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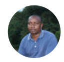
Paul M. Kirika
National Museums of Kenya



George G. Ndiritu
Karatina University, Kenya

Thorsten Lumbsch
Field Museum of Natural History

Diversity and Altitudinal Distribution of Understorey Corticolous Lichens in a Tropical Montane Forest in Kenya (East Africa)

Paul M. Kirika[1, 2], George G. Ndiritu[3], George K. Mugambi[4], Leonard E. Newton[2] and H. Thorsten Lumbsch[5*]

[1]Botany Department, EA Herbarium, National Museums of Kenya, P.O. Box 40658-00100, Nairobi, Kenya
[2]Department of Plant Sciences, Kenyatta University, P. O Box 43844-00100, Nairobi, Kenya
[3]Department of Environmental Studies Karatina University, P. O. Box 1957-10101, Karatina, Kenya
[4]Department of Biological Sciences, School of Pure and Applied Sciences, Meru University of Science and Technology, PO Box 972-60200, Meru, Kenya
[5]Integrative Research Center, Science & Education, The Field Museum, 1400 S. Lake Shore Drive, Chicago, IL60605, USA

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Corresponding author:
Email: tlumbsch@fieldmuseum.org

ABSTRACT

Lichens constitute an important component of tropical forest biodiversity. This study inventoried corticolous lichens and examined their variation in various forest types with varying climatic conditions in Mt. Kenya, East Africa. Specifically we evaluated variation of lichen assemblages in relation to forest types and tree diversity along an altitudinal gradient (1800-3100m). Ten study sites were established on two contrasting sides of Mt. Kenya in the indigenous forest: six of them at Chogoria which is on the humid southeastern windward side of the mountain and four sites on the Sirimon side located on the drier northwestern leeward side. Overall 242 lichen taxa were documented; with Chogoria and Sirimon forests having 148 and 94 species that translated to an adequate sampling effort of 74 % and 68 %, respectively. The two contrasting forest types (Chogoria and Sirimon) supported slightly different lichens assemblages. Meanwhile lichen assemblages were found to significantly vary with elevation (or forest types) and with tree host. Posterior analyses showed that the differences were significant among sampling sites (or forest types) on the Chogoria side and insignificant on the Sirimon side. Similarly the number of lichens differed significantly among the host tree species. This study stresses the urgent need to upscale the sustainable management of the presently threatened tropical forests in order to preserve their structural heterogeneity.

INTRODUCTION

Tropical forests constitute important ecosystems, covering a total area of 23.6 million km^2 (Coad et al. 2009). They serve as key biodiversity hotspots and are sinks for the worldôs largest terrestrial carbon dioxide emissions (Kapos et al. 2008). Unfortunately these two major roles played by tropical forests are threatened by deforestation and forest degradation (UNEP 2008). A major component of tropical forest diversity is the lichen community, which regulate critical ecosystems services such as nutrients cycling, nitrogen fixation, water cycles and soil formation (Gradstein et al. 1996, 2003; McCune 2000; Purvis 2000; Lücking et al. 2009). Moreover, lichens are sensitive to environmental conditions (Uliczka & Angelstam 2000), and hence have been used to monitor changes in climate and as ecological indicators of forest health (Brodo et al. 2001; Gradstein et al. 2003; Aptroot & van Herk 2007). Over the last century tropical forests have been experiencing varying degrees of natural and anthropogenic pressures thereby influencing their ecological conditions and consequently lichen assemblages (Uliczka & Angelstam 2000; Yeshitela 2008). Threats to the forest range from human activities such as deforestation, selective logging of high quality woody tree species and forest fires, to defoliation by large ungulates such as elephants. These threats influence structure and composition of the forest stands (Bussman 1994; Musila et al. 2009).

Impacts of climate changes on forest ecosystem affect species occurrences and distribution from local to regional levels (Ellis 2012). At the same time, vegetation responds to temperature and humidity; which are two surrogate measures of climatic conditions, which also correlate strongly with altitudinal gradient (Ellis et al. 2007). Vegetation diversity and associated species have been reported to decrease with increase in altitude. Increase in tree diversity shows strong correlation with environmental heterogeneity in forests, hence a general assumption that high tree diversity corresponds to diverse lichen communities. For

Table 1. Description of the study sites in Chogoria (C1 - C7) and Sirimon (S1 - S4). Classification of vegetation zonation follows Bussman (2006).

Study site	**Altitude**	**Location**	**Habitat / vegetation zones**
C1	1827m	00˚14′S, 37˚34′E	Supratropical mountain forest dominated by *Podocarpus falcatus* Mirb., *Neoboutonia macrocalyx* Pax, *Strombosia scheffleri* Engl., *Harungana madagascariensis* Poir.
C2	2018m	00˚14S, 37˚32'E	Supratropical mountain forest dominated by *S. scheffleri*, *Lasianthus kilimandscharicus* K.Schum, *Tabernaemontana stapfiana* Britten, *Syzygium guineense* (Willd.) DC., *Podocarpus latifolius* (Thunb.) Mirb., *N. macrocalyx* and *Ocotea usambarensis* Engl.
C3	2232m	00˚13S, 37˚31'E	Supratropical mountain forest dominated by *Macaranga* spp., *N. macrocalyx*, *Xymalos monospora* (Harv.) Warb., *Psychotria* spp., and *P. latifolius*.
C4	2475m	00˚11'S, 37˚29'E	Supratropical mountain forest with closed canopy dominated by *Podocarpus* spp., *Afrocrania volkensii* (Harms) Hutch., *Lepidotrichilia volkensii* (Gürke) Leroy, *Cassipourea malosana* (Bak.) Alston and *Psychotria* spp.
C5	2687m	00˚10'S, 37˚27'E	Orotropical montane forest of dominated by bamboo interspersed with a few scattered *Podocarpus* spp. mainly along forest edges.
C6	2950m	00˚10'S, 37˚26'E	Orotropical bambo forest. Primarily vegetation pure bamboo vegetation.
C7	3043m	00˚09'S, 37˚25'E	Orotropical cloudy forest with patches of forest of *Hagenia abyssinica* (Bruce) J.F. Gmel., *Hypericum revolutum* Vahl. and *Juniperus procera* Endl.
S1	2465m	00˚01'N, 37˚14'E	Xerotropical upland forest with *J. procera*, *Dodonaea angustifolia* L.f., *Faurea saligna* Harv., *Rhus natalensis* Krauss and *Rhamnus prunioides* L'Hérit.
S2	2660m	00˚00'S, 37˚15'E	Orotropical montane forest with *J. procera, Podocarpus* spp. *Agarista salicifolia* and *F. saligna.*
S3	2870m	00˚00'S 37˚16'E	Orotropical bamboo forest with *P. latifolius*, *J. procera*, *Olea europaea* L., *H. revolutum,* and *Arundinaria alpina* K.Schum.
S4	3080m	00˚01'S, 37˚17'E	Orotropical cloud forest characterized by open patches of grasslands vegetated forest stands of *J. procera*, *P latifolius*, *H. abyssinica* and *A. alpina.*

instances several studies have found significant relationships between lichen flora and altitude (e.g., Dietrich & Scheidegger 1997; Pintado 2001; Dolezal & Srutek 2002), a pattern attributed to differences in humidity and temperature along an altitudinal-environmental gradient complex (Kurschner et al. 1999; Zotz 1999; Zotz et al. 2003).

One of the predicted impacts of forest degradation to lichen diversity is loss of available environmental heterogeneity that can be partitioned at three major levels: (i) variation within a single tree species; (ii) variation in stand density and (iii) variation controlled by stand-scale factors within a forest (Ellis 2012). Selective logging and occurrences of forest fires are expected to damage forest canopies and expose treesôtrunks both lateral and vertical environments to adverse effects of sun and wind. At the tree level, lichen assemblages change along tree heights

Table 2. Number of species (observed and estimated) the percentage (%) sampling effort, and diversity indices (Shannon, Pielou's and Beta) in various sampling sites in Chogoria (C) and Sirimon (S) forests.

Sampling areas	C1	C2	C3	C4	C5	C7	S1	S2	S3	S4	Sum for Chogoria	Sum for Sirimon
Samples	49	72	72	27	10	29	30	34	53	17	249	134
Species observed	56	58	47	37	15	34	39	34	53	24	148	94
ACE	59	62	50	42	93	36	52	36	59	27	157	106
ICE	93	97	77	109	97	45	88	46	128	40	217	154
Chao2	96	99	67	98	45	43	87	44	150	38	230	157
Average estimated species	83	86	65	83	78	41	76	42	112	35	201	139
% sampling effort	68	67	73	45	19	82	52	81	47	69	74	68
Shannon index (H')	3.67	3.65	3.14	3.40	2.60	2.96	3.38	3.19	3.46	2.92	4.32	3.60
Pielou's evenness	0.92	0.90	0.82	0.94	0.96	0.84	0.92	0.91	0.87	0.92	0.87	0.87
Mean species per sample	7.43	4.88	4.17	4.75	2.00	8.45	4.93	5.53	6.64	7.29	5.47	6.06
Beta diversity	0.37	0.39	0.32	0.25	0.10	0.23	0.41	0.36	0.56	0.26	0.28	0.40

(Moe & Botnen 1997, 2000; Johansson et al. 2010; Marmor et al. 2013) as well as differ between branches and trunks (Williams & Sillett 2007; Rambo 2010), an indication of different habitats created by branching types and positioning (Lie et al. 2009). Also within a tree, vertical positioning influences environmental factors, such as pH and nutrient content in response to stem flow volume (Rambo 2010); though thought to vary depending on biogeographical settings in reaction to levels of humidity and moisture content. Current data available indicate that few lichen species are restricted to particular tree species (Foucard 2001; Smith et al. 2009), with many species displaying preferences to several tree types depending on their bark physical and chemical characteristics (Gauslaa & Holien 1998; Kermit & Gauslaa 2001; Benner & Vitousek 2007; Cácares et al. 2007; Spier et al. 2010; for review see Ellis 2012).

The environmental condition of forest stands is a factor of tree diversity and forest structural heterogeneity. Generally forests with high structural heterogeneity are associated with forest stands with healthy environmental conditions that are characterized by high turnover of tree species, age structure, density, canopy cover as well as volume and quality of dead wood (Zenner 2004; McMullin et al. 2010). Old forests with minimal natural and anthropogenic pressures are associated with high environmental heterogeneity and are rich in epiphytic lichens (Neitlich & McCune 1996). For instance, pristine tropical primary forests display high degree of structural complexities. Loss of tree species is predicted to reduce the structural complexities of forests and consequently diversity of niches available for colonization by various species, including lichens. Such forests are characterized by forest stands that are the early phases of succession.

Most ecological studies on lichens are from temperate regions with only a few from tropical regions, primarily from the Neotropics (Wolf 1993a b; Cornelissen & Ter Steege 1989; Komposch & Hafellner 2000; Kessler 2000; Plata et al. 2008) and Asia (Wolseley & Aguirre-Hudson 1997; Baniya et al. 2010). Consequently our knowledge on lichen diversity, ecology and distribution in the palaeotropical regions of sub-Saharan Africa is relatively poor (e.g., Ellis 2012), although such data would be important for comparative studies. This study inventoried lichen assemblages along an elevation gradient in various forest types in Mt Kenya and thereafter investigated their relationships with forest characteristics. Specifically the following ecological factors were evaluated on their influence on lichen diversity and

Table 3. Analysis of similarity (ANOSIM) among sampling sites. Provided are R values and significance levels with asterisks indicating significant levels at p = 0.001. Note R value is a measure of separation, ranging from 0 (indistinguishable) to 1 (well separated).

	C1	C2	C3	C4	C5	C7	S1	S2	S3
C2	0.00								
C3	0.08*	0.04*							
C4	0.09*	0.04*	0.12*						
C5	0.10*	0.04	0.15*	0.03					
C7	0.22*	0.10*	0.21*	0.28*	0.37*				
S1	0.11*	0.06*	0.15*	0.06*	0.05	0.22*			
S2	0.13*	0.06*	0.16*	0.09*	0.09	0.14*	0.04		
S3	0.14*	0.08*	0.14*	0.12*	0.11	0.11*	0.07*	0.12	
S4	0.11*	0.05*	0.15*	0.08*	0.11	0.33*	0.05	0.08	0.07

assemblages: (i) forest types, (ii) tree types or host species, and (iii) spatial factors. The outcome of this study was envisaged to influence the management of Mt. Kenya forest by providing additional data on how the above natural factors influences lichen diversity and assemblage.

MATERIALS AND METHODS

Study area

Mount Kenya is the second highest mountain in Africa, situated in the central part of Kenya (00°10ôS and 37°20ôE), and is crossed by the equator (Fig. 1). The mountain is of volcanic origin with two main peaks (Batian [5199 m], Nelion [5188 m]) that are remnants of the hard volcanic plug (Bussman 2006). The mountain has a rich biodiversity and constitutes a major water catchment area in Kenya, and is a UNESCO world heritage site. The area has two distinct rainy seasons: i.e., long rains occurring between March and June and short rains between October and November. Similarly there are two distinct dry seasons: from December to February and July to September. The amount of rains received change spatially with the northern (leeward) side receiving an average annual rainfall of 900 mm while the southeast (windward) side rains averaging 2300 mm (Bussman 2006). Temperatures are largely influenced by altitude with temperatures characterized by large daily fluctuations and small mean monthly variations. Altitudinal temperatures decrease at a rate of 0.56 ^{o}C/100m, with frost occurring from 2500 m upwards.

The vegetation types of Mt. Kenya are a function of temperature, amount of rainfall, topography, geology and human-induced disturbances. The dry northwest side supports a vegetation that is different from the southeast humid areas. The lower zones (1800-2700 m) on the humid side are covered by tropical montane mixed forest with the dominant tree species changing with elevation (Table 1). Bamboo forests interspersed with *Podocarpus* spp. dominate the mid elevation zones between 2700 to 3000 m. The area above 3000 m is covered with tropical cloud forests primarily with *Hagenia abyssinica*, *Hypericum revolutum* and *Juniperus procera*. The lower zones (2400-2600 m) of the northern side support disturbed dry tropical forests, with mid elevation (2600-2800 m) having mixed montane forests of *Juniperus procera, Podocarpus* spp., *Agarista salicifolia* and *Faurea saligna.* The upper elevation (above

Table 4. Analysis of similarity (ANOSIM) of lichens among host trees. Provided are R values and significance levels with asterisks indicating significance levels at p = 0.001. Full names of tree species are provided in Figure 3D.

	Tab_sta	Syz_gui	Str_sch	Psy	Pod	Neo_mac	Mac_kil	Jun_pro	Hyp_rev
Syz_gui	0.00								
Str_sch	0.14*	0.14*							
Psy	0.01	0.00	0.08*						
Pod	0.06*	0.04	0.06*	0.05					
Neo_mac	0.00	0.00	0.15*	0.00	0.01				
Mac_kil	0.06	0.03	0.09*	0.06	0.05*	0.00			
Jun_pro	0.16*	0.15*	0.18*	0.15*	0.02	0.15*	0.11*		
Hyp_rev	0.42*	0.52*	0.33*	0.31*	0.02	0.54*	0.13*	0.01	
Cas_mal	0.06	0.00	0.19*	0.02	0.08*	0.12	0.10*	0.15*	0.54*

Table 5. Indicator Species Analysis (ISA) for selected lichen species with significant preference to tree species (p = 0.05).

Lichen species	Tree host	Observed indicator value (IV)	p value
Heterodermia japonica	*Hypericum revolutum*	64.7	0.00
Leptogium cochleatum	*Hypericum revolutum*	41.2	0.00
Lobaria pulmonaria	*Hypericum revolutum*	63.0	0.00
Heterodermia allardii	*Juniperus procera*	50.0	0.03
Leptogium burnetiae	*Juniperus procera*	50.0	0.03
Pertusaria endoxantha	*Juniperus procera*	50.0	0.03
Pertusaria krogiae	*Juniperus procera*	100.0	0.00
Usnea exasperata	*Juniperus procera*	41.1	0.03
Graphis illinata	*Macaranga kilimanscharica*	37.5	0.04
Brigantiaea leucoxantha	*Neoboutonia macrocalyx*	57.1	0.00
Porina sp. 1	*Strombosia scheffleri*	66.6	0.00
Porina sp. 2	*Strombosia scheffleri*	44.4	0.02

2800 m) is characterised by open patches of grasslands with forest stands of *J. procera*, *Podocarpus latifolius*, *H. abyssinica* and *Arundinaria alpina.* Generally elevation and plants composition changes gradually on the humid southeast side whereas on the drier northern side both elevation and vegetation changes are drastic.

The land surrounding Mt. Kenya is densely populated with intensive farming activities that over the past have extended into the forested areas depending on suitability for cultivation. For instance cultivation reached up to 1800 m on the southern, up to 2400 m on the eastern and western sides, and nearly up to 2900 m on the northern slopes. The low and mid-elevation forests are protected as forest reserves managed by the Kenya Forest Service (KFS), whereas the alpine zone is a national park managed by the Kenya Wildlife Service (KWS). One of the popular forest management approaches is subsistence use of forest resources by the local communities, which includes collection of firewood and plant parts for medicinal purposes, livestock grazing, and harvesting of honey. Vanleeuwe and Lambrechts (1999) observed that these activities affect the structural complexity of the forest thereby posing a management problem and potentially compromising the capacity of Mt. Kenya ecosystem to sustain the needs of its wildlife in the long term. Crucially, effects of subsistence use of forest resources on forest ecosystems are least understood although the practice is widespread and common in most forest reserves in the country (Banana et al. 2008; NEMA 2011).

Sampling strategy and protocols

Ten study sites were established in the indigenous forest of Mt. Kenya, on the humid windward side (Chogoria) and dry leeward side (Sirimon) sides (Fig. 1, Table 1). The study sites were located along two main tracks that started at the bottom of the mountain and ended at the upper zones, as such the sampling strategy resembled transects made along an altitudinal gradients. Study sites were subjectively established so that all the major vegetation zones were represented. For each study site, a sampling plot measuring (10 × 200) m were established and subdivided into five sub-plots of 10 × 20 m. Within each sub-plot, two to three free standing mature and undamaged trees were randomly selected where possible and four quadrats measuring (0.1 × 0.5) m each made on the tree trunks at 1.5 m from the ground (Asta et al. 2002, Scheidegger et al. 2002). The quadrats comprised of four metal ladders placed on tree trunks such that each ladder faced one of the four main compass directions (North, N; East, E; South, S; West, W); which were determined using a magnetic compass. Each quadrat was divided further into five contiguous parts (0.1 × 0.1) m. Quadrats (0.1 × 0.5) m were the focal sampling unit where data on all lichens both macro- and microlichens, their abundances (coverage) and frequency were collected and later used for analyses.

However, the quadrat sampling method was not employed in the bamboo vegetation (site C6) due to their small-sized dbh but lichens were collected randomly in the (10 × 200) m sampling plot. Thus lichen data obtained from sampling area C6 were not subjected to rigorous statistical analysis. Opportunistic collections were also made outside the sampling plots to target lichens that may have been missed or absent in the established sampling plots for the purpose of documenting diversity. During this study an effort was made to identify all host tree species up to genus and / or species level and the vegetation type for each

Table 6. List of 97 lichen species and their total abundances in the ten study sites used to generate the DCA biplots. Letter (C) refers to Chogoria and (S) Sirimon sides of Mount Kenya forest. Included are the abbreviations (Abbrv.) used for the lichen species.

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Agonimia pacifica (H. Harada) Diederich	Ago_pac	3	0	2	0	0	0	0	0	0	0
Anzia afromontana R. Sant.	Anz_afro	0	0	0	0	0	8	16	2	0	0
Bacidia aff. *medialis* (Tuck.) Zahlbr.	Bac_med	25	9	0	0	0	0	0	0	0	0
Bacidia sp.	Bac_sp	5	16	7	11	0	5	10	3	2	0
Brigantiaea leucoxantha (Spreng.) R. Sant. & Hafellner	Brig_leu	0	0	1	6	0	0	0	0	0	0
Caloplaca brebissonii (Fée) J. Sant. ex Hafellner & Poelt	Calo_bre	0	0	0	0	0	0	0	0	1	2
Chrysothrix xanthina (Vain.) Kalb	Chr_xan	0	0	0	0	0	0	0	0	10	9
Coccocarpia pellita (Ach.) Müll. Arg.	Coc_pel	16	2	0	0	0	0	0	0	0	0
Coenogonium luteum (Dicks.) Kalb & Lücking	Coe_leu	0	0	0	0	0	0	1	0	13	0
Cryptothecia sp.	Cry_sp	0	5	1	0	1	0	0	0	0	0
Fellhanera fragilis (Vezda) Lücking & Kalb	Fel_fra	0	5	3	0	0	0	0	0	0	0
Flavoparmelia caperata (L.) Hale	Fla_cap	0	0	0	0	0	3	18	7	0	0
Flavoparmelia soredians (Nyl.) Hale	Fla_fla	0	0	0	0	0	0	3	5	10	5
Flavopunctelia flaventior (Stirt.) Hale	Fla_sor	0	0	0	0	0	0	3	0	5	8
Graphis illinata Eschw.	Gra_ill	0	6	18	0	0	0	0	0	0	0
Graphis proserpens Vain.	Gra_pro	0	2	2	1	0	0	0	0	0	0
Graphis streblocarpa (Bél.) Nyl.	Gra_str	2	1	2	0	0	0	0	0	0	0
Heterodermia allardii (Kurok.) Trass	Het_all	0	0	0	0	0	3	6	0	5	0
Heterodermia casarettiana (A. Massal.) Trevis.	Het_cal	0	0	0	0	0	8	23	0	0	0
Heterodermia japonica (M. Satô) Swinscow & Krog	Het_jap	0	2	0	0	0	14	30	15	33	2
Heterodermia lepidota Swinscow & Krog	Het_lep	0	0	0	0	0	0	0	7	6	1
Heterodermia leucomelos (L.) Poelt	Het_leu	0	0	0	0	0	3	6	25	16	0
Heterodermia microphylla (Kurok.) Skorepa	Het_mic	3	0	0	2	0	0	0	0	3	0
Heterodermia reagens (Kurok.) Elix	Het_rea	0	0	0	0	0	3	6	0	0	0
Heterodermia sp.	Het_sp	0	0	0	1	0	4	14	5	5	0
Hypotrachyna immaculata (Kurok.) Hale	Hyp_imm	0	2	0	0	0	0	0	2	0	0
Lecanora sp.	Lec_sp	0	0	0	5	0	0	5	0	0	1
*Lepraria*_sp.	Lep_sp	18	7	13	0	0	5	15	0	0	0
Lepraria cf. *incana* (L.) Ach.	Lep_cfin	7	0	5	0	0	0	0	0	0	0
Lepraria coriensis (Hue) Sipman	Lep_cori	0	0	0	0	0	0	8	10	0	0
Lepraria incana (L.) Ach.	Lep_inc	2	0	5	12	0	0	5	3	0	0
Lepraria lobificans Nyl.	Lep_lob	0	0	0	5	0	0	0	5	4	0
Lepraria usnica Sipman	Lep_usn	0	0	2	4	0	0	0	0	7	0
Leptogium austroamericanum (Malme) C.W. Dodge	Lep_aus	0	0	0	0	0	2	4	0	0	0
Leptogium azureum (Sw. ex Ach.) Mont.	Lep_azu	0	0	0	7	0	5	11	3	0	0
Leptogium burgessii (L.) Mont.	Lep_burg	0	0	0	0	0	1	2	0	0	0
Leptogium burnetiae C.W. Dodge	Lep_burn	0	0	0	0	0	5	12	0	1	0
Leptogium cochleatum (Dicks.) P.M. Jørg. & P. James	Lep_coc	0	0	1	0	0	4	8	0	0	0
Leptogium cyanescens (Pers.) Körb.	Lep_cya	12	15	17	4	0	0	0	1	0	5
Leptogium furfuraceum (Harm.) Sierk	Lep_fur	0	0	0	0	0	2	4	0	0	2
Letrouitia flavocrocea (Nyl.) Hafellner & Bellem.	Let_fla	0	2	0	0	0	0	0	0	2	0
Lobaria pulmonaria (L.) Hoffm.	Lob_pul	0	0	0	0	0	55	110	0	1	0
Malmidea ceylanica	Mal_cey	12	4	5	0	0	0	0	0	0	0
Malmidea sp.	Mal_sp	16	23	67	0	0	0	0	0	1	0
Megalospora _sp.	Meg_sp	2	3	0	0	0	0	0	0	0	0

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Megalospora coccodes (Bél.) Sipman	Meg_coc	3	9	0	0	0	0	0	0	0	0
Megalospora tuberculosa (Fée) Sipman	Meg_tub	3	1	2	0	0	0	0	0	0	0
Micarea sp.	Mic_sp	0	0	2	3	0	0	0	4	5	0
Nephroma tropicum (Müll. Arg.) Zahlbr.	Nep_tro	0	0	0	0	0	6	12	0	0	0
Parmotrema chinense (Osbeck) Hale & Ahti	Par_chi	0	0	0	0	1	10	20	4	0	0
Parmotrema commensuratum (Hale) Hale	Par_com	0	0	0	0	0	0	2	0	0	0
Parmotrema cooperi (J. Steiner & Zahlbr.) Sérus.	Par_coo	0	0	0	0	0	0	7	0	5	0
Parmotrema hababianum (Gyeln.) Hale	Par_hab	0	0	0	5	0	0	5	3	2	0
Parmotrema lophogenum (Abbayes) Hale	Par_lop	0	0	0	0	0	1	2	0	0	0
Parmotrema reticulatum (Taylor) M. Choisy	Par_ret	0	5	1	2	1	0	9	6	25	4
Parmotrema sancti-angelii (Lynge) Hale	Par_sac	0	0	0	5	0	0	0	0	4	0
Parmotrema subarnoldii (Abbayes) Hale	Par_subi	1	0	0	0	0	0	0	1	0	0
Parmotrema sp.	Par_sp	0	12	0	3	3	37	81	18	26	11
Peltigera polydactyloides Nyl.	Pel_pol	0	0	0	0	0	2	4	0	0	0
Peltigera ulcerata Müll. Arg.	Pel_ulc	0	0	0	0	0	2	4	0	0	0
Pertusaria sp.	Per_sp	3	0	0	4	0	0	1	0	2	2
Pertusaria cf. *krogiae* A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Per_cfkr	0	0	0	0	0	0	2	5	2	0
Pertusaria endoxantha Vain.	Per_end	0	0	0	0	0	5	20	4	1	0
Pertusaria fosseyae A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Per_fos	0	6	0	0	0	4	8	4	3	3
Pertusaria krogiae A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Pel_kro	0	0	0	0	0	6	21	6	13	6
Pertusaria pilosula A.W. Archer & Elix	Per_pil	1	0	0	0	0	0	1	1	0	1
Pertusaria scaberula A.W. Archer	Per_sca	0	0	0	4	0	0	0	15	8	0
Pertusaria sp. 2	Per_sp2	0	3	0	1	0	0	0	0	0	0
Pertusaria sp. 3	Per_sp3	0	0	0	0	0	3	6	0	0	0
Phaeographis girringunensis A.W. Archer & Elix	Pha_gir	5	1	0	0	0	0	0	0	0	0
Phaeophyscia hispidula (Ach.) Essl.	Pha_his	0	0	0	0	0	1	5	2	0	0
Phlyctis sp.	Phly_sp	9	7	3	4	3	0	0	0	0	0
Phyllopsora albicans Müll. Arg.	Phyl_alb	9	18	11	0	0	0	0	1	14	0
Phyllopsora confusa Swinscow & Krog	Phyl_con	10	19	36	1	0	0	0	0	13	5
Phyllopsora mediocris Swinscow & Krog	Phyl_med	13	19	16	0	0	0	0	0	0	0
Phyllopsora santensis (Tuck.) Swinscow & Krog	Phyl_san	2	4	5	0	0	0	0	0	0	0
Phyllopsora sp. 1	Phyl_sp1	4	0	2	0	0	0	0	0	0	0
Phyllopsora sp.	Phyl_sp	1	4	0	3	0	0	0	4	0	0
Physcia albata (F. Wilson) Hale	Phys_alb	0	0	0	0	0	0	0	0	2	13
Porina nucula Ach.	Por_nuc	0	7	4	0	0	0	0	0	0	0
Porina sp. 1	Por_spnv	17	2	0	0	0	0	0	0	0	0
Porina sp. 2	Por_sp	25	25	3	0	0	0	0	0	0	0
Pseudoparmelia sp.	Pse_sp	0	0	0	3	0	0	1	0	0	5
Punctelia rudecta (Ach.) Krog	Pun_rud	0	0	0	0	0	0	0	3	38	0
Punctelia subrudecta (Nyl.) Krog	Pun_sub	0	0	0	0	0	0	0	0	3	15
Pyrenula macrocarpa Massal.	Pyr_cru	6	2	1	3	0	0	0	0	0	0
Pyrenula mastophora (Nyl.) Müll. Arg.	Pyr_mas	5	0	3	1	0	0	0	0	0	0
Pyrenula santensis (Nyl.) Müll. Arg.	Pyr_san	3	0	3	2	0	0	0	0	0	0
Pyrenula sp.	Pyr_sp	3	2	4	0	0	0	0	0	0	0
Sticta ambavillaria (Bory) Ach.	Sti_amb	0	0	0	0	0	4	8	0	0	0
Sticta fuliginosa (Dicks.) Ach.	Sti_ful	0	0	0	0	0	5	10	0	0	0
Sticta weigelii Isert	Sti_wei	0	3	2	2	1	0	0	0	0	0
Usnea exasperata (Müll. Arg.) Motyka	Usn_exa	0	0	0	0	1	13	26	0	0	0
Usnea firmula (Stirt.) Motyka	Usn_fir	0	0	0	0	0	4	8	0	0	0
Usnea picta (J. Steiner) Motyka	Usn_pic	0	0	0	0	0	5	10	0	0	0
Usnea trichodeoides Motyka	Usn_tri	0	0	0	0	0	9	18	0	0	0
Usnea undulata Stirt.	Usn_und	0	0	0	0	1	0	0	3	0	0

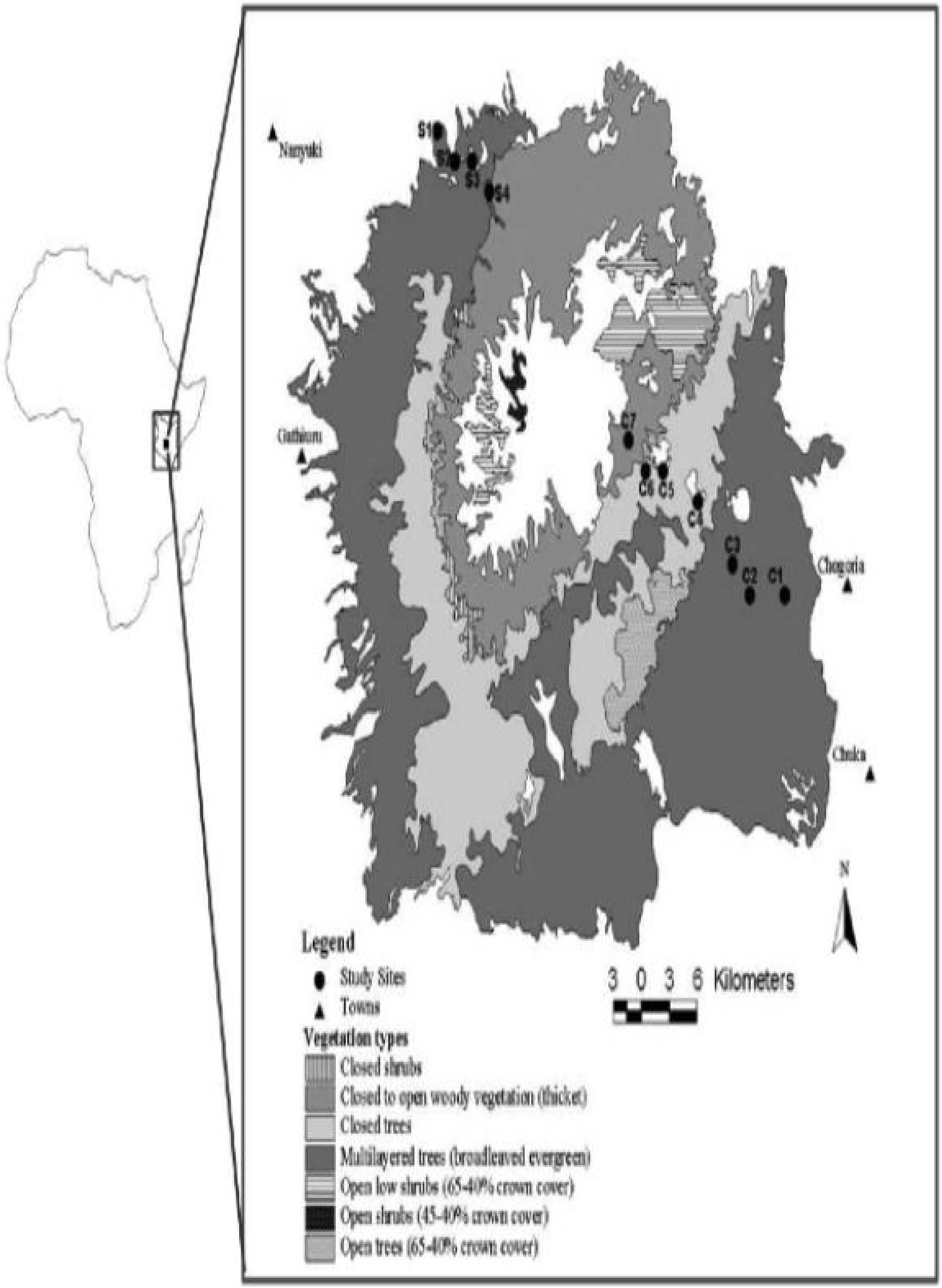

Fig. 1. Map of Mount Kenya forest showing major vegetation zones and the location of study sites in Chogoria (C1-C7) and Sirimon (S1-S4).

sampling site described using the dominant tree species. Elevation and geographical coordinates were determined using a global positioning system receiver (GPS). Sampling plots were located roughly 50 m from the tracks In order to minimize edge effects and about 200m from each other.

Data analysis

The completeness of our sampling effort for each of the ten sampling sites was assessed using three nonparametric estimator methods: incidence-based coverage (ICE), abundance-based coverage (ACE) and CHAO2 (Colwell 2013). These estimators are conservative

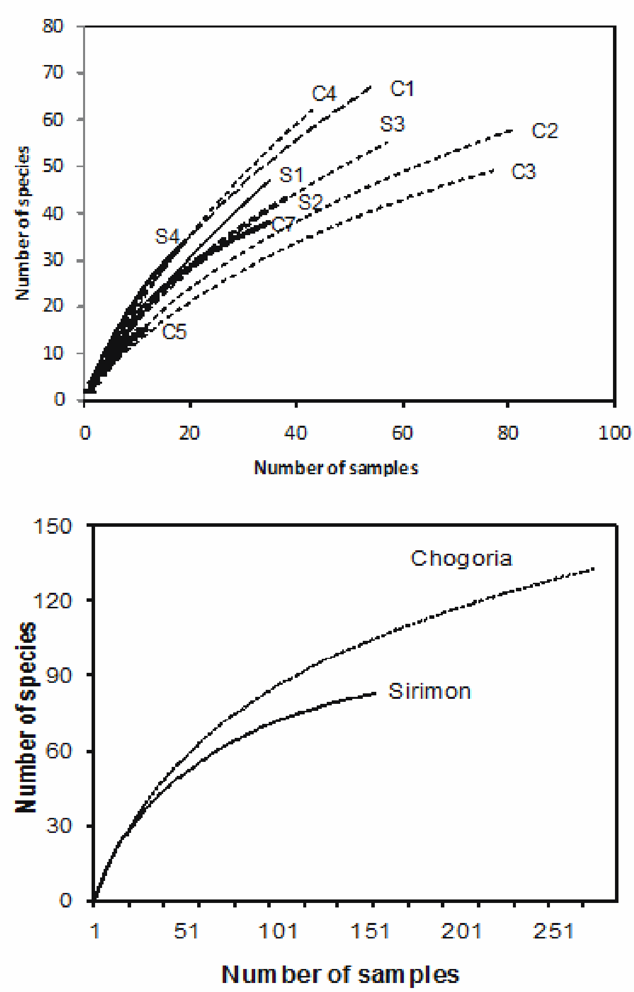

Fig. 2. Sample-based species accumulations / rarefactions curves of the ten sampled sites (above) and the two forest areas (below). Abbreviations 'C' and 'S' respectively refer to sampling areas in Chogoria and Sirimon forests in Mt. Kenya.

and suitable for many species even though their robustness might depend on the sample size, habitat heterogeneity and organisms under consideration (Unterseher *et al*. 2008). Estimated levels of the percentage of completeness of each sampling site were determined by dividing the actual number of species recorded by the maximum average number of species estimated by the three estimators.

Species abundance and distribution measures were used to describe the lichen community structure. Species diversity was analysed using Shannon index $H := -\sum^{s}_{i=}j\,(\rho_{i})\,(\log_{i}\rho_{i})$, $p_i = n_{i}/N$; where H' = index of species diversity, ρ_i= proportion of total sample belonging to the i^{th} species; N= total number of species; ni = individual number of species j; whereas evenness was quantified using Pielou's evenness: $J' = H'/\mathrm{Log}_e\,S$ where J' = Pielou's evenness, S = total species. Beta diversity = β_w or species turnover across an environmental gradient or between habitats, a measure of habitat heterogeneity (Magurran 2004) was calculated using the Whittaker index (Whittaker 1960), β_w = S/á where β_w= Whittaker's index of diversity, s = alpha diversity (number of species / sampling area) divided by gamma diversity, which is the number of species recorded in either dry (Sirimon) or humid (Chogoria) forest. Similarly sample-based rarefaction was used to analyse and compare community structure for the ten sampling sites using the Coleman's sampling with replacement method (Coleman et al. 1982); the analyses give both rarefaction and species accumulation curves (Gotelli & Colwell 2001). Differences in species composition were determined using analysis of similarity (ANOSIM) using PRIMER software package (Clark & Gorley 2001, PRIMER-E, Plymouth, UK).

The interaction between species data and three main factors was studied with analysis of variance (ANOVA) using STATISCA software (Stat soft. Inc. Tulsa, OK, USA). Hypotheses relating to the effects of the main factors were tested with a generalized linear model:

Species richness = constant + vegetation zones + host (vegetation zones) + random deviation, where constant is the overall mean, vegetation zones is random factor within an area, host is randomly nested within vegetation zones. The model tested the hypotheses that lichen assemblages varied along elevation gradient and corresponding vegetation zones, and the host trees' species. To further investigate the effects of vegetation zones and hosts, post-hoc pairwise comparisons of means were performed (ANOVA, Tukey HSD for unequal N). However, spatial effects or distances between the two main study areas (humid versus dry sides of the forest) were tested separately. Prior to the analyses, species richness was log transformed (log(x+1) and the normality tested and confirmed by the Shapiro-Wilk Test.

Further multivariate analysis to determine species distribution patterns at two levels of community organization (forest types and host tree) were examined using Detrended Correspondence Analysis (DCA) using PCORD version 6.0 (McCune & Mefford 2011). During DCA analyses quadrats that had less than three species represented were omitted as well as lichen species that occurred in less than two sites. Indicator Species Analysis (ISA) was performed to established lichen species with specific preference to particular tree species. The ISA give an indicator value (IV) for each species based on their relative abundance and relative frequency on the host tree. The IV performs a Monte Carlo permutation test of significance based on 1000 randomizations and assesses the faithfulness of the lichen to a tree.

RESULTS

Sampling effort and completeness of the survey

During this study a total of 373 quadrats were sampled, which comprised of 239 and 134 quadrats from Chogoria and Sirimon forests, respectively (Table 2, list of all species collected is given as appendix 1). The samples yielded a total of 242 taxa. Chogoria and Siromon forests had 148 and 94 species that translated to a sampling effort of 74% and 68%, respectively. Percentage sampling efforts for the ten sampling sites ranged from 19 to 80%, with most sites registering more than 50% except C5 with 19%; C4, 45%, and S3, 47% (Table 2). Pointedly there was an element of under-sampling in sites C5, C4, S1 and S3, as shown by species rarefaction and accumulation curves (Fig. 2), which is an indication that significant number of occasionally occurring species were missed during this study. The performance of the estimators varied with ACE estimating lower values than ICE and Chao2, with the latter two giving comparable and reasonable estimates. Overall, the number of samples made per sampling area and the overall completeness of the study 74 % in Chogoria and 68 % in Sirimon (Table 2) were considered sufficient to allow for further comparative analysis of the data compiled.

Comparison of lichen assemblages between humid and dry zones

More lichen species were recorded on Chogoria side of the forest (148) than Sirimon side with 94 species. Comparison of species richness using ANOVA between Chogoria and Sirimon sampled sites were found to be insignificant ($F = 1.89$, $p = 0.17$). Similarly lichen assemblages between the two sides were indistinguishable when using AMISOM analysis. Generally, the sampled sites in Chogoria and Sirimon forests supported comparable species numbers and diversities. Shannon diversity was 4.3 and 3.6 for Chogoria and Sirimon respectively (Table 2). In contrast Sirimon forest had slightly higher species evenness than Chogoria.

The DCA analyses showed that Chogoria and Sirimon had differences in the occurrence of lichen species, except for Chogoria site C7 that grouped together with Sirimon sampling sites (Fig. 3A, Table 3). Macrolichens were more dominant on the Sirimon side, with the common species comprising of *Flavoparmelia soredians, F. caperata, Lobaria pulmonaria, Leptogium azureum, Heterodermia leucomelos, H. japonica, Pertusaria pilosula* and *Usnea exasperata* (Fig. 3B). In contrast the common lichens on Chogoria side included; *Lepraria usnica, Megalospora tuberculosa, Phyllopsora confusa, Pyrenula cruenta, P. mastophora* and *Porina* sp. (Fig. 3C). Meanwhile sampling site C7, which was ordered separately, supported *Lobaria pulmonaria*, *H. japonica, F. caperata*, *Anzia afromontana Pertusaria krogiae* and *Parmotrema chinense* (Fig. 3B).

Variation of lichens with altitude and forest type

Overall the number of species significantly varied with elevation or forest type ($F = 72.04$, $p = 0.00$); with differences being insignificant between sampling sites (or forest types) on Sirimon side ($F = 1.10$, $p = 0.78$) but significant on Chogoria side ($F = 61.72$, $p < 0.00$). Further post hoc analyses found significant differences between C1 vs C2, C3; C3 vs S3, C7 vs C1, C2, C3, C4, S1, S2 and S3 at $p < 0.00$ whereas none was found among the four sampling sites on Sirimon side. Further analyses using ANOSIM found significant differences existed among lichen assemblages among most forest types (Table 4). Whereas most sampling sites showed significant differences ($p = 0.001$) on Chogoria side, only two sampling sites were found to significantly differ on the Sirimon forest side (S1 vs S3, $p = 0.001$). The DCA analyses agreed with the similarities analyses of ANISOM and ANOVA that elevation significantly affected lichens more in Chogoria than in Sirimon. For Chogoria DCAôs biplot, the first variation (55%) was attributed to elevation while for Sirimon, the first axis variation (36.9%) was attributed to elevation while the second axis (42.2%) was attributed to effects of

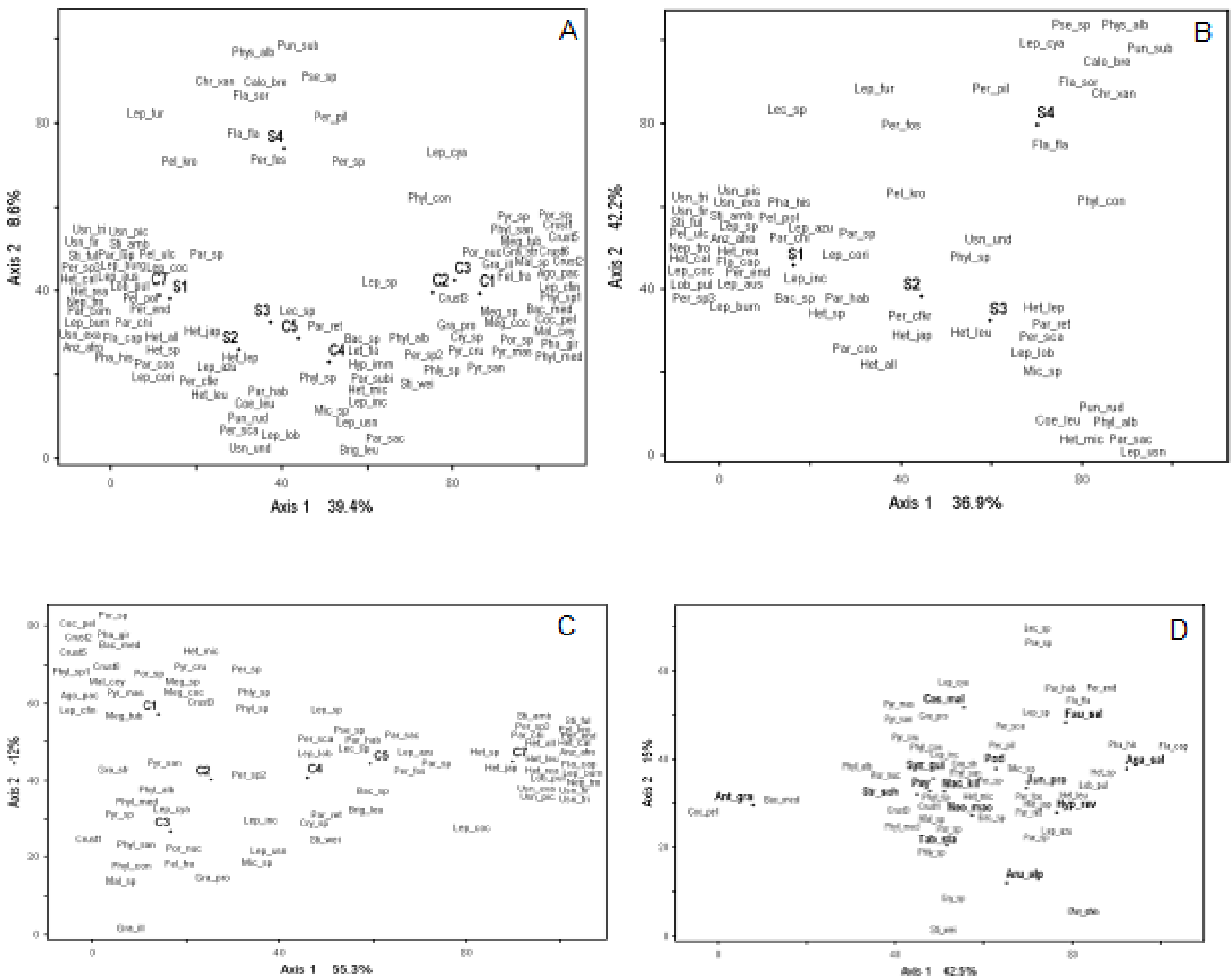

Fig. 3 DCA biplots for ordination of lichens and sites in Chogoria and Sirimon forests (A), Sirimon forest (B), Chogoria forests (C), whereas D is lichens with tree hosts. Variance explained by the first and second axes is given next to each axes and full names for abbreviated lichens are provided in Table 3. Full names for abbreviated tree species are Aga_sal, *Agarista salicifolia*; Ant_gra, *Anthocleista grandiflora*; Cas_mal, *Cassipourea malosana*; Fau_sal, *Faurea saligna*; Hyp_rev, *Hypericum revolutum*; Jun_pro, *Juniperus procera*; Mac_kil, *Macaranga kilimandscharica*; Neo_mac, *Neoboutonia macrocalyx*; Pod, *Podocarpus* sp.; Psy, *Psychotria* sp.; Str_sch, *Strombosia scheffleri*; Syz_gui, *Syzygium guineenses*; Tab_sta, *Tabernaemontana stapfiana*.

host tree species (Fig. 3B & C).

Association of lichens to particular tree host species

A total of 203 taxa were obtained from 112 tree hosts sampled. Overall the number of lichens differed significantly among the nine tree species that were adequately sampled ($F = 30.45$, $p = 0.03$). Further post hoc analyses showed that *Hypericum revolutum* had significantly higher number of lichens (3.50±0.26 per quadrat) than the other eight tree species, which had low to moderate number of lichens (ranged from 1.20±0.19 to 2.25±0.15). Analysis of similarity (ANOSIM) showed that lichen assemblages between *H. revolutum* and *J. procera* were similar with both significantly differing with other tree species, except with *Podocarpus* spp (Table 5).

Most tree species tended to support unique lichen assemblages except for a few trees species that had similar lichen assemblages. The DCA results (Fig. 3D) were to a certain degree similar to those of Indicator Species Analysis (ISA), which found 12 lichen species to have significant preference for five tree species (Table 6). For instance five lichen species showed preference to *J. procera*, *H. revolutum* had three lichen species, *S. scheffleri* (two species) and one lichen species each for *N. macrocalyx* and *M. kilimandscharica*.

DISCUSSION

This study assessed lichen assemblages in various forest types under varying ecological and climatic conditions in the Mt Kenya forest. In the study ca. 73 species belonging to 24 genera were recorded for the first time in Kenya. In addition, a number of crustose samples in the genera *Graphis Hemithecium*, *Porin*a, *Strigul*a, and *Thelotrema* are likely to be new species to science, however further studies on these samples are required. Most collectors recognize that widespread or abundant species are likely to be encountered with minimal sampling effort unlike rare and new species, which require adequate effort (Longino et al. 2002. Overall this study recorded an impressive number of lichen species although it only considered two eco-climatic areas contrasting transects along an elevation gradient, one on the more humid windward side and other the on the drier leeward side of Mt Kenya. It is imperative that sampling more areas with different eco-climatic conditions in Mt Kenya will likely result in more species being inventoried. This is consistent with the findings of Lücking (1999), who predicted that tropical regions support high lichen diversity that might equal or even surpass that of the well known temperate regions.

Only a few lichen inventories have been undertaken in Africa and a couple from the Neotropics and Asia. This study primarily focused on the understorey corticolous lichens in both closed and open forest types. Whereas lichen assemblages recorded may not be directly compared with others from tropical regions that considered whole tree trunks including the tree canopies, we can draw some general conclusions. For instance the overall species richness from the humid Chogoria and dry Sirimom, respectively, were considered moderate to high and comparable with other findings reported elsewhere in the tropics. In Kenya, Frisch & Hertel (1998) recorded 155 macrolichens in the alpine and subalpine zone of Mt. Kenya. Similarly Yeshitela (2008) recorded 137 species of foliicolous lichens in Kakamega forest (Yeshitela 2008; Yeshitela et al. 2009 a, b). In Asia, Boonpragop & Polyiam (2007) reported 270 species from two host tree species in KhaoYai National Park in Thailand. In the Neotropics Komposch & Hafellner (2000, 2003) recorded 250 and 173 species, respectively, from Venezuelan tropical lowland rainforest, Moontfoort & Ek (1990) found 209 species from trees in French Guiana, Holtz & Gradstein (2005) 168 species on trees in Costa Rica, Cáceres et al. (2007) 150 species of microlichens in Atlantic forests in Brazil, and Wolf (1993a) 178 species from the Northern Andes in Central Cordillera, Colombia.

The two forest areas with different ecological and climatic conditions studied (i.e., Chogoria and Sirimon) produced two unique set of lichen assemblages. The humid Chogoria was more diverse in species than the drier Sirimon side. Forests on the Sirimon side were dominated by open canopy, whereas those on Chogoria side had relatively closed canopies (Bussman 2006). Aridity and amount of moisture are factors known to influence vegetation and subsequently expected to affect lichen distribution with temperature and humidity being two surrogatesômeasures of climatic conditions that correlates strongly with altitudinal gradient (Ellis et al. 2007). Open forests in Sirimon were more dominated by foliose ca. 70 species, while closed forests on the Chogoria side were dominated by ca. 110 crustose lichen species. Notably a strong correlation between lichen assemblages and elevation existed on the Chogoria side (Fig. 3C). However sampling site C7, situated at high elevation on the Chogoria side, was exceptional and supported a unique cluster of lichen species similar to those found in sampling sites on Sirimon side (Fig. 3A). This was interestingly and suggested other factors apart from altitudinal-environment complex gradient affects lichens occurrences at higher stand-scale levels. Krog (1987) noted that local composition of lichens in the tropics is a function of a number of interacting factors, most important being humidity and temperature along an elevation gradient. As such high lichen abundance and diversity occurs in areas with high humidity even though actual precipitation may be occasional. Additionally high montane forests with low temperatures and high humidity also tend to have higher diversity of lichens. These observations were consistent with our findings.

Overall lichen abundance and distribution change along the elevation was found to be significant although the variation was more pronounced on the Chogoria side (Fig. 3C). These results underline the importance of vegetation and specific tree species in determining lichen occurrence. On the steep Sirimon side, tree species of *J.*

procera and *Podocarpus* spp. occurred in all sampled sites while the gentle sloping Chogoria side, no individual tree species dominated completely any of the seven sampled sites. These results suggest that forest types and heterogeneity has an importance in determining lichen occurrences in montane forests. Consequently decrease in vegetation diversity with elevation is expected to negatively affect lichens as was found in this study. Several studies have reported negative significant relationships between lichen flora and altitude (e.g., Pintado 2001; Dolezal & Srutek 2002), a scenario attributed to reduced vegetation diversity and habitat heterogeneity due to environmental stress associated with decreasing temperatures (Kurschner et al. 1999; Zotz 1999; Zotz et al. 2003). Pointedly most of these studies are from temperate regions with only a few from tropics, primarily from Neotropics and Palaeotropics regions (Ellis 2012).

We found a significant relationship between lichen assemblages and individual tree host species. Some trees supported higher number of lichens and of different composition. These include *Hypericum revolutum, Juniperus procera, Macaranga kilimanscharica, Neoboutonia macrocalyx* and *Strombosia scheffleri,* which also had significant levels of host specificity with a number of lichen species (Table 5). *Pertusaria krogiae* was exclusively found on *Juniperus procera*. Similar results of distinct lichens host specificity have been reported in previous studies (Moontfoot & Ek 1990; Wolf 1993a; Holtz & Gradstein 2005). Ecological niche requirements of lichens available on different tree hosts are hypothesized to influence their occurrences, though specific influences of environmental factors on lichens were not part of this study. Findings from this study were consistent with those Foucard (2001) and Smith et al. (2009) who observed that only a few lichen species are restricted to particular tree species with many lichen species displaying preferences to trees types depending on their bark physical and chemical characteristics, principally bark-pH levels that are affected by several factors among them accumulation of nutrients (e.g., K, Ca and Mg), availability of limiting nutrients such as phosphorus, epiphytic communities, differences in tree age and dbh, prevailing soil types in an area, bark texture, hardness as well as water holding capacity (for review see Ellis 2012). Meanwhile more studies are required to substantiate the aforementioned ecological preferences of lichens on tree hosts particularly in tropical forests.

Lichens assemblages were affected by factors relating to different ecological and climatic zones, forest types, and tree species. Maintenance of these three attributes is mandatory for proper and sustainable management of tropical forests that are presently undergoing serious anthropogenic and natural induced changes. Generally high heterogeneity is associated with forest stands with healthy environmental conditions that are characterized by high turnover of tree species, age structure, density, canopy cover as well as volume and quality of dead wood (Zenner 2004; McMullin et al. 2010). In order to preserve forest structural heterogeneity and in the process create niches for many species, including lichens, forest managers must formulate sustainable forest management practices that eliminate improper activities that threaten forest heterogeneity, such as selective logging, subsistence agriculture, fuel wood collections, forest fires, and natural degradation; which are widespread in Mt. Kenya (Bussman 1994; Vanleeuwe & Lambrechts 1999).

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Appendix 1 ð

List of species, abbreviations (Abbrv.) and occurrences in the ten study sites considered. Number (1) indicates presence, zero (0) absence of a species the study sites, whereas letter (C) refers to Chogoria and (S) Sirimon sides of Mount Kenya forest.

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Agonimia pacifica (H. Harada) Diederich	Ago_pac	1	0	1	0	0	0	0	0	0	0
Agonimia papillata (O.E. Eriks.) Diederich & Aptroot	Ago_pap	0	0	0	0	0	0	0	0	1	0
Agonimia tristicula (Nyl.) Zahlbr.	Ago_tri	0	1	0	0	0	0	0	0	0	0
Anzia afromontana R. Sant.	Anz_afro	0	0	0	0	0	1	0	1	0	0
Arthonia complanata Fée	Art_com	0	0	0	0	0	0	0	0	1	0
Bacidia aff. *medialis* (Tuck.) Zahlbr.	Bac_med	1	1	1	0	0	0	0	0	0	0
Bacidia sp.	Bac_sp	1	1	1	1	0	1	1	1	1	0
Bacidiopsora sp.	Baci_sp	0	0	0	0	0	0	0	0	1	0
Brigantiaea leucoxantha (Spreng.) R. Sant. & Hafellner	Brig_leu	1	0	1	1	0	0	0	0	0	0
Byssoloma leucoblepharum (Nyl.) Vain.	Bys_leu	1	0	0	0	0	0	0	0	0	0
Calicium salicinum Pers.	Cali_sal	0	0	0	0	0	0	0	0	1	0
Calicium sp. B	Cali_spB	0	0	0	0	0	0	0	0	1	0
Calicium sp. C	Cali_spC	0	0	0	0	0	0	0	0	1	0
Caloplaca brebissonii (Fée) J. Sant. ex Hafellner & Poelt	Calo_bre	0	0	0	0	0	0	0	0	1	1
Caloplaca sp. 1	Calo_sp1	0	0	0	0	0	0	0	0	0	1
Canoparmelia ecaperata (Müll. Arg.) Elix & Hale	Pse_eca	0	0	0	0	0	0	1	0	0	0
Canoparmelia nairobiensis (J. Steiner & Zahlbr.) Hale	Pse_nai	0	0	0	0	0	0	1	0	0	0
Canoparmelia texana (Tuck.) Elix & Hale	Can_tex	0	0	0	0	0	0	0	0	1	0
Catillochroma sp.	Cat_sp	0	0	0	1	0	0	0	0	0	0
Cetrelia braunsiana (Müll. Arg.) W.L. Culb. & C.F. Culb.	Cet_bra	0	0	0	0	0	0	0	0	0	0
Chrysothrix xanthina (Vain.) Kalb	Chr_xan	0	0	0	0	0	0	0	0	1	1
Cladestinotrema cladestinum (Ach.) Rivas Plata,Lücking and Lumbsch	Cla_cla	1	0	0	0	0	0	0	0	0	0
Cladonia insolita Ahti & Krog	Cla_ins	0	0	0	0	0	0	0	0	1	0
Cladonia leucophylla Ahti & Krog	Cla_leu	1	0	0	0	0	0	0	0	0	0
Coccocarpia erythroxyli (Spreng.) Swinscow & Krog	Coc_erl	0	0	0	0	0	0	1	0	0	0
Coccocarpia palmicola (Spreng.) Arv. & D.J. Galloway	Coc_pal	0	1	0	0	0	0	0	0	0	0
Coccocarpia pellita (Ach.) Müll. Arg.	Coc_pel	1	1	0	0	0	0	0	0	0	0

Species	Abbrv.	C1	C2	C3	C4	C5	C7	S1	S2	S3	S4
Coenogonium fallaciosum (Müll. Arg.) Kalb & Lücking	Coe_fal	0	0	1	0	0	0	0	0	0	
Coenogonium geralense (Henn.) Lücking	Coe_ger	1	0	0	0	0	0	0	0	0	
Coenogonium kalbii Aptroot, Lücking & Umaña	Coe_kal	0	0	0	1	0	0	0	1	0	
Coenogonium luteum (Dicks.) Kalb & Lücking	Coe_leu	0	0	0	0	0	0	1	0	1	
Coenogonium nepalense (G. Thor & Vezda) Lücking, Aptroot & Sipman	Coe_nep	0	0	0	0	1	0	0	0	0	
Coenogonium siquirrense (Lücking) Lücking	Coe_siq	0	1	0	0	0	0	0	0	0	
Coenogonium stenosporum (Malme) Lücking, Aptroot & Sipman	Coe_ste	0	0	0	0	0	0	1	0	0	
Coenogonium subfallaciosum (Vezda & Farkas) Lücking, Aptroot & Sipman	Coe_sub	0	0	0	0	1	0	0	0	0	
Cryptolechia caudata Kalb	Cry_cau	0	0	0	1	0	0	0	0	0	
Cryptothecia sp.	Cry_sp	0	1	1	0	1	0	0	0	0	
Diorygma minisporum Kalb, Staiger & Elix	Dio_min	0	0	1	0	0	0	0	0	0	
Eschatogonia triptophyllina (Nyl.) Kalb	Esc_tri	0	1	0	0	0	0	0	0	0	
Fellhanera fragilis (Vezda) Lücking & Kalb	Fel_fra	0	1	1	0	0	0	0	0	0	
Fissurina sp.	Fis_sp	0	1	0	0	0	0	0	0	0	
Fissurina triticea (Nyl.) Staiger	Fis_tri	1	0	0	0	0	0	0	0	0	
Flavoparmelia caperata (L.) Hale	Fla_cap	0	0	0	0	0	1	1	1	0	
Flavoparmelia soredians (Nyl.) Hale	Fla_fla	0	0	0	0	0	0	1	0	1	
Flavopunctelia flaventior (Stirt.) Hale	Fla-sor	0	0	0	0	0	0	1	1	1	
Graphis acharii Fée	Gra_ach	1	0	0	1	0	0	0	0	0	
Graphis consanguinea (Müll. Arg.) Lücking	Gra_con	0	0	0	1	0	0	0	0	0	
Graphis illinata Eschw.	Gra_ill	0	1	1	1	0	0	0	0	0	
Graphis macella Kremp.	Gra_mac	0	1	0	1	0	0	0	0	0	
Graphis proserpens Vain.	Gra_pro	1	1	1	1	0	0	0	0	0	
Graphis sp. nov.	Gra_spnv	0	0	0	1	0	0	0	0	0	
Graphis streblocarpa (Bél.) Nyl.	Gra_str	1	1	1	0	0	0	0	0	0	
Graphis subtenella Müll. Arg.	Gra_sub	0	1	0	0	0	0	0	0	0	
Haematomma collatum (Stirt.) C.W. Dodge	Hae_col	1	0	0	0	0	0	0	0	0	
Hemithecium chlorocarpum (Fée) Trevis.	Hem_chl	0	1	0	0	0	0	0	0	0	
Hemithecium sp.	Hem_sp	0	1	0	0	0	0	0	0	0	

Species	Abbrv.	C1	C2	C3	C4	C5	C7	S1	S2	S3	S4
Hemithecium sp. nov	Hem_spnv	0	1	0	0	0	0	0	0	0	0
Heterodermia allardii (Kurok.) Trass	Het_all	0	0	0	0	0	1	0	0	1	0
Heterodermia casarettiana (A. Massal.) Trevis.	Het_cal	0	0	0	1	0	1	1	0	0	0
Heterodermia hypoleuca (Mühl.) Trevis.	Het_hyp	0	0	0	0	0	0	0	0	1	0
Heterodermia japonica (M. Satô) Swinscow & Krog	Het_jap	0	1	0	0	0	1	1	1	1	1
Heterodermia lepidota Swinscow & Krog	Het_lep	0	0	0	0	0	0	0	1	1	1
Heterodermia leucomelos (L.) Poelt	Het_leu	0	1	0	1	0	1	0	1	1	1
Heterodermia microphylla (Kurok.) Skorepa	Het_mic	1	0	0	1	0	0	0	0	1	0
Heterodermia reagens (Kurok.) Elix	Het_rea	0	0	0	0	0	1	0	0	0	0
Heterodermia sp.	Het_sp	0	0	0	1	0	1	1	1	1	0
Heterodermia sp. nov.	Het_spnv	0	1	0	0	0	0	0	0	0	0
Hypotrachyna afrorevoluta (Krog & Swinscow) Krog & Swinscow	Hyp_afr	0	0	0	0	0	0	1	0	0	0
Hypotrachyna croceopustulata (Kurok.) Hale	Hyp_cro	0	0	0	0	0	0	1	0	0	0
Hypotrachyna immaculata (Kurok.) Hale	Hyp_imm	0	1	0	1	0	0	1	1	0	0
Hypotrachyna microblasta (Vain.) Hale	Hyp_mic	0	0	0	0	0	0	0	1	0	0
Hypotrachyna minarum (Vain.) Krog & Swinscow	Hyp_min	0	0	0	0	0	0	0	0	1	0
Hypotrachyna orientalis (Hale) Hale	Hyp_ori	0	0	0	0	0	0	0	0	1	0
Hypotrachyna polydactyla (Krog & Swinscow) T.H. Nash	Hyp_pol	0	0	0	0	0	0	1	0	0	0
Hypotrachyna sp.	Hyp_sp	1	0	0	0	0	0	0	0	0	0
Hypotrachyna sorocheila (Vainio) Divakar, A. Crespo, Sipman, Elix & Lumbsch	Cet_sor	0	0	0	0	1	0	0	0	0	0
Lecanactis platygraphoides (Müll. Arg.) Zahlbr.	Lecn_pla	0	0	0	1	0	0	0	0	0	0
Lecanora leprosa Fée	Lec_lep	1	0	0	0	0	0	0	0	0	0
Lecanora sp.	Lec_sp	0	0	0	1	0	0	1	0	0	1
Lecanora kenyana	Lec_sp1	0	0	0	0	0	0	0	0	1	0
Lecanora sp. 2	Lec_sp2	0	1	0	0	0	0	0	0	0	0
Lecanora sp. nov.	Lec_spnv	0	0	0	0	0	0	0	0	1	0
Lepraria cf. *caesioalba* (B. de Lesd.) J.R. Laundon	Lep_cfca	0	0	1	0	0	0	0	0	0	0
Lepraria cf. *incana* (L.) Ach.	Lep_cfin	1	0	1	0	0	0	0	0	0	0
Lepraria coriensis (Hue) Sipman	Lep_cori	0	0	0	0	0	0	1	1	0	0
Lepraria cupressicola (Hue) J.R. Laundon	Lep_cup	0	0	0	0	0	0	1	0	0	0
Lepraria incana (L.) Ach.	Lep_inc	1	0	1	1	0	0	1	1	0	0
Lepraria lobificans Nyl.	Lep_lob	0	0	0	1	0	0	0	1	1	0
Lepraria sp.	Lep_sp	1	1	1	0	0	1	1	0	0	0
Lepraria sp. 1	Lep_sp1	0	0	1	0	0	0	0	0	0	0

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Lepraria sp. 2	Lep_sp2	1	0	0	0	0	0	0	0	0	0
Lepraria sp. 3	Lep_sp3	0	0	0	0	0	0	0	1	0	0
Lepraria sp. 4	Lep_sp4	0	0	0	0	1	0	0	0	0	0
Lepraria usnica Sipman	Lep_usn	0	0	1	1	0	0	0	0	1	0
Leptogium austroamericanum (Malme) C.W. Dodge	Lep_aus	0	0	0	1	0	1	0	0	0	0
Leptogium azureum (Sw. ex Ach.) Mont.	Lep_azu	0	0	0	1	0	1	1	1	1	0
Leptogium burgessii (L.) Mont.	Lep_burg	0	0	0	0	0	1	0	0	0	1
Leptogium burnetiae C.W. Dodge	Lep_burn	0	0	0	1	0	1	1	0	1	1
Leptogium cochleatum (Dicks.) P.M. Jørg. & P. James	Lep_coc	0	0	1	0	0	1	0	0	0	0
Leptogium coralloideum (Meyen & Flot.) Vain.	Lep_cor	0	0	0	1	0	0	0	0	0	1
Leptogium cyanescens (Pers.) Körb.	Lep_cya	1	1	1	1	0	0	0	1	0	1
Leptogium furfuraceum (Harm.) Sierk	Lep_fur	0	0	0	0	0	1	0	0	0	1
Leptogium marginellum (Sw.) Gray	Lep_mar	0	0	0	0	0	0	0	0	1	1
Leptogium phyllocarpum (Pers.) Mont.	Lep_phy	0	0	0	0	0	1	0	1	0	0
Letrouitia flavocrocea (Nyl.) Hafellner & Bellem.	Let_fla	1	1	0	0	0	0	0	0	1	0
Lobaria patinifera (Taylor) Hue	Lob_pat	0	0	1	0	0	0	0	0	0	0
Lobaria pulmonaria (L.) Hoffm.	Lob_pul	0	0	0	0	0	1	0	1	1	0
Lobaria retigera (Bory) Trevis.	Lob_ret	0	0	0	1	0	0	0	1	0	0
Malmidea ceylanica	Mal_cey	1	1	1	0	0	0	0	0	0	0
Malmidea gyalectoides	Mal_gya	1	0	1	0	0	0	0	0	0	0
Malmidea sp.	Mal_sp	1	1	1	0	0	0	0	0	1	0
Megalospora coccodes (Bél.) Sipman	Meg_coc	1	1	0	0	0	1	0	0	0	0
Megalospora sp.	Meg_sp	1	1	0	0	0	0	0	0	0	0
Megalospora tuberculosa (Fée) Sipman	Meg_tub	1	1	1	0	0	0	0	0	0	0
Micarea sp.	Mic_sp	0	0	1	1	0	0	0	1	1	0
Mycoporum sparsellum Nyl.	Myc_spa	1	0	0	0	0	0	0	0	0	0
Nephroma tropicum (Müll. Arg.) Zahlbr.	Nep_tro	0	0	0	0	0	1	0	0	0	0
Ocellularia pluripora Hale	Oce_plu	1	0	0	0	0	0	0	0	0	0
Pannaria conoplea (Pers.) Bory	Pan_con	0	0	0	0	0	0	1	0	0	0
Parmeliella pannosa (Sw.) Müll. Arg.	Par_pan	0	0	0	0	0	0	1	0	0	0
Parmotrema abessinicum (Nyl. ex Kremp.) Hale	Par_abe	0	0	0	0	0	0	1	0	0	0
Parmotrema austrosinense (Zahlbr.) Hale	Par_aus	0	0	0	0	0	0	0	0	1	0
Parmotrema cetratum (Ach.) Hale	Par_cet	0	0	0	1	0	0	0	0	0	0
Parmotrema chinense (Osbeck) Hale & Ahti	Par_chi	0	0	0	1	1	1	0	1	0	0

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Parmotrema commensuratum (Hale) Hale	Par_com	0	0	0	0	0	0	1	0	0	0
Parmotrema cooperi (J. Steiner & Zahlbr.) Sérus.	Par_coo	0	0	0	0	0	0	1	0	1	0
Parmotrema gardneri (C.W. Dodge) Sérus.	Par_gar	0	1	0	0	0	0	0	0	0	0
Parmotrema hababianum (Gyeln.) Hale	Par_hab	0	0	0	1	0	0	1	1	1	0
Parmotrema indicum Hale	Par_ind	0	0	0	0	0	0	0	0	1	0
Parmotrema lophogenum (Abbayes) Hale	Par_lop	0	0	0	0	0	1	0	0	0	0
Parmotrema reticulatum (Taylor) M. Choisy	Par_ret	0	1	1	1	1	0	1	1	1	1
Parmotrema sancti-angelii (Lynge) Hale	Par_sac	0	0	0	1	0	0	0	0	1	0
Parmotrema sp.	Par_sp	0	1	0	1	1	1	1	1	1	1
Parmotrema subarnoldii (Abbayes) Hale	Par_suba	1	1	0	0	0	0	0	0	0	0
Parmotrema subisidiosum (Müll. Arg.) Hale	Par_subi	1	0	0	0	0	0	0	1	0	0
Parmotrema subschimperi (Hale) Hale	Par_subs	0	0	0	1	0	0	0	0	0	0
Parmotrema subtinctorium (Zahlbr.) Hale	Par_subt	0	0	0	0	0	0	0	0	1	0
Peltigera polydactyloides Nyl.	Pel_pol	0	0	0	0	0	1	0	0	0	0
Peltigera praetextata (Flörke ex Sommerf.) Vain.	Pel_pra	0	0	0	1	0	1	0	0	1	1
Peltigera ulcerata Müll. Arg.	Pel_ulc	0	0	0	0	0	1	0	0	0	0
Pertusaria cf. *krogiae* A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Per_cfkr	0	0	0	0	0	0	1	1	1	0
Pertusaria cf. *melanostoma* Nyl.	Per_cfme	0	0	0	0	0	0	1	0	0	0
Pertusaria cf. *scaberula* A.W. Archer	Per_cfsc	1	0	0	0	0	0	0	0	0	0
Pertusaria endoxantha Vain.	Per_end	0	0	0	0	0	1	1	1	1	0
Pertusaria fosseyae A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Per_fos	0	1	0	0	0	1	0	1	1	1
Pertusaria krogiae A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Pel_kro	0	0	0	0	0	1	1	1	1	1
Pertusaria lambinonii A.W. Archer, Elix, Eb. Fischer, Killmann & Sérus.	Per_lam	0	0	0	1	0	0	0	0	0	0
Pertusaria maritima A.W. Archer & Elix	Per_mar	0	0	0	1	0	0	0	0	0	0
Pertusaria microstoma Müll. Arg.	Per_mic	0	0	0	1	0	0	0	0	0	0
Pertusaria pilosula A.W. Archer & Elix	Per_pil	1	0	0	0	0	0	1	1	0	1
Pertusaria scaberula A.W. Archer	Per_sca	0	0	0	1	0	0	0	1	1	0

Species	Abbrv.	C1	C2	C3	C4	C5	C7	S1	S2	S3	S4
Pertusaria sp.	Per_sp	1	0	0	1	0	0	1	0	1	1
Pertusaria sp. 1	Per_sp1	0	0	1	0	0	0	0	0	0	0
Pertusaria sp. 2	Per_sp2	0	1	0	1	0	0	0	0	0	0
Pertusaria sp. 3	Per_sp3	0	0	0	0	0	1	0	0	0	0
Pertusaria subrigida Müll. Arg.	Per_sub	0	0	0	1	0	0	0	0	0	0
Pertusaria velata (Turner) Nyl.	Per_vel	1	0	0	0	0	0	0	0	0	0
Phaeographis dendritica (Ach.) Müll. Arg.	Pha_den	1	0	0	0	0	0	0	0	0	0
Phaeographis girringunensis A.W. Archer & Elix	Pha_gir	1	1	0	0	0	0	0	0	0	0
Phaeophyscia hispidula (Ach.) Essl.	Pha_his	0	0	0	0	0	1	1	1	0	0
Phlyctis sp.	Phly_sp	1	1	1	1	1	0	0	0	0	0
Phyllopsora albicans Müll. Arg.	Phyl_alb	1	1	1	0	0	0	0	1	1	0
Phyllopsora chlorophaea (Müll. Arg.) Zahlbr.	Phyl_chl	0	0	1	0	0	0	0	0	0	0
Phyllopsora confusa Swinscow & Krog	Phyl_con	1	1	1	1	0	0	0	0	1	1
Phyllopsora mediocris Swinscow & Krog	Phyl_med	1	1	1	0	0	0	0	0	0	0
Phyllopsora santensis (Tuck.) Swinscow & Krog	Phyl_san	1	1	1	0	0	0	0	0	0	0
Phyllopsora sp.	Phyl_sp	1	1	0	1	0	0	0	1	0	0
Phyllopsora sp. 1	Phyl_sp1	1	0	1	0	0	0	0	0	0	0
Physcia albata (F. Wilson) Hale	Phys_alb	0	0	0	0	0	0	0	0	1	1
Physcia dilatata Nyl.	Phys_dil	0	0	1	0	0	0	0	0	0	0
Physcia sp.	Phys_sp	0	0	0	0	0	0	0	0	0	1
Physconia muscigena (Ach.) Poelt	Physc_mu	0	0	0	0	0	0	0	0	0	1
Piccolia elmeri (Vain.) Hafellner	Pic_elm	1	0	0	0	0	0	0	0	0	0
Platygramme caesiopruinosa (Fée) Fée	Pla_cae	1	0	0	1	0	0	0	0	0	0
Porina brisbanensis Müll. Arg.	Por_bri	0	0	1	0	0	0	0	0	0	0
Porina conspersa Malme	Por_con	0	1	0	0	0	0	0	0	0	0
Porina distans Vezda & Vivant	Por_dis	0	1	0	0	0	0	0	0	0	0
Porina exocha (Nyl.) P.M. McCarthy	Por_exo	1	0	0	0	0	0	0	0	0	0
Porina imitatrix Müll. Arg.	Por_imi	1	0	0	0	0	0	0	0	0	0
Porina internigrans (Nyl.) Müll. Arg.	Por_int	0	1	0	0	0	0	0	0	0	0
Porina nucula Ach.	Por_nuc	0	1	1	0	0	0	0	0	0	0
Porina nuculastrum (Müll. Arg.) R.C. Harris	Por_nucl	1	0	0	0	0	0	0	0	0	0
Porina sp.	Por_sp	1	1	1	0	0	0	0	0	0	0
Porina sp. 1	Por_sp2	0	1	0	0	0	0	0	0	0	0
Porina sp. nov.	Por_spnv	1	1	0	0	0	0	0	0	0	0
Pseudocyphellaria aurata (Ach.) Vain.	Pseu_aur	0	0	0	0	0	1	1	0	0	0
Pseudoparmelia sp.	Pse_sp	0	0	0	1	0	0	1	1	0	1
Pseudoparmelia sphaerospora (Nyl.) Hale	Pse_sph	1	0	0	0	0	0	0	0	0	0

Species	Abbrv.	C1	C2	C3	C4	C5	C7	S1	S2	S3	S4
Punctelia neutralis (Hale) Krog	Pun_neu	0	0	0	0	0	1	0	0	0	0
Punctelia rudecta (Ach.) Krog	Pun_rud	0	0	0	1	0	0	0	1	1	0
Punctelia semansiana (W.L. Culb. & C.F. Culb.) Krog	Pun_sem	0	0	0	0	1	0	0	0	0	0
Punctelia sp.	Pun_sp	0	0	0	0	0	0	0	0	1	0
Punctelia subrudecta (Nyl.) Krog	Pun_sub	0	0	0	1	0	0	0	0	1	1
Pyrenula acutispora Kalb & Hafellner	Pyr_acu	0	0	0	1	0	0	0	0	0	0
Pyrenula cf. *cruenta* (Mont.) Vain.	Pyr_cfcr	0	0	1	0	0	0	0	0	0	0
Pyrenula cruenta (Mont.) Vain.	Pyr_cru	1	1	1	1	0	0	0	0	0	0
Pyrenula globifera (Eschw.) Aptroot	Pyr_glo	0	0	0	1	0	0	0	0	0	0
Pyrenula macrocarpa Massal.	Pyr_mac	0	1	0	0	0	0	0	0	0	0
Pyrenula mastophora (Nyl.) Müll. Arg.	Pyr_mas	1	0	1	1	0	0	0	0	0	0
Pyrenula nitidula (Bres.) R.C. Harris	Pyr_nit	0	1	0	0	0	0	0	0	0	0
Pyrenula platystoma Müll. Arg.	Pyr_pla	0	1	0	0	0	0	0	0	0	0
Pyrenula pyrenuloides (Mont.) R.C. Harris	Pyr_pyr	0	0	1	0	0	0	0	0	0	0
Pyrenula quassiaecola Fée	Pyr_qua	0	1	0	0	0	0	0	0	0	0
Pyrenula santensis (Nyl.) Müll. Arg.	Pyr_san	1	0	1	1	0	0	0	0	0	0
Pyrenula sp.	Pyr_sp	1	1	1	1	0	0	0	0	0	0
Ramalina celastri (Spreng.) Krog & Swinscow	Ram_cel	0	0	0	0	0	0	0	0	0	0
Ramalina pollinaria (Westr.) Ach.	Ram_pol	0	0	0	0	0	0	0	0	0	1
Ramalina pusiola Müll. Arg.	Ram_pus	0	0	0	1	0	0	0	0	0	0
Ramalina sp.	Ram_sp	0	0	0	0	0	0	1	0	0	0
Rinodina sp. 1	Rin_sp1	0	0	0	0	0	0	1	0	0	0
Sphaerophorus melanocarpus (Sw.) DC.	Sph_mel	0	0	1	0	0	0	0	0	0	0
Sphinctrina tubiformis A. Massal.	Sph_tub	0	0	0	0	0	0	0	0	1	0
Sticta ambavillaria (Bory) Ach.	Sti_amb	0	0	0	0	0	1	1	1	1	1
Sticta fuliginosa (Dicks.) Ach.	Sti_ful	0	0	0	0	0	1	0	1	1	0
Sticta kunthii Hook. f.	Sti_kun	0	0	0	0	1	0	0	0	0	0
Sticta tomentosa (Sw.) Ach.	Sti_tom	1	0	1	0	0	0	0	0	0	0
Sticta weigelii Isert	Sti_wei	0	1	1	1	1	0	0	0	0	0
Strigula sp. nov.	Str_spnv	0	0	0	0	1	0	0	0	0	0
Teloschistes exilis (Michx.) Vain.	Tel_exi	0	0	0	0	0	0	1	0	0	0

Species	**Abbrv.**	**C1**	**C2**	**C3**	**C4**	**C5**	**C7**	**S1**	**S2**	**S3**	**S4**
Tephromela atra (Huds.) Hafellner	Tep_atr	0	0	0	1	0	0	0	0	0	0
Thelotrema canarense Patw. & C.R. Kulk.	The_can	0	1	0	0	0	0	0	0	0	0
Thelotrema diplotrema Nyl.	The_dip	0	0	0	1	0	0	0	0	0	0
Thelotrema lepadinum (Ach.) Ach.	The_lep	0	0	0	0	0	0	0	0	1	0
Thelotrema sp. nov.	The_spnv	0	1	0	0	0	0	0	0	0	0
Trapeliopsis gelatinosa (Flörke) Coppins & P. James	Tra_gel	1	0	0	0	0	0	0	0	0	0
Unknown Crust 1	Crust1	1	0	1	0	0	0	0	0	0	0
Unknown Crust 2	Crust2	1	0	1	0	0	0	0	0	0	0
Unknown Crust 3	Crust3	1	1	0	0	0	0	0	0	0	0
Unknown Crust 4	Crust4	0	0	1	0	0	0	0	0	0	0
Unknown Crust 5	Crust5	1	0	1	0	0	0	0	0	0	0
Unknown Crust 6	Crust6	1	1	1	0	0	0	0	0	0	0
Unknown Crust 7	Crust7	0	0	1	0	0	0	0	0	0	0
Unknown Crust 8-isidiate	Crust8	0	0	0	0	0	0	1	0	0	0
Usnea albomaculata Motyka	Usn_alb	0	0	0	0	0	0	0	1	0	0
Usnea articulata (L.) Hoffm.	Usn_art	0	0	0	0	0	0	0	1	0	1
Usnea bicolorata Motyka	Usn_bic	0	0	0	0	0	1	0	0	0	0
Usnea exasperata (Müll. Arg.) Motyka	Usn_exa	0	0	0	1	1	1	0	1	0	0
Usnea firmula (Stirt.) Motyka	Usn_firm	0	0	0	0	0	1	0	0	0	0
Usnea picta (J. Steiner) Motyka	Usn_pic	0	0	0	0	0	1	0	0	0	0
Usnea rubicunda Stirt.	Usn_rub	0	1	0	0	0	0	0	0	0	0
Usnea sp.	Usn_sp	0	0	0	0	0	0	0	0	0	1
Usnea trichodeoides Motyka	Usn_tri	0	0	0	0	0	1	0	0	0	0
Usnea undulata Stirt.	Usn_und	0	0	0	0	1	0	1	1	0	0
Xanthoria candelaria (L.) Th. Fr.	Xan_can	0	0	0	0	0	0	0	0	0	1
Xanthoria parietina (L.) Beltr.	Xan_par	0	0	0	0	0	0	0	0	0	1