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## Species diversity, chorology and conservation of the lichen flora in Tessala Mountains forest (North-West Algeria)

### Abstract

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This study is a first investigation of the lichen flora of the Tessala Mountains green oak forest in northwestern Algeria. Field research using stratified sampling method allowed us to propose a first checklist of the lichen flora of this region containing 53 taxa with taxonomic, chorological and biogeographical data in North-West Africa (Algeria, Morocco and Tunisia) of each of them. Among these lichens, 3 taxa are cited for the first time for the NW Africa. Comments on some interesting species are added, especially those with wide distribution reported currently only in Algeria, which are to be found in neighboring countries (Morocco, Tunisia). Finally, 17 taxa present in our list are protected by the Algerian law. The forest of Tessala Mountains must urgently benefit from an official protection status in order to preserve this lichen biodiversity of proven interest.

*Key words:* checklist, inventory, North-West Africa, *Quercus ilex* subsp. *ballota*, Sidi Bel Abbès.

### Introduction

In North Africa, the lichen flora is mainly Mediterranean with a very high endemism (Werner 1955). It is essentially the region of folded mountains at the northwestern of the continent dominated by the Atlas Mountains with a Mediterranean climate (White 1996).

The study of lichen of Algeria is a relatively old (Amrani & al. 2015) dating back to the written first contribution in 1799 by René Desfontaines in his *Flora Atlantica* (1798-1799). Although there is no real flora of lichens in Algeria. Thus, the current knowledge of lichens in Algeria is still mainly based on the multitude of works carried out during the colonial period including: Montagne (1838); Durieu de Maisonneuve & Montagne (1846); Nylander (1854); Flagey (1892, 1895, 1896); Werner (1938, 1949); Faurel & al. (1951, 1953). Since the independence of the country, several studies have been interested in lichens: Ozenda & Clauzade (1970); Hertel (1971, 1987); Schwarz (1976); Leuckert & al. (1977); Clauzade & Roux (1984); Esnault (1985); Esnault & Roux (1987). The work of the



natives on this flora began with the study of Zouaoui (1989) on the lichens of Akfadou, then Semadi & al. (1997) in the region of Annaba and that of Rahali (2003) in the region of Algiers. Subsequently, some studies have been published mainly in the west of the country Bendaikha (2006); Ait Hammou & al. (2008, 2011, 2013); Khedim (2012); Khedim & al. (2013, 2018). Some studies have also been published in the east of the country (Rebbas & al. 2011; Serradj & al. 2013; Slimani & al. 2013; Ali Ahmed & al. 2018). Finally, we have to underline the very important recently published synthesis studies (Ait Hammou & al. 2014; Amrani & al. 2015; Amrani & al. 2018).

Specifically, Algeria, the largest country in Africa (2381741 km<sup>2</sup>) is rather poorly explored from a lichenological point of view and almost certainly contains many lichen taxa yet to be discovered (Ait Hammou 2014; Amrani & al. 2015).

The data on the Algerian lichen flora is still very incomplete and the revision of the lichen flora of Algeria must be encouraged (Khedim & al. 2018).

The region of the Mount of Tessala in western Algeria which containing a very rich flora (Bouiadjra & al. 2011) is floristically one of the least explored areas of the country (Saidi 2017). Indeed, the lichen flora of this region remains totally unknown and to our knowledge, no research study on lichens of this region has been published.

So, this study was considered in the main objective to bring new data to the country's lichen flora through the proposal of a first checklist of lichens of the Tessala Mountain, then to look for possible novelties within this list in particular in terms of chorology of taxa.

## The Study area

The forest of Tessala Mountain also called “forest of El Attouche” is located in the North West of the country (Fig. 1) between three wilayas “provinces”: Sidi Bel Abbès, Oran and Ain Témouchent. It is part of the commune of Tessala located at 20 km from Sidi Bel Abbès city and covers an area of 2036 ha. The altitudes vary between 200 and 600 m a.s.l. on the dominant medium Mountains and up to 1060 m on the top of the Mountain (Bouiadjra & al. 2011).

The forest of Tessala includes vegetation dominated by holm oak. It contains the following formations: preforests of *Quercus ilex* subsp. *ballota* (Desf.) Samp. and *Q. coccifera* L. in the East and South-East; scrubs formations of *Q. coccifera*, *Calycotome intermedia* Rchb.f. and *Chamaerops humilis* L. in the West and Southwest; degraded scrubs of *Calycotome intermedia*, *Chamaerops humilis* and *Ampelodesmos mauritanicus* T.Durand & Schinz in the center, East and in the extreme North-East; a clear forest of *Pinus halepensis* Mill. and *Quercus ilex* subsp. *ballota* on the high peaks (Saidi 2017).

The climate of the Tessala Mountains is Mediterranean as well as all the West Northern Algeria. It is characterized by concentrated rains during the cold period (autumn and winter, monthly average = 40.9 mm) and a marked drought during the warmer months (summer, monthly average = 1.76 mm). The bioclimatic levels vary according to the altitude from the arid to the sub-humid while the dominant level is the semi-arid (Ferka-Zazou 2006).



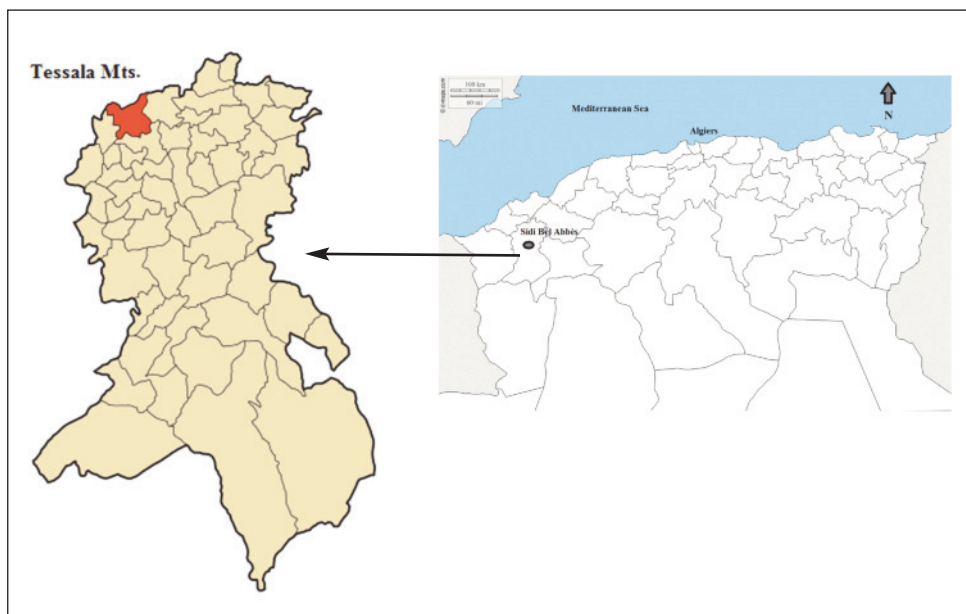


Fig.1. Location map of the study area.

## Materials and Methods

Field work was started in 2013 using a stratified sampling method (Gounot 1969). Initially, we consulted the aerial photography of the region in order to explore the relief. The layer of vegetation being homogeneous (stands of holm oaks); we proceeded to the definition of the different environments of the site “strata”: e.g. altitudes, exposure, topography. Then, in the field, we went through the zones previously defined. This allowed us to carry out sufficiently large lichen samplings in nine stations of one hectare (10000 m<sup>2</sup>) each “square 100 m long and 100 m wide”. At these stations, survey corresponds to a part of a tree, mainly the trunk and the branches. According to Roux (1990), a maximum number of species are recorded in the field and sufficient samples are collected, especially those difficult to detect with the naked eye, and each phorophyt was georeferenced while the several parameters were recorded (height, circumference, position, density, slope, exposure, altitude, pH, sunshine). Within each station, terricolous, saxicolous and muscicolous lichens were also considered. Several special floras have been used for the botanical identification of taxa harvested in the field, including: Ozenda & Clauzade (1970); Boistel (1986); Hale (1990); Kirschbaum & Wirth (1997); Serusiaux & al. (2004); Jahns (2007); Aptroot & Schumm (2008); Krzewicka & al. (2009); Aptroot (2009) and Haluwyn & al. (2009, 2012). The nomenclature follows Roux & coll. (2017), while the collected specimens have been deposited in the herbarium of the laboratory of botany, the University of Tiaret.



In order to be able to search for possible new taxonomic and chorological novelties, we compare our results with the published works in the NW of Africa (Algeria, Morocco and Tunisia), by using all the available bibliography for Algeria: Durieu de Maisonneuve & Montagne (1846); Nylander (1854); Jourdan (1867); Flagey (1896); Zahlbruckner (1904); Maheu (1928); Bouly de Lesdain (1907, 1911, 1939); Maire & Senevet (1928); Zahlbruckner (1930, 1931); Werner (1931, 1955); Reichert (1937); Dubuis & Faurel (1945); Faurel & al. (1951, 1953); Semadi (1989); Djebbar & Fradjia (1992); Djellil (1989); Egea (1996); Boutabia (2000); Hamrlaine (2013); Bendaikha (2006); Mosbah (2007); Ait Hammou & al. (2008, 2011, 2014); Rebbas & al. (2011); Fadel & al. (2012); Khedim (2012); Slimani & al. (2013); Serradj (2013); Khedim & al. (2018); Ali Ahmed & Al (2018) and Amrani & al. (2018). For neighboring countries, we used mainly: Seaward (1996); El Mokni & al. (2015); Guttová & al. (2015) for Tunisia and Ajaj & al. (2013) for Morocco.

### ***GPS limitation of sampled stations***

#### **Station 1**

35°16'19.1"N 0°47'12.9"W

35°16'15.1"N 0°47'06.5"W

35°16'10.5"N 0°47'12.4"W

35°16'15.6"N 0°47'17.5"W

#### **Station 2**

35°16'20.7"N 0°47'17.5"W

35°16'26.7"N 0°47'20.7"W

35°16'24.3"N 0°47'28.5"W

35°16'19.3"N 0°47'23.4"W

#### **Station 3**

35°16'23.4"N 0°47'14.2"W

35°16'27.9"N 0°47'18.2"W

35°16'32.5"N 0°47'13.0"W

35°16'29.3"N 0°47'05.4"W

#### **Station 4**

35°16'34.3"N 0°47'04.0"W

35°16'27.4"N 0°47'05.1"W

35°16'25.0"N 0°46'56.6"W

35°16'31.6"N 0°46'54.2"W



**Station 5**

35°17'04.7"N 0°47'21.2"W

35°17'01.4"N 0°47'19.7"W

35°16'59.7"N 0°47'26.0"W

35°17'03.4"N 0°47'30.5"W

**Station 6**

35°17'00.4"N 0°47'32.4"W

35°16'55.3"N 0°47'34.5"W

35°16'57.1"N 0°47'42.2"W

35°17'02.5"N 0°47'43.4"W

**Station 7**

35°16'59.5"N 0°47'49.8"W

35°17'05.1"N 0°47'46.2"W

35°17'03.2"N 0°47'58.7"W

35°17'08.1"N 0°47'54.4"W

**Station 8**

35°16'51.4"N 0°47'46.4"W

35°16'44.3"N 0°47'43.3"W

35°16'42.5"N 0°47'52.6"W

35°16'52.3"N 0°47'53.6"W

**Station 9**

35°16'47.4"N 0°47'28.9"W

35°16'52.4"N 0°47'24.4"W

35°16'49.2"N 0°47'16.6"W

35°16'43.2"N 0°47'21.0"W

**List of substrates and their abbreviations:**Co: Corticolous on *Quercus ilex* subsp. *ballota* (holm oak)

Te: Terricolous

Sa: Saxicolous

Mu: Muscicolous

**Results and discussion*****Checklist of lichen and lichenicolous fungi of Tessala Mountains***

The presented list includes 53 species recorded in the study area and contains the following information: species name, botanical family, station numbers in which the lichen was recorded and substrate "in brackets", information on published data. For each species,



the known distribution in NW Africa (Algeria, Tunisia, and Morocco) is given with references. The new species reported for the first in NW Africa with asterisks (\*):

***Amygdalaria continua*** Brodo & Hertel

*Lecideaceae*; 5 (Sa); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Hamralaine (2013). No data published in Morocco and Tunisia.

***Anaptychia ciliaris*** (L.) Körb. ex A. Massal.

*Physciaceae*; 1, 2, 3, 4, 6, 9, 8 (Co); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Ait Hammou (2013); Bendaikha (2006); Boutabia (2000); Djellil (1989); Hamralaine (2007, 2013); Khedim (2012); Mosbah (2007); Slimani & al. (2013); Werner (1940, 1949, 1955); Alonso & Egea (2003); Fadel & al. (2012); **Tun**, Seaward (1996); El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Buellia conioips*** (Wahlenb.) Th. Fr.

*Caliciaceae*; 5 (Sa); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Hamralaine (2013). No data published in Morocco and Tunisia.

***Caloplaca cerina*** (Ehrh. ex Hedw.) Th. Fr.

*Teloschistaceae*; 1, 9 (Co); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Haina & Bendeckach (2004); Hamralaine (2007); Hamralaine (2013); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Caloplaca flavorubescens*** (Huds.) J.R. Laundon

*Teloschistaceae*; 4 (Co); Published data in NW Africa: **Alg**, Egea & al. (1990); Faurel & al. (1953); Haina & Bendeckach (2004); Hamralaine (2013); **Mor**, Ajaj & al. (2013); **Tun**, Guttová & al. (2015).

***Candelariella superdistans*** (Nyl.) Malme

*Candelariaceae*; 3 (Co); Published data in NW Africa: **Alg**, Hamralaine (2013); Nylander (1854); No data published in Morocco and Tunisia.

***Collema furfuraceum*** (Arnold) Du Rietz

*Collemataceae*; 4, 5, 7 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Boutabia, 2000; Djellil (1989); Alonso & Egea (2003); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Rahali (2003); Semadi (1989); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Evernia prunastri*** (L.) Ach.

*Parmeliaceae*; 2, 4, 5, 7, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Ait Hammou & al. (2011); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Khedim (2012); Rahali (2003); Rebbas & al. (2011); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Flakea papillata*** O.E. Erikss.

*Verrucariaceae*; 6 (Co); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Hamralaine (2013). No data published in Morocco and Tunisia.

***Hypogymnia physodes*** (L.) Nyl. (= *Parmelia physodes* (L.) Ach.)

*Parmeliaceae*; 2, 3, 4, 6, 8, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Brongniart (1882); Dubuis & Faurel (1945); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Mosbah (2007); Nylander (1854); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).



***Lathagrium auriforme*** (With.) Otálora, P.M. Jørg. & Wedin

*Collembataceae*; 5, 6 (Co, Mu); Published data in NW Africa: **Alg**, Rebbas & al. (2011), Slimani & al. (2013), Amrani & al. (2018); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Lecanora allophana*** Nyl.

*Lecanoraceae*; 2, 4 (Co); Published data in NW Africa: **Alg**, Hamralaine (2013); Rebbas & al. (2011); Rehali (2003); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Lecanora carpinea*** (L.) Vainio

*Lecanoraceae*; 3, 4, 6 (Co); Published data in NW Africa: **Alg**, Serradj & al. (2013); Boutabia (2000); Djellil (1989); Flagey (1896); Haina & Bendeckach (2004); Merabti (2008); Mosbah (2007); Rebbas & al. (2011); Slimani & al. (2013); Werner (1949, 1955); **Tun**, Seaward (1996); El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Lecanora glabrata*** (Ach.) Malmé

*Lecanoraceae*; 2, 3, 4, 6, 7, 9 (Co); Published data in NW Africa: **Alg**, Alonso & Egea (2003); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Werner (1940); **Mor**, Ajaj & al. (2013).

***Lecanora dispersa*** (Pers.) Sommerf.

*Lecanoraceae*; 4, 7 (Sa); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Bendaikha (2006); Egea & al. (1990); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Merabti (2008); Mosbah (2007); Rahali (2003); Semadi (1989); Werner (1949, 1955); **Tun**, Seaward (1996); **Mor**, Ajaj & al. (2013).

***Lecanora pulicaris*** (Pers.) Ach.

*Lecanoraceae*; 1, 2, 3, 4, 7, 8, 9 (Co); Published data in NW Africa: **Alg**, Bendaikha (2006); Djellil (1989); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Semadi (1989); Rahali (2003); **Mor**, Ajaj & al. (2013).

**\**Lecanora praesistens*** Nyl.

*Lecanoraceae*; 4, 3 (Co); No data published in NW Africa.

***Lecanora rupicola*** (L.) Zahlbr.

*Lecanoraceae*; 6 (Sa); Published data in NW Africa: **Alg**, Djellil (1989); Dubuis & Faurel (1945); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Nylander (1854); Steiner (1902); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Lecidea exigua*** Chaub.

*Lecideaceae*; 5, 6 (Co); Published data in NW Africa: **Alg**, Boutabia & al. (2015), Amrani & al. (2018). No data published in Morocco and Tunisia.

***Lecidella euphorea*** (Flörke) Hertel

*Lecanoraceae*; 6 (Co); Published data in NW Africa: **Alg**, Djellil (1989); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Merabti (2008); Rahali (2003); Semadi (1989); **Tun**, Seaward (1996); **Mor**, Ajaj & al. (2013).

***Lepraria incana*** (L.) Ach.

*Stereocaulaceae*; 2, 3, 4, 6, 7, 8, 9 (Co); Published data in NW Africa: **Alg**, Serradj (2013); Bendaikha (2006); Alonso & Egea (2003); Haina & Bendeckach (2004); Hamralaine (2013); Khedim (2012); Merabti (2008); Rebbas & al. (2011); Rahali (2003); Semadi (1989); Slimani & al. (2013); **Tun**, El Mokni & al. (2015).



- Lichenomphalia umbellifera*** (L.: Fr.) Redhead, Lutzoni, Moncalvo & Vilgalys  
*Hygrophoraceae*; 6, 7 (Co, Te); Published data in NW Africa: **Alg**, Khedim & al. (2018);  
Hamralaine (2013). No data published in Morocco and Tunisia.
- \**Multiclavula vernalis*** (Schwein.) R.H. Petersen  
*Clavulinaceae*; 5 (Mu); No data published in NW Africa.
- Opegrapha varia*** Pers.  
*Roccellaceae*; 3, 4, 9 (Co); Published data in NW Africa: **Alg**, Bendaikha (2006); Haina &  
Bendeckach (2004); Hamralaine (2013); Merabti (2008); **Tun**, Seaward (1996).
- Parmelia horrescens*** (Taylor) Elix & Hale  
*Parmeliaceae*; 2, 3, 4, 5, 6, 7, 8 (Co); Published data in NW Africa: **Alg**, Djellil (1989); Haina  
& Bendeckach (2004); Hamralaine (2013); Werner (1955); **Tun**, El Mokni & al. (2015).
- Parmelina carporrhizans*** (Taylor) Poelt & Vězda  
*Parmeliaceae*; 1, 3, 4, 5, 6, 7, 9 (Co); Published data in NW Africa: **Alg**, Slimani & al.  
(2013); Hamralaine (2013); **Mor**, Ajaj & al. (2013).
- Parmelina quercina*** (Willd.) Hale  
*Parmeliaceae*; 2, 5 (Co); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011);  
Hamralaine (2013). No data published in Morocco and Tunisia.
- Phaeophyscia hirsuta*** (Merschk.) Moberg  
*Physciaceae*; 1, 2, 3, 4, 6, 7, 8, 9 (Co); Published data in NW Africa: **Alg**, Boutabia (2000);  
Alonso & Egea (2003); Fadel & al. (2012); Hamralaine (2013); **Tun**, Seaward (1996),  
El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).
- Phaeophyscia orbicularis*** (Neck.) Moberg  
*Physciaceae*; 2, 3, 4, 5, 6, 7 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018);  
Boutabia (2000); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013);  
Mosbah (2007); Semadi (1989); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**,  
Ajaj & al. (2013).
- Phlyctis argena*** (Sprengel) Flotow  
*Phlyctidaceae*; 4, 5, 7 (Co); Published data in NW Africa: **Alg**, Serradj & al. (2013); Djellil  
(1989); Fadel & al. (2012); Haina & Bendeckach (2004); Hamralaine (2013); Merabti  
(2008); Slimani & al. (2013); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).
- Physcia adscendens*** (Fr.) H. Olivier  
*Physciaceae*; 1, 2, 3, 4, 5, 6, 7, 8, 9 (Co); Published data in NW Africa: **Alg**, Bendaikha  
(2006); Boutabia (2000); Fadel & al. (2012); Egea & al. (1990); Egea & Llimona  
(1991); Alonso & Egea (2003); Haina & Bendeckach (2004); Hamralaine (2013);  
Khedim (2012); Merabti (2008); Rahali (2003); Rebbas & al. (2011); Semadi (1989);  
Slimani & al. (2013). No data published in Morocco and Tunisia.
- Physcia albinea*** (Ach.) Nyl.  
*Physciaceae*; 5 (Sa); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011);  
Bendaikha (2006); Boutabia (2000); Haina & Bendeckach (2004); Hamralaine (2007,  
2003); Reichert (1937); Semadi (1989); Werner (1940); **Mor**, Ajaj & al. (2013).
- Physcia biziana*** (A. Massal.) Zahlbr.  
*Physciaceae*; 1, 2, 8, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018);  
Bendaikha (2006); Boutabia (2000); Haina & Bendeckach (2004); Hamralaine (2013);  
Reichert (1937); Semadi (1989); Werner (1940); **Tun**, Seaward (1996); Guttová & al.  
(2015); **Mor**, Ajaj & al. (2013).



***Physcia aipolia* (Ehrht.) E. Humb.**

*Physciaceae*; 2, 3, 4, 6, 7, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Ait Hammou & al. (2011); Djellil (1989); Alonso & Egea (2003); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Khedim (2012); Mosbah (2007); Semadi (1989); Slimani & al. (2013); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Physcia caesia* (Höffm.) Fűrnröhr**

*Physciaceae*; 5, 6, 7 (Sa); Published data in NW Africa: **Alg**, Egea & Llimona (1991); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Nylander (1854); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Physcia dubia* (Hoffm.) Lettau**

*Physciaceae*; 4, 5, 6, 7 (Sa); Published data in NW Africa: **Alg**, Serradj & al. (2013); Bendaikha (2006); Egea & Llimona (1991); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Semadi (1989); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Physcia stellaris* (L.) Nyl.**

*Physciaceae*; 1, 3, 4, 7, 8, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Boutabia (2000); Haina & Bendeckach (2004); Hamralaine (2013); **Tun**, Seaward (1996); **Mor**, Ajaj & al. (2013).

***Physcia tenella* (Scop.) DC.**

*Physciaceae*; 3, 4, 5, 8, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Ait Hammou & al. (2011); Bendaikha (2006); Boutabia (2000); Djellil (1989); Egea & al. (1990); Egea (2003); Fadel & al. (2012); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2007, 2013); Khedim (2012); Mosbah (2007); Rahali (2003); Semadi (1989); Slimani & al. (2013); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Physcia tribacia* (Ach.) Nyl.**

*Physciaceae*; 3, 5, 7 (Co, Sa); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Hamralaine (2013); **Mor**, Ajaj & al. (2013).

***Physconia detersa* (Nyl.) Poelt**

*Physciaceae*; 5 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Dubuis & Faurel (1945); Flagey (1896); Haina & Bendeckach (2004); **Mor**, Ajaj & al. (2013).

***Physconia grisea* (Lam.) Poelt**

*Physciaceae*; 3, 4, 5, 7 (Co); Published data in NW Africa: **Alg**, Bouly de Lesdain (1939); Boutabia (2000); Alonso & Egea (2003); Fadel & al. (2012); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Mosbah (2007); Rahali (2003); Semadi (1989); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Physconia perisidiosa* (Erichs.) Moberg**

*Physciaceae*; 1, 5, 9 (Co, Mu); Published data in NW Africa: **Alg**, Khedim & al. (2018); Alonso & Egea (2003); Hamralaine (2013); Haina & Bendeckach (2004); Semadi (1989); **Tun**, Seaward (1996); **Mor**, Ajaj & al. (2013).

**\* *Physconia distorta* var. *subvenusta* Cromb.**

*Physciaceae*; 4, 6 (Co); No data published in NW Africa.

***Pseudevernia intensa* (Nyl.) Hale & W.L. Culb.**

*Parmeliaceae*; 4, 6, 7 (Co); Published data in NW Africa: **Alg**, Haina & Bendeckach (2004); Hamralaine (2013). No data published in Morocco and Tunisia.



***Ramalina canariensis*** Steiner

*Ramalinaceae*; 4, 5 (Co); Published data in NW Africa: **Alg**, Serradj & al. (2013); Djellil (1989); Haina & Bendeckach (2004); Hamralaine (2013); Semadi (1989); Slimani & al. (2013); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Ramalina farinacea*** (L.) Ach.

*Ramalinaceae*; 2, 3, 4, 6, 7, 8 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Serradj & al. (2013); Alonso & Egea (2003); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Khedim (2012); Rebbas & al. (2011); Slimani & al. (2013); Werner (1940, 1949); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Ramalina fastigiata*** (Pers.) Ach.

*Ramalinaceae*; 1, 2, 4, 6, 8, 9 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); Serradj & al. (2013); Alonso & Egea (2003); Flagey (1896); Haina & Bendeckach (2004); Hamralaine (2013); Khedim (2012); Rebbas & al. (2011); Slimani & al. (2013); Werner (1940, 1949); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Ramalina celastri*** (Sprengel) Krog & Swinscow

*Ramalinaceae*; 5, 6, 7 (Co); Published data in NW Africa: **Alg**, Ait Hammou & al. (2011); Hamralaine (2013). No data published in Morocco and Tunisia.

***Ramalina reagens*** (B. de Lesd.) W.L. Culb.

*Ramalinaceae*; 4, 5 (Co); Published data in NW Africa: **Alg**, Khedim & al. (2018); **Tun**, Seaward (1996); El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Usnea florida*** (L.) F.H. Wigg.

*Parmeliaceae*; 2, 4 (Co); Published data in NW Africa: **Alg**, Flagey (1896); Haina & Bendeckach (2004); Nylander (1854); Trabut (1928); **Mor**, Ajaj & al. (2013).

***Xanthoparmelia conspersa*** (Ehrh. ex Ach.) Ach.

*Parmeliaceae*; 3, 6, 9 (Sa); Published data in NW Africa: **Alg**, Ali Ahmed & al. (2018), Amrani & al. (2018); **Tun**, El Mokni & al. (2015).

***Xanthoria fallax*** (Hepp)

*Teloschistaceae*; 1, 4, 6, 8 (Co, Sa); Published data in NW Africa: **Alg**, Hamralaine (2007); **Tun**, El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Xanthoria parietina*** (L.) Ach.

*Teloschistaceae*; 1, 2, 3, 4, 5, 6, 7, 8, 9 (Co, Sa); Published data in NW Africa: **Alg**, Khedim & al. (2018); Boutabia (2000); Fadel & al. (2012); Hamralaine (2007, 2013); Khedim (2012); **Tun**, Seaward (1996), El Mokni & al. (2015); **Mor**, Ajaj & al. (2013).

***Floristic richness***

Field investigations lead us to sample 532 phorophyts “trees” at the 8 stations visited across the Tessala Mountains. It allowed identifying in total 53 lichen taxa growing in this region. These taxa belong to 16 different families dominated by *Physciaceae* (16 species), *Parmeliaceae* and *Lecanoraceae* (8 species each).

Although the number of 53 lichens may seem interesting for a region with a predominantly semi-arid bioclimate (Saidi 2017), the great part of these species are nitrophitic, or ubiquitous lichens, generally distributed (Roux & al. 2017). Indeed, this flora is strongly masked by foreign elements of mainly temperate origin. The temperate element, which arrived before, at the



time of the glaciations or after, is substantially equal in the three territories (Algeria, Morocco and Tunisia), although at a slightly higher percentage in Algeria (Werner 1955).

Otherwise, this number is much important than that reported by Ait Hammou & al. (2013) for green oak lichens in the semi-arid region of Tiaret (29 species).

### ***Chorology and biogeography***

The analysis of the obtained data following this research allowed us to identify 3 species that we report for the first time to NW Africa. These are the following taxa: *Lecanora praesistens*, *Multiclavula vernalis* and *Physconia distorta* var. *subvenusta*. These reports indicate first of all the richness of the lichen flora of Algeria, but also the fact that the Algerian lichen flora is poorly known (Khedim & al. 2018).

### ***Comments on some interesting species***

Several species in our list are listed either for the first time in NW Africa (*Lecanora praesistens*, *Multiclavula vernalis*, *Physconia distorta* var. *subvenusta*) or they are cited only in Algeria and missing in neighboring countries (*Amygdalaria continua*, *Buellia coniops*, *Candelariella superdistans*, *Flakea papillata*, *Lecidea exigua*, *Lichenomphalia umbellifera*, *Intense Pseudevernia* and *Ramalina celastri*).

*Lecanora praesistens* is a corticolous lichen on deciduous or coniferous trees, in moderately humid, well-lit and sunny biotopes. It is characterized by ellipsoid spores, simple, colorless, 12-16, 10-17 × 6-9 µm. In the thallin rim are large crystals clearly visible in polarized light and soluble in N but not in K. It differs from *L. chlorotera* Nyl. present in Tunisia and Morocco (Seaward & al. 1996; Ajaj & al. 2013) which shows only eight spores, coarse crystals in epithecium, large crystals in the thallin (P-) edge of apothecia. *Lecanora allophana* Nyl. and *L. pulicaris* (Pers.) Ach. reported both in Morocco (Ajaj & al. 2013) are distinguished from *L. praesistens* by the fact that the first has eight spores, an epithecium devoid of crystals, small crystals in the thallin (P-) edge of apothecia, then that the second also has fine crystals in the epithecium but the spores are eight, and the thallin edge of the apothecia is most often (P+) red (AFL 2019).

*Multiclavula vernalis* is one of a relatively small number of lichen-forming basidiomycetes, i.e. fungi that incorporate cells of a green alga within their tissues. The species remains to be searched in neighboring countries. The genus *Multiclavula* has not been quoted before in Algeria, Morocco and Tunisia.

*Physconia distorta* var. *subvenusta* is distinguished from *P. distorta* (With.) J. R. Laundon by its apothecia with lobules; the underside of the lobes is black as in *P. distorta*; in *P. venusta* (Ach.) Poelt, the underside of the lobes is white.

*Amygdalaria continua* is a species characterized by a continuous thallus with a finely smooth, rarely cracked or cracked texture, usually thick brownish gray with black tips. It can be recognized by the absence of soredia or by Apothecia entirely immersed, sunk in the thallus and no chemical staining (K-, C-, KC-, P-). It differs from *Amygdalaria consentiens* var. *consentians* with a cracked and cracked thallus and *Amygdalaria consentiens* var. *japonica* with a cracked thallus containing stictic and constictic acidss (Brodo & Hertel 1987). According to Amrani & al. (2018), *A. continua* is one of the taxa cited in the literature for Algeria with erroneous or doubtful records unsupported by herbarium material. But here we confirm his presence in our country. Genus and



species do not appear in the lists published in the neighboring countries including Seaward & al. (1996) and Ajaj & al. (2013).

*Buellia coniops* is a calcareous lichen, but can be found on non-calcareous (mainly granitic) rocks on the seacoasts. It is acidophilic, nitrophilous and halophilic (Roux & al. 2017). It has spores 1 times septated with uniformly thick, finely punctuated walls,  $13-18 \times 7-9 \mu\text{m}$ . This species is to be distinguished from *B. atrocinerella* (Nyl.) reported in Morocco (Ajaj & al. 2013) which has spores by 8, brown, uniseptated,  $14.9-18 \times 9.5-10.8 \mu\text{m}$ .

With its small, scattered yellow fruits (no hint of orange) and an inapparent thallus, *Candelariella superdistans* appears superficially similar to *C. aurella* (Hoffm.) Zahlbr. present in Morocco and Tunisia (Seaward & al. 1996; Ajaj & al. 2013), but that species has a paraplectenchymatous thalline margin without protruding hyphae.

A few years after the description of *Flakea papillata* in 1992, the species was included in the genus *Agonimia* by Aptroot & al. (1997), but the molecular data of Muggia & al. (2010) show that the taxon should be kept in a separate genus. *F. papillata* differs from other *Agonimia* species by its thallus structure. These are usually squamous-leper (Eriksson 1992, Perlmutter 2006). This species remains to be found in the two neighboring countries.

The epithecium of *Lecidea exigua* is highly charged with crystals is very similar to *Lecidella elaeochroma* found in Morocco and Tunisia (Seaward & al. 1996; Ajaj & al. 2013) but apothecia and spores are smaller and especially narrower.

*Lichenumphalia umbilefera* is a basidiolichen with a granular, green, conspicuous thallus; the granules are agglomerates of algae (*Coccomyxa*) traversed by thick-walled hyphae (AFL, 2019). The species has only been indicated in Algeria (Khedim & al. 2018) and remains to be searched in neighboring countries. So far, there is no other species of the genus *Lichenumphalia* in NW Africa.

*Pseudevernia intensa* is characterized by a thallus sometimes exceeding 10 cm in length, often during, formed of 2-5 mm wide, branched strips, with a greyish upper surface and a black underside, canaliculate, with curved edges. This thallus has a dorsiventrals organization (like the foliaceous) and no isidies on its upper face. Coloring: K-, KC-, P-, C +. *Pseudevernia furfuracea* (L.) Zopf .Beih.Bot is a close species present in Morocco and Tunisia (Seaward & al. 1996; Ajaj & al. 2013) and shares the same morphologic characteristics, but only the thallus does not stain C-, in addition to the presence of isidies (Roux, 2017).

*Ramalina leptocarpha* Tuck. might be confused with *R. celastri* that differs in having flat laciniae, a convex apothecial disc without pruina, lacking pseudocyphellae on the margins and never producing zeorin. In addition, blades of *R. leptocarpha* produce apothecia on both sides, but they are usually characteristically found on upper side of blades in *R. celastri*. In addition, *R. leptocarpha* looks like *R. calicaris* (L.) Fr., a European species present in Morocco and Tunisia (Seaward & al. 1996; Ajaj & al. 2013) that differs in having more protruded pseudocyphellae.

## Conservation and conclusion

Of the lichens identified in this study, 17 taxa (*Amygdalaria continua*, *Evernia prunastri*, *Hypogymnia physodes*, *Phlyctis argena*, *Physcia adscendens*, *Physcia biziana*, *Physcia*



*aipolia*, *Physcia caesia*, *Physcia dubia*, *Physcia stellaris*, *Physcia tenella*, *Physconia grisea*, *Physconia perisidiosa*, *Physconia distorta* var. *subvenusta*, *Ramalina canariensis*, *Ramalina farinacea*, *Ramalina fastigiata*) are officially protected in Algeria (Radp 2012). They represent the 16% of all protected species in the country. This percentage indicates the importance of the lichen flora of the Tessala Mountains region. This flora seems to shelter a very significant and original lichen diversity which deserves to be protected against the different anthropic constraints. Indeed, the natural habitats of this region, especially the original vegetation of green oak covering these mountains remain very weakened and vulnerable because of a very important anthropic activity putting this floristic and ecological wealth in potential danger (Saidi 2017). Only by the presence of this large number of protected lichens by Algerian law, this region must have an official protection status. That is why we propose that the Tessala Mountain forest be granted the status of a natural reserve in order to conserve this biodiversity.

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