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Assessment of Floral Composition for the Restoration of Mount Bamboutos, Western Highlands of Cameroon

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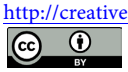

Abstract

The study was aimed at assessing the floral composition of the Mount Bamboutos landscape. A literature search was used to gather information about plants found in Mount Bamboutos. For field data collection, forest patches found along a proposed two-line transect of 12 km each were explored for the collection and identification of plant specimens. A total of 332 species of plants (herbs, shrubs, trees, lianas, climbers and epiphytes) were identified belonging to 89 families. Out of these, the Rubiaceae and Asteraceae had the highest number of species; 41 and 32 respectively. 18 species were identified as threatened in Mount Bamboutos. For the purpose of restoration, 57 species belonging to 25 families were proposed to be adapted to montane and sub-montane ecosystems.

Subject Areas

Plant Science

Keywords

Mount Bamboutos, Species, Restoration, Threatened

1. Introduction

The Cameroon Highlands is characterized by land above an altitudinal range of 1500 m above sea level. The peak of Mt Bamboutos constitutes the fourth highest point on the Cameroon Highlands chain, with an altitude of 2740 m. Mount Bamboutos cuts across three regions notably; West, South West and North West Regions.

The Cameroon Highlands is widely known for its high level of biodiversity and endemism and is considered to host many biodiversity hotspots [1]. Mount Bamboutos, like most parts of the Cameroon highlands, has witnessed an estimated 96.5% clearance of the original montane forest [2]. The destruction of these forest patches is attributed to enormous anthropogenic activities by the adjacent communities in trying to address livelihood and household income needs [3]. The Western Highlands of Cameroon is one of the most densely populated areas in Cameroon and this loss of primary forest has been accompanied by a significant loss of the rich biodiversity that was found in the area.

Some initiatives have been carried out to stimulate community engagement in forest conservation with the creation of community forests in some parts of the country [4]. However, very little has been done to protect Mount Bamboutos, which is a vital link between the South and North parts of the Cameroon Highlands. Part of the initial and elementary activity to restore the Mount Bamboutos ecosystem is to establish the reference situation of the mountain at the level of the communities as well as at the level of the biodiversity of the mountain. The restoration of the ecology of Mount Bamboutos will build on the existing floral diversity of the remnant forest patches found at different altitudes. The survey of the floral diversity with particular focus on tree species of the mountains will not only establish the reference situation of the mountain but will also pave the way for an appropriate reconstruction of the floral diversity of the area through reforestation using the right native species.

This paper presents a baseline for existing plants in Mount Bamboutos obtained through sample biodiversity surveys in key sites across the study area. The baseline data obtained will contribute to the floral diversity of Cameroon, enhance restoration of the Mount Bamboutos by proposing native species of trees for effective restoration activities and foster conservation of the mountains by identifying threatened species of plants existing on the mountain. This study was geared towards understanding the floral composition of the Mount Bamboutos landscape. The Richness of plant species, plant families with the high number of species, threatened plants of the Mount Bamboutos area and recommended tree species for forest regeneration in the landscape.

2. Materials and Methods

2.1. Soils, Climate, Temperature, Rainfall and Humidity

The soils are characterized by low bulk density (0.73 g/cm^3) and a loamy texture. The low bulk density indicates the andosolic nature of these soils [5]. It might be attributed to more ground biomass input in the form of leaf [6]. High fine particles (silt + clay) content might be due to the absence of translocation of finer particles from the surface horizons. The soils are stable with a high structural stability index [7].

The Climate of Mount Bamboutos is more or less the same as that of the western highlands of Cameroon and West Africa [8]. The rainy season stretches from

March to October and the drying season from November to February. The combination of altitude, temperature inversion, slope orientation, hamattan, mist and cloud leads to the development of different local climatic zones. Mean maximum: 20˚C - 22˚C; mean minimum 13˚C - 14˚C. November has the lowest mean minimum temperature and December has the highest mean maximum. Temperature inversions at night in narrow valleys which suffer from poor air drainage lead to some ground frost, mainly in January or February. Rainfall varies from 1780 - 2290 mm per year. The most rain falls between July and September. Generally, January and February have the lowest relative humidity (average 45% - 52%). The monthly average humidity exceeds 80% in July and August. Mist and low clouds frequently occur during the rainy season.

2.2. Vegetation

The Mount Bamboutos area is part of the Western Highlands of Cameroon, with an altitudinal range of slightly below 1000 m to 2740 m at the summit of Mt Bamboutos. According to the Cameroon vegetation map [9], the vegetation of Mount Bamboutos is classified into the submontane forest, which ranges from 800 m to 1900 - 2000 m of altitude and the montane forest 1900 - 2000 m and above. However, Mount Bamboutos also carries vast derived grasslands and woodlands as described by [8].

2.3. Methods

Both literature review and field data collection were used to establish the baseline situation of plants found in Mount Bamboutos. A literature review was used to collect and process secondary data from publications on the plants of the Mt Bamboutos area. The principal source of plant lists of the area was collected through herbaria specimens of plants that had been collected by the National herbarium and the Royal Botanic Gardens Kew from the Mt Bamboutos area.

For field data collection, forest patches found along the proposed two line transects of 12 km each were explored for the collection and identification of plant specimens as shown on the map below (**Figure 1**). Collections were carried out in the southern part of Mount Bamboutos including; Bangang sacred forest of about 50 hectares and the Mesan area towards Tuala. In the northern part notably through the Pinyin-Menka area, collections were carried out in the Menka forest and all small patches of forest in the area were also visited towards the Bamumbu (**Figure 2**).

Filed identification of specimens was carried out for the majority of species that were easy to identify on the field. Collected voucher specimens were tagged, dried and labeled following conventional plant specimen processing techniques with no spirit collections or carpological. Confirmation of identification was carried out at the Cameroon National Herbarium. Occurrences of the main tree species within the different altitudinal ranges were observed and recorded to establish the dominant species of trees given that most of the study site is above 2000 m above sea level.

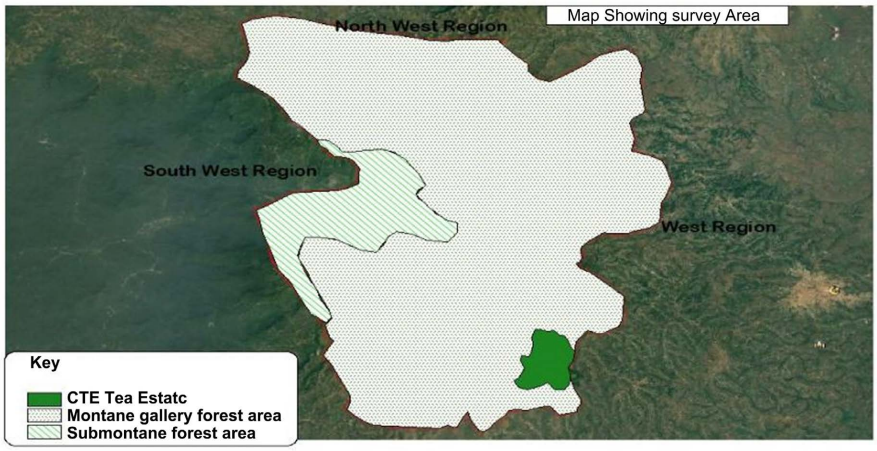

Figure 1. Map showing the study area.

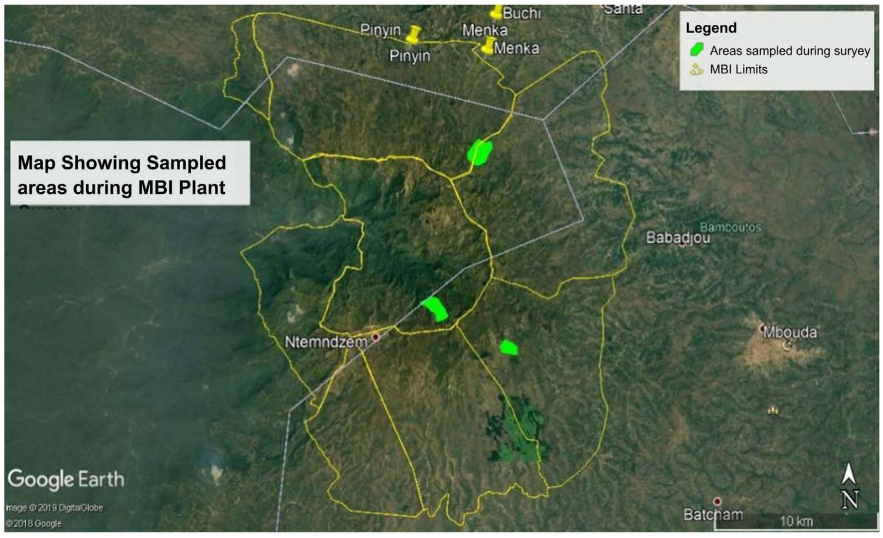

Figure 2. Map showing the areas sampled.

3. Results and Discussion

3.1. The Richness of Plant Species in the Mount Bamboutos

A total of 332 specimens of plants (herbs, shrubs, trees, small trees, lianas, climbers and epiphytes) were identified and documented from Mount Bamboutos. The identified species belong to 89 families. The collected species were composed of 25.3% herbs, 24.1% trees, 241% shrubs, 19.3% small trees, 4.2% climbers, 2.4% epiphytes and 0.6% liana (Figure 3).

The results of this study agree with those of [10] who reported that trees are usually the most frequent life forms in tropical mountain rainforests. The Rubiaceae and the Asteraceae had the highest number of species respectively; 41 and 32 (Table 1). Up to 22 families in the study area had at least 5 species. This shows the high level of diversity of the study site.

The Rubiaceae had the highest number of species and equally had the highest number of endangered species (4 species) (Table 2). The Meliaceae and Asteraceae

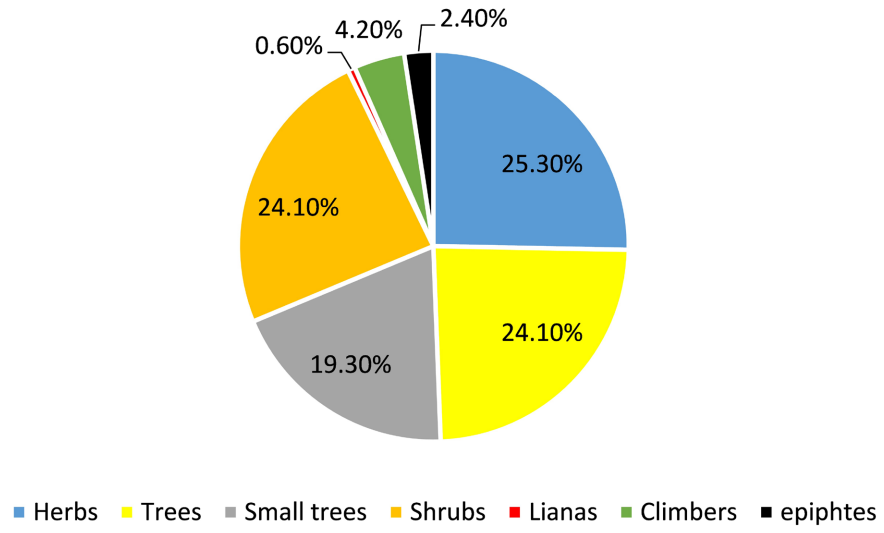

Figure 3. Plant habitats in the study area.

Table 1. Top 22 plant families with high number of species.

No	Family	Number of species	Number of endangered species	Family	Number of species
1	Rubiaceae	41	12	Moraceae	6
2	Asteraceae	32	13	Orchidaceae	6
3	Euphorbiaceae	19	14	Rosaceae	6
4	Apocynaceae	15	15	Ulmaceae	6
5	Labiatae	11	16	Acanthaceae	5
6	Guttiferae	10	17	Meliaceae	5
7	Annonaceae	8	18	Olacaceae	5
8	Fabaceae	8	19	Sapindaceae	5
9	Melastomataceae	8	20	Sapotaceae	5
10	Sterculiaceae	7	21	Solanaceae	5
11	Araliaceae	6	22	Zingiberaceae	5

Table 2. Threatened plants of the Mount Bamboutos area.

Family	Scientific name	Habit	Rating
Annonaceae	*Xylopia africana* (Benth.) Oliv.	Tree	VU
Araliaceae	*Schefflera mannii* (Hook. f.) Harms.	Tree	VU
Asteraceae	*Crassocephalum bougheyanum* C.D. Adams	Herb	VU
Asteraceae	*Heichrysum cameroonense* Hutch. & Dalziel	Herb	VU
Begonaceae	*Impatiens sakeriana* Hook. f.	Herb	VU
Campanulaceae	*Lobelia columnaris* Hook. f.	Herb	VU
Guttiferae	*Allanblackia gabonensis* (Pellegr.)Bamps	Tree	VU

Continued

Meliaceae	*Carapa grandifolia Harms.* Harms.	Tree	VU
Meliaceae	*Entandrophragma angolense* (Welw.) C. DC.	Tree	VU
Myrtaceae	*Syzygium staudtii* (Engl.) Mildbr.	Tree	VU
Rosaceae	*Prunus africana* (Hook. f.) Kalkman	Tree	VU
Rosaceae	*Alchemilla fisheri* Engl. Subsp. *Camerunensis letouzey*	Herb	CR
Rubiaceae	*Chasselia liakomensis* Cheek ined.	small tree	CR
Rubiaceae	*Cuviera longiflora* Hiern	Tree	VU
Rubiaceae	*Ixora foliosa* Hiern	Small tree	VU
Rubiaceae	*Pavetta hookeriana* Hiern var. hookeriana	small tree	VU
Sterculiaceae	*Dombeya ledermanii* Engl.	Tree	CR
Theaceae	*Ternstroemia cameroonensis* Cheek	Tree	CR

VU = Vulnerable, CR = Critically Endangered.

each had 2 endangered species. The main threat to the species is associated with habitat loss through clearance and transformation of the forest to agricultural land. Some species like *Prunus africana*, *Xylopia africana* are targeted because of their medical uses that have resulted in unsustainable harvesting of the species in the wild putting the survival of the species at risk. *Prunus Africana* is used for the treatment of venereal infections, kidney and prostrate disorders [11]. In fact, a good number of species found in the studied area are of conservation value and importance. Out of the 332 species recorded, 18 species were threatened. Among the 18 species, 4 species were critically endangered. These species included *Alchemilla fisheri*, *Chasselia liakomensis*, *Dombeya ledermanii* and *Ternstroemia cameroonensis*. 16 other species were considered vulnerable according to the International Union for the Conservation of Nature [12]. The most commonly used plant families for the treatment of typhoid fever in Bamboutos Division were Asteraceae and Fabaceae [13] which could account for the vulnerable nature of these herbs in these families.

The threatened species found during this study were different from those obtained by [14]. This is because of the difference in the sampling sites. In this study, sampling was concentrated in the forest areas while [14] collected samples from the savanna area. *Ternstroemia cameroonensis* is used for the treatment of sexually transmitted diseases, as a blood tonic and to address female sterility [15].

3.2. Tree Species Recommended for Restoration

As stated by [16], restoration of biodiverse ecosystems, such as tropical mountain ecosystems, has the potential to simultaneously recover lost biodiversity and ecosystem functioning and improve local livelihoods and has recently come to the fore of global conservation efforts [17]. The Society for Ecological Restoration (SER) defined restoration as *"the process of assisting the recovery of an*

ecosystem that has been degraded, damaged or destroyed" [18] and, as such, encompasses a broad suite of approaches ranging from passive restoration, to assisted recovery and active restoration. The urgency for global restorative actions culminated in global restoration pledges like the 2011 Bonn Challenge and the proclamation of the UN Decade of Ecosystem Restoration. Several reasons exist for the restoration of damaged ecosystems and include; conserving biodiversity (specific habitats or species), enhancing ecosystem processes (such as nutrient cycling), combatting climate change (through carbon storage or adaptation), and providing ecosystem services (such as water regulation or food provision) for cultural and spiritual reasons [19]. While restoration is by no means a replacement for the protection of intact ecosystems, it is a useful complementary conservation strategy to recover degraded land, such as in this case of reforestation. Enrichment planting has been found to contribute to the conservation of forest cover in degraded areas. Enrichment planting may influence overstory, understory (seedling/sapling density), and herbaceous species richness [20]. The following species (**Table 3**) were proposed for the regeneration of Mount Bamboutos using the analog-forestry approach where the climax community for montane and sub-montane forest is targeted as the final ideal forests.

Table 3. Recommended tree species for forest regeneration.

Family	Species	Preferred Habitat
Anacardiaceae	*Sorindeia grandifolia*	Dominant submontane canopy level
Anacardiaceae	*Pseudospondias microcarpa*	Dominant submontane canopy level
Annonaceae	*Xylopia africana*	Dominant submontane small tree/shrub level
Annonaceae	*Monodora tenuiflora*	Dominant submontane small tree/shrub level
Annonaceae	*Xylopia acutiflora*	Dominant submontane canopy tree level
Apocynaceae	*Tabernaemontana crassa*	Dominant submontane small tree/shrub level
Apocynaceae	*Voacanga bracteata*	Dominant submontane small tree/shrub level
Apocynaceae	*Alstonia boonei*	Dominant submontane canopy level
Apocynaceae	*Rauwolfia vomitoria*	Dominant submontane small tree/shrub level
Aquifoliaceae	*Illex mitis*	Dominant submontane small tree/shrub level
Araliaceae	*Schefflera mannii*	Dominant montane canopy level
Araliaceae	*Polyscias fulva*	Dominant submontane canopy level
Araliaceae	*Schefflera abyssinica*	Dominant montane canopy level
Bignonaceae	*Kigelia africana*	Dominant submontane small tree/shrub level
Bignonaceae	*Spathodea campanulata*	Dominant submontane canopy level
Bignoniaceae	*Stereospermum kunthianum*	Dominant submontane canopy level
Bignoniaceae	*Markhamia tomentosa*	Dominant montane small tree/shrub level
Boraginaceae	*Cordia cf. africana*	Dominant montane canopy level
Buddlejaceae	*Nuxia congesta*	Dominant montane canopy level
Burseraceae	*Canarium schweinfurthii*	Dominant submontane canopy level

Continued

Cecropiaceae	*Myrianthus preussii*	Dominant submontane small tree/shrub level
Chrysobalanaceae	*Chrysobalanus icaco*	Dominant submontane canopy level
Ericaceae	*Agauria salicifolia*	Dominant montane canopy level
Euphorbiaceae	*Macaranga monandra*	Dominant submontane small tree/shrub level
Euphorbiaceae	*Bridelia micrantha*	Dominant montane canopy level
Euphorbiaceae	*Sapium ellipticum*	Dominant montane small tree/shrub level
Euphorbiaceae	*Bridelia ferruginea*	Dominant submontane canopy level
Euphorbiaceae	*Bridelia speciosa*	Dominant montane canopy level
Euphorbiaceae	*Croton macrostachyus*	Dominant montane canopy level
Euphorbiaceae	*Macaranga occidentalis*	Dominant submontane small tree/shrub level
Euphorbiaceae	*Neoboutonia mannii*	Dominant submontane canopy level
Euphorbiaceae	*Bridelia micrantha*	Dominant submontane canopy level
Fabaceae	*Albizia adianthifolia*	Dominant submontane canopy level
Fabaceae	*Piptadeniastrum africanum*	Dominant submontane canopy level
Guttiferae	*Allanblackia gabonensis*	Dominant submontane small tree/shrub level
Guttiferae	*Garcinia smeathmanii*	Dominant montane small tree/shrub level
Guttiferae	*Harungana madagascariensis*	Dominant montane small tree/shrub level
Guttiferae	*Symphonia globulifera*	Dominant submontane canopy level
Guttiferae	*Hypericum peplidifolium*	Dominant submontane small tree/shrub level
Leguminosae-mimosoideae	*Albizia gummifera*	Dominant montane canopy level
Loganiaceae	*Anthocleista scandens*	Dominant submontane canopy level
Meliaceae	*Carapa grandifolia*	Dominant montane canopy level
Meliaceae	*Entandrophragma angolense*	Dominant montane canopy level
Myristicaceae	*Pycnanthus angolensis*	Dominant submontane canopy level
Myrsinaceae	*Maesa lanceolata*	Dominant submontane canopy level
Myrsinaceae	*Ardisia Kivuensis*	Dominant montane small tree/shrub level
Myrtaceae	*Syzygium staudtii*	Dominant montane canopy level
Pittosporaceae	*Pittosporum virdiflorum*	Dominant montane small tree/shrub level
Rubiaceae	*Chassalia liakomensis*	Dominant montane small tree/shrub level
Rubiaceae	*Cuviera longiflora*	Dominant montane small tree/shrub level
Rubiaceae	*Ixora foliosa*	Dominant montane small tree/shrub level
Rubiaceae	*Pavetta hookeriana*	Dominant submontane small tree/shrub level
Sterculiaceae	*Dombeya ledermanii*	Dominant submontane small tree/shrub level
Thymelaeaceae	*Gnidia glauca*	Dominant submontane small tree/shrub level
Ulmaceae	*Trema guineensis*	Dominant submontane small tree/shrub level
Ulmaceae	*Trema orientalis*	Dominant montane small tree/shrub level
Verbenaceae	*Vitex cf doniana*	Dominant submontane canopy level

A total of 57 different species were proposed belonging to 25 different families. The Euphorbiaceae had the highest number of species (9) followed by the Guttiferae with 5 species. The Apocynaceae and the Bignoniaceae each had 4 species. The rest of the families had 3 or fewer species.

4. Conclusion

A checklist of the plants of the mount Bamboutos was carried out with a total of 332 species recorded. Out of these species, 18 species were considered threatened, with the major threat being habitat loss and overharvesting. Some of the threatened species had medicinal values. 57 different plant species belonging to 25 families were suggested for reforestation of the study site. The habitat of the suggested species was the dominant montane and sub-montane. The checklist of plant species in Mount Bamboutos is highly necessary to the understanding of plant species and their status for effective conservation and rehabilitation. These have led to calls for urgent conservation attention as up to 18 of the species in the study area were found to be under threat. The restoration of Mount Bamboutos will improve its biodiversity, social, economic and cultural values.

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Conflicts of Interest

The authors declare no conflicts of interest.

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