Plant Life Form Classification and Distribution at Suba Sebeta Forest, Central Ethiopia

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GRADUATE PROGRAMMES

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ABSTRACT

Plant Life form Classification and Distribution at Suba Sebeta Forest, Central Ethiopia

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A study focusing on altitudinal distribution of life forms of vascular plants was conducted in Suba Sebeta Forest, located 40 km southwest of Addis Ababa in Oromia National Regional State. The objective of the study was to document the life form composition of Suba Sebeta Forest based on life form spectrum. Systematic sampling method was used to collect vegetation data from 48 (20 m x 20 m) plots. These entire quadrats included 16 (5 m x 5 m each) subplots to incorporate all life form types. Vegetation classification was done based on Raunkiaer major life form group. R- Software package was used to classify the life forms. The data were collected along altitudinal gradients, ranging from 2400 to 2870 m a.s.l. A total of 135 species belonging to 67 families were recorded from the study area; the results showed that Asteraceae was the dominant family accounting for 15.6% of the total record. Analysis of life form spectrum showed Phanerophytes as the dominant life form contributing 48 species (35.6%) followed by Hemicryptophytes (34 species, 25.18%), Chamaeophytes (22 species, 16.30%), Therophytes (20 species, 14.81%) and Geophytes (11 species, 8.15%) to the total life form record. Correspondence analysis between life form and environmental gradients showed no significant relationship between life forms and soil pH while altitudinal difference affects the life form distribution. The number of Chamaeophytes increased with increasing altitude whereas that of Therophytes decreased with increasing altitude. The Phanerophytes and Hemicryptophytes were well distributed in the study area.In Geophytes, altitude did not show significant influence. These life forms percentages are contributs a lot for ferther stady of life form related to climat change.

Key Words/ Phrases: Life form, Life form Spectrum, Raunkiaer, Suba Sebeta Forest

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Abbreviations and Acronyms

AAU ---------------------------- Addis Ababa University

EFAP---------------------------- Ethiopian Forestry Action Program

ETH ----------------------------- National Herbarium of Ethiopia

FAO ----------------------------- Food and Agricultural Organization

FEE ------------------------------ Flora of Ethiopia and Eritrea

GPS ------------------------------ Geographical Position System

IBC ------------------------------ Institute of Biodiversity Conservation

IUCN -------------------------- International Union for the Conservation of Nature and Natural Resource.

NMA ------------------------- National Meteorological Agency

PGRFA ------------------------- Plant Genetic Resources for Food and Agriculture

UNEP --------------------------- United Nations Environment Program

UNESCO ----------------------- United Nations Education, Science and Culture organization

CHAPTER ONE

1. Introduction

1.1. Background and Justification

Vegetation may be characterized either by the component species or the combination of structural and functional attributes. Vegetation cover of an area has a definite structure and composition developed as a result of long-term interaction of biotic and abiotic factors (Peters, 1996). Vegetation structure is the organization in space of the individuals that form a community and by extension a vegetation type or plant association (Muller-Dombois and Ellenberg, 1974). It is the spatial pattern of growth forms in a plant community, especially with regard to their height, abundance or coverage within the individual layer (Jennings *et al*., 2003). Functional characters are those that provide an adaptive role which help the survival of organisms in the present and past environments (Goldsmith *et al*., 1986).

There are about 23 vegetation types that have been recognized in Ethiopia. These types have been grouped into nine major categories or zones (PGRFA, 2008; Friis, *et.al*. 2010). According to the Flora of Ethiopia and Eritrea (FEE) volume eight the vegetation of the flora area is divided in to nine broad types including the coastal vegetation which is not found in Ethiopia. These vegetation types are described as Desert and semi-desert scrubland; *Acacia-Commiphora*; Moist evergreen forest, which is further divided into two sub categories (afromontane and transitional forest); Lowland semi-evergreen forest; *Combertum-Terminalia*; Dry evergreen Montane Forest; Afro- alpine and sub-afro alpine; and Riparian and swamp vegetation types.

Vegetation is an assemblage of plants growing together in a particular area. Several native and foreign scholars (Logan, 1946; Pichi-Sermolli, 1957; von Breitenbach, 1961, 1963; Westphal, 1975; Chaffey, 1979; Friis et. al., 1982; Tewolde Berhan Gebre Egziabher, 1986, 1988; Friis, 1986, 1992; Friis and Mesfin Tadesse, 1990; EFAP, 1994; Teshome Soromessa and Sebsebe Demissew, 2002; Teshome Soromessa *et.al*., 2004) have attempted to study the vegetation resources of Ethiopia, which mostly comprises forests, woodlands and bushlands and the researchers employed different methods of vegetation classification. From the beginning of 19thC to mid 20thC foreign travelers undertook most of the vegetation studies, identifications and descriptions in Ethiopia.

Vegetation distribution and pattern is influenced by environmental factors such as altitude, climate (precipitation and temperature), soil type and the interaction of these factors. The rainfall pattern in Ethiopia is influenced by two rain-bearing wind systems: the monsoonal wind system that is brought from the South Atlantic and the Indian Ocean and the winds from the Arabian Sea. The two wind systems alternate, causing different rainfall regimes in different parts of the country (IBC, 2005).

Several quantitative measures are employed to describe the structure of plant communities with much ecological precision, qualitative characters such as species richness, life form spectrum and vertical disposition of species. Raunkiaer (1934) described communities of different climatic zones or phytoclimatic zones of the earth on the basis of life form spectrum or biological spectrum. Any change in the life form composition away from its phytoclimatic zone is considered an indicator of alteration in vegetation either due to biotic or edaphic factors or both. However, recently the natural structural complexities of plant communities are being affected mostly due to reckless anthropogenic activities. Excessive utilization of forest resources and overgrazing has resulted in negative changes in the life form composition of plant communities (Reddy *et al*., 2002; Verma and Shukla, 1993). Vegetation profile of the component species indicates the phyto-climatic condition of an area and is employed commonly in community structural description through profile diagrams (Ashton and Hall, 1992; Chen, 1995; Pignatti, 1995; Sahunalu and Dhanmanonda, 1995; Unwin, 1989 and Visalakshi, 1995).

In 1904, Raunkiaer proposed a classification system based on the position and degree of protection of renewing buds, which are responsible for the renewal of the plant aerial body after unfavorable season. Although the system was sometimes strongly criticized (Sarmiento and Monasterio, 1983), Raunkiaer's system is still the simplest and, in many ways, the most satisfying classification of plant life forms (Begon *et al*., 1996). This system has been widely applied in many vegetation types to classify plant species in life forms, such as, tundra (Raunkiaer, 1934), tropical rain forests (Cain *et al*., 1956), meadows (Beaman and Andresen, 1966), temperate forests (Buell and Wilbur,1948; Gao and Chen,1998), savannas (Cole and Brown, 1976; Sarmiento and Monasterio,1983), deserts (Qadir and Shevty ,1986; El-Demerdash *et al*., 1994; El-Ghani, 1998), prairies (Stalter *et al*.,1991), tropical grasslands (Shankar *et al*., 1991) and Mediterranean vegetation (Dimopoulus and Georgiadis,1992; Christodoulakis,1996)

According to Box (1981), study of plant life forms is important for the following reasons: (1) plant life forms provide the basic structural components of vegetation stands, being the most obvious level of subdivision for describing and explaining vegetation structure. (2) Primary physiological processes of plants are controlled by aspects of plant form which provides a useful means of getting at general principles of plant-environment relations without becoming mired in taxonomic detail. Odland (2009) stated that, plant life forms are functional types that have been used to describe plant adaptation to certain ecological conditions. Plants with a similar life form are assumed to have a similar effect on the dominant ecosystem processes (Pausas and Austin, 2001). Therefore, these morpho-ecological types can be used to indicate particular climate properties, biogeographic regions, major biomes of the world (Raunkiaer, 1934) and other environmental differences especially in regions with a seasonal climate (Klimes, 2003).

Muller-Dombois and Ellenberg (1974) stated that, plants of the same life form growing together are likely to compete directly for the same space or niche (ecological role of a species in an environment). Their similarity in structure and form indicates a similarity in adaptation to the utilization of the environmental resources offered in a given space. Wherever they grow close together, they are also the strongest competitors, because they are adapted to use the environmental resources in the same manner. Variation in life forms along altitudinal gradients has been used for a better interpretation of vegetation and species richness patterns in relation to environmental gradients. Life form diversity creates ecological opportunity, and this positive feedback culminates in the high biotic diversity that is found in tropical forests. The distribution with altitude of every plant species gives an idea of its ecological plasticity. The life form of plants include species, which have similarities in the complex of ecological conditions characteristic of their habitats (Angelova and Tashev, 2005)

Different factors such as environment, periodic phenomena, and community development influence life forms. On the other hand, internal ecosystem functioning can be influenced by an already established life forms. Solbrig (1993) described life forms as single character based functional groups, yet even at this level there are some similarities in life history and resource use that lend coherence to the categories. This is perhaps to be expected if life forms are the result of evolutionary forces that lead to ecological convergence (Bocher, 1977).

Tropical forests are the storehouses of biodiversity and comprise the most diverse plant communities on earth (Brady, 1994; Supriya and Yadava, 2006). The forests are good sources of timber, medicinal plants, wild edible plants, fuel, and fodder and play critical role in watershed protection. They also contribute significantly to the global carbon pool and net primary productivity of terrestrial ecosystem. According to Wilson (1977), the tropical forests make up over half of the global number of species. Tropical forests account for 52% of the total forest area of the world, of which 42% is dry forest, 33% is moist forest and 25% is wet and rainforest (Murphy and Lugo, 1986).

The largest proportion of tropical dry forests is found in Africa, where it accounts for 70 – 80% of the forest area (Demel Teketay, 1996) and Africa’s rich biodiversity is estimated to comprise about 25% of global biodiversity in terms of ecosystems, species composition and genetic variety

(Mugabe, 1998). In ecological complexity dry forests are next to rainforests, which arises from the strong seasonal and inter-annual variability in rainfall, which permits the occurrence of very diverse flora and fauna (Khurana and Singh, 2001). The Ethiopian highlands contribute to more than 50% of the land area with Afromontane vegetation of which dry mountain forests form the largest part (Tamrat Bekele, 1994).

Within the tropics, precipitation is a major determinant of life form distribution. If life form definitions emphasize the types in the tropics, the general trend of life form richness with increasing rainfall. On the other hand, if, Raunkiaer's system is assumed, which emphases on adaptations to harsh environments, life form richness increases with aridity (Shreve, 1936; Whittaker and Niering, 1965). Different life forms respond in different ways to increasing availability of water, even in tropical forests.

Several studies focusing on forests or vegetation of specific regions in Ethiopia were carried out by different scholars (Hedberg, 1951 ; 1957; Mooney, 1963; Gilbert, 1970; Coetzee, 1978; Friis *et al*., 1982 ; 2010; Hailu Sharew, 1982; Zerihun Woldu, 1985; Sebsebe Demissew, 1988; Uhlig, 1988; Zerihun Woldu *et al*., 1989; Uhlig and Uhlig, 1990; Zerihun Woldu and Backeus, 1991; Haugen, 1992; Mesfin Tadesse, 1992; Tamrat Bekele, 1993 ; 1994; Miehe and Miehe, 1994; Kumlachew Yeshitila and Taye Bekele, 2003; Simon Shibru and Girma Balcha, 2004; Teshome Soromessa *et al*., 2004).

Furthermore, the vegetation resources of Ethiopia have been also studied by different scholars (Logan, 1946; Pichi-Sermolli, 1957; von Breitenbach, 1962, 1963; Westphal, 1975; Chaffey, 1979; Tewolde Berhan Gebre Egziabher, 1986, 1988; Friis, 1986, 1992; Friis and Mesfin Tadesse, 1990; EFAP, 1994; Teshome Soromessa and Sebsebe Demissew, 2002; Friis *et al*., 1982). Even though lots of studies have been done on the vegetation classification and different ecological parameters; plant life form work has never been done in Ethiopia. This study therefore, focuses on vegetation classification based on Raunkiaer life form spectrum along an altitudinal gradient in the Suba Sebeta Forest.

1.2. Statement of the Problem

Life form spectrum and vertical disposition of species are some of the important parameters to describe vegetation. The life form of any plant is a constant character of morphological adaptation. This realization is highly influenced by genetics and environmental factors since environment can be vital in shaping different forms of plants. Of the several classifications of plant life forms, the most widely used is that of the Raunkiaer system. Raunkiaer's system has been built based on vegetative buds position after unfavorable condition for plant growth. This explanation clearly shows that vegetation in different climatic zone also different in life form diversity.

Until recently, studies have been done to describe the vegetation of Suba Sebeta Forest based on usual floristic composition. As can be clearly understood from the previous studies, there is no work that considers the plant life form composition which is regarded as the major indicator of regional and global climate change across the world. In order to fill the scientific information gap in the study area, this research primarily focused on studying the plant life form composition in Suba Sebeta Forest.

1.3. Objectives of the study

1.3.1. General objective

- To document the life form composition of Suba Sebeta Forest based on biological (life form) spectrum for better understanding of the vegetation characteristic.

1.3.2. Specific objectives

- To describe life form composition of Suba Sebeta Forest.
- To classify the vegetation in terms of plant life forms.
- To identify the dominant life form groups in the forest.
- To describe the life form distribution along an altitudinal gradient.
- To scale up the understanding on the vegetation for possible use in developing sound conservation measures.

CHAPTER TWO

2. Literature Review

2.1. Plant life Form

A life form of the plant is the sum of all life processes and evolved directly in response to the environment (Cain, 1950). The life forms of plants are classified on the basis of adaptation of their perennating organs to veil over the unfavorable conditions. Humboldt (1886) for the first time formulated the concept of the life forms for which he considered the location of perennating buds or organs. Raunkiaer (1934) used it as descriptive tool for classifying plant life forms based on the position and degree of protection of the renewing buds, which are responsible for the renewal of the plant's aerial body when the favorable season comes (Sudhakar, *et.al.*, 2011).

A plant life form is usually understood as a growth form that displays an obvious relationship to key environmental factors (Mueller-Dombois and Ellenberg, 1974), being characterized by the adaptations of plants to certain ecological conditions. According to Box (1981), the study of plant life forms is important for providing the basic structural components of vegetation stands, being the most obvious level of subdivision for describing and explaining vegetation structure and providing useful means of getting general principles of plant-environment relations without becoming hindered in taxonomic detail.

Plants are classified taxonomically into families, genera, species, subspecies, varieties, etc. This, however, is not the only way to classify plants. Plants can also be grouped into life form classes on the basis of their similarities in structure and function (Mueller-Dombois and Ellenberg, 1974). A life form is characterized by the adaptation of plants to certain ecological conditions (Mera *et al*., 1999). Life form study is an important part of vegetation description, ranking next to floristic composition (Cain, 1950).

2.2. Raunkiaer's Plant Life form Classification

Raunkiaer proposed a classification system based on the position and degree of protection of the renewing buds. They are responsible for the renewal of the plant aerial body after the unfavorable season. In this system, the more pronounced the unfavorable season, the more protected the renewing buds. In Raunkiaer's classification there are five major classes, arranged according to increased protection of the buds.

2.2.1. Phanerophytes

Phanerophytes are plants having their dormant buds on branches which project into the air and thus are woody plants. These may further be classified according to size, since this is determined by the relation between the plants and the humidity of the environment. The subgroups are: (1) the Megaphanerophytes, which have a stature of over 30 metres; (2) the Mesophanerophytes, 8-30 metres tall; (3) the Microphanerophytes, ranging in height from 2-8 metres; and (4) the Nanophanerophytes, which are less than 2 meters in height.

2.2.2. Chamaeophytes

Plants in which the surviving buds or shoot apices are born on shoots very close to the ground, up to 25 cm from soil surface. They include those bearing erect shoots which die back to the portion that bears the surviving buds. They may be passive or active Chamaeophytes. Passive Chamaeophytes – persistent weak shoots that trail on or near the ground and active Chamaeophytes that trail on or near the ground because they are persistent and have horizontally directed growth.

2.2.3. Hemicryptophytes

Plants which have the surviving buds or shoot apices situated in the soil surface. These are rosette plants bearing all their foliage in basal rosette and partial rosette plants bearing most of their foliage (and the largest) on short internodes near ground level.

2.2.4. Cryptophytes

Cryptophytes are plants having their dormant parts entirely covered and well hidden. There are three divisions of the Cryptophytes: the Geophytes, the Helophytes and the Hydrophytes.

In the case of the Geophytes, there are bulbs, rhizomes, tubers or similar structures deep below the soil surface. The Helophytes are characterized by semi-aquatic dormant buds and are marsh plants. The Helophytes do not include all marsh species, but only such plants as are Cryptophytes and have their buds buried at the bottom of the water or in the subjacent soil. The Hydrophytes are the water plants and have either perennating rhizomes or similar structures or winter buds beneath the water.

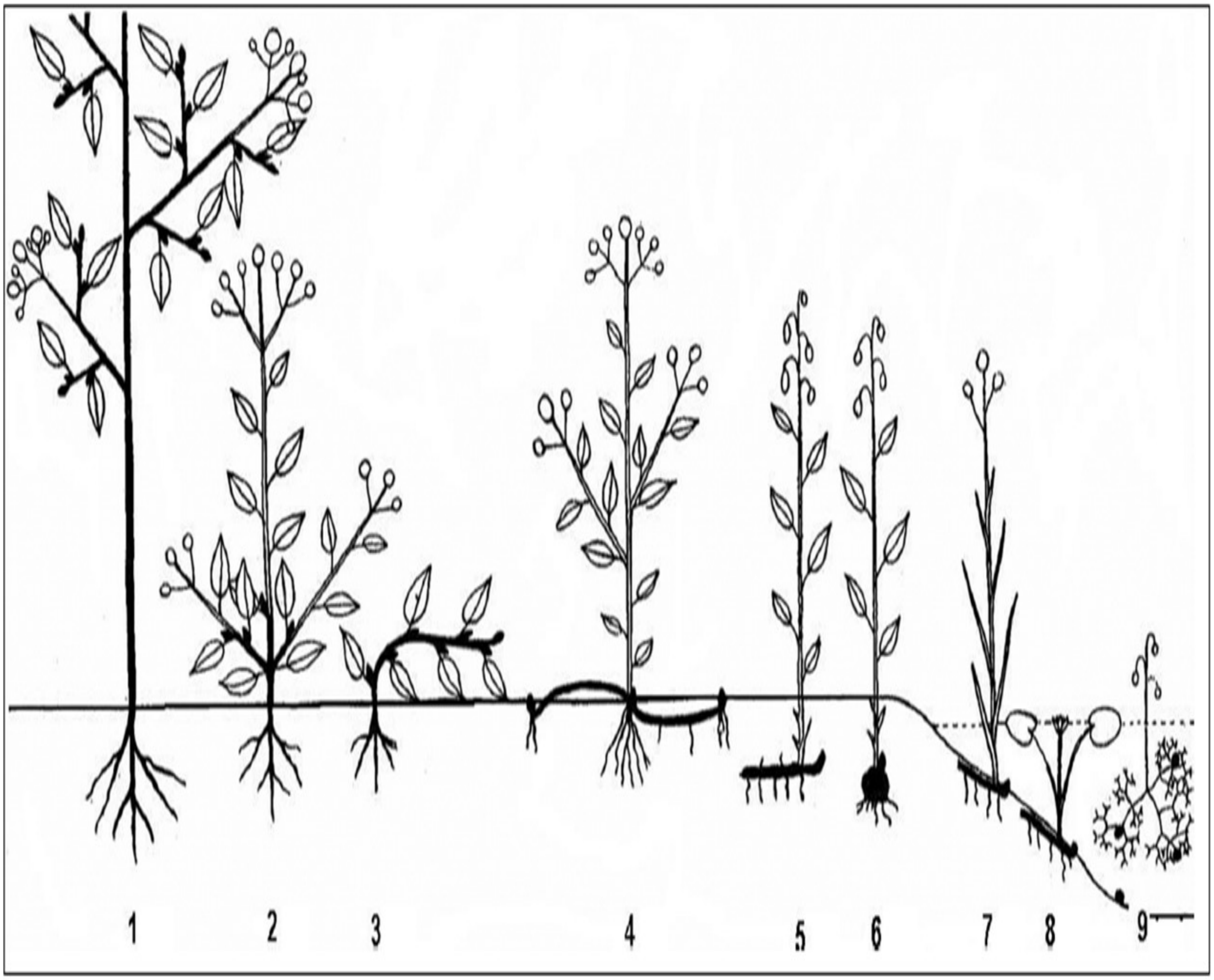

Figure 1 Major life form types as proposed by Raunkiaer: 1 - Phanerophytes, 2, 3 - Chamaeophytes, 4 – Hemicryptophytes and 5, 6, 7, 8, 9 – Cryptophytes (5, 6 are geophytes, 7 Helophytes and 8, 9 Hydrophytes). The parts of the plant which die during the unfavourable season are unshaded and the persistent axes with the surviving buds are black. The Therophytes - the annuals- are not shown due to the absence of over-wintering buds.

Adopted from Figure 2 in Margit *et.al,* (2006). This was redrawn from Figure 7 in Raunkiaer (1934).

2.2.5. Therophytes

Plants that complete their life cycle from seed to seed and die within a season. Shoot apical meristems (perennating bud) persist during unfavorable climatic conditions only within seeds. Annuals and desert ephemerals are examples of therophytes. In cases of Ethiopia, this group also includes species that germinate in summer (rainy season), flower and die in the autumn of the following year.

Raunkiaer's system was modified, among others, by Braun-Blanquet (1928) and Mueller-Dombois & Ellenberg (1974), to include plant traits in the favorable season, which were originally neglected by Raunkiaer (1934).

2.3. Life form (Biological) Spectrum

The biological spectrum is defined as percentage ratio of life form of plant present in any area. It is an important physiognomic attribute that has been widely used in vegetation studies. Life form spectrum tells about the climate of an area and can be predicted for particular climate properties for any continent, bio geographic region and altitude (Sarmiento and Monasterio, 1983).

Raunkiaer (1934) described communities of different climatic zones or phytoclimatic zones of the earth on the basis of life form spectrum or biological spectrum. Any change in the life form composition away from its phytoclimatic zone is considered an indicator of alteration in vegetation either due to biotic or edaphic factors or both. The occurrence of similar biological spectra in different regions indicates similar climatic conditions.

The most conspicuous feature of the primary tropical and subtropical humid forests such as species richness, community architecture and structure are greatly influenced by rainfall pattern and temperature. These are further modified by edaphic, orographic, biotic and historical influences (UNESCO/UNEP/FAO, 1978). In recent years man has abused the natural vegetation so much so that often plant communities do not show their natural structural complexities. Excessive utilization of forest resources and overgrazing has resulted in change in the life form composition of plant communities (Verma & Shukla, 1993; Reddy *et al*., 2002).

2.4. Disturbance and Change in Life form

Plant life forms differentiate not only due to climatic variations, but seem also to relate to human disturbance and management. Studies from India on the effect of anthropogenic factors (e.g. pollution and grazing) on both species and life form composition have found relationship between changes in species composition and changes in life form composition (Pandey and Verman, 1990; Prasad, 1995). Pandey and Verman (1990) studied the effect of coal dust pollution on plant species and life form composition and found that Chamaeophytes, Hemicryptophytes and Therophytes where more abundant on polluted grasslands than on unpolluted grasslands and that species diversity was higher on unpolluted grasslands than on polluted. On the other hand, Prasad (1995) studied the effects of grazing on plant species and life form composition and found that more grassland species were present at grazed areas than on protected areas and that the percentage of Therophytes was higher on grazed areas than on protected areas.

In theory, the plant life form combinations will adjust to the environmental conditions (Raunkiaer, 1934) which has been strengthen by field studies on the relation between environmental impacts and life form composition (McIntyre *et al*., 1995; Pandey and Verman, 1990; Prasad, 1995; Vind and Andreasen, 1997). The study of change in life form compositions can relate to changes in biodiversity whether caused by climate change or by change in land use. Understanding the relationships between changes in life form composition and changes in species composition still needs further study (Mcintyre *et al*., 1995).

CHAPTER THREE

3. Materials and Methods

3.1. Description of the Study Area

This study was carried out at Suba Sebeta Forest. It is one of the remaining examples of dry afromontane forest. This type of forest together with grassland and woodland once formed a vegetation mosaic across the Ethiopian plateau. The forests and woodlands occur on the better drained soils of the mountains and sides of the valleys while the grassland occupies the heavy clay soils of the valley bottoms. Suba Sebeta Forest is located 40 km southwest of Addis Ababa. It is found between $38^0$31´ and $38^0$35´ E and $9^0$89´ and $9^0$00´ N in Oromia National Regional State. Suba Sebeta Forest is located in West Shewa Zone and is part of central plateau with altitudinal range of 2200 - 3385 m a.s.l. (Afework Bekele, 1994) (Fig 2). It is found on the south-western slopes of Mt. Wochacha and can be reached via either the Jimma or Ambo roads. Mt. Wechecha is a massive (3,385 m) dead volcano. The mountain sides are generally steep with ravines cut by streams and rivers. The southern base of the mountain is at 2, 200 m and flanks the Becho plains.

3.1.1. Geology

The geological aspect of Suba Sebeta Forest (Menagesha Suba State Forest) could be defined based on volcanic dome of Mountian Wochacha. The topography of Suba Sebeta Forest (Menagesha Suba State Forest) was the result of siliceous volcanic cone. There are various rock types, including trachytes and basalt trap series. According to Mohr (1971), the basalts are the main rock types from which the soil parent material of this area was derived.

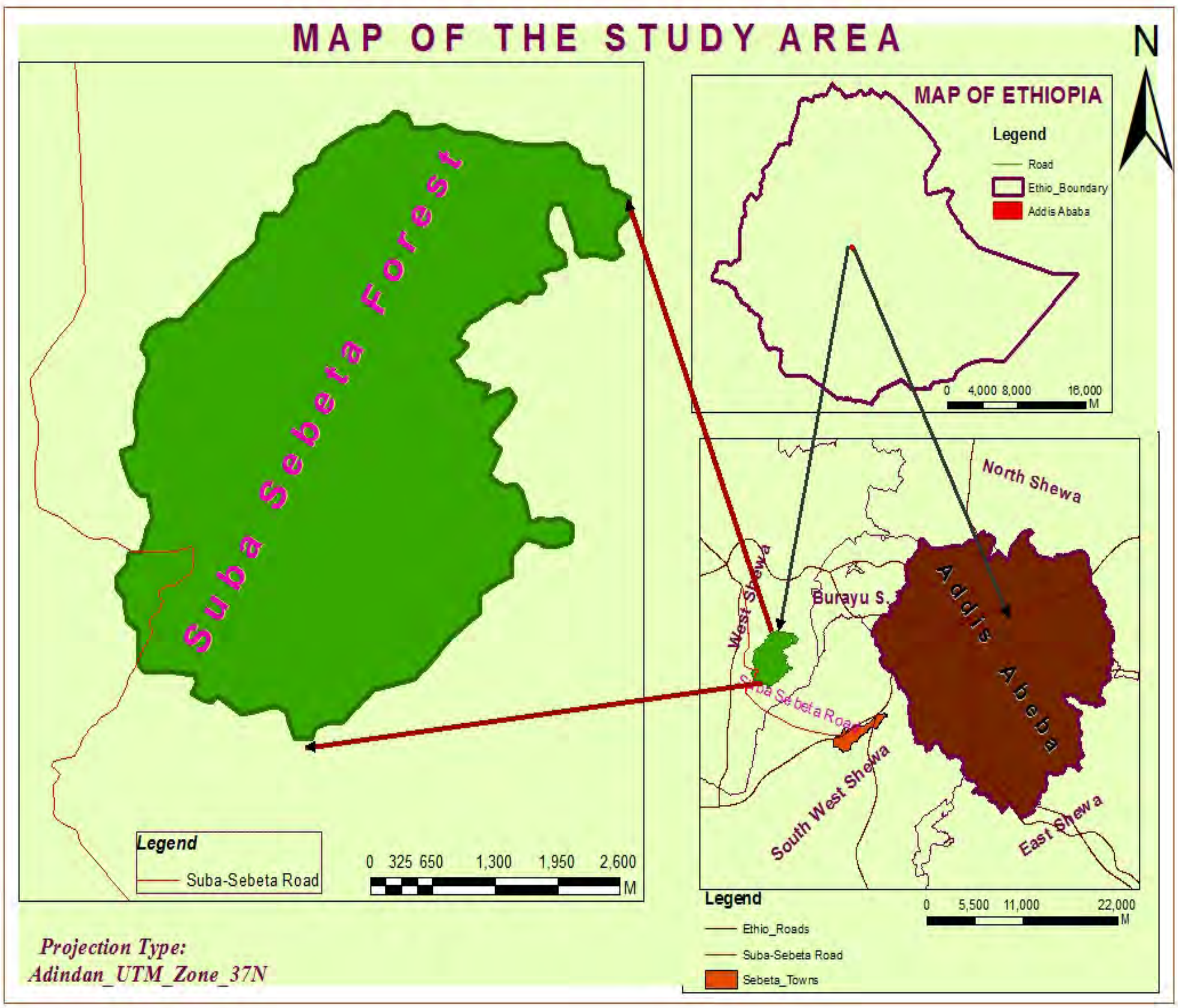

Figure 2 Map of Ethiopia showing the study area

3.1.2. Climate

There is no meteorological station in Suba Sebeta Forest. But there are two stations that are near the forest, Addis Ababa (Ayertena) and Sebeta. The rainfall and the temperature condition of the area was described based on the data collected from 2003 - 2013 by the National Meteorological Agency (NMA). According to the data from NMA, the result of the analysis showed that the mean annual temperature of the study area is 16.3^{O}C. The range of mean monthly minimum and maximum temperature of the study area is 9.8^{O}C and 23.6^{O}C respectively. The hottest month is May with a maximum temperature of 26.1^{O}C, followed by April (25.9^{O}C) and the coldest month is December with a minimum temperature of 7.3^{O}C (Figure 3).

The mean annual rainfall is 984 mm with the rains mainly falling from June to September, with the highest concentration in July and August. August to September comprises the wet season and November to March the dry season. Even if the amount is varied, the ten years data of NMA (2003 - 2013) indicates that it can also rain in any month of the year and the Forest gets additional moisture from low clouds and mist.

3.1.3. Soils

Detailed accounts of the forest site history and soil characteristics are found in Zewedu Eshetu (2000). Accordingly, the soils in Menagesha Suba Forest are shallow brown soils, Chromic Luvisol, on steep slopes and deep red soils profiles Rhodic Nithiosols, mainly in the depressions and on gentle sloping sites. The soil profiles consist of about 3 cm thick litter layer, about 15 cm mollic A horizon and understanding argic B horizon. In the Luvisoils, the argic B horizon is overlaying a C horizon of gray cemented volcanic ashes. The soil texture varies from silt clay loams in the surface soils to clay or silt clay loams in the B horizon. The soil of the Forest at lower altitudes was reddish brown, deep and less gravelly, whereas at higher altitudes light brown and shallow; the substrate is locally rocky (Tamrat Bekele, 1993).

3.1.4. Flora and Fauna

The vegetation of Suba Sebeta Forest varied with altitude, from high forest on the lower slopes to sub-afro-alpine vegetation at higher altitudes (Feyera Senbeta and Demel Teketay, 2001). Suba Sebeta Forest covers 9,248 ha, and in 1990 plantation forest comprised 1,316 ha and natural forest 2,720 ha, the remainder being open farmland, grazing and bare land. The natural forest is dominated by *Juniperus procera* that grows to 30 m, and forms a relatively open canopy. *Olea europaea* subsp. *cuspidata*, *Allophylus abyssinicus*, *Maytenus* spp. and *Euphorbia ampliphylla* form the understorey, and some *Podocarpus falcatus* trees are scattered throughout the forest. At higher altitudes, smaller *Juniperus procera* are mixed with *Erica arborea*, *Rosa abyssinica* and the endemic *Jasminum stans*. Two giant herbs, *Lobelia gibberoa* and *Solanecio gigas* dominate the sides of the valleys, while the striking *Scadoxus multiflorus* carpets the forest floor.

The area around Suba Sebeta Forest is intensively but traditionally farmed, for livestock and crops. The Forest is popular with visitors. It is the habitat of numerous wild animals, including baboons, Colobus monkeys, Bushbucks, Bush pigs, Caracal, Spotted hyena, Wildcat and a variety of many mammalian and avifauna (Feyera Senbeta and Demel Teketay, 2001; Tadesse Hailu, 2001). However, these forests had been under commercial exploitation as early as the beginning of the 20th century, when the first sawmill was established in the country (Von

Breitenbach and Koukol, 1962). As a result, most of the forest was destroyed due to over-exploitation of timber from the Forest. Additionally, there is an encroachment of agriculture to the forestland.

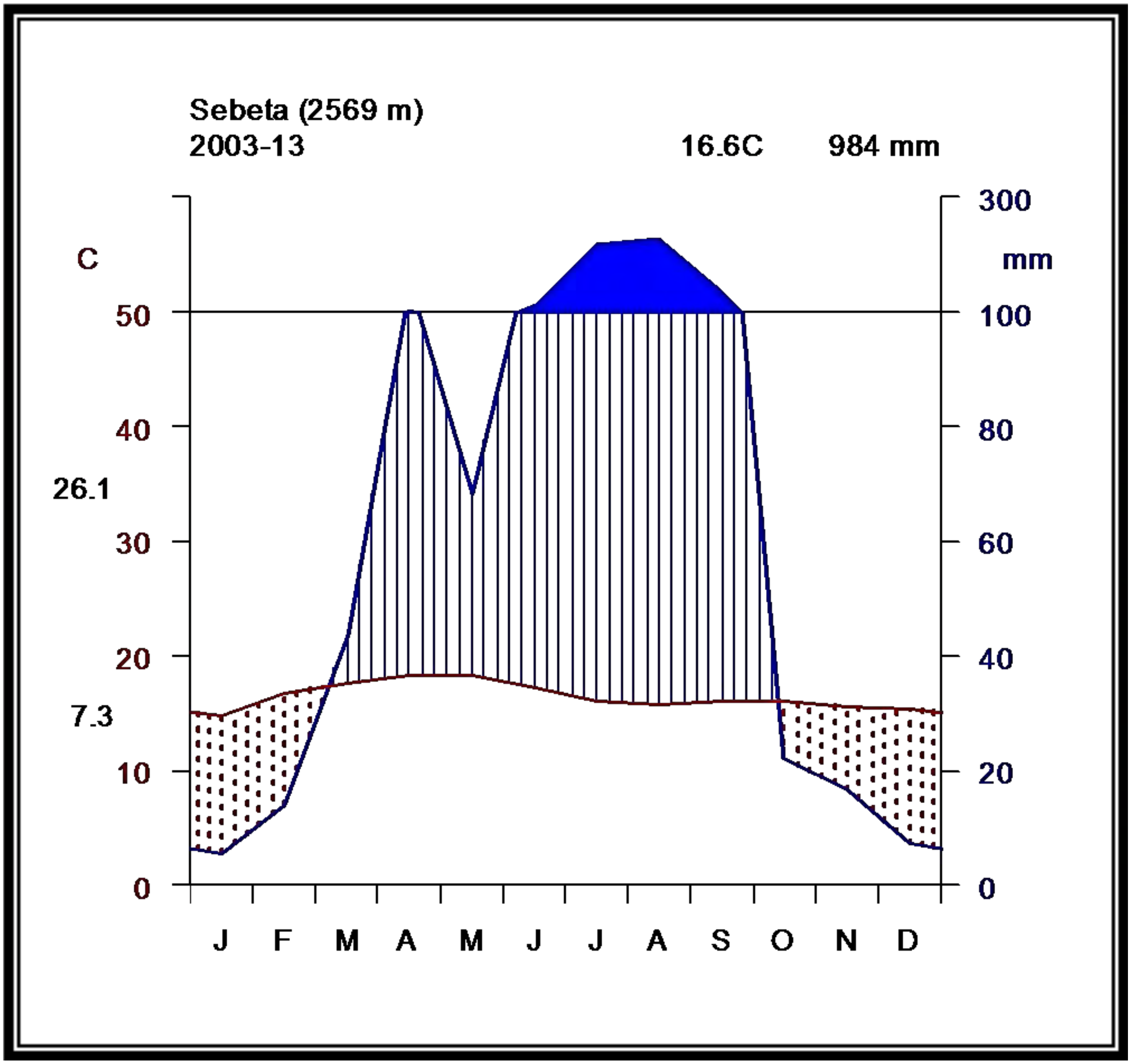

Figure 3 Climatic diagram of Suba Sebeta Forest (Sebeta Town)

Sources: NMA (National Meteorological Agency: 2014) (2003-2013)

3.2. Methodology

3.2.1. Sampling design

A reconnaissance survey of the vegetation was made in October 2013 in order to obtain an impression of the vegetation and topographic features. Actual field data were collected from October to November 2013. Vegetation and environmental data were collected in sample quadrats placed along transect lines, which are systematically laid. A total of 48 quadrats were laid between 2400 - 2870 m a.s.l in natural vegetation along transect lines. Quadrats were laid at every 10 m altitudinal drop along transect lines. All woody plant species including trees and shrubs were recorded in 20 m × 20 m quadrats while herbaceous species were recorded in 16 sub quadrats (5 m × 5 m) that systematically cover the entire main quadrat.

Information on habit, habitat, vegetation type, the nature of perennating bodies was recorded so as to draw a biological spectrum, following the concept of Raunkiaer (1934). In the construction of life form spectra each species was assigned to a single life form. All vascular plant species, climbers, trees, and shrubs correspond to the main life form groups of Raunkiaer, such as Phanerophytes (trees), Nanophanerophytes and Chamaeophytes (shrubs). The herbaceous group is most heterogeneous and consists of several life forms defined by Raunkiaer.

In the study area, physiographic variables such as altitude and longitude were measured for each quadrat using GPS. Specimens of all vascular plant taxa were collected, pressed, dried and brought to the National Herbarium (ETH), Addis Ababa University for identification. The specimens were dried in the dryer, kept in a deep freezer for 72 hours and identified referring to the volumes of Flora of Ethiopia and Eritrea, compairing to the specimens housed at the

Herbarium, student thesis such as, Abate Zewdie (2007), Dinkissa Beche (2011), Lema Etefa (2011), and Honeybee Flora of Ethiopia (Fichtl and Admasu Adi, 1994) and finally documented.

3.2.2. Soil sample

A mixture of soil sample measuring 250 – 300 gm was taken by mixing samples from five different points in the plot, four located in the corners and one in the center. Separate soil samples were taken from 0 - 15cm depth of soil layers. Elevation of the sampling points varied from 2400 - 2870 m.a.s.l. The samples were mixed thoroughly, air dried and passed through a 2 mm mesh sieve to remove the stone pieces and large root particles. The combined soil sample was used for pH analysis. The pH of soil samples were analyzed in the eco-physiology laboratory of the Department of Plant Biology and Biodiversity Management, Collage of Natural Science AAU.

3.3. Vegetation Data Analysis

3.3.1. Plant life form determination

All the plant species recorded were grouped into different life forms based on criteria outlined by Raunkiaer (1934) and Mueller-Dombois and Ellenberg (1974). The simple metrics was used to analyze proportions of life forms (Pharswan *et.al*. 2010). The percentage life form is calculated as follows:

$$\%\ \text{Life form} = \frac{\text{Number of species in any life form}}{\text{Total number of species of all life forms}} \times 100$$

3.3.2. Frequency

Frequency is defined as the probability or chance of finding a plant species in a given sample area or quadrat (Kent and Coker, 1992). It is calculated with the formula

$$\text{Frequency} = \frac{\text{Number of Plots in which a Species Occur}}{\text{Total Number of Plots}} \times 100$$

The frequencies of all species in all quadrats were computed. The higher the frequency the more important the plant is in the community.

A better idea of the importance of a species with the frequency can be obtained by comparing the frequency of occurrences of all species present. This gives relative frequency and is calculated by the formula:

$$\text{Relative Frequency} = \frac{\text{Frequency of species}}{\text{Frequency of all species}}\ x\ 100.$$

3.3.3. Cover value

The cover values of the study Forest for all species was first estimated visually, recorded and later converted to the Braun-Banquet 1-9 modified scale (Kent and Coker, 1992) as follows: 1 = one or few individuals, 2 = occasional and less than 5% cover, 3 = abundant and with very low cover or less abundant but with higher cover, in any case less than 5% cover, 4 = very abundant and less than 5% cover, 5 = cover values between 5 - 12.5% irrespective of number of individuals, 6 = cover values between 12.5 - 25%, 7 = cover values between 25 - 50%, 8 = cover values between 50-75%, 9 = cover values between 75 - 100%, of the total quadrat area.

3.4. Soil pH Analysis

Soil pH was measured by mixing 20 gram of soil sample and 20 ml of distilled water and stirred (1:1 ratio) for 30 minutes in a 100 ml beaker. The soil-water mixture was kept for 5 minutes and the reading was taken with the help of Jenway 3345 Digital pH meter.

CHAPTER FOUR

4. Result

4.1. Life form Composition

A total of 135 vascular plant species were recorded in Suba Sebeta Forest belonging to five major life form groups (Appendix 1). The percentage of species belonging to each life form category relative to the total number of species is presented in Figure 4. Phanerophytes represented with 48 species (35.5 %) were the dominant life form followed by Hemicryptophytes, 34 species (25.2 %), Chamaeophytes, 22 species (16.3%), Therophytes, 20 species (14.8%) and Geophyte, 11 species (8.2%).

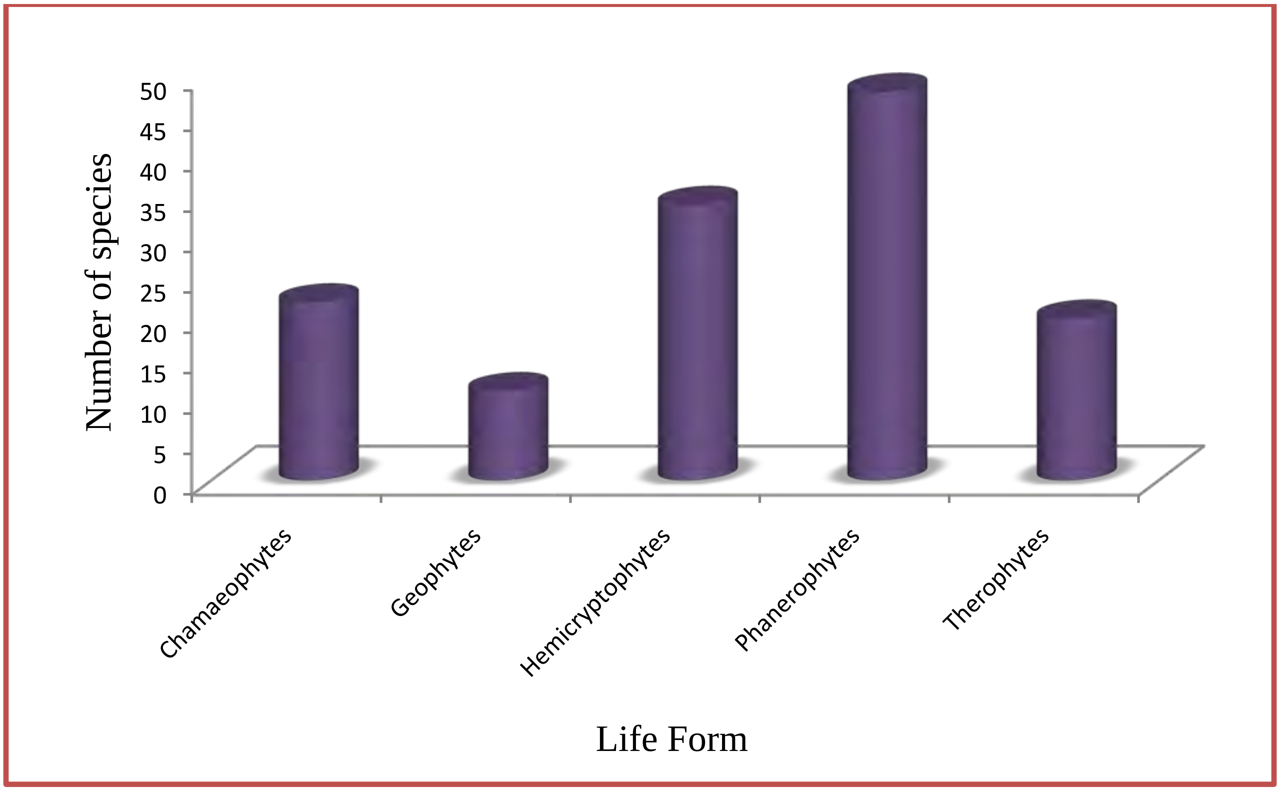

Figure 4 Number of species per life form in Suba Sebeta Forest

Figure 5 The chamaeophytic life form of *Prunus africana* (photo by Mistire Yifru, 2013)

Figure 6 *Dichondra repens*, Hemicryptophytic herb (photo by Mistire Yifru, 2013)

Figure 7 *Alchemilla abyssinica,* Hemicryptophyte with basal rosette leaves (Photo by Mistire Yifru, 2013).

The 135 species recorded in the study belong to 67 Families (Apenpendex 1). The dominant families were Asteraceae, (21 species, 15.6%), followed by Fabaceae, (8 species, 5.9 %), Lamiaceae, (6 species, 4.4%), Apiaceae, Rubiaceae, Scrophularaceae each represented by (5 species, 3.7%) (Appendex 1).

The family Asteraceae (15.6%) is represented by all the five major life form groups. The representative species in this family include *Tagetes minuta* - Therophyte, *Lactuca inermis* – Hemicryptophyte, *Sonchus bipontini* - Geophyte, *Solanecio gigas* - Chamaeophyte and *Vernonia wollastonii* – Phanerophyte. Fabaceae with 5.9 % is the next diverse family represented by Therophyte - *Trifolium simensis*, Chamaeophyte - *Dolichos sericeus* and Phanerophyte - *Albizia schimperiana*. Hemichryptophytic and Geophytic life forms are not represented in Fabaceae.

Table 1 Dominant species in the five major life form groups and their % contribution in Suba Sebeta Forest.

Life Form	**Dominant Species**	**%Life Form Contribution**	**Growth Form**
Phanerophyte	*Bersama abyssinica*	43.8%	Tree
	Dovyalis abyssinica		Shrub
	Dovyalis verrucosa		Shrub
	Jasminum abyssinicum		Shrub
	Juniperus procera		Tree
	Maytenus gracilipes		Shrub
	Maytenus undata		Tree
	Myrsine africana		Shrub
	Olea europaea L. subsp. *cuspidata*		Tree
	Olinia rochetiana		Tree
	Podocarpus falcatus.		Tree
	Scolopia theifolia		Shrub
	Sideroxylon oxyacanthum		Shrub
	Teclea nobilis		Shrub
Hemicryptophyte	*Adiantum poireti*	25%	Herb
	Asplenium monanthes.		Herb
	Cyperus tenuispica		Herb
	Geranium arabicum		Herb
	Kalanchoe petitiana		Herb
	Mimulopsis solmsii		Herb
	Oplismenus hirtellus.		Herb
	Sanicula elata		Herb
Chamaeophyte	*Achyranthes aspera*	15.6%	Herb
	Hypoestes triflora		Herb
	Lobelia giberroa		Herb
	Mikaniopsis clematoides		Herb
	Solanecio gigas		Herb
Therophyte	*Agrocharis melanantha*	12.5%	Herb
	Cynoglossum coeruleum		Herb
	Galium aparinoides		Herb
	Impatiens hochstteteri		Herb
Geophyte	*Cynoglossum amplifolium*	3.1%	Herb

4.1.1. Frequency

In Suba Sebeta Forest, plants were classified into five frequency classes on the basis of their frequency values. The most frequent species per life form group were *Juniperus procera* (97.92%) - Phanerophyte, *Cyperus tenuispica* (89.6%) - Hemicryptophyt, *Cynoglossum coerulem* (75%) - Therophyte, *Cynoglossum amplifolium* (89.6%) - Geophyte and *Achyranthes aspera* (83.33%) - Chamaeophyte. The least frequent species were *Hypericum quartinianum*, (2.08%) - Chamaeophyte, *Rumex nepalensis* and *Scadoxus multiflorus*, (2.1%) - Geophyte, *Vernonia urticifolia* (2.08%) - Hemicryptophyte, *Agarista salicifolia*, *Albizia schimperiana*, *Euphorbia ampliphylla*, *Ficus sur*, *Crotalaria laburnifolia* and *Maytenus addat,* (2.1%) – Phanerophyte, *Coriandrum sativum, Erucastrum pachypodum* and *Trifolium simensis* (2.1%) - Therophyte.

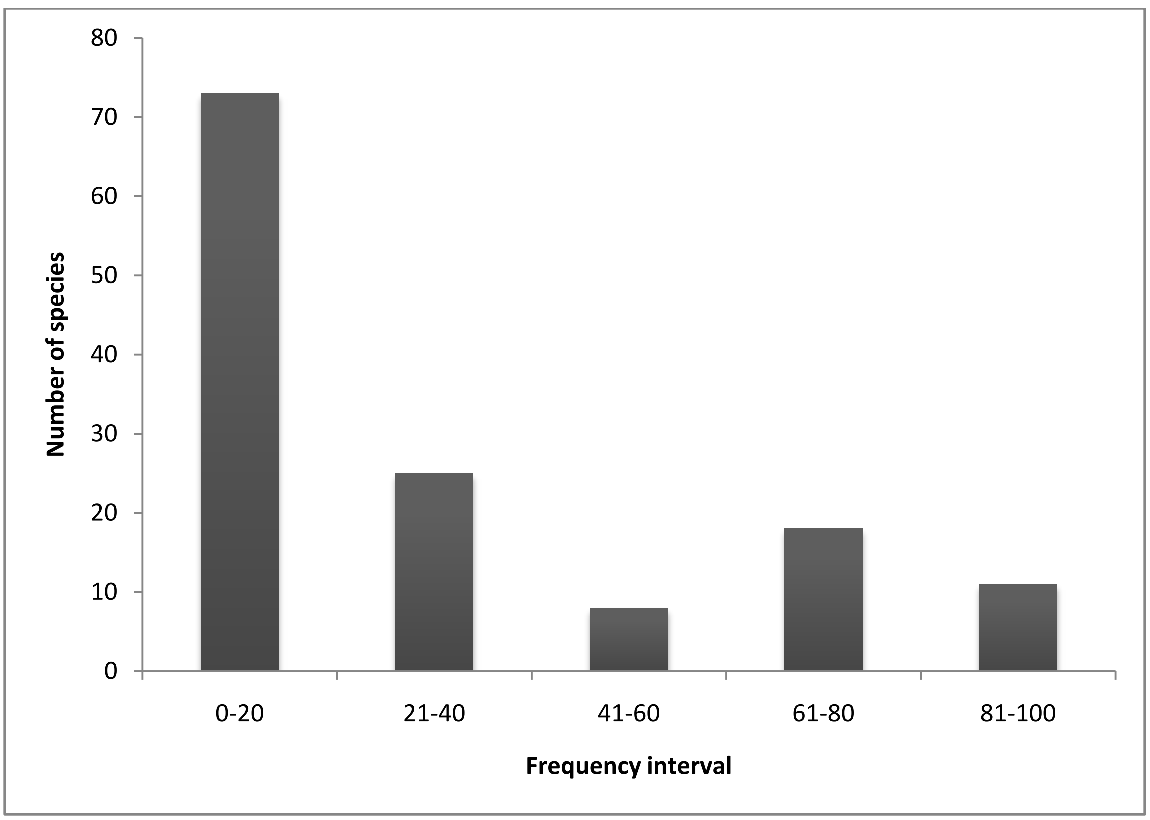

Figure 8 Frequency of species in Suba Sebeta Forest

4.2. Life form Similarity Among Plots

Five clusters were documented from the similarity ratio cluster analysis output of R-software. Communities can be defined using various characteristics. One of these approaches is classification by dominant life form. Based on this arrangement each cluster distinguished in this study was described as structure and named based on the dominant life form. The data matrix contains 48 quadrats and 135 species.

The clustering indicates that the plots with the same dominant life form were assigned into similar group. Based on the life form cluster group, cluster one contains the plot that is dominated by Chamaeophytic life form, that included (plots: 1, 8, 9, 10, 11, 12) ; cluster two with Geophytic life form (plots: 2, 3, 7, 41, 42), cluster three Phanerophytic life form , (plots: 4, 22, 24, 28, 29, 32, 33, 37, 38, 39, 40, 43,47); cluster four Hemicryptophytic life form which is with the largest number of plots, (5,6,13,14,15,16,17,18,19,20,21,23,25,27,31,34,36 46); and cluster five Therophytic life form (plots: 26, 30, 35, 44, 45, 48) (Figure 9).

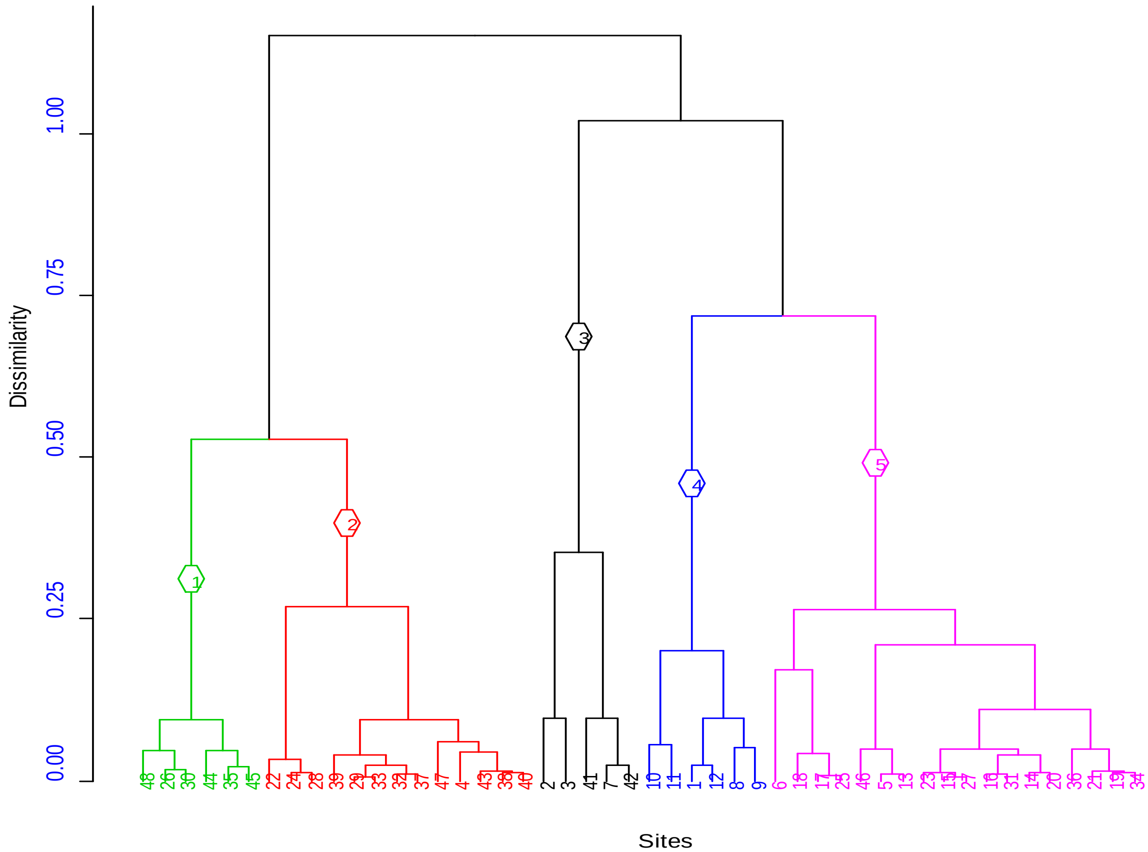

Figure 9 Dendrogram outputs of the life form data obtained from hierarchical cluster analysis.

The plot code and arrangement of plot along the dendrogram based on their cluster group (Figure 9).

C1: (Plots 1, 8, 9, 10, 11, 12)

C2: (Plots 2, 3, 7, 41, 42)-

C3: (Plots 4, 22, 24, 28, 29, 32, 33, 37, 38, 39, 40, 43, 47)

C4: (Plots 5, 6, 13, 14, 15,16,17,18,19,20,21,23,25,27,31,34,36,46)-

C5: (Plots 26, 30, 35, 44, 45, 48)

4.3. Relation between Altitude and Soil pH

Negative coorelation coefficient (- 0.4) of soil pH with altitude showed a pH range between 5.6 and 7.3. The lower pH (i.e 5.6) indicating acidic soil was recorded at a high altitude (i.e 2870 m.a.s.l.). The highest pH (i.e 7.3) indicating a more or less neutral soil was measured at lower altitude (i.e 2570 m.a.s.l.)

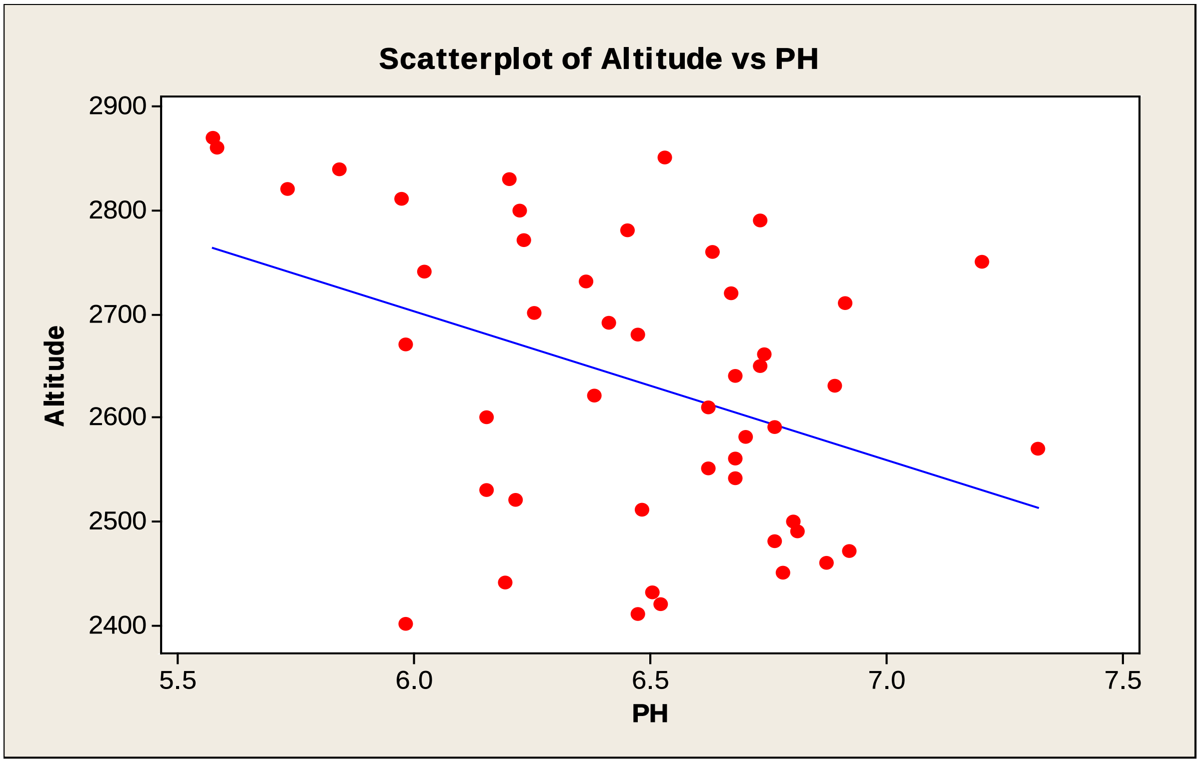

Figure 10 The distribution of soil pH value along altitude.With negative coorelation coefficient (- 0.4).

4.4. Impact of Altitude on Life form Distribution

Environmental factors are causes for difference in diversity and pattern of vegetation. In the present study, altitude was taken as a factor that causes the difference in life form distribution in Suba Sebeta Forest.

To test the influence of altitude in life form distribution, one way analysis of variance (ANOVA) was done. A significant test was done by using plot wise comparison of Kruskal-Wallis rank sum test within 95% family wise confidence level. The results are shown in Figures 11 and 12.

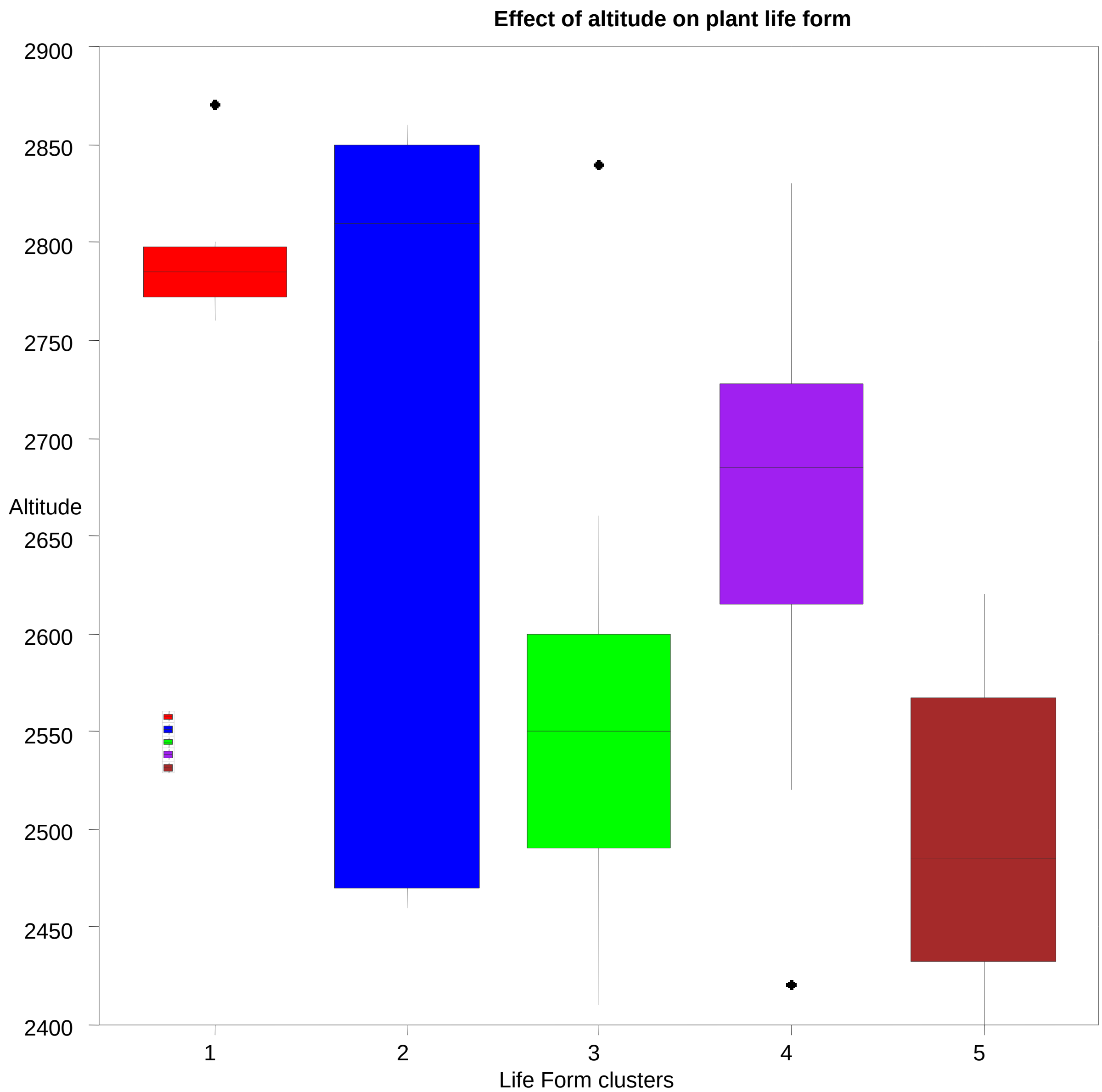

Figure 11 Boxplots of Life form clusters distribution along altitude gradient: the dots represente sample plots that are causes for great differeance

Table 2 The table of dominant life form in each Cluster and altitudinal range.

No	**Dominant life form**	**Cluster number**	**Number of plot**	**% contribution**	**Altitudinal range**
1	Chamaeophyte	Cluster 1	6	12.5%	2760-2870
2	Geophyte	Cluster 2	5	10.4%	2460-2860
3	Hemicryptophyte	Cluster 4	18	37.5%	2410-2860
4	Phanerophyte	Cluster 3	13	27.1%	2410-2840
5	Therophyte	Cluster 5	6	12.5%	2400-2620

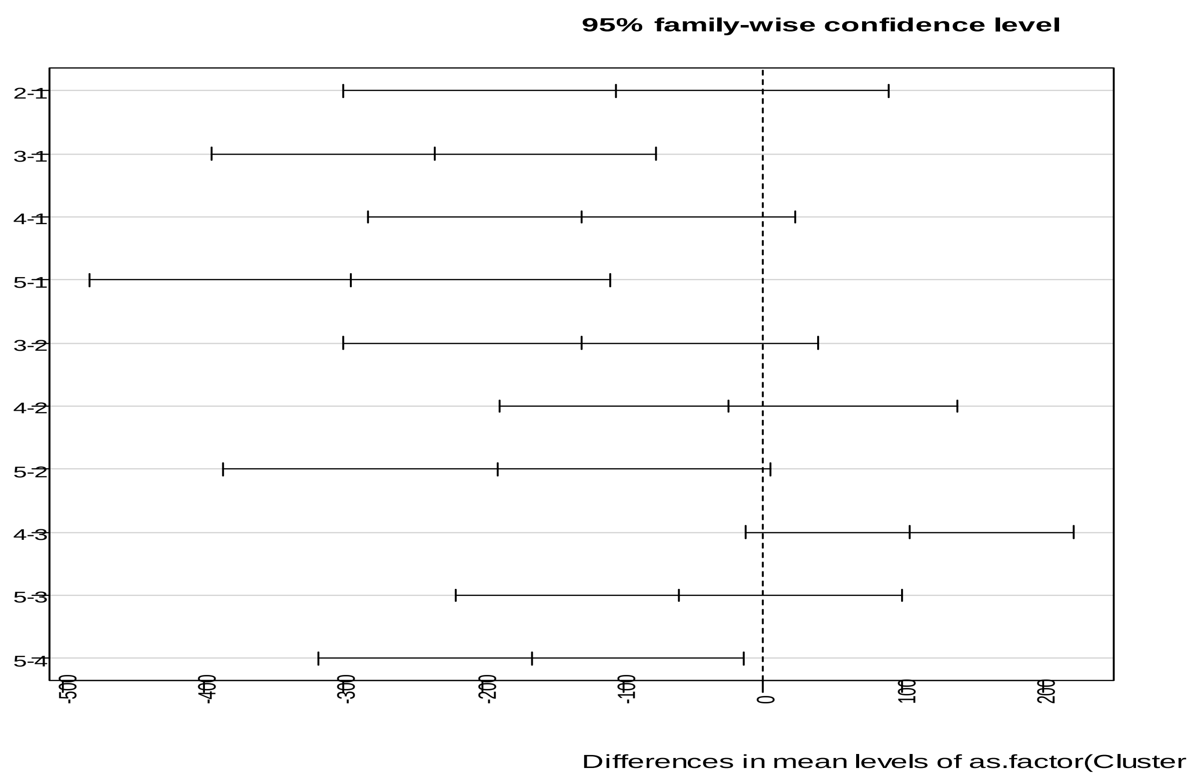

Figure 12 Mean difference of life form clusters distribution along altitudinal gradient at 95% family wise confidence level. The indicated number on the left side of the graph stands for

dominant life form clusters. Thus, 1 - represents Chamaeophyte, 2 - Geophyte, Hemicryptophyte, 4 - Phanerophyte and 5 - stands for Therophyte.

4.5. The Effect Soil pH on Life form Distribution

The pH value of soil analyses that related with the life form cluster distribution indicated in Figure 13. Kruskal-Wallis rank sum test at 95% family wise confidence level significant test was done by using plot wise comparison.

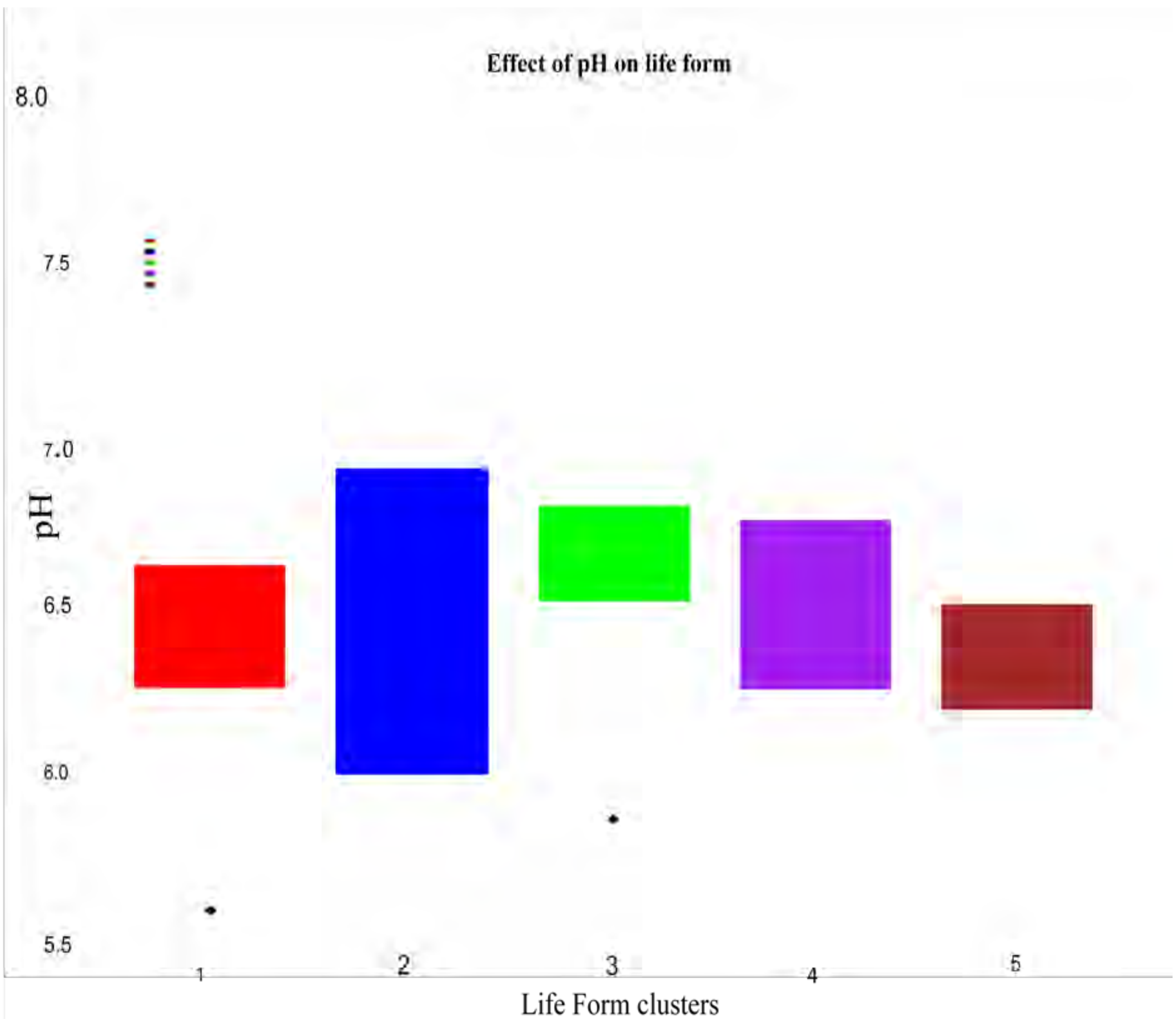

Figure 13 Boxplots of relation of soil pH value and life form distribution: the dots represent sample plots found in lower pH.

4.6. Endemic Plants and Their Life form in Suba Sebeta Forest

Endemic plant species that were collected from Suba Sebeta Forest and their life forms contribution in the study area is given in Table 3.

Table 3 List of endemic plant species and their life form in Suba Sebeta Forest

No	**Species name**	**Family**	**Life form**	**Growth form**
1	*Cirsium schimperi*	Asteraceae	Geophyte	Herb
2	*Conyza nana*	Asteraceae	Hemicryptophyte	Herb
3	*Jasminum stans*	Oleaceae	Phanerophyte	Shrub
4	*Laggera tomentosa*	Asteraceae	Chamaeophyte	Shrub
5	*Maytenus addat*	Celastraceae	Phanerophyte	Tree
6	*Mikaniopsis clematoides*	Asteraceae	Chamaeophyte	Climber
7	*Millettia ferruginea*	Fabaceae	Phanerophyte	Tree
8	*Satureja paradoxa*	Lamiaceae	Hemicryptophyte	Herb
9	*Solanecio gigas*	Asteraceae	Chamaeophyte	Herb
10	*Vernonia leopoldii*	Asteraceae	Chamaeophyte	Shrub

CHAPTER FIVE

5. Discussion, Conclusion and Recommendations

5.1. Discussion

5.1.1. Life form Composition

Life form classification is a powerful instrument employed for several purposes like land management and climate control, and it also provides way of summarizing our knowledge of life form pattern. Individuals who show the same general vegetative character belong to the same life form. The life form of a plant is the vegetative form of plant body which is thought to be hereditary and an adjustment to the environment. Life form composition of the vegetation to a certain extent is an indicator of the climate, and is also helpful to compare geographical distribution and to identify widely distributed plant communities (Muhammad, 2012). Plants in the study area have been categorized into Raunkiaer group to develop life form spectrum of Suba Sebeta Forest. These life forms differ in every zone on the basis of altitude. Long-lived life forms, such as Phanerophytes, dominate in tropical zones and Hemicryptophytes dominate in arctic or alpine zones, whereas short-lived life forms such as Therophytes are most frequent in deserts. Raunkiaer (1934) reported three types of climates on the earth: Phanerophytic in tropics, therophytic in deserts and Hemicryptophytic in cold temperate zone based on life forms dominance. Cain and Castro (1959) and Shimwell (1971) also reported that Hemicryptophytes indicate temperate zones whereas Therophytes and Geophytes are indicators of desert climate and Mediterranean climate respectively.

In this study, out of the 135 species 48 belonged to the Phanerophytic life form. The dominant Phanerophyte life form includes the two important Gymnosperms, *Juniperus procera* and *Podocarpus falcatus,* which are characteristic species of dry Afromontane forests. Tree and shrubby angiosperms like *Olea europaea*. subsp. *Cuspidata, Olinia rochetiana*, *Myrsine africana and Rosa abyssinica* also belong to this life form. Hemicryptophytes with 34 species also had a high number of contributions to the life form spectrum because of the humid nature of Suba Sebata Forest. Most Hemicryptophytes are herbaceous in habit (Figur 6 & 7) that includes *Thymus schimperi*, *Veronica simensis* and *Rubia cordifolia*.

The Chamaeophytic life form in Suba Sebeta Forest is represented by shrubyy *Hypericum quartinianum* and herbaceous *Mikaniopsis clematoides*, which carpeted the ground in higher altitudes and some, are herbs like *Achyrospermum schimperi, Hypoestes triflora* and *Solanecio gigas.* Chamaeophytes are indicators of alpine vegetation (Muhammad, 2012). This form is found in moderate number (16 species). In the life form composition, Therophytes and Geophyte have great contributions comprising 20 and 11 species each, respectively. Therophytes are annuals that include *Agrocharis melanantha*, *Dichrocephala chrysanthemifolia* and *Cynoglossum coerulem* which reproduce through seeds and complete their life cycle in a short period of time. Geophytes are represented by *Cynoglossum amplifolium*, *Arisaema enneaphyllum* and *Scadoxus multiflorus* (Appendix 1).

Suba Sebeta Forest also constitutes 10 (7.4 %) endemic species drawn from five families (Table 4). Asteraceae is the largest family and genus in terms of endemicity contributing 6 species (60%) that belong to Chamaeophytic, Hemicryptophytic and Geophytic life forms. The remaining four families contain one species each and altogether covered 40% of the overall endemicity. From these four families, three of them belong to Phanerophytic life forms and one is Hemicryptophytic life form. There are also specieses that are endemic to the Flora of Ethiopia and Eritrea. These near endemic specieses include *Kalanchoe petitiana, Thymus schimperi and Veronica simensis* that occurred in Hemicryptophytic life form while *Plectocephalus varians, Sideroxylon oxyacanthum* and *Erucastrum pachypodum* are found in Geophytic, Phanerophytic and Therophytic life forms respectively.

The life form of plant species is usually a constant character (Muller-Dombois and Ellenberg, 1974) and life forms are species specific. But some species show different life forms when growing under very different environmental conditions. Plants of the same life form growing together are likely to compete directly for the same space. The impacts of one species, *Homo sapiens*, are so pervasive that there is scarcely a tropical forest in the world in which human activities have not left their mark on life form diversity (Denslow and Padoch, 1988; Goldhammer, 1992). Hence, during this study, *Prunus africana* showed two different life form strategies that was Chamaeophytic (Figure 5) and Phanerophytic.

Since trees are known by their Phanerophytic life form, this result indicates that *Prunus africana* developed two life form fashions in the same forest to cope up with environmental influence that may be caused by human activity. The human activities in this species include removing the bark of the tree for traditional medicine, using the tree for timber production, as source of material for building local houses, fire purpose and making charcoal. This explanation is strongly supported by the works of Legesse Negash (2002).

5.1.2. Similarity of Life form among Plot

The highest similarities of life form cluster along altitude were recorded between phanerophytic and hemichryptophyte life form (Figure 12). These life forms were similar due to similar soil pH range and altitude (Appendex 2). Soil pH and altitude were correlated negatively (with negative correlation coefficients) and as the altitude increased pH value decreased or becom slightly acidic. Great life form cluster differences was created between clusters three and cluster one which were dominated with Phanerophytic and Chamaeophytic life form respectively. Chamaeophytic life forms are known in the higher altitude and phanerophytes have a decreasing trend in higher altitude. From this result, Chamaeophytic life form one adapted better in slightly acidic soil. The second difference was created by the Therophytic and Chamaeophytic life forms, which created a great difference. The third one was between Therophytic and Hemichryptophyte, which may be due to altitude, soil moisture and the soil pH differences.

5.1.3. The Effect of Altitude on Life form Distribution

Altitude is a complex environmental gradient associated with variation in several ecological factors (Odland, 2009). The distribution of every plant species along altitude gives an idea about its ecological plasticity. The life form of plants subsumes species, which have similarities in the complex ecological conditions characteristic of their habitats (Angelova and Tashev, 2005).

Diversity and distribution of life forms is usually correlated with climatic heterogeneity (Cowling, *et al*., 1994) decreasing with increasing altitude (Montana & Valientebanuet, 1998; Pavon, *et al*., 2000). Results of the present study indicate that altitude is the main factor influencing life form composition. In this investigation, Therophyte occur from 2400-2620 m a.s.l., while their number decreases towards higher altitudes. The frequent Therophytic species include *Agrocharis melanantha, Cynoglossum coerulem, Galium aparinoides* and *Impatiens hochstteteri*. These species are ephemerals that complete their life cycle just in short period of time. The predominance of annuals at low altitudes can partly be explained by soil disturbance (Klimes, 2003). The more intense or the more frequent the disturbance is, the lower is the proportion of long-lived life forms.

The two giant Chamaeophytic herbs *Lobelia giberroa* and *Solanecio gigas* were found to be dominant at altitude (2760-2870 m a.s.l) while *Hypoestes triflora* and *Mikaniopsis clematoides* carpeted the floor at the same altitude. *Hypericum quartinianum* and *Swertia abyssinica* were restricted to the higher altitude. The results from Klimes (2003) confirm that Chamaeophytes show an increasing trend towards higher altitudes. The work of Muhammad (2012) concluded that Chamaeophytes are generally the most common life form both in high altitudes and high latitudes.

Geophytes are characteristic of Mediterranean type of climate (Shimwell, 1971). Geophytes have well protected new growing buds in the ground. They are present in small numbers in the study area. Even though the number was limited, they were widely distributed in a wide altitudinal range (2460-2860 m a.s.l). In this study, the percentages of geophytes are remarkably unvarying and the numbers of species belonging to geophytes were very few along the altitudinal gradient. Geophytic life form species including the dominant *Cynoglossum amplifolium*, found in most sample plots and *Chllorophytum tetraphyllum, Rumex nepalensis, Arisaema enneaphyllum,* and *Habenaria vaginata* are included in this life form.

Hemicryptophytes were found at wider altitudinal ranges (2410 - 2860 m a.s.l). From field observation, they were supported by the canopy of the Phanerophyte, which protect the ground from direct radiation and keep the soil moist. The time of sampling was also conducive for the predominance of this life form (October to November 2013). The dominant Hemicryptophyte species in Suba Sebeta Forest included *Cyperus tenuispica, Geranium arabicum, Kalanchoe petitiana*, *Mimulopsis solmsii*, *Oplismenus hirtellus* and *Sanicula elata*, which were well distributed along the altitude. A strong relation between moisture in the upper soil layers and Hemicryptophytes prevalence was reported by Mahdavi *et al.* (2013).

The Phanerophytes, the most represented and dominant life form in the study area, are distributed across a wider altitudinal range (2410 - 2840 m a.s.l.). The dominant Phanerophyte species include *Bersama abyssinica, Dovyalis abyssinica, Dovyalis verrucosa, Jasminum abyssinicum, Juniperus procera, Maytenus gracilipes*, *Maytenus undata*, *Myrsine africana, Olea europaea*, *Olinia rochetiana, Podocarpus falcatus*, *Scolopia theifolia, Sideroxylon oxycanthum* and *Teclea nobilis*. According to Korner (1998), Phanerophytes occur rarely above 5000 m a.s.l. elsewhere in the world.

5.1.4. The Effect of Soil pH on Life form Distribution

Most plants prefer a pH range from 5.5 to 7.5 while some species prefer more acidic or alkaline soils. Nevertheless, every plant requires a particular range of pH for optimum growth. The levels of soil pH can be used as a general guide for determining what species will grow on a given site and are typically indicative of available nutrient levels. The soil pH provides a good indication of the chemical status of the soil and can help to determine potential plant growth (Andrew, 2013). The soil pH is also a function of parent material, time of weathering, vegetation and climate.

At higher altitude precipitation is high resulting in leaching of the upper surface, which leads to increasing of soil acidity.With increasing altitude, temperature will typically decrease and the corresponding precipitation will increase (Barry, 1981; Ineson, *et al*., 1998; Shen *et al*. 2013). Plants absorb dissolved nutrients in the soil water and the nutrient solubility that depends largely on the pH value. Hence, the availability of elements varies at different pH levels.

In the present study, soils from the low altitudes were slightly alkaline (7.3) and those of high altituds were slightly acidic (5.57) (Appendex 2). Even though the results from this study showed variation in pH value, there is no life form restricttion in slightly acidic or slightly alkaline condition. From the results of correlation in Figure 13, soil pH did not show direct significant influence on life form distribution.

5.2. Conclusion

This study contributes basic data on life form composition and life form spectrum of vascular plants at Suba Sebeta Forest to provide base line information for subsequent studies. A total of

135 species were identified and assigned to 67 families. Family Asteracceae was the most dominant followed by Fabaceae and Lamiaceae. The study of biological (life form) spectrum more accurately describes the vegetation physiognomy, since individuals are counted by their life form. The life form spectrum with dominating Phanerophyte (35.56 %) followed by Hemicryptophytes (25.18%), Chamaeophytes (16.30%), Therophytes (14.81%) and Geophyte (8.15%), indicates prevailing tropical vegetation in the study area..

Altitudinal variation played a great role in life form distribution and composition in the study area. At higher altituds, Chamaeophyte life form was dominant while Hemicryptophytes were well distributed in the studied altitudinal range.

Cluster analysis of the vegetation data of the Forest produced five communities each of which have its own indicator and dominant life form type. The distributions of these plant life form communities in the Forest were influenced by environmental factors and biotic stresses which are derivative of the life form of plant and composition.

5.3. Recommendation

Climate of a region is characterized by life form while the biological spectrum of the region exceeds the percentage of the same life form in the normal biological spectrum. However, biotic agencies are the chief causes for changing the biological spectrum in a given floristic zone i.e. agricultural practices, grazing and deforestation. The creation of awareness among the local communities in the Forest conservation activities and management is the only realistic choice to reduce the forest loss and climatic change. The results of this study can pave the way for understanding the life form spectrum and composition of dry montane forest that have considerable importance in its conservation and keeping for environmental change. Based on the results of the study, the researcher would forward the following recommendations.

- Studying the life form of the area is important for ecological functioning, concerning the life form composition and distribution of life form in relation to the environmental factors such as soil type, moisture and content; decomposition rate and the amount of carbon dioxide consumed by each life form type.
- Further work on the study area is still required for the knowledge of plant life form is not only important in restoration and conservation strategy but also to select the exact life form type that adapts on the climatic condition of the area.
- There should be deep rooted investigation on invasive species life form which has great contribution to reduce the invasiveness of plants.
- Advanced research is needed to compute change in life form of the area that is derived from biotic and abiotic factors to develop conservation and restoration strategies.

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APPENDICES

Appendix 1 List of vascular plant with their family and life form.

No	Species Name	Family	Life form
1	*Phaulopsis imbricata* (Forssk) Sweet	Acantaceae	Hemicryptophyte
2	*Hypoestes forskaolii (*Vahl)R.Br.	”	Hemicryptophyte
3	*Hypoestes triflora* (Forssk.) Roem.& Schult	”	Chamaeophyte
4	*Mimulopsis solmsii* Schweinf.	”	Hemicryptophyte
5	*Adiantum poreiti* Wikstr.	Adiantaceae	Hemicryptophyte
6	*Achyranthes aspera* L.	Amaranthaceae	Chamaeophyte
7	*Scadoxus multiflorus* (Martyn) Raf	Amaryllidaceae	Geophyte
8	*Rhus glutinosa* A. Rich.	Anacardiaceae	Phanerophyte
9	*Chlorophytum tetraphyllum*(L.f) Baker	Anthricaceae	Geophyte
10	*Agrocharis melanantha* Hochst.	Apiaceae	Therophyte
11	*Alepidia peduncularis* Steud. ex A.Rich.	”	Geophyte
12	*Coriandrum sativum L.*	”	Therophyte
13	*Cenella asiatica* (L.) Vrsan	”	Therophyte
14	*Sanicula elata Buch.* Ham. ex D. Don	”	Hemicryptophyte
15	*Carissa spinarum* L.	Apocynaceae	Phanerophyte
16	*Landolphia buchananii* (Hall.f.) Stapf		Phanerophyte
17	*Arisaema enneaphyllum* Hochst. ex. A. Rich.	Araceae	Geophyte
18	*Periploca linearifolia* Quart.-Dill. & A.Rich.	Asclepiadaceae	Chamaeophyte
19	*Asparagus africanus* Lam.	Asparagaceae	Phanerophyte
20	*Asplenium aethiopicum* (Burm.f.)Bech.	Asplenaceae	Hemicryptophyte

21	*Asplenium monanthes* L.	,,	Hemicryptophyte
22	*Carduus leptacanthus* Fresen.	Asteraceae	Chamaeophyte
23	*Carduus schimperi* Sch. Bip. ex A.Rich.	”	Geophyte
24	*Conyza nana* Sch. Bip. ex Olivo & Hiern	”	Hemicryptophyte
25	*Cirsum schimperi Sch.* Bip. ex A.Rich.	”	Hemicryptophyte
26	*Dichrocephala chrysanthemifolia* (B.l.) DC.	”	Therophyte
27	*Galinsoga qudriradiata* Ruiz & Pavon	”	Therophyte
28	*Gerbera piloselloides* (L.) Cass.	”	Hemicryptophyte
29	*Helicbrysum argyranthum* O.Hoffm.	”	Hemicryptophyte
30	*Lactuca inermis* Forssk.	”	Hemicryptophyte
31	*Launaea rueppellii (*Sch.Bip.exoliv &Hiern)L. Boulos	”	Geophyte
32	*Plectocephalus varians* (A.Rich.) C.Jeffery ex Cufod.	”	Geophyte
33	*Solanecio gigas* (Vatke) C. Jeffrey	”	Chamaeophyte
34	*Sonchus aspera* (L.) Hill	”	Therophyte
35	*Sonchus bipontini* Asch.	”	Geophyte
36	*Tagetes minuta* L.	”	Therophyte
37	*Laggera tomentosa* (Sch.Bip. ex A. Rich.) Oliv. & Hiern	”	Chamaeophyte
38	*Mikaniopsis clematoides* (Sch.Bip.ex A.Rich.) Milne- Redh.	”	Chamaeophyte
39	*Pseudognaphalium richardianum* (Cufod.) Hilliar & Burtt.	”	Phanerophyte
40	*Vernonia leopoldii* (Sch.Bip.exWalp.) Vatke	”	Chamaeophyte
41	*Vernonia urticifolia* A.Rich.	”	Hemicryptophyte
42	*Vernonia wollastonii* S.Moore	”	Phanerophyte
43	*Impatiens hochstetteri* Warb.	Balsaminaceae	Therophyte

44	*Cynoglossum amplifolium* Hochst.exA.DC	Boraginaceae	Geophyte
45	*Cynoglossum coerulem* Hochst.exA.DC	„	Therophyte
46	*Erucastrum pachypodum* (Chiov.) Jonsell	Brassicaceae	Therophyte
47	*Lobelia giberroa* Hemsl.	Campanulaceae	Chamaeophyte
48	*Stellaria media* (L.) Vill.	Caryophyllaceae	Therophyte
49	*Maytenus* gracilipes (Welw. ex 0Iiv.) Exell	Celastraceae	Phanerophyte
50	*Maytenus addat* (Loes.) Sebsbe	”	Phanerophyte
51	*Maytenus undata* (Thunb.) Blakelock	”	Phanerophyte
52	*Dichondra repens* J.R. & G. Forst.	Convolvulaceae	Hemicryptophyte
53	*Kalanchoe petitiana* A.Rich.	Crassulaceae	Hemicryptophyte
54	*Juniperus procera* Hochst. ex. A. Rich.	Cuppressaceae	Phanerophyte
55	*Cyperus tenuispica* Steud.	Cyperaceae	Hemicryptophyte
56	*Scabiosa columbaria* L.	Dipsacaeae	Hemicryptophyte
57	*Agarista salicifolia* (Comm.ex Lam.) *Don*	Ericaceae	Phanerophyte
58	*Erica arborea* L.		Phanerophyte
59	*Croton macrostachyus* Del.	Euphorbiaceae	Phanerophyte
60	*Euphorbia ampliphylla* Pax.	”	Phanerophyte
61	*Dolichos sericeus* E.Mey	Fabaceae	Chamaeophyte
62	*Trifolium simensis* Fresen.	”	Therophyte
63	*Vigna vexillata* (L.) A.Rich.	”	Chamaeophyte
64	*Albizia schimperiana* Oliv.	”	Phanerophyte
65	*Calpurnea aurea* (Ait.) Benth.	”	Phanerophyte
66	*Crotalaria laburnifolia* L.	”	Phanerophyte
67	*Millettia ferruginea* (Hochst.) Bak.	”	Phanerophyte
68	*Pterolobium stellatum* (Forssk.) Brenan	”	Phanerophyte

69	*Dovyalis abyssinica* (A. Rich.) Warb.	Flacourtiaceae	Phanerophyte
70	*Dovyalis verrucosa* (Hochst.) Warb.	”	Phanerophyte
71	*Scolopia theifolia* Gilg.	”	Phanerophyte
72	*Swertia abyssinica* Hochst.	Gentianaceae	Chamaeophyte
73	*Geranium arabicum* Forssk.	Geraniaceae	Hemicryptophyte
74	*Hypericum quartinianum* A. Rich.	Guttiferea	Chamaeophyte
75	*Apodytes dimidiata* E. Mey. ex. Arn.	Icacinaceae	Phanerophyte
76	*Achyrospermum schimperi* (Hochst.exBriq) Perkins	Lamiaceae	Chamaeophyte
77	*Ajuga integrifolia* Buch.-Ham.exD.Don	”	Chamaeophyte
78	*Satureja abyssinica* (Benth.) Briq.	”	Hemicryptophyte
79	*Satureja paradoxa* (Vatke) Engl.ex Seybold	”	Hemicryptophyte
80	*Satureja simensis* (Benth.) Briq.	”	Hemicryptophyte
81	*Thymus schimperi* Ronninger	”	Hemicryptophyte
82	*Linum trigynum* L.	Linaceae	Therophyte
83	*Nuxia congesta* R. Br. ex Fresen.	Loganiaceae	Phanerophyte
84	*Ekebergia capensis* Sparrm.	Meliaceae	Phanerophyte
85	*Bersama abyssinica* Fresen.	Melianthaceae	Phanerophyte
86	*Stephania abyssinica* (Dill. and A.Rich) Walp.	Menispermaceae	Hemicryptophyte
87	*Ficus sur* Forssk.	Moraceae	Phanerophyte
88	*Myrica salicifolia* Hochst ex. A. Rich.	Myricaceae	Phanerophyte
89	*Myrsine africana* L.	Myrsinaceae	Phanerophyte
90	*Myrsine melanophloeos* (L.) R. Br.		Phanerophyte
91	*Jasminum abyssinicum* Hochst. ex. DC.	Oleaceae	Phanerophyte
92	*Jasminum stans* Pax.	”	Phanerophyte

93	*Olea europaea* L. subsp. *cuspidata* (Wall. ex. G. Don.) Cif.	”	Phanerophyte
94	*Olinia rochetiana* A. Juss.	Oliniaceae	Phanerophyte
95	*Habenaria vaginata* A.Rich	Orchidaceae	Geophyte
96	*Oxalis procumbens* Steud. ex A. Rich.	Oxalidiaceae	Therophyte
97	*Pittosporum viridiflorum* Sims	Pittosporaceae	Phanerophyte
98	*Plantago lanceolata* L.	Plantaginaceae	Hemicryptophyte
99	*Plantago palmata* Hook. f.	„	Hemicryptophyte
100	*Bromus leptoclados* Nees	Poaceae	Hemicryptophyte
101	*Oplismenus hirtellus*. (L.) P. Beauv.	„	Hemicryptophyte
102	*Podocarpus falcatus* (Thunb) R.B.Ex.Mirb	Podocarpaceae	Phanerophyte
103	*Polygala sphenoptera* Fresen.	Polygalaceae	Hemicryptophyte
104	*Rumex nepalensis* Spreng.	Polygonaceae	Geophyte
105	*Ardisiandra sibthoripioides* Hookf.	Primulaceae	Therophyte
106	*Thalictrum rhynchocarpum* Dill. & A.Rich.	Rannunculaceae	Hemicryptophyte
107	*Rhamnus* staddo A. Rich.,	Rhamnaceae	Phanerophyte
108	*Alchemilla abyssinica* Fresen.	Rosaceae	Hemicryptophyte
109	*Prunus africana (Hook*. f.) Kalkm.	”	Phanerophyte
110	*Rosa abyssinica* Lindley	”	Phanerophyte
111	*Rubus steudneri* Schweinf.	”	Chamaeophyte
112	*Galium aparinoides Forssk.*	Rubiaceae	Therophyte

113	*Galium thunbergianum Eckl.* & *Zeyh.*,	”	Therophyte
114	*Rubia cordifolia* L.	”	Hemicryptophyte
115	*Pentas schimperiana* (A. Rich.) Vatke	”	Hemicryptophyte
116	*Rytigynia neglecta* (Hiern) Robyns	”	Phanerophyte
117	*Clausena anisata* (Willd.) Benth.	Rutaceae	Phanerophyte
118	*Teclea nobilis* Del.	”	Phanerophyte
119	*Osyris quadripartite* Decn.	Santalaceae	Phanerophyte
120	*Allophylus abyssinicus* (Hochst.) Radlk.	Sapindaceae	Phanerophyte
121	*Sideroxylon oxyacanthum* Baill.	Sapotaceae	Phanerophyte
122	*Halleria lucida* L.	Scrophularaceae	Phanerophyte
123	*Craterostigma plantagineum* Hochst.	„	Hemicryptophyte
124	*Craterostigma pumilum* Hochst.,	Scrophulariaceae	Chamaeophyte
125	*Veronica abyssinica* Fresen.	”	Hemicryptophyte
126	*Veronica simensis* Fresen.	”	Hemicryptophyte
127	*Selaginella goudotiana* (Spring) Bizzarri	Selaginellaceae	Therophyte
128	*Brucea antidysenterica* J.F. Mill.	Simaroubaceae	Phanerophyte
129	*Cheilanthes farinosa* (Forssk.) Kaulf	Sinopetridaceae	Hemicryptophyte
130	*Smilax* aspera L.	Smilacaceae	Phanerophyte
131	*Girardinia diversifolia* (Link) Friis	Urticaceae	Chamaeophyte
132	*Parietaria dibilis* G.Frost.	”	Therophyte
133	*Pilea tetraphyla* (Steudel) Blume.	”	Therophyte
134	*Urera hypselodenderon* (A.Rich.) Wedd.	”	Chamaeophyte
135	*Hypodematium crenatum (*Forssk.)Kuhn	Woodsiaceae	Hemicryptophyte

Appendix 2 Sample plot, P^H measurement and altitude of Suba Sebeta Forest

Plot Number	**Altitude**	**P^H value**
1	2870	5.57
2	2860	5.58
3	2850	6.53
4	2840	5.84
5	2830	6.20
6	2820	5.73
7	2810	5.97
8	2800	6.22
9	2790	6.73
10	2780	6.45
11	2770	6.23
12	2760	6.63
13	2750	7.20
14	2740	6.02
15	2730	6.36
16	2720	6.67
17	2710	6.91
18	2700	6.25
19	2690	6.41
20	2680	6.47
21	2670	5.98
22	2660	6.74
23	2650	6.73
24	2640	6.68
25	2630	6.89
26	2620	6.38

27	2610	6.62
28	2600	6.15
29	2590	6.76
30	2580	6.70
31	2570	7.32
32	2560	6.68
33	2550	6.62
34	2540	6.68
35	2530	6.15
36	2520	6.21
37	2510	6.48
38	2500	6.80
39	2490	6.81
40	2480	6.76
41	2470	6.92
42	2460	6.87
43	2450	6.78
44	2440	6.19
45	2430	6.50
46	2420	6.52
47	2410	6.47
48	2400	5.98
49	Plantation(3010)	5.02

Appendix 3 % Frequency and Relative Frequency of each species and life form

No	Species name	Life form	Frequen	% freque	Relative Freque
1	*Juniperus procera* Hochst. ex. A. Rich.	Phanerophyte	47/48	97.92	2.61
2	*Olea europaea* L. subsp. *cuspidata* (Wall. ex. G. Don.) Cif.	Phanerophyte	46/48	95.83	2.56
3	*Cynoglossum amplifolium* Hochst.exA.DC	Geophyte	43/48	89.6	2.39
4	*Cyperus tenuispica* Steud.	Hemicryptophyte	43/48	89.6	2.39
5	*Maytenus gracilipes* (Welw. ex 0Iiv.) Exell	Phanerophyte	42/48	85.42	2.28
6	*Oplismenus hirtellus. (*L.) P. Beauv.	Hemicryptophyte	41/48	85.42	2.28
7	*Achyranthes aspera* L.	Chamaeophyte	40/48	83.33	2.22
8	*Kalanchoe petitiana* A.Rich.	Hemicryptophyte	40/48	83.33	2.22
9	*Dovyalis abyssinica* (A. Rich.) Warb.	Phanerophyte	39/48	81.25	2.17
10	*Jasminum abyssinicum* Hochst. ex. DC.	Phanerophyte	39/48	81.25	2.17
11	*Solanecio gigas (Vatke) C.* Jeffrey	Chamaeophyte	39/48	81.25	2.17
12	*Hypoestes triflora (*Forssk.) Roem.& Schult	Chamaeophyte	38/48	79.17	2.11
13	*Sanicula elata Buch. Ham.* ex D. Don	Hemicryptophyte	38/48	79.17	2.11
14	*Myrsine africana* L.	Phanerophyte	37/48	77.08	2.06
15	*Sideroxylon oxyacanthum* Baill.	Phanerophyte	37/48	77.08	2.06
16	*Cynoglossum coerulem* Hochst.exA.DC	Therophyte	36/46	75.00	2
17	*Lobelia giberroa* Hemsl.	Chamaeophyte	36/48	75.00	2

18	*Asplenium monanthes* L.	Hemicryptophyte	35/48	72.92	1.95
19	*Dovyalis verrucosa* (Hochst.) Warb.	Phanerophyte	35/48	72.92	1.95
20	*Adiantum poreti* Wikstr.	Hemicryptophyte	34/48	70.83	1.89
21	*Mimulopsis solmsii* Schweinf.	Hemicryptophyte	34/48	70.83	1.89
22	*Agrocharis melanantha* Hochst.	Therophyte	33/48	68.75	1.83
23	*Bersama abyssinica* Fresen.	Phanerophyte	33/48	68.75	1.83
24	*Olinia rochetiana A.* Juss.	Phanerophyte	33/48	68.75	1.83
25	*Geranium arabicum* Forssk.	Hemicryptophyte	31/48	64.58	1.72
26	*Maytenus undata* (Thunb.) Blakelock	Phanerophyte	30/48	62.50	1.67
27	*Mikaniopsis clematoides* Sch.Bip.ex A.Rich.) Milne- Redh.	Chamaeophyte	35/48	60.42	1.61
28	*Podocarpus falcatus* (Thunb) R.B.Ex.Mirb	Phanerophyte	29/48	60.42	1.61
29	*Teclea nobilis* Del.	Phanerophyte	29/48	60.42	1.61
30	*Galium aparinoides* Forssk.,	Therophyte	28/48	58.33	1.56
31	*Impatiens hochstetteri* Warb.	Therophyte	28/48	58.33	1.56
32	*Scolopia theifolia* Gilg.	Phanerophyte	28/48	58.33	1.56
33	*Parietaria dibilis* G.Frost.	Therophyte	26/48	54.17	1.45
34	*Alchemilla abyssinica* Fresen	Hemicryptophyte	25/48	52.10	1.39
35	*Asplenium aethiopicum* (Burm.f.)Bech.	Hemicryptophyte	24/48	50.00	1.33
36	*Oxalis procumbens Steud.* ex A. Rich.	Therophyte	22/48	45.83	1.22
37	*Brucea antidysenterica* J.F. Mill.	Phanerophyte	20/48	41.67	1.11
38	*Allophylus abyssinicus* (Hochst.) Radlk.	Phanerophyte	19/48	39.58	1.06
39	*Pilea tetraphyla (*Steudel) Blume.	Therophyte	19/48	39.58	1.06
40	*Bromus leptoclados* Nees	Hemicryptophyte	18/48	37.50	1.00

41	*Satureja abyssinica* (Benth.) Briq.	Hemicryptophyte	18/48	37.50	1.00
42	*Dichrocephala chrysanthemifolia* (B.l.) DC.	Therophyte	17/48	35.42	0.95
43	*Smilax aspera* L.	Phanerophyte	17/48	35.42	0.95
44	*Conyza nana* Sch. Bip. ex Olivo & Hiern	Hemicryptophyte	16/48	33.33	0.89
45	*Cirsum schimperi Sch.* Bip. ex A.Rich..	Geophyte	16/48	33.33	0.89
46	*Prunus africana (Hook.* f.) Kalkm.	Phanerophyte	15/48	31.25	0.83
47	*Calpurnea aurea* (Ait.) Benth.	Phanerophyte	14/48	29.17	0.78
48	*Carissa spinarum* L.	Phanerophyte	14/48	29.17	0.78
49	*Rhus glutinosa* A. Rich	Phanerophyte	14/48	29.17	0.78
50	*Carduus leptacanthus* Fresen.	Chamaeophyte	13/48	27.10	0.72
51	*Landolphia buchananii* (Hall.f.) Stapf	Phanerophyte	13/48	27.08	0.72
52	*Sonchus bipontini* Asch.	Geophyte	13/48	27.08	0.72
53	*Cheilanthes farinosa* (Forssk) Kaulf	Hemicryptophyte	12/48	25.00	0.67
54	*Hypoestes forskaolii* (Vahl)R.Br.	Hemicryptophyte	12/48	25.00	0.67
55	*Nuxia congesta* R. Br. ex Fresen	Phanerophyte	12/48	25.00	0.67
56	*Rytigynia neglecta* (Hiern) Robyns	Phanerophyte	12/48	25.00	0.67
57	*Asparagus africanus* Lam.	Phanerophyte	11/48	22.92	0.61
58	*Launaea rueppellii* (Sch.Bip.exoliv &Hiern)L. Boulos	Geophyte	11/48	22.92	0.61
59	*Croton macrostachyus* Del.	Phanerophyte	10/48	20.83	0.56
60	*Laggera tomentosa* (Sch.Bip. ex A. Rich.) Oliv. & Hiern	Chamaeophyte	10/48	20.83	0.56
61	*Myrsine melanophloeos* (L.) R. Br.	Phanerophyte	10/48	20.83	0.56
62	*Rubia cordifolia* L.	Hemicryptophyte	9/48	18.75	0.5

63	*Ekebergia capensis* Sparrm.	Phanerophyte	8/48	16.67	0.44
64	*Galium thunbergianum* Eckl. & Zeyh.,	Therophyte	7/48	14.58	0.39
65	*Stephania abyssinica* (Dill. and A.Rich) Walp.	Hemicryptophyte	7/48	14.58	0.39
66	*Phaulopsis imbricata* (Forssk) Sweet	Hemicryptophyte	6/48	12.50	0.33
67	*Erica arborea* L.	Phanerophyte	5/48	10.42	0.28
68	*Jasminum stans* Pax.	Phanerophyte	5/48	10.42	0.28
69	*Osyris quadripartite* Decn.	Phanerophyte	5/48	10.42	0.28
70	*Tagetes minuta* L.	Therophyte	5/48	10.42	0.28
71	*Cassipourea malosana* (Baker)Alston	Phanerophyte	4/48	8.30	0.22
72	*Galinsoga qudriradiata* Ruiz & Pavon	Therophyte	4/48	8.33	0.22
73	*Girardnia diversifolia (*Link) Friis	Chamaeophyte	4/48	8.33	0.22
74	*Lactuca inermis* Forssk.	Hemicryptophyte	4/48	8.33	0.22
75	*Plantago palmata* Hook. f.	Hemicryptophyte	7/48	8.33	0.22
76	*Plectocephalus varians* (A.Rich.) C.Jeffery ex Cufod.	Geophyte	4/48	8.33	0.22
77	*Polygala sphenoptera* Fresen	Hemicryptophyte	4/48	8.33	0.22
78	*Rhamnus staddo* A. Rich.,	Phanerophyte	4/48	8.3	0.22
79	*Thymus schimperi* Ronninger	Hemicryptophyte	4/48	8.33	0.22
80	*Veronica abyssinica* Fres.	Hemicryptophyte	4/48	8.33	0.22
81	*Ajuga integrifolia* Buch.-Ham.exD.Don	Chamaeophyte	3/48	6.25	0.17
82	*Alepidia peduncularis* Steud. ex A.Rich.	Geophyte	3/48	6.25	0.17
83	*Centella asiatica* (L.) Vrsan	Hemicryptophyte	3/48	6.25	0.17
84	*Dichondra repens* J.R. & G. Forst.	Hemicryptophyte	3/48	6.25	0.17

85	*Hypodematium crenatum* (Forssk.)Kuhn	Hemicryptophyte	3/48	6.25	0.17
86	*Linum trigynum* L.	Therophyte	3/48	6.25	0.17
87	*Myrica salicifolia* Hochst ex. A. Rich.	Phanerophyte	3/48	6.25	0.17
88	*Pittosporum viridiflorum* Sims	Phanerophyte	3/48	6.25	0.17
89	*Rosa abyssinica* Lindley	Phanerophyte	3/48	6.25	0.17
90	*Satureja paradoxa* (Vatke) Engl.ex Seybold	Hemicryptophyte	3/48	6.25	0.17
91	*Satureja simensis (*Benth.) Briq.	Hemicryptophyte	3/48	6.25	0.17
92	*Selaginella goudotiana* (Spring) Bizzarri	Therophyte	3/48	6.25	0.17
93	*Sonchus aspera* (L.) Hill	Therophyte	3/48	6.25	0.17
94	*Stellaria media* (L.) Vill.	Therophyte	3/48	6.25	0.17
95	*Urera hypselodendron* (A.Rich.) Wedd.	Chamaeophyte	3/48	6.25	0.17
96	*Achyrospermum schimperi* (Hochst.exBriq) Perkins	Chamaeophyte	2/48	4.17	0.11
97	*Apodytes dimidiata* E. Mey. ex. Arn.	Phanerophyte	2/48	4.17	0.11
98	*Ardisiandra sibthoripioides* Hookf.	Therophyte	2/48	4.17	0.11
99	*Arisaema enneaphyllum* Hochst. ex. A. Rich.	Geophyte	2/48	4.17	0.11
100	*Chlorophytum tetraphyllum(* L.f) Baker	Geophyte	2/48	4.17	0.11
101	*Clausena anisata* (Willd.) Benth.	Phanerophyte	2/48	4.17	0.11
102	*Craterostigma pumilum* Hochst.,	Chamaeophyte	2/48	4.17	0.11
103	*Habenaria vaginata* A.Rich	Geophyte	2/48	4.17	0.11
104	*Halleria lucida* L.	Phanerophyte	2/48	4.17	0.11
105	*Millettia ferruginea* (Hochst.) Bak.	Phanerophyte	2/48	4.17	0.11

106	*Pentas schimperiana* (A. Rich.) Vatke	Hemicryptophyte	2/48	4.17	0.11
107	*Periploca linearifolia* Quart.-Dill. & A.Rich.	Chamaeophyte	2/48	4.17	0.11
108	*Plantago lanceolata* L.	Hemicryptophyte	2/48	4.17	0.11
109	*Pseudognaphalium richardianum* (Cufod.) Hilliar & Burtt.	Phanerophyte	2/48	4.17	0.11
110	*Pterolobium stellatum* (Forssk.) Brenan	Phanerophyte	2/48	4.17	0.11
111	*Rubus steudneri* Schweinf.	Chamaeophyte	2/48	4.17	0.11
112	*Agarista salicifolia* (Comm.ex Lam.) *Don*	Phanerophyte	1/48	2.08	0.06
113	*Albizia schimperiana* Oliv.	Phanerophyte	1/48	2.08	0.06
114	*Coriandrum sativum* L.	Therophyte	1/48	2.10	0.06
115	*Craterostigma plantagineum* Hochst.	Hemicryptophyte	1/48	2.10	0.06
116	*Crotalaria laburnifolia* L.	Phanerophyte	1/48	2.08	0.06
117	*Erucastrum pachypodum* (Chiov.) Jonsell	Therophyte	1/48	2.10	0.06
118	*Euphorbia ampliphylla* Pax.	Phanerophyte	1/48	2.08	0.06
119	*Ficus sur* Forssk.	Phanerophyte	1/48	2.08	0.06
120	*Gerbera piloselloides* (L.) Cass.	Hemicryptophyte	1/48	2.10	0.06
121	*Helichrysum argyranthum* O.Hoffm.	Hemicryptophyte	1/48	2.10	0.06
122	*Hypericum quartinianum* A. Rich.	Chamaeophyte	1/48	2.08	0.06
123	*Maytenus addat* (Loes.) Sebsbe	Phanerophyte	1/48	2.08	0.06
124	*Rumex nepalensis* Spreng.	Geophyte	1/48	2.10	0.06
125	*Scabiosa columbaria* L.	Hemicryptophyte	1/48	2.10	0.06
126	*Scadoxus multiflorus* (Martyn) Raf	Geophyte	1/48	2.10	0.06
127	*Swertia abyssinica* Hochst.	Chamaeophyte	1/48	2.10	0.06
128	*Thalictrum rhynchocarpum* Dill. & A.Rich.	Hemicryptophyte	1/48	2.10	0.06

129	*Trifolium simensis* Fresen.	Therophyte	1/48	2.10	0.06
130	*Vernonia leopoldii* (Sch.Bip.exWalp.) Vatke	Chamaeophyte	1/48	2.08	0.06
131	*Vernonia urticifolia* A.Rich.	Hemicryptophyte	1/48	2.08	0.06
132	*Vernonia wollastonii* S.Moore	Phanerophyte	1/48	2.08	0.06
133	*Veronica simensis* Fres.	Hemicryptophyte	1/48	2.10	0.06
134	*Vigna vexillata* (L.) A.Rich.	Chamaeophyte	1/48	2.10	0.06
135	*Hypodematium crenatum*	Hemicryptophyte	1/48	2.10	0.06