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Research Article

Altitudinal Distribution of Loranthaceae Parasites of Woody Plants in the Mandara Mountains in the Far North Region of Cameroon

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Abstract: Despite the importance of Loranthaceae parasites of woody plants in african traditional medicine, very few studies have been carried out on their diversity in the Sudano-Sahelian zone of Cameroon. This study aims at evaluating the diversity of Loranthaceae parasites of woody plants and equally determine their altitudinal distribution in the Mandara Mountains in Far North region of Cameroon. It was carried out in nine (09) Sub-Divisions redistributed into four (04) Divisions of the Mandara Mountains. The experimental design is made up of 15 Mountains (altitude ≥ 1000 m), representing the main treatment. These 15 Mountains were chosen at the rate of one Mount every 10 km in the entire Mandara Mountains. The Mounts were grouped into five (5) categories of three (3) Mountains each according to the altitudinal level of the plain : Mount 1 (< 500 m = Mount 1 + Mount 2 + Mount 15) ; Mount 2 ([500 m - 600 m [= Mount 4 + Mount 5 + Mount 3) ; Mount 3 ([600 m - 700 m [= Mount 6 + Mount 7 + Mount 13) ; Mount 4 ([700 m - 800 m [= Mount 8 + Mount 9 + Mount 14) ; Mount 5 (> 800 m = Mount 10 + Mount 11 + Mount 12)). On each Mountain, two flanks (East and West) were chosen and they constituted the secondary treatment. On each flank, 50 m x 20 m transects (repetitions) were installed by altitude level (tertiary treatment) starting from the plain to the top of the Mountain with a space of 50 m between transects. All woody plants (both parasitized trees and non-parasitized) as well all Loranthaceae parasites were inventoried. A total of 120 host species distributed in 34 families and 75 genera were inventoried. Combretaceae and Mimosaceae were the most represented with 13 species i.e 10.83% for each family. *Acacia* were the most diversed with 10 species i.e 8.33% of the host species. 18 genera i.e 24% of the flora, were reported to be monospecific in this zone. In all of the 120 listed host species, 68 species (56.66%) of the host species were parasitized by 1 or 2 parasitic species and represents the first class (I), class of less sensitivity to host species to parasitism of Loranthaceae. The second class (II) of sensitive host species was made up of 8 species (6.66%) of the host species which represents species sensitive to parasitism. The third class (III) of host plants consists of species highly sensitive to parasitism. It was represented by 4 species (3.33%) of the host species. Seven (07) species of Loranthaceae were identified (*Tapinanthus globiferus* (A. Rich.) Danser, *Tapinanthus ophiodes* (Sprague) Danser, *Tapinanthus belvisii* (DC) Danser), *Agelanthus dodoneifolius* (DC) Polh. & Wiens, *Tapinanthus bangwensis* (Engl. and Kr.) Danser, *Phragmanthera capitata* (Spreng) Ballé and *Globimetula braunii* (Engl.) Tiegh.), belonging to four genera (*Tapinanthus*; *Phragmanthera*; *Agelanthus* and *Globimetula*). *Tapinanthus* was the most diverse with four species (*T. bangwensis*, *T. globiferus*, *T. ophiodes* and *T. dodoneifolius*). *Phragmanthera*, *Globimetula* and *Agelanthus* each had one species. *T. globiferus* was the most represented (125.66 ± 71.86 tufts / ha) and was more dense on the Western flank and at Mountain tops of the Mandara Mountains. Slopes and altitude influence the distribution of Loranthaceae over the Mounts.

Keywords: Loranthaceae, Parasite, Hemiparasite, Mandara Mountains, Far North Region of Cameroon.

INTRODUCTION

Loranthaceae constitute a family of chlorophyllian, epiphytic, phanerogamous hemiparasitic plants, which implants on the aerial parts of their host plants [1]. They are responsible for enormous economic, ecological and morphogenetic damages which varies according to the crops or woody species parasitized [2-4]. These parasitic plants are subdivided into two large groups, holoparasites; which are devoid of chlorophyll thus, derives all their nutrients from their

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hosts and hemiparasites; which take only water and mineral elements from the host while retaining their photosynthetic power, using chlorophyll. Loranthaceae are widely distributed around the world and are grouped into 77 genera with more than 950 species [5-8]. In Africa, Loranthaceae are very common and have caused extensive damages to natural formations and plantations in countries such as Burkina Faso, Cote d'Ivoire, Cameroon, Gabon, Ghana, Mali and many more other african countries [4, 9, 10]. In Cameroon, Loranthaceae are represented by about 26 species grouped into seven (07) genera. They lead to a huge drop in the yield of fruit species such as *Dacryodes edulis* and *Cola nitida* in the Littoral, East, South-West and West Regions [3, 11]. These woody parasitic plants are today a real scourge, given the damage they cause both in natural plant formations [3, 12] and in fruit plantations [11, 13]. Woody species of environmental and economic importance such as *Azadirachta indica* (Meliaceae), *Balanites aegyptiaca* (Balanitaceae), *Terminalia mantaly* (Combretaceae), *Dalbergia sisso'o* (Fabaceae), *Acacia albida* (Mimosaceae), *Ficus* sp. (Moraceae), *Dacryodes edulis* (Burseraceae) and fruit species of socio-economic importance such as *Psidium guajava* (Myrtaceae), *Vitellaria paradoxa* (Sapotaceae), *Persea americana* (Lauraceae), are unfortunately attacked by Loranthaceae [14, 15, 3, 13]. Loranthaceae, although parasitic plants, are used internationally by traditional therapists and traditional healers in the treatment of various diseases such as cancer, hypertension, hypotension, diabetes, hepatitis, cerebral vascular accidents, infertility, microbial diseases and mental disturbances [16, 17, 18, 19]. They are also used for mystical purposes. In Cameroon, very few studies have been carried out on Loranthaceae parasites of woody plants except for the works of Dibong *et al*. [15, 20, 3] in the Littoral Region, Azo'o *et al*. [13] in the East Region, Balle [21] in the South Region, and Ngotta *et al*. [14] in the South West Region, Mapongmetsem *et al*. [22] and Ibrahima *et al*. [23] in Adamawa Region. The purpose of this study was to identify the species of Loranthaceae parasites that parasitize of woody plants and highlight their distribution according to altitude in the Mandara Mountains in Far North Region of Cameroon.

MATERIALS AND METHODS

Study site

The study was carried out in the Sudano-Sahelian zone of the Far North Region of Cameroon, located between latitude 10°0' and 12°0' North and between longitude 14°0' and 15°0' East (Figure1). Covering an area of 7660 km² which encompasses the Mayo Sava, Mayo Tsanaga Divisions, the Meri and Pette Sub-Divisions of Diamare Division and the Mayo-Oulo and Mayo-Louti Divisions in the North Region i.e 16.2% of the total area of the Far North Region. It forms a vast plain to the east and north and a set of mountain ranges called the Mandara Mountains in its western part along the Nigerian border, very rocky with peaks reaching over 1200m altitude. The climate is of the Sudano-Sahelian type, slightly mild and a single-mode rainfall, with two (2) seasons, a short rainy season (from June to October) and a long dry season (from November to May) [16]. The annual average temperature is 28ºC [24]. The soil is sandy-clay and sandy. The plant formation is of the Sudano-Sahelian type characterized by a predominantly thorny and shrub steppe and its extreme fragmentation due to natural conditions and human action. The main dominant species are *Acacia albida*, *Ziziphus mauritiana*, *Tamarindus indica*, *Azadirachta indica*, *Acacia seyal*, *Diospyros mespiliformis*, *Dalbergia sisso'o*. Some of these plants are used in traditional medicine. The population of this Region was estimated at approximately 1,165,700 inhabitants in 2005 [25]. It is dominated by Mafa, Moufou, Hide, Foulbe (peuhl), Mabas and Woula ethnic groups. The main activities carried out are agriculture, commerce, animal husbandry and crafts.

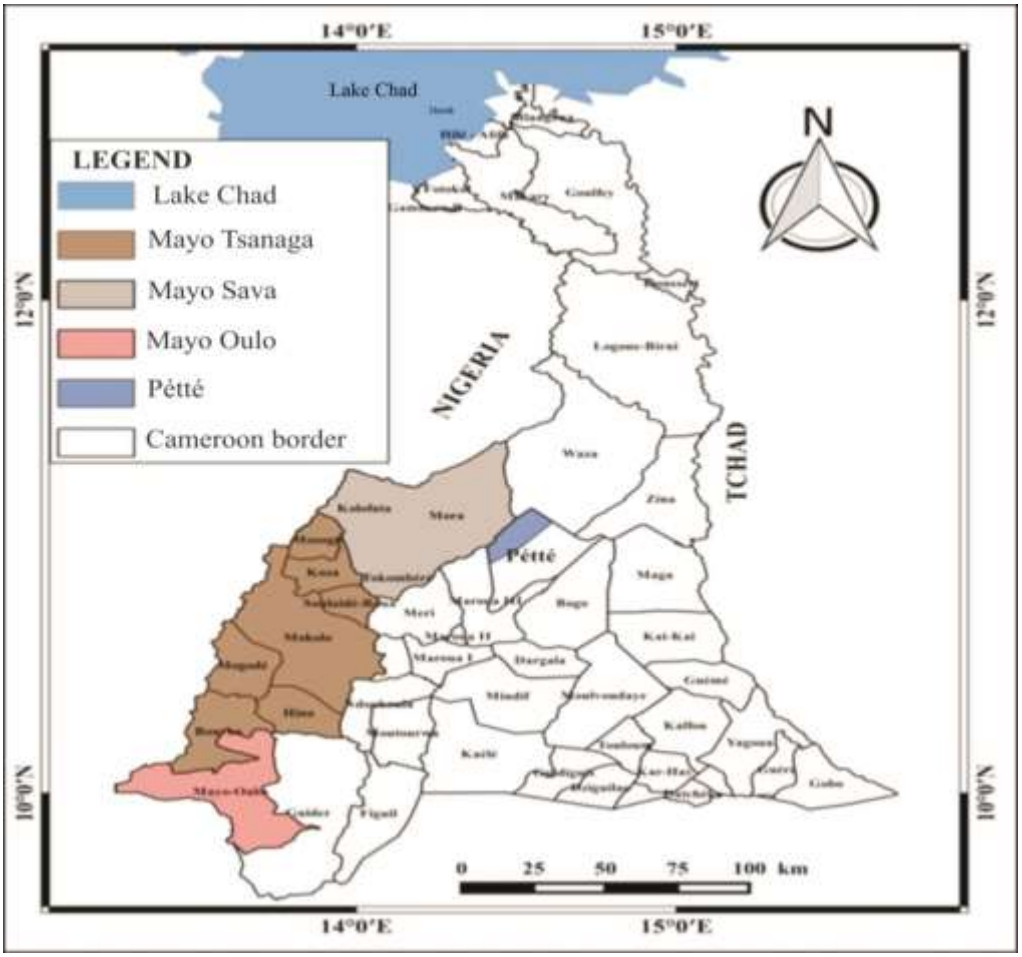

Figure 1 : Location of the study area (Source : Bello Bienvenu, 2019)

Collection of data

The botanical inventory of woody plants as potential hosts of Loranthaceae was carried out to highlight the sensitivity of each woody species to the parasitism of Loranthaceae. Surveys were carried out to identify parasitized and non-parasitized host plants and to inventory the parasitic species per infested plant in the Mandara Mountains. We used the Trees, Shrubs and Lianas of the Drylands of West Africa [26] guide book to identify species in the field.

The parasitic inventory was also carried out in the Mandara Mountains area. It consisted of listing all the parasitic plants (Loranthaceae) encountered. All parasitic species were systematically harvested with their hosts, and species located at the crowns of large trees were observed using binoculars. The transect survey method was used for the floristic survey. The study took place in nine (09) Sub-Divisions in four Divisions of the Mandara Mountains. The inventory is carried out on 15 mountains chosen at the rate of one Mount every 10km on the Mandara Mountains chain as a whole. On each Mount, two sides were chosen (East and West) and each side was subdivided into 16 altitudinal gradients. The experimental plan installed is therefore a split-plot (15 x 2) x 16 made up of 15 Mount (Altitude ≥ 1000 m) representing the main treatment already developed by [36]. The two flanks (East and West) of each mountain constitute the secondary treatment and on each side, 50m x 20m transects (repetitions) were installed by altitude level (tertiary treatment) starting with the plain, up to the top of the Mount with a space of 50m between two transects. After data collection, the 15 Mounts were grouped into five (5) categories of three (3) Mountains each according to the altitudinal level of the plain : Mount 1 (< 500 m = Mount 1 + Mount 2 + Mount 15) ; Mount 2 ([500 m - 600 m [= Mount 4 + Mount 5 + Mount 3) ; Mount 3 ([600 m - 700 m [= Mount 6 + Mount 7 + Mount 13) ; Mount 4 ([700 m - 800 m [= Mount 8 + Mount 9 + Mount 14) ; Mount 5 (> 800 m = Mount 10 + Mount 11 + Mount 12)). On each Mount, three 50m x 20m transects were installed on sixteen (16) altitudinal gradients. The latter were also grouped into four to find four gradients (plain [< 500 m]; altitude 1 [500 m - 700 m [; altitude 2 [700 m - 900 m [; and altitude 3 [> 900 m]). In each transect of each altitude level, all parasitized and non-parasitized woody species, the parasites and the number of Loranthaceae tufts were counted. For each tree encountered, several parameters are noted, including the presence or absence of parasites and the name of the species or species of Loranthaceae present on the host plant. A sample (leaves, flowers,

seeds) of each plant-parasite and its host is taken for identification purposes or for confirmation of identification made in the field.

Data analysis and processing

The collection of inventory data in the field made it possible to determine the species richness of Loranthaceae species. It is the number of Loranthaceae species found in the study area [8]. The data were classified by Mount, flank and by altitude. The Excel 2016 spreadsheet was used to calculate the means and draw histograms ; density was calculated according to the formula: D = N / S (where N = number of individuals of the species of the study environment and S = area occupied by the species) ; Shannon index was calculated according to the formula $H' = -\sum Pi \ln Pi$, where H'= Shannon biodiversity index; i = a middle species ; p (i) = Proportion of a species i compared to the total number of species (S) in the study environment (or specific diversity of the environment) which is calculated as follows: p (i) = ni / N where ni is the number of individuals of the species and N is the total number of individuals of all species [27]. From this index, Pielou's (E) equitability index was calculated using the formula ISH / log2N. Statgraphic 5.0 software was used for analysis of variance (ANOVA) and Xlstat 2007 software for principal component variable analysis and Duncan's test for the comparison of different Means. The Loranthaceae species determination keys used by Boussim [4] and by Houénon [8] are used to identify Loranthaceae species.

RESULTS

Floristic composition and sensitivity of host plants

In total, 120 host species distributed in 34 families and 75 genera were recorded in the Mandara Mountains (Table 1). Combretaceae and Mimosaceae are the most represented with 13 species each (10.83% for each family). They are followed by Caesalpiniaceae with 10 species (8.33%) and Moraceae with 9 species (7.5%). *Acacia* is the most diverse genus with 10 species (8.33%) of the host species. It is followed by *Combretum* and *Ficus* with 9 species each (7.5%) of the host plants for each genus. 18 genera (24%) are reported to be monospecific.

Three classes of host species are defined depending on the level of sensitivity to parasitism. In all of the 120 host species listed, 68 species (56.66% of the host species) are parasitized by 1 or 2 parasitic species and represent the first class (I); which is the class of host species that are not very sensitive to the parasitism of Loranthaceae. Among these species are: *Haematostaphis barteri*, *Lannea acida*, *Lannea fruticosa*, *Sclerocarya birrea*, *Annona senegalensis*, *Hexalobus monopetalus*, *Vernonia thomsoniana*, *Stereospermum kunthianum*, *Adansonia digitata*, *Boswellia dalzielii*, *Commiphora africana*, *Piliostigma thonningii*, *Piliostigma reticulatum*, *Capparis fascicularis*, *Boscia angustifolia*. The second class (II) of sensitive host species is made up of 8 species, (6.66% of the host species), which represent species sensitive to the parasitism of Loranthaceae. Among these species are: *Balanites aegyptiaca*, *Tamarindus indica*, *Boscia senegalensis*, *Anogeissus leiocarpus*, *Dalbergia sisso'o*, *Acacia seyal*, *Ziziphus abyssinica*, *Citrus limon*. The third class (III) of host plants consists of species highly sensitive to parasitism by Loranthaceae. It is represented by 4 species (3.33% of the host species). They include: *Ziziphus mauritiana*, *Khaya senegalensis*, *Azadirachta indica* and *Diospyros mespiliformis*, among others.

Regarding Loranthaceae species, *T. globiferus* is much more represented with 41.67%. It is followed by *A. dodoneifolius* with 38.47% and *T. ophiodes* with 12.50%. The least parasitic plant is *G. braunii* with 7.50%.

Table 1 : List of host species and their sensitivity to Loranthaceae parasitism

Host plants	Loranthaceae								
	AD	TG	TO	TE	TB	PC	GB	Nep	SPS
Anacardiaceae									
Haematostaphis barteri Hook f.	+	+						2	vshp
Lannea acida A. Rich.s.l.		+						1	vshp
Lannea fructicosa (Hochst. ex A. Rich.) Engl.		+						1	vshp
Lannea schimperi (Hochst. ex A. Rich.) Engl.									
Lannea velunita A. Rich.									
Mangifera indica L.									
Sclerocarya birrea (A. Rich.) Hochst.		+						1	vshp
Annonaceae									
Annona senegalenis Pers.			+			+		2	vshp
Annona squamosa L.									
Hexalobus monopetalus (A. Rich.) Engl. & Diels	+	+						2	vshp
Apiaceae									
Steganotaenia araliacea Hochst.									
Apocynaceae									
Holarrhena floribunda (G. Don) Dur. & Schinz									
Asclepiadaceae									
Calotropis procera (Ait.) Ait. f.									

Asteraceae									
Vernonia thomsoniana Oliv. & Hiern		+						1	vshp
Balanitaceae									
Balanites aegyptiaca (L.) Del.	+	+			+			3	shp
Bignoniaceae									
Stereospermum kunthianum Cham.		+						1	vshp
Bombacaceae									
A*dansonia digitata* L.		+						1	vshp
Ceiba pentandra (L.) Gaertn.									
Burseraceae									
Boswellia dalzielii Hutch.		+		+				2	vshp
Boswellia papyrifera (Del.) A. Rich.									
Commiphora africana (A. Rich.) Engl.							+	1	vshp
Commiphora kerstingii Engl.									
Caesalpiniaceae									
Bauhinia rufencens Lam.	+	+						2	vshp
Afzelia africana Smith ex Pers.									
Daniellia oliveri (Rolfe) Hutch. & Dalz.				+				1	vshp
Isoberlinia doka Craib & Stapf									
Piliostigma reticulatum (DC.) Hochst.	+	+						2	vshp
Piliostigma thonningii (Schum.) Milne-Redh.		+						1	vshp
Pterocarpus erinaceus Poir.									
Senna siamea Lam.									
Senna singueana (Del.) Lock									
Tamarindus indica L.	+	+	+	+				4	shp
Capparaceae									
Capparis fascicularis DC.		+			+			2	vshp
Boscia angustifolia A. Rich.		+						1	vshp
Boscia senegalensis (Pers.) Lam. ex Poir.	+	+	+					3	shp
Cadaba farinosa Forssk.						+		1	vshp
Capparis sepiaria L.						+		1	vshp
Maerua angolensis DC.									
Celastraceae									
Maytenus senegalensis (Lam.) Exell.		+						1	vshp
Combretaceae									
Anogeissus leiocarpus (DC.) Guill. & Perr.	+	+					+	3	shp
Combretum aculeatum Vent.									
Combretum adenogonium Steud. ex. A. Rich.							+	1	vshp
Combretum collinum Fresen.									
Combretum glutinosum Perr. ex DC.	+						+	2	vshp
Combretum lecardii Engl. & Diels					+	+		2	vshp
Combretum micranthum G. Don			+					1	vshp
Combretum molle R. Br. ex G. Don									
Combretum nigricans Lepr. ex Guill. et Perr.			+		+			2	vshp
Combretum nioroense Aubrév. ex Keay									
Guiera senegalensis J.F. Gmel.	+	+						2	vshp
Terminalia glaucescens Hochst.		+	+					2	vshp
Terminalia macroptera Guill. & Perr.		+						1	vshp
Terminalia mantaly H. Perr.									
Ebenaceae									
Diospyros mespiliformis Hochst. ex A. Rich.	+	+	+	+	+			5	hshp
Euphorbiaceae									
Croton macrostachyus Hochst. ex Del.		+						1	vshp
Croton psedopulchellus Pax		+						1	vshp
Euphorbia kamerunica Pax	+	+						2	vshp
Flueggea virosa (Roxb. ex Willd.) Voigt									
Jatropha gossypiifolia L.		+	+					2	vshp
Phyllanthus muellerianus (O. Ktze) Exell	+							1	vshp
Uapaca togoensis Pax							+	1	vshp
Fabaceae									
Andira inermis (Wright) DC.									
Dalbergia boehmii Taub.	+	+						2	vshp
Dalbergia melanoxylon Guill. & Perr.	+							1	vshp

Dalbergia sissoo Roxb.	+	+			+			3	shp
Dicrostachys cinerea (L.) Wight & Arn.						+	+	2	vshp
Entada africana Guill. & Perr.							+	1	vshp
Pterocarpus erinaceus Poir.	+							1	vshp
Pterocarpus lucens Guill. & Perr.	+							1	vshp
Flacourtiaceae									
Flacourtia indica Willd.		+						1	vshp
Loganiaceae									
Strychnos spinosa Lam.		+						1	vshp
Meliaceae									
Azadirachta indica A. Juss.	+	+	+		+	+		5	hshp
Khaya senegalensis (Desr.) A. Juss.	+	+	+	+		+		5	hshp
Mimosaceae									
Acacia albida Del.	+	+						2	vshp
Acacia amythethophylla Steud. ex A. Rich.		+						1	vshp
Acacia ataxacantha DC.					+		+	2	vshp
Acacia ehrenbergiana Hayne	+							1	vshp
Acacia erythrocalyx Brenan									
Acacia gerardii Benth.									
Acacia hocki De Wild.	+				+			2	vshp
Acacia nilotica (L.) Willd. ex Del	+							1	vshp
Acacia seyal Del.	+		+	+				3	shp
Acacia tortilis sub sp. raddiana (Savi) Brenan	+	+						2	vshp
Albizia chevalieri Harms									
Albizia zygia (DC.) J.F. Macbr.		+		+				2	vshp
Prosopis juliflora (Sw.) DC.									
Moraceae									
Ficus sycomorus (Miq.) C.C. Berg		+	+					2	vshp
Ficus abutilifolia (Miq.) Miq.									
Ficus asperifolia Miq.	+							1	vshp
Ficus cordata ssp. lecardii (Warb.) C.C. Berg	+	+						2	vshp
Ficus dicranostyla Mildbr.									
Ficus glumosa Del.					+	+		2	vshp
Ficus platyphylla Del.	+							1	vshp
Ficus thonningii Blume									
Ficus umbellata Vahl		+						1	vshp
Myrtaceae									
Psidium guajava L.	+	+						2	vshp
Ochnaceae									
Ochna schweinfurthiana F. Hoffm.									
Olacaceae									
Jasminum obtusifolium Bak.									
Ximenia americana L.	+	+						2	vshp
Polygalaceae									
Securidaca longipedunculata Fres.									
Rhamnaceae									
Ziziphus abyssinica Hochst. ex A. Rich.	+	+	+	+				4	shp
Ziziphus mauritiana Lam.	+	+	+	+	+	+		6	hshp
Rubiaceae									
Crossopteryx febrifuga (Afzel. ex G. Don) Benth.									
Feretia apodanthera Del.	+	+						2	vshp
Gardenia aqualla Stapf. & Hutch.	+							1	vshp
Pavetta corymbosa (DC.) F. N. Williams									
Sarcocephalus latifolius (Smith) Bruce		+						1	vshp
Tricalysia okelensis Hiern									
Rutaceae									
Citrus limon (L.) Burm. F.		+	+	+				3	shp
Citrus sinensis (L.) Osbeck	+	+						2	vshp
Sapotaceae									
Malacantha alnifolia (Bak.) Pierre									
Vitellaria paradoxa Gaertn. f.		+						1	vshp
Sterculiaceae									
Sterculia setigera Del.					+		+	2	vshp

Tilliaceae									
Grewia barteri Burret						+		1	vshp
Grewia bicolor Juss.									
Grewia flavescens Juss.	+							1	vshp
Guibourtia copallifera Benn.									
Ulmaceae									
Celtis integrifolia Lam.									
Verbenaceae									
Lippia chevalieri Moldenke									
Vitex doniana Sweet.	+	+						2	vshp
Vitex madiensis Oliv.		+			+			2	vshp
SeP (%)	31.67	41.67	12.5	8.33	10.83	8.33	7.5		

AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitata*, GB : *Globimetula braunii*, SPS : Specificity of parasitic species, Npshp : number of parasitic species per host plant, pshp : parasitic sensitivity of the host plant (1 to 2 parasites = not very sensitive host plant (vshp), 3 to 4 parasites = sensitive host plant (shp), 5 to 6 parasites = highly sensitive host plant (hshp), + : presence

Taxonomic composition of Loranthaceae

In total, seven (7) species of Loranthaceae have been recorded in the Mandara Mountains (Table 2). *Tapinanthus globiferus* (A. Rich.) Danser is the most represented with an average density of 125.66 ± 71.86 tufts / ha. It is followed by *Agelanthus dodoneifolius* (DC) Polh. & Wiens with 116.39 ± 53.74 tufts / ha; *Tapinanthus ophiodes* (Sprague) Danser with 92.65 ± 51.06 tufts / ha; *Tapinanthus belvisii* (DC) Danser with 70.24 ± 53.63 tufts / ha; *Phragmanthera capitata* (Spreng) Ballé with 57.74 ± 27.2 tufts / ha and *Tapinanthus bangwensis* (Engl. and Kr.) Danser with 51.4 ± 33.24 tufts / ha. *Globimetula braunii* (Engl.) Tiegh. is the least represented parasitic species on the Mountains with an average density of 45.57 ± 19.01 tufts / ha. The specific richness of Loranthaceae species varies between 1 and 3 parasitic species per host plant. Variance analysis shows that there is a highly significant difference between Loranthaceae species ($P < 0.001$).

Table 2 : Taxonomic diversity of Loranthaceae

Genera	Species	Density
Agelanthus	*Agelanthus dodoneifolius*	59.69 ± 34.91^{e}
Tapinanthus	*Tapinanthus globiferus*	73.38 ± 37.48^{f}
	Tapinanthus ophiodes	44.35 ± 42.8^{d}
	Tapinanthus bangwensis	25.22 ± 36.87^{b}
	Tapinanthus belvisii	35.01 ± 17.77^{c}
Phragmanthera	*Phragmanthera capitate*	26.96 ± 21.89^{b}
Globimetula	*Globimetula braunii*	17.26 ± 29.36^{a}
Average/ Standard deviation		40.27±31.58

Values assigned the same letters in superscript do not show significant statistical differences

Loranthaceae species are unevenly dispersed over the Mountains. *T. globiferus*, *A. dodoneifolius* and *T. ophiodes* are respectively the most represented in the study area (Figure 2). These dispersed species are the densest, that is to say the species for which we are more likely to encounter on all the Mountains in the study area. The other species which are less represented form clouds around the two (axes f1 and f2: 99.91%). These species represented in the form of a cloud are less dense and are less common in the study area.

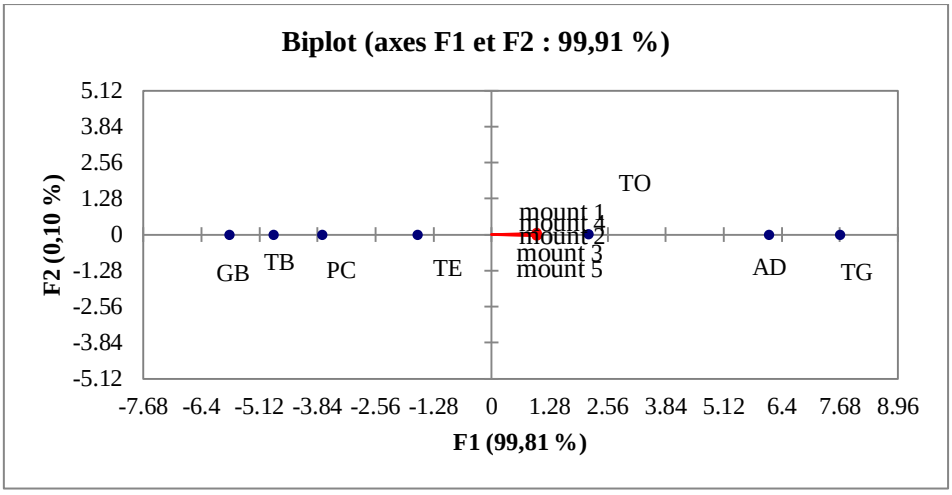

Figure 2 : Dispersion of species on the Mountains

AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitata*, GB : *Globimetula braunii*

Density of Loranthaceae on the Mountains

Table 3 shows the density on the two flanks of the Mandara Mountains. Between these two, the density of parasitic species is higher on the Eastern flank (82.07 ± 61.68 tufts / ha) than on the Western flank (77.83 ± 49.62 tufts / ha). Amongst the Loranthaceae species on the Eastern flank, *T. globiferus* is more abundant (150.11 ± 125.69 tufts / ha). It is followed by *A. dodoneifolius* with average density is 120.24 ± 136.19 tufts / ha and *T. ophiodes* with 92.58 ± 104.9 tufts / ha; *T. belvisii* (71.78 ± 71.8 tufts / ha); *P. capitata* (56.19 ± 50.87 tufts / ha); and *T. bangwensis* (48.44 ± 27.92 tufts / ha). On this slope, the least represented species is *G. braunii* with an average density of 35.14 ± 126.43 tufts/ha.

On the Western flank, *T. globiferus* has a higher density (143.42 ± 82.3 tufts / ha) but below the density on the Eastern flank. *A. dodoneifolius* comes next with an average density of 114.5 ± 87.3 tufts / ha; followed by *T. ophiodes* (82.03 ± 29.45 tufts / ha); *T. belvisii* (68.28 ± 70.94 tufts / ha); *P. capitata* (51.64 ± 40.54 tufts / ha); and *T. bangwensis* (51.03 ± 56.87 tufts / ha). *G. braunii* is less represented on this slope with an average density of 33.92 ± 99.23 tufts / ha. The analysis of variance (ANOVA) indicates that there is no difference between the two flanks ($P > 0.05$) while between the parasitic species the difference is highly significant ($P < 0.001$).

Table 3 : Density of Loranthaceae on the Mounts

Species	M 1	M 2	M 3	M 4	M 5	average/SD
TD	347.71	343.96	347.71	347.71	358.75	349.17±5.6
TG	378.33	365.00	376.46	385.42	379.69	376.98±7.49
TO	278.33	286.88	276.04	273.13	275.42	277.96±5.32
TB	152.92	153.33	155.00	150.21	159.58	154.21±3.46
TE	201.04	211.98	215.31	213.44	211.77	210.71±5.59
PC	173.75	172.50	171.35	177.81	170.63	173.21±2.83
GB	135.21	136.98	134.38	137.60	139.38	136.71±1.98
average/SD	238.18±97.17	238.66±93.17	239.46±95.94	240.76±97.43	242.17±97.5	239.85±96.15

M 1 = Mount 1 (< 500 m = M 1 + M 2 + M 15), M 2 = Mount 2 ([500 m - 600 m [= M 4 + M 5 + M 3), M 3 = Mount 3 ([600 m - 700 m [= M 6 + M 7 + M 13), M 4 = Mount 4 ([700 m - 800 m [= M 8 + M 9 + M 14), M 5 = Mount 5 (> 800 m = M 10 + M 11 + M 12), SD : Standard deviation, AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitata*, GB : *Globimetula braunii*

Values assigned the same superscript letters on the same lines on one hand and the same columns on the other hand, do not show significant statistical differences.

Principal component analysis of variables (PCA) shows that the five (05) Mountains are positively correlated with each other. Figure 3 shows the correlation between the different Mounts. The correlation is very strong (Pearson, r = 0.987) between Mount 3 and Mount 4, between Mount 3 and Mount 5 (0.986) and between Mount 1 and Mount 2 (Pearson, r = 0.942).

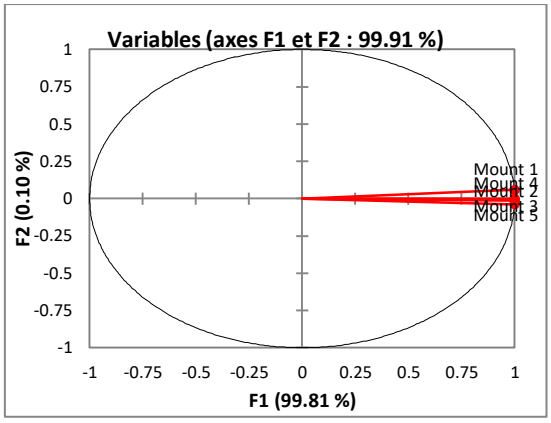

Figure 3 : Correlation between Mount

Loranthaceae density on the slopes

Table 4 shows the density on the two flanks of the Mandara Mountains. Between the two, the density of parasitic species is higher on the Eastern flank (82.07 ± 61.68 tufts / ha) than on the Western flank (77.83 ± 49.62 tufts / ha). Between the Loranthaceae of the Eastern flank, *T. globiferus* is more abundant (150.11 ± 125.69 tufts / ha). It is followed by *A. dodoneifolius* (120.24 ± 136.19 tufts / ha) and *T. ophiodes* (92.58 ± 104.9 tufts / ha); *T. belvisii* (71.78 ± 71.8 tufts / ha); *P. capitata* (56.19 ± 50.87 tufts / ha); *T. bangwensis* (48.44 ± 27.92 tufts/ha). On this slope, the least represented species is *G. braunii* with an average density of 35.14 ± 126.43 tufts / ha.

On the Western flank, *T. globiferus* has a higher density (143.42 ± 82.3 tufts / ha) but below the density on the Eastern flank. *A. dodoneifolius* comes second with an average density of 114.5 ± 87.3 tufts / ha; followed by *T. ophiodes* (82.03 ± 29.45 tufts / ha); *T. belvisii* (68.28 ± 70.94 tufts / ha); *P. capitata* (51.64 ± 40.54 tufts / ha); and *T. bangwensis* (51.03 ± 56.87 tufts / ha). *G. braunii* is less represented on this slope with an average density of 33.92 ± 99.23 tufts / ha. The analysis of variance (ANOVA) indicates that there is no difference between the two slopes ($P = 0.395 > 0.05$) while between the parasitic species the difference is highly significant ($P < 0.001$).

Table 4 : Density of Loranthaceae species on the slopes

		Eastern flank	Western flank
Genera	Species	Density	Density
Agelanthus	*Agelanthus dodoneifolius*	120.24±136.19^{e}	114.5±87.3^{e}
Tapinanthus	*Tapinanthus globiferus*	150.11±125.69^{f}	143.42±82.3^{f}
	Tapinanthus ophiodes	92.58±104.9^{d}	82.03±29.45^{d}
	Tapinanthus bangwensis	48.44±27.92^{b}	51.03±56.87^{b}
	Tapinanthus belvisii	71.78±71.8^{c}	68.28±70.94^{c}
Phragmanthera	*Phragmanthera capitata*	56.19±50.87^{b}	51.64±40.54^{b}
Globimetula	*Globimetula braunii*	35.14±126.43^{a}	33.92±99.23^{a}
Average/ Standard deviation		82.07±61.68^{a}	77.83±49.62^{a}

On the same column, the values assigned the same letters in superscript do not show significant statistical differences

Loranthaceae density according to the altitudinal gradient

The density of Loranthaceae species varies between the plain and the Mount but also between different altitude levels of the Mountain, ranging from the bottom (A1) to the top (A3). Between the different height differences, the summit of the Mount (A3) has a higher density (25.02 ± 12.65 tufts / ha) compared to the other altitude levels. It precedes the middle of Mount (A2) which has an average density of 21.83 ± 10.69 tufts / ha; and the bottom (A1). Therefore, the average density on the Mountains (18.19 ± 9.83 tufts / ha) and plain (A0) is the least dense zone in individuals (14.9 ± 8.87 tufts / ha). The average density of Loranthaceae species increases as one moves from the plain (A0) to the top of the Hills (A3). At the species level, the density of six species increases from bottom to top. These are *A. dodoneifolius*, *T. globiferus*, *T. ophiodes*, *T. belvisii*, *P. capitata* and *G. braunii*. On the other hand, the average density of *T. bangwensis* decreases as one goes from the plain (A0) to the top of the Mountains. This species rather prefers the plain than the summit of the Mounts compared to the other species which are summit loving. The analysis of variance (ANOVA) shows a highly significant difference between the altitude levels ($P < 0.001$).

Table 5 : Density of Loranthaceae species on altitudinal gradients

Species	A 0	A 1	A 2	A 3	Average/SD
TD	21.15	26.65	33.19	38.38	29.84±7.52
TG	28.75	33.22	38.73	44.75	36.36±6.92
TO	17.07	21.57	23.14	26.22	22±3.81
TB	15.72	14.44	10.81	8.76	12.43±3.21
TE	11.36	16.13	20.00	22.54	17.51±4.87
PC	9.15	11.64	14.96	16.78	13.13±3.4
GB	1.11	3.71	11.99	17.72	8.63±7.63
Average/SD	14.9±8.87	18.19±9.83	21.83±10.69	25.02±12.65	19.99±10.07

A 0 = plain (< 500 m), A 1 = Altitude 1 ([500 m - 700 m [), A 2 = Altitude 2 ([700 m - 900 m [), A 3 = Altitude 3 (> 900 m), SD : Standard deviation, AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitata*, GB: *Globimetula braunii*

Values assigned the same superscript letters on the same lines on one hand and the same columns on the other hand, do not show significant statistical differences.

Density of Loranthaceae interaction between Mounts and Slopes

The density of the two flanks of each Mount varies from one Mount to another (table 6). Mount 5 is denser with an average density of 142.03 ± 3.87 tufts / ha on both flanks. It is followed by Mount 4 which has an average density of 131.24 ± 4.36 tufts / ha for the two slopes; Mount 3 (120.67 ± 5.53 tufts / ha); Mount 2 (114.16 ± 5.62 tufts / ha) and Mount 1 has the lowest density for the two slopes (95.92 ± 5.09 tufts / ha). The analysis of variance shows that the difference is highly significant between the different Mounts (P = 0.004). Between the two sides of each Mount, ANOVA does not show any significant difference (P > 0.05).

Table 6 : Density of Loranthaceae species of the interaction between the Mounts and the Slopes

Species	M 1		M 2		M 3		M 4		M 5	
	East flank	West flank	East flank	West flank	East flank	West flank	East flank	West flank	East flank	West flank
TD	154.38	146.46	175.42	159.17	183.75	179.58	191.04	183.75	216.88	200.21
TG	192.08	185.21	222.29	209.79	216.88	206.46	239.79	227.71	254.79	246.46
TO	116.67	109.58	107.71	100.00	140.42	122.08	156.46	135.42	183.54	158.54
TB	38.96	36.46	78.54	75.00	79.58	75.63	100.63	97.50	76.04	98.13
TE	107.71	96.46	96.04	87.29	99.79	97.29	116.04	114.58	118.75	116.46
PC	61.25	52.08	89.38	78.96	94.79	84.79	90.83	83.75	85.21	87.71
GB	25.63	20.00	57.50	61.04	56.88	51.46	45.42	54.38	78.13	67.50
Average/SD	99.52 ±56.73^{a}	92.32 ±55.86^{a}	118.13 ±58.88^{b}	110.18 ±54.12^{b}	124.58 ±58.28^{c}	116.76 ±56.83^{c}	134.32 ±65.95^{d}	128.15 ±59.99^{d}	144.76 ±73.25^{e}	139.29 ±65.32^{e}
	95.92±5.09^{a}		114.16±5.62^{ab}		120.67±5.53^{abc}		131.24±4.36^{bc}		142.03±3.87^{c}	

Mount 1 (< 500 m = M 1 + M 2 + M 15), Mount 2 ([500 m - 600 m [= M 4 + M 5 + M 3), Mount 3 ([600 m -700 m [= M 6 + M 7 + M 13), Mount 4 ([700 m - 800 m [= M 8 + M 9 + M 14), Mount 5 (> 800 m = M 10 + M 11 + M 12), SD : Standard deviation, TD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitate*, GB : *Globimetula braunii*

On the same lines, values assigned the same superscript letters do not show statistically significant differences.

Density of Loranthaceae of interaction between slopes and altitudes

For the four altitude levels combined, the mean density of Loranthaceae species varies from species to species (Table 7). *T. globiferus* shows a higher density of 899.38 ± 19.01 stufts / ha. It is followed by *A. dodoneifolius* (842.77 ± 19.23 tufts / ha). *T. ophiodes* occupies the third position with a density of 784.44 ± 19.64 tufts / ha. A density of 575 ± 15.12 tufts / ha is then recorded by *T. bangwensis*. The latter is followed by *T. belvisii* which obtains a density of 556.12 ± 5.26 tufts / ha. A relatively low density of 440.56 ± 7.5 tufts / ha is observed by *P. capitata* and the lowest density (378.89 ± 6.99 tufts / ha) is obtained by *G. braunii*. For the difference between species, the analysis of variance (ANOVA) specifies a highly significant difference (P < 0.001).

Table 7 : Density of Loranthaceae species on the slopes with the four levels of altitude

Species	East				West				Average/SD
	A 0	A 1	A 2	A 3	A 0	A 1	A 2	A 3	
AD	118.00	121.00	123.00	129.28	86.50	82.72	87.44	94.83	842.77±19.23^{e}
TG	124.67	126.78	127.72	138.44	94.83	88.44	95.33	103.17	899.38±19.01^{f}
TO	105.78	115.44	115.22	124.83	75.39	75.50	83.00	89.28	784.44±19.64^{d}
TB	86.89	82.11	77.44	92.61	50.39	57.72	60.78	67.06	575±15.12^{c}
TE	64.11	65.44	71.89	77.06	67.06	63.28	71.89	75.39	556.12±5.26^{c}
PC	55.22	54.33	55.22	65.39	42.06	49.39	54.67	64.28	440.56±7.5^{b}
GB	41.89	48.78	49.67	55.94	33.72	45.50	50.22	53.17	378.89±6.99^{a}

A 0 = plain (< 500 m), A 1= Altitude 1 ([500 m -700 m [), A 2 = Altitude 2 ([700 m - 900 m [), A 3 = Altitude 3 (> 900 m), SD : Standard deviation
AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitate*, GB : *Globimetula braunii*

Values assigned the same letters in superscript do not show statistically significant differences.

Relative frequency of distribution of Loranthaceae species

The number of species of Loranthaceae parasite on ligneous plants does not vary from one slope to another (P = 0.597). All 7 species of parasitic plants are present on the two slopes (Table 8). The parasitic flora common to both sides is made up of all seven species (*A. dodoneifolius, T. globiferus, T. ophiodes, P. capitata, T. bangwensis, T. belvisii and G. braunii).* In slopes, *A. dodoneifolius* and *T. globiferus* are the most frequent species with a frequency of 100% on both slopes. *T. ophiodes* is more frequent on the Eastern flank (93.33%) than on the Western flank (86.66%). As for *T. bangwensis*, it has the same frequency of occurrence on both flanks (80%). *T. belvisii* is much more present on the Western slope (93.33%) than on the Eastern slope (86.66%). *P. capitata* and *G. braunii* are more frequent on the Eastern slope with respectively 66.66% and 40% than on the Western slope (40% and 26.66% respectively). In terms of species presence, there is no significant difference between the two flanks. Depending on the frequency of presence, the analysis of variance (ANOVA) shows a small significant difference between the two slopes (P > 0.05). In terms of the frequency of species on the slopes, the analysis of variance (ANOVA) shows a highly significant difference (P < 0.001).

Table 8 : Frequencies of presence of Loranthaceae species on the east and west slopes

Species	Relative frequency of presence of species (%)	
	Eastern slope	Western slope
AD	100^{e}	100a
TG	100^{e}	100a
TO	93.33^{d}	86.66c
TB	80^{c}	80c
TE	86.66^{c}	93.33b
PC	66.66^{b}	40d
GB	40^{a}	26.66e

AD : *Agelanthus dodoneifolius*, TG : *Tapinanthus globiferus*, TO : *Tapinanthus ophiodes*, TB : *Tapinanthus bangwensis*, TE : *Tapinanthus belvisii*, PC : *Phragmanthera capitate*, GB : *Globimetula braunii*

On the same columns, the values assigned the same letters in superscript do not present statistically significant differences.

Diversity indices of Loranthaceae of the Mandara Mountains

The Shannon diversity index and the evenness index of Pielou are higher on Mount 5 (0.328 and 0.120 respectively) which is made up of the Mount whose plain has an altitude greater than 800 m (table 9) while these indices are more weak on Mount 1 where the plain is less than 500 m (0.317 for the Shannon index and 0.113 for the evenness of Piélou). This means that the diversity of Loranthaceae is less dense in Mount 1 where the plain has a low altitude (ISH = 0.317; EQ = 0.113) compared to the Mount where the altitude of the plain is greater than 800 m (ISH = 0.328; EQ = 0.120).

Table 9 : Loranthaceae diversity indices

Parameters	M1	M2	M3	M4	M5
D	536.32	544.13	559.34	573.99	584.44
ISH	0.317	0.318	0.322	0.325	0.328
EQ	0.113	0.113	0.115	0.117	0.120

Mount 1 (< 500 m = M 1 + M 2 + M 15), Mount 2 ([500 m - 600 m [= M 4 + M 5 + M 3), Mount 3 ([600 m - 700 m [= M 6 + M 7+M 13), Mount 4 ([700 m - 800 m [= M 8 + M 9 + M 14), Mount 5 (> 800 m = M 10 + M 11 + M 12), D = Density, ISH = Shannon's Index, EQ = Piélou's Equitability

DISCUSSION

The taxonomic diversity of the host plants in our study is made up of 120 species belonging to 75 genera and grouped into 34 botanical families. These results are different from those of Houénon *et al*. [8] who obtained a diversity of 105 species distributed in 85 genera and 33 families. Our results reveal that Combretaceae and Mimosaceae are the most represented with 13 species (10.83%) for each family. *Acacia* is the most diverse genus with 10 species (8.33%) of the host species. It is followed by *Combretum* and *Ficus* with 9 species each (7.5% of the host plants for each genus). 18 genera (24%) are reported monospecific. These results are different from those of Souare *et al*., [28] who obtained 34 species in the Diamare plain located in the same Sudano-Sahelian zone and from those of Houénon *et al*., [8] who showed in their study that *Ficus* is the most diverse genus with 5 species (5.9%) of host plants. It is followed by *Albizia* with 4 species (4.7%). Leguminosaceae represent the highest family with 25 species (23.8%). The differences observed would be due to the Mountains which are rich in biodiversity. In all of the 120 listed host species, 68 species (56.66% of the host species) are parasitized by 1 or 2 parasitic species and represent the first class (I); which is the class of host species that a not highly sensitive to parasitism of Loranthaceae. These species include: *Haematostaphis barteri*, *Lannea acida*, *Lannea fruticosa*, *Sclerocarya birrea*, *Annona senegalensis*, *Hexalobus monopetalus*, *Vernonia thomsoniana*, *Stereospermum kunthianum*, *Adansonia digitata*, *Boswellia dalzielii*, *Commiphora africana*, *Piliostigma reticulatum*, *Capparis fascicularis*, *Boscia angustifolia* etc. The second class (II) of sensitive host species consists of 8 species (6.66% of the host species), that represent the species susceptible to Loranthaceae parasitism. Among these species are: *Balanites aegyptiaca*, *Tamarindus indica*, *Boscia senegalensis*, *Anogeissus leiocarpus*, *Dalbergia sisso'o, Acacia seyal*, *Ziziphus abyssinica*, *Citrus limon*. The third class (III) of host plants consists of species highly sensitive to Loranthaceae parasitism. It is represented by 4 species (3.33% of the host species). They include *Ziziphus mauritiana*, *Khaya senegalensis*, *Azadirachta indica and Diospyros mespiliformis*. These parasitic sensitivity classes are different from those of Houénon *et al.*, [8] who indicated that in a sample of 105 identified host species, 79 species (75.2%) are infested with 1 or 2 species and represent class I (insensitive). They cited species such as *Calotropis procera*, *Jatropha multifida*, *Khaya senegalensis*, *Persea americana*, *Triplochiton scleroxylon* and *Vitex doniana*. Class II of sensitive hosts are 20 species (19.1%) including *Adansonia digitata*, *Ceiba pentandra*, *Irvingia gabonensis*, *Morinda lucida*, *Newbouldia laevis*, *Parkia biglobosa*. Class III (highly sensitive) had 4 species (3.8%) namely: *Acacia auriculiformis*, *Citus reticulata*, *Senna siamea* and *Tectona grandis*. The last class, class IV contains only *Citrus sinensis* which is the only plant-host with a very high parasitic sensitivity.

The Mandara Mountains of Cameroon are host of the Loranthaceae flora. Of the 7 genera (*Agelanthus*, *Englerina*, *Globimetula*, *Helixanthera*, *Phragmanthera*, *Tapinanthus* and *Viscum*) and 25 species reported in Cameroon [29, 1, and 30], the Loranthaceae of this area are grouped into 4 genera (*Agelanthus*, *Tapinanthus*, *Phragmanthera* and *Globimetula*) or 57.14% and 7 species (*T. globiferus*, *A. dodoneifolius*, *T. ophiodes*, *T. belvisii*, *T. bangwensis*, *P. capitata* and *G. braunii*) or 26.92%. These results do not corroborate those of Souare *et al*. [28], who identified 3 genera (*Agelanthus*, *Tapinanthus* and *Phragmanthera*) and 9 species. This taxonomic diversity of 4 genera and 7 is higher than that obtained by Ahamide *et al*. [31], who identified 3 genera (*Globimetula*, *Phragmanthera* and *Tapinanthus*) and 6 species in southern Benin, those of Boussim [32, 4] who inventoried 3 genera and 6 species in Burkina Fasso. Similarly, these results are superior to those of 2 genera and 3 species observed in Lokomo in East Cameroon [13] and to those of 2 species of the same genus reported by Mony *et al*. [30] on the Logbessou Plateau in Douala Cameroon but less than 6 genera and 19 species recorded in Côte d'Ivoire [33], 6 genera and 25 species examined in Cameroon [21] and those by Aka *et al*. [33] who identified eleven (11) species of parasitic plants in Côte d'Ivoire. In contrast, these results are close to those of Houénon *et al*. [8] who inventoried 4 genera and 10 species in the Guinean and Sudan-Guinean areas in Benin. The differences observed between these different results would be due to the altitudinal gradients of the study areas but also to climatic factors.

Our study reveals that the abundance of parasitic species is variable with a dominance of *T. globiferus* (73.38 ± 37.48 tufts / ha). Our results are in contradiction with those of Amon *et al*. [35] who instead showed that *T. bangwensis* dominates in Côte-d'Ivoire and Mony *et al*. [30] showing *T. ogowensis* that dominates on the Logbessou plateau in Douala in Cameroon. This difference would be due to the fact that our study is focused on the Mountains while the previous studies were conducted in orchards. In the Sudano-Guinean Savannas of Adamawa Cameroon, Mapongmetsem *et al*. [22] found five species of parasitic plants on woody plants. Likewise, Boussim [32] observed five species and three genera of parasitic plants on Shea butter in the savannas of Burkina Faso. For Soro *et al*. [7], *P. capitata* is abundant at 74.82% in the forest zone of the Sub-Divisions of Gagnoa and Ouragahio in Côte d'Ivoire. Our study shows that the frequency of Loranthaceae species varies according to height difference, with Mountain tops being the preferred altitude. These results corroborate those obtained by Jiofack *et al.* [1] who found that Loranthaceae species evolve with altitude in the Bafou group in Cameroon. These authors also reported that Loranthaceae species are characterized by their variable expansion from one level to another depending on the temperature fluctuation in altitude.

CONCLUSION

The Mandara Mountains present a very rich woody plant diversity, likely to be parasitized by Loranthaceae. In total, we inventoried 120 host species belonging to 34 families and 75 genera. Combretaceae and Mimosaceae are the most represented, each with 13 species (10.83%) for each family. *Acacia* is the most diverse genus with 10 species (8.33% of the host species). 18 genera (24% of the flora) are reported to be monospecific. These Mountains abound over their area a taxonomic diversity of Loranthaceae of four (4) genera (*Tapinanthus, Phragmanthera, Agelanthus* and *Globimetula*) and 7 species (*T. bangwensis*, *T. belvisii*, *T. globiferus, A. dodoneifolius, T. ophiodes*, *P. capitata* and *Globimetula braunii*). From the ecological distribution point of view of Loranthaceae species, *T. globiferus* is the most represented (125.66 ± 71.86 tufts / ha). It is followed by *A. dodoneifolius* (116.39 ± 53.74 tufts / ha); *T. ophiodes* (92.65 ± 51.06 tufts / ha); *T. belvisii* (70.24 ± 53.63 tufts / ha.); *P. capitata* (57.74 ± 27.2 tufts / ha) and *T. bangwensis* (51.4 ± 33.24 tufts / ha). *G. braunii* is the least represented parasitic species with an average density of 45.57 ± 19.01 tufts / ha in the Mandara Mountains. The diversity and frequency vary according to the altitude and slope of the Mountains. *T. globiferus* is most common in the Mandara Mountains, followed by *T. dodoneifolius*. These hemiparasites parasitize plants throughout their range in the Mandara Mountains. Knowledge of the diversity and altitudinal distribution of parasitic plants will contribute to their sustainable management in the Mandara Mountains in particular and in the Mountains of the World in general.

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