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# Endemic plant species composition and their status in Boda Dry Evergreen Montane Forest, West Showa, Ethiopia

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**The present study was aimed to show the species compositions and their status in Boda forest Oromia Regional State, West Ethiopia. Systematic sampling method was used to collected vegetation data from 60 plots of 20 x 20 m (400 $m^2$) quadrats laid at every 50 m along five transect lines from south-north direction was employed for the analysis of woody species using compass and subplots of 1 x 1 m at the four corners and the center of the large quadrat was used for herbaceous plants. A total of 133 species of plants (herbs, shrubs, lianas and trees) were recorded. Out of these, 11 plant species were endemic which have been included in the preliminary list assessed for IUCN Red Data List, of which 1 species is nearly threatened, one species is vulnerable, and the other nine of them are at the status least concern. To provide a better management and monitoring as well as to maintain the biodiversity, cultural and economic values of the forest unsustainable used would be controlled by implementing various conservation activities in place.**

**Key words:** Dry evergreen montane forest, endemic species, Boda forest.

## INTRODUCTION

Tropical forests are the storehouses of biodiversity and constitute the most diverse plant communities on earth (Supriya and Yadava, 2006). According to Wilson (1988), over half of the global number of species, which is estimated to be in millions, is found to be in tropical forests. 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 forested area (Demel, 1996) and Africa's rich biodiversity is estimated to comprise about 25% of global biodiversity in terms of ecosystems, species composition and genetic variety (MOA, 1998). According to Cotzee (1978), the East African Mountains have the richest and most diversified tree flora. The Ethiopian highlands contribute to more than 50% of the land area with Afromontane vegetation of which dry montane forests form the largest part (Tamirat, 1994).

Ethiopia has also several major ecological systems that support large and highly varied genetic resources along with its extremely variable agro-climatic conditions. The

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country has a great topographical diversity with high, rugged mountains, flat topped plateaus, deep gorges, incised river valleys and rolling plains. The altitudinal variation ranges from 110 m below sea level in some areas of Kobar Sink, to 4,620 m a.s.l. at Ras Dejen [Dashen] (FAO, 1996). The country also consists of two major high plateau regions separated by the Rift Valley and bounded on all sides by lowlands (Friis 1992; Tamrat, 1993). The diversity of Ethiopia's terrain determines regional variations in climate, natural vegetation, soil composition and settlement patterns. These diverse topographic features and climatic conditions of the country have led to the emergence of habitats that are suitable for the evolution and survival of various plant and animal species (EWNHS, 1996). The size of Ethiopian flora is estimated to be over 6500-7000 species of vascular plants, of which about 12% are considered endemic (Tewolde, 1991). Endemism is high on the plateau, mountains, in the Ogaden and Borana and Bale lowlands (Vivero et al., 2006; Girma, 2008).

According to Fikadu et al. (2014) as cited from Ensermu et al. (1992), 120 threatened endemic plant species are known from Ethiopia. Thirty five of these species were from the Dry Afromontane forests of the country. Dry evergreen montane forest has a very complex type of vegetation, roughly above 1500 m a.s.l. and below 3200 m a.s.l., with an average annual temperature and rainfall of 14-25°C and 700-1100 mm, respectively (Friis, 1992; Zerihun, 1999). Boda dry evergreen montane forest is one of the remnant dry afromontane forests that are found in the high lands of West Showa next to Chilimo National priority forest. Settlements, illegal cutting, small patches of farmland, substitution by the exotic species and open pasture fields are challenges that are facing this forest. Overgrazing and continuous human interference are believed to lead to an irreversible change in the function of forests (Badege, 2001). These frequently lead to loss of forest cover and biodiversity, erosion, desertification and reduced water resources (Ensermu and Teshome, 2008). Indigenous knowledge on medicinal and other useful plants is also eroded with destruction of these forests (Kitessa and Tsegaye, 2008). Therefore, this study was aimed to assess the diversity of endemic plant species and their status in Boda forest. The information gathered is supposed to be important for further studies and conservation measure.

## MATERIALS AND METHODS

### The study area

The study area, Dendi district, is one of the eighteen districts of the West Showa zone of Oromia Regional State. The district capital city, Ginchi, is located 77 km west of Addis Ababa, on the Addis Ababa-Naqamte Road. Geographically, the district lies within the coordinates of 8°43'N-9°17' N and 37°47'E-38°20' E. The district covers about a total area of 104,680 ha. Of which, 72,836 ha is covered by farm land, 19,080 ha grazing-land, 9,685 ha forest and shrubs and others 3,079 ha with the population of 192,784 (99,475 males and 93309 females). The district has 48 peasant associations and 5 urban out of which Ghinchi and Olankomi have municipal governments (Fikadu et al., 2014).

Boda Natural forest is at Boda Bosoka Peasant associations, 22 km away from the district's capital city, close to the main road running Ginchi-Busa town. It got its name from the town found nearby called Boda. Sometimes it is called "Renda Beteskane" Because of the Orthodox Church found at the tip of the mountain of the forest. It covers around 20 ha.

The physiographic region of the district is characterized by one major escarpment running from east to west direction. The steepness of the escarpment varies from place to place being generally steeper at the central part of the district. Both on the top and bottom, the escarpment merges with flat lands largely used for farming. The altitudinal range of the district is between 2,000 and 3,288 m a.s.l. Besides, the relief feature of the area is characterized by rugged topography, which provides a variety of hills having interesting scenes. The district is an important watershed area for Awash and Nile river basin (Tamrat, 1994).

Dendi district has some natural endowments to attract scientists and researchers:

1. The importance of the Chilimo Natural Forest at country level;
2. The topography and the soil type that the district stretches from 2,000 to 3,288 m above sea level;
3. The existence of Lake Dendi, from where the district got its name, is a unique lake found at highland in the shape of an "8" and encircled by a chain of mountains. Recently, the attempts by ALMOEZ Holding Group, a Qatari-Egyptian Investment Company (dendilake.com) that intruded into the area with "investment card", and the US, NASA that posted the Dendi report have made the area popular these days. Only a few years ago, the lake area was an inaccessible area where nobody was interested to go, because of the ragged landscape.
4. Cave of Gifo and Cave of Aba Ife, with no investigation done on them. Although, both of them found at attractive physical form of landscape and each of them have many classes at inside and many openings (Plate 1).

### Vegetation and environmental data

The vegetation data were collected systematically from 60 plots of 20 x 20 m (400 $m^2$) quadrats laid at every 50 m along 5 transect lines from south-north direction using compass following the Braun-Blanquet approach of phytosociology as modified by vander Maarel (1979). Sub plots of 1 x 1 m at four corners and the center of the large quagrat was used for herbaceous plants. The distance between each transect line was 100 m in a zigzag form of starting point of laying plot. This is to include as much vegetation as possible that can represent the vegetation of the study area. Additional plant species occurring outside the quadrats, but inside the forest within 10 m distance was also recorded only as 'present' for floristic composition, but they were not used in the subsequent vegetation data analysis (Tamrat, 1994). The vernacular (local) names were used when available. Plant species in each plot was counted and recorded at individual level, and voucher specimens was also collected, numbered, pressed and taken to the National Herbarium of Ethiopia (ETH), Addis Ababa University, for identification and storage following standard taxonomic method (Bridson and Forman, 1992).

## RESULTS

### The richness of plant species in Boda Forest

A total of 133 specimens of plants (herbs, shrubs, trees,

**Plate 1.** Cave of Gifo and Cave of Aba Ife (Photo by Fikadu, September, 2013 G.C).

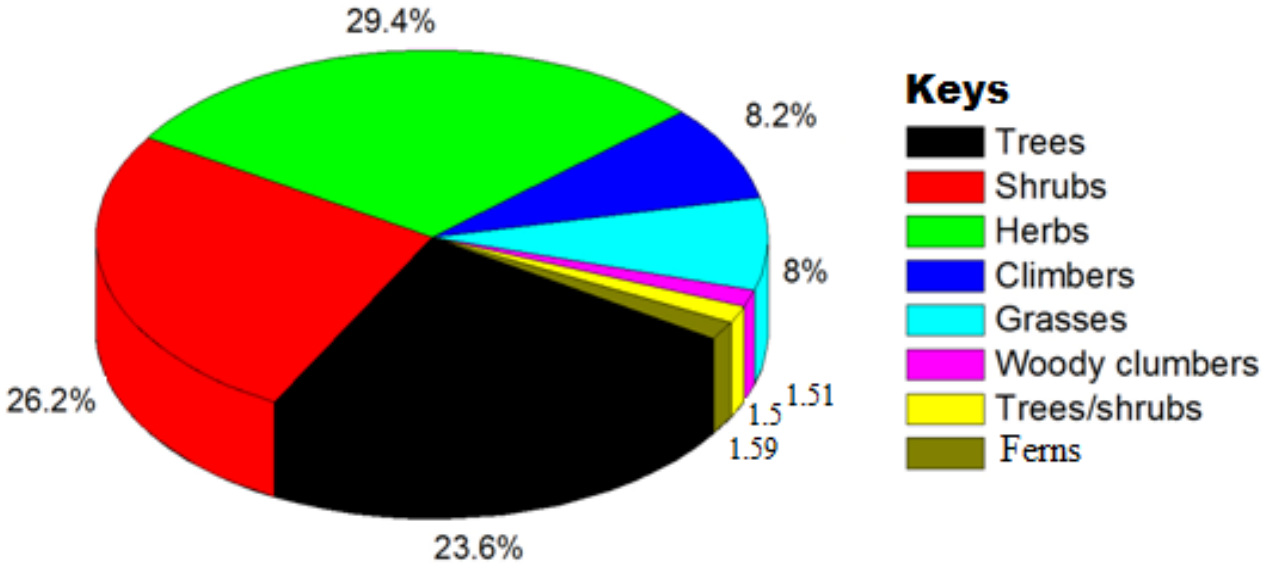


**Figure 1.** Habit of plants in the study forest.

shrubs/trees, climbers and tree/climbers) were identified and documented from the Boda forest. The identified species belong to 114 genera and 62 families. Two species, *Geranium arabicum* and *Opuntia ficus indica* were collected outside the sampling plot. The collected species were composed of 23.6% trees, 26.2% shrubs, 29.4% herb, 1.5% trees/shrubs, 8.2% climbers, 8% grass, 1.51% woody climbers, 1.5% tree/shrubs, and 1.59% fern (Figure 1).

Table 1 below indicates the number of Families, Genera and species of woody species in Boda Forest. The major families were Fabaceae represented by 14 spp.

**Table 1.** The number of families, genera and species of plants in Boda Forest

| Family | Genera | species | Percentage | Family | Genera | species | Percentage |
|---|---|---|---|---|---|---|---|
| Acanthaceae | 2 | 3 | 2.70 | Myrsinaceae | 2 | 3 | 2.70 |
| Acacardiaceae | 1 | 1 | 0.90 | Myrtaceae | 1 | 1 | 0.90 |
| Adiantaceae | 1 | 1 | 0.90 | Oleaceae | 2 | 2 | 2.00 |
| Anacardiaceae | 1 | 1 | 0.90 | Orchidaceae | 1 | 1 | 0.90 |
| Apocynaceae | 1 | 1 | 0.90 | Papilionaceae | 1 | 1 | 0.90 |
| Araceae | 1 | 1 | 0.90 | Phytolaccaceae | 1 | 1 | 0.90 |
| Asclepiadaceae | 2 | 3 | 2.70 | Piperaceae | 1 | 1 | 0.90 |
| Asparagaceae | 1 | 1 | 0.90 | Pittosporaceae | 1 | 1 | 0.90 |
| Asteraceae | 9 | 12 | 10.90 | Plantaginaceae | 1 | 1 | 0.90 |
| Balsaminaceae | 1 | 1 | 0.90 | Poaceae | 6 | 9 | 8.18 |
| Boraginaceae | 1 | 1 | 0.90 | Podocarpaceae | 1 | 1 | 0.90 |
| Celastraceae | 1 | 2 | 2.00 | Polygalaceae | 1 | 1 | 0.90 |
| Commelinaceae | 2 | 2 | 2.00 | Polygonaceae | 2 | 2 | 2.00 |
| Crassulaceae | 1 | 1 | 0.90 | Pteridaceae | 1 | 1 | 0.90 |
| Cucurbitaceae | 1 | 1 | 0.90 | Ranunculaceae | 1 | 1 | 0.90 |
| Cupressaceae | 2 | 2 | 2.00 | Rhamnaceae | 1 | 2 | 2.00 |
| Cyperaceae | 2 | 2 | 2.00 | Rosaceae | 3 | 4 | 3.63 |
| Ebenaceae | 1 | 1 | 0.90 | Rubiaceae | 5 | 6 | 5.00 |
| Ericaceae | 1 | 1 | 0.90 | Rununculaceae | 1 | 1 | 0.90 |
| Euphorbiaceae | 3 | 5 | 4.50 | Rutaceae | 2 | 2 | 2.00 |
| Fabaceae | 12 | 14 | 12.70 | Salicaceae | 1 | 1 | 0.90 |
| Flacourtiaceae | 2 | 2 | 2.00 | Santalaceae | 1 | 1 | 0.90 |
| Geraniaceae | 1 | 1 | 0.90 | Sapotaceae | 1 | 1 | 0.90 |
| Guttiferaeceae | 1 | 2 | 2.00 | Scrophulariaceae | 1 | 1 | 0.90 |
| Iridaceae | 1 | 1 | 0.90 | Solanaceae | 2 | 4 | 3.63 |
| Lamiaceae | 6 | 6 | 5.50 | Thelypteridaceae | 1 | 1 | 0.90 |
| Loranthaceae | 1 | 1 | 0.90 | Tiliaceae | 1 | 1 | 0.90 |
| Malvaceae | 3 | 3 | 2.70 | Urticaceae | 2 | 2 | 2.00 |
| Meliaceae | 1 | 1 | 0.90 | Usnaceae | 1 | 1 | 0.90 |
| Menispermaceae | 1 | 1 | 0.90 | Verbanaceae | 1 | 1 | 0.90 |
| Moraceae | 1 | 1 | 0.90 | Vitaceae | 1 | 1 | 0.90 |
| Total | | | | 62 | 114 | 133 | 100 |

(12.7%), Asteraceae by 12 species (10.9%), Poaceae by 9 species (8.18%), Lamiaceae and Rubiaceae each with 6 species (5% each), Euphorbiaceae by five species (4.5%), Solanaceae and Rosaceae, by 4 species (3.63 each), Acanthacerae, Asclepiadaceae, Malvaceae, and Myrsinaceae are represented by 3 species (2.7% each), Celastraceae, Commelinaceae, Cupressaceae, Cyperaceae, Flacourtiaceae, Guttiferaeceae, Oleaceae, Polygonaceae, Rhamnaceae, Rutaceae and Urticaceae are represented by 2 species (2% each) of the total floristic composition. The remaining (38%) families were represented by one species only.

Out of the plants identified in this study area, 11 (8.4%) were endemic plant species which are included in the preliminarily assessed list for IUCN Red Data List, of these 1 species is nearly threatened (*Maytenus addat* (Loes.) Sebsebe), and 1 species is vulnerable (*Echinops kebericho* Mesfin) the other 9 of them are least concern (Table 2). From the endemic species that were recorded in IUCN Red List in the study area herbs, shrubs, trees and climbers constitute 45, 27, 18 and 9%, respectively.

## DISCUSSION

### Species diversity and endemism

Ethiopia possesses a large natural and cultural diversity with a wide range of climates which results from its topography and latitudinal location. The great plains of Ethiopia occur at top two massive highland plateaus, divided into unequal halves by the Great Rift Valley. From the very hot arid and semi-arid lands in the east, the lowlands bordering the Sudan in the west and Dalol in the

**Table 2.** Endemic species of the study area, their IUCN Red List categories and distributions (Ha = Habit, T = tree, Sh = shrub, H = herb, C = climber, NT= nearly threatened, LC= least concern, VU= vulnerable).

| Scientific name | Family | Ha | IUCN Red List Category |
|---|---|---|---|
| *Bidens ghedoensis* Mesfin | Asteraceae | H | LC |
| *Clematis longicauda* Steud. ex A. Rich. | Rununculaceae | C | LC |
| *Echinops kebericho* Mesfin | Asteraceae | H | VU |
| *Erithrina brueci* Schweinf | Fabaceae | T | LC |
| *Impatiens rothii* Hook.f. | Balsaminaceae | H | LC |
| *Kalanchoe petitiana*A.Rich. | Crassulaceae | H | LC |
| *Maytenus addat* (Loes.) Sebsebe | Celestraceae | T | NT |
| *Solanum giganteum* Jacq. | Asteraceae | Sh | LC |
| *Solanum marginatum* L.f. | Solanaceae | Sh | LC |
| *Urtica simensis* Steudel | Urticaceae | H | LC |
| *Lippia adoensis* Hochst. ex Walp. | Verbanaceae | H | LC |

north, where Africa crashes into Arabia, the land rising through semi-arid lowlands and pockets of tropical jungle, montane forests, and reaching afroalpine pastures on the slopes such as the Semien and Bale mountain ranges. Many of these mountain ranges reach over 4000 m asl, and are home to numerous endemic species of flora. There is a great disparity in altitude ranging from 116 m below sea level in Dalol to 4620 m asl in Semien (IBC, 2009). The variations in elevation and latitude have resulted in a wide difference in climates, which along with differences in soils form the basis for the wide plant diversity of the country. As a result, Ethiopia becomes a center of biological diversity with sizeable endemism, especially about 12% of the flora (Tewolde Berhan Gebre Egziabher, 1991). But the current studied afromontane forest belongs to the western massive highland plateaus where 131 plant species were recorded, of which 8.4% of the studied vegetation becomes endemic to the studied afromontane forest. The Ethiopian Flora is estimated to consist of between six and seven thousand species distributed in about 245 plant families (Tadesse and Mesfin, 2010). This biodiversity is of vital importance in the socio-economic, cultural and political life of the people. The highlands of Ethiopia, together with the highlands of East Africa, constitute the Afromontane floristic region (White, 1978). Though the Ethiopian highlands are the most extensive of the African mountainous regions, the number of species in them is lower than in the less extensive East African Mountains. This is probably because the Ethiopian highlands are, on the whole, drier than their East African counterparts (Tewolde Berhan Gebre Egziabher, 1991). However, the implicit belief that has existed hitherto, that the Ethiopian flora is rich both in species numbers and in endemics is, therefore, valid.

## Loss of forest plant diversity

With escalating demographic pressure on diminishing natural resources, plant biodiversity is still being cleared at an alarming rate to open up land for agriculture and livestock production (Vivero et al., 2005). From the present study, *Echinops kebericho* has been registered under national red list as vulnerable for it is considered to be facing a high risk of extinction in the wild, mainly associated with its traditional medicinal use. Currently, medicinal plants are under threat in Ethiopia largely due to anthropogenic factors (Demisse, 2001; Giday et al., 2007; Birhane et al., 2011), environmental degradation, change in the peoples' lifestyles (Edwards, 2001; Hunde et al., 2006), agricultural expansion, deforestation and over harvesting of species (Kelbessa et al., 1992).

The genus *Echinops* is composed of about 12 species inhabiting usually degraded and dry land in Ethiopia. It is commonly referred to as "globe thistle" in Europe because of the spherical arrangement of the flowers. *Echinops kebericho* Mesfin, in depth and reported "… copious amounts of sesquiterpenes (10%) of which the dehydrocostus lactone is the major constituent." The roots and flower heads (capitula) of four species of *Echinops* are used in the treatment of headache and hemorrhoids by traditional people. One species, *E. kebericho* Mesfin, has been used as a fumigant, particularly after child birth, and as a medicinal plant to treat leprosy for centuries. The large tuberous roots are sold either cut up as small pieces or in whole in many open markets in Shewa, Gojjam and Wellega regions in Ethiopia (Tadesse and Mesfin, 2010). A study of Borana pastoralists in southern Ethiopia described the purpose (hygienic and perfumery), facilities used and processes associated with traditional fumigation techniques (Gemedo *et al.*, 2005). Fumigation using *E. kebericho* is particularly important after child birth in large areas of rural Ethiopia and it may be utilized in much the same way as in the Borana region. Furthermore, *E. kebericho* has been traditionally reported to have abortifacient action, and also used to treat epilepsy, epistaxis, atrophy, and sudden and devil sickness by people of Kembatta,

Southern Ethiopia (Melesse Maryo, 2013). Thus, due to its overuse in the wild the species is facing a high risk of extinction in the wild.

Similarly, *Juniperus procera*, *Podocarpus falcatus* and *Hagenia abyssinica* are tree species of dry evergreen montane forests of Ethiopia, which are dominant trees of the current study forest. They harbor the aforementioned endemic plant species but are currently facing big anthropogenic impacts. In Ethiopian Constitution, the State is the legal owner of the natural forests and woodlands of the country (FDRE, 1995). However, the State has failed to put in place organizations that give proper support to the forestry sector. The lack of effective institutions and the weak law enforcement means the forests and woodlands of the country remain open to all forms of exploitation. People access forests for timber, firewood, charcoal, other construction material, as well as forest grazing and browsing because there is no regulatory system or overseeing body over the harvesting of the products or other uses. This has resulted in the continuous and uncontrolled illegal logging that skims off selected valuable timber species, such as *Hagenia abyssinica, Afrocarpus* (*Podocarpus*) *falcatus* and a few others (Edwards, 2010). This in turn brings decline in the productivity and regenerative capacity such dominant and valuable tree species as well as the rich diversity of endemic plant species harbored within them.

*Podocarpus falcatus* and *Hagenia abyssinica* are two enormously important tree species in Ethiopia, both economically and ecologically. *H. abyssinica* is important as a source of medicine and also timber. *P. falcatus* yields a precious timber and is a source of food (fruits) and shelter for many birds and wild animals. A Global Trees Campaign project undertaken in 2000 studied the germination and propagation of the two species for ecological restoration. In July 2004, a Centre for Indigenous Trees Propagation and Biodiversity Development was established at area located some 50 km west of Addis Ababa, with a view to conserve *H. abyssinica, P. falcatus* and many other endangered Ethiopian trees. It was aimed to fight against plant biodiversity loss at the genetic, species and ecosystem levels, and to increase the capacity to provide practical solutions to conservation problems (Vivero et al., 2005). However, the condition seems improving in the current study at least in forest patches situated away from the urban centre. It was examined that the second most important timber tree species, *Juniperus procera* is regenerating at alarming rate, while *Podocarpus falcatus* also shows encouraging recovery.

Therefore, such good practices need to be further strengthened to save many valuable forest plant diversity in the country.

## Conclusion and recommendations

Boda Forest is one of the remaining Afromontane forests harboring many endemic species. This forest is ecologically, socially, economically and culturally very important for the inhabitants residing nearby who are mostly dependent on forest products to make their living. Loss of such a forest including the various threatened species would have negative impact on the environment, biodiversity and socio-economic setup of the communities. This forest harbors species that are endemic, economically and ecologically important, which requires urgent conservation measures that will enhance healthy regeneration and guarantee sustainable uses of these species. Although, *J. procera* and *P. falcatus* are both common in Boda Forest, the former has been more affected than the later for the extraction of timber. Thus, conservation priority should be given to Boda Forest due to its richness in endemism and natural resources diversity. In general, the following points should be taken into consideration concerning human impact on the forest.

1. Enhance diversification of livelihood (e.g poultry production and using improved varieties of crops),
2. Introduction of modern beehives,
3. Encourage ecotourism industry among local people.
4. Finally, further studies on soil properties, land use management system and detailed ethno-botanical studies are also required to explore the wealth of indigenous knowledge on the diversity of plants and their implications in conservation are recommended.

## Conflict of Interests

The author(s) have not declared any conflict of interests.

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