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Diversity of lichens at Mount Cameroon, South West Region, Cameroon

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Concern about maintaining the biodiversity of lichen communities' species has been an issue with lichenologists for many years. Many of the understudied regions face increasing threats from urban development, pollution, and potentially climate change, among other factors. The objective of this study was to examine the diversity of lichens on Mt. Cameroon. To achieve this objective, eight collection sites were surveyed on two flanks of the mountain at elevations ranging from 3 to 2178 m above sea level. The visual estimate sampling method using circular plots was adopted for the survey. Voucher specimens were collected in triplicate and deposited in the herbaria in Limbe and the University Buea. Lichens were identified by studying the morphology and chemical spot test. The morphology of the thallus and reproductive structures were examined under the stereomicroscope at 10×. The K-test, C-tests and KC-spot test were performed for each specimen with KOH and $Ca(OCl)_2$. The abundance rating scale, species diversity, similarity and richness indices were computed. Identification by molecular, morphological and chemical spot tests produced a total of 89 species, 22 site-specific species, 52 genera belonging to 27 families and 11 orders. Four lichen specimens were identified to genus level and eighty-five to species level. According to the Cameroon lichen database, 82 of these are new discoveries. Parmeliaceae, *Heterodermia, Usnea* and *Dirinaria applanata* dominated the area. The identified species occurred in six growth forms and from nine substrates types. Foliose and corticolous lichens were most represented. Among the sites surveyed, Upper Buea situated on the leeward flank at high altitude >1000 m, recorded the highest diversity and site-specific species.

Key words: Lichens diversity, Mt. Cameroon, Upper Buea Leeward flank.

INTRODUCTION

The lichen mycobiota in several areas of the world especially in the tropics is still under-explored (Feuerer and Hawksworth, 2007). Many of the understudied regions face increasing threats from urban development, pollution, and potentially climate change, among other factors (Bjerke, 2011). Concern about maintaining the biodiversity of lichen communities' species has been an issue with lichenologists for many years (Will-Wolf et al., 2006). This is observed over 100 years ago with effects of air pollution and expanding in the last 50 years to

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include effects of climate change (Ellis, 2019), deforestation, land management, fragmentation of natural habitats and loss of biodiversity. With the loss of sensitive lichen species from Europe and America due to the high rate of deforestation, global climate change and air pollution (Rocha et al., 2019), lichenologists are emphasizing the need to catalogue lichen species before their natural diversity is lost and to create 'protected areas' for their conservation (Jovans, 2008).

Accurate identification of lichen species is crucial to effectively assess biotic diversity, species' response to disturbance in monitoring programs and implementation of effective conservation management strategies in an area (Giordani and Brunialti, 2015**).** An effective monitoring program depends on complete and accurate inventory information about the full extent of the species assemblage within an area (McClenahen et al., 2007). Thus, rapid inventories of lichen taxonomic diversity assessment achieved by morphological, anatomical, chemical, and molecular identification (Lumbsch et al., 2011) are particularly relevant. Nevertheless, while DNA-based molecular identification may be successful in areas where lichens are well studied (Kelly et al., 2011), it is not for underexplored areas like Mt. Cameroon (Orock et al., 2012).

Compared to tropical America and South East Asia, the lichen flora of tropical Africa is insufficiently known and that of western Africa is largely unknown (Feuerer and Hawksworth, 2007). Urgent survey is required in the countries within these regions to obtain data on lichen status with focus on rare and declining species found in the world red- list of lichens. Currently, only 101 lichenized fungal species are listed for the Republic of Cameroon, West Africa (Feuerer, 2011). However, floristic surveys of lichenized fungi in an important ecological area like Mt. Cameroon are lacking. Mount Cameroon area with extensive biodiversity is often threatened by volcanic eruptions and deforestation. This volcano with a return period of 20 years (Suh et al., 2003), has had the most frequent eruptions than any other West African volcano with eight eruptions in the last 100 years (1909, 1922, 1925, 1954, 1959, 1982, 1999, and 2000). Also, human-related activities are fragmenting, degrading, and isolating the remaining forest patches despite conservation efforts. It is therefore necessary to know the different lichen species remaining around Mt. Cameroon after various eruptions and alarming deforestation rates. The objectives of this work are to assemble a checklist of lichens at Mt. Cameroon.

MATERIALS AND METHODS

Study area and sites

Mount Cameroon is located between 4° North and 6° 20' North latitude and 8° 50' East and 10° East longitude in the Southwest region of the Republic of Cameroon, on the coastal belt of the Gulf of Guinea (Figure 1). It covers a land surface area of approximately 24, 900 km^2. It is the highest mountain in Central and West Africa, rising up steeply from sea level to 4100 m at the summit (Suh et al., 2003).

This region of the Republic of Cameroon has an average annual rainfall of 4000 mm which declines inland to 1800 mm. Mean temperatures are around 20°C varying with the effects of elevation. Soils are andosols supporting lowland submontane and montane tropical forests, and a microcosm of tropical plantation agriculture. In White's phytogeographical classification (1983), the area falls within the afromontane eco-region (Ndenecho, 2009). Human-related activities are fragmenting, degrading, and isolating the remaining forest patches despite conservation efforts.

Sampling procedures

This study was carried out in 8 sites, located in ecologically diverse sites of Mt Cameroon, at elevations ranging from 3 to 2178 m above sea level (Figure 1). The study sites and their characteristics are presented in Table 1 and they constitute a general representation of the study area. However, some important habitats remain un-sampled, including sub-alpine and alpine habitats near the mountain summit.

Sampling procedures

The lichen survey consisted of a visual estimate and opportunistic random sampling method described by Jovans (2008) and McClenahen et al. (2007). This sampling method employs the concept of fine focused searches, looking in areas where high diversity is expected. These methods were selected based on their ability to maximize the detection of species diversity. At each sampling point, a circular plot of about 30 m radius with four (04) macro sub circular plots within was created (Figure 2). Each macro subplot was 20 m radius from its centre. In each macro plot, micro plots of 10 m radius from their centre were created. The distance between sub-macro plots centres was 30 m.

Sampling was done from each micro subplot to macro subplots from plot 1 to plot 4 systematically.

A total of 50 plots were sampled with a minimum of 5 plots per site, except for Lower and Upper Buea where 10 plots each were sampled because of their vast surface area. The chosen plots received a numbered identification plate and the precise positions were marked with a Global Positioning System (GPS). Lichens were observed, and measured in the field. Specimens were collected from live and dead tree barks, fallen branches, twigs, rocks and soil substrates in triplicate. Live trees were sampled from the base to about 2.0 m above the ground. For canopy sampling, some small twigs were cut with a secateurs and falling branches and twigs were sampled. A knife was used to remove lichens from the live and dead branches and twigs of trees. A hammer and chisel were used to remove lichens on rocks, while specimens on the soil were collected with the hand. All the substrates were examined using magnifying lenses of (x10) for morphological identification. Pictures of all specimens collected were taken using a NikonD80/D40 professional digital camera and produced in Buea, Cameroon used for identification. The specimens on wet barks were kept in plant press and tied tightly to avoid curling up. Each specimen was placed in a paper envelope and labelled with appropriate tracking and identification information. A number code such as Sp1, Sp2…. for example, was assigned to the specimens. Quantitative evaluation of lichen species was noted using the abundance rating frequency scale by Jovans (2008). Species were

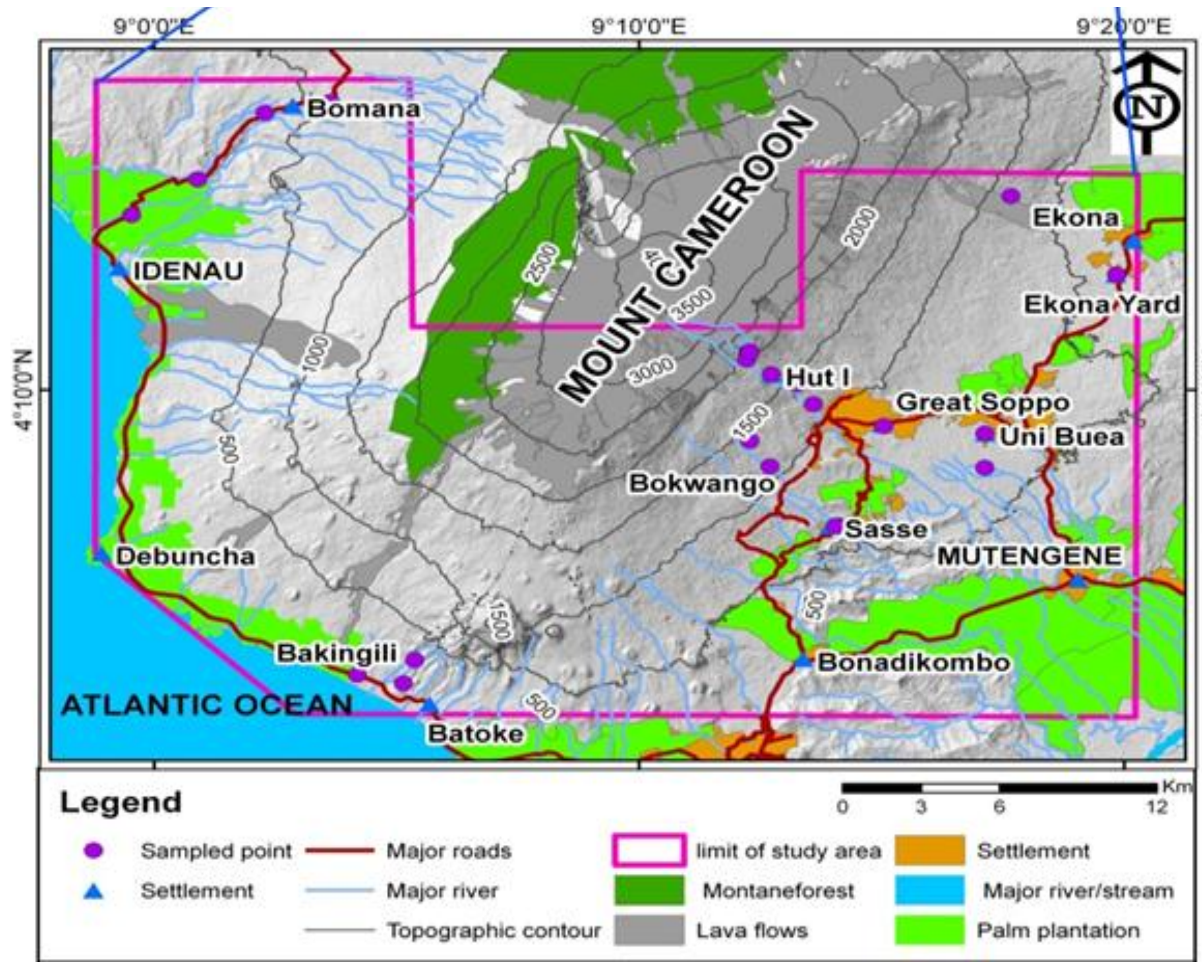

Figure 1. Topographic features of Mt. Cameroon and location of sampling sites mentioned in the text.

Table 1. Characteristics of the sampling sites for Lichens in Mt Cameroon.

Main site	Study sites	Site characteristics					
		Latitude	Longitude	Altitude (M)	Temperature (°C)	Light intensity (Lux)	Relative humidity (%)
Leeward site	Ekona Mbegue	14° 09′ 1″ N	18° 29′ 9″E	504.6±6.1	28.6±0.4	1846.2±4.4	79±1.0
	IRAD Ekona	12° 48′ 8″N	19° 50′ 3″E	416.3±8.1	29.0±0.4	1805.6±4.3	77±2.2
	Upper-Buea	10° 56′ 2″N	12° 16′ 7″E	1830.2±6.1	27.1±0.2	640.5±6.6	89±2.2
	Lower Buea	08 ° 56′ 3″N	17° 07′ 3″E	750.8±7.2	29.7±0.4	1630.6±5.5	89±3.1
Winward site	Batoke	02° 00′ 2″N	05°° 49′ 9″E	156.4±6.7	30.5±1.0	658.8±6.1	83±2.0
	Bakingili	03°17′4″N	03° 40′ 2″E	173±7.8	30.9±0.2	1706.9±5.6	83±1.0
	Idenau	14° 15′ 8″N	59°° 31′ 8″E	124.4±4.3	30.9±0.5	1454.5±4.5	83±3.0
	Bomana	17° 01′ 3″N	03°° 38′ 0″E	507.7±3.4	29.8±0.3	1452.8±5.1	80±3.1

Values of altitude, temperature, light intensity and relative humidity are means of 3 readings± standard deviation.

classified as rare (1 -2 individuals in the sampling unit), uncommon (3-5 individuals in the sampling unit), common (6-10 individuals in sampling unit) and abundant (>10 individuals in sampling unit).

Processing specimens for identification

All the specimens brought from the field were taken to the

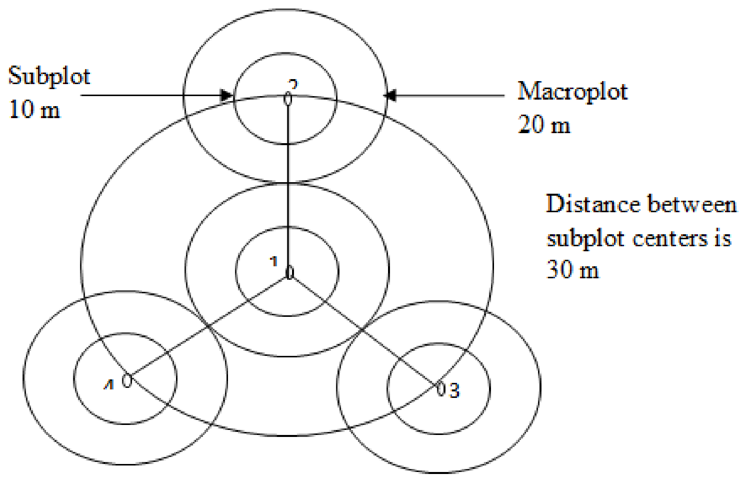

Figure 2. Outline of Lichen sampling technique for each site.

University of Buea Life Sciences Laboratory. The specimens were sorted, curated and prepared for drying. The specimens were dried in an oven at 60°C for 6 h. The dried specimens were then placed inside herbarium bags. Crust-like specimens on rock and wood/bark were glued using acid free herbarium glue. Fragile foliose specimens were placed between folded pieces of cotton padding for extra protection inside the envelope. The specimens were placed in the freezer for four days, to kill any insects, before being stored in the herbarium. Three voucher specimen packets were prepared and one packet each was deposited in the herbarium of the Botany laboratory of the University of Buea Cameroon and the Herbarium of the Limbe Botanic garden Cameroon.

Data analysis

Specimens were identified to generic and species level with the aid of "artificial field keys'' and by extensive matching with correctly identified specimens from herbaria and pictorials from online databases. Microscopic observations of free-hand sections of thallus and fruiting bodies were also made on some of the lichens in order to assess diagnostic characters provided in the keys. Chemical spot tests were carried out to distinguish some species of lichens using freshly prepared calcium hypochlorite, 10% aqueous solution of potassium hydroxide and freshly prepared paraphenylenediamine. Color reactions of the thallus to the above chemicals were observed by applying a small drop to the cortex on the upper surface or to the medulla after scraping off the cortex to expose the medulla. Lichens were preserved in packets by oven drying at 60°C for 6 h. Each specimen was transferred to a new envelope and information such as the name, family, site, altitude, tree species, recorders' names and date of collection were recorded on the envelope.

The morphological and chemical spot test observations were compared to keys of Coppins (2002), Brodo et al. (2001), May et al. (2000), St. Clair (1999), illustrations of St. Clair (1999), Goward et al. (1994), Goward (1999), and manuals of Gilbert (2004) and St. Clair (1999). The identity of each specimen was confirmed at the Herbarium of Nonvascular Cryptogams at Brigham Young University, Utah, USA.

Descriptive statistics were used to analyze the morphological and chemical identification data. Species diversity, richness and similarity were determined using Shannon-Weaver diversity index (H'), Margalef species richness index (D) and the Sørensen coefficient (Ss), respectively. All analyses were done with Microsoft Excel 2007, Inc, US 19.

RESULTS

A total of 89 lichen specimens were identified (Appendix 1). Four of the specimens were identified to genus level and eighty-five to species level. The lichens were identified in 27 families (Figure 3). Of these families, Parmeliaceae with 22 species was most represented followed by Physciaceae with 17 species. Twelve families of the lichen samples identified were represented by only one species each.

The lichens species identified from Mt. Cameroon belong to 52 genera (Figure 4). The genus *Usnea* was the most represented with 07 species followed by *Heterodermia* with 06 species. 31% of the lichen species identified in the study area were rated as common, while 18% were rated as rare (Figure 5).

A total of 22 species cut across sites and altitudes (Table 2). The placodioid species *Dirinaria applanata* with 36 individiuals was the most represented followed by the crustose species *Graphis scripta* with 24 individuals. *Leptogium gelatinosum* and *Heterodermia obscurata* were the most represented foliose species, while the species *Caloplaca citrina* had the least individuals 10.

The highest lichen diversity (4.70) by Shannon-Weaver index was recorded from Upper Buea in the Leeward Flank and the lowest (2.41) from Idenau in the Windward Flank (Table 3).

Lichen species richness by Margalef index was highest on the leeward flank from Upper Buea with 29.7% and

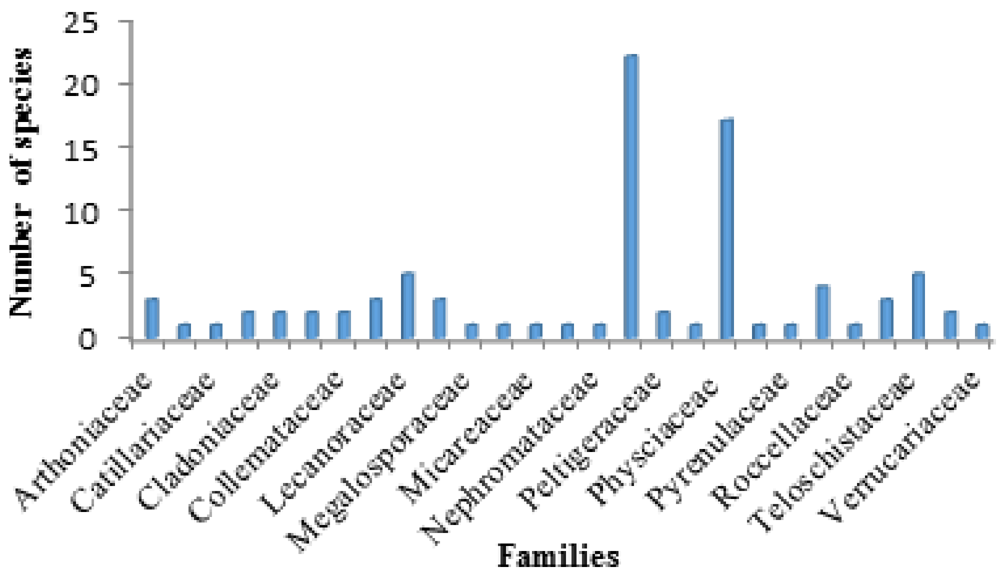

Figure 3. Abundance of lichen families on Mt. Cameroon.

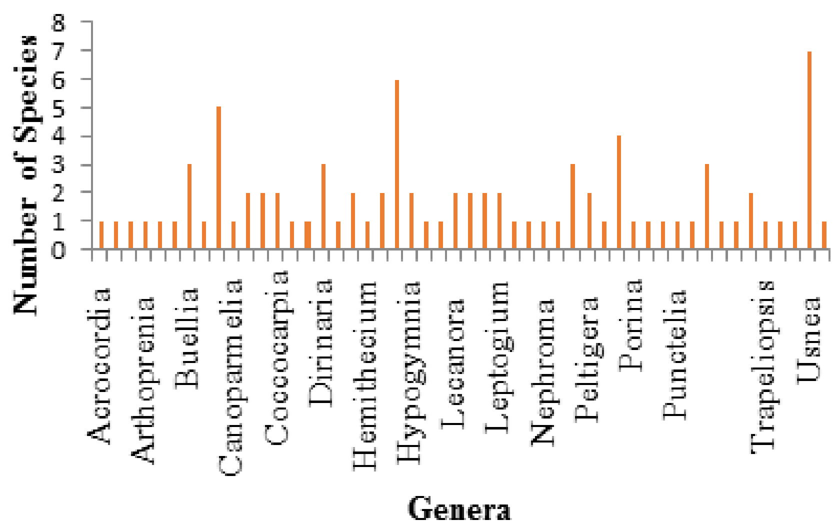

Figure 4. Abundance of lichen genera identified on Mt. Cameroon.

lowest on the windward flank with 8.3% from Idenau (Table 4).

From the Sørensen's coefficient of lichen species similarity, Batoke and Idenau on the windward flank show about 20% species similarity than any other sampling site in the study area (Table 5).

Distribution of lichen growth forms on Mt. Cameroon

Lichens from this study belong to six growth forms (crustose, foliose, fruticose, leprose, placodioid and squamulose). Foliose was the most represented with 35 species identified, while squamulose with 02 species was the least represented (Figure 6).

Distribution of lichen growth forms

Crustose, Leprose and Placodioid growth forms cut across all the sampling sites while fruticose growth forms were found at three sites (Ekona Mbenge, Lower and Upper Buea) (Figure 7).

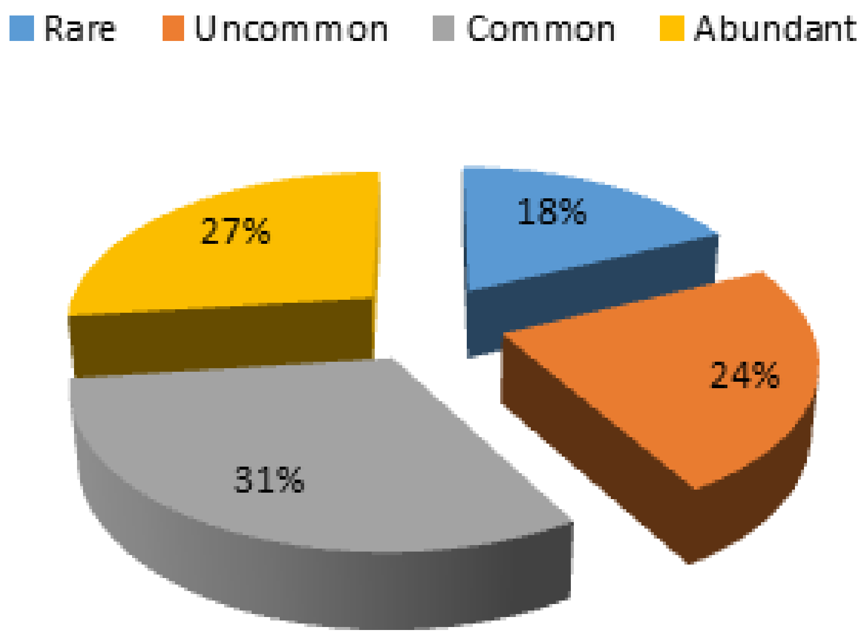

Figure 5. Abundance rating of lichen species identified on Mt. Cameroon.

Table 2. Lichen species identified that cut accross all sites, slopes and altitudes on Mt. Cameroon.

Species	Growth form	Individuals
Arthonia punctiformis	C	15
Aspicilia calcarea	C	14
Caloplaca citrina.	C	10
Caloplaca crenularia	C	16
Caloplaca microthallina	C	16
Catillaria nigroclavata	C	22
Cresponea permnea	C	17
Graphis elegans	C	16
Graphis scripta	C	24
Hemithecium rufopallidum	C	13
Lecidella elaeochroma	C	14
Porina heterospora	C	17
Pyrenula ochraceoflava	C	13
Thelotrema lepadinum	C	13
Heterodermia obscurata	Fo	17
Leptogium gelatinosum	Fo	19
Chrysothrix candelaris	Lep	16
Chrysothrix chlorina	Lep	17
Lepraria ecorticata	Lep	17
Lepraria obtusatica	Lep	13
Psilolechia lucida	Lep	21
Dirinaria applanata	Pla	36

C = Crustose; Fo = Foliose; Lep = Leprose and Pla = Placodioid.

Table 3. Shannon -Weaver Indices of lichen diversity at various sampling sites of Mt. Cameroon.

Main sites	Sub site	Shannon-Weaver index
Leeward	IRAD Ekona	2.82
	Ekona Mbenge	4.30
	Lower Buea	4.17
	Upper Buea	4.70
Windward	Batoke	3.49
	Bakingili	3.45
	Idenau	2.41
	Bomana	3.62

Table 4. Margalef Indices of lichen species richness at various sampling sites of Mt. Cameroon.

Main sites	Sub site	Richness index (%)
Leeward	IRAD Ekona	13.8
	Ekona Mbenge	17.5
	Lower Buea	23.7
	Upper Buea	29.7
Windward	Batoke	11.8
	Bakingili	12.3
	Idenau	8.3
	Bomana	13.0

Table 5. Sørensen's coefficient of lichen species similarity in various sampling sites of Mt. Cameroon.

Slope	Sites	IRAD Ekona	Ekona Mbenge	Lower Buea	Upper Buea	Batoke	Bakingili	Idenau	Bomana
Leeward	IRAD Ekona	1							
	Ekona Mbenge	0.39	1						
	Lower Buea	0.36	0.40	1					
	Upper Buea	0.45	0.35	0.34	1				
Windward	Batoke	0.47	0.49	0.39	0.34	1			
	Bakingili	0.46	0.48	0.38	0.33	0.57	1		
	Idenau	0.50	0.45	0.41	0.35	0.62	0.54	1	
	Bomana	0.46	0.45	0.46	0.38	0.56	0.55	0.60	1

Distribution of growth forms in different flanks

Out of the six growth forms identified in the study, no fruticose types were identified from the windward flank (Figure 8).

Crustose and foliose forms dominate all the different altitudes whereas no fruticose lichen was identified in the low altitude (Figure 9).

Distribution of lichen substrates

Lichens were identified from nine substrate types (Figure 10). Most species were corticolous lichens, while

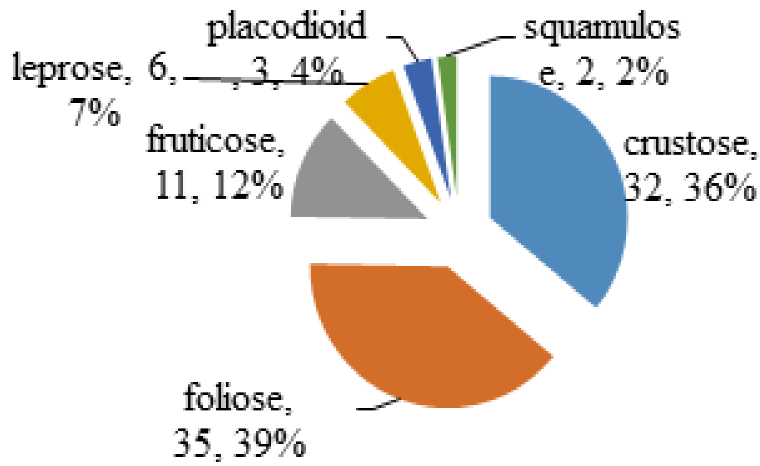

Figure 6. Distribution of lichen growth forms identified on Mt. Cameroon.

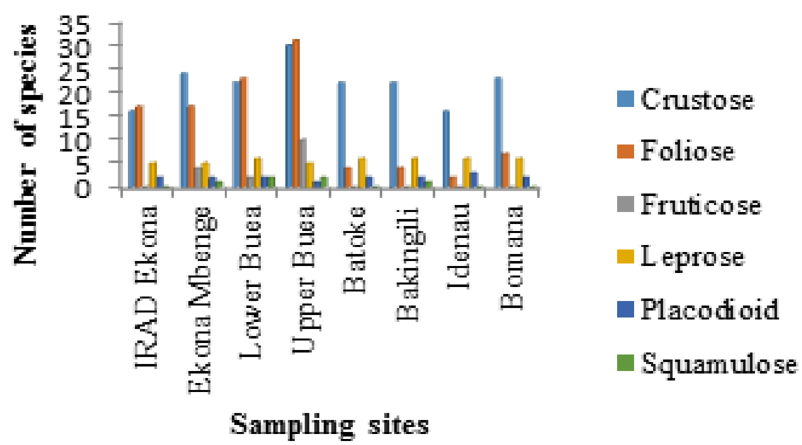

Figure 7. Distribution of lichen growth forms identified at different sampling sites on Mt. Cameroon.

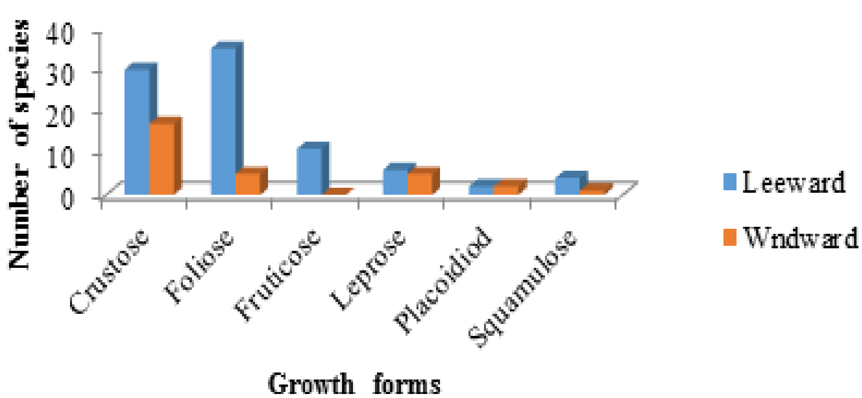

Figure 8. Distribution of lichen growth forms on different sampling flanks on Mt. Cameroon.

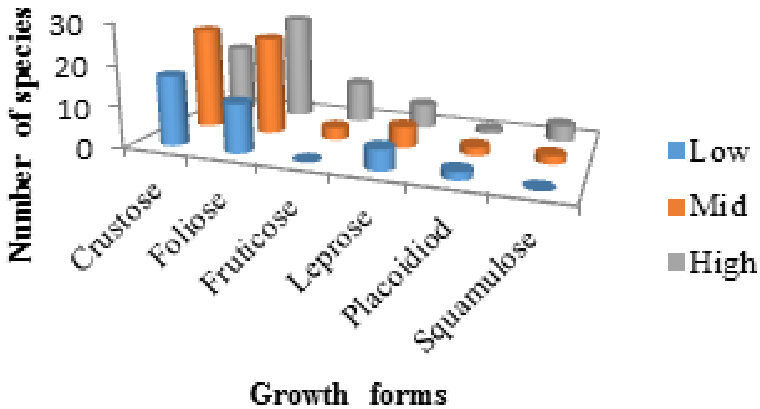

Figure 9. Distribution of lichen growth forms along different altitudinal ranges on Mt. Cameroon.

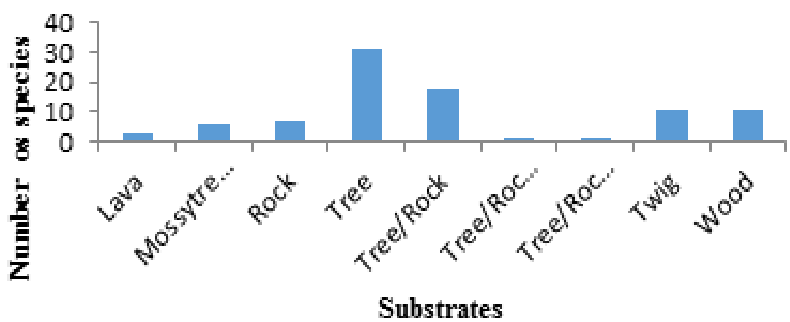

Figure 10. Distribution of lichen substrates on Mt. Cameroon.

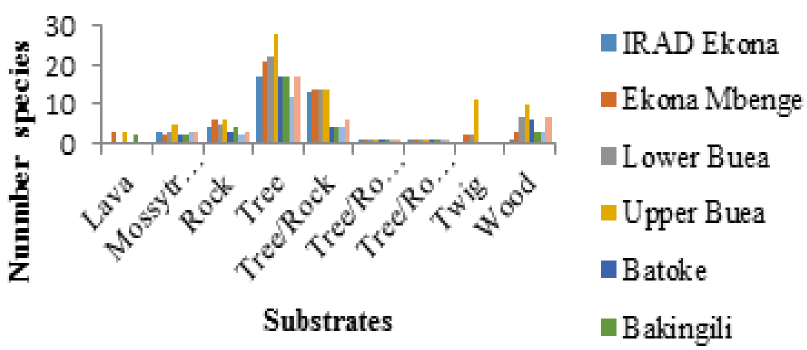

Figure 11. Distribution of lichen substrates at the different sampling sites on Mt. Cameroon.

tree/rock/soil and tree/rock/wood species were the least represented.

All the sampling sites were represented by corticolous, mossy tree/rock, tree/rock/soil and tree/rock/wood lichens (Figure 11). Ramicolous (twig) lichens were found only in Ekona Mbenge, Lower and Upper Buea.

Of the different lichen substrates, the leeward flank had all the ramicolous lichens and none was recorded at the

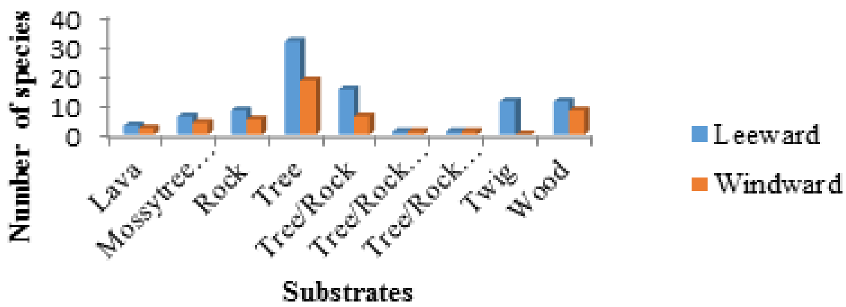

Figure 12. Distribution of lichen substrates at the different sampling flanks of Mt. Cameroon.

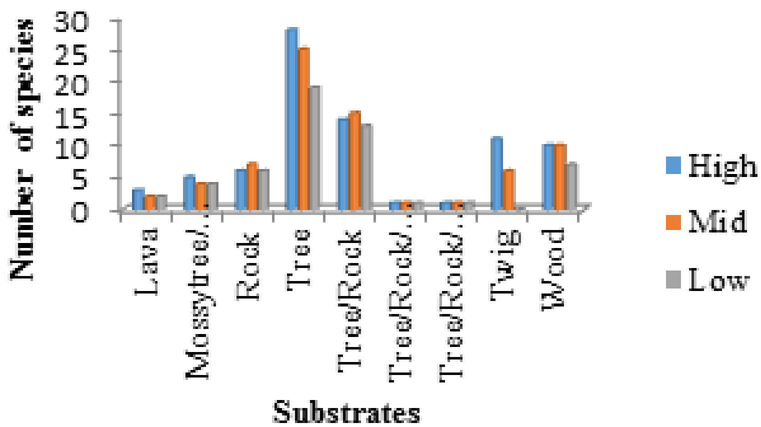

Figure 13. Distribution of lichen substrates at the different sampling altitudes on Mt. Cameroon.

windward flank (Figure 12).

Distribution of substrates along different altitudes

Eight of the nine different substrates were represented in the three altitudes (Figure 13). Ramicolous lichens were absent in the low altitude.

Distribution map of site-specific lichen species of Mt. Cameroon

Of the 89 lichen species identified from Mt. Cameroon, 22 were site-specific (Figure 14). 17 of these species were restricted to Upper Buea, 2 to Ekona Mbenge and one each to Great Soppo in lower Buea, Bakingili and Idenau.

According to this inventory, out of the 89 lichen species identified, 07 were common with that of Feuerer (2011), while 82 were not found and are therefore added as new species records for Cameroon (Table 6).

DISCUSSION

Among the sites surveyed at Mt Cameroon, Upper Buea situated on the leeward flank at high altitude >1000 m, recorded the highest diversity, similar to studies on Mt. Uludag (Öztürk and Güvenç, 2010) with maximum diversities recorded at 1400 m and poor below 600 m. The highest lichen diversity and richness on Mt, Cameroon from the mid-high altitude (>500 m Lower Buea, Ekona Mbenge Bomana and Upper Buea) and lowest diversity at low altitude (<200 m IRAD Ekona, Batoke, Bakingili and Idenau) may be attributed to a number of factors influencing the abundance and richness of lichens such as altitude, humidity temperature, forest type and land use changes from human activities (Sevgi et al., 2019). Notably, Shyam et al. (2010) reported altitude as one of the main factor

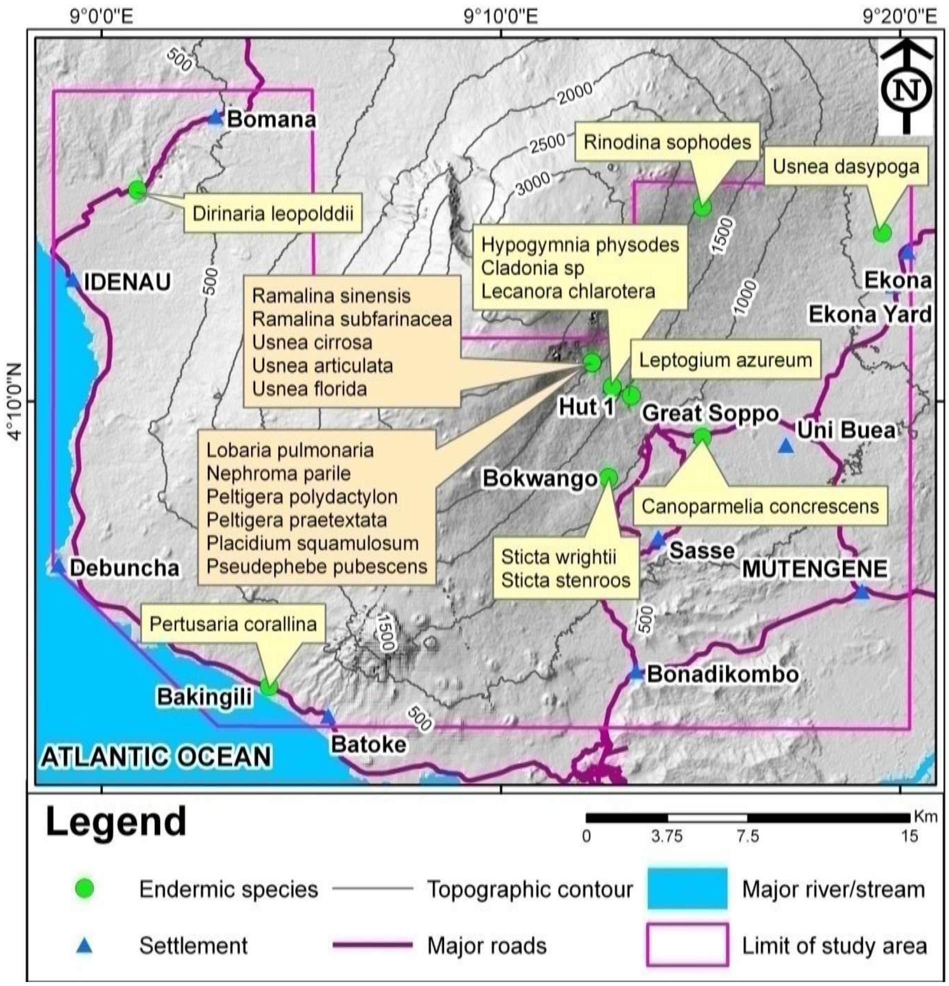

Figure 14. Identified site-specific lichen species and their collection points on Mt. Cameroon.

controlling the diversity and distribution of epiphytic lichens in Kollihills. Furthermore, Bassler et al. (2016) and Chitra et al. (2009), found decrease in lichen diversity along increasing altitude and their preference of corticolous habitat can be attributed to the abiotic factors such as humidity, light, temperature and substrate. All the sampling sites above 500 m in this study with high diversities, recorded higher humidity levels (>80 mm) than the sites below this elevation with lower humidity levels (<80 mm). Matteucci et al. (2012) in their studies observed that one of the most lichen-rich forest types with maximum species diversity and abundance are humid and cooler montane forest located in the cloud zones like the Upper Buea and Ekona Mbenge sampling sites. Most researchers (Nascimbene et al., 2010) have shown that, the composition of lichen communities depends on factors that operate at multiple spatial and temporal scales. At the local scale, lichen composition is mainly related to microclimatic and substrate factors associated with forest structure and continuity, while at broader scales climate and dispersal limitations are further important drivers.

The richness of species, growth forms and substrate types in this sites may be attributed to the well-developed preferences for habitats and microhabitats by lichens which are influenced by small differences in chemical (mineral contents) and physical factors (light, temperature, humidity, wind, altitude and unpolluted air, substrate) playing an important role in shaping lichen species richness patterns. A relationship between the concentration of certain lichen secondary compounds and the degree of exposure to environmental variables such as light, moisture, altitude, climate change and pollution have demonstrated (Brodo et al., 2001). A lichen's ability to protect itself from high levels of visible light and ultraviolet radiation is determined by the production of secondary compounds which influenced the habitats it is able to occupy (Hess et al., 2008;

Table 6. Checklist of lichen species in Cameroon as of 2012.

Family	Species	Feuerer's collection	Present study
Arthoniaceae	*Arthonia punctiformis*	-	+
	Herpothallon spp.	-	+
	Herpothallon rubrocinctum	-	+
Aspidotheliaceae	*Aspidothelium fugiens*	-	+
Catillariaceae	*Catillaria nigroclavata*	-	+
	Catillaria bouteillei	+	-
Chrysotrichaceae	*Chrysothrix candelaris*	-	+
	Chrysothrix chlorine	-	+
Cladoniaceae	*Cladonia convoluta*	-	+
	Cladonia spp.	-	+
	Cladonia diplotypa	+	-
	Cladonia fimbriata	+	-
Coccocarpiaceae	*Coccocarpia erythroxyli*	+	+
	Coccocarpia *pellita*	-	+
Coenogoniaceae	*Dimerella epiphylla*	+	-
Collemataceae	*Leptogium* aff.*azureum*	-	+
	Leptogium gelatinosum	-	+
	Leptogium burgessii	+	-
	Leptogium inflexum	+	-
	Collema nigrescens	+	-
Ectolechiaceae	*Lopadium fuscum*	+	-
	Lopadium phyllogenum	+	-
	Lopadium puiggarii	+	-
	Tapellaria epiphylla	+	-
	Tapellaria phyllophila	+	-
Gomphillaceae	*Aulaxina epiphylla*	+	-
	Aulaxina opegraphina	+	-
	Calenia depressa	+	-
	Calenia graphidea	+	-
	Echinoplaca epiphylla	+	-
	Echinoplaca pellicula	+	-
	Gyalectidium filicinum	+	-
	Tricharia albostrigosa	+	-
	Tricharia vainioi	+	-
Graphidaceae	*Graphis elegans*	-	+
	Graphis scripta	-	+
	Hemithecium rufopallidum	-	+
Lecanoraceae	*Bacidia inundata*	-	+

Table 6. Contd.

	Bacidia apiahica	+	-
	Bacidia pallidocarnea	+	–
	Bacidia rhapidophylli	+	–
	Bacidia stanhopeae	+	–
	Bacidia sublecanorina	+	-
	Lecanora cenisia	-	+
	Lecanora chlarotera	-	+
	Lecidella euphorea	-	+
	Lecidella elaeochroma f.elaeochroma	-	+
	Lecanora subfusca	+	-
Bacidiaceae	*Japewiella tavaresiana*	-	+
	Lobaria pulmonaria	-	+
	Lobaria quercizans	+	-
Lobariaceae	*Sticta fuliginosa*	+	-
	Sticta sp. Stenroos	-	+
	Sticta wrightii	-	+
Megalosporaceae	*Megalospora tuberculosa*	-	+
Megasporaceae	*Aspicilia calcarea*	-	+
Micareaceae	*Psilolechia lucida*	-	+
Monoblastiaceae	*Acrocordia conoidea*	-	+
Nephromataceae	*Nephroma parile*	-	+
Pannariaceae	*Microtheliopsis uleana*	+	-
	Arctoparmelia centrifuga	-	+
	Bulbothrix tabacina	-	+
	Bulbothrix meizospora	+	-
	Canoparmelia concrescens	-	+
	Flavoparmelia caperata	-	+
	Hypogymnia austeroides	-	+
	Hypogymnia physodes	-	+
	Hypotrachyna/(Parmelia) revoluta	+	+
	Parmelinella aff.Wallichiana	-	+
	Parmelia megaleia	+	-
	Parmeliella mariana	+	-
Parmeliaceae	*Parmeliella stylophora*	+	-
	Parmotrema perlatum	-	+
	Parmotrema stuppeum	-	+
	Parmotrema subrugatum	+	-
	Parmotrema tinctorum	-	+
	Pseudoparmelia sphaerospora	+	-
	Pseudephebe pubescens	-	+
	Punctelia subrudecta	-	+
	Remototrachyna spp.	-	+
	Tuckermannopsis platyphylla	-	+
	Usnea africana	+	-
	Usnea articulata	-	+
	Usnea baileyi	-	+

Table 6. Contd.

	Usnea bornmuelleri	+	-
	Usnea ceratina	+	-
	Usnea cirrosa	-	+
	Usnea dasypoga	-	+
	Usnea firmula	+	-
	Usnea florida	+	+
	Usnea hirta	-	+
	Usnea hispida	+	-
	Usnea implicata	+	-
	Usnea meyeri	+	-
	Usnea pulvinata	+	-
	Usnea pseudocyphellata	+	-
	Usnea submollis	+	-
	Xanthoparmelia plittii	-	+
Peltigeraceae	*Peltigera polydactylon*	+	+
	Peltigera praetextata	-	+
	Peltigera polydactyloides	+	-
	Peltigera rufescens	+	-
Pertusariaceae	*Pertusaria coralline*	-	+
Physciaceae	*Buellia frigida*	-	+
	Buellia stillingiana	-	+
	Buellia disciformis	-	+
	Dirinaria applanata	-	+
	Dirinaria aspera	-	+
	Dirinaria leopoldii	-	+
	Heterodermia boryi	-	+
	Heterodermia diademata	-	+
	Heterodermia flabellata	-	+
	Heterodermia japonica	-	+
	Heterodermia obscurata	-	+
	Heterodermia propagulifera	-	+
	Heterodermia squamulosa	-	+
	Heterodermia speciosa	+	-
	Physcia aipolia	-	+
	Physcia atrostriata	-	+
	Physcia biziana	-	+
	Physcia caesia	-	+
	Physcia dilatata	+	-
	Physcia speciosa var. *dactylifera*	+	-
	Physcia speciosa var. *hypoleuca*	+	-
	Pyxine berteriana	+	+
	Rinodina sophodes	-	+
Pilocarpaceae	*Byssolecania deplanata*	+	-
	Byssolecaniafumosonigricans	+	-
	Byssoloma leucoblepharum	+	-
	Byssoloma rotuliforme	+	-

Table 6. Contd.

	Sporopodium leprieurii	+	-
Porinaceae	*Porina heterospora*	-	+
	Porina epiphylla	+	-
	Porina epiphylla	+	-
	Porina follmanniana	+	-
	Porina imitatrix	+	-
	Porina limbulata	+	-
	Porina kamerunensis	+	-
	Porina mirabilis	+	-
	Porina nitidula	+	-
	Porina obducta	+	-
	Porina pallescens	+	-
	Porina radiata	+	-
	Porina semecarpi	+	-
	Porina sphaerocephala	+	-
	Porina tetramera	+	-
	Porina trichothelioides	+	-
	Trichothelium alboatrum	+	-
	Trichothelium annulatum	+	-
Pyrenulaceae	*Pyrenula* aff.*ochraceoflava*	-	+
	Melanotheca cameroonensis	+	-
Ramalinaceae	*Ramalina fastigiata*	-	+
	Ramalina sinensis	-	+
	Ramalina subfarinacea	-	+
	Ramalina scopulorum	+	-
Roccellaceae	*Cresponea permnea*	-	+
	Mazosia melanophthalma	+	-
	Mazosia paupercula	+	-
	Mazosia phyllosema	+	-
	Opegrapha puiggarii	+	-
Stereocaulaceae	*Lepraria ecorticata*	-	+
	Lepraria obtusatica	-	+
	Stereocaulon denudatum	+	-
	Stereocaulon turgescens	+	+
Strigulaceae	*Strigula elegans*	+	-
	Strigula elegans	+	-
	Strigula nemathora	+	-
	Strigula nitidula	+	-
	Strigula subtilissima	+	-
Teloschistaceae	*Caloplaca citrina*	-	+
	Caloplaca crenularia	-	+
	Caloplaca ferruginea	-	+
	Caloplaca fraudans	-	+

Table 6. Contd.

	Caloplaca microthallina	-	+
Thelotremataceae	*Chroodiscus mirificus*	+	-
	Diploschistes scruposus	+	+
	Thelotrema cameroonensis	+	-
	Thelotrema lepadinum	-	+
	Tremotylium africanum	+	-
Trypetheliaceae	*Asterothyrium pittieri*	+	-
Trapeliaceae	*Trapeliopsis flexuosa*	-	+
Verrucariaceae	*Placidium squamulosum*	-	+
	Phylloblastia dolichospora	+	-
	Phyllophiale alba	+	-

+ Present in a reference; -Abscent in a reference.

Paolo, 2019). Also, as lichens possess a wide range of optima with regards to light, moisture, temperature, substrate quality and stability, and nutrient inputs, various life-history traits (biomolecules accumulation from different photobiont in association) are expected to modify the lichen response to various environmental factor and land use (Aptroot and van Herk, 2007; Chuquimarca et al., 2019).

The abundant families (Physciaceae and Parmeliaceae) in this study correspond to the studies of Divakar et al. (2010), who found these as the most common families in tropical regions, particularly abundant in humid climates at mid-high elevations. The family Physciaceae with 17 species, harbours thermophilic lichens like H. obscurata and Physcia americana (Moberg, 2004) which response to distributional changes are attributed to global warming (Hickling et al., 2005) and are among the most common and particularly abundant in humid climates at low and mid elevations (Ellis and Coppins, 2017).

The most represented genus Usnea with 07 different species in tree canopies at high elevations is similar to study performed in West Greenland (Bjerke and Dahl, 2002) which showed that, lichen species with high concentrations of usnic acid inhabit more light-exposed areas than species with lower levels of this compound. Presumably, this may be the reason for the highest diversity and richness of canopy ramicolous fruticose and foliose usnic acid producing species at Upper Buea and Ekona Mbenge sampling sites. Most of these species and others were positive red and yellow with spot test than the species of the low altitude. This is findings are consistent with a survey of lichen distribution in Thailand by Wolseley and Aguirre-Hudson (1997) who found that, lichen which showed red and yellow colours with spot test were found at high-altitude montane oak forest and lacking in low-altitude tropical mixed deciduous forest. They reported that, lichen communities must experience a threshold level of light intensity before it becomes adaptive to begin producing expensive secondary compounds for protection from intense irradiance. This adaptation may be attributed to the absence of usnic acid producing species in the low altitude sampling sites of this work. Although these lower altitude sampling sites recorded higher mean light intensities (1706.9±5.6 lux) than high altitude (640.5±6.6 lux), the lichen species may not have experienced the threshold to produce irradiance-protecting substances because of land use changes.

At Mt. Cameroon, macro lichens (foliose, fruticose and squamulose) growth forms recorded highest diversities in the mid and high altitudes, while micro lichens (crustose, leprose and placodioid) growth forms were highest in the low altitude sites might have been influenced by land use activities. According to Ahti (2000), lichens show preferences to either sexual or asexual reproductive methods due to differences in morphological tolerance to trampling. For example, macro-lichens are more susceptible to trampling and so rarely reproduce sexually, while micro-lichens are more tolerant to trampling therefore reproduce both sexually and asexually. Therefore, foliose growth forms with the most representative probably relates to the fact that the presence of foliose lichens is independent of landscape condition and relies on a small amount of fragmentation to disperse to new sites (Cáceres et al., 2007). Managed forests like those in the low altitude (Batoke, Bakingili, Idenau and Ekona IRAD) are normally young and fragmented for wood fuel, timber and plantation agriculture in which young tree stems are repeatedly cut down to near ground level with short rotation cycles (Kaufmann et al., 2017). Management activities such as forestry (Aragon et al., 2010) agriculture (Styres et al., 2010) livestock grazing and quarrying (Boudreault et al., 2008) have been recognized as the most important driving forces for lichen species richness and composition. Habitat fragmentation (Kubiak et al., 2016) has led to the isolation of many lichen communities by creating limitations and hampering their dispersal and reproduction (Lorenzo et al., 2011). The generation time, from spore to spore determined in some lichens takes so many years (Ranius et al., 2008). Red-list species *Cliostomum corrugatum* and *Lobaria pulmonaria* for example, have reach an average age of 30 and 35 years respectively before they are able to produce and disperse their spores (Edman et al., 2008).

Mature forests like Upper Buea sampling site with high conservation value are forest where regeneration is usually of seedling origin, either natural or artificial (or a combination of both) and the rotation cycles are generally long to harbour red-list threaten species (Hofmeister et al., 2015). Owing to the evidence of their low dispersal ability and long generation the red-list has been widely used as an indicator species of undisturbed forest ecosystems and forest areas of a high ecological continuity and conservation (Nascimbene et al., 2014; Vondrak et al., 2015). This dispersal limitation may be one of the reasons for more (17) site-specific species including *L. pulmonaria* at Upper Buea in the high. Furthermore, the IUCN (2000) red-list criteria emphasizes the conservation of lichen species in areas were rating is not abundant, like case with Mt. Cameroon where rating is mostly common (31%).

Most lichens occurring in Mt. Cameroon are corticolous (tree) species with the highest diversity of perennial substrates in Upper Buea sampling site. Ioana (2011) revealed some lichens, especially the endangered red-listed species are restricted to specific perennial substrates and habitats in montane regions. The vegetation in Upper Buea still covers relatively large and continuous areas with perennial substrates for colonisation and stability of the genera *Lobaria, Nephroma*, *Ramalina, Cladonia* and *Usea*. These red-list species are found on branches and twigs with dense canopies of mature trees with rough barks. According to Ellis and Coppins (2007), these lichens have some degree of substrate specificity and stability of the habitats over a long period giving an impact of lichen status. Therefore, the probable reason for the high diversity of quality perennial substrates in Upper Buea site may be attributed to forest maturity and reduced human activity unlike IRAD Ekona, Batoke, and Idenau which are highly disturbed by land use changes from anthropogenic activities like agriculture. Since many species are restricted to specific microclimatic pockets, any change in the original structure of the forest will decrease species diversity (Benıtez et al., 2018).

Deforestation of old forest for instance leads to the removal of decaying logs and stumps and conversion to secondary forest with different substrate quality in the low altitude resulting in a decrease in species diversity like the case of this study. Pinho et al. (2008) reported that the nature of the substrate (tree age, size and bark nature, that is, rough or smooth) has considerable influence on the diversity and abundance of lichen species. This may be reflected by smooth bark *Graphis scripta, Arthonia punctiformis, Lecidella elaeochroma* species for example, recorded in the young tree with smooth barks found in the lower altitude sampling sites.

The Mt. Cameroon windward flank (Batoke, Bakingili, Idenau and Bomana) of this study, recorded fewer lichen species than the leeward flank (Upper and lower Buea, IRAD and Ekona Mbenge) which can be attributed to air quality. Bjerke (2011) reported that wind often favours lichen growth, distribution and abundance positively if the wind circulation is nutrient-rich or negatively if the wind circulation is pollutant-rich (Paolo, 2019). This may be the effect of the poor lichen diversity and richness in the windward flank because, studies by Suh et al. (2008) reveal the dominant prevailing winds direction of Mt. Cameroon is from the NE-SW direction, which tends to drive volcanic ash plumes and degassing over the south-western (windward) flank. Upper Buea sampling site situated in the leeward flank recorded all the fruticose air quality sensitive species and none of this species was recorded in any of the sampling sites in the windward flank. Perlmutter (2010) recognised air quality as one of the main factors influencing development of lichen species. They found that shrubby lichens (fruticose) thrive in clean air while only crusty lichen thrives in polluted air. Using the Rose and Harkworth (1970) scale documented in Brodo et al. (2001), the assemblage of lichen species in Upper Buea in the high altitude has the best air quality. This was indicated by the occurrence of all the fruticose and foliose lichen species in the genera (*Lobaria, Nephroma*, *Ramalina, Cladonia, Usea* and *Flavoparmelia*) associated with good air quality.

Feuerer (2011), listed only 101 lichenized fungal for the Republic of Cameroon, but according to these findings, out of the 89 lichen species identified, 82 species were not found on Feuerer list, therefore are added as new species records for Cameroon lichen check list. According to Feuerer and Hawksworth (2007), the lichen mycobiota in most regions, especially in the tropics, is still largely unknown and surveys will always reveal new species. The numerous new species in Cameroon indicates that Mt. Cameroon lichens are still unexplored, and new inventories are required to understand the potential of its diversity. This research generates new data on lichen of MC and contributes to a better understanding of the existing lichen flora.

Conclusion

Despite harbouring rich lichen diversity, the Mt. Cameroon region in particular and Cameroon in general is grossly under explored. Mt Cameroon has a thick moist forest vegetation which provide a suitable habitat for the colonization of different lichen species on different substrates. The high altitudes and the Leeward sites show less anthropogenic pressure and less habitat alteration. It is no surprise that the habitats with the highest lichen species diversity are the remnants of ancient forests and undisturbed ecosystems like Upper Buea sampling site.

Current study reveals region-specific distribution of lichens, which is very different in the sampling sites of Mt. Cameroon region. This disparity can be primarily attributed to the different climatic factors and anthropogenic pressures in the form of land use patterns influencing the lichen communities of the area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendix 1. Diversity of lichens in Mt Cameroon.

Species	Family	Order	Substrate	Growth form	Sites 1	2	3	4	5	6	7	8
Acrocordia conoidea (Fr.) Körb	Monoblastiaceae	Pyrenulales	Wood	C	-	-	+	+	+	-	-	-
Arctoparmelia centrifuga (L.)Hale.	Parmeliaceae	Lecanorales	Rock	Fo	-	-	+	+	-	-	-	+
Arthonia punctiformis Ach.	Arthoniaceae	Arthoniales	Tree	C	-	+	+	-	-	-	-	-
Arthoprenia nitescen (Salwey) Mudd	Arthopyreniaceae	Incertae sedis	Tree	C	-	-	+	-	-	-	-	-
Aspicilia calcarea (L.)Mudd,Man.	Megasporaceae	Pertusariales	Rock	C	+	-	+	-	-	+	-	-
Bacidia inundata (Fr.) Körb	Ramalinaceae	Lecanorales	Tree	C	-	-	-	+	+	+	+	+
Buellia disciformis (Fr.)Mudd Man.	Physciaceae	Lecanorales	Wood	C	+	-	+	-	-	-	-	+
Buellia frigida Darb	Physciaceae	Lecanorales	Tree	C	+	+	+	+	+	+	-	+
Buellia stillingiana J.Steiner	Physciaceae	Lecanorales	Tree	C	+	+	+	+	+	+	-	+
Bulbothrix tabacina (Mont. & Bosch) Hale	Parmeliaceae	Lecanorales	Tree	Fo	+	+	+	+	-	-	-	-
Caloplaca citrine (Hoffm.)Th.Fr.	Teloschistaceae	Teloschistales	Tree/wall	C	+	+	+	+	+	+	-	-
Caloplaca crenularia (With.) J.R. Laundon	Teloschistaceae	Teloschistales	Tree	C	-	+	-	-	-	-	-	-
Caloplaca ferruginea (Huds.) Th. Fr.	Teloschistaceae	Teloschistales	Wood	C	-	-	+	+	-	-	-	-
Caloplaca fraudans (Th.Fr.)H.Olivier	Teloschistaceae	Teloschistales	Tree	C	-	-	-	+	-	-	-	-
Caloplaca ignea Arup	Teloschistaceae	Teloschistales	Rock	C	+	-	+	+	+	+	-	-
Caloplaca microthallina (Wedd.) Zahlbr.	Teloschistaceae	Teloschistales	Wood	C	-	-	-	-	+	-	-	-
Canoparmelia concrescens (Vain.) Elix & Hale	Parmeliaceae	Lecanorales	Tree	Fo	-	-	+	-	-	-	-	-
Chrysothrix candelaris (L)J.R.Laundon	Chrysotrichaceae	Arthoniales	Tree	Lep	+	+	+	+	+	+	+	+
Chrysothrix chlorina (Ach.) J.R.Laundon	Chrysotrichaceae	Arthoniales	Tree/wood/rock	Lep	+	+	+	+	+	+	+	+
*Cladonia convoluta (*L.) Hoffm. Duke	Cladoniaceae	Lecanorales	Lava	Dim	-	+	-	+	-	+	-	-
Cladonia sp	Cladoniaceae	Lecanorales	Rock	Fr	-	-	-	+	-	-	-	-
Coccocarpia erythroxyli Pers	Coccocarpiaceae	Peltigerales	Mossy tree	Squ	-	-	-	+	-	-	-	+
Coccocarpia pellita (Ach.) Müll. Arg.	Coccocarpiaceae	Peltigerales	Lava	Squ	-	+	-	+	-	-	-	-
Cocotrema maritimum Müll Arg.	Cocotremataceae	Pertusariales	Lava	Lep	-	+	-	+	-	+	-	-
Cresponea permnea (Nyl.)Egea &Torrente.	Roccellaceae	Arthoniales	Tree	C	-	-	+	-	-	-	-	-
Dirinaria applanata (Fee)D.D.Awasthi	Physciaceae	Lecanorales	Tree/rock	Pla	+	+	+	+	+	+	+	+
Dirinaria aspera (H. Magn.) D.D. Awasthi	Physciaceae	Lecanorales	Tree	Pla	-	-	+	-	-	-	-	-
Dirinaria leopoldii (Stein) D.D. Awasthi	Physciaceae	Lecanorales	Mossy tree	Pla	-	-	-	-	-	-	+	-
Flavoparmelia caperata (L)Hale.	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	-
Graphis elegans (Borrer ex Sm.) Ach.	Graphidaceae	Ostropales	Tree	C	-	-	+	-	-	-	-	-
Graphis scripta (L.)Ach	Graphidaceae	Ostropales	Tree	C	-	-	+	-	-	-	-	-
Graphis sp	Graphidaceae	Ostropales	Tree	C	+	+	+	-	+	+	-	+
Herpothallon rubrocinctum (Ehrenb.: Fr.) Aptroot, Lücking & G. Thor	Arthoniaceae	Arthoniales	Wood	C	-	-	+	+	+	+	+	+

Appendix 1. Contd.

Herpothallon sp	Arthoniaceae	Arthoniales	Wood	C	-	-	+	+	+	-	-	+
Heterodermia boryi (Fée) K.P. Singh & S.R. Singh	Physciaceae	Lecanorales	Twig	Fo	-	-	-	+	-	-	-	-
Heterodermia diademata (Taylor.)D.D.Awasthi.	Physciaceae	Lecanorales	Twig	Fo	-	-	+	+	-	-	-	-
Heterodermia flabellata (Fee.)D.D.Awasthi.	Physciaceae	Lecanorales	Tree	Fo	-	-	+	+	-	-	-	-
Heterodermia japonica (Sato)Swinscow&Krog	Physciaceae	Lecanorales	Mossy tree/rock	Fo	+	-	+	+	-	+	-	+
Heterodermia obscurata (Nyl.)Trevis, Nuovo Giorn.	Physciaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	+
Heterodermia propagulifera (Vain.)J.P. Dey.	Physciaceae	Lecanorales	Mossy tree	Fo	-	-	-	+	-	-	-	-
Heterodermia squamulosa (Degel.)Culb.	Physciaceae	Lecanorales	Tree/rock	Fo	-	-	+	-	-	-	-	-
Hypogymnia austeroides (Nyl.)Nyl	Parmeliaceae	Lecanorales	Tree	Fo	-	-	+	-	-	-	-	-
Hypogymnia physodes (L.)Nyl	Parmeliaceae	Lecanorales	Tree	Fo	-	-	-	+	-	-	-	-
Hypotrachyna afrorevoluta (Flörke) Hale	Parmeliaceae	Lecanorales	Tree	Fo	-	-	+	-	-	-	-	-
Japewiella tavaresiana (H. Magn.) Printzen	Bacidiaceae	Lecanorales	Twig	C	-	+	-	+	-	-	-	-
Lecanora cenisia Ach.	Lecanoraceae	Lecanorales	Tree	C	-	+	-	+	-	-	-	-
Lecanora chlarotera Nyl	Lecanoraceae	Lecanorales	Twig	C	-	-	-	+	-	-	-	-
Lecidella elaeochroma f. elaeochroma (Ach.) M.Choisy Seaward & Hitch	Lecanoraceae	Lecanorales	Tree	C	-	-	-	+	-	-	-	-
Lecidella euphoria (Florke)Hertel.	Lecanoraceae	Lecanorales	Wood	C	+	-	-	-	-	-	-	-
Lepraria ecorticata (J.R. Laundon) Kukwa	Stereocaulaceae	Lecanorales	Rock	Lep	-	+	+	+	+	+	+	+
Lepraria obtusatica Tønsberg	Stereocaulaceae	Lecanorales	Tree/rock	Lep	-	-	-	+	-	-	-	-
Leptogium azureum (Sw.) Mont	Collemataceae	Peltigerales	Mossy tree	Fo	-	-	-	+	-	-	-	-
Leptogium gelatinosum (With.) J.R. Laundon	Collemataceae	Peltigerales	Mossy tree/rock	Fo	+	+	+	+	+	+	+	+
Lobaria pulmonaria (L.)Hoffm	Lobariaceae	Peltigerales	Tree	Fo	-	-	-	+	-	-	-	-
Megalospora tuberculosa (Fée) Sipman	Megalosporaceae	Pertusariales	Tree	C	-	-	+	+	-	-	-	+
Nephroma parile (Ach.)Ach.	Nephromataceae	Peltigerales	Tree	Squ	-	-	-	+	-	-	-	-
Parmelinella aff. Wallichiana(Taylor)Elix&Hale	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	-
Parmotrema perlatum (Huds.) M.Choisy	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	-
Parmotrema stuppeum (Taylor)Hale	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	-
Parmotrema tinctorum (Despr.ex NYL.)Hale	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	+	+	+	-	-	-	-
Peltigera praetextata (Flörke ex Sommerf.) Zopf	Peltigeraceae	Lecanorales	Tree	Fo	-	-	-	+	-	-	-	-
Peltigera polydactylon (Neck.) Hoffm.	Peltigeraceae	Lecanorales	Tree	Fo	-	-	-	+	-	-	-	-
Pertusaria corallina (L.) Arnold	Pertusariaceae	Pertusariales	Rock	C	-	-	-	-	-	+	-	-
Physcia aipolia (Mont. & Bosch) Hale	Physciaceae	Lecanorales	Twig	Fo	-	-	+	+	-	-	-	-
Physcia atrostriata Moberg	Physciaceae	Lecanorales	Tree	Fo	-	+	+	-	+	-	-	+
Physcia biziana. (Massal.)Zahlbr	Physciaceae	Lecanorales	Wood	Fo	-	+	-	+	-	-	-	-
Physcia caesia (Hoffm.) Furnr.	Physciaceae	Lecanorales	Tree/Rock	Fo	+	+	+	-	-	-	-	-
Placidium squamulosum(Ach.) Breuss	Verrucariaceae	Verrucariales	Tree	Squ	-	-	-	+	-	-	-	-
Porina heterospora (Fink *ex* J. Hedrick) R.C. Harris	Porinaceae	Trichotheliales	Tree	C	+	+	+	+	+	+	+	+

Appendix 1. Contd.

Pseudephebe pubescens (L.) Choisy	Parmeliaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Psilolechia lucida (Ach.) M.Choisy	Micareaceae	Lecanorales	Tree/rock/soil	Lep	-	-	+	+	+	-	-	-
Punctelia subrudecta (Nyl)Krog	Parmeliaceae	Lecanorales	Tree/rock	Fo	+	-	+	+	-	-	-	-
Pyrenula aff.ochraceoflava (Nyl.)R.C.Harris	Pyrenulaceae	Pyrenulales	Tree	C	-	+	-	-	-	-	+	-
Ramalina fastigiata (Pers.) Ach.	Ramalinaceae	Lecanorales	Twig	Fr	-	+	-	+	-	-	-	-
Ramalina sinensis Jatta	Ramalinaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Ramalina subfarinacea (Nyl. *ex* Cromb.) Nyl.	Ramalinaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Remototrachyna sp	Parmeliaceae	Lecanorales	Rock	Fo	-	-	+	-	-	-	-	-
Rinodina sophodes (Ach.) A.Massal.	Physciaceae	Lecanorales	Rock	C	-	+	-	-	-	-	-	-
Sticta sp. Stenroos	Lobariaceae	Peltigerales	Wood	Fo	-	-	-	+	-	-	-	-
Sticta wrightii Tuck.	Lobariaceae	Peltigerales	Tree	Fo	-	-	-	+	-	-	-	-
Trapeliopsis flexuosa (Fr.) Coppins & P.James	Agyriaceae	Agyriales	Wood	C	-	-	+	-	+	+	+	+
Thelotrema lepadinum (Ach.)Ach.	Thelotremataceae	Ostropales	Tree	C	+	+	+	+	+	+	+	+
Tuckermannopsis platyphylla (Tuck.)Hale.	Parmeliaceae	Lecanorales	Wood	Fo	-	-	+	+	-	-	-	-
Umbilicaria spodochroa (Nyl.)Harm	Umblicaraceae	Lecanorales	Tree	Fo	-	-	-	+	-	-	-	-
Usnea cirrosa Mot.	Parmeliaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Usnea articulate(L.)Hoffm	Parmeliaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Usnea baileyi Stirt	Parmeliaceae	Lecanorales	Tree/rock	Fr	-	+	+	+	-	-	-	-
*Usnea florida (*L.) Wigg	Parmeliaceae	Lecanorales	Twig	Fr	-	-	-	+	-	-	-	-
Usnea dasypoga (Ach.) Nyl.	Parmeliaceae	Lecanorales	Tree	Fr	-	+	-	-	-	-	-	-
Usnea hirta (L.)F.H.Wigg.	Parmeliaceae	Lecanorales	Tree	Fr	-	-	-	+	-	-	-	-
Xanthoparmelia hottentota aff.epacridea Maf-Lich	Parmeliaceae	Lecanorales	Rock	Fo	-	+	+	-	-	-	-	-

+: Species present in the site. - : Species absent in the site. Sites: 1 IRAD Ekona (419m) 2. Ekona Mbegue (406 – 790 m); 3. Lower Buea (581 - 985 m); 4. Upper Buea (1108 - 2178 m); 5. Batoke (9 - 320 m); 6. Bakinglili (9 - 425 m); 7. Idenau (3 - 260 m); 8. Bomana (276 - 596 m).