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Assessing Floristic Diversity and Ecological Characteristics of Mount Mbapit Savannah, Western Highlands of Cameroon

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ABSTRACT

Background and Objective: Cameroon is one of the richest biologically diverse African countries due to its wide range of altitudes, topographic features and agroecological zones. Therefore, the aim of this study was to determine the floristic diversity and functional traits of Mount Mbapit Savannah, West Cameroon. **Materials and Methods:** Floristic data were collected on a total of 62 sample plots of 10×10 m between May and June, 2014, 2015 and 2022. Frequency, abundance and diversity indices were computed for the floristic diversity and life traits spectra (growth habit, life form, leaf size, diaspore type, dispersal syndromes and phytogeographical affinities). **Results:** In total, 144 plant species (91 herbaceous and 53 woody) belonging to 110 genera and 50 families were identified. The most abundant families were Poaceae (28 species) and Asteraceae (20 species). The species diversity indices were Shannon-Weaver (4.92 and 3.61) and evenness index (0.73 and 0.62) for herbaceous and woody species, respectively. The most represented life forms were phanerophytes (43.75%). Anemochory (45.83%) was the dominant dispersal syndrome. Phytogeographical distribution analysis showed the predominance of afro-tropical species. **Conclusion:** Appropriate conservation measures such as assisted natural regeneration and increased protection should be taken for the threatened species.

KEYWORDS

Floristic diversity, functional traits, Mount Mbapit, ecological characteristics, cameroon

INTRODUCTION

The flora of vascular plants flora of Cameroon is estimated at 7,884 taxa and ranks fourth among the richest African countries in floristic biodiversity with 585 plant species known only in Cameroon[1]. The Cameroon Highlands are formed by an interrupted volcanic line and contain Africa's highest

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mountains west of the Albertine Rift, namely Mount Cameroon, Mount Oku, Mount Bamboutos and Mount Mbapit, which are part of the 25 'biodiversity hotspots' defined as priorities in the planet scale for the conservation of biodiversity[2] peaking at 1988 m, this mountain has an attractive Crater Lake. The ecosystem of the Mount Mbapit has been degraded mainly by human activities through uncontrolled farming, overgrazing, cutting down trees for firewood, bushfires, an increasing need for agricultural land which makes people clear the forest, leaving the bare soils and natural factors such as climate change, soil erosion and the presence of invading species. This tropical mountain once covered by mountain forests has been suddenly changed into savannah.

Floristic composition and ecological diversity are among the most significant ecological attributes of a particular plant communities, which show variations in response to biotic and abiotic factors[3,4]. Such information is useful not only in understanding plant diversity and the ecological functions of plant communities but also in providing insight into the environmental requirements of the plant species to adapt in specific habitats[5]. Studying functional plant traits of a given area is an important tool that helps in understanding the relationship between plant community structure, environmental factors and distribution, ultimately revealing the ecological functions of individual species in a community[6]. Savannahs, compared to the forest, are easier to convert to crops and their degradation is not considered as a serious environmental attack compared to the clearing of forests[7,8]. These ecosystems have often been noticed as the epicentres of different destructive bushfires that, along the history of Mount Mbapit have decimated large tracts of other habitats such as the closed evergreen forest and bamboo areas. Floristic knowledge, from several authors in the Western Highlands Region of Cameroon[6-7,9-14], showed high floristic diversity. These studies do not cover the entire region. Thus, the current knowledge of these tropical mountain savannahs lacks quantitative data, which are particularly crucial for estimating the floristic diversity and the functional traits of plant communities and for ensuring good management of the plant resources.

This study is a good contribution to describing the floristic diversity and the ecological characteristics of the plant communities in order to provide scientific data for the conservation and sustainable management of Mount Mbapit Savannahs biodiversity. Such information is useful not only for understanding the impact of altered environmental conditions on plant community structure, but also for providing insight into the environmental requirements of species necessary for successful ecological restoration and biodiversity protection. The aim of this study was to assess the phytodiversity and functional traits of the savannahs of Mount Mbapit, West Cameroon.

MATERIALS AND METHODS

Study area: This study was carried out in Mount Mbapit which is located in the Noun Division of the West region of Cameroon between the localities of Foumbot and Foumban (5°40'-5°52'N and 10°30'-10°45'E). The study was carried out from May to June, 2014, 2015 and 2022. This mountain with its maximum height of 1988 m. The climate is defined as tropical equatorial-guinean type characterized by a rainy season which extends from March to November and a dry season from December to February. The average annual precipitation was 2500 mm while the mean annual temperature was 21°C. A dry season occurs between November and March and a rainy season takes place between March and November. The predominant soils are vitric andosols. The predominant ecosystem is open grassland with trees and shrubs at some points. The vegetation is a savannah dominated by *Pennisetum purpureum* and *Imperata cylindrica* in the herbaceous layer with ligneous cover highly modified by human activities such as agriculture, bushfire, grazing and wood collection[7,9].

Sampling: Floristic inventory was carried out during the months of May and June, 2014, 2015 and 2022. Plant species were inventoried in 10×10 m (100 m²) plots and equidistant of at least 200 m. Trees and shrubs were named and encountered within plots of 100 m^2 and herbs within 5 subplots of 1 m^2 placed within each 100 m^2 plot (4 in each corner 100 m^2 plot and one in the centre). In total, 62 plots of 100 m^2 and 310 of 1 m^2 were sampled in the present study. The sampling of herbaceous vegetation was done according to the Braun-Blanquet method using mixed sampling. Some plants species were identified directly in the field using monographs, for the other species, specimens were collected and compared which those available at the National Herbarium of Cameroon. Farming lands were not examined. The plant nomenclature system of family adopted was Angiosperms Phylogeny Group 4 (APG IV) classification.

The growth habit of the plant species was determined in the field by observation of the plants. The types of life forms allowed to determine adaption strategies as well as the physiognomy of the vegetation were defined and classified according to Raunkiaer[15]. Leaves sizes were also determined and classified according to Ohsawa[16]. The types of diaspores which show the ability of plants to disperse, regenerate and establish in the ecosystem were defined and classified according to the classification of Dansereau and Lems[17]. The dispersal type which shows the ability to migrate, colonize new environments and dispersal distance, were identified using the morphological attributes developed by the species to disperse the seeds[17]. The phytogeographic type which shows flora stability and age, response to natural disturbances and to human presence (species exchanges between continents) and response to isolation and forest degradation (endemic species), adopted correspond to the major chronological subdivisions retained for Africa according to Gonmadje[18].

Data processing and statistical analysis: Floristic composition was assessed on the basis of species richness, genus and family, abundance and frequency of species. The floristic diversity was calculated using PAST 3.0 software and according to several indices that take into account both the number of species and their dominance cover-abundance: Shannon-Weaver diversity index:

$$H' = -\sum(Pi)*\log_2(Pi), \text{ with } Pi = ni/N$$

where, ni is the number of individuals of species, i and N is the total number of individuals of all species. Pielou evenness index:

$$E = H'/\log_2(S)$$

where, S is the total number of species. Simpson's diversity index:

$$D = 1-\sum(pi)^2$$

The Margalef index:

$$R = S-1/\ln(N)$$

where, S is the total number of species and N is the total number of individuals for all species.

The proportions of each ecological spectrum were also calculated. All data were subject to descriptive statistical analysis using Microsoft Excel 2017 software.

RESULTS

Plant species composition and diversity: A total of 144 plant species (91 herbaceous and 53 woody) belonging to 110 genera and 50 families (APG IV) were reported in the current study area (Table 1). Four species remained determined only to the genus level while five species, represented by only one

Table 1: Floristic composition and functional traits of the savannah vegetation of the mount Mbapit

Families	Species name	IUCN status	Growth form	Raunkiaer life-form	Types of diaspores	Dispersal syndromes	Leaf size	Phytochoria
Amaranthaceae	*Cyathula cylindrica* (Moq.)	LC	Herb	Ch	Ballo	Auto	Mi	Afro-Trop
	Cyathula uncinulata (Schard.) Schinz	LC	Herb	Ch	Desmo	Zoo	Mi	AM
	Mangifera indica L.	LC	Tree	MaPh	Baro	Auto	Mg	Pan
Annonaceae	*Annona senegalensis* Pers.	LC	Shrub	McPh	Sarco	Zoo	Me	Plur-Afr
Apocynaceae	*Mondia whitei* (Hook. f.) Skeel	NE	Liana	PhL	Sarco	Zoo	Me	Afro-Trop
Araliaceae	*Cussonia arborea* Hochst. ex. A. Rich	LC	Tree	MaPh	Sarco	Zoo	Mg	Afro-Trop
	Polyscias fulva (Hiern) Harms	LC	Tree	MaPh	Sarco	Zoo	Me	Mo (Afrtrop)
	Schefflera abyssinica (Hochst. ex. A. Rich) Harms	LC	Tree	MaPh	Sarco	Zoo	Ma	Mo (Afrtrop)
Arecaceae	*Elaeis guineensis* Jacq.	LC	Tree	MsPh	Sarco	Zoo	Mg	Pan
	Phoenix reclinata Jacq.	LC	Tree	MsPh	Sarco	Zoo	Mg	Pan
Asclepiadaceae	*Brachystelma omissum* Bullock	VU	Herb	Ge	Sclero	Ane	Me	Cos
	Margaretta rosea Oliv	LC	Herb	McPh	Sarco	Zoo	Mi	Cos
Asparagaceae	*Asparagus racemosus* Willd.	DD	Shrub	McPh	Ind	Ind	Me	Pan
Aspleniaceae	*Asplenium abyssinicum* Fée	LC	Herb	Ge	Sporo	Ane	Me	Pan
	Asplenium mannii Hook.	LC	Herb	Ge	Sporo	Ane	Me	Cos
Asteraceae	*Acanthospermum brasilum* Schrank	LC	Herb	Ch	Ballo	Auto	No	AA
	Ageratum conyzoides Linn.	LC	Herb	Th	Pogo	Ane	No	Pan
	Aspilia africana (Pers.) C.D. Adams	LC	Herb	Nph	Pogo	Ane	Mi	Plur-Afr
	Bidens pilosa (L.)	LC	Herb	Th	Pogo	Ane	Me	Pan
	Chromolaena odorata (L.) R. M. King and H. Rob.	LC	Shrub	Nph	Pogo	Ane	Me	Pan
	Conyza sumatrensis (Retz.) E. Walker	LC	Herb	Ch	Pogo	Ane	Mi	Pan
	Coreopsis carupokum Hutch	LC	Herb	Nph	Pogo	Ane	Me	Afro-Trop
	Crassocephalum bauchiense (Hutch.) Milne-Redh.	NT	Herb	Ch	Pogo	Ane	Me	Mo (DC)
	Crassocephalum gracile (Hook. f.) Milne-Redh.	LC	Herb	Ch	Pogo	Ane	Me	Mo (DC)
	Echinops gracilis (O. Hoffen)	LC	Herb	Ch	Pogo	Ane	Na	Afro-Trop
	Emilia coccinea (Sims) G. Don	LC	Herb	Ch	Pogo	Ane	No	Pan
	Helichrysum antunesi Volkens and O. Hoffm.	LC	Herb	Th	Pogo	Ane	No	Mo (DC)
	Helichrysum mechowianum Klatt	LC	Herb	Th	Pogo	Ane	No	Afro-Trop
	Helichrysum sp.	LC	Herb	Th	Pogo	Ane	No	Ind
	Laggera pterodonta (DC.) Sch. Bip. ex. Oliv.	LC	Herb	Ch	Pogo	Ane	No	Pan
	Microglossa angolensis	LC	Shrub	MsPh	Pogo	Ane	Me	Pal
	Tithonia diversifolia A. Gray (Nat.)	LC	Shrub	Nph	Sclero	Ane	Me	Pan
	Vernonia acrocephala (Klatt)	NT	Herb	Nph	Pogo	Ane	Mi	SZ
	Vernonia amygdalina (Delile)	LC	Shrub	McPh	Pogo	Ane	Me	Plur-Afr
	Vernonia guinensis Benth	LC	Herb	Nph	Pogo	Ane	Me	SZ

Table 1: Continue

Families	Species name	IUCN status	Growth form	Raunkiaer life-form	Types of diaspores	Dispersal syndromes	Leaf size	Phytochoria
Balsaminaceae	*Impatiens burtonii* Hook. f.	LC	Herb	Ch	Sarco	Zoo	Me	SZ
Cannabaceae	*Celtis africana* Burm. f.	LC	Tree	MsPh	Sarco	Zoo	Me	Afro-Trop
Capparaceae	*Maerua pseudopetalosa* (Gil and Gil-Ben) de Wolf	LC	Shrub	McPh	Ballo	Auto	Mi	Afro-Trop
	Cleome iberidella Welw. ex. Oliv.	LC	Herb	Ch	Ballo	Auto	Me	Mo (Afrtrop)
Combretaceae	*Terminalia glaucescens* Planch. ex. Benth.	LC	Tree	MaPh	Ptero	Ane	Me	SZ
Commelinaceae	*Commelina benghalensis* L.	LC	Herb	Ch	Ballo	Auto	Mi	Pal
	Cyanolis mannii C.B. Clarcke	LC	Herb	Ch	Ballo	Auto	Mi	Afro-Trop
Convolvulaceae	*Ipomoea involucrata* P. Beauv.	LC	Liana	He	Baro	Auto	No	Pans
Costaceae	*Costus spectabilis* (Fenzl) K. Schumann	LC	Herb	Ge	Sarco	Zoo	Me	SZ
Crassulaceae	*Crassula mannii* (Hook. f.)	LC	Herb	Ch	Sclero	Ane	Mi	Afro-Trop
Cyperaceae	*Cyperus difformis* L.	LC	Herb	Ge	Ptéro	Ane	No	Pan
	Cyperus distans (Linn. F)	LC	Herb	Ge	Ptéro	Ane	No	Pan
Dennstaediaceae	*Microlepia speluncae* (L.) T. Moore	LC	Herb	He	Sporo	Ane	No	Pan
	Pteridium aquilinum (L.) Kuhn	LC	Herb	Ge	Scléro	Ane	Ma	Cos
Dryopteridaceae	*Ctenitis* sp.	Ind	Herb	Ge	Sclero	Ane	Me	Ind
Euphorbiaceae	*Alchornea cordifolia* (Schumach. and Thonn.) Mll. Arg.	LC	Herb	PhL	Pogo	Ane	Me	GC
	Euphorbia hirta (L.)	LC	Herb	Th	Sarco	Zoo	Mi	Pan
	Manihot esculenta Crantz	LC	Shrub	MsPh	Baro	Auto	Me	Pan
Fabaceae	*Calopogonium mucunoides* Desv	LC	Herb	Ch	Sclero	Ane	Me	Pan
	Crotalaria astragalina Hochst.	LC	Herb	Nph	Ballo	Auto	Mi	Afro-Trop
	Cyclocarpa stellaris (Afzel and buk)	LC	Herb	Nph	Ballo	Auto	Mi	Pal
	Daniellia oliveri (Rolfe) Hutch. and Dalziel	LC	Tree	MaPh	Ballo	Auto	Me	GC
	Desmodium adscendens (Sw.) D.C.	LC	Herb	Th	Desmo	Zoo	Mi	Pan
	Entada africana (Guill and Perr.)	LC	Tree	MaPh	Ballo	Auto	Ma	SZ
	Eriosema bauchiense (Huth. R.) Dalg	NT	Herb	Ge	Ballo	Auto	No	Afro-Trop
	Eriosema glomeratum Hook. f.	LC	Herb	Ge	Ballo	Auto	No	Plur-Afr
	Erythrina senegalensis A.D.C.	LC	Shrub	McPh	Ballo	Auto	Ma	SG
	Indigofera mimozoides (Bak.)	LC	Herb	Nph	Ballo	Auto	Mi	Afro-Trop
	Mimosa pigra (Linn.)	LC	Herb	Ch	Ballo	Auto	Na	Pan
	Mimosa pudica L.	LC	Herb	Nph	Pogo	Ané	Mi	Cos
	Mucuna stans (Welw. and Bak)	LC	Shrub	Nph	Ballo	Auto	Mi	SZ
	Piliostigma thonningii (Schumach.) Milne-Redh.	LC	Shrub	MsPh	Ballo	Auto	Me	SZ
	Stylosanthes hamata (L.) Taub.	LC	Herb	Ch	Ballo	Auto	No	Cos

Table 1: Continue

Families	Species name	IUCN status	Growth form	Raunkiaer life-form	Types of diaspores	Dispersal syndromes	Leaf size	Phytochoria
Hypericaceae	*Harungana madagascariensis* Lam. ex. Poir.	LC	Shrub	MsPh	Sarco	Zoo	Me	Afro-Trop
	Hypericum lanceolatum Lam	LC	Shrub	McPh	Ballo	Auto	No	Mo (Afrtrop)
	Hypericum quartinianum A. Rich.	LC	Shrub	McPh	Ballo	Auto	No	Mo (Afrtrop)
	Psorospermum cf *senegalense* (Stems and Le)	LC	Shrub	McPh	Sarco	Zoo	Me	Afro-Trop
	Psorospermum corymbiferum Hochr.	LC	Shrub	McPh	Sarco	Zoo	Me	Afro-Trop
	Psorospermum febrifugum Spach	LC	Shrub	McPh	Sarco	Zoo	Me	SZ
	Psorospermum ferruginea (Le)	LC	Shrub	McPh	Sarco	Zoo	Me	Afro-Trop
Lamiaceae	*Leucas oligocephala* (Hook. f.)	LC	Herb	Ch	Sclero	Ane	Mi	Afro-Trop
	Vitex. grandifolia Gürke	LC	Tree	MsPh	Sarco	Zoo	No	Afro-Trop
Lauraceae	*Persea americana* Mill.	LC	Tree	MaPh	Baro	Auto	Me	Pan
Malvaceae	*Pavonia schimperiana* Hoscht.	LC	Shrub	Nph	Desmo	Zoo	Mi	Afro-Trop
	Sida acuta Burm. F.	LC	Herb	Nph	Acan	Zoo	Mi	Pan
	Sida corymbosa (R.E.) Fries	LC	Herb	Th	Desmo	Zoo	Mi	Pan
	Urena lobata L.	LC	Herb	Ch	Desmo	Zoo	No	Pan
Melastomataceae	*Dissotis phaeotricha* (Hochst.)Hook. f.	LC	Herb	Ch	Sarco	Zoo	Me	Afro-Trop
	Dissotis princeps (Bompl.)triana	LC	Herb	Ch	Sarco	Zoo	No	Afro-Trop
	Dissotis thollonii Coginiaux et Buttner	LC	Herb	Ch	Sarco	Zoo	Me	Afro-Trop
Meliaceae	*Carapa grandiflora* Sprague	NE	Tree	MaPh	Sarco	Zoo	Me	Mo (Afrtrop)
Moraceae	*Ficus alata* (L).	LC	Tree	MaPh	Sarco	Zoo	Me	Pal
	Ficus ex. asperate	LC	Tree	MsPh	Sarco	Zoo	Me	Pal
	Ficus mucuso Ficalho	LC	Tree	MaPh	Sarco	Zoo	Me	GC
	Ficus sycomorus L.	LC	Tree	MsPh	Sarco	Zoo	Me	Pal
	Ficus thonningii Blume	LC	Tree	MsPh	Sarco	Zoo	Me	Afro-Trop
	Ficus vallis-choudae Delile	DD	Shrub	MaPh	Sarco	Zoo	Me	SG
Musaceae	*Ensete livingstonianum* (J. Kirk) Cheesman	LC	Shrub	Ch	Ballo	Auto	Mg	SZ
Myrtaceae	*Eucalyptus saligna* Hort. Berol ex. Maiden	LC	Tree	MaPh	Ballo	Auto	Me	Pal
	Psidium guajava (L.)	LC	Tree	MaPh	Sarco	Zoo	Me	Pan
Ochnaceae	*Lophira lanceolata* Tiegh. ex. Keay	LC	Tree	MaPh	Ptero	Ane	Me	GC
Onagraceae	*Ludwigia abyssinica* (A. Rich.)	LC	Herb	Th	Sclero	Ane	Mi	Plur-Afr
Orchidaceae	*Disa nigerica* (Rolf.)	LC	Herb	Ch	Sclero	Ane	No	Afro-Trop
Oxalidaceae	*Oxalis corniculata* L.	LC	Herb	Th	Ballo	Auto	Na	Cos
Phyllanthaceae	*Bridelia ferruginea* Benth.	LC	Shrub	MsPh	Sarco	Zoo	Me	Afro-Trop
	Bridelia scleroneura Müll. Arg.	LC	Shrub	McPh	Sarco	Zoo	Me	Pal
	Phyllanthus muellerianus (Kuntze) ex. ell	LC	Shrub	MsPh	Ballo	Auto	Na	Afro-Trop

Table 1: Continue

Families	Species name	IUCN status	Growth form	Raunkiaer life-form	Types of diaspores	Dispersal syndromes	Leaf size	Phytochoria
Pittosporaceae	*Pittosporum mannii* Hook. f.	LC	Shrub	MsPh	Sarco	Zoo	Me	MO (D.C.)
Poaceae	*Andropogon lima* (Hackel) Stapf	LC	Herb	He	Sclero	Ane	Me	Pal
	Andropogon mannii Hooker f.	LC	Herb	He	Sclero	Ane	Me	Pal
	Digitaria adamaouensis Van der Zon	EN	Herb	Th	Sclero	Ane	Mi	Afro-Trop
	Digitaria debilis (Desfontaines) Willdenow	LC	Herb	Ge	Sclero	Ane	Mi	GC
	Digitaria diagonalis (Nees) Stapf	LC	Herb	Th	Sclero	Ane	Me	Afro-Trop
	Digitaria uniglurnis Stapf.	LC	Herb	Ge	Sclero	Ane	Mi	Afro-Trop
	Diheteropogon grandiflorus Stapf	LC	Herb	Ge	Sclero	Ane	Me	Afro-Trop
	Eleusine indica (Linne) Gaertner	LC	Herb	Th	Sclero	Ane	No	Pan
	Festuca abyssinica A. Richard	LC	Herb	Th	Sclero	Ane	Me	Mo (Afrtrop)
	Helictotrichon elongatum (A. Rich.) C.E. Hubbard	LC	Herb	Th	Sclero	Ane	Na	Mo (DC)
	Heteropogon contortus (L.) Roem. and Schult	LC	Herb	Th	Pogo	Ane	Na	Pal
	Hyparrhenia bracteata (Humb. and Bonpl.) Stapf	LC	Herb	He	Sclero	Ane	Na	Afro-Trop
	Hyparrhenia rufa Stapf	LC	Herb	He	Sclero	Ane	Na	Pan
	Imperata cylindrica (L.) Raeuschel.	LC	Herb	Ge	Scléro	Ané	No	Pan
	Loudetia camerunensis (Stapf) C.E. Hubbard	LC	Herb	He	Sclero	Ane	No	Afro-Trop
	Melinis repens (Willdenow) Zizka	LC	Herb	Th	Sclero	Ane	Mi	Pan
	Panicum brevifolium L.	LC	Herb	Ch	Sclero	Ane	Mi	Pal
	Panicum hochstetteri Steudel	LC	Herb	He	Sclero	Ane	Mi	MO (DC)
	Panicum laxum (Swartz)	LC	Herb	He	Sclero	Ane	Mi	Pan
	Pennisetum clandestinum Chiovenda	LC	Herb	Th	Sclero	Ane	Me	Pan
	Pennisetum polystachion (Linne) Schultes	LC	Herb	Th	Sclero	Ane	Me	Pan
	Pennisetum purpureum Schumacher	LC	Herb	Th	Sclero	Ane	Mi	Afro-Trop
	Pennisetum unisetum (Nees) Bentham	LC	Herb	Th	Sclero	Ane	No	SZ
	Raphia mambillensis Otedoh	LC	Shrub	McPh	Sarco	Zoo	Mg	AM
	Setaria barbata (Lam.) Kunth	LC	Herb	He	Sclero	Ane	Ma	Cos
	Sporobolus pyramidalis P. Beauv.	LC	Herb	Th	Sclero	Ane	Mi	AM
	Sporobolus subulatus Hackel	LC	Herb	Th	Sclero	Ane	Mi	AM
	Stenotaphrum secundatum (Walter) Kuntze	LC	Herb	Ch	Ballo	Auto	Mi	Cos
Primulaceae	*Maesa lanceolata* (Forssk.)	LC	Shrub	McPh	Sarco	Zoo	Me	Afro-Trop
Proteaceae	*Protea madiensis* Oliv.	LC	Shrub	Mcph	Pogo	Ane	Me	SZ
Ranunculaceae	*Clematis altissima* Hutch.	LC	Liana	PhL	Pogo	Ane	Mi	Pal

Table 1: Continue

Families	Species name	IUCN status	Growth form	Raunkiaer life-form	Types of diaspores	Dispersal syndromes	Leaf size	Phytochoria
Rosaceae	*Prunus africana* (Hook. f.) Kalkman	NT	Tree	MsPh	Sarco	Zoo	Me	Mo (Afrtrop)
Rubiaceae	*Coffea* sp.	Und	Shrub	MsPh	Baro	Auto	Me	Ind
	Fadogia sp.	Und	Herb	Ch	Sarco	Zoo	No	Ind
	Sarcocephalus latifolius (Sm.) E.A. Bruce	LC	Shrub	MsPh	Sarco	Zoo	Me	Afro-Trop
	Spermacoce pusilla (Wall.)	LC	Herb	Ch	Ballo	Auto	Mi	SZ
Rutaceae	*Fagara leprieurii* (Guil. and Perr) Engl.	LC	Shrub	Th	Sarco	Zoo	No	Pal
Sapotaceae	*Vitellaria paradoxa* C.F. Gaertn.	VU	Tree	MaPh	Sarco	Zoo	No	SZ
Verbenaceae	*Lippia adoensis* (Hoscht)	LC	Herb	Nph	Ptero	Ane	Mi	AA
Woodsiaceae	*Diplazium sammatii* (Kuhn) C. Chr	LC	Herb	Ge	Sporo	Ane	Ma	Afro-Trop
Zingiberaceae	*Aframomum daniellii* (Hook. f.) K. Schum.	LC	Herb	Ge	Sarco	Zoo	Mg	GC

IUCN status: LC: Least concern, EN: Endangered, VU: Vulnerable, NT: Near threatened. DD: Data deficient, Life forms Th: Therophytes, He: Hemicryptophytes, MaPh: Macrophanerophytes, NnPh: Nanophanerophytes, Ch: Chamaephytes, Ge: Geophytes, MsPh: Mesophanerophytes, McPh: Microphanerophytes, Diaspores types: Acan: Acanthochores, Ballo: Ballochores, Pogo: Pogonochores, Baro: Barochores, Desmo: Desmochores, Ptéro: Pterochores, Sarco: Sarcochores, Scléro: Sclerochores, Sporo: Sporochores, Und: Undetermined, Dispersal syndrome: Ane: Anemochory, Zoo: Zoochory, Auto: Autochory, Leaf size: Mg: Megaphyll, Ma: Macrophyll, Mé: Mesophyll, No: Notophyls, Mi: Microphyll, Na: Nanophyll, Phytogeographical affinities: AA: Afro-American, Afro-Afro-Trop: Tropical, AM: Afro-Malagasy, Cos: Cosmopolitan, GC: Guineo-Congolian, Pal: Paleotropical, Pan: Pantropical, Plur-Afr: Pluriregional African, SG: Sudano-guinean, SZ: Sudano-Zambezian, MO (DC): Only in Cameroonian mountain, Mo (Afrtrop): Afro-Tropical mountains and Und: Undetermined individual each, remained undetermined. The most frequent herbaceous species were: *Imperata cylindrica* (present in 68.6% of all the plots), followed by *Asplenuim abyssinicum* (54.2%) and *Vernonia guinensis* (48.6%). In terms of cover-abundance, the most dominant herbaceous species were *Imperata cylindrica* (20.2% of the total area), *Hypparhenia barcteata* (14.6%), *Pennisetum polystachion* (8.2%), *Chromolena odorata* (5.4%), *Digitaria debilis* (3.4) and *Asplenuim abyssinicum* (2.9%). The richest genus was Ficus with 6 species followed by Digitaria, Pennisetum, Psorospermum with 4 species each and Dissotis, Helichrysum, Panicum, Vernonia with 3 species each.

In total, 2033 individuals belonging to 53 woody species were recorded on the study site (Table 1). The most frequent species were *Terminalia glaucescens* (50%), *Annona senegalensis* (41.66%), *Cussonia arborea* 33.33%) and *Entada africana* (33.33%). The most abundance woody species were *Tithonia diversifolia* (14.46%), *Piliostigma thonningii* (9.24%), *Annona senegalensis* (6.64%) and *Protea madiensis* (6.24%).

The most represented families were Poaceae (28 species, 19.58%), Asteraceae (20 species, 13.98%), Fabaceae (15 species, 10.48%), Hypericaceae (7 species, 4.89%) and Moraceae (6 species, 4.19%) (Fig. 1). The eleven richest families accounted for 96 species (67.61%). However, in terms of cover-abundance, the most abundant families are Poaceae (covering 49.8%), Asteraceae (covering 15.6%), Aspleniaceae (12.5%) and Fabaceae (4.8%).

The Shannon-Weaver diversity index was 4.92 and 3.61, the Pielou evenness index was 0.73 and 0.62, the Simpson index was 0.07 and 0.12, respectively for herbaceous and woody species. The Margalef species richness was 11.12 species per hectare.

Species conservation status: The conservation status of 144 plants was assessed and seven were found important for conservation in the study area. This assessment showed that *Digitaria adamaouensis* is Endangered, *Brachystelma omissum, Crassocephalum bauchiense, Vitellaria paradoxa* are Vulnerable and *Eriosema bauchiense, Prunus africana, Vernonia acrocephala* are near threatened.

FUNCTIONAL TRAITS

Plant growth forms: In the current study, the highest number of plant species (87) were Herbaceous plants (60.83% of all species), followed by 31 shrubs species (21.52%), 21 trees (15.97%) and three climbers (2.03%) (Fig. 2).

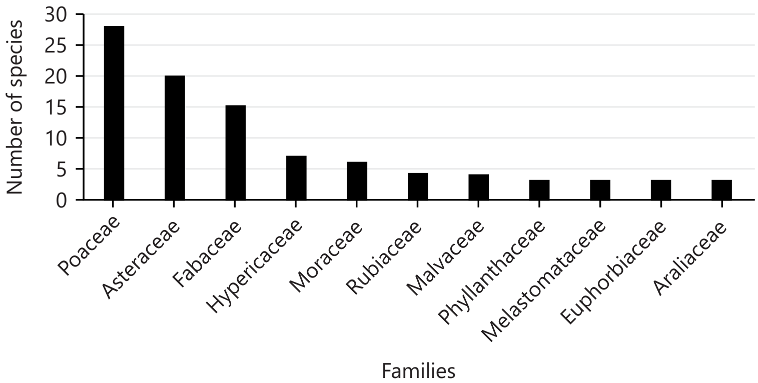

Fig. 1: Diversity of the richest families in the study plots

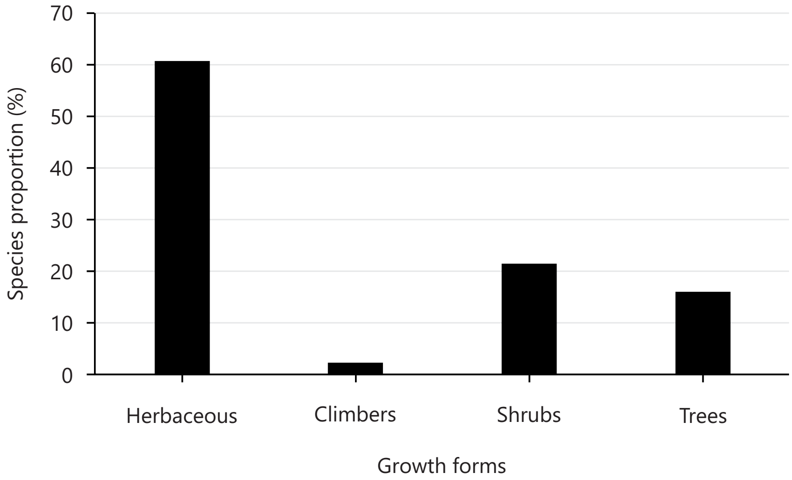

Fig. 2: Proportion of plant growth forms

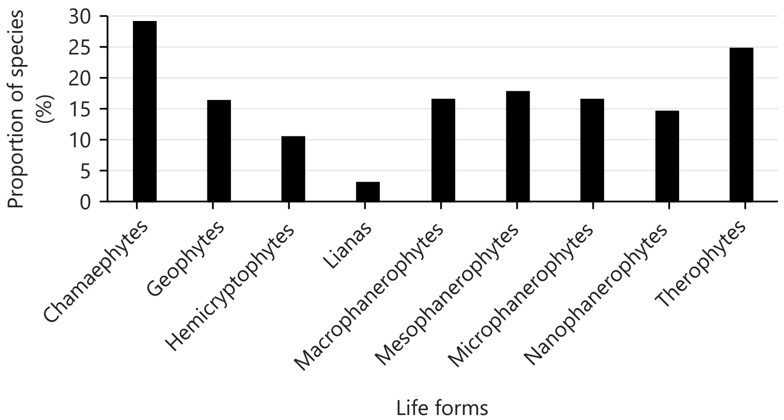

Fig. 3: Percentage of plant life forms spectra

Life forms: About 43.75% of the species (63 species) were phanerophyte which constituted the dominant life form, followed by 28 species of chamaephytes (19.44%), 24 species of therophytes (16.67%) and 16 species geophytes with (11.11%) (Fig. 3). The least represented life forms were hemicryptophytes with 10 species (6.94%) and lianas with 3 species (2.08%). The detailed phanerophyte life form showed a high proportion of mesophanerophytes with 16 species (11.80%), macrophanerophytes and microphanerophytes with 17 species each (11.11%) and nanophanerophytes with 14 species (09.72%).

Leaf size spectrum: The most common leaf size was mesophylls with 60 species (41.66%), followed by microphylls 36 species (25%) and notophylls 27 species (18.75%) (Fig. 4). Species with large leaves sizes (megaphylls and macrophylls) and small leaf size (nanophylls) were less in abundant. Aphyllous species were absent.

Type of diaspores and their dispersal syndromes: The ability of species to colonize new sites, regenerate and persist locally showed that sarcochores (27.78%) were the most dominant diaspores type. This was followed by sclerochores (23.61%), ballochores (18.06%) and pogonochores (15.97%) (Table 2). The majority of taxa in the study plots were dispersed by wind (anemochorous species, 45.83%), followed by zoochory (31.94%) and the least was autochory (22.22%).

Phytogeographic affinities: The survey of the geographical distribution of plants species indicated that the total flora was composed mainly of Afro-Tropical species (25.69%) followed by Pantropical species

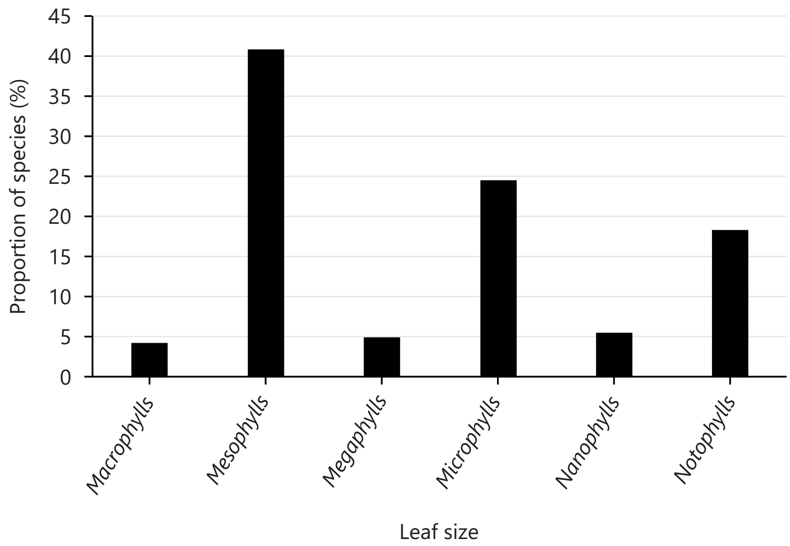

Fig. 4: Distribution of plant species according to leaf size spectra

Table 2: Proportion of species with different types of diaspores and dispersal syndromes

Diaspores types	Dispersal syndrome	Species number	Proportion (%)
	Anemochory	66	45.83
Sclerochores	34	23.61	
Pterochores	5	3.47	
Pogonochores	23	15.97	
Sporochores	4	2.77	
	Zoochory	46	31.94
Acanthochores	1	0.70	
Sarcochores		40	27.78
Desmochores	5	3.47	
	Autochory	32	22.22
Ballochores		26	18.06
Barochores		5	3.47
Undetermined	1	0.70	

Table 3: Geographic distribution of plants showing the proportion of species in each chorotype

Phytogeographic affinities	Proportion (%)
Afro-American	1.39
Afro-Tropical	25.69
Afro-Malagasy	2.78
Cosmopolitan	6.25
Guineo-Congolian	4.16
Paleotropical	9.72
Pantropical	22.92
Pluriregional African	3.47
Sudano-Guinean	1.39
Sudano-Zambezian	9.72
Only in Cameroonian Mountains	4.19
Undetermined	2.78
Afro-tropical mountains	5.55

(22.92%), Sudano-Zambezian (9.72%) and Paleotropical (9.72%) (Table 3). Afro-American and Sudano-Guinean species were the least represented with 1.39% each of the total species recorded.

DISCUSSION

Mount Mbapit is rich and diverse in plant species with 144 plant species belonging to 110 genera and 50 families recorded. Several factors including geomorphological (slope zones), edaphic (soil types) and climatic conditions can explain the high species richness of this mountain. The number of plant species recorded in this survey was lower than the 209 species belonging to 139 genera and 63 families reported by Wouokoue *et al.*[9] in the Bambouto mountains but was higher than the 121 plant species belonging to 91 genera and 34 families reported by Mbogue *et al.*[11] in the Western Highlands of Cameroon. The factors determining the spatial distribution of plants in this mountain are the edaphic conditions, the local geomorphology, the intensity of land use but also anthropogenic activities such as grazing, bush fire and the cutting of wood. The Shannon diversity index obtained was high indicating a high diversity of species in this mountain.

The number of species recorded in the woody vegetation of the study is higher compared to the 33 species recorded by Konsala *et al.*[19] in Mount Maroua (Far North Cameroon) and is small compared to the 80 species recorded by Nangndi *et al.*[20] in the woody vegetation of Larmanaye (Chad). The differences observed in these studies could be attributed to the difference in the level of human influence through uncontrolled agriculture, cutting down of trees for firewood, overgrazing and bushfires.

Regarding families, Poaceae, Asteraceae and Fabaceae were the richest families in this study, this may be due to the high number of seeds produced by plants of these families. These families are also the most represented plant families in other studies in the Western Highlands region of Cameroon in the same order[6,7,11]. These results were different to those obtained by Konsala *et al.*[19] in Mount Maroua, Far North Cameroon who found that Fabaceae and Poaceae were the richest families. The Poaceae are the fifth most diverse family of flowering plants and the second most diversified family of Monocotyledons (APG IV). The Asteraceae are the second largest family of flowering plants after Orchidaceae[21]. Zerbo *et al.*[22] stated that the high presence of species of the Gramineae family is explained by the fact that savannahs are grass-dominated ecosystems. Moreover, Poaceae taxa have a high potential for tillage and a high regrowth rate after grazing if environmental conditions are favourable. According to Ramirez *et al.*[23], the high proportion of Asteraceae can be attributed to their great ecological tolerance range and high seed dispersal capacity. Poaceae and Asteraceae species, due to their wide ecological range, are diverse in their habitat occurrence. The high number of families (48 families), which revealed a varied distribution of ora in the study area, could be explained by variation in microhabitat, morphological characteristics, life duration and dynamic ecological niche[24].

The high value of the Shannon diversity index indicates the high diversity of the study area and can be associated with the high number of plant species and the diversity of the observed biotope (lowlands, slope area and road boundary). According to Baudoin *et al.*[7], each topographic position corresponds to a specific type of soil and type of drainage, which can constitute niches for various plant species. The high evenness value means that the number of species recorded is in equilibrium.

The presence of threatened species/Vulnerable/Near-Threatened in Mount Mbapit, which is considered an ecologically fragile ecosystem subject to high anthropogenic activities (agricultural activities, grazing, bushfires and wood collection), suggests that this savannah ecosystem mountain is of considerable conservation importance. Judicious use of the available forest resources must be ensured by the government and measures taken to control human and animal exploitation of the mountain, to prevent its extinction in the coming decades and to make it available for future generations.

The dominance of this study sites by herbs corresponds to the previous studies which show that savannahs are ecosystems dominated by herbs[6,10,11,19,23,25]. The high proportion of Herbaceous species should be explained by the anthropogenic pressures (bushfires, overgrazing and firewood collection). Tropical savannahs are highly resilient and even dependent on frequent fires and mega-herbivores, which maintain savannah plant diversity and vegetation structure, i.e. low tree cover[26].

The study of functional groups provides clear information on the physiological adaptations of plant communities to particular environmental conditions[24]. The predominance of phanerophytes, chamaephytes and therophytes over other life forms could be a response to the hot climate, topographic variations and anthropogenic pressure. Similar conclusions were also reported by Baudoin *et al.*[6] and Mbogue *et al.*[11] in their studies in the savannahs ecosystems. The phanerophytes of this study are mainly made up of trees and shrubs of savannah which are equipped with devices allowing them to resist the passage of current fires (thickening of the bark): *Protea madiensis, Entada africana, Terminalia glaucescens* and *Vitellaria paradoxa* are particularly demonstrative in this respect, these trees are never jointed. According to Baudoin *et al.*[6] the plants of the regions which undergo bushfires with certain periodicity present a series of adaptations assuring survival or allowing fast colonization of the medium. These strategies include the capacity to reject strains, the existence of underground organs (bulbs and rhizomes), thick barks to resist high temperatures, the release of seeds, or the stimulation of their germinative capacities after bush burning[27]. The high representation of macrophanerophytes and mesophanerophytes could be explained by the fact that the vegetation cover of the Mbapit mountain was primarily covered by wooded savannah. The proportion of therophytes in this savannah indicates high biotic disturbance levels on the habitat via grazing and bushfires. Moreover, variations in topography and climatic characteristics signi cantly affect the existence and distribution of various plant species and life forms.

Concerning leaf size, the most frequent are mesophylls, microphylls and notophylls, this could be explained by the influenced of humidity, light and wind. Ohsawa[16] obtained the same results in the intact zones in sub-tropical forests. These findings are similar to the results of Baudoin *et al.*[6] and Mbogue *et al.*[11] in the Western Highlands of Cameroon.

Sarcochores and sclerochores were the most abundant types of diaspores. The importance of sarcochores compared to other types of diaspores can be justified by the fact that these species are carried either by birds or by other animals and have the chance to arrive at their destination. Sclerochores or light non-fleshy diaspores, due to their lightness, are more likely to be dispersed by the wind. Similar results were obtained in the savannahs Highlands of Cameroon[6] and, in the Nyungwe montane savannahs[8] where, sclerochores were the main types of diaspores. The seed dispersal spectrum of the studied Mount Mbapit savannahs was characterized by the dominance of anemochory, followed by zoochory and autochory species. These results are consistent with those reported for other savannahs[6,8,28]. Anemochory is a principal strategy for diaspora dispersal in open canopy areas.

The high proportion of afro-tropical and pantropical species indicate disturbed areas[29]. The importance of species with broad phytogeographical amplitude translates to the loss of identity of the vegetation by the invasions of species with broad distribution. The high proportion of widely distributed taxa reflects the opening of this flora to external influences. This disturbance could be due to grazing and agricultural activities that strongly modify the original flora. Most of the pantropical species are annual weeds. These results are similar to previous investigations, African distribution species constitute a remarkable proportion of the flora studied[6,27].

The creation of an integral ecological zone for the long-term preservation of present and future populations of threatened species and to restore the denuded areas in this mountain. A similar study should be made in the gallery forest and cultivated areas in order to have an exhaustive list of the species present.

CONCLUSION

A total of 144 species belonging to 110 genera and 50 families have been recorded in Mount Mbapit. It was revealed that the flora was dominated by Poaceae and Asteraceae families. Herbs were the most dominant growth habit. Anemochory is the main dispersal syndrome. Afro-tropical species were the most dominant chorotype. Sustainable management for restoration should be used as a practice of assisted forest regeneration of threatened species in the natural habitats of this mountain.

SIGNIFICANCE STATEMENT

This study examined the rich floristic potential and their ecological traits in Mount Mbapit. That was an important and necessary investigation to carry out because it has been noticed that species richness and diversity are under serious threats from anthropogenic pressures and climate change, especially in the mountain areas. Studying the overall ecological scenario and biodiversity might be helpful as a reference study for the protection and manageable utilization of plants.

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