

Diversity and distribution of epiphytic lichens on *Cedrus atlantica* and *Quercus faginea* in Mount Babor Forest, Algeria

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Abstract. Belguidoum A, Lograda T, Ramdani M. 2021. Diversity and distribution of epiphytic lichens on *Cedrus atlantica* and *Quercus faginea* in Mount Babor Forest, Algeria. *Biodiversitas* 22: 887-899. Information about lichen diversity in Algeria is limited despite their important role as biological indicators of ecosystem health. The aim of the study was to carry out an inventory of epiphytic lichens in the Mount Babor Forest on two types of phorophytes (host trees), i.e., *Cedrus atlantica* and *Quercus faginea*, in varying altitudinal gradients and the diameter of host tree. The similarity of the sampled sites was assessed by the Sorensen index (β). Sixty-six species of epiphytic lichens were identified, which belong to 24 families and 38 genera. *C. atlantica* hosted a higher number of species than *Q. faginea*. The majority of lichen on *C. atlantica* belonged to the *Parmeliaceae* family, whereas those on *Q. faginea* belonged to the *Physciaceae* family. Crustose and foliose lichens were the most common species in the study area. The results showed the existence of a distinct relationship between the parameters of the distribution (i.e., tree diameter, elevation) and the specific lichen richness. The greatest number of lichen species (59 species) was observed on large diameter trunks (41-60 cm). Lichen diversity increased along with the increase in altitude. Sorensen's similarity index revealed the presence of heterogeneity in the community composition of lichen vegetation.

Keywords: Algeria, biodiversity, *Cedrus atlantica*, epiphytic lichens, Mount Babor Forest, *Quercus faginea*

INTRODUCTION

Lichens play an important role in forest ecosystems. They provide food resources and refuges for other organisms and influence forest hydrology and nutrients cycling (Stapper and John 2015; Van Stan and Pypker 2015). However, lichens are unfamiliar to common people, and even for naturalists whose knowledge of species is imperfect. Despite there is an increasing trend in the discoveries of newly described lichens. They are subject to very strong anthropogenic pressure caused by industrialization, increased urbanization, and exploitation of forest areas, especially those in the Mediterranean forests, which are a fragile natural environment (Scheidegger and Goward 2002; Bricaud 2010; Root et al. 2015; Nardi et al. 2016; Lubek et al. 2018).

Because of their sensitivity to any changes in environmental conditions, lichens are often used as biological indicators of habitat change (Vondrák et al. 2018). Lichens are able to integrate the effects of different biotic and abiotic environmental factors. For example, analysis of their occurrence on forest stands provides guidance on media interference levels and the state of maturation of forest stands (Jonsson et al. 1999; Watt et al. 2007; Bergamini et al. 2009; Bricaud 2010).

Species richness, abundance, and distribution of lichens in an ecosystem can be used as a model to characterize the responses of lichens to environmental changes (Stofer et al. 2006; Pinho et al. 2012). Environmental factors, microclimatic changes, and habitat characteristics, such as

age and diameter of trees and physical properties of bark, as well as altitude, influence significantly the growth and distribution of lichen species (Hedenas and Ericson 2000; Van Herk 2001; Radies and Coxson 2004). In some cases, the Sorensen similarity index has been used to compare the assessment of species from two populations (Sevgi et al. 2010; Sanogo and Kabre, 2014; Boni et al. 2015). This classic method of calculating this coefficient is widely used in ecological studies (Benítez et al. 2018; Vondrák et al. 2018).

Algeria is poorly explored from a lichenological perspective despite its vast area (i.e., 2,381,741 km²). Only few fragmentary and occasional floristic inventory studies have been devoted to it (Amrani et al. 2015). One of the most important biodiversity areas in the country is Mount Babor. The floristic diversity of the Mount Babor Forest is much more marked than that of most other regions of Algeria, because of its orographic and essentially climatic peculiarities. It is an area known for its natural landscapes and exceptionally rich biodiversity, rare and endemic species (Quézel and Santa 1962; Ledant et al. 1985; Bougaham et al. 2015, 2020; Bougaham and Rebbas 2020).

The aim of this study is to investigate the diversity and distribution of epiphytic lichens on two species of phorophytes (host trees), namely *Cedrus atlantica* and *Quercus faginea* in the Mount Babor Forest. We expect that the results of this study can enrich the checklist of lichens species in Algeria, and the Mediterranean region more broadly.

MATERIALS AND METHODS

Study area and period

The study was conducted in the Mount Babor Forest during the period of March to November 2020. Mount Babor Forest is located in the southern part of the province of Setif, Algeria and lies between the latitudes $36^{\circ} 29' 18''$ - $36^{\circ} 19' 05''$ N and the longitudes $5^{\circ} 24' 56''$ – $5^{\circ} 30' 46''$ E (Figure 1). The forest covers a total area of 1000 ha. The highest elevation of the study area is 2004 m above sea level (asl).

The lengthening of mountainous masses, perpendicular to the direction of the humid winds, favors the condensation of clouds on the northern slope, which receives 1190mm of precipitation, while the southern slope receives only 717mm. The most intense precipitation occurs during the months of December through March. The average snowfall duration is 156 days/year (Gharzouli 2007). The climate of the region is continental with February being the coldest month of the year, while the

hottest month is August. The minimum temperature is -3°C , while the maximum is 28°C .

The Babor forest ecosystem is dominated by cedar (*Cedrus atlantica*). This species is widely distributed especially on the north side of Mount Babor; the *Cedrus* is very dominant above 900 m asl. The vegetation below 800 m asl consists of *Cedrus atlantica*, *Quercus ilex*, *Juniperus oxycedrus*, *Buxus sempervirens*, *Populus tremula*, *Acer campestre*, *Acer obtusatum* and *Quercus faginea* accompanied with *Abies numidica*, species endemic to Mount Babor (Quézel and Santa 1962; Ledant et al. 1985; Gharzouli 2007).

Sampling methods

Specimens of epiphytic lichen living on *Cedrus atlantica* and *Quercus faginea* phorophytes were collected from 15 sampling sites in the Mount Babor Forest (Table 1). All samples were collected at a height of 0 to 2m from the ground and around the trunk. The diameters of *Cedrus atlantica* phorophytes were grouped into five diameter classes: 0-20, 21-40, 41-60, 61-100 and over 100 cm.

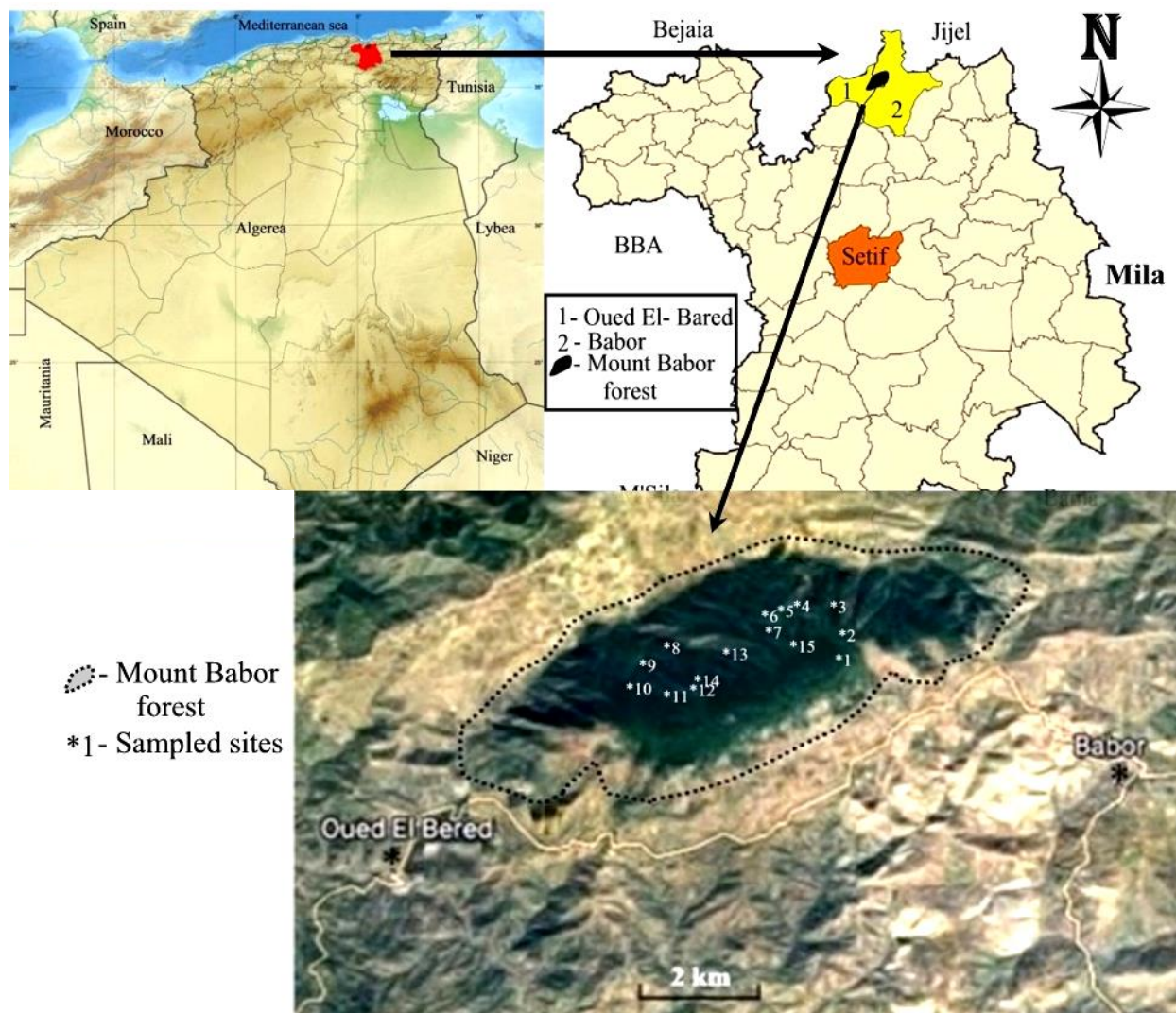


Figure 1. Location of the sampling sites in Mount Babor Forest, Setif Province, Algeria

Table 1. Geographical coordinates of the sampled sites

Sites	Geographical coordinates	Alt. (m)	Phorophytes
1	36° 30' 13" N 5° 29' 08" E	1400	<i>C. atlantica</i>
2	36° 30' 23" N 5° 29' 09" E	1514	
3	36° 30' 38" N 5° 28' 38" E	1580	
4	36° 30' 28" N 5° 28' 28" E	1718	
5	36° 30' 28" N 5° 28' 22" E	1778	<i>C. atlantica</i> and
6	36° 30' 40" N 5° 28' 28" E	1790	<i>Q. faginea</i>
7	36° 30' 33" N 5° 28' 24" E	1812	
8	36° 30' 10" N 5° 26' 37" E	1868	
9	36° 30' 10" N 5° 26' 40" E	1900	
10	36° 30' 10" N 5° 26' 19" E	1930	
11	36° 30' 05" N 5° 26' 35" E	1940	
12	36° 30' 08" N 5° 27' 17" E	1948	
13	36° 30' 15" N 5° 27' 40" E	1952	
14	36° 30' 10" N 5° 27' 22" E	1950	
15	36° 30' 15" N 5° 28' 38" E	1774	

Lichens identification

The lichen materials were observed in detail using a binocular (Optika) and an optical microscope (Aksioscop 40, Zeiss; magnification: 40X), using spot tests with chemicals. The identification of the lichens was based on references from several books, including Ozenda and Clauzade (1970); Boistel (1986); Tiévant (2001); Jans (2011); Van Haluwyn et al. (2013), and websites, such as French Association of Lichenology (<http://www.afl-lichenologie.fr>), LIAS light – A Database for Rapid Identification of Lichens (<http://liaslight.lias.net/>) and the British Lichen Society (<https://www.britishtichensociety.org.uk/>). Specimens of the identified lichens have been preserved in the herbarium of the VRBN Laboratory of the Faculty of Nature and Life Sciences of Ferhat Abbas University, Algeria.

Calculation of the Sorensen Index

The Sorensen index (β) measures the similarity between species from two sites (Sorensen 1948; Whittaker 1960). It is based on the following formula:

$$\beta = 2C / (S1 + S2)$$

Where;

C : Number of common species between two sites

S1: Number of species for site 1

S2: Number of species for site 2

The Sorensen index ranges from zero (no common species between two sites); to one (all species from site 1 exist in site 2).

RESULTS AND DISCUSSION

Species richness

The inventory of lichen species on two phorophytes (*Cedrus atlantica* and *Quercus faginea*) at the 15 sites in

the Mount Babor Forest resulted in 66 species of epiphytic lichens (Table 2). Species richness of the lichens on the two types of phorophytes was different with a larger number of lichen species were found on *Cedrus atlantica*, which was the dominant species in the region. Some species were present in all stations including *Pleurosticta acetabulum*, *Pseudevernia furfuracea*, *Parmelina pastillifera*, *Pertusaria amara*, *Lecanora alpigena*, *Anaptychia ciliaris*, and *Lecanora argentata*, suggesting that they are generalist species adapted to wide range of ecological conditions. Many nitrophilic species from the genera of *Caloplaca*, *Physcia*, and *Xanthoria* were present. These species disappear during the closure and aging of the afforestation.

Physiognomic forms

All physiognomic forms of the lichens were represented in the study area (Figure 2). A clear dominance of crustacean thalli was to be noted in which 60% of the morphological forms were found on *C. atlantica* and 64% were found on *Q. faginea*. The foliose thalli were represented by 21% of species on *C. atlantica* and 15% on *Q. faginea*. On the other hand, the complex and fruticose thalli were the least represented in the study area. As for the categories of squamulose, gelatinous and leper's thalli, they were poorly represented. The corticolous and lignicolous sampling carried out in the Mount Babor Forest showed that epiphytic lichens grew luxuriantly on *C. atlantica* than on *Q. faginea*.

The inventory of the lichens on *C. atlantica* allowed us to identify 62 species, belonging to 36 genera grouped into 23 families (Figure 3). *Parmeliaceae* revealed their dominance over the phorophyte *C. atlantica* with nine species, followed by *Teloschistaceae* and *Lecanoraceae* with seven species for each. The *Physciaceae* and *Pertusariaceae* families, were represented each one by six species, followed by *Ochrolechiaceae* with four species, while the rest of the families was represented by one or two lichen species.

On *Q. faginea*, 39 species of lichens were inventoried, belonging to 21 genera and 18 families (Figure 3). The *Phlyctidaceae* family, with eight species of lichens, was the richest in specific diversity, followed by *Lecanoraceae* (5 species) and *Teloschistaceae* with 4 species. The two families *Cladoniaceae* and *Ochrolechiaceae* were represented by three species for each one.

The systematic spectrum shows greater generic biodiversity on *Cedrus atlantica* than *Quercus faginea* (Figure 4). On *C. atlantica*, the genus *Lecanora* with seven lichen species was the richest in specific diversity, followed by the genus *Caloplaca* with 6 species, *Ochrolechia* with 4 species, and *Physcia* with 3 species, while the other 31 genera were represented by one or two species. However, the genera *Phlyctis* and *Lecanora* were represented by 5 lichen species each on *Q. faginea*, followed by the genus *Caloplaca*, with 4 species, *Ochrolechia* and *Cladonia* with 3 species and two species for each of the genera (*Physconia*, *Pertusaria*, and *Acrocordia*), while the 13 genera were represented by a single species.

Table 2. Lichen species identified on two phorophytes (host trees) at 15 stations in Mount Babor Forest, Algeria

Species	Thalli	Phorophyte		Stations
		1	2	
<i>Acrocordia conoidea</i> (Fr.) Körb.	Cr	-	+	S8, S12, S13, S15
<i>Acrocordia punctata</i> (Ach.) A. Massal.	Cr	+	+	S5-S7, S9-S15
<i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid	Cr	+	-	S5-S15
<i>Anaptychia ciliaris</i> (L.) Körb. Ex Massal.	Fr	+	+	S1-S15
<i>Bacidia rubella</i> (Hoffm.) Massal	Cr	+	+	S4-S11, S12-S15
<i>Bryoria capillaris</i> (Ach.) Brodo et Hawksw.	Fr	+	-	S4-S8
<i>Bryoria fuscescens</i> (Gyeln.) Brodo & Hawksw.	Fr	+	-	S4-S11
<i>Calicium viride</i> Pers.	Cr	+	-	S5-S15
<i>Caloplaca cerina</i> (Ehrh. Ex Hedw.) Th. Fr.	Cr	+	-	S5-S12
<i>Caloplaca ferruginea</i> (Huds.) Th. Fr.	Cr	+	+	S5-S8, S12
<i>Caloplaca flavorubescens</i> (Huds.) Laundon	Cr	+	-	S3-S15
<i>Caloplaca flavovirescens</i> (Wulfen) D.T. & Sarnth.	Cr	+	+	S3-S7, S12
<i>Caloplaca inconnexa</i> (Nyl.) Zahlbr.	Cr	+	+	S4-S11
<i>Caloplaca suaedae</i> o.l. Gilbert et Coppins	Cr	+	+	S4-S13
<i>Candelariella reflexa</i> (Nyl.) Lettau	Cr	+	+	S5-S15
<i>Candelariella vitellina</i> (Hoffm.) Müll. Arg. Chémo.	Cr	+	-	S4-S8, S10-S14
<i>Chrysothrix flavovirens</i> Tønsberg	Le	+	+	S5-S11, S13
<i>Cladonia coniocraea</i> (Flörke) Spreng.	Co	+	+	S1-S8, S12-S15
<i>Cladonia fimbriata</i> (L.) Fr	Co	-	+	S7, S8, S15
<i>Cladonia symphylicarpa</i> (Flörke) Fr.	Co	-	+	S15
<i>Cliostomum griffithii</i> (Sm.) Hepp	Cr	-	+	S7, S8, S12-S15
<i>Coenogonium luteum</i> (Dicks.) Kalb et Lücking	Cr	+	-	S5, S10-S14
<i>Collema nigrescens</i> (Huds.) Dc	Ge	+	-	S5, S10-S14
<i>Collema subflaccidum</i> Degel.	Ge	-	+	S7, S8
<i>Evernia prunastri</i> (L.) Ach Chémo.	Fr	+	-	S4-S9
<i>Flavoparmelia caperata</i> (L.) Hale	Fo	+	-	S1, S5-S8, S12-S15
<i>Heteropladidium fuscum</i> (Nyl.) G. et Roux	Fo	+	-	S5-S12, S14
<i>Hypocnomyce scalaris</i> (Ach.) M. Choisy	Sq	+	+	S5, S6, S9-S15
<i>Hypogymnia tubulosa</i> (Schaer.) Hav.	Fo	+	-	S6-S14
<i>Imshaugia aleurites</i> S.l.f. Meyer	Fo	+	-	S1, S3, S6, S13, S14
<i>Lecanora allophana</i> (Ach.) Nyl.	Cr	+	-	S2-S6, S9-S13
<i>Lecanora alpigena</i> (Ach.) Roux	Cr	+	+	S1, S3, S5, S6, S9-S13, S15
<i>Lecanora argentata</i> (Ach.) Malm	Cr	+	+	S1-S15
<i>Lecanora carpinea</i> (L.) Vain.	Cr	+	+	S1-S4, S6, S7, S10-S14
<i>Lecanora chlorotera</i> Nyl.	Cr	+	+	S1, S3, S5, S6, S9-S15
<i>Lecanora conizaeoides</i> Nyl. Ex cromb.	Cr	+	+	S1-S6, S10-S15
<i>Lecanora strobilina</i> (Spreng.) Kieff.	Cr	+	-	S2-S15
<i>Lecidella elaeochroma</i> (Ach.) M.	Cr	+	+	S1-S3, S5-S14
<i>Lepraria incana</i> (L.) Ach	Le	+	-	S2, S3, S5-S15
<i>Mycoblastus sanguinarius</i> (L.) Norman	Cr	+	+	S2-S13
<i>Nephroma parile</i> Ach.	Fo	+	-	S5-S15
<i>Ochrolechia subviridis</i> (Høeg) Erichsen	Cr	+	-	S2-S15
<i>Ochrolechia tatarea</i> (L.) Massal.	Cr	+	+	S2-S15
<i>Ochrolechia turneri</i> (Sm.) Hasselr.	Cr	+	+	S1-S3, S6-S14
<i>Ochrolechia alboflavescens</i> (Wulfen) Zahlbr.	Cr	+	+	S3-S15
<i>Parmelia tiliacea</i> (Hoffm.) Hale	Fo	+	-	S7, S15
<i>Parmelina pastillifera</i> (Harm.) Hale	Fo	+	-	S1-S15
<i>Pertusaria amara</i> (Ach.) Nyl.	Cr	+	+	S1-S15
<i>Pertusaria flavida</i> (Dc.) Laundon	Cr	+	-	S1-S8, S12-S15
<i>Pertusaria hymenea</i> (Ach.) Schaerer	Cr	+	-	S3-S7, S9-S15
<i>Pertusaria mammosa</i> Harm.	Cr	+	-	S4-S6, S9, S13-S15
<i>Pertusaria pertusa</i> (Weigel) Tuck.	Cr	+	+	S3-S15
<i>Phlyctis agelaea</i> (Ach.) Flot.	Cr	+	+	S3-S11
<i>Phlyctis argena</i> (Sprengel) Flotow	Cr	+	+	S3-S14
<i>Physcia aipolia</i> (Ehrh. Ex Humb.) Fűrnröhe	Fo	+	+	S3-S11
<i>Physcia leptalea</i> (Ach.) Dc.	Fo	+	+	S4, S8
<i>Physcia tenella</i> (Scop.) Dc	Fo	+	+	S3-S5, S9-S11
<i>Physconia grisea</i> (Lam.) Poelt	Fo	+	+	S1, S12
<i>Physconia venusta</i> (Ach.) Poelt	Fo	+	+	S4-S8, S10-S12, S15
<i>Pleurosticta acetabulum</i> (Neck.)	Fo	+	+	S1-S15
<i>Protoblastenia rupestris</i> (Scop.) Steiner	Cr	+	+	S2, S4
<i>Pseudevernia furfuracea</i> (L.) Zopf – Lég.	Fr	+	+	S1-S15
<i>Ramalina farinacea</i> (Hoffm.)	Fr	+	-	S7, S9, S10, S12
<i>Tephromela atra</i> (Wld.) Vainio	Cr	+	+	S1, S4, S5
<i>Varicellaria hemisphaerica</i> (Flörke)	Cr	+	-	S1, S4, S12, S14, S15
<i>Xanthoria parietina</i> (L.) Th. Fr.	Fo	+	-	S1, S2

Note: Thallus (Cr: Crustose, Fr: Fruticose, Co: Complex, Fo: Foliose, Le: Lepers, Sq: Squamulose, Ge: Gelatinous); Phorophyte (1: *C. atlantica*, 2: *Q. faginea*; (+) Present, (-) Absent; Lichens images are assembled in Figure S1.

Diameter classes

The distribution of lichens according to the diameter of the trees showed that a very low number of lichens occupied trees with a trunk diameter less than 20 cm (young trees) (Figure 5). The greatest number of lichens (59 species) was observed on medium diameter trunks (41–60 cm in diameter). The number of species decreased again when the tree diameter increases (on old trees with a diameter exceeding 100 cm).

Altitudinal gradient

A close relationship between the altitudinal gradient and the number of epiphytic species on *C. atlantica* was detected (Figure 6). The increase in altitude had a positive relationship with the increase of the number of epiphytic species, confirmed by the regression curve. The highest richness was observed for an altitudinal range between 1750 and 1955 m asl. The smallest number of species, 19 species, was found at the lowest elevation which is 1400 m asl.

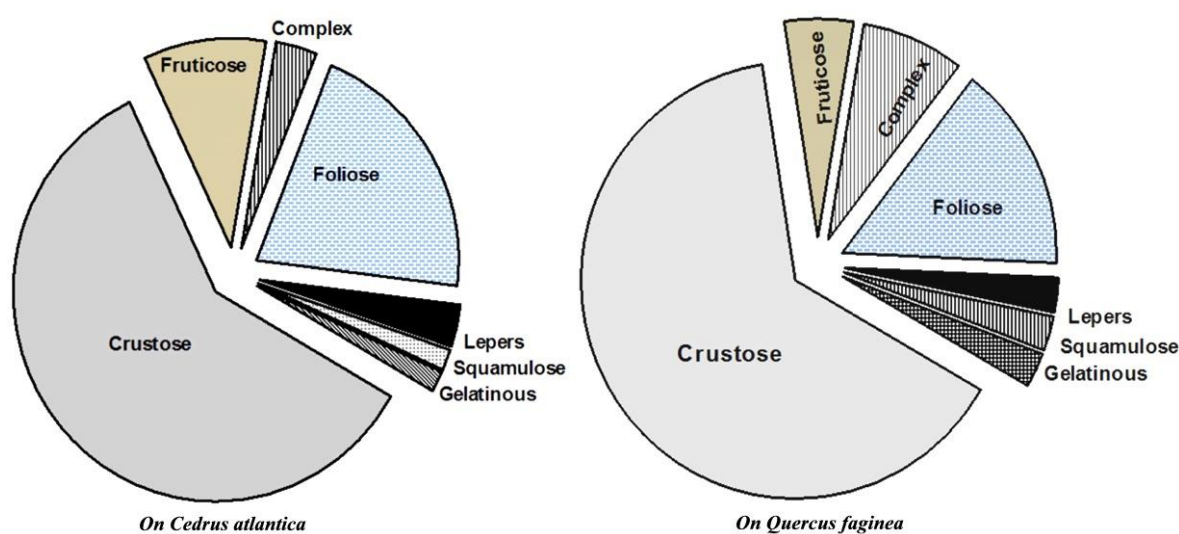


Figure 2. Morphological type of lichens on *Cedrus atlantica* and *Quercus faginea*

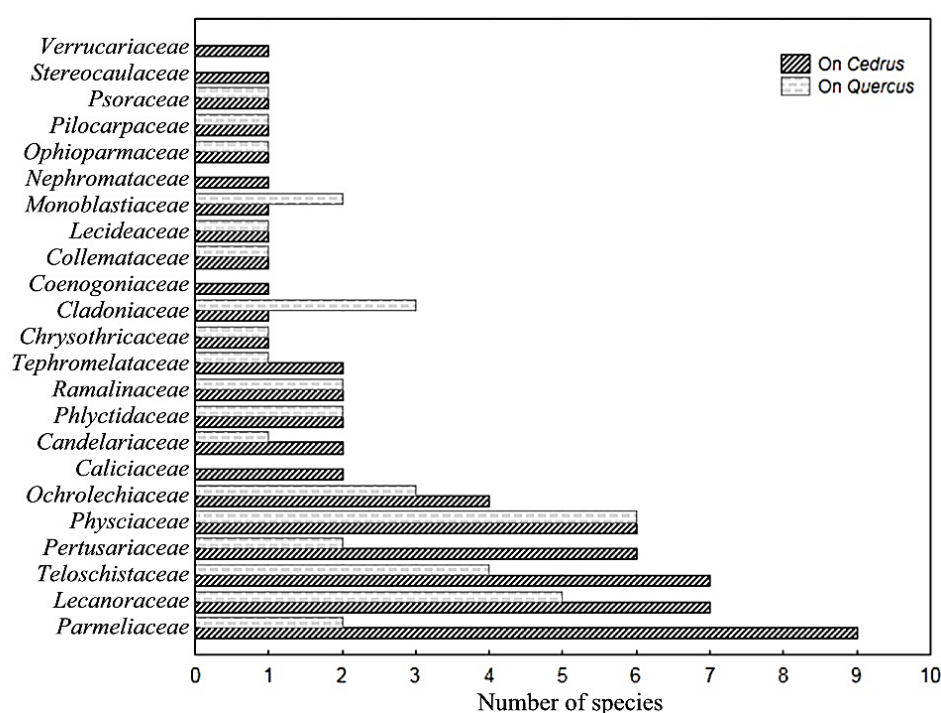


Figure 3. Number of species in each family identified on *Cedrus atlantica* and *Quercus faginea*

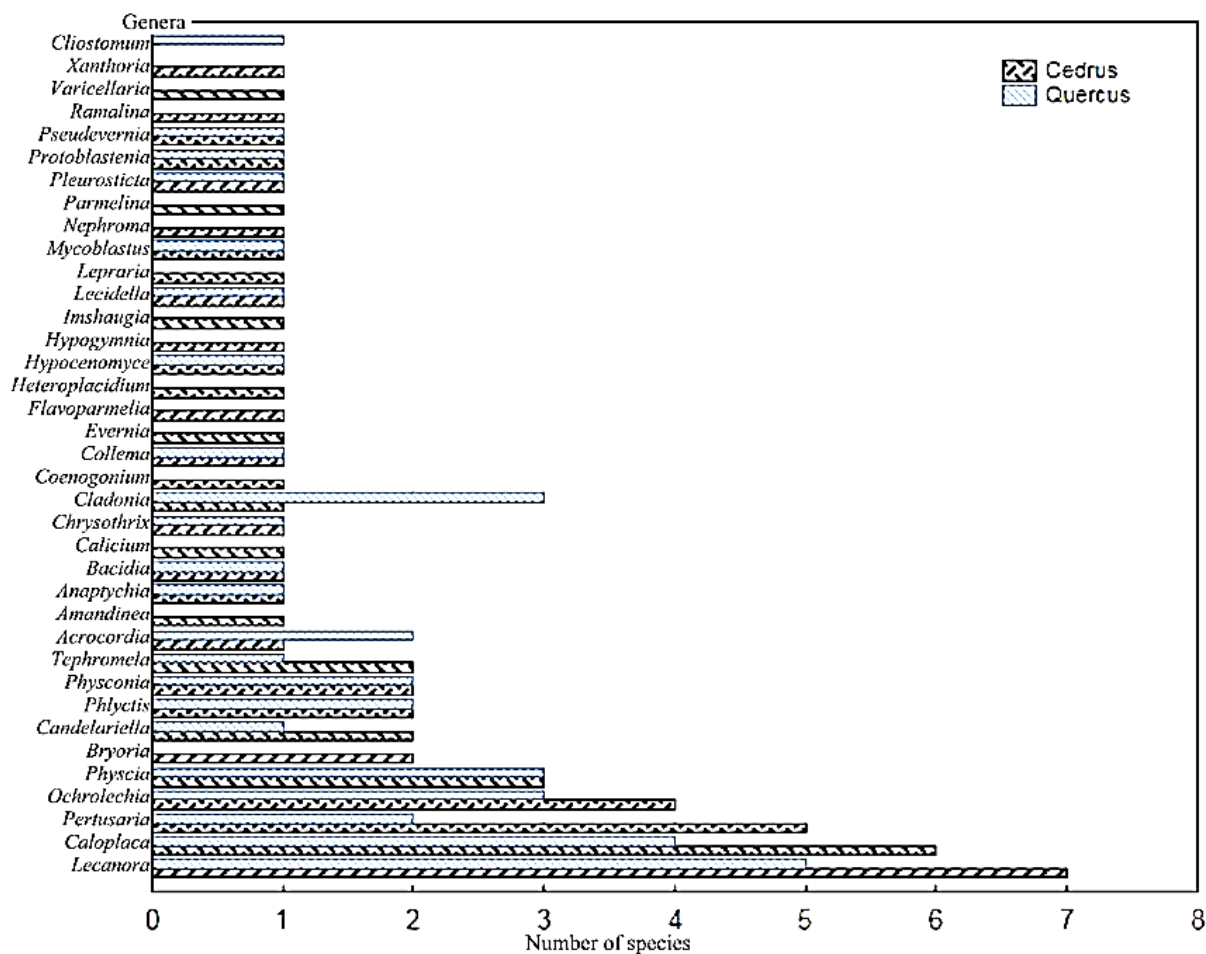


Figure 4. Number of species in each genus identified on *Cedrus atlantica* and *Quercus faginea*

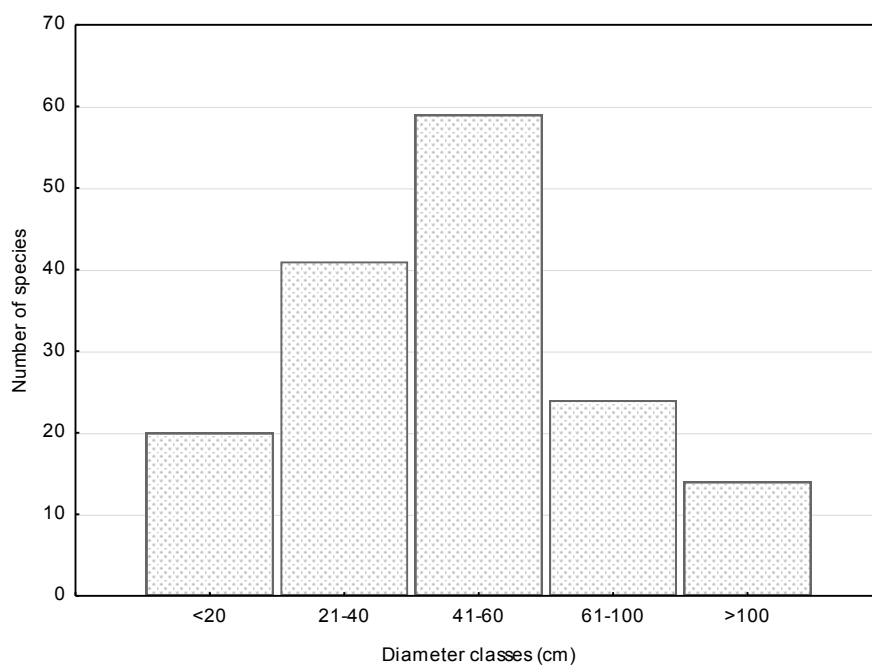


Figure 5. Number of lichens according to trunk diameter of *Cedrus atlantica*

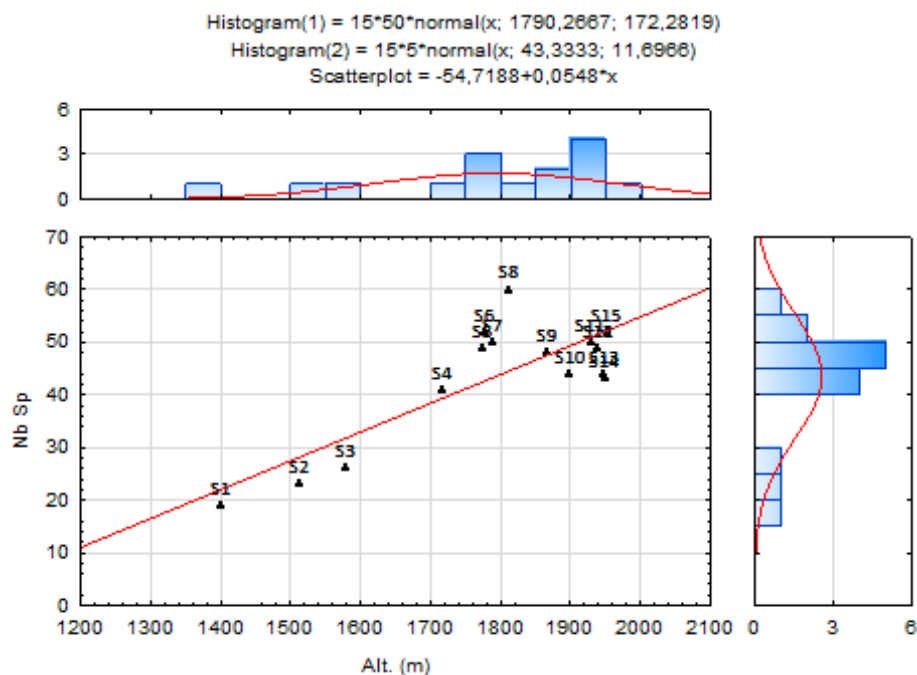


Figure 6. The relationship between the number of lichen species and altitude

Table 3. Sorensen Similarity Index between the 15 sites in Mount Babor Forest, Algeria

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	
S1		16	13	9	15	15	13	11	10	9	12	12	13	15	10	Species number in common
S2	0.76		20	14	20	21	15	13	15	19	18	18	14	16	14	
S3	0.57	0.81		18	22	22	18	12	20	22	20	16	21	22	19	
S4	0.30	0.43	0.53		33	33	29	26	25	31	31	20	28	30	27	
S5	0.42	0.53	0.56	0.70		47	41	36	38	46	44	33	42	38	40	
S6	0.43	0.57	0.57	0.72	0.92		44	41	38	40	41	42	39	36	34	
S7	0.32	0.36	0.41	0.57	0.73	0.8		41	36	40	35	31	37	34	36	
S8	0.32	0.36	0.32	0.58	0.72	0.83	0.75		31	34	34	26	32	30	30	
S9	0.31	0.44	0.57	0.58	0.79	0.80	0.69	0.67		42	40	31	32	30	29	
S10	0.26	0.52	0.57	0.68	0.90	0.80	0.72	0.69	0.89		49	36	36	36	32	
S11	0.35	0.5	0.53	0.68	0.87	0.82	0.64	0.53	0.86	0.98		36	42	36	29	
S12	0.38	0.53	0.45	0.47	0.68	0.89	0.59	0.55	0.7	0.76	0.77		40	37	30	
S13	0.36	0.73	0.53	0.6	0.80	0.76	0.66	0.58	0.66	0.70	0.83	0.83		42	35	
S14	0.48	0.48	0.63	0.71	0.73	0.92	0.66	0.65	0.68	0.77	0.78	0.85	0.88		35	
S15	0.29	0.38	0.5	0.6	0.79	0.68	0.66	0.61	0.79	0.64	0.59	0.64	0.69	0.76		

Habitat similarity

The Sorensen similarity index applied to epiphytic lichens revealed heterogeneity in the structure and community composition of the flora lichen of Mount Babor Forest. Similarity values ranged from 0.26 to 0.98 (Table 3). It is observed that the similarity is very high, with a coefficient of similarity greater than 90%, for sites 10-11 (98%), it is 92% for sites 5-6 and 6-14 and 90% for sites 5-10. These sites had the same types of forest habitat (topography and forest structure). Weak similarities (<30%) were detected for sites 1-10 (26%), it was 29% for sites 1-15 and it was 30% for sites 1-4.

Discussion

The Mount Babor Forest has rich epiphytic lichen diversity, despite the small area of the region studied.

Sixty-six species recorded on two phorophytes: *Cedrus atlantica* and *Quercus faginea*. Lichen richness in this study was higher compared to the lichen richness in other regions carried out on the genera of *Cedrus* and *Quercus*. Boutabia et al. (2018) reported 50 species in El Kala region (Algeria) on *Quercus coccifera*. Monia et al. (2017) reported 24 corticole taxa on *Q. suber* and *Q. faginea* in North East of Algeria. In Morocco, 47 taxa were identified on *C. atlantica* (Massari and Ravera, 2002). While in Turkey Cobanoglu and Sevgi (2009) identified 52 taxa on *C. libani*.

Among the lichens inventoried in the Mount Babor Forest, 16 species are protected by Algerian legislation (Executive Decree No. 12-03 of 4 January 2012). These are *Anaptychia ciliaris*, *Evernia prunastri*, *Ramalina farinacea*, *Cladonia coniocraea*, *Cladonia fimbriata*,

Cladonia symphylicarpa, *Nephroma laevigatum*, *Parmelina tiliacea*, *Parmelina pastillifera*, *Phlyctis agelaea*, *Phlyctis argena*, *Physcia aipolia*, *Physcia leptalea*, *Physcia tenella*, *Physconia grisea*, and *Physconia venusta*.

The physiognomic types of lichens in the study area were dominated by crustose and foliose thalli. On the other hand, the least represented categories were the squamular, gelatinous, and leprosy thalli. The same findings were obtained in Algeria by Rebbas et al. (2011) in Gouraya National Park (Béjaïa) and in Elkala National Park (Boutabia et al. 2015) as well as in Tunisia by El Mokni et al. (2015).

The lichen richness between the two phorophytes of *Cedrus atlantica* and *Quercus faginea* was different. *Quercus faginea*, which has a moderately acidic smooth bark tree, provides suitable habitat for the colonization of *Collema* which prefers smooth bark, while *C. atlantica* is an acidic environment for epiphytes (Bricaud 2006; Hauck 2011). *C. atlantica*, with thick and rough bark, is mainly preferred by *Parmeliaceae* (11 species of lichens recorded). The same findings were reported in the Himalayas (Mishra and Upreti 2016). Nitrophilic lichen species have shown a significant decrease with altitude. The closure and aging of afforestation play a significant role in this decrease (Bricaud 2010).

A positive relationship between the number of epiphytic lichen species and the diameter of *C. atlantica* trees was notable in this study. This result is in line with similar recent studies reporting the effect of tree diameter on the distribution and composition of the number of lichen species (Johansson et al. 2007; Cobanoglu and Sevgi 2009). The correlation between lichen richness and tree diameter is probably due to chemical properties and physical changes in the bark of *C. atlantica* with age. Since the lichens grow very slowly and the colonization of species on the trees take many years, trees with diameters less than 20 cm are too young for the lichens to reach visible thalli (Snäll et al. 2003; Kantvilas and Jarman 2004; Nascimbene et al. 2009). Therefore, epiphytes appear to be more diverse on trunks with a diameter between 41 and 60 cm. Likewise, Moning et al. (2009), found that high levels of lichen diversity were generally associated with large tree diameters. However, the number of species decreases again on old trees with large diameters ($\varnothing > 100$ cm). Because, if the diameter of the tree increases, pieces of bark are replaced by new, smoother plates of bark. This, to a certain extent, favors the establishment of new lichen colonization (Cobanoglu and Sevgi 2009).

The number of lichen species is closely related to the altitudinal gradient. The highest number of species was observed in high altitude stations. The macro lichens (indicators of abundant humidity) such as representatives of the *Collemataceae* and *Physciaceae* families were infrequent in all stations but their proportion increases with altitude. This is mainly linked to climatic parameters (humidity, temperature, precipitation) (Normann et al. 2010; Bässler et al. 2016).

The diversity of forest species at high altitudes may also cause the richness in lichen biodiversity in the Mount Babor Forest. Our observations are in agreement with those

of a study in northern Norway, where forest structure has been shown to be a richness for macro lichen communities (Werth et al. 2005). On the other hand, Moning et al. (2009) showed that in the Bavarian Forest National Park in southeastern Germany, the effects of forest structure as a defining characteristic of habitat have no effect on lichen biodiversity.

The decline of lichen species in low altitudes can also be caused by anthropogenic activities, such as overgrazing, deforestation, and overexploitation. This adds the indirect effects of atmospheric pollution, caused by serious annual and repeated fires (Eversman 2001; Quezel and Médail 2003). A study carried out in the coniferous forests of Sierra Nevada and the Warner Mountains of California by Miller et al. (2018) suggested that fires can lead to significant losses of lichen biodiversity. Recent studies in Brazil, and the Amazonian forests, have shown the decline in the diversity of tropical lichens and that many of these species disappear under disturbance (Flakus 2013; Plata and Lucking 2013; Cáceres et al. 2017).

In conclusion, the study of epiphytic lichens in the Mount Babor Forest resulted in the identification of 66 species belonging to 24 families and 38 genera. Morphological types (crustose and foliose) were the most common in the study area. A distinct relationship between the parameters (i.e., tree diameter and altitude) and the specific lichen richness has been established. The altitude favors the increase in the number of epiphytic species. The Sorensen similarity index revealed heterogeneity in the structure and community composition of epiphytic lichen vegetation between all the sites studied.

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Anaptychia ciliaris



Bryoria capillaris



Bryoria fuscescens



Calicium viride



Caloplaca ferruginea



Caloplaca flavovirescens



Cladonia coniocraea



Cladonia fimbriata



Votre texte se trouve ici.

Coenogonium lueum



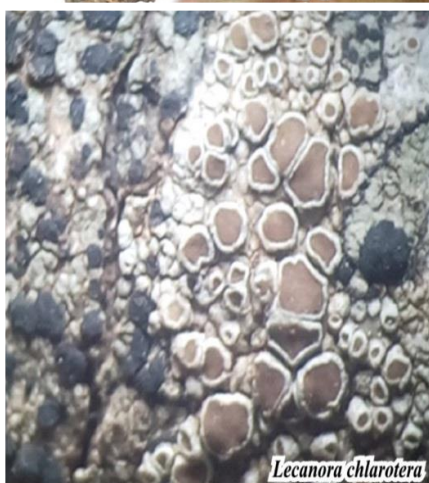
Collema nigrescens



Collema subflaccidum



Evernia prunastri

*Hypocomyce scalaris**Hypogymnia tubulosa**Imshaugia aleurites**Lecanora alpigena**Lecanora chlorotera**Lecanora conizaeoides**Mycoblastus sanguinarius**Nephroma parile**Ochrolechia subciridis**Ochrolechia tartarea**Parmelia pastillifera**Parmelia tiliacea*

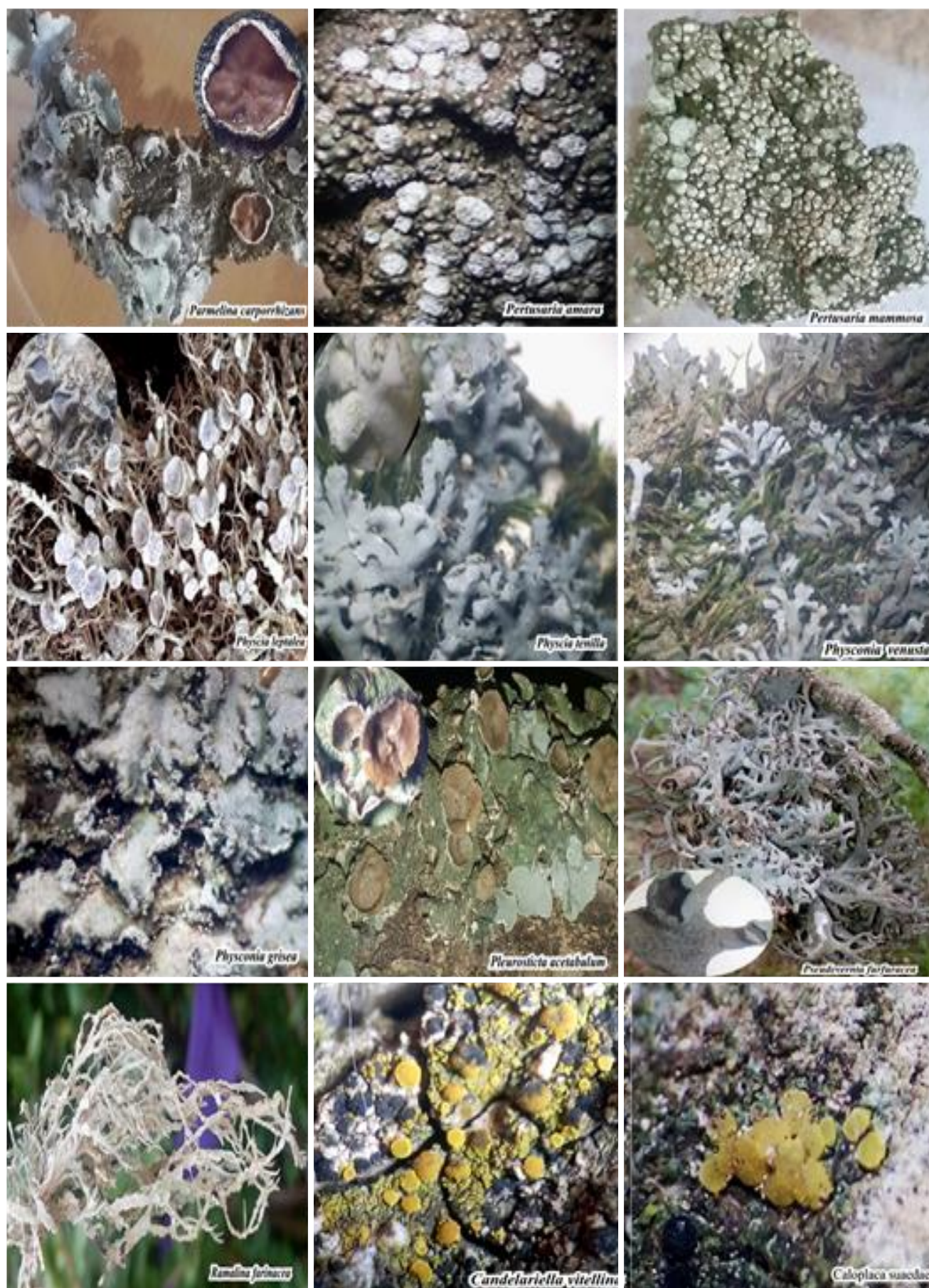


Figure S1. Some lichen species in Mount Babor Forest, Algeria