INVENTORY OF EPIPHYTIC LICHENS IN THE CEDARS OF OUANOUGHA AND MAADID (MOUNTS OF HODNA, ALGERIA)

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Abstract: *The authors present the unpublished inventory of epiphytic lichens in the cedar forests of the Hodna region. This inventory constitutes a database of the lichens of the Hodna mountains in particular and an enrichment of the list of Algerian lichenoflora in general. Thirty stations spread over three study areas were studied and characterized by the calculation of various parameters. After the collection and identification of the lichen samples, the study area is home to 51 lichen taxa spread over 14 families, the most represented of which are the Physciaseae (16 species), Parmeliaceae (07 species), Lecanoraceae (06 species), Ramalinaceae (06 species).*

From a physiognomic point of view, foliose lichens are the most dominant with 44.31% followed by crustaceans 34.09 %, fruticose 15.36 % and finally scaly and gelatinous and leprous with respectively 02.27 %, 02.27% and 01.13 %. Specifically, the 31 lichen species are present on cedar, with a clear dominance of the genus Physcia and Parmelia followed by the genus Lecanora then Ramalina. From the lichen floristic richness point of view, the cedar forest represents a ratio of 31/51 species (60.78 %) of the local lichen diversity.

The Ouanougha cedar forest is richer than the Maadid cedar forest, this can be partly explained by the fact that the latter is much more degraded (in advanced decline) than the first which benefits from the humid influences of Djurdjura.

Keywords:*Inventory, Lichens, Cedars, Hodna Mountains, Algeria*

1. Introduction

The Hodna region is remarkable for its richness and the originality of its flora [1]. This region has been recognized as one of the "hot spots" of plant biodiversity [2] and as an "important for plants" area in Algeria [3]. According to Boudy (1955), lichens present a great biological diversity in natural environments, by the many forms they present and by their peculiarities of adaptation to ecological variables [4].

Lichens are still poorly known to naturalists and knowledge of the species also remains very imperfect, more particularly in Mediterranean forests which constitute a fragile natural environment [5].

According to the literature, several botanical inventories devoted to the lichen flora of Algeria such as: Desfontaines (1798-1799) [6], Steinheil (1834) [7], Montagne (1838-1846) [8,9], Durieu (1846) [10], Nylander (1853-1854-1858-1864) [11,12,13,14], Reboud (1867) [15], Flagey (1888-1891-1892-1895-1896) [16,17,18,19,20], Steiner (1902) [21], Zahlbruckner (1904) [22], Maheu (1906) [23], Bouly de Lesdain (1911) [24], Werner (1941-49) [25,26], Faurel *et al*. (1952abc-1953ab-1954ab) [27,28,29,30,31,32,33], Collenot *et al*. (1960) [34]. Work in lichenology continued in Algeria, particularly in the West, East and Center of the country, as part of the preparation of end-of-study dissertations and doctoral theses. Several works in this field have been published in scientific journals.

Then a new renewal of interest will begin with the work of Werner (1975) [35], Esnault & Roux (1987) [36], Egea (1988) [37], Semadi (1988-1989) [38,39], Djellil (1989) [40], Van Haluwyn & Letrouit-Galinou (1990) [41], Egea *et al*. (1990) [42], Van Haluwyn *et al*. (1994) [43], Semadi *et al*. (1995-1997) [44,45], Boutabia (2000) [46], Rahali 2003 [47] followed by Rico *et al*. (2007) [48], Abbar (2009) [49], Fadel *et al*. (2010) [50], Ait Hammou *et al*. (2011) [51], Rebbas *et al*. (2012) [52], Slimani *et al*. (2013) [53], Ait Hammou (2014-2015) [54,55], Lograda *et al*. (2015) [56], Boutabia *et al*. (2015, 2018) [57,58], Ghennam & Abdoun (2017) [59], Bendaikha (2018) [60], Khedim (2018) [61],

Chermat (2019) [62], Hamralaine *et al*. (2019) [63], Yahia & Marniche (2019) [64], Belguidoum *et al*. (2021) [65], Chaker *et al*. (2021) [66], Maazouz *et al*. (2022) [67].

What is remarkable, the little work on the lichens of southern Algeria and the highlands. Nevertheless, a synthesis on the lichens of Algeria was made by Ait Hammou *et al*. (2014) [54], and Amrani *et al*. (2015-2018) [68, 69]. This work will undoubtedly constitute an important contribution to the knowledge of the regional lichen flora of the Hodna mountains. The objective is to establish an inventory of epiphytic lichens and to characterize the lichen processions of the sites according to the different compartments and natural habitats.

2. Material and method

2. 1. Physical setting of the study area

The study area covers the forest of Maadid, with that of Ouanougha, has about 7807 hectares, formed mainly by juniper (*Junipersus oxycedrus*), holm oak (*Quercus ilex* subsp. *ballota*), cedar (*Cedrus atlantica*) and pine. Aleppo (*Pinus halepensis*). A forest that is distinguished by a significant number of woody species (trees and shrubs). Unfortunately, this flora is now generally degraded as a whole.

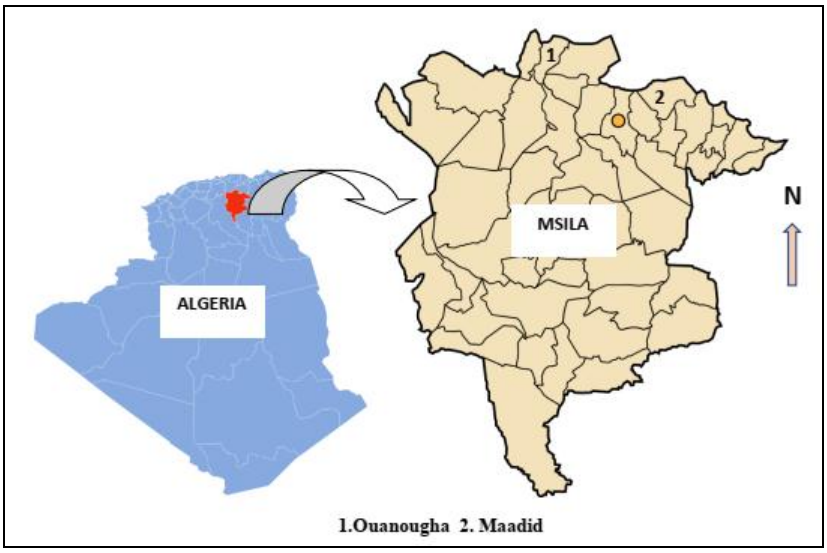

Fig. 1. *Geographical location of the study area*

The territory of the Wilaya of M'sila is located in the high plateau area between the two mountain ranges which are the Atlas Tellien and the Saharan Atlas on an altitude varying on average between 400 and 1600 m.

Despite the steppe vocation of the wilaya, the mountain area covering a large area of 199,925 Ha, it represents 7% of the territory, spread over a few forest massifs of great ecological value, in particular the cedar forest of Maadid and that of Ouanougha.

Fig. 2. *Ouanougha cedar forest (Photo K. Rebbas, 2020)*

Fig. 3. *Maadid cedar forest (Photo K. Rebbas, 2019)*

Endemic and present in a spontaneous state in the mountains of the Maghreb, *Cedrus atlantica* represents par excellence the noble essence of the Algerian forests [70]. The cedar has been known since the work of Maire (1926) [71] as a relatively xerophilic tree, supporting a dry climate in summer and cold in winter, it resists temperatures of - 0 degrees.

From an ecological point of view, the cedar forests of Hodna, developed in a bioclimatic environment at the limit of semi-arid and sub-humid bioclimates, are characterized by annual rainfall of between 500 and 800 mm.

Located at the absolute southern limit of the distribution area of cedars. They grow on a substrate characterized by limestone, marl and sandstone series from the Cretaceous. Not very effectively protected, these cedar forests are in a very advanced state of degradation, particularly within Djebel Maadid where they only exist as a relic [72].

Having a very heterogeneous structure, it presents a very irregular stratification: The tree stratum (average height of 20 m). Very low density, consists exclusively of cedar represented by very old subjects. The rest of the formation is clearing with a shrubby stratum, very scarce (*Crataegus laciniata, Juniperus oxycedrus, Quercus ilex* subsp. *ballota*). The floristic procession is very poor compared to the cedar forests linked to the humid bioclimate of the sublittoral Tell. From a dynamic point of view, the absence of cedar regeneration is an indication of a regressive evolution of the cedar forests of the Hodna Mountains. Cedar occupies the northern slopes of the highest massifs of the Hodna and Bibans mountains (Djebels Afghane, 1890 m; Maadid, Righa-Dahra, 1600 m and Ouanougha 1500 m) [72].

2. 2. Method of studying and identifying lichens

After a preliminary analysis of the cartographic data available, a punctual inventory was carried out according to a path walking in the study site with the objective of traversing the maximum of types of forest environments. The harvest of plant material was made on different parts of the plant (Lichens: corticoles, lignicoles and folicoles).

Initially, all available phorophyte species *Crataegus laciniata, Juniperus oxycedrus, Quercus ilex* subsp. *ballota, Olea europea*, *Cedrus atlantica* and *Pinus halepensis* are visited in order to harvest the maximum number of lichen species present in the study area. Then in a second part the lichen species present on the cedar are noted apart from estimating the lichen biodiversity of the cedar in relation to the entire forest formation.

30 inventory points (micro stations) were chosen semi-randomly and stratified (altitudes). The main natural habitats present, identified beforehand, are covered. The protocol was implemented in three main study areas: Ouanougha, Maadid North and Maadid South.
Several sampling campaigns were carried out during the period from April 2018 to November 2019. Hundreds of thalli of different species were collected.

Identification of lichen samples is initiated in the field where samples are determined at least to genus. Afterwards the samples collected are determined in the laboratory, using stereoscopic binocular magnifying glasses (linear magnification from x10 to x40) and microscopes (x40, x100, x400 magnifications).

Species identification is first made by observing general morphological characteristics, such as shape, color, frond diameter as well as frond tip orientation and branching type. Observation under a binocular microscope reveals the presence or absence of cilia, soralia, isidia as well as apothecary structures. Identification is supported by colorimetric reactions, which give different reactions depending on the species. The reagents are applied directly to the thalli, on a surface free of impurities beforehand. Thus, we used the reagents usually used in lichenology: Potash (10% solution), commercial bleach, lugol, paraphenylene diamine in 2% alcoholic solution.

The main works used for the determination are the flora of Ozenda and Clauzade (1970) [73], the flora "The lichen flora of Great Britain and Ireland" of Purvis *et al.* (1992) [74] and Van Haluwyn & Lerond's guide to lichens (1993) [75].

2.2.1. Inventory and collection of lichens in the cedar forest

In each of the micro stations, five feet of cedar all having a vertical trunk and the same diameters (varying from 120cm to 150cm) are chosen to make readings. Lichen vegetation surveys are carried out using the technique of Crespo & Bueno (1982) [76]. The list of all the species present on the trunk is drawn up whatever the exposure.

Parameters characterizing the species

In each station (Sx), each species (e) is characterized by: The number of companion species in the station is: n(Sx) – 1. With n(Sx): number of species observed in the station Sx. The total presence Pt which is equal to the number of stations where the species is present Average presence Pm which is equal to the number of readings where the species is present (Ce) divided by the number of readings carried out (C): Pm= C(e) /C

Parameters characterizing the station and the floristic composition

Each region is characterized by:

1. Number of species recorded in the station.
2. Lists of species: obtained by combining the list of species recorded
3. The floristic richness D: the ratio of the number of species of this station to the number of species of the richest station.

3. Results and discussion

3.1. Lichen species inventoried in the Hodna Mountains

After collecting and identifying the samples, we identified 51 lichen species spread over 18 families, the most dominant of which are the Physciaseae (16 species), Parmeliaceae (7 species), followed by Lecanoraceae and Ramalinaceae of 6 species. From the physiognomic point of view, foliose lichens are dominant with 49.01% followed by crustaceans 35.29%, fruticose 9.80% and finally gelatinous and leprous with respectively 3.92% and 1.96%.

Table 1. *Global list of lichen species inventoried in the Hodna Mountains (Maadid and Ouanougha cedar forests) M'Sila, Algeria*

N°	*Espèce*	Famille	Type de thalle
1	*Anaptychia ciliaris* (L.) Körb. ex A. Massal. subsp. *ciliaris*	Physciaceae	Foliacé
2	*Bacidia rubella* (Hoffm.) Massal.	Ramalinaceae	Crustacé

3	*Caloplaca cerina* (Eheh.ex Hedw.) Th.Fr.	Telochistaceae	Crustacé
4	*Caloplaca pyracea* (Ach.) Th. Fr.	Telochistaceae	Crustacé
5	*Collema furfuraceum (*Arnold) Du Rietz	Collemataceae	Foliacé
6	*Diploicia canescens* (Dicks.) A.Massal.	Caliciaceae	Crustacé
7	*Evernia prunastri* (L.) Ach.	Parmeliaceae	Fruticuleux
8	*Flavoparmelia caperata* (L.) Hal form *caperata*	Parmeliaceae	Foliacé
9	*Hyperphyscia adglutinata* (Flörke) H.Mayrhofer & Poelt	Physciaceae	Foliacé
10	*Hypogymnia physodes* (L.) Nyl.	Parmeliaceae	Foliacé
11	*Lecanactis paterllaroides* (Nyl.) Vain	Roccellaceae	Crustacé
12	*Lecania naegelii* (Hepp) Diederich et Van den Boom	Ramalinaceae	Crustacé
13	*Lecanora carpinea* (L.) Vain.	Lecanoraceae	Crustacé
14	*Lecanora chlarotera* Nyl. *subsp. chlarotera*	Lecanoraceae	Crustacé
15	*Lecanora dispersa* B. de Lesd.	Lecanoraceae	Crustacé
16	*Lecanora expallens* Ach.	Lecanoraceae	Crustacé
17	*Lecanora horiza* (Ach.) Linds.	Arthoniaceae	Crustacé
18	*Lecanora siena* B. de Lesd.	Lecanoraceae	Crustacé
19	*Lecidella elaechroma* (Ach.) M.Choisy	Lecanoraceae	Crustacé
20	*Lecidella euphorea* (Flörke) Hertel	Lecanoraceae	Crustacé
21	*Lepra albescens* (Huds.) Hafellner	Pertusariaceae	Crustacé
22	*Leprarea incana* L. Ach.	Steriocaulaceae	Lépreux
23	*Leptochidium albociliatum* (Desm.) M. Choisy	Massalongiaceae	Foliacé
24	*lobaria virens* (With.) J.R.	Lobariaceae	Foliacé
25	*Parmelia saxatilis* (L.) Ach.	Parmeliaceae	Foliacé
26	*Parmelia sulcata* Taylor s.l.	Parmeliaceae	Foliacé
27	*Parmelia tiliacea* (Hoffm.) Hale	Parmeliaceae	Foliacé
28	*Phaeophyscia ciliata* (Hoffm.) Moberg	Physciaceae	Foliacé
29	*Phaeophyscia hizuta* (Mereschk.) Essl.	Physciaceae	Foliacé
30	*Phaeophyscia orbicularis* (Neck.) Moberg	Physciaceae	Foliacé
31	*Phlyctis argena* (Spreng.) Flot.	Phlyctidaceae	Crustacé
32	*Physcia adscendens* (Fr.) H.Olivier	Physciaceae	Foliacé
33	*Physcia aipolia* (Ehrh. ex Humb.) Fürnr.	Physciaceae	Foliacé
34	*Physcia biziana* (A.Massal.) Zahlbr.	Physciaceae	Foliacé
35	*Physcia clementei* (Turner) Lynge	Physciaceae	Foliacé
36	*Physcia stellaris* (L.) Nyl.	Physciaceae	Foliacé
37	*Physcia tenella* (Scop.) DC.	Physciaceae	Foliacé
38	*Physconia distorta* (With.) J. R. v*ar. distorta*	Physciaceae	Foliacé
39	*Physconia distorta var. subvenusta* (Cromb.)	Physciaceae	Foliacé
40	*Physconia perisidiosa* (Erichsen) Moberg	Physciaceae	Foliacé
41	*Physconia venusta* (Ach.) Poelt	Physciaceae	Foliacé
42	*Pleurosticta acetabulum* (Neck.) Elix & Lumbsch	Parmeliaceae	Foliacé
43	*Ramalina farinacea* (L.) Ach.	Ramalinaceae	Fruticuleux
44	*Ramalina fastigiata* (Pers.) Ach.	Ramalinaceae	Fruticuleux
45	*Ramalina fraxinea* (L.) Ach.	Ramalinaceae	Fruticuleux
46	*Ramalina pollinaria* (Westr.) Ach.	Ramalinaceae	Fruticuleux
47	*Rinodina roboris* (Dufour ex Nyl.) Arnold	Physciaceae	Crustacé
48	*Schismatomma pericleum* (Ach.) Branth & Rostr.	Roccellaceae	Crustacé
49	*Scytinium gelatinosum* (With.) Otálora, P.M.Jørg. & Wedin	Collemataceae	Gelatineux
50	*Scytinium lichenoides* (L.) Otálora, P.M.Jørg. & Wedin	Collemataceae	Gelatineux
51	*Xanthoria parietina* (L.) Th.Fr.	Telochistaceae	Foliacé

The most common species in the study area are: *Anaptichia ciliaris, Physcia adscendens, Phlyctis argena, Parmelia acetabulum, Bacidia nageli, Collema furfuraceum, Lecanora clarothera and Xanthoria parietina.*

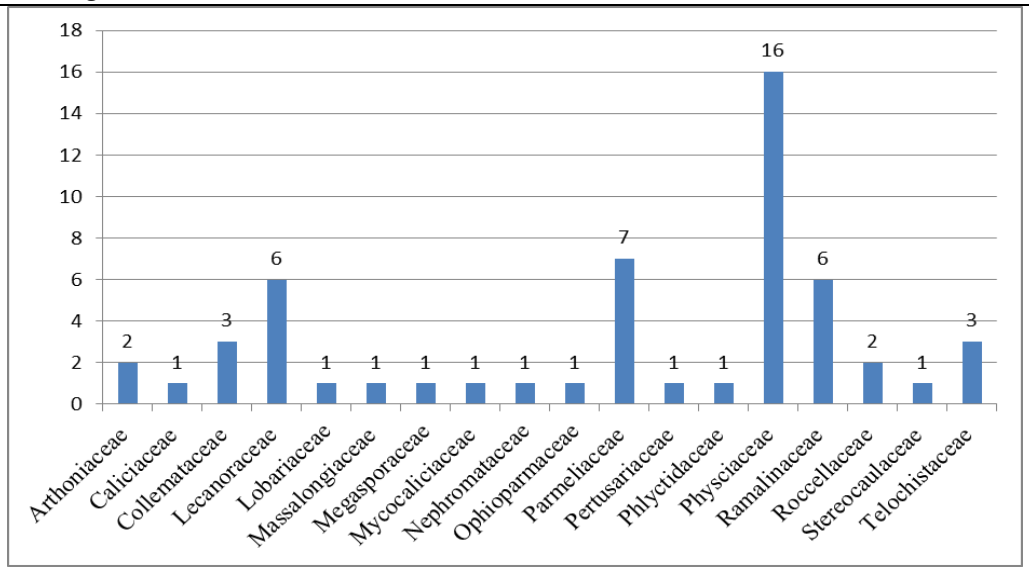

Fig. 4. *Distribution of species according to families*

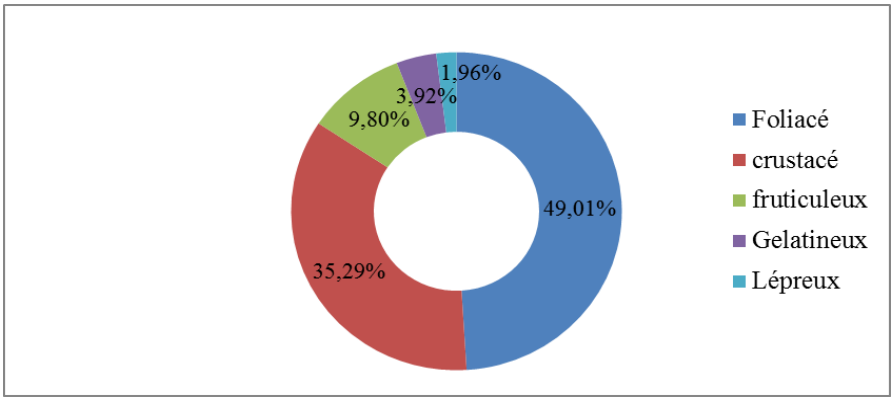

Fig. 5. *Physiognomic appearance of the lichens inventoried*

3.2.Lichens in the cedar forest

Specifically, 31 lichen species present on cedar have been identified, with a clear dominance of the genus Physcia and Parmelia followed by the genus Lecanora then Ramalina. From the lichen floristic richness point of view, the cedar forest represents a ratio of 31/51 species, namely (60.78%) of the local lichen diversity. The 31 inventoried taxa are spread over 12 Families, the most represented of which are the Physciaseae 06 taxa, Parmeliaceae 06, Lecanoraceae 05, Ramalinaceae 04 taxa.

From the physiognomic point of view, foliaceous and crustose lichens are dominant with the same rate of 41.93% followed by fruticose 9.67% and finally gelatinous and leprous with 3.22% and 3.22% respectively.

Table 2. *List of lichen species inventoried on the phorophyte Cedrus atlantica*

N°	Espèce
1	*Anaptychia ciliaris* (L.) Körb. ex A. Massal. subsp. *ciliaris*
2	*Bacidia rubella* (Hoffm.) Massal.
3	*Caloplaca pyracea* (Ach.) Th. Fr.
4	*Collema furfuraceum* (Arnold) Du Rietz
5	*Diploicia canescens* (Dicks.) A.Massal.
6	*Evernia prunastri* (L.) Ach.
7	*Flavoparmelia caperata* (L.) Hal form *caperata*
8	*Hyperphyscia adglutinata* (Flörke) H.Mayrhofer & Poelt
9	*Hypogymnia physodes* (L.) Nyl.
10	*Lecanactis paterllaroides* (Nyl.) Vain

11	*Lecania naegelii* (Hepp) Diederich et Van den Boom
12	*Lecanora chlarotera* Nyl. *subsp. chlarotera*
13	*Lecanora expallens* Ach.
14	*Lecanora horiza* (Ach.) Linds.
15	*Lecanora siena* B. de Lesd.
16	*Lecidella elaechroma* (Ach.) M.Choisy
17	*Lecidella euphorea* (Flörke) Hertel
18	*Lepra albescens* (Huds.) Hafellner
19	*Leprarea incana* L. Ach.
20	*Parmelia sulcata* Taylor s.l.
21	*Parmelia tiliacea* (Hoffm.) Hale
22	*Phaeophyscia hizuta* (Mereschk.) Essl.
23	*Phlyctis argena* (Spreng.) Flot.
24	*Physcia adscendens* (Fr.) H.Olivier
25	*Physcia stellaris* (L.) Nyl.
26	*Physcia tenella* (Scop.) DC.
27	*Pleurosticta acetabulum* (Neck.) Elix & Lumbsch
28	*Ramalina farinacea* (L.) Ach.
29	*Ramalina fraxinea* (L.) Ach.
30	*Scytinium lichenoides* (L.) Otálora, P.M.Jørg. & Wedin
31	*Xanthoria parietina* (L.) Th.Fr.

The diversity of lichens on cedar for the three stations was slightly heterogeneous: Ouanougha 30 species, North Maadid 27 species and South Maadid 23 species. This can be explained by the extraordinary diversification of topographic and microclimatic conditions, the difference in density of plant stands in each station (adult and young stands, closed and open) and finally the intensity of anthropogenic actions. The stations in the Ouanougha region are very close in terms of number of species, therefore indices of similar diversity. The richest station is S4 with 18 species and the least rich station S8 with only 8 species (Annex 1).

For the stations in the Maadid North region, there are significant variations in terms of the number of species between stations, such as station S10 with 6 species and station S5 with 17 species, in this case an index of double diversity (Annex 2).

On the other hand, in the stations of the Maadid South region, we note that the lichen flora is the least rich of the three zones studied with a number of species which is around 7 to 8 taxa per station with the lowest diversity indices. The richest station is S4 with 14 species and the least rich stations S7, S2 and S9 with only 7 species (Annex 3).

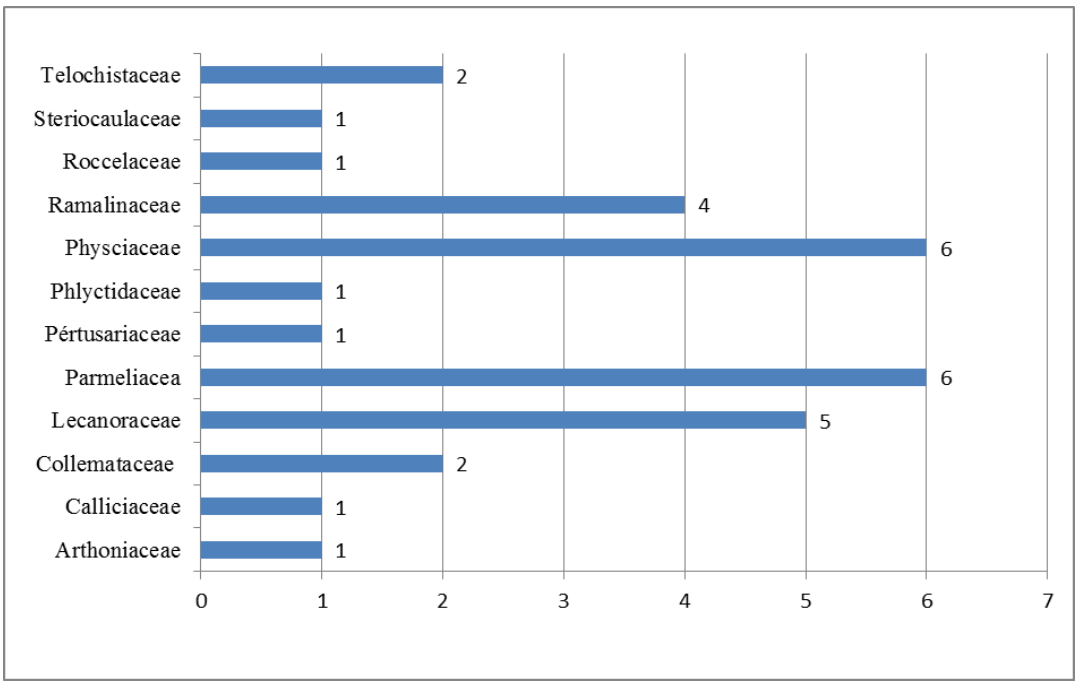

Fig. 6. *Distribution of species by family (cedar section)*

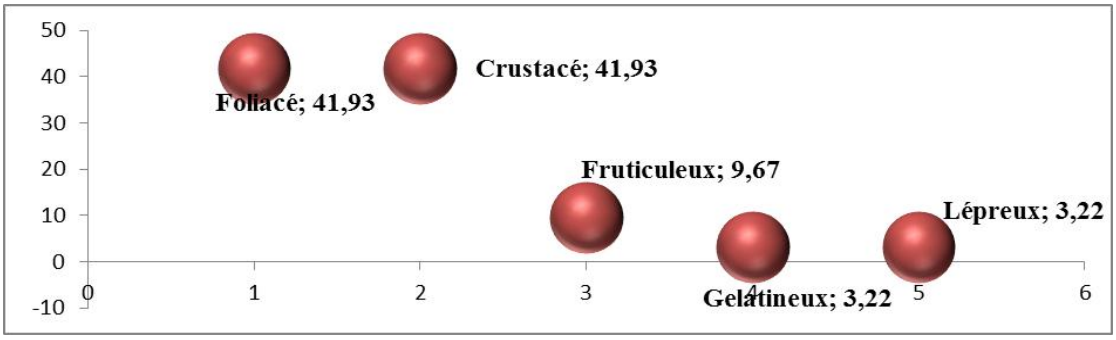

Fig. 7. *Physiognomic appearance of the inventoried lichens (cedar section)*

This inventory of lichens in the cedar forests of Hodna (M'sila region), constitutes a modest work but without doubt an important and unprecedented contribution to the knowledge of the regional lichen flora.

By comparing our results with previous work, we see that the number of species is slightly lower than the number of taxa found in other cedar forests in Algeria such as Khedim (2018) [61] at Theniat Elhad (70 species), Belguidoum *et al*. (2021) [65] in the Babors region (66 species) and Chaker *et al.* (2021) [66] in the Djurdjura (70 species) all genera combined.

This is logical knowing that the Hodna cedar forest is located in a bioclimatic environment located at the absolute southern limit of the cedar forest distribution area and it is subject to a very accentuated xenophilia predominance of hot winds (sirocco), which has negatively influenced on the plant cover and constitutes a real danger for the corticolous or epiphyte lichen flora which continues to decline as the forest degrades.

Conclusion

The cedar forests of Ouanougha and Maadid are home to 51 lichen taxa spread over 14 families, of which the most represented are Physciaceae 15, Parmeliaceae 9 taxa, Lecanoraceae, Ramalinaceae 6 taxa. From the physiognomic point of view the foliaceous lichens are dominant with 49.01% followed by the crustaceans 35.29%, the fruticose 9.82% and finally the gelatinous and the lepers with respectively 3.92% and 01.96%.

The cedar forest considered alone includes 31 lichen species, i.e. a rate of 50% of the total recorded. The 31 taxa inventoried are spread over 8 Families, i.e.

Finally, in general, the diversity of lichens on cedar for the three stations proved to be slightly heterogeneous (Ouanougha 30 species,

Maadid North 27 species and Maadid South 23 species. This can be explained by the extraordinary diversity of topographic conditions, microclimatic, the difference in density of plant stands and the number of species in place in each station (adult and young stands, closed and open).

This inventory of the lichens of the cedar forests of Hodna constitutes a modest work but without doubt an important contribution to the knowledge of the regional lichen flora.

It emerges from our observations in the field that the lichen epiphytic flora of the sites to be studied is in regression, however there is a strong biological potential of soil and saxicolous lichens in the surveyed region, the work that we wish to carry out by way of perspective in the near future after this study.

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ANNEX 1
D= (diversity index)

Area 1 : Ouanougha

		Micro-stations	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
		Number of trees	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
		Number of species	**13**	**12**	**15**	**18**	**15**	**12**	**13**	**13**	**8**	**9**
		D	**0.72**	**0,66**	**0,83**	**1**	**0,83**	**0,66**	**0.72**	**0.72**	**0,44**	**0,5**
Species	**Pt**	**Pm**										
Anaptychia ciliaris (L.) Körb. ex A. Massal. subsp. *ciliaris*	**10**	**43**	X	X	X	X	X	X	X	X	X	X
Bacidia rubella (Hoffm.) Massal.	**5**	23		X			X	X	X	X		
Caloplaca pyracea (Ach.) Th. Fr.	**3**	9					X	X	X			
*Collema furfuraceum (*Arnold) Du Rietz	**7**	26		X	X	X	X		X	X		X
Diploicia canescens (Dicks.) A.Massal.	**3**	8			X		X	X				
Evernia prunastri (L.) Ach.	**6**	27	X	X		X			X	X		X
Flavoparmelia caperata (L.) Hal form *caperata*	**3**	12		X	X	X						
Hyperphyscia adglutinata (Flörke) H.Mayrhofer & Poelt	**5**	29	X		X		X	X	X			X
Hypogymnia physodes (L.) Nyl.	**5**	26		X				X	X	X	X	
Lecanactis paterllaroides (Nyl.) Vain	**6**	23	X		X	X		X		X	X	
Lecania naegelii (Hepp) Diederich et Van den Boom	**4**	13		X	X	X					X	
Lecanora chlarotera Nyl. subsp. *chlarotera*	**4**	26	X		X			X	X	X		
Lecanora expallens Ach.	**2**	13		X		X						
Lecanora horiza (Ach.) Linds.	**3**	11				X		X	X			
Lecanora siena B. de Lesd.	**2**	7	X	X								
Lecidella elaechroma (Ach.) M.Choisy	**2**	6		X					X			
Lecidella euphorea (Flörke) Hertel	**3**	13	X		X	X						
Lepra albescens (Huds.) Hafellner	**6**	18	X		X		X	X	X			
Leprarea incana L. Ach.	**1**	2					X					
Parmelia sulcata Taylor s.l.	**6**	27	X		X	X	X				X	X
Parmelia tiliacea (Hoffm.) Hale	**1**	2								X		
Phaeophyscia hizuta (Mereschk.) Essl.	**3**	6	X			X	X					
Phlyctis argena (Spreng.) Flot.	**6**	13			X	X	X		X	X	X	
Physcia adscendens (Fr.) H.Olivier	**7**	27		X	X	X	X	X		X	X	
Physcia stellaris (L.) Nyl.	**3**	6			X	X				X		
Physcia tenella (Scop.) DC.	**1**	1										
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	**5**	10	X			X	X			X		X
Ramalina farinacea (L.) Ach	**4**	8	X			X	X					X
Ramalina fraxinea (L.) Ach.	**2**	6				X						X
Scytinium lichenoides (L.) Otálora, P.M.Jørg. & Wedin	**0**	0										
Xanthoria parietina (L.) Th.Fr.	**10**	**43**	X	X	X	X	X	X	X	X	X	X

ANNEX 2 D=(diversity index) **Area 2 : Maadid nord**		**Micro-stations** **Number of trees** **Number of species** **D**	**S1** **5** **11** **0,64**	**S2** **5** **13** **0,76**	**S3** **5** **10** **0,58**	**S4** **5** **15** **0,88**	**S5** **5** **17** **1**	**S6** **5** **12** **70**	**S7** **5** **11** **0,64**	**S8** **5** **9** **0,52**	**S9** **5** **8** **0,47**	**S10** **5** **6** **0,52**
Species	**Pt**	**Pm**										
Anaptychia ciliaris (L.) Körb. ex A. Massal. subsp. *ciliaris*	**10**	**39**	X	X		X	X	X	X	X	X	X
Bacidia rubella (Hoffm.) Massal.	**3**	7		X		X	X					
Caloplaca pyracea (Ach.) Th. Fr.	**3**	9		X			X		X			
*Collema furfuraceum (*Arnold) Du Rietz	**7**	23	X	X	X		X	X		X		X
Diploicia canescens (Dicks.) A.Massal.	**7**	21		X	X	X	X		X	X	X	
Evernia prunastri (L.) Ach.	**1**	7			X	X						
Flavoparmelia caperata (L.) Hal form *caperata*	**6**	13	X		X	X		X	X	X		
Hyperphyscia adglutinata (Flörke) H.Mayrhofer & Poelt	**5**	19		X	X		X	X	X	X		
Hypogymnia physodes (L.) Nyl.	**1**	2							X			
Lecanactis paterllaroides (Nyl.) Vain	**3**	9		X			X				X	
Lecania naegelii (Hepp) Diederich et Van den Boom	**6**	16	X				X		X	X	X	
Lecanora chlarotera Nyl. subsp. *chlarotera*	**4**	13	X	X		X		X				
Lecanora expallens Ach.	**2**	3			X				X			
Lecanora horiza (Ach.) Linds.	**3**	6		X		X		X				
Lecanora siena B. de Lesd.	**2**	7				x	x			X		X
Lecidella elaechroma (Ach.) M.Choisy	**7**	23		X	X	X	X	X			X	X
Lecidella euphorea (Flörke) Hertel	**1**	1		X								
Lepra albescens (Huds.) Hafellner	**3**	7	X				X		X			
Leprarea incana L. Ach.	**2**	3					X	X				
Parmelia sulcata Taylor s.l.	**0**	0										
Parmelia tiliacea (Hoffm.) Hale	**0**	0										
Phaeophyscia hizuta (Mereschk.) Essl.	**2**	3				X	X					
Phlyctis argena (Spreng.) Flot.	**3**	3	X		X	X						
Physcia adscendens (Fr.) H.Olivier	**8**	27	X	X	X		X	X		X	X	X
Physcia stellaris (L.) Nyl.	**0**	0										
Physcia tenella (Scop.) DC.	**0**	0										
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	**6**	10	X			X	X	X	X	X		
Ramalina farinacea (L.) Ach.	**3**	8	X			X	X					
Ramalina fraxinea (L.) Ach.	**2**	6				X		X				
Scytinium lichenoides (L.) Otálora, P.M.Jørg. & Wedin	**1**	0									X	
Xanthoria parietina (L.) Th.Fr.	**9**	**42**	X	X	X	X	X	X	X		X	X

ANNEX 3
D= (diversity index)

Area 3 : Maadid Sud

		Micro-stations	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
		Number of trees		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
		Number of species	**9**	**7**	**10**	**14**	**13**	**8**	**7**	**8**	**7**	**13**
		D	**0,64**	**0,5**	**0,71**	**1**	**0,92**	**0,57**	**0,5**	**0,57**	**0,5**	**0,92**
Species	**Pt**	**Pm**										
Anaptychia ciliaris (L.) Körb. ex A. Massal. subsp. *ciliaris*	**8**	**39**	X	X	X	X	X	X		X		X
Xanthoria parietina (L.) Th.Fr.	8	**40**		X	X	X		X	X	X	X	X
Bacidia rubella (Hoffm.) Massal.	**7**	23	X		X		X	X	X	X		X
Caloplaca pyracea (Ach.) Th. Fr.	**7**	13	X	X	X	X	X				X	X
*Collema furfuraceum (*Arnold) Du Rietz	**6**	20	X			X	X		X	X		X
Diploicia canescens (Dicks.) A.Massal.	**5**	13			X	X	X			X	X	
Evernia prunastri (L.) Ach	**5**	8		X	X				X		X	X
Flavoparmelia caperata (L.) Hal form *caperata*	**5**	11			X	X			X		X	X
Hyperphyscia adglutinata (Flörke) H.Mayrhofer & Poelt	**5**	10	X			X	X				X	X
Hypogymnia physodes (L.) Nyl.	**4**	9	X						X	X		X
Lecanactis paterllaroides (Nyl.) Vain	**4**	12				X	X			X		X
Lecania naegelii (Hepp) Diederich et Van den Boom	**3**	9		X			X	X				
Lecanora chlarotera Nyl. subsp. *chlarotera*	**3**	7				X	X					X
Lecanora expallens Ach.	**3**	6	X		X							X
Lecanora horiza (Ach.) Linds.	**3**	3				X	X			X		
Lecanora siena B. de Lesd.	**2**	3		X		X						
Lecidella elaechroma (Ach.) M.Choisy	**2**	6			X		X					
Lecidella euphorea (Flörke) Hertel	**2**	7					X	X				
Lepra albescens (Huds.) Hafellner	**2**	6		X								X
Leprarea incana L. Ach.	**2**	3				X		X				
Parmelia sulcata Taylor s.l.	**0**	0										
Parmelia tiliacea (Hoffm.) Hale	**0**	0										
Phaeophyscia hizuta (Mereschk.) Essl.	**0**	0										
Phlyctis argena (Spreng.) Flot.	**2**	7	X					X				
Physcia adscendens (Fr.) H.Olivier	**6**	23	X		X	X	X		X		X	
Physcia stellaris (L.) Nyl.	**0**	0										
Physcia tenella (Scop.) DC.	**0**	0										
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	**2**	2				X		X				
Ramalina farinacea (L.) Ach.	**0**	0										
Ramalina fraxinea (L.) Ach.	**0**	0										
Scytinium lichenoides (L.) Otálora, P.M.Jørg. & Wedin	**0**	**0**										