

Original research

New data on lichen flora of the Edough Peninsula in north-eastern Algeria

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Abstract

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New information on the diversity of lichen flora of the Edough Peninsula in Algeria is presented and analysed. This study aimed to estimate the diversity of corticolous lichens on the rhytidome of *Quercus suber* L. in the district of Seraïdi, Annaba town, which is situated in north-eastern Algeria. During this study, nineteen species new to the Edough Peninsula were identified. Two species of the Pannariaceae family, *Pectenia plumbea* (Lichtf.) P.M. Jørg., L. Lindblom, Wedin & S. Ekman and *Fuscopannaria leucosticta* (Tuck.) P.M. Jørg., are rare in the region. *Pectenia plumbea* is a new species to the region, whereas *Fuscopannaria leucosticta* is new to the region and, after a long time, was rediscovered in Algeria.

Keywords: Algeria, lichen, Pannariaceae family, rhytidome, squamules.

INTRODUCTION

The extreme northeast of Algeria and the northwest of Tunisia are considered the Mediterranean regional hotspots due to their high biological diversity (Véla & Benhouhou, 2007), comprising many vital areas for plants richness (Radford et al., 2011), such as the Edough Peninsula. Eastern Numidia belongs to two bioclimatic areas: the subhumid and the humid, resulting in high atmospheric humidity that allows the development of a rich flora within a variety of ecosystems, including the oak tree forest, which has a special place among the Mediterranean forests (Bennadja et al., 2013). In addition to the undeniable economic role played by the cork oak forests,

they play an essential ecological role, contributing to the maintenance of rich biodiversity (Bennadja et al., 2013). Furthermore, some lichen species that have never been observed in Algeria have recently been recorded on this type of substrate in the study region. Such species include *Usnea cornuta* Körb. (Fekroune-Chaker, 2016), *Nephroma parile* (Ach.) Ach., and *Parmelioropsis afrorevoluta* (Krog & Swinscow) Elix & Hale (Ali Ahmed et al., 2018).

Chaker et al. (2021) have reported that, according to the Ministry of Land Management and Environment (MATE, 2014), Algerian lichen diversity has received little scientific attention from 1854 (Nylander, 1854) to 1955 (Werner, 1955). Then, however, the Second World War and the Algerian War of

Independence interrupted this work. Subsequently, some fragmentary regional inventories have been performed (Semadi et al., 1997; Rebbas et al., 2011; Serradj et al., 2013, Khedim, 2014; Boutabia et al., 2015; Ali Ahmed et al., 2018; Merabti et al., 2018; Chaker et al., 2021; etc.), including updates of the earlier inventories (Aït Hammou et al., 2014).

This study aimed to update the current data on the diversity of lichen flora of the Edough Peninsula in north-eastern Algeria.

MATERIALS AND METHODS

The Edough Peninsula is a small coastal massif that borders Annaba (Bône) from the west-southwest to the north (Fig. 1). Its highest point, Kef Sabaa, reaches 1.008 m above sea level. The peninsula protrudes from the coastline between the Cap de Garde to the east, which closes the bay of Annaba, and the Cap de Fer to the west, which closes the bay of Annaba, and the Cap de Fer to the west of the massif (Boulemtafes, 2015), which delimits the Gulf of Skikda (Philippeville). The Edough Peninsula is in the region of Annaba, which belongs to the Mediterranean bioclimate region characterised by temperate, humid winters and hot, dry summers. According to Hamel et al. (2013), the average annual rainfall in the Edough Peninsula is 1115.5 mm, with an average maximum temperature of 28.9 °C in the hottest month and an average minimum temperature of 4.6 °C in the coldest month.

The surveyed locality is situated on the northern slope of the Edough (36.920198° N, 7.697600° E) at an altitude of 742 m above sea level. This station

comprises a 3419 ha forest of *Quercus suber*. The lichens were primarily found on the rhytidome of *Quercus suber*. The lichen surveys were conducted on forty-two cork oak trees. These surveys systematically covered all four sides of the trunk from 0.50 m to 2.0 m above the soil level to avoid the basal protection provided by the grass cover and the eutrophication caused by animal faeces (Oran & Öztürk, 2012; Boutabia, 2016). Specimens with a well-developed thallus bearing typical, clear, and unaltered fruiting bodies were chosen, which facilitated the identification of species. A sample of each species was taken with a knife by gently removing a piece of bark to verify species that could not be identified in situ. These samples were then analysed in the laboratory.

For the identification, we used an *Optika* binocular magnifier with 20- and 40-times magnification, as well as the usual chemical reactions: K (10% KOH solution), C (NaOCl solution), I (lugol) commonly used in lichenology (Coste, 2011a; Thiévant, 2001; Van Haluwyn et al., 2013).

RESULTS AND DISCUSSION

The analysis of lichen samples from the Edough Peninsula on the rhytidome of *Quercus suber*, revealed the presence of 45 lichen taxa (Table 1). Nineteen taxa were newly discovered in the study area. However, they have neither been mentioned by Ali Ahmed et al. (2018) in their work on the lichen diversity of the Edough Peninsula nor by Fekroune-Chaker (2016) in their report on species to be protected in the



Fig. 1. Map of the location of the study area. The Edough massif is in green (OSM, 2022)

Edough Peninsula. Among these nineteen species, we identified two taxa (*Pectenia plumbea* morphotype *plumbea* and *Fuscopannaria leucosticta*) that are quite rare in their distribution area, found on only three proximal phorophytes in an area of 120 m². According to the Management Plan of *Degelia plumbea* in Canada, this endangered species occurs only in Canada, the United States, the British Isles, Scandinavia and the Iberian Peninsula (Environnement et Changement Climatique Canada, 2022). However, Otálora et al. (2017) have concluded that the biogeographic analysis of *Pectenia plumbea* indicates that the Mediterranean basin is the most likely ancestral distribution area of this species. *Pectenia plumbea* occurs in Western Europe, according to COSEPAC (2010), but in Algeria, it has been reported in previous studies (Flagey, 1896; Harmand, 1909 or Werner, 1949) as well as more recently (Djellil, 1989; Boutabia, 2016; Hamralaine et al., 2019), but never in the current study area (Edough Peninsula).

Fuscopannaria leucosticta has previously been considered non-existent in Algeria (Otálora et al., 2017). However, according to Amrani et al. (2018), this species has been reported in earlier studies on Algerian lichen flora, including Flagey (1891, 1896), Harmand (1909) and Werner (1949). Since then, it has neither been mentioned in the *Update of the inventory of lichens in Algeria* (Aït Hammou et al., 2014) nor the *Lichenological exploration of Algeria* (parts I and II) by Amrani et al. (2015, 2018). Therefore, besides being considered new to the region, it represents a national rediscovery. This species has also reappeared in Japan (Jørgensen, 2000).

***Pectenia plumbea* (Lightf.) P.M. Jørg.**

According to the description of Cannon et al. (2021), *Pectenia plumbea* has a one-piece foliose thallus (Fig. 2), often with a broad distinct margin. However, it appears to be formed by radiating imbricate lobes arranged in a rosette of 5 cm diameter (Fig. 2).

As stated in Jørgensen's (1999) identification key for the diagnostic character of the family Pannariaceae, with apothecia and without a thalline margin, the genus *Degelia* (now *Pectennia*) was characterised by a placodioid thallus. Accordingly, its margin has a distinctly lobed aspect (Fig. 3, A–C), and apothecia

often “coronate”, surrounded by a separate thalline rim (Fig. 3, B).

Regarding the thallus's upper surface, we can observe small wrinkles (Fig. 3, C) and longitudinal whitish striations arranged in a distinct network, as Cannon et al. have reported (2021). Moreover, the margin of the thallus is formed by broadly rounded lobes with thick margins and upright tips (Fig. 3, A, C). The absence of isidia and soredia (Fig. 3, A–C) confirms the *plumbea* morphotype, as noted in the scientific literature (LM, 2022; AFL, 2022; COSEPAC, 2010). This proves the *plumbea* morphotype as it is distinguished from the isidia morphotype by the absence of isidia and the presence of warts (as explained by Roux et al., 2017), which are large and thick globular lobes (Fig. 2; Fig. 3, B), formed primarily in the central part of the thallus.

It was observed that the upper face of the thallus of *P. plumbea* is light grey (Fig. 2), and the lower face is covered with a strong, thick whitish tomentum (Fig. 3, A). Its apothecia are lecidein (called biatorine) and are usually numerous (Fig. 3, B). LM (2022), AFL (2022) and COSEPAC (2010), report that apothecia have a planar disc rarely convex except in rainy weather, reddish-brown to orange-brown, with no thallin margins but with lighter, non-persistent hyaline margins and pale. These morphological characteristics were noted for our samples (Fig. 2; Fig. 3, B).

No significant chemical colour reactions were observed. The photosymbiont is a cyanobacterium: *Nostoc*, so the thallus takes on a dark grey-blue col-



Fig. 2. Dry thallus of *Pectenia plumbea* in rosette. Photo by A. Chaker, April 2021. Scale: 0.7 cm

Table 1. Lichen species recorded on the rhytidome of *Quercus suber* L. in the Edough Peninsula. Asterisk (*) indicates species first recorded in the study area

Number	Species	Position on tree	Reports in Algeria	Previously recorded localities in Algeria
1	* <i>Amandina punctata</i> Hoffm.	On branch	Slimani et al. (2013), Chaker et al. (2021)	National Park of El Kala (El Tarf), National Park of Djurdjura (Tizi Ouzou and Bouira)
2	<i>Anapychia ciliaris</i> (L.) Körb. ex A. Massal.	On trunk and branches	Slimani et al. (2013), Ali Ahmed et al. (2018), Hamralaine (2013), Hamralaine et al. (2019), Chaker et al. (2021)	National Park of El Kala (El Tarf), Edough Peninsula (Annaba), Tessala (Sidi Bel Abbès), National Park of Djurdjura (Tizi Ouzou and Bouira)
3	<i>Bacidia rubella</i> (Hoffm.) A. Massal	On trunk	Semadi (1989), Djellil (1989), Boutabia (2000), Slimani et al. (2013), Ali Ahmed et al. (2018), Chaker et al. (2021)	Annaba area, Tizi Ouzou area, National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
4	* <i>Caloplaca ferruginea</i> (Huds.) Th.Fr.	On trunk and branches	Djellil (1989), Bendaikha (2006), Rebbas et al. (2011), Chaker et al. (2021)	Tizi Ouzou area, Oran area, National Park of Gouraya (Bejaïa), National Park of Djurdjura (Tizi Ouzou and Bouira)
5	* <i>Collema furfuraceum</i> (Arnold) Du Rietz	On lower part of trunk	Semadi (1989), Djellil 1989, Rahali 2003), Boutabia 2000), Hamralaine (2013), Hamralaine et al. (2019), Chaker et al. (2021)	Annaba area, Tizi Ouzou area, Algiers area, National Park of El Kala (El Tarf), Tessala (Sidi Bel Abbès), National Park of Djurdjura (Tizi Ouzou and Bouira)
6	<i>Collema nigrescens</i> (Huds.) DC	On lower part of trunk	Fadel et al. (2012), Slimani et al. (2013), Ali Ahmed et al. (2018)	Skikda area, National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
7	* <i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Spreng	On lower part of trunk	Djellil (1989), Boutabia (2000), Slimani et al. (2013), Chaker et al. (2021)	Tizi Ouzou area, National Park of El Kala (El Tarf), National Park of Djurdjura (Tizi Ouzou and Bouira)
8	<i>Evernia prunastri</i> (L.) Ach	On trunk	Boutabia (2000), Ali Ahmed et al. (2018), Hamralaine et al. (2019), Chaker et al. (2021)	National Park of El Kala (El Tarf), Edough Peninsula (Annaba), Tessala (Sidi Bel Abbès), National Park of Djurdjura (Tizi Ouzou and Bouira)
9	<i>Flavoparmelia caperata</i> (L.) Hale	On trunk	Aït Hammou (2013), Slimani et al. (2013), Ali Ahmed et al. (2018)	Guezoul (Tiaret area), National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
10	* <i>Fuscopannaria leucosticta</i> (Tuck. ex E. Michener) P.M. Jørg	On trunk	Flagey (1891, 1896), Harmand (1909), Werner (1949)	Tellian region
11	* <i>Gyalolechia flavorubescens</i> (Huds.) Söchting, Frödén & Arup	On trunk	Fekroune-Chaker (2016)	New record on <i>Quercus suber</i> ; it has previously been found on <i>Crataegus monogyna</i> by Fekroune-Chaker (2016) in the Edough Peninsula (Annaba)
12	* <i>Lecanora chlarotera</i> Nyl	On trunk	Bendaikha (2006), Merabti (2008), Rebbas (2011), Slimani et al. (2013), Chaker et al. (2021)	Oran area, Algiers area, National Park of Gouraya (Bejaïa), National Park of El Kala (El Tarf), National Park of Djurdjura (Tizi Ouzou and Bouira)
13	* <i>Lecidella elaeochroma</i> (Ach.) M. Choisy	On trunk	Semadi (1989), Djellil (1989), Rahali (2003), Mosbah (2007), Rebbas et al. (2011), Bendaikha (2006), Boutabia (2000), Merabti (2007), Slimani et al. (2013)	Annaba area, Tizi Ouzou area, Algiers area, Oum El Bouaghi area, National Park of Gouraya (Bejaïa), Oran area, National Park of El Kala (El Tarf)
14	* <i>Lepra albescens</i> (Huds.) Hafellner	On trunk	Semadi (1989), Djellil (1989), Boutabia (2000), Bendaikha (2006), Rebbas et al. (2011), Fadel et al. (2012), Khedim (2012), Slimani et al. (2013), Chaker et al. (2021)	Annaba area, Tizi Ouzou area, National Park of El Kala (El Tarf), Oran area, National Park of Gouraya (Bejaïa), Skikda area, National Park of Theniet el Had (Tissemsilt), National Park of Djurdjura (Tizi Ouzou and Bouira)
15	<i>Lepra amara</i> (Ach.) Hafellner	On trunk	Boutabia (2000), Mosbah (2007), Slimani et al. (2013), Chaker et al. 2021	National Park of El Kala (El Tarf), Oum el Bouaghi area, National Park of Djurdjura (Tizi Ouzou and Bouira)

Number	Species	Position on tree	Reports in Algeria	Previously recorded localities in Algeria
16	<i>Lobaria amplissima</i> (Scop.) Forssell.	On trunk	Slimani et al. (2013), Ali Ahmed et al. (2018)	National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
17	<i>Lobaria pulmonaria</i> (L.) Hoffm.	On trunk	Djellil (1989), Rahali (2003), Slimani et al. (2013), Ali Ahmed et al. (2018)	Tizi Ouzou area, Algiers area, National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
18	<i>Nephroma laevigatum</i> (Ach.) Ach.	On trunk	Djellil (1989), Rahali (2003), Boutabia (2000), Slimani et al. (2013), Ali Ahmed et al. (2018)	Tizi Ouzou area, Algiers area, National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
19	* <i>Normandina pulchella</i> (Borrer.) Nyl.	On trunk (and <i>Erica arborea</i>)	Semadi (1989), Boutabia (2000)	Annaba area, National Park of El Kala (El Tarf)
20	* <i>Ochrolechia androgyna</i> (Hoffm.) Arnold	On trunk	This paper	New record
21	<i>Parmelia sulcata</i> Taylor	On trunk	Djellil (1989), Boutabia (2000), Rahali (2003), Khedim (2012), Slimani et al. (2013), Ali Ahmed et al. (2018)	Tizi Ouzou area, National Park of El Kala (El Tarf), Algiers area, National Park of Theniet el Had (Tissemsilt), Edough Peninsula (Annaba)
22	<i>Parmelina pastillifera</i> (Harm.) Hale	On trunk	Ali Ahmed et al. (2018)	Edough Peninsula (Annaba)
23	* <i>Parmotrema perlatum</i> (Huds.) M. Choisy	On trunk (and on <i>Erica arborea</i>)	Slimani et al. (2013), Fekroune-Chaker (2016)	National Park of El Kala (El Tarf) New record on <i>Quercus suber</i> ; it has previously been found on <i>Crataegus monogyna</i> by Fekroune-Chaker (2016) in the Edough Peninsula (Annaba)
24	<i>Parmotrema reticulatum</i> (Taylor) M. Choisy	On trunk (and on <i>Erica arborea</i>)	Ali Ahmed et al. (2018)	Edough Peninsula (Annaba)
25	* <i>Pectenia plumbea</i> (Lightf.)	On trunk	Durieu (1846), Nylander (1858), Hue (1891), Flagey (1895, 1896), Harmand (1909), Degelius (1935), Dubuis & Faurel (1945), Werner (1949), Djellil (1989), Boutabia (2016)	Tellian region. In recent studies: Tizi Ouzou area, Park of El Kala (El Tarf)
26	* <i>Pertusaria coccodes</i> (Ach.) Nyl	On trunk	Djellil (1989), Semadi (1989), Boutabia (2000), Fadel et al. (2012)	Tizi Ouzou area, Anaba area, National Park of El Kala (El Tarf), Skikda area
27	<i>Pertusaria pertusa</i> (Weigel) Tuck.	On trunk	Djellil (1989), Ali Ahmed et al. (2018)	Tizi Ouzou area, Edough Peninsula (Annaba)
28	<i>Phaeophyscia orbicularis</i> (Neck.) Moberg	On trunk	Semadi (1989), Boutabia (2000), Mosbah (2007), Hamralaine (2013), Ali Ahmed et al. (2018)	Annaba area, National Park of El Kala (El Tarf), Oum el Bouaghi area, Tessala (Sidi Bel Abbès), Edough Peninsula (Annaba)
29	<i>Physcia aipolia</i> (Ehrh. ex Humb.) Fűrnr.	On branch	Djellil (1989), Semadi (1989), Boutabia (2000), Mosbah (2007), Slimani et al. (2013), Ali Ahmed et al. (2018)	Tizi Ouzou area, Annaba area, National Park of El Kala (El Tarf), Oum el Bouaghi area, Edough Peninsula (Annaba)
30	<i>Physcia leptalea</i> (Ach.) DC.	On trunk and branches	Boutabia (2000), Mosbah (2007), Rebbas et al. (2011), Khedim (2012), Hamralaine (2013), Slimani et al. (2013), Ali Ahmed et al. (2018), Chaker et al. (2021)	National Park of El Kala (El Tarf), Oum el Bouaghi area, National Park of Gouraya (Bejaïa), National Park of Theniet el Had (Tissemsilt), Tessala (Sidi Bel Abbès), Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)
31	<i>Physconia distorta</i> (With.) Laundon	On trunk and branches	Mosbah (2007), Khedim (2012), Hamralaine (2013), Ali Ahmed et al. (2018), Chaker et al. (2021)	Oum el Bouaghi area, National Park of Theniet el Had (Tissemsilt), Tessala (Sidi Bel Abbès), Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)

Number	Species	Position on tree	Reports in Algeria	Previously recorded localities in Algeria
32	<i>Physconia perisidiosa</i> (Erichsen) Moberg	On lower part of trunk	Semadi (1989), Hamralaine (2013), Ali Ahmed et al. (2018), Chaker et al. (2021)	Annaba area, Tessala (Sidi Bel Abbès), Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)
33	<i>Physconia venusta</i> (Ach.) Poelt.	On trunk	Semadi (1989), Djellil (1989), Ali Ahmed et al. (2018), Chaker et al. (2021)	Annaba area, Tizi Ouzou area, Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)
34	<i>Pleurosticta acetabulum</i> (Neck.) Elix & Lumbsch	On trunk	Khedim 2012, Ali Ahmed et al. (2018), Chaker et al. (2021)	National Park of Theniet el Had (Tissemsilt), Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)
35	<i>Punctelia subrudecta</i> (Nyl.) Krog	On trunk	Semadi (1989), Djellil (1989), Boutabia et al. (2015), Ali Ahmed et al. (2018)	Annaba area, Tizi Ouzou area, National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
36	<i>Ramalina canariensis</i> J. Steiner	On branch	Semadi (1989), Djellil (1989), Hamralaine (2013), Slimani et al. (2013), Ali Ahmed et al. (2018), Hamralaine et al. (2019)	Annaba area, Tizi Ouzou area, Tessala (Sidi Bel Abbès), National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
37	<i>Ramalina farinacea</i> (L.) Ach	On trunk and branches	Rebbas et al. (2011), Khedim (2012), Hamralaine (2013), Slimani et al. (2013), Ali Ahmed et al. (2018), Hamralaine et al. (2019), Chaker et al. (2021)	National Park of Gouraya (Bejaïa), National Park of Theniet el Had (Tissemsilt), Tessala (Sidi Bel Abbès), National Park of El Kala (El Tarf), Edough Peninsula (Annaba), National Park of Djurdjura (Tizi Ouzou and Bouira)
38	<i>Ramalina fastigiata</i> (Pers.) Ach	On trunk and branches	Semadi (1989), Hamralaine (2013), Slimani et al. (2013), Ali Ahmed et al. (2018), Hamralaine et al. (2019)	Annaba area, Tessala (Sidi Bel Abbès), National Park of El Kala (El Tarf), Edough Peninsula (Annaba)
39	* <i>Ramalina fraxinea</i> (L.) Ach.	On branch	Khedim (2012), Hamralaine (2013), Boutabia (2016), Fekroune-Chaker (2016)	National Park of Theniet el Had (Tissemsilt), Tessala (Sidi Bel Abbès), National Park of El Kala (El Tarf). New record on <i>Quercus suber</i> ; it has previously been found on <i>Crataegus monogyna</i> by Fekroune-Chaker (2016) in the Edough Peninsula (Annaba)
40	* <i>Ramalina pollinaria</i> (Westr.) Ach.	On branch (36.925556 °N and 7.704722 °E)	Djellil (1989), Bendaikha (2006)	Tizi Ouzou area, Oran area
41	* <i>Scytinium lichenoides</i> (L.) Otálora	On trunk	Semadi (1989), Rebbas et al. (2011), Slimani et al. (2013), Chaker et al. (2021)	Annaba area, National Park of Gouraya (Bejaïa), National Park of El Kala (El Tarf), National Park of Djurdjura (Tizi Ouzou and Bouira)
42	* <i>Teloschistes chrysophthalmus</i> (L.) Th.Fr	On branches (and on <i>Prunus domestica</i> , 36.925556 °N and 7.704722 °E)	Rebbas et al. (2011), Bendaikha (2006), Fekroune-Chaker (2016)	National Park of Gouraya (Bejaïa), Oran area. New record on <i>Quercus suber</i> ; it has previously been found on <i>Crataegus monogyna</i> by Fekroune-Chaker (2016) in the Edough Peninsula (Annaba)
43	* <i>Usnea ceratina</i> Ach.	On trunk and branches (and on <i>Erica arborea</i>)	Flagey (1896), Harmand (1907), Werner (1949), Boutabia et al. (2015)	Tellian region. In recent studies: National Park of El Kala (El Tarf)
45	<i>Xanthoria parietina</i> (L.) Th.Fr.	On trunk	Boutabia (2000), Bendaikha (2006), Khedim (2014), Fadel et al. (2012), Hamralaine et al. (2019)	National Park of El Kala (El Tarf), Oran area, National Park of Theniet el Had (Tissemsilt), Tessala (Sidi Bel Abbès)

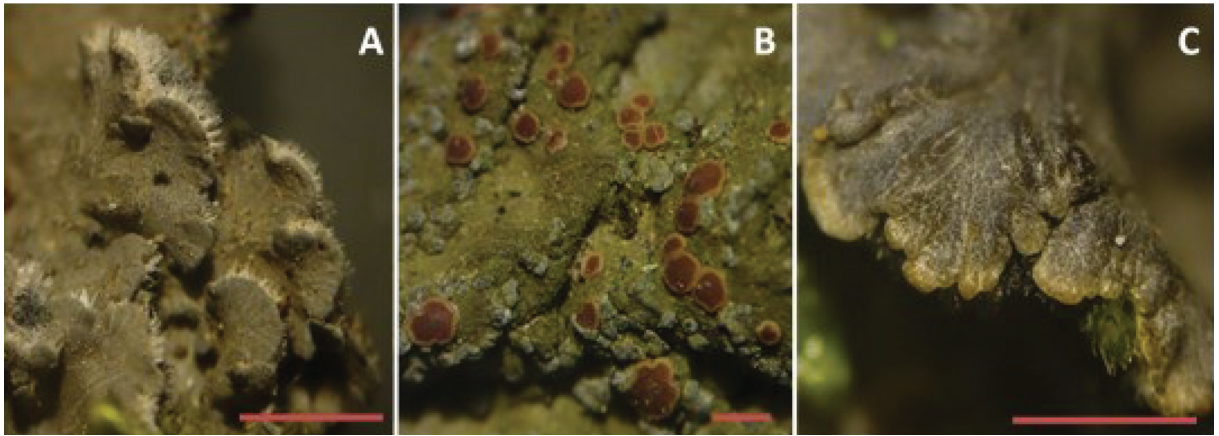


Fig. 3. Details of the thallus of *Pectenium plumbeum* seen under binocular: A, broad lobes with upright tips and tomentose underside (A); thallus neither isidic nor soriolate with globose lobes in the centre of the thallus, biatorial apothecia (B); rounded lobes with thick margins and the upper side of the thallus with longitudinal whitish striae (C). Photo by A. Chaker, April 2021. Scales: A = 0.7 mm, B = 0.5 mm, C = 1 mm

our in the presence of water (Fig. 3 A, B and C compared to thalli in the dry state in Fig. 2 and Fig. 4). Jørgensen (2000, 2007) has made the same observation. Species in Fig. 4 are present up to the mountain zone (above 700 m in altitude), on the cracked bark of *Quercus suber*, together with mosses (Fig. 4) in our study area (Edough Peninsula). *Pectenium plumbeum* was observed at the same locality (Edough) on three trees of *Q. suber*. Most of the thalli were mature and had numerous apothecia (Fig. 3, B; Fig. 4).

Furthermore, *Pectenium plumbeum* is a component of the *Lobarion pulmonariae* Hiltzer1925 (Gilbert, 2000; Roux, 2013; Coste, 2011b), a lichen alliance of the *Quercus suber* forests of the Edough Peninsula, which is used in this region for the biomonitoring of air pollution due in particular to acid precipitation. *Lobarion pulmonariae* is most often found on mosses on trunks of generally old deciduous trees, in very humid sites where microclimatic conditions are relatively stable (Roux & Coste, 2005; Coste, 2011b), which is the case in the *Quercus suber* forests of our study area.

***Fuscopannaria leucosticta* (Tuck.) P. M. Jørg.**

Fuscopannaria leucosticta is the second species of the family Pannariaceae studied in this research. It was found on the rough bark of cork oak (Fig. 5, A and B). This lichen is known to be very aerohydrophilic, as has been reported by Roux et al. (2017). Its thallus consists of many small overlap-



Fig. 4. *Pectenium plumbeum* and *Fuscopannaria leucosticta* with some accompanying species (like *Lobaria pulmonaria*) on *Quercus suber*. Photo by A. Chaker, April 2021. Scale: 0.7 cm

ping lobes (like shingles) (Fig. 5, B and Fig. 6, B), usually forming irregularly shaped colonies of a few centimetres in diameter (Fig. 5, A). We also observed apothecia with a distinct thalline margin (Fig. 5, B and Fig. 6, A), as described by Jørgensen (1999). The



Fig. 5. Several thalli of *Fuscopannaria leucosticta* with *Lepra albescens* (A) and thallus (B) details. Photos by A. Chaker, April 2021. Scales: A = 1 cm, B = 2 mm

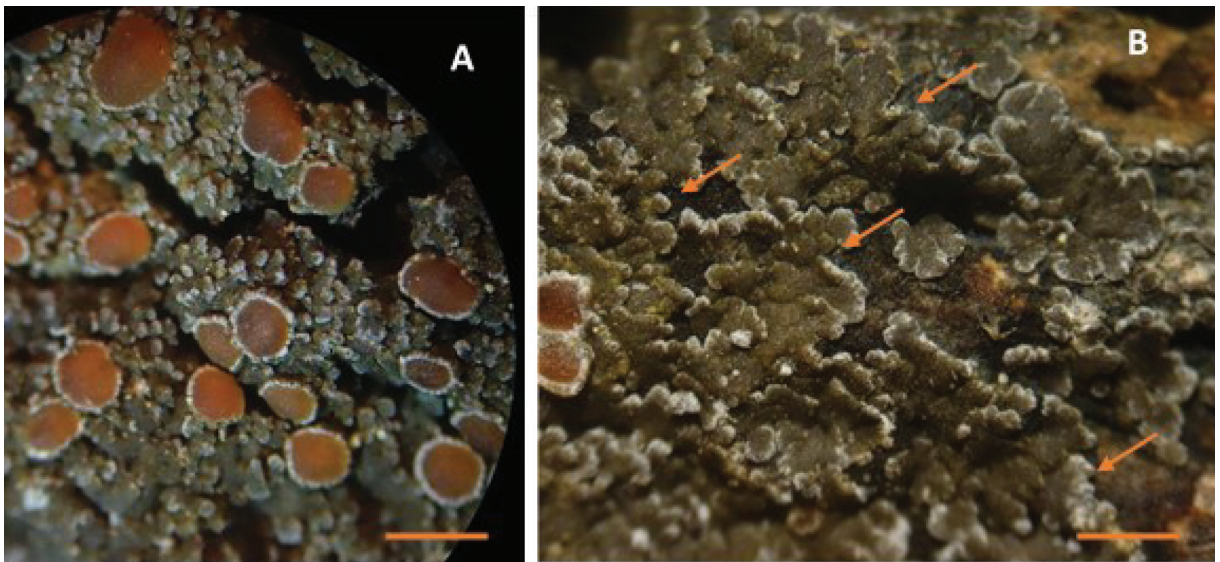


Fig. 6. Thallus of *Fuscopannaria leucosticta* seen under binocular ($\times 20$). Rusty brown apothecia with white felted thallin margin (A); margins of lobes distinctly white; hypothallus, indicated by arrows, is black (B). Photos by A. Chaker, April 2021. Scales: A = 1 mm, B = 1 mm.

disc of apothecia is less than 1 mm in size (Fig. 6, A), and it extends above the surface of the cortex and is surrounded by a margin of the same colour as the thallus (Fig. 6, A and B), consisting of both the fungus and the cyanobacterium.

The thallus's upper surface (cortex) is often olive grey (Figs 5 and 6), as it has been reported by

COSEPAC (2019). At the same time, the upper surface of their small squamules (less than 0.5 mm in diameter) has lobes of a visible white border formed by the tomentum (Fig. 6, A and B). *Fuscopannaria leucosticta* has a black prothallus (Fig. 6, B) consisting of a blue-black fibrous mat of hyphae that underlies the thallus and extends beyond its edges (Fig. 5, B).

Asexual reproductive structures, such as soredia, were absent, a typical characteristic of the species, as has been reported by COSEPAC (2019).

Pectenium plumbeum and *Fuscopannaria leucosticta* prefer isolated old oaks over one metre in diameter in open forests with a clear undergrowth, as observed at the sites where these two lichens of the Pannariaceae family were found. Haughian et al. (2019) have pointed out that these species are a valuable indicator of undisturbed old-growth forests.

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