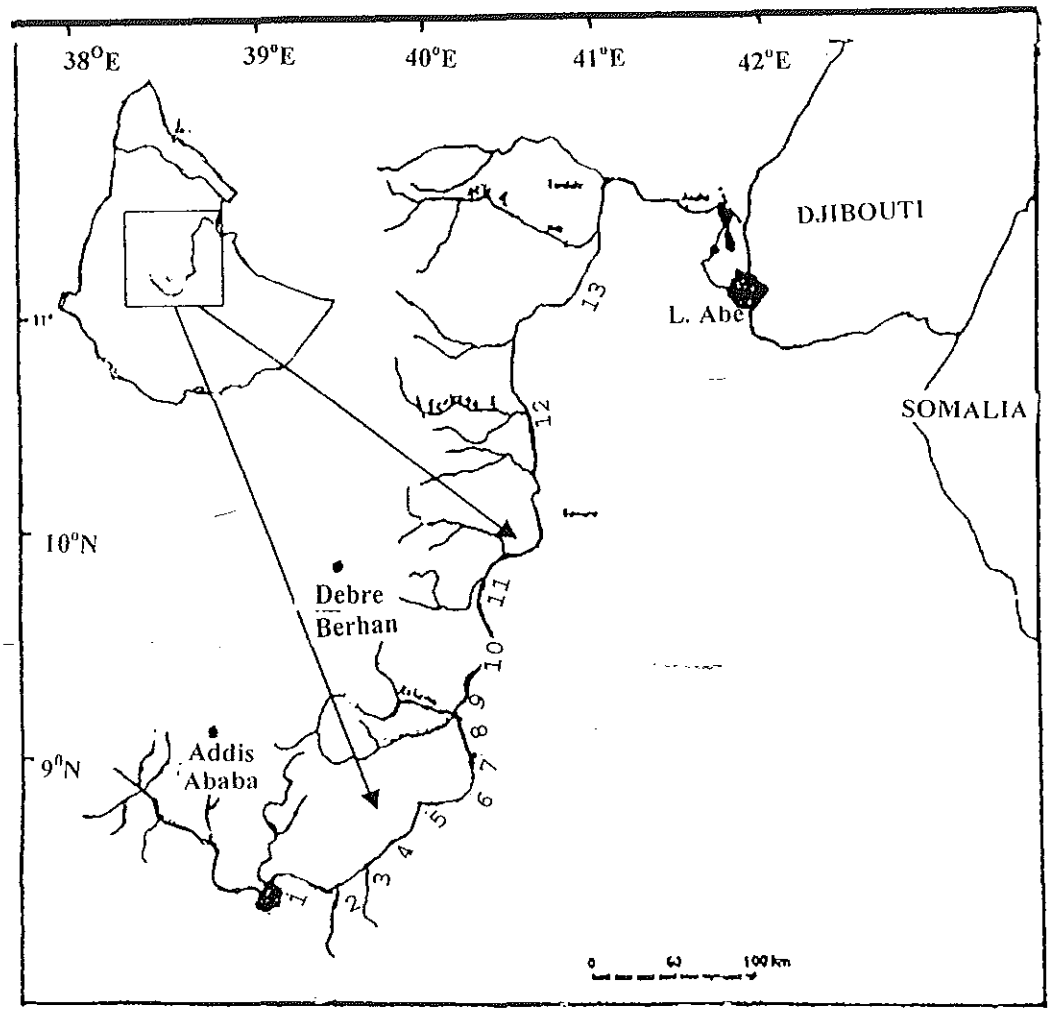


Figure 1. Map Of Ethiopia Showing The Study Area.

3:2. Soil

Soil is a complex feature of the terrestrial habitat, without which much evolution of land-plants could not have taken place (Slingsby & Cook, 1986). Volcanic activity in the Rift Valley has resulted in rich soils made up of layers of volcanic dusts and ashes sandwiched between sands and silts made up from erosion of the Ethiopian plateau and subsequent flooding (EWNHS, 1996). Along the Awash River series of recently deposited soil is found on which the riverine vegetation is established.

According to Mitch & Gosselink (1993), some of the most important soil properties are aeration, organic and clay content. The flooding and subsequent drying of these ecosystems influences all of these characteristics and the characteristics of the soil greatly affect the structure and function of the plant communities that are found in the riparian ecosystem. Soil oxygen is one of the most important (yet changeable) characteristics of the riparian zone soils. Anaerobic conditions are created rapidly when the floodplain is flooded, sometimes in a period as short as a few days. Aerobic condition returns quickly as the water recedes. This is important for the transmission of oxygen from the atmosphere to the root zone of the vegetation. Organic matter usually improves the soil structure and thus increases the aeration of clay soils. Soil aeration also depends on how close the water level is to soil surface. The compactness of the riparian zone soils decreases the level of soil aeration.

On the other hand the coarse textured immature riparian soils generally drain more rapidly and are better aerated and they don't show signs of prolonged saturation, when saline or sodic soils may have sharp-cemented horizons that prevent drainage.

Furthermore, Mitch & Gosselink (1993), noted that the organic content of riparian soils depends upon a number of processes like decomposition rates, allochthonous inputs and erosion. The organic content of the bottomland soils is usually intermediate (2-5%) and upland soils (0.4-1.5%). Because much of the sediment deposited by rivers consists of fine grained clays and silts, nutrients such as phosphorus are likely to be deposited to greater amounts than if the material were coarse grained (8-9.8 mg/g) dry weight for phosphorous. In arid zones, nutrients and salts accumulate through evapotranspiration, sometimes to toxic levels, where streams carry water and dissolved salts to the riparian zone.

3:3. Climate

The climate of the Awash Basin comes under the influence of ITCZ (Inter-Tropical Convergence Zone). This zone of low pressure marks the convergence of the dry tropical easterlies and the moist equatorial westerlies. The seasonal rainfall distribution within the basin results from the annual migration of the ITCZ. In March the ITCZ advances across the basin from the South, bringing the small or spring rains. In June and July it reaches its most northerly location beyond the basin, which experiences the heavy or summer rains. Potential evapotranspiration (PET) is also significantly correlated with altitude.

Meteorology data obtained from the nearest stations in the Awash Basin show the highest mean monthly rainfall at Koka Dam (166.1 mm) in August and the highest for Assaita was 31.6 mm in June. Maximum mean temperature registered for Koka was 31.3°C and 46.9°C for Assaita both in May (see figures 2a, 2b and 2c) and tables 1-2.

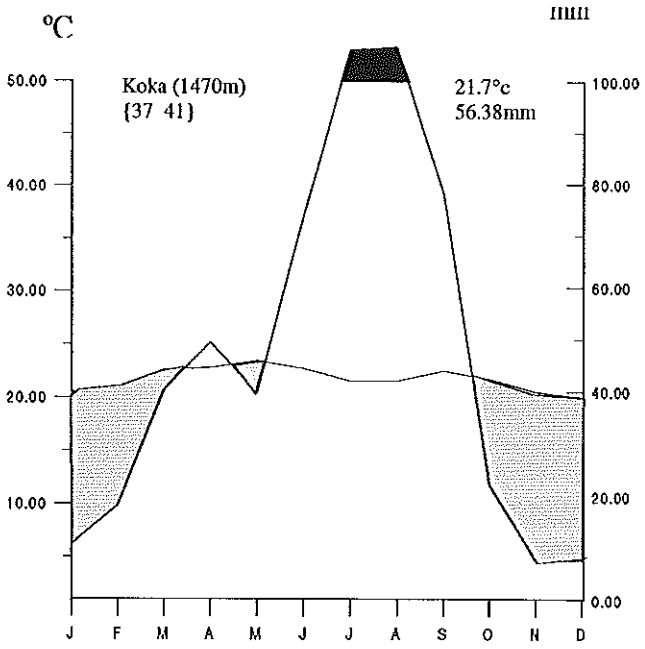
Table 1. Average Monthly Rainfall (mm) For Koka, Gewane and Assaita.

STATION	J	F	M	A	M	J	J	A	S	O	N	D
Koka Dam(41 years)	10.7	18.6	40.4	49.5	39.8	73.9	162.0	166.0	78.1	22.2	7.6	7.7
Gewane(18 years)	11.2	48.3	54.9	48.1	41.4	14.0	92.7	111.0	37.3	12.1	4.0	2.6
Assaita(36 years)	3.1	8.5	17.3	16.4	8.7	3.0	31.6	27.7	10.3	5.4	2.7	0.1

Table 2. Average Monthly Temperature (°C) For Koka, Gewane and Assaita.

STATION	J	F	M	A	M	J	J	A	S	O	N	D
Koka Dam (37 years)	20.5	21.0	22.6	22.8	23.4	22.7	21.5	21.5	22.5	21.7	20.5	20.0
Gewane (10 years)	24.7	25.7	27.8	29.3	30.9	32.6	29.9	29.2	29.5	26	26.5	24.5
Assaita (12 years)	20.1	25.8	27.5	29.5	33.9	31.8	31.8	30.7	30.4	28.1	26.0	25.0

a)



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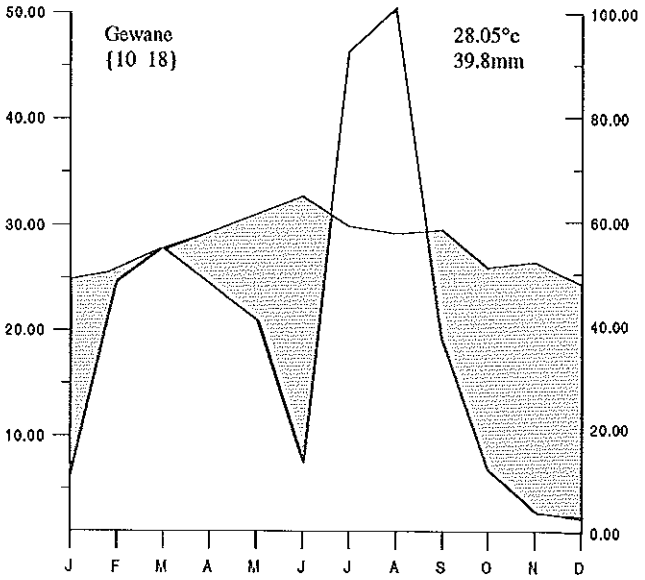

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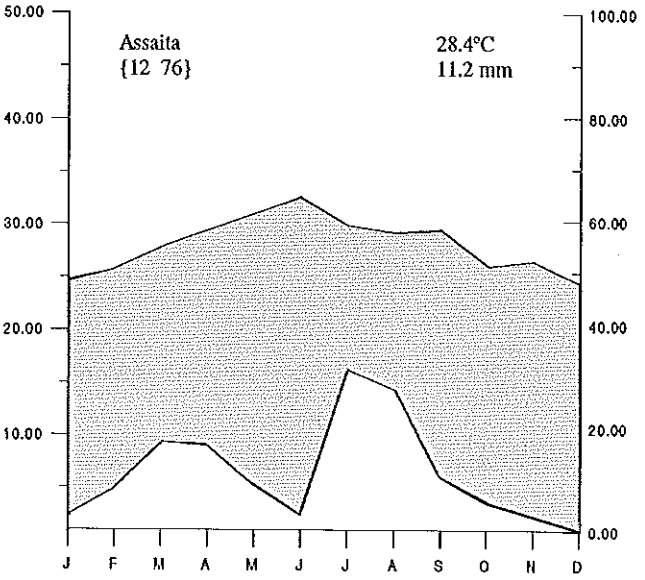

Fig. 2a-c. Climate diagrams from the study region: a) Koka dam, b) Gewane, c) Assaiyta

The hydrology of the Awash River is influenced by flood peak in the catchment during the torrential rainfall (June-September) in the central highlands of Ethiopia.

Most of the rivers draining into the Awash are seasonal with sand deposition dry channels during the long dry season. The perennial rivers draining to the Awash like Mille and Arba Rivers, are expected to loose most of their water by evapo-transpiration in the drylands. The Koka Dam, built in the 1950s, was built for hydroelectric generation and regulation of the river input for down stream irrigation schemes. The different impoundment and river diversions in the extensive state farms have a direct effect on the hydro-biological formations of the Awash. The extensive overflowing during the peak rainfall has led to extensive damage, especially at the riparian zones in the middle Awash. The seasonal variation in the river flow rate seems to affect the level and diversity of the riverine vegetation

3:4. Vegetation

Series of terraces on the back slopes of the study area, varying with the depth level of river channel dissection, are observed as having variation in vegetation cover. The lower one is only few meters higher than the underlying alluvial plain with very gradual transition. The higher series of terraces are clearly separated from the alluvial plain by a sharp escarpment up to 8-10 m. high. The remarkable volcanic activity that left numerous levic materials outcropping surrounding the plains and the terraces in some cases is

observed (Longhtano & Bavazzano, 1973). The upland volcanic lava formation is the representative geologic feature for the riverine vegetation.

FAO (1984) noted that the wetland vegetation is unevenly distributed in Ethiopia and that it is found in narrow strips along part of the lakes and rivers. The main areas are along Baro, Gilo, Awash and Wabi Shebelle.

Mesfin Tadesse & Friis (1990) noted that only a brief summary with reference to the literature can be given on the riparian and riverine vegetation of Ethiopia. They further noted that the riverine forest on the Awash River was studied by Sebald & Pichi-Sermolli. Cufodontis studied the riverine vegetation of the Dawa River at Melka Guba. Important species in these forests are: *Ficus sycamorus, Lepisanthes senegalensis, Mimusops kummel, Phoenix reclinata, Tamarindus indica and Trichilia emetica.*

Friis (1992) noted that the major part of the Afar Depression is covered by Somalia-Masai semi-desert grassland and bushland. Riverine vegetation including riverine forest occurs along watercourses in almost all of the vegetation types.

The studies on the riverine vegetation of Ethiopia were based as part of taxonomic surveys. A floristic analysis was rarely carried out to describe the different plant communities found along the river channels. Riverine vegetation, which tremendously contrasts with the semi-arid zones, where intensive irrigation schemes are implemented within the livelihood of the pastoral societies need detailed ecological studies.

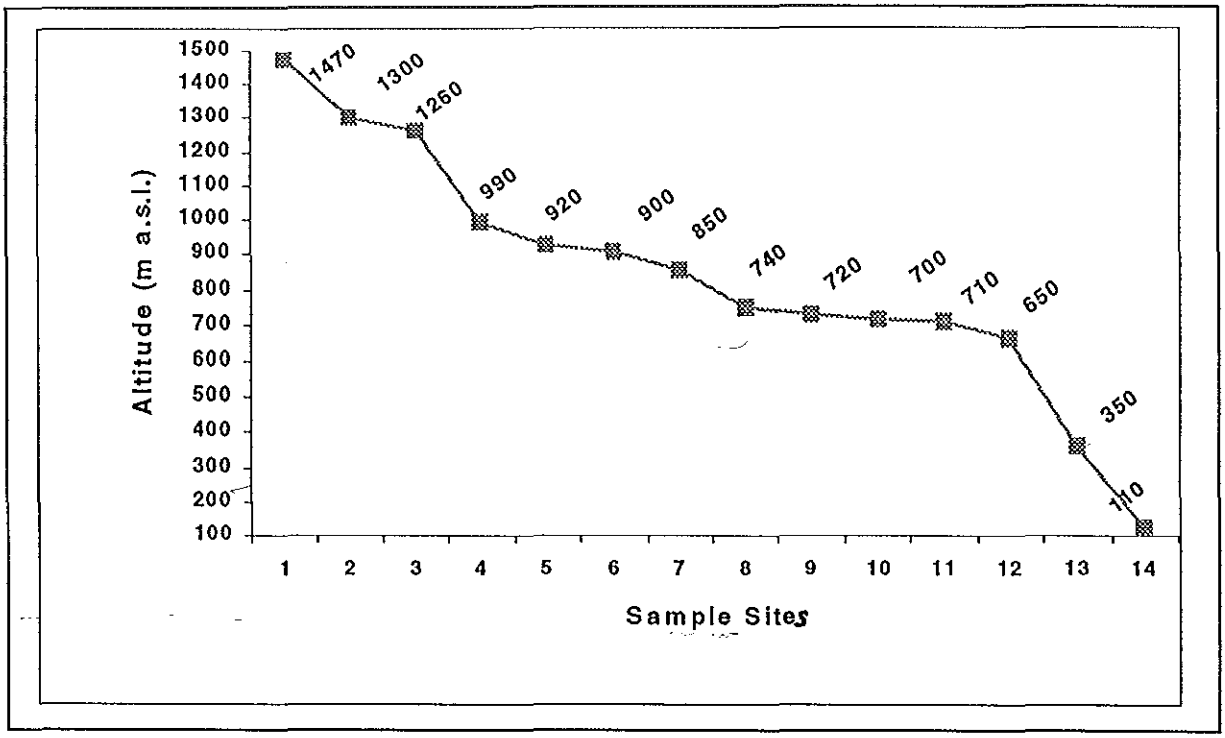

Figure 2. Sample Sites and Altitude Gradient Along the Awash River.

4. MATERIALS AND METHODS

4:1. Vegetation Sampling

Reconnaissance survey of the Awash riverine vegetation was conducted in December 1999 to identify sampling sites in Upper Awash Valley, Middle Awash and Lower Awash Plains. The Koka Dam site was selected at the highest altitude of 1470 m a.s.l. and Logia Bridge at the lowest altitude at 350 m a.s.l. to study the riverine vegetation along the Awash River within the semi-arid and arid zones.

Sample sites along the Awash River were preferentially laid from Koka Dam to Logia Bridge. An open transect of 100 m length and 10 m width was systematically sampled to collect floristic data. A cover-abundance value of all woody plants was estimated according to the Braun-Blanquet scale as modified by van der Maarel (1979).

At each sampling site, homogenous vegetation was analysed along a 100 m transect laid parallel to the river channel. Five quadrants of 10 x 10 m stands were systematically laid for the sampling of the vegetation thus resulting in an open transect (see figure 3). A total of 65 sample plots following the Braun Blanquet approach (Braun-Blanquet, 1965) was analysed.

4;2. Environmental Data

Soil samples, were taken from the upper 10 cm. from each sampling plot using an auger, four from the corners and one from the middle of the quadrants, and were mixed to form a composite sample. 1-2 kg of the composite was taken to the National Soil Laboratory Centre of Ethiopia in Addis Ababa for analysis. Soil samples were analysed for texture with the categories sand, silt and clay (expressed as % weight), pH and electrical conductivity (m mhos/1), both in 1:1 soil-water suspension; available phosphorus (Bray No. II method, ppm), calcium and magnesium (atomic absorption method), sodium and potassium (flame photometry), and cation exchange capacity (extraction with ammonium acetate at pH 7) (all in meq./100g).

Meteorological data obtained from Koka, Gewane and Assaita, stations in the Upper, Middle and Lower Awash Valley respectively were analysed for mean monthly temperatures and mean monthly rainfall registered at all sites for at least 10 years (see figure Altitude of all sample plots was measured using Everest Altimeter. Clinometer was used to measure the slopes of the sample plots.

4:3. Plant Specimen Collection & Ethnobotanical Information

All plant species in the sample plots were collected in triplicates, numbered, pressed, dried and identified at the National Herbarium (ETH) following Hedberg and Edwards (1989, 1995), Edwards *et al.* (1995) and Stace (1980). The local names of the plants and their uses were recorded during the sampling process. Local informants and field guides

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from the local people were used as key informants for the ethnobotanical data. The ethnobotanical information was further enriched by literature and notes written on the labels of plant specimens deposited in the National Herbarium ETH.

4.4. Data Analysis

Vegetation data was analysed and classified by using the computer program **TWINSPAN** (TWo-way INdicator SPecies ANalyses) Version 1.0, written by Hill (1979) resulting in a hierarchical structure of relevés and species groups. Analysis of Variance (ANOVA) and Spearman's product moment analyses were computed for environment data. Tukey's Multiple Range Test was also used for the environmental variables and the plant communities.

5. RESULTS AND DISCUSSION

5.1. Vegetation Analysis

Based on the cover/abundance values of a total of 93 plant species (Appendix 1) that were identified from the study area the riverine vegetation of the Awash River was described. The final homogenous groups that resulted from the analyses were identified as plant community types and subsequently designated as **1, 2, 3, 4, 5, 6** and **7** (Table 3). The plant communities were named by the characteristic species, which have the highest cover/abundance values. The seven major plant communities are described as follows:

1. *Acacia nilotica* subsp. *leiocarpa-Carissa edulis* type:

Acacia nilotica subsp. *leiocarpa* (L.) Willd ex Del. and *Carissa edulis* Vahl. were found

to be the characteristic species in the Upper Awash Valley between the Koka Dam and Sodore. Scattered shrubs of *Sesbania sesban* var. *nubica* Chiov., *Lantana camara* L., *Euclea racemosa* subsp. *schimperi* (A. DC.) Dandy dominate the shrub layers. This community type is found between altitudes 1470-1320 m between Koka and Sodore.

2. *Acacia robusta* subsp. *usambarensis-Acokanthera schimperi* type:

Acacia robusta Burch subsp. *usambarensis* (Taub) Brenan and *Acokanthera schimperi* (A. DC.) Schweinf. is the characteristic species along the altitudinal gradient between 1300-980 m between Sodore and Nura Era in the Upper Awash Valley. *Acacia robusta* subsp. *usambarensis, Manilkara butugi* Chiov., *Pappea capensis* Eckl. & Zeyh.; *Tamarindus indica* L. and *Combretum adenogonium* Steud ex. A. Rich., form the upper canopy in this community. *Salix subserrata* Willd.; *Ziziphus spina-christi* (L.) Desf.; *Balanites aegyptiaca* (L.) Del. and *Euclea divinorum* Hiern. form the shrub layer.

3. *Celtis africana-Mimusops laurifolia* type.

Celtis africana Burm. f. and *Mimusops laurifolia* (Forssk.) Friis make the characteristic species between altitude 920-850 m. along the Awash National Park. *Combretum molle* R. Br., *Cordia gharaf* (Forssk.) D., *Tamarindus indica* L., *Combretum adenogonium*, *Diospiros abyssinica* (Hiern) F. White, dominate the higher tree canopy. *Grewia bicolor* Juss., *Grewia tenax* (Forssk.) Fiori., *Ziziphus mucronata* Willd., *Euclea divinorum* Heirn., *Rhus natalensis*, form the middle shrub layer. Between steep rock outcropings *Sansevieria powelli* and *Sansevieria abyssinica* N. E. Br. grow. *Cissus rotundifolia* (Forssk.) Vahl grows as a liana.

4. *Acacia senegal-Acacia mellifera-Dobera glabra* type.

Acacia senegal (L.) Willd., *Acacia mellifera* (Vahl) Benth. and *Dobera glabra* (Forssk.) Poir. were sampled as characteristic species at a steep back slope along the Awash River at an altitude 740-720 m. the seasonal tributary from the Eastern Highlands makes a confluence with the main Awash River. Roofs of high escarpments, with the deep cutting of the rivers makes a habitat for the Hamadrias and Anubis baboons. Trees that are more or less similar to the adjacent dryland vegetation were sampled. *Barleria acanthoides* Vahl, *Euphorbia glochidiata* Pax., *Euphorbia nigrispinoides* M. Gilbert, *Euphorbia petersi* Rchb. f., *Balanites aegyptiaca, Terminalia brownii* Fresen., *Sida collina* Schlechtend, *Capparis tomentosa* Lam. and *Cadaba rotundifolia* Forssk. form inaccessible dense shrub layer. *Sansevieria abyssinica, Heteropogon contortus* (L.) Roem & Schult, *Aristida cumingiana* Trin. & Rupr., grow in between the steep volcanic rock cover.

5. *Tamarix nilotica-Acacia hockii* type

Tamarix nilotica (Ehrenb) Bunge is the characteristic species of the extensive riparian zone of the Awash River luxuriantly growing on the riverbank at an altitude of 350 m. at the more arid Logia Bridge in the Lower Awash basin. Among the scattered *Tamarix nilotica*, *Prosopis juliflora* (Sw.) DC. is densely established as one of the very recent invasion of this species in the middle and lower Awash rangelands. Except for the scattered *Tamarix nilotica* there is distinct shrub and herb coverage on the fine sand. *Capparis tomentosa* and *Acacia hockii* scrubs are found on the outer fringe.

6. *Acacia nilotica* subsp. *indica-Ficus capreaefolia* type.

Acacia nilotica subsp. *indica* is well established as a characteristic species forming the highest canopy as well. *Ficus capreaefolia* Del. is well established along the very wet riverbanks adjacent to the river channel. Lower shrubs like *Phyllanthus reticulatus* Poir., *Acalypha crenata* A. Rich., *Achyranthes aspera, Senna floridbunda, Cycantheropsis parviflora, Datura inoxia* L., *Megalochlamys violacea* (Vahl) Vollesen, *Solanum incanum* L., *Withania somnifera* (L.) cover the middle canopy and ground cover of the alluvial plain making the riverine vegetation at the middle Awash inaccessible.

7. ***Lannea schimperi-Glycine wightii*** var. *longicauda* type.

At an altitude 650 m a.s.l. along the Awash flood plain at Angalale high canopy *Lannea schimperi* was sampled. This vegetation type is distinctively established on the two sides of the flood plain. *Glycine wightii* var. *longicauda* (Weight & Arn) Verdc., *Creptostegia grandiflora* R. Br., *Phyllanthus reticulatus* Poir. form the lower ground cover of the alluvial plane.

Table 3. Awash Riverine Vegetation Twinspan Output

Relevé

		11111	113112	2322231333333334	2222244444	66666	4445455555	55556	
		12345	67812345906079O	7968938456172BO	1234512354	34512	8973601245	68970	
7	Acacia nilotica subsp. leiocarpa	33332	----------	----------	----------	-----	----------	-----	001000
18	Asparagus africanus	-1---	----------	----------	----------	-----	----------	-----	001000
25	Carissa edulis	-2222	----------	----------	----------	-----	----------	-----	001000
38	Dichrostachys cinerea	3--23	----------	----------	----------	-----	----------	-----	001000
41	Equisetum ramosissimum	2----	----------	----------	----------	-----	----------	-----	001000
43	Euclea racemosa subsp. schimperi	-23-3	----------	----------	----------	-----	----------	-----	001000
55	Gomphocarpus physocarpus	-----	-11-------	----------	----------	-----	----------	-----	001000
60	Ipomoea carica	--1-1	11--------	- ----------	----------	-----	----------	-----	001000
61	Lantana camara	--322	----------	----------	----------	-----	----------	-----	001000
63	Lythrum salicaria	--2--	----------	----------	----------	-----	----------	-----	001000
67	Maytenus senegalensis	3-2--	--3-------	----------	----------	-----	----------	-----	001000
76	Pterolobium stellatum	23-33	----------	----------	----------	-----	----------	-----	001000
84	Sesbania sesban	-2322	----------	----------	----------	-----	----------	-----	001000
95	Veronica anagalis-aquatica	--1-1	----------	----------	----------	-----	----------	-----	001000
1	Acacia brevispica	--3-3	3-3------3-	----------	----------	-----	----------	-----	001001
15	Acokanthera schimperi	-----	333-----33-	----------	----------	-----	----------	-----	001001
83	Senna petersiana	-----	2-2-----2-	----------	----------	-----	----------	-----	001001
9	Acacia robusta subsp.usambarensis	-----	3333333333-	----------	----------	-----	----------	-----	001010
59	Hippocratea africana	-----	--1------1-	----------	----------	-----	----------	-----	001010
72	Phoenix reclinata	-----	--3-----33-	----------	----------	-----	----------	-----	001010
51	Ficus salicifolia	-----	----------3-	----------	----------	-----	----------	-----	001011
64	Maerua subcordata	-----	---2-22----	----------	----------	-----	----------	-----	001011
65	Manilkara butugi	-----	----------3	----------	----------	-----	----------	-----	001011
66	Maytenus gracilipes	-----	---2322----	----------	----------	-----	----------	-----	001011
71	Pappea capensis	-----	--4-----2---333	----------	----------	-----	----------	-----	001011
73	Phragmites communis	-----	--------11-	----------	----------	-----	----------	-----	001011
78	Salix subserrata	-----	----------2--	----------	----------	-----	----------	-----	001011
103	Ziziphus spinachristi	-----	-----2222--2---	----------	----------	-----	----------	-----	001011
29	Combretum adenogonium	-----	---33--33---3-3	----------33	----------	-----	----------	-----	001100
39	Diospyros abyssinica	-----	----------	3---3-3--------	----------	-----	----------	-----	001100
91	Tamarindus indica	-----	-3-------3333-3	3-333----------	----------	-----	----------	-----	001100
42	Euclea divinorum	-----	-33------3-----	----------3----	----------	-----	----------	-----	001101
81	Sansevieria powelli	-----	111-----11-----	--------2---1--	----------	-----	----------	-----	001101
20	Balanites aegyptiaca	-----	-22-----2------	----------	----33----	-----	----------	-----	00111
70	Hinuusops laurifolia	-----	----------	-----3-3-3-3333	----------	-----	----------	-----	01000
77	Rhus natalensis	--222	----------	-3----------2-3	----------	-----	----------	-----	01000
100	Ziziphus mucronata	-----	---------- -	3---2-563-----	----------	-----	----------	-----	01000
27	Celtis africana	-----	----------	-33333--33-----	----------	-----	----------	-----	010010
30	Combretum molle	-----	----------	------3333--3--	----------	-----	----------	-----	010010
32	Cordia gharaf	-----	----------	--333--------3-	----------	-----	----------	-----	010010
56	Grewia bicolor	-----	----------	--------2336---	----------	-----	----------	-----	010010
57	Grewia tenax	-----	----------	-----2-2-------	----------	-----	----------	-----	010010
80	Sansevieria abyssinica	-111-	----------	-1--------142--	-----2----	-----	----------	-----	010010
104	cissus rotundifolia	-----	----------	--------2------	----------	-----	----------	-----	010010
10	Acacia senegal	-----	----------	----------	-3533-33--	-----	----------	-----	010011
11	Acacia seyal	-----	----------	------ 2222--2-	----------	-----	----------	-----	010011
16	Andropogon contortus	-----	----------	----------	----222---	-----	----------	-----	010011
17	Aristida spectabilis	-----	----------	----------	---12-2---	-----	----------	-----	010011
19	Barlaeria acanthoides	-----	----------	----------	----2-2---	-----	----------	-----	010011
45	Euphorbia glochdiata	-----	----------	----------	----2-22--	-----	----------	-----	010011
47	Euphorbia nigrispinoides	-----	----------	----------	----2-22--	-----	----------	-----	010011
48	Euphorbia petersiana	-----	----------	----------	---- -2-2-	-----	----------	-----	010011
85	Sida collina	-----	----------	----------	------2---	-----	----------	-----	010011
94	Terminalia brownii	-----	----------	----------	2-----3-3-	-----	----------	-----	010011
4	Acacia mellifera	-----	----------	----------	-3-233-22-	-----	----------	-----	0101
40	Dobera glabra	-----	----------	----------	-22232-2--	-----	----------	-----	0101
3	Acacia hockii	-----	----------	----------	----------	2222-	----------	-----	011
92	Tamarix nilotica	-----	----------	----------	----------	33333	----------	----	100
24	Capparis tomentosa	-----	----------	----------	2---------	--22-	---------2	-----	100
75	Prosopis juliflora	-----	----------	----------	----------	22222	--2-23----	-----	100
49	Ficus capreaefolia	-----	----------22---	----------3	----------	-----	3233332333	-----	101010
8	Acacia nilotica subsp. indica	-----	----------	----------	----------	-----	3333333333	-----	101011
34	Creptostegia grandiflora	-----	----------2-	----------	2-2-------	-----	--32-22222	22222	10100
74	Phyllanthus reticulatus	-----	----------	----------	----------	-----	----222222	22222	10100
54	Glycine wightii	-----	----------	----------	----------	-----	----------	22222	10100
62	Linnea schimperi	-----	----------	----------	----------	-----	----------	33333	10100
13	Acalypha crenata	-----	----------	----------	----------	-----	-1--------	-----	101011
14	Achyranthes aspera	-----	----------	----------	----------	-----	-1--1--1--	-----	101011
26	Senna floribunda	-----	----------	----------	----------	-----	----2-----	-----	101011
35	Cycantheropsis parviflora	-----	----------	----------	----------	-----	--2-------	-----	101011
37	Datura inoxia	-----	----------	----------	----------	-----	2-2-------	-----	101011
68	Hegalochylames violacea	-----	----------	----------	----------	-----	22--2-----	-----	101011
87	Solanum incanum	-----	----------	----------	----------	-----	2---------	-----	101011
96	Withania somnifera	-----	----------	----------	----------	-----	--22---2--	-----	101011
		00000	000000000000000	000000000000000	0000000000	11111	1111111111	11111	
		00000	000000000000000	011111111111111	1111111111	00000	1111111111	11111	
		00000	000111111111111	100000000000111	1111111111	00011	0000000000	11111	
		00000	111000000000111	100000111111000	0000111111		0011111111	00011	
		01111	000000011	101111000011000	1111000011		001	11111	
							000	00111	
		1	2	3	4	5	6	7	

5:2. Soil Properties and Plant Communities.

Soil pH:- Soil pH values, averaged for all quadrants in each community shows slightly alkaline value (7.79-8.38), (Table 4). The highest pH value was obtained in community **5** and the lowest in community **1.** Soil pH gradient revealed an increasing trend with decreasing altitude. Community **5** with the highest soil pH supports the *Tamarix nilotica-Acacia hockii* community type. No significant difference between the communities was revealed based on pH measurement. According to Slingsby & Cook (1986), soil pH measurements are often difficult to interpret. If the value is over 7, this suggests that the parent rock is limestone in origin. Pearson's Product Moment Correlation computed (Table 5), showed negative correlation for altitude and soil pH value, but a positive correlation for pH and organic carbon content. Alkaline soils are characteristic of most arid and semi-arid regions. Alkalinity occurs when there is a comparatively high degree of base saturation. The presence of salts especially calcium, magnesium and sodium carbonates makes the soil very strong alkaline. Base saturation is high for the soil along the Awash River, ranging from 68-75 percent. The soil alkalinity is attributed to the high base saturation and the presence of salts. The slight runoff or the nearly absence of leaching causes in the soil a neutral or alkaline reaction and the pH is never inferior to 7 (Longhitano & Bavazzano, 1973).

Electrical Conductivity:- The mean value of sampling plots in each community type showed the highest electrical conductivity in community **5** and the lowest in community **4.** This shows the saline soil environment at the lower Awash with high electrical conductivity on which the *Tamarix nilotica-Acacia hockii* community type is established

and the well-drained back slope of the Awash River at Agle, Awash Arba from which the mineral nutrients were leached. Communities **3, 1, 2, 7** and **6** showed mean values of electrical conductivity in a decreasing order. ANOVA test showed significance between communities **1, 3, 5** and **2, 4, 6, 7.**

Soil Texture:- Soil bulk density averaged for all quadrants in each community had the highest value for community **7** and the lowest for community **3**. Communities **6, 2, 1, 5** and **4** were arranged in decreasing gradient of bulk density. Community **7** in the riparian zone of the Middle Awash revealed a compacted, cracked silty-soil deposited mainly by seasonal alluvial deposition of fine silt and clay. Community **7** supports the establishment of high canopy vegetation dominated by *Lannea schimperi* and the lower ground cover comprised of *Glycine wightii.* Luxuriously growing *Lannea schimperi* was observed on the east and west bank of the Awash on the alluvial deposition of the flooding season. Computed ANOVA test showed significance for communities between communities **3, 4, 5** and **7, 6, 1, 2.** The lowest bulk density was recorded for community **3**, in the Upper Awash, which supports old stand relic of *Celtis africana-Mimusops laurifolia* community type.

Community **7** in the riparian flood plain of the Awash showed the highest silt percent and the lowest record was for community **4,** in the Upper Awash at Koka Dam. The decreasing gradient of the silt percent showed communities **5, 3, 2, 5** and **1** in decreasing order. The highest silt percent supported *Lannea schimperi-Glycine wightii* community type and the least silt percent supported *Acacia nilotica* subsp. *spirocarpa-Carissa edulis* community type. Significance test revealed differences between communities **4, 5** and **2,**

3, 6 and community 7. Correlation coefficient value computed for the environmental variables shows positive correlation between silt percent, slope and pH. Negative correlation was shown between silt percent and altitude. This shows that the silt deposition along the Awash River increases with decreasing altitude.

The highest clay percent obtained from the average values of all quadrants in a community was found to be highest for community **3** and lowest for community **4**. Along the Awash National Park between altitudes 920-850 m.a.s.l. the *Celtis africana-Mimusops laurifolia* community was found to have the highest clay content. *Acacia mellifera-Acacia senegal-Dobera glabra* community at Awash Arba back slope of the Awash contrasts with this community in clay content. ANOVA test revealed significance between communities **4, 5** and **1, 2, 3, 6, 7.** The physiochemical characteristics of the soils of riparian ecosystems are different from those of either upland ecosystems or permanently flooded swamps. In erosion and transport systems, sediments are coarse and soils poorly developed (Mitch & Gosselink, 1993). Seasonal inundation takes place along the *Celtis africana-Mimusops laurifolia* community whereas the *Acacia mellifera-Acacia senegal-Dobera glabra* community is a high slope which is not over flooded seasonally. Correlation coefficient value computed shows that there is a strong positive correlation between clay content and pH. The water supply of plants in arid regions depends upon the soil texture (particle size). Quantity of rain is only of indirect importance; the amount of water remaining in the soil, and thus available to plants, is far more important (Walter, 1985). Considering the toposequence of soils from the Awash River it often really seems to follow a chain strictly related to erosion and deposition of soil materials and especially to the soil moisture regime (Longhitano and Bavazzano, 1973). So

the Awash Riverine vegetation is established mainly on eroded and deposited soils.

Soil Nutrients:-

From the values of available sodium averaged for quadrants in each community, community 7 located at the Lower Awash flood plain showed the highest salinity and community 4 showed the least sodium content. Due to the long time water logging and high evapotranspiration sodium is deposited at the soil surface by capillary movement from the ground water. *Tamarix nilotica* is established on the saline flood plain. ANOVA test showed significance between community **5**; and communities **1, 2, 3, 7, 4** and **6.**

The highest Potassium content was recorded for community **3** and the lowest for community **5.** As potassium is an important nutrient for plant growth the high concentration of potassium was revealed in community **3**, which is a high canopy and well established evergreen riverine forest of *Celtis africana-Mimusops laurifolia* community. Community **5**, in the lower Awash Basin *Tamarix nilotica-Acacia hockii* community type contrasts well with community **3**. Significance test carried out shows difference between communities **1, 2, 3, 6** and **4, 7, 5** (see Table 4). The highest available Calcium was recorded for community **6** and the lowest for community **5**. *Acacia nilotica* subsp. *indica-Ficus capreaefolia* community type was described in community 5 established along the riverine zone at Melka Warar; extending to Sheleko and Ambash. When aluminium and hydronium ion dominate the humid environments calcium cations dominate the semi-arid soil exchange complex (Etherington, 1975)

Table 4. Results of Tukey's Multiple Range Test between Environmental Variables and Plant Communities.

com.	pH	EC	BD	Sand %	Silt %	Clay %	Na	K	Ca	Mg	CEC	BS	OC
1.	7.79 a	0.13 b	1.29 bcd	52 bc	30 b	18 b	2.48 bc	3.82 b	13.1 ab	1.75 a	31.4 ab	68 a	2.95 c
2.	8.24 b	8.86 a	1.32 bcd	37 abc	41 cd	21 b	3.12 c	4.56 bc	15.5 abc	2.05 a	33.9 ab	75 a	1.80 b
3.	8.14 b	0.14 b	1.19 a	35 abc	42 cd	22 b	2.37 bc	5.04 c	17.7 c	2.61 b	37.5 b	75 a	3.05 c
4.	8.16 b	5.95 a	1.23 ab	39 abc	7 a	4 a	1.28 a	2.44 a	12.2 a	1.62 a	25.5 a	73 a	0.85 ab
5.	8.20 b	5.83 a	1.34 cd	27 ab	51 de	21 b	1.73 ab	2.38 a	19.0 c	2.75 bc	35.7 b	73 a	1.04 ab
6.	8.14 b	7.50 a	1.36 d	19 a	60 e	21 b	2.72 c	4.65 bc	17.2 bc	3.08 bc	39.2 b	71 a	1.19 ab
7.	8.24 b	0.15 b	1.25 abc	57 c	34 bc	9 a	3.68 d	1.40 a	11.9 a	3.25 c	30.2 ab	68 a	0.29 a

Significant differences at $p \leq 0.05$ (if any) are indicated with different letter notations below each column. (COM.=COMMUNITY TYPE; EC=ELECTRICAL CONDUCTIVITY; BD= BULK DENSITY; CEC=CATION EXCHANGE CAPACITY; BS= BASE SATURATION).

The highest magnesium was found for the *Tamarix nilotica-Acacia hockii* community in the lower Awash. The least magnesium was recorded for the *Acacia mellifera-Acacia senegal-Dobera glabra* community type on the well drained back slope of the Awash River. The magnesium content showed a trend of decreasing in the quadrants sited in the upper Awash. This could be attributed to the leaching of magnesium in the upper catchment.

Cation Exchange Capacity (CEC):- The highest cation exchange capacity was recorded

for community 7 in the Middle Awash which supports high canopy vegetation of *Lannea schimperi* and *Glycine wightii* on the ground cover. The lowest cation exchange capacity was recorded for the well-drained back slope at Awash Arba, where *Acacia mellifera-Acacia senegal-Dobera glabra* community was described. Due to the leaching of the nutrients at this site, the least cation exchange capacity was recorded. ANOVA test revealed significance between the different communities based on cation exchange capacity. Significant difference was observed between communities **1, 2, 4** & communities **3, 6**.and **7**. Cation exchange capacity shows a general trend of increasing with fine particles of clay; as clay soils have a high adsorptive capacity for mineral nutrients.

Organic carbon content:- The highest organic carbon content was found in community **3** and the lowest in community **5**. This shows that the organic humus content is the highest in *Celtis africana-Mimusops laurifolia* community type and the lowest in the *Tamarix nilotica-Acacia hockii* community in the lower Awash flood plain. Organic carbon content in communities **1, 2, 7, 6** and **4** was shown in decreasing order from the average values of all quadrants in each community. Significance was found between plant communities based on organic carbon content. ANOVA test showed significance between communities **4, 5, 7** and **1, 3, 2** and **5**.

5:3. Correlations between Environmental Factors

Correlations between environmental factors were computed using Pearson's Product Moment Correlation. Negative correlation was found between sand percent and silt percent value. As

the silt percent increases along the alluvial plane along the Awash River the the amountg of sand percentage decreases. The available potassium positively correlates to the amount of clay particles. As the surface area of the clay particles is high there is a greater chance of adsorbing mineral particles like potassium. This is mainly true for the Middle Awash Valley. Cation exchange capacity is positively correlated to clay particles. Organic carbon percentage and silt percentage are all positively correlated to electrical conductivity. Clay and silt percentage are both negatively correlated to altitude. As the altitude along the Awash increases the silt and clay percent gradually decrease. Clay and silt contents are positively correlated to the pH values (see Table 5).

Table 5. Pearson's Product Moment Correlation Cofficient
For Correlations between Environmental Variables at $p<.05$.

	pH	EC	SAND	SILT	CLAY	Na	K	Ca	Mg	CEC	BS	OC	SL
EC	-0.6												
	ns												
SAND	0.001	-0.13											
	ns	ns											
SILT	0.0369	-0.03	-0.98										
	ns	ns	Sig.										
CLAY	-0.15	0.68	-0.71	0.54									
	ns	ns	ns	ns									
Na	-0.34	0.29	-0.65	0.55	0.70								
	ns	ns	ns	ns	ns								
K	-0.21	0.75	-0.44	0.24	0.94	0.69							
	ns	ns	ns	ns	Sig.	ns							
Ca	0.49	0.19	-0.60	0.55	0.57	-0.03	0.34						
	ns	ns	ns	ns	ns	ns	ns						
Mg	0.19	0.07	-0.79	0.86	0.32	0.06	-0.03	0.74					
	ns	ns	ns	bs	ns	ns	ns	ns					
CEC	-0.19	0.65	-0.82	0.70	0.94	0.57	0.77	0.69	0.59				
	ns	ns	ns	ns	Sig.	ns	ns	ns	ns				
BS	0.97	-0.41	-0.03	0.02	0.03	-0.28	-0.01	0.59	0.16	-0.04			
	Sig.	ns	ns	ns	ns	ns	ns	ns	ns	ns			
OC	-0.69	0.95	-0.13	-0.05	0.69	0.51	0.82	-0.03	-0.24	0.58	-0.50		
	ns	Sig.	ns	ns	ns	ns	ns	ns	ns	ns	ns		
SL	-0.52	0.96	-0.01	-0.18	0.67	0.33	0.82	0.09	-0.28	0.54	-0.31	0.96	
	ns	Sig.	ns	ns	ns	ns	ns	ns	ns	ns	ns	Sig.	
AL	-0.51	0.30	0.55	-0.64	-0.07	0.26	0.25	-0.78	-0.92	-0.34	-0.46	0.52	0.47
	ns	ns	ns	ns	ns	ns	ns	ns	Sig.	ns	ns	ns	ns

Alt=Altitude; EC=Electrical Conductivity; BD=Bulk Density; SA%=Sand Percent; SI%=Silt Percent; CL%=Clay Percent; CEC=Cation Exchange Capacity; BS= Base Saturation; OC=Organic Carbon Percent)5:4.

5:4. The Awash Riverine Vegetation

The Awash Riverine Vegetation floristic analyses showed 7 plant communities along the Awash River within the semi-arid zone between altitude 350-1470 m.a.s.l. Forman (1995) discussed the general types of plants that dominate the riverbanks as disturbance tolerant or resistant and the opportunistic. The disturbance resistants have extensive root systems and strong resprouting ability. The opportunistic are the species, which are readily eliminated by disturbance. As the Awash River seasonally over flows during the heavy rainy seasons from June-September in the central highlands of Ethiopia, the vegetation that is established on the flood plains and inundated riverbanks resist the seasonal flooding and water logging. The soil texture and the soil chemical properties with other environmental factors like geomorphology, slope and gradient in altitude determine the type of vegetation communities described along the Awash River. The edaphic factors, which are in a cycle of erosion, transportation and deposition with the period of water logging from seasonal flooding, also determine the type of communities established along the Awash River. The human interference in the river corridor for irrigation, dam construction and over grazing by pastoral livestock has an impact on the riverine vegetation succession.

The upper Awash valley is characterised with narrow and relatively straight river channel along which 4 of the plant communities were described. The upper Awash is characterised with deep cutting river valley in the highland with relatively narrower flood plains, high flow rates and steep slopes. The soil particles eroded and transported in the upper Awash are relatively coarse when compared to the middle and lower Awash. The

period of inundation is shorter when compared to the middle and lower Awash, which is confined to the narrow river banks with high slopes flushing the flood down stream. Some of the sample sites are not flooded even during the heavy rain in the central highlands of Ethiopia. *Acacia nilotica* subsp. *spirocarpa-Carissa edulis* community type, *Acacia robusta* subsp. *usambarensis-Acokanthera schimperi* type, *Celtis africana-Mimusops laurifolia* type, *Acacia mellifera-Acacia senegal-Dobera glabra* type were described in the upper Awash Valley. In the upper Awash Community **3** is inundated for a longer period of time, when compared to communities **1, 2** and **4** which are on a relatively higher slopes. Vegetation formation of community 3 is with increased canopy and diameter at breast height (dbh) with old formation of *Celtis africana* and *Mimusops laurifolia*. According to Forman (1995) average soil conditions are wettest near the river and driest near the hill slope. *Acacia mellifera-Acacia senegal-Dobera glabra* community types were described on back slopes and dry areas, which resemble the upland vegetation in the semi-arid zone. Roofs of deep canyons dissected by the river from time immemorial support different vegetation types in the upper Awash valley. The altitude of this site is 740 m. a.s.l. The relevés are covered with basaltic rocks where hardly accessible *Acacia mellifera, Acacia senegal and Dobera glabra* are established as scrubs 3-4 m. high. *Acacia mellifera* savanna begins on sandy soil at a rainfall of 250-400 mm. (Walter, 1985). The vegetation is established on a steep slope along the river, where grazers could hardly reach.

Within the Middle and the lower Awash, both slope and altitude decrease and alluvial planes stretch from the river bank forming wide areas flooded during June to October. The

vegetation at the middle Awash valley covers extensive areas along the alluvial plains. It seems that the vegetation cover has been reduced by the deforestation for state farms to increase agricultural land. Three plant communities; *Acacia nilotica* subsp. ***indica-Ficus capreaefolia***, *Lannea schimperi-Glycine wightii*, *Tamarix nilotica-Acacia hockii* were described on the flood plains along the Awash River. The alluvial deposites are comprised of fine sediments of silt and clay; and the pH is slightly alkaline. The flow rate of the river is highly reduced in the riparian zone and fine silt and clay is deposited. *Creptostegia grandiflora* R. Br., a very common liana in the middle Awash, profusely grows on the trees and shrubs and its seedlings are well established on the wet flat clay soil. It seems that the height of the *Acacia nilotica* subsp. *indica* decreases as one goes further down the Awash River to the arid lands where the potential evapo-transpiration gradually decreases and moisture content decreases. This woody lianas is well established along the riverside in the middle Awash making the riverine vegetation practically inaccessible.

As one proceeds along the Awash River to the arid zone where the precipitation is highly reduced the soil salinity increases. 1-1.5 m *Acacia* scrubs are found on the upland whereas, *Tamarix nilotica-Acacia hockii* community type is a conspicuous feature all along the Awash in the arid zone. The river deposits gravel and fine sandy particles along its banks as it slowly flows in the arid environment. According to Walter (1985), favourable conditions for the growth of halophytic plants like *Tamarix* sp. is provided by the washing of some of the salts and the soaking of the soil to considerable depth.

Tamarix nilotica which can resist the salinity effect grows with other species like *Acacia*

hockii, though the current trend shows the intensive growth of the invasive shrub, *Prosopis juliflora.* It is possible to imagine that the intensive invasion of the invasive weed will be a serious nuisance in the Afar Rangelands, and the Awash River bank in the future. The functioning of riparian systems is determined by a complex interplay between hydrological, geomorphologic and biological factors and that this is often reflected in the structure of riparian plant communities (Gregory, 1991). It follows that a vegetation description has the potential to identify functional land units, that is landscape units which are defined by their response to the disturbance regimes and resource gradients which determine a system's functioning (Higgins, 1997). The riverine vegetation of the Awash along the environmental gradient is mainly the results of the interactions between the hydrology, slope, altitude, edaphic factors and climate. Which could be the attributes of mainly geomorphology, edaphic factors, hydrology and climate.

6. ETHNOBOTANICAL INVESTIGATION

The ethnographic approach borrowed from the social sciences was employed to gather data on the ethno-ecological and ethnobotanical investigation. Ethnographic approach means that a researcher becomes a student and comes to the field with an attitude of complete ignorance as coined by Furz *et al.* (1996). This technique of rapid and participatory rural appraisal was implemented by identifying key informants, those best able to inform on particular topics, or to give special points of view, individually or as groups.

The natural systems and processes of biodiversity are the fabrics of life on the planet. They provide the environment in which humans live. Human beings have a relationship with nature, which depends on complex social, cultural, economic and political processes. The understanding of the importance of biodiversity conservation, therefore, requires not only the understanding of the ecological processes but social ones as well (Furz *et al.*, 1996).

Sedentary people rely on their cultivated crops for their main source of food, with additions, from wild sources as a supplement and as a source of alcohol or flavouring. The use of wild sources for food is, however, extremely important in time of food scarcity and for the nomadic tribesmen or travellers generally (Wickens, 1980).

All species that have been studied are arranged under plant group names. Plant families

are arranged alphabetically while genera within each family and species within each genus were also arranged alphabetically. Each plant taxon is provided with botanical description, vernacular name and use (s). In addition to the ethnobotanical data gathered in the study area about the plant taxa provided below, information on the same that are obtained from literature are also included. The use category of the plants collected for the ethnobotanical significance is summarised in figure 6.

6.1. Description of Plants Used in Ethnobotany.

Abutilon anglosomalie Cufod. **(Malvaceae)**

Botanical Description:- Shrubby herb ca. 2 m high; leaves often held like a V (folded when dry); petiole1.5-10 cm; lamina circular to reniform; flowers in leafless, densely glandular pubescent sticky panicles, with yellow to orange petals.

Habitat and distribution: It grows in *Acacia-Commiphora* bushland, on silty alluvial or on red sandy soil, at an altitude of 350-1200 m in Harerge and Sidamo. It also occurs in Somalia and northeast Kenya.

Vernacular name: Hambukto (Af.)

Use: Animal forage

Acacia brevispica Harms **(Fabaceae)**

Botanical description:- A tree ca. 4 m high; leaves with petiole 0.4-1.5 cm., long; pinnae up to 18 pairs; leaflets up to 50 or more pairs; flowers yellowish to white, in heads which are arranged racemosely or in long panicles; pods straight, dehiscent; seeds compressed.

Habitat and distribution:- It grows in bushland scrub at 900-2000 m. in Welo, Shewa, Bäle, Hararge, Kefa, Gamo Gofa and Sidamo and widespread in tropical Africa.

Vernacular name: Hamarrecha (Or.)

Use:- For construction (termite resistant). Coppock (1994) reported that extract of the root has medicinal value.

Acacia hecatophyla Steud. ex Rich. **(Fabaceae)**

Botanical description:- Tree ca. 6 m high; prickles inconspicuous, in pairs, recurved, up to 6 mm long; leaves pinnae up to 11-20 pairs; petiole with a conspicuous elongated gland; flowers yellowish-white, sessile, in up to 12 cm long spikes; pods straight with conspicuous veins on surface.

Habitat and distribution:- Growing in woodland and wooded grassland, at an altitude of 1450-1700 m., distributed in Tigray, Gonder and Gojam; also reported to occur in Eritrea; Sudan; Uganda and Zaire.

Vernacular name:-Adado (Af.)

Use:- Browse for livestock especially camel and goats.

Acacia mellifera (Vahl) Benth. **(Fabaceae)**

Botanical description:- A shrub or tree up 4 m high; young branchlets brownish; prickles in pairs, hooked; leaflets 1-2 pairs, obovate; flowers cream to white in spiciform racemes; pods oblong, straight, dehiscent, pale brown to straw- coloured.

Habitat and distribution:- Deciduous bushland, dry scrub, often forming thickets and an indicator of overgrazing; It grows at an altitude of 400-2500 m. It is distributed in Wollega, Welo, Shewa, Harerge, Bale, Kefa, Gamo Gofa and Sidamo; and also

distributed from Egypt to Tanzania; Eritrea; Angola; Namibia and in Arabia.

Vernacular names: Saphansa (Or.); Maka'arto (Af)

.Uses:- Browse for camels, goats and wild browsers. The gum is important famine food; some informants told me that they go a long distance to search for the gum during the long dry season.

Acacia nilotica (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan **(Fabaceae)**

Botanical description:- Tree ca. 12 m high; leaves with pinnae 2-4 pairs; flowers bright yellow in heads; pods deeply constricted between seeds, the outer surface of pods whitish, necklace-like.

Habitat and distribution:- Woodland at an altitude of 600 m., distributed in Afar, Shewa and Harerge. Also growing in Eritrea and it is a native of India.

Vernacular name:- Kasalto (Af.)

Uses:- The livestock mainly feed on the pods. It is also used for construction, as fuelwood and for charcoal.

Acacia nilotica (L.) Willd. ex Del. subsp. *leiocarpa* Brenan **(Fabaceae)**

Botanical description:- Tree with reflexed stipular spines; leaves pinnae 2-14 pairs; flowers bright yellow in heads; pods straight, indehiscent, glabrous.

Habitat and distribution:- Growing in woodland and scrub, at an altitude of 1100-1700 m.; distributed in Shoa, Arsi, Harerge; and also in Somalia; Kenya and Tanzania.

Vernacular name: Kasalee (Or.)

Uses:- For firewood, charcoal, fence and house construction.

Acacia robusta Burch. subsp. *usambarensis* (Taub.) Brenan **(Fabaceae)**

Botanical description:- Tree ca. 12 m high; spines straight; leaves pinnae, 3-8 pairs; flowers white in heads; pods nearly straight to falcate; dehiscent, 3 x 14 cm.

Habitat and distribution:- Growing in woodland, usually riparian; at an altitude of 500-1450 m.; distributed in Shewa, Arsi, Hararge, Bale and Sidamo; also growing in Kenya; Tanzania and Mozambique.

Vernacular name: Waangaayyo (Or.)

Uses:- Besides its use in agroforestry; the leaves are reported to be crushed and added to wound for quick healing.

Acacia senegal (L.) Willd. **(Fabaceae)**

Botanical description:- Tree ca. 6 m high; prickles in threes, the central one hooked downwards and the two laterals curved upwards; leaves bipinnate; flowers white in long spikes; pods straight, dehiscent.

Habitat and distribution:- Growing in wooded grassland, deciduous bushland, dry scrubs between altitudes of 600-1700 m. Growing in Afar, Welo, Shewa, Arsi, Bale, Gamo Gofa and Sidamo. It is also widespread in tropical Africa.

Vernacular name: Saphansa (Or.)

Uses:- Mainly used as a browse for animals and for making pastoralist huts. Its gum is used as a famine food.

Acacia seyal Del. **(Fabaceae)**

Botanical description:- Tree ca. 7 m. high with flat crown; trunk with yellowish powder; epidermis reddish; stipular spines basally inflated into "ant-galls"; leaves pinnate; flowers

bright yellow, in heads.

Habitat and distribution:- Growing in woodland and wooded grassland at altitude ranging from 1200-2100 m. Distributed in Tigray, Welo, Gonder, Gojam, Shewa, Arsi, Hararge, Ilubabor, Kefa and Sidamo. It is also widespread in northern tropical Africa extending to Egypt.

Vernacular name:- Waaccuu (Or.)

Uses:- Besides its use as browse plant, the gum is used as famine food. Coppock (1994) reported that bark extracts are prepared for painting wooden handicrafts and gum is mixed with *Balanites aegyptiaca* and left to stand to form syrup.

Acacia tortilis (Forssk.) Hayne **(Fabaceae)**

Botanical description:- Tree ca. 6 m. high; leaves with pinnae 2-10 pairs; leaflets 6-22 pairs; flowers whitish in heads; pods contorted or spirally twisted, indehiscent or very slowly dehiscent.

Habitat and distribution:- It grows in woodland, wooded grassland and dry scrub at altitudes between 600-1900 m. The species is distributed in Afar, Tigray, Welo, Shewa, Arsi, Hārerge and Bale. It also occurs growing in Eritrea; Sudan; Somalia and Southward to Southern Tropical Africa.

Vernacular name: Dhadacha (Or.)

Uses:- Besides agroforestry use it is known among the Oromoo for rules and regulations are formulated exclusively under the shade of this *Acacia* species.

Acalypha crenata A. Rich. **(Euphorbiaceae)**

Botanical description:- A herb ca. 15 cm.; leaves uniformly distributed along stem, leaf-

blade with rounded base, crenate; flowers in raceme up to 4 cm. long, female bracts dentate. (Gilbert, 1995).

Habitat and distribution:- Growing in dry alluvial plain, silty clay soil. It is distributed in Afar, Gamo Gofa, Sidamo and Harerge. It also grows in Eritrea; and throughout drier Old World Tropics and was introduced into the New World.

Vernacular name:- Baro barbare (Af.)

Uses and administration:- Reported as a cure for headache and related malaria complications. The leaf is crushed; mixed with water and sniffed.

Achyranthes aspera L. **(Amaranthaceae)**

Botanical description:- Herb ca. 15 cm high; leaves simple, opposite; flowers in spike.

Habitat and distribution:- Growing in alluvial floodplain at the riparian zone at Melka Warar; on silt-clay soil. Bushland and riverine forest throughout the country at altitudes between 700-3500 m.

Vernacular name:- Ilmole (Af.)

Darguu (Or.)

Uses and administration: It is an important mix for every traditional medicine. The root is chewed for unidentified ailments like stomach-ache.

Acokanthera schimperi (A. DC.) Schweinf. **(Apocynaceae)**

Botanical description:- A tree ca. 4 m. high; leaves with shiny upper surface, flowers with tubular petals and whitish-cream colour.

Habitat and distribution:- Growing in evergreen bushland occasionally forming clumps in *Acacia* woodland or *Acacia-Commiphora* bushland. It grows at altitudes ranging from

600-2300 m. It is distributed on the eastern escarpment and on the slopes of the river gorges of the NW Highlands, in the slopes of the Rift Valley. It also occurs in Eritrea, mountain ranges of Djibouti; Somalia; Uganda; Sudan; Kenya and Tanzania.

Vernacular name:- Qaraaruu (Or.)

Uses and administration:- Human medicine: Crushed leaves and roots are used for treatment of rectal problems like haemorrhoids. It was also reported that leaves and twigs are used in arrow poisoning (ILCA, 1980).

Dawit Abebe and Ahadu Ayehu (1993) also reported that root and bark powder mixed with butter of a black cow and applied once on the body for remedies acting on central nervous system.

Amaranthus dubius Mart. **(Amaranthaceae)**

Botanical description:- A herb ca. 15 cm. high; leaves simple and alternate, slightly glabrous.

Habitat and distribution:-In alluvial flood plains and farm lands.

Vernacular name: Ashara (Af.)

Uses and administration:- Leaves crushed and sniffed for headache and other unidentified ailments. Leaves are also cooked and eaten as an additional food

Asparagus africanus Lam. **(Asparagaceae)**

Botanical description:- An erect shrub with greenish stem; lanceolate leaves and distinct stipules; spines hooked.

Habitat and distribution:- Grows in moist river banks. It is distributed in Tigray, Gonder, Gojam, Welo, Shewa, Arsi, Welega, Kefa, Gamo Gofa, Sidamo, Bale and

Harerge. It also grows in Eritrea; Sudan; Somalia; Uganda; Kenya; Tanzania and South Africa.

Vernacular name:- Sariitii (Or.)

Uses and administration:- Leaves are crushed and tied on swollen part of the body to ease the problem. Also used among the Oromo as a label for some ceremonial undertakings. It is tied on poles, put on the door or front part of the house to show that something ceremonial is going on. This could be circumcision *"dhandha qabaa"*, time of delivery *"dubartii deesse"*, etc. This plant is also used to warn people not to walk in farmlands or any other prohibited footpath. If *"sariitii"* is put on the path no one dares to walk ahead because it is considered that they will be cursed.

Balanites aegyptiaca (L.) Del. *var aegyptiaca* **(Balanitaceae)**

Botanical description:_ A tree ca. 5 m. high; spiny; leaves leathery, rounded; flowers variously arranged in loose or tight cymose fascicles at spinous nodes, on spineless stems; fruit ripens yellow.

Habitat and distribution:- Dry savannah or *Acacia* woodland. It grows in Tigray, Welo, Shewa, Arsi, Harerge, Ilubabor, Gamo Gofa and Sidamo. It is also distributed from Senegal to Somalia and from Egypt south into Zimbabwe and also in the Jordan valley and western Arabian peninsula.

Vernacular name: Baddannoo (Or.)

Uses: The bark is used to treat elephantiasis, cough, emetic, and it is used as a vermifuge. The root is used for snakebite, jaundice, yellow fever, syphilis and colic. Young shoots are used for wound dressing. Fruit is edible; leaves are boiled and eaten in times of

famine.

Houerou (1980) noted that syrup from the fruit is mixed with gum of *Acacia seyal* and that cooking oil is prepared from the fruit. Boiled leaves are eaten as famine food. Coppock (1992) reported that the leaves of new shoots are chewed into paste for application for lesions, edible fruit, smoked for good smell, gum, fumigation wood for milk containers, wood for utensils like butter whisk and butter spoons; construction wood; firewood. The medicinal value and use as forage for livestock is reported at the study area. It was mentioned that when the strong livestock are taken to distant places for grazing, the weak ones browse this plant. Sick cattle are isolated and kept under this tree for treatment with crushed leaves until they recover.

Carissa edulis (Forssk.) Vahl **(Apocynaceae)**

Botanical description:- A shrub ca. 3.5 m. high, spiny branches forming a profusely branched thicket; leaves simple, shiny upper lamina with entire margins.

Vernacular name: Hagamsa (Or.).

Uses:- It is used for fencing and the fruit is edible. Coppock (1994) noted that the fruit is a medicine for toothache and that the spines are used for piercing the ears and that the seeds are used for dyes. According to Wickens (1980) the root is used as "bitters" in rum, gin, etc. and used to improve water and food flavour.

Cissus quadrangularis L. **(Vitaceae)**

Botanical description:- Succulent climber to 4 m.; frequently leafless; young stems 4-angled, green with red edges, slightly constricted at nodes; old stems woody, with greyish bark; leaves broadly ovate, dentate; fruit ovoid to ellipsoid.

Habitat and distribution:- Dry *Acacia* woodland and bushland; riverine forest and scrub; semi-desert scrub; often on rocky slopes and out-crops; Growing at altitudes of 0-2250 m., in Afar, Tigray, Gonder, Welo, Shewa, Arsi, Gojam, Kefa, Gamo Gofa, Sidamo, Bale and Harerge. It is also widespread in tropical Africa and Asia.

Vernacular name: Ali'e (Af.); Cophii (Or.).

Uses:- Root crashed and boiled in water and the filtrate is drunk for pneumonia, cough and *kimbiro hara (Af.),* diabetes, used to facilitate the elimination of placenta in livestock, if for some reasons the placenta delays after delivery.

Combretum molle R. Br. **(Combretaceae)**

Botanical description:- Tree ca. 7 m. high; bark black and deeply fissured; leaves opposite, apex rounded; flower axillary.

Habitat and distribution. A wide variety of *Comberetum* and *Combretum-Terminalia* woodland and grassland, usually on rock surface. It is distributed in Tigray, Gondar, Gojjam, Welo, Shewa, Arsi, Welega, Ilubabor, Kefa, Gamo Gofa, Sidamo, Bale and Harerge and also widespread in tropical Africa, S. Africa and Yemen.

Vernacular: Rukkensa (Or.)

Uses: Used commonly as a *fumigant* for improving the taste and smell of water and milk containers by the pastoralists.

Commelina benghalensis L. **(Commelinaceae)**

Botanical description:- A creeping perennial herb; rooting at the lower nodes; leaf-sheaths purple veined and with purplish long bristles along free edges; flowers bisexual, with the pedicels protruding when flowering and reflexed and enclosed in the spathe

when fruiting.

Habitat and distribution. Growing in Gojam, Welo, Shewa, Welega, Illubabor, Kefa, Gamo Gofa, Sidamo and Harerge. It also occurs in tropical and South Africa, Madagascar and Mascarene Islands, tropical Asia, Indonesia, Polynesia, Pacific Islands and Australia.

Vernacular name:- Gororsaa (Or.)

Uses and administration: The leaf is crushed and applied to wound for quick recovery.

Creptostegia grandiflora R. Br. **(Asclepiadaceae)**

Botanical description:- A woody climber; leaves simple, upper lamina shinny, margin entire, exudes a poisonous white latex; flower funnel shaped, creamy-white in colour; fruit dehisces releasing wind blown achene seeds.

Habitat and distribution:- Extensively growing and invading the riparian zone along the silty clay alluvial deposition of the Awash River at Malka Sadi, Malka Warar and Shalako.

Vernacular names: Halimaro (Af.) Hoqonqol; muka farrisaa (Or.)

Use:- The latex is used for marking the wooden part of their knives and rifles. Some of them told me that they can write their names or number their knives and weapons with the latex and it is permanently stamped. The white latex is highly poisonous.

Equisetum ramosissimum Desf. **(Equisetaceae)**

Botanical Description:- Stem to 1-2 m. long, freely branched, with 8-10 grooves. Sheaths green, becoming brown with a dark band at the bottom; leaf scales as many as grooves, dark; branches hollow; strobili 6-18 mm. long.

Habitat and distribution: Moist places; altitude ranging from 1250-1700 m. Widely

distributed in Ethiopia, occuring in (old Regions), and reported to occur in other African countries, Europe and Asia.

Vernacular name:- Rigaa (Or.)

Use:- It is used as a toothbrush. According to the key informant it gives the extreme whitish colour for the enamel.

Ficus capreaefolia Del. (**Moraceae**)

Botanical Description:- Shrub or small tree up to 7 m tall, with a trunk up to 0.8 m in diameter. Bark grey or greyish brown. Young branches puberulous to to hirsute, with brownish bark, leaves opposite or subopposite, oblong to lanceolate.

Habitat and Distribution: A prominent component of riparian scrub in drier areas, often associated with Salix subserrata; 1000-2600 m. Distributed in East Eritrea; East Wollo, Tigrai uplands, Afar, Shewa East, Hararghe, Kefa, Gamo Gofa, Sidamo and South Somalia; widespread in tropical Africa west to Senegal; south to South Africa Republic.

Vernacular name: Luugoo (Or.)

Use:- It is used for building temporary ritual huts for Oromo *Gadaa* celebrations held at the sites of assembly called *melkaa* at specific sites along the Awash River. It is important in riverbank protection because it closely grows to the river channel, and protects bank erosion during the overflooding of the river.

Ficus sycomorus L. (**Moraceae**)

Botanical Description:- A large tree up to 30 m tall, buttressed, with a trunk up to 3.5 m in

diameter; crown spreading, bark greyish to brown, grey or yellowish; slash pale brown, yellowish or pinkish. Young branches with brown bark, puberulous to pubescent or lanate.

Habitat and Distribution:- River and lake margins, woodland, wooded grassland, evergreen bushland, forest edges and clearings, *"coffee forest"*. 500-2000 m.

Vernacular name: Subla (Af.), Odaa (Or.)

Uses:- The stem is used to make a canoe for crossing the river during the rainy season. The tree forms a high canopy along the river bank cooling the water, giving shelter to people and livestock, the dropped leaves are good dry season feed for livestock, the fruits produce attractive scent both for livestock and other animals during the dry season and are good feed.

Glycine wightii (Wight & Arn.) Verdc. var. *longicauda* (Schweinf.) Bak. **(Fabaceae)**

Botanical description:- Climbing perrenial; stems glabrescent to densely velvety; leaflets ovate or elliptic; racemes many flowered; pod linear oblong, glabrous to densely rusty-red pubescent, constricted between the seeds.

Habitat and distribution:- It grows in grassland, woodland and sometimes in cultivation at altitude ranging from 380-2600 m., it is distributed in Afar, Tigray, Gondar, Welo, Gojam, Welega, Shewa, Arsi, Harerge, Ilubabor, Kefa, Gamo Gofa and Sidamo. It is also widely distributed in Tropical Africa and Arabia.

Vernacular name: Hidda (Or.)

Use:- A good feed for goats, sheep and cattle.

Grewia mollis Juss. **(Tiliaceae)**

Botanical description:- A tree ca. 3-4 m. high; with few or no lenticels; leaf blade pale green and glabrous above, greyish and covered with white indumentum below, ellyptic to lanceolate, apex acute to sub acuminate; petals yellow, obovate.

Habitat and distribution:- Common in *Acacia-Combretum* woodland between altitude of 600-2200 m. Growing in Tigray, Gondar, Gojam, Shewa, Welega, Ilubabor, Kefa, Gamo Gofa and Bale. Also grows in Somalia; Kenya; West to Senegal and Yemen.

Vernacular name:- Harooressa (Or.)

Uses:- Shaped as a stick, for farm tools and house construction. Livestock browses it.

Lannea schimperi (A.Rich.) Engl. **(Anacardiaceae)**

Botanical description: A tree ca. 8 m. high, wider than high, crown rounded; bark dark, smooth; leaves pinnate, petiole and rachis ca. 7 cm. long, leaflets elliptic, inflorescence produced before leaves in apparently apical clusters; flowers fragrant; drupes glabrous, wine red (Gilbert, 1989).

Habitat and distribution:- Deciduous woodland on rocky slopes and outcrops, on volcanics, limestone and basement complex, or in lowland deciduous woodland. Growing at altitude ranging from 800-2200 m. It is distributed in Welo, Tigray, Gondar, Gojam, Shewa, Welega, Kefa, Sidamo, Bale and Harerge. It also occurs west to Nigeria; south to Zaire; Zambia; Malawi & Mozambique.

Vernacular name: Datahara (Af.)

Uses:- It has been mentioned that the drupe is edible when fresh and ripe, and the root is used for intestinal distension. The bark is used for snakebite, which the Afar informants

relate to stimulating vomiting which removes the venom. They are reserved as always to tell the details of the preparation and the administration of the medicine.

Manilkara butugi Chiov. **(Sapotaceae)**

Botanical description:- A tree 6-7 m. high, with dense shiny simple leaves, not deciduous.

Habitat and distribution:- According to Friis (1992), the species is restricted to the south-western part of the North West Highlands. It is also reported from Sudan, Kenya and Uganda.

Vernacular name:- Butujjii (Or.)

Uses:- As fumigant for household utensils, such as water and milk containers. It is believed to give good aroma and taste for milk and milk products. It is also used as *Qayya* (an option for perfume) smoke for pleasant and attractive scent.

Maytenus senegalensis (Lam.) Excell **(Celastraceae)**

Botanical description:- Shrub ca. 2.5 m. high; leaves leathery with rounded apex, margin crenate; flowers in cyme.

Habitat and distribution:- Deciduous woodland, open dry scrub, dry mountain slopes, riverbanks, edges of lakes. It grows at altitudes ranging from 380-2440 m. It is distributed in Tigray, Welo, Gondar, Gojam, Welega, Shewa, Harerge, Arsi, Bale, Ilubabor, Kefa, Gamo Gofa and Sidamo. It is also distributed in tropical Africa from Somalia to Senegal, and southwards to South Africa; north Africa and the Canary Islands; also in southern Spain; Yemen; Afghanistan; Pakistan; India; Bangladesh and Madagascar.

Vernacular name: Kombolcha (Or.)

Uses:- Leaves are used for treating cataract and haemorrhoids. The wood and leaf ash is

used as vegetable salt. The leaves and flowers are also eaten as soup. The bark is used to treat fever and gastric alcers.

Mimusops laurifolia (Forssk.) Friis **(Sapotaceae)**

Botanical description:- A tree ca. 15 m. high. Leaves simple, not deciduous. No thorns or buttresses (Friis, 1992).

Habitat and distribution:- Along the east escarpment of the northern part of the NW Highlands, of the Rift Valley, and of the northern part of the SE also on the Goda Mts in Djibouti, Somalia, Yemen (Friis, 1992).

Vernacular name:- Qolaatii (Or.)

Use:- The fruit is eaten both by man and other primates.

Pappea capensis Eckl. & Zeyh. **(Sapindaceae)**

Botanical description:- Tree ca. 10 m. high; leaves simple, puberulous to tomentellous, lamina elliptic, entire to crenate or serrate, margin wavy; apex rounded to shallowly emarginate; inflorescence ca. 15 cm long, petals white or yellowish green; bark black and rough; fruits round and dehiscent, oozing a reddish latex when fresh.

Habitat and distribution:- *Acacia, Combretum-Terminalia, Combretum-Piliostigma* woodland, at altitudes ranging from 1200-2300 m. It is distributed in Shewa, Arsi, Gamo Gofa, Sidamo, Bale and Hararge. It also grows South to South Africa.

Vernacular name: Biiqqaa (Or.)

Uses:- It is used as a fumigant for household utensils used as milk and water containers.

Phoenix reclinata Jacq. **(Arecaceae)**

Botanical description:- Rosette tree often forming clumps, up to 8 m. high. Leaves compound (pinnate), not deciduous, thorns present.

Habitat and distribution:- Throughout the highlands and lowlands where sufficient water is available. Widespread African linking species. (Friis, 1992). Observed along the Awash River mainly at Sodore area below the Shewa Recreation.

Vernacular name:- Meexxii (Or.)

Uses:- The plant has several household uses like making mats, hats and baskets.

Pterolobium stellatum (Forssk.) Brenan **(Fabaceae)**

Botanical description:- A climbing shrub, with recurved prickles paired at the nodes; leaves bipinnate; flowers small and sweetly scented, pale creamy yellow in terminal panicles.

Habitat and distribution:- It commonly forms thickets in upland dry evergreen forest margins and clearings, upland bushland, *Acacia* woodland and riparian formations; Growing at altitude range between (750-)1200-2500 m. It is distributed in Tigray, Gondar, Welo, Gojam, Welega, Shewa, Arsi, Bale, Harerge, Kefa, Gamo Gofa and Sidamo. It also grows in Arabia and eastern Africa from Sudan to South Africa. (Asfaw Hunde & Thulin, 1989).

Vernacular name: Hallaan Qabeecha (Or.)

Uses:- It is used for fencing in the study area. According to Dawit Abebe and Ahadu Ayehu (1993), leaf powder is boiled in three glasses of water and one glass that remains after evaporation is applied every evening as eye drop for good eyesight.

Rhus natalensis Krauss (**Anacardiaceae**)

Botanical description:- Densely branched shrub; denely lenticillate; leaflets rarely acute; drupes obliquely oblong, compressed, smooth, red when ripe.

Habitat and distribution:- Deciduous bushland with *Acacia, Combretum* or evergreen bushland with *Euclea, Dodonea* etc. Growing at altitude ranging from 1200-2200 m. It grows in Tigray, Gondar, Welo, Shewa, Arsi, Ilubabor, Gamo Gofa, Sidamo, Bale and Harerghe. It also grows from Guinea east to Somalia and tropical Arabia and south to Natal.

Vernacular name: Xaxessaa (Or.)

Uses:- The roots are used for the problems associated with the swelling of the rectum and associated complications in humans, for stomach complaints, gonorrhoea, influenza, wounds, repeated abortion of still birth. The leaves are used for gonorrhoea and to treat irritation of the skin that oozes fluid. Also used as food, the fruit is edible.

Sansevieria ehrenbergii Schweinf. ex Baker

Botanical description:- Xerophytic plant; stem growing up to 20 cm high, usually concealed by leaf bases.

Habitat and distribution:- On rocky ground, under shade or in open *Acacia-Combretum* woodland; Growing at altitude ranging from 400-1100 m. It is distributed in Gamo Gofa, Harerghe, Kefa, Shewa and Sidamo. It also grows in Eritrea; Arabia; Djibouti; Kenya; Sudan; Somalia and Tanzania.

Vernacular name: Algee (Or.)

Uses:- The fibre is used for making whip, which is used for commanding farm oxen and

other livestock. Bos and Demel Teketay (1997) reported that the plants of this species produce edible gum, and the fibres are made into soft brushes for cleaning houses. He also noted that the fibres are used as straps for carrying water gourds and to tie up bundles. He further reported that beads from the stem, fruits and the plant has some traditional medicinal applications.

Sansevieria forskaoliana (Schult. f.) Hepper & Wood **(Dracaenaceae)**

Botanical description:- Plant with no arial stem; rhizome 2 cm. or more in diameter; leaves usually erect, lanceolate, acute, with a hardened apical point; flowers white and borne in clusters occupying the upper half, white.

Habitat and distribution:- In a wide range of habitats in dry areas including rocky places, combretaceous woodland with tall grasses, riverine vegetation, and under trees and shrubs within altitudinal range of 550-2000 m. It is distributed in Shewa, Ilubabor, Gamo Gofa, Sidamo, Bale and Harerge. It also grows in Djibouti; Somalia; Kenya; Sudan and Congo.

Vernacular name: Algee korma (Or.)

Uses:- The fiber is used for making baskets, and other decorations. Among the Kereyou Oromo the mothers teach their daughters how to make good baskets from the fibres. The time when the daughters go in peers to the forest to search for the fibres is called *algee luqifatnaa* a sign of puberty and readiness for marriage. The best decorations made by the girl is displayed on the wedding day and her peers sing waving the baskets.

6:2. Other Sources of Traditional Medicine

1. Eventhough, the plants are the major sources of traditional medicine for the pastoralists living along the Awash River (mainly Kereyou Oromo and the Afar), it has been also found out that animals also contribute to the traditional medicine resource. The Afar sell in specific places in Melka Warar, corals brought from the Red Sea, as a cure from mental disorders-*Likift* (Amharic), *Jinnii* (Or.). A small pieces of the coral reefs is put in fire and smoked.

2. The Marshal Eagles which rest on electric poles waiting for their pray are also sources of traditional medicine. I was informed that the droppings of the eagles is collected in a pit dug under their usual resting place and this is mixed with soil to form a round eliptical greyish medicine. This is mixed with water and drank and the rest rubbed on the skin to be relieved from fever, pneumonia, pain etc.

3. The other source of traditional medicine is collected from caves. The Afar tell that there are places along the Awash River where the steam produced from hotsprings produces a sluggish mucous material on the roofs of caves. They go down into the caves and collect this material to be dried. The material is mixed with water and the patient drinks it to be relieved from *Likift.*

The local medicine practitioners in the Afar are knowledgeable and confidently tell that the highlanders even come to their area to buy their effective medicines. They

tell that they sell their medicinal collections in Metahara, Nazareth and Addis Ababa.

7. CONCLUSION AND RECOMMENDATIONS

The Awash, as the major river in the economy of Ethiopia, is an important centre for dryland biodiversity conservation. The diverisity of life within the Awash National Park; the Yangudi Rasa National Park and the buffer zones, use the Awash River corridor in different ways. River corriders as a source of water resource both for humans and wildlife, corridor of migration for avifauna and other mammals, source of water for irrigation; hydro-electric power generation are targeted for fierce competition in water use. The competition among human uses means rapid river corridor change. The Awash River plays an important role in the sugar industries and the small-scale production schemes within the valley. The sustainable use of the resources within the Awash Basin; guarantees the future natural resources utilisation and management; which is the base for the national economy and the conservation of biodiversity.

As water is the most essential resource for all forms of life including human beings, the management of riverine ecosystem and all diversity of life along river corridors need not be over looked. It seems that human beings focus only on the means of utilisation of water resources and are not worried about sustainable utilisation of river corridors and other body of water. This has evidently led to the drying of some of perennial rivers and streams due to removal of vegetation cover along river corridors and the land use

complications in the catchment areas. The use of fertilizers and different chemicals in the uplands may have an effect on the quality of water used for livestock and humans in the drylands. It has been observed during the survey that the Awash River at the Awash National Park camping sites has a disgusting odour due to the waste discharge from the Metahara Sugar Estate into the river. In the drylands where pastoralism is the predominant economy, and where water is the most precious resource, integrated riverine system management needs to be designed as a major component of the conservation of biodiversity.

The semi-arid zone of the Awash riverine vegetation seems to face a serious land use complication both on the use of the water resources and the rangelands. Development schemes established in the valley seem to have complicated the traditional pastoral system and the use of resources. Most of the *Acacia* woodlands have already been cut down for charcoal production; firewood and extensive state owned farms in the valley. It seems that the flourishing small towns in the Awash valley; and the ever-increasing human population exacerbated the situation; to the extent that the conservation area destiny fails under question. As the Awash riverine vegetation diminishes in size due to several anthropogenic factors, the wildlife will be denied a proper habitat and a route for seasonal migration. As the ecosystem deteriorates, the trend might give way for invasion of other alien non-palatable species like *Prosopis juliflora,* which is a threat to the indigenous species diversity and access to the rangelands for the pastoral livestock. Other weeds can as well invade this highly human influenced ecosystem. It seems that the flush flooding during the rainy season seems to increase in intensity within the last decade, and

this can be attributed mainly to the deforestation of the Awash catchment areas, which is already under intense cultivation for extension of farmlands and overstocking.

The management of resources in the Awash basin, as a challenge towards the national economy and the conservation of biodiversity need to be planned and implemented in an integrated approach. This could not be a task that could be planned and implemented at a micro-level with government-delegated organisation only. It demands the full participation of all beneficiaries from the River Awash. It requires the full participation and empowerment of the pastoral society, the irrigation schemes, governmental and non-governmental organisations. Full fledged environmental education and communication of conservation of resources needs planning and implementation. The gaps that were not covered by this study need to be supplemented by other studies. The following are some of the options that could be proposed for the conservation of riverine vegetation of Ethiopia.

A. Raising the awareness of the sustainable use of river corridors at every level.

B. Carrying out researches on the diversities of life forms along Ethiopia's river corridors and identifying their spacial and temporal distribution.

C. Integration of river corridor conservation within the conservation area plans.

D. Conservation of the indigenous plants and ecosystem and reducing the conditions that lead to the exotic species invasion along the river corridors.

E. Documentation of the indigenous knowledge on the riverine vegetation and the diversity of life in the Awash valley assists in the communication of conservation education.

REFERENCES

Asfaw Hunde & Thulin, M. (1989). Fabaceae subfamily Mimosoideae. In: Hedberg I. & Edwards, S. (eds.), *Flora of Ethiopia, Vol. 3.* The National Herbarium, Addis Ababa. Pp. 71-96.

Bos, J. J. & Demel Teketay (1997). Dracaenaceae. In: Hedberg I., Edwards S. and Sebsebe Demessew (eds.), *Flora of Ethiopia and Eritrea. Vol. 6.* The National Herbarium, Addis Ababa. Pp. 76-82.

Braun-Blanquet, J. (1965). *Plant Sociology: The Study of Plant Communities.* Hafner Publishing Company, New York. Pp. 439.

Carr, C. J. (1998). Patterns of vegetation along the Omo River in southwest Ethiopia. *Plant Ecology.* 135:135-163.

Coppock, D. L. (1994). *The Borana Plateau of Southern Ethiopia: Synthesis of pastoral research, development and change, 1980-91.* ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

Dawit Abebe & Ahadu Ayehu (1993). *Medicinal Plants & Enigmatic Health Practices of Northern Ethiopia.* Berhanena Selam Printing Press; Addis Ababa, Ethiopia. Pp. 511.

Edwards, S., Mesfin Tadesse & Hedberg I. (eds.). (1995). *Flora of Ethiopia and Eritrea. Vol. 2(2).* The National Herbarium, Addis Ababa. Pp. 456.

EMA-Ethiopian Mapping Agency. (1988). *National Atlas of Ethiopia,* Ethiopian Mapping Agency, Addis Ababa. Pp. 76.

EMA-Ethiopian Mapping Authority (1994). *Topographic maps;* 1:50,000, Addis Ababa, Ethiopia.

Ensermu Kelbessa, Sebsebe Demissew, Zerihun Woldu & Edwards, S. (1992). Some

threatened endemic plants of Ethiopia. *NAPRECA MONOGRAPH SERIES*. 2:35-55.

EPA-Environmental Protection Authority. (1998). Background Information on Drought and Desertification in Ethiopia. Berhanena Selam Printing Enterprise, Addis Ababa, Ethiopia.

Etherington J. R. (1974). *Environment and Plant Ecology.* John Wiley & Sons, Ltd. New Delhi. Printed in India. Pp. 347.

EWNHS-Ethiopian Wildlife and Natural History Society (1996). *Important Bird Areas of Ethiopia. First Inventory.* Samayata Press, Addis Ababa, Ethiopia. Pp. 300.

FAO (1965). *Report on Survey of the Awash River Basin.* Volume 1. Rome.

FAO (1984). *Assistance to Land-Use Planning. Ethiopia:* Vegetation and Natural Regions and their significance for Land Use Planning. Technical Report 4. Rome.

Finch, D.M. & Ruggiero, L. G. (1998). Wildlife habitats and biological diversity in the Rocky Mountains and northern Great Plains. *Natural areas.* **13**: 191-203.

Forman, T.T. (1995). *Land Mosaics: The ecology of landscapes and regions.* Press Syndicate of the University of Cambridge, Cambridge University, United Kingdom. Pp. 632.

Friis, I., (1989). Moraceae, In: Hedberg I. & Edwards, S. (eds.), *Flora of Ethiopia,* Vol. 3. The National Herbarium, Addis Ababa. Pp. 271-301.

Friis, I. (1992). Forests and Forest Trees of Northeast Tropical Africa. ***Kew Bull. Additional Series XV***: HMSO, UK. Pp. 336.

Friis, I. & Mesfin Tadesse (1990). The Evergreen Forests of Tropical N.E. Africa. Proceedings of the Twelfth Plenary Meetings of AETFAT. Hamburg.

Furz, B., Lacy, T. D. and Birckhead, J. (1996). *Culture, Conservation and biodiversity.* The social dimension of linking local level development and conservation through

protected areas. John Wiley and Sons Ltd. West Sussex; England Pp. 269.

Gilbert, M. G. (1989). Anacardiaceae. In: I. Hedberg & S. Edwards, S. (eds.), *Flora of Ethiopia, Vol. 3.* The National Herbarium Addis Ababa. Pp. 513-532.

Gilbert, M. G. (1995). Euphorbiaceae. In: Edwards S., Mesfin Tadesse & Hedberg I. (eds.), *Flora of Ethiopia and Eritrea 2:2.* The National Herbarium, Addis Ababa. Pp. 265-380.

Godreau, V., (1999). Biodiversity in the floodplain of Saone: A global Approach. *Biodiversity and Conservation.* 8:839-864. Kluwer Academic Publishers. Netherlands

Gregory, S.V. (1991). An ecosystem perspective of riparian zones. *BioScience.* 41:540-551.

Halcrow, W. (1989). *Master Plan for the Development of Surface Water Resources in the Awash Basin, Final Report, Vol. 2.* EVDSA, Addis Ababa.

Hedberg, I. & Edwards, S. (eds.). (1989). *Flora of Ethiopia*, Vol. 3. The National Herbarium, Addis Ababa. Pp. 659.

Hedberg, I. & Edwards, S. (eds.). (1995). *Flora of Ethiopia and Eritrea, Vol. 7.* The National Herbarium, Addis Ababa. Pp. 420.

Higgins, S. I.; Rogers, K. H & Kempler, K. (1997). A description of the functional vegetation pattern of a semi-arid floodplain, South Africa. *Plant Ecology.* 129:95-101.

Hill, M. O. (1974). *TWINSPAN: A FORTRAN Program for Arranging Multivariate data in an Ordered Two-way Table Classification of Individuals and Attributes.* Cornell University, Ithaca, New York. Pp. 31.

Houerou, N. L. (ed.) (1980). *Browse in Africa: The current state of knowledge.* ILCA, Addis Ababa, Ethiopia. Pp. 491.

Huston, M. A. (1994). *Biological Diversity: The coexistence of species on changing landscapes.* Cambridge University Press; United Kingdom. Pp. 680.

Johansson, Mats, E., Nilsson, C. & Nilsson, E. (1996). Do rivers function as corridors for plant dispersal? *Journal of Vegetation Science.* 4:609-620.

Johnson, W.C. (1992). Dams and riparian forests: a case study from upper Missouri River. *Rivers.* 3:229-242.

Kent, M. & Coker, P. (1992). *Vegetation description and Analysis: A Practical Approach.* Belhaven Press (A division of Pinter Publishers), 25 Floral Street, London, UK. Pp. 361.

Klosowski, S. & Tomaszewicz, H. (1993). Analysis of Distribution, Structure and Habitat conditions of Riparian Vegetation in the River-Lake System of the Upper Szeszupa (Suwalki Landscape Park-North-Eastern Poland). *Ekologia Polska.* **41:1-2;** 123-156.

Kusler, J. (1989). Multi-objective river corridor management: an introduction to issues: recommendations for implementing programs. *Wetlands.* **17:(1):**138-148.

Longhitano, N. & Bavazzano, R. (1973). Researches on the vegetation of the Middle Valleys of Awash River (Ethiopia). *Webbia.* **28:** *543-565.*

Martin, G. J. (1995). *Ethnobotany: A Methods Manual.* Chapman and Hall, London. Pp. 268.

Medley, K. E. (1992). Patterns of forest diversity along the Tana River, Kenya. *Journal of Tropical Ecology*: **8**:353-371.

Mitch, J. & Gosselink, G. (1993). *Wetlands.* Van Nostrand Reinhold, USA Pp. 559.

Mohr, P. A. (1971). *The Geology of Ethiopia.* 2nd ed. University College of Addis Ababa Press, Addis Ababa.

Muller-Dombois, D. & Ellenberg, H. (1974). *Aims and Methods of Vegetation Ecology.* John

Wiley & Sons, New York. Pp. 547.

Pollock, M. M. (1998). Plant species richness in riparian in riparian wetlands-a test of biodiversity theory. *Ecology.* 79:94-105.

Rood, S. B. & Mahoney, J. M. (1990). Collapse of riparian popular downstream from dams in western prairies: probable cases and prospects for mitigation. *Environ. Manage.* 14:451-464.

Rood, S. B. & Mahoney, J. M. (1990). River damming and riparian cottonwoods along the Marias River, Montana. *Rivers.* 5:195-207.

Singsby, D. & Cook, C. (1986). *Practical Ecology.* The Macmllan Press Ltd. Hong Kong.

Soule, M. E. (1986). *Conservation Biology: The science of Scarcity and Diversity.* Sinaues Associates Inc., Sunderland, Massachusetts, USA. Pp. 584.

Springuel, I. (1990). Riverine Vegetation in the Nile valley in Upper Egypt. *Journal of Vegetation Science.* 1:595-598.

Tesfaye Chernet (1993). *Hydrology of Ethiopia and Water Resources Development.* Ethiopian Institute Of Geological Surveys, Ministry of Mines and Energy, Addis Ababa. Pp. 179.

Trémoliéres, M., Carbiener, R., Orscheit, A., & Klein, J. P. (1994). Changes in aquatic vegetation in Rhine floodplain streams in Alsace in relation to disturbance. *Journal of Vegetation Science.* 5:169-178.

UNCED (1992). An introduction to the United Nations Convention to Combat Desertification. The secretariat for the Convention to Combat Desertification; France.

Van der Maarel (1979). Transformation of cover/abundance values in phytosociology and its effect on community similarity. *Vegetatio.* 39:97-114.

Vollesen, K & Sebsebe Demissew (1995). Tiliaceae. In: Edwards S., Mesfin Tadesse & Hedberg I. (eds.), *Flora of Ethiopia and Eritrea, Vol. 2:2.* The National Herbarium, Addis Ababa. Pp. 145-164.

Walter, H. (1985). *Vegetation of the Earth and Ecological Systems of the Geo-biosphere.* Springer-Verlag, Berlin Heidelberg. Printed in Germany. Pp. 318.

Appendix 1. List of Vascular Plant Species That Were Collected and Identified In The Study.

No.	SCIENTIFIC NAME	FAMILY	VOUCHER NUMBER
1.	*Abutilon anglosomalie* Cufod.	Malvaceae	24
2.	*Acacia brevipsica* Harms.	Fabaceae	25
3.	*Acacia hecatophyla* Steud. ex. Rich.	"	26
4.	*Acacia hockii* Del.	"	27
5.	*Acacia mellifera* (Vahl) Benth.	"	28
6.	*Acacia nilotica* subsp. *indica* L. Willd ex Del.	"	29
7.	*Acacia nilotica subsp. leiocarpa* (L.) Willd. ex. Del.	"	30
8.	*Acacia nubica* Benth.	"	31

9.	*Acacia robusta* Burch subsp. *usambarensis* (Taub.) Brenan	"	32
10.	*Acacia senegal* (L.) Willd.	"	33
11.	*Acacia seyal Del.*	"	34
12.	*Acacia tortilis* (Forssk.) Hayne	"	35
13.	*Acalypha crenata* A. Rich.	Euphorbiaceae	36
14.	*Achyranthes aspera* L.	Amaranthaceae	37
15.	*Acokanthera schimperi* (A. DC.) Schweinf.	Apocynaceae	38
16.	*Amaranthus dubius* mart.	Amaranthaceae	115
17.	*Aristida cumingiana* Trin. & Rupr.	Poaceae	39
18.	*Asparagus africanus*	Asparagaceae	114
19.	*Balanites aegyptiaca* (L.) Del.	Balanitaceae	41
20.	*Barleria acanthoides* Vahl	Acanthaceae	42
21.	*Cadaba rotundifolia* Forssk.	Capparidaceae	43
22.	*Capparis tomentosa* Lam.	"	44

23.	*Carissa edulis* Vahl	Apocynaceae	45
24.	*Celtis africana* Burm. f.	Ulmaceae	46
25.	*Cissus quadrangularis* L.	Vitaceae	47
26.	*Cissus rotundifolia* (Forssk) Vahl	"	48
27.	*Combretum adenogonium* Steud. ex. A. Rich.	Combretaceae	49
28.	*Combretum molle* R. Br.	"	50
29.	*Commelina benghalensis* L.	"	51
30.	*Corchorus aestuans* L.	Tiliaceae	52
31.	*Corchorus fascicularis* Lam.	"	53
32.	*Cordia gharaf* (Forssk.) D.	Boraginaceae	54
33.	*Creptostegia grandiflora* R. Br.	Asclepiadaceae	55
34.	*Cyperus nutans* Vahl	Poaceae	56
35.	*Datura inoxia* L.	Solanaceae	57
36.	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	58

37.	*Diospiros abyssinica* (Hiern) F. White	Ebenaceae	59
38.	*Dobera glabra* (Forssk.) Poir.	Salvadoraceae	60
39.	*Equisetum ramosissimum* Desf.	Equisetaceae	61
40.	*Euclea divinorum* Hiern.	Ebenaceae	62
41.	*Euclea racemosa* subsp. *schimperi* (A. DC.)F. Dandy	"	63
42. .	*Eulophia petersi* Rchb. f.	Orchidaceae	64
43.	*Euphorbia glochidiata* Pax.	Euphorbiaceae	65
44.	*Euphorbia nigrispinoides* M. Gilbert	"	66
45.	*Ficus capreaefolia* Del.	Moraceae	67
46.	*Ficus salicifolia* Vahl	"	68
47.	*Ficus sycamorus* L.	"	69
48.	*Glycine wighti* var. *longicauda* (Weight & Arn.) Verdc.	Fabaceae	70

49.	*Gomphocarpus physocarpus R. Br.*	Asclepiadaceae	71
50.	*Grewia bicolor* Juss.	Tiliaceae	72
51.	*Grewia mollis* Juss.	"	73
52.	*Grewia tenax* (Forssk.) Fiori	"	74
53.	*Heteropogon conturtus* (L.) Roem. & Schult	Poaceae	75
54.	*Grewia tenax* (Forssk.) Fiori	"	76
55.	*Hippocratea africana* (Willd.) Loes	Celastraceae	77
56.	*Ipomoea carica* (L.) Sweet	Convolvulaceae	78
57.	*Lannea schimperi* (A. Rich) Engl.	Anacardiaceae	79
58.	*Lythrum salicaria L.*	Lythraceae /Punicacea	80
59.	*Maerua subcordata* Forssk.	Capparidaceae	81
60.	*Manilkara butugi* Chiov.	Sapotaceae	82
61.	*Maytenus gracilipes* subsp. *arguta* (Loes) Sebsebe	Celastraceae	83

62.	*Maytenus senegalensis* (Lam.) Exell	"	85
63.	*Megalochlamys violacea* (Vahl) Vollesen	Acanthaceae	86
64.	*Mimusops laurifolia* (Forssk.) Friis	Sapotaceae	87
65.	*Nicotiana glauca* L.	Solanaceae	88
66.	*Pappea capensis* Eckl. & Zeyh	Sapindaceae	89
67.	*Phoenix reclinata* Jacq.	Arecaceae	90
68.	*Phragmites communis* Trin.	Cyperaceae	91
69.	*Phyllanthus reticulatus* Poir.	Euphorbiaceae	92
70.	*Prosopis juliflora* (Sw.) DC.	Fabaceae	93
71.	*Pterolobium stellatum* (Forssk.) Brenan	"	94
72.	*Rhus natalensis* Krauss.	Anacardiaceae	95
73.	*Rhus vulgaris* Meikle	"	96
74.	*Ricinus communis* L.	Euphorbiaceae	97
75.	*Salix subserrata* Willd.	Salicaceae	98

76.	*Sansevieria abyssinica* N. E. Br.	Dracenaceae	99
77.	*Sansevieria powelli* N. E. Br.	"	100
78.	*Senna petersiana* (Bolle) Lock	Fabaceae	101
79.	*Sesbania sesbans* var. *nubica* Chiov.	"	102
80.	*Sida collina* Schlechtend.	Malvaceae	103
81.	*Sida schimperiana* Hochst ex. A. Rich.	"	104
82.	*Solanum dubium* L.	Solanaceae	105
83.	*Solanum incanum* L	"	106
84.	*Sterculia africana* (Lour.) Fiori	Sterculiaceae	107
85.	*Tamarindus indica* L.	Fabaceae	108
86.	*Tamarix nilotica* (Ehrenb.) Bunge	Tamaricaceae	109
87.	*Terminalia brevipes* Pampan.	Combretaceae	110
88.	*Terminalia brownii* Fresen.	"	111
89.	*Veronica anagallis aquatica* L.	Scrophulariaceae	112
90.	*Withania somnifera* (L.)	Solanaceae	113

91.	*Xanthium strumarium* L.	Compositae	114
92.	*Ziziphus mucronata* Willd.	Rhamnaceae	115
93.	*Ziziphus spina-christi* (L.) Desf.	"	116

Appendix 2. Summary For Ethnobotanically Significant Plants.

No.	Scientific Name	FAMILY	VERNACULAR	USES	PARTS USED
1	*Abutilon anglosomalie* Cufod.	MALVACEAE	Hambukto (Af.)	Animal forage	Leaves
2	*Acacia brevipsica* Harms	FABACEAE	Hamarrecha (Or.)	Medicinal and domestic use	Bark & roots
3	*Acacia hecatophyla* Steud ex. Rich.	"	Adado (Af.)	Browse	Leaves and twigs
4	*Acacia mellifera* (Vahl) Benth.	"	Saphansa (Or.) Maka'arto (Af.)	Browse and food value	Leaves & Gum
5	*Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan	"	Kasalto (Af.)	Browse & domestic use	Pods; leaves and bark
6	*Acacia nilotica* (L.) Willd. ex Del. subsp. *leiocarpa* Brenan	"	Kasalee (Or.)	Domestic use	Bark and branches
7	*Acacia robusta* Burch. *subsp. usambarensis* (Taub.) Brenan	"	Waangaayyoo (Or.)	Domestic and medicinal use	Leaves; bark & branches
8	*Acacia senegal* (L.) Willd.	"	Saphasa (Or.)	Browse and food value	Leaves and gum
9	*Acacia seyal* Del.	"	Waaccuu (Or.)	Browse and food value	Leaves and gum
10	*Acacia tortilis* (Forssk.) Hayne	"	Dhadacha (Or.)	Ritual & domestic use	Bark and leaves
11	*Acalypha crenata* A.Rich.	EUPHORBIACEAE	Barobarbare (Af.)	Medicinal use	Leaves
12	*Achyranthes aspera* L.	AMARANTHACEAE	Ilmole (Af.) Darguu (Or.)	Medicinal use	Leaves and roots
13	*Acokanthera schimperi* (A.DC.) Schweinf.	APOCYNACEAE	Qaraaruu (Or.)	Medicinal & domestic use	Leaves and roots
14	*Amaranthus dubius* Mart	"	Ashara Af.)	Medicinal use & food value	Leaves
15	*Asparagus africanus* Lam.	ASPARAGACEAE	Sariitii (Or.)	Ritual & medicinal use	The whole plant

16	*Balanites aegyptiaca* (L.) Del.	BALANITACEAE	Badannoo (Or.)	Medicinal; food value & forage	Leaves & fruits
17	*Carissa edulis* (Forssk) Vahl	"	Hagamsa (Or.)	Domestic; medicinal and food value	Fruits; seeds; spines
18	*Cissus quadrangulari* L.	VITACEAE	Cophii (Or.) Ali'e (Af.)	Medicinal use	Leavea and roots
19	*Combretum molle* (R.Br. ex. Don.)	COMBRETACEAE	Rukeensa (Or.)	Domestic use	Bark
20	*Commelina benghalensis* L.	COMMELINACEAE	Gororsaa (Or.)	Medicinal use	Leaves
21	*Creptostegia grandiflora* R.Br.	ASCLEPEDIACEAE	Halimaro (Af.) Hoqonqol; Muka farrisaa (Or.)	Domestic use	Latex
22.	*Ficus capreaefolia Del.*	MORACEAE	Luugoo (Or.)	For building temporary ritual huts, river vank protection	Whole part
23.	*Ficus sycamorusL.*	"	Subla (Af.) Odaa (Or.)	Shade, livestock feed.	Leaves and fruit
24.	*Equisetum ramosissimum* Desf.	EQUISETACEAE	Rigaa (Or.)	Tooth brush	Whole plant
25.	*Glycine wightii* (Wight & Ar n.) Verdc. var. *longicauda* (Schweinf.) Bak.	"	Hidda (Or.)	Browse	Whole plant
26.	*Grewia mollis* Juss	TILIACEAE	Harooressa (Or.)	Domestic use & browse	Stem
27.	*Lannea schimperi* (A. Rich) Engl.	ANACARDIACEAE	Datahara (Af.)	Medicinal use	Bark & root
28.	*Manilkara butuji* Chiov.	SAPOTACEAE	Butujii (Or.)	Domestic use	Bark
29.	*Maytenus senegalensis* (Lam.) Excell	CELASTERACEAE	Kombolcha (Or.)	Medicinal and food value	Leaves; flowers and barks
30.	*Mimusops laurifolia* (Forssk.) Friis	"	Qolaatii (Or.)	Food value	Fruits
31.	*Pappea capensis* Eckl. & Zeyh	SAPINDACEAE	Biiqaa (Or.)	Domestic use	Bark
32.	*Phoenix reclinata* Jacq.	ARECACEAE	Meexxii r.)	Domestic use	Leaves

33.	*Pterolobium stellatum* (Forssk.) Brenan	"	Hallaan qabeecha (Or.)	Domestic use and medicinal use	Leaves and stems
34.	*Rhus natalensis* Krauss	"	Xaxessaa (Or.)	Medicinal and food value	Roots and fruits
35.	*Sansevieria ehrenbergii* Schweinf. ex Baker	DRACAENACEAE	Algee (Or.)	Domestic and medicinal use	Leaves; fruits; stems
36.	*Sansevieria forskaoliana* (Shult. f.) Hepper & Wood	"	Algee korma (Or.)	Domestic use	Leaves