

NOTEWORTHY RECORDS OF THE LICHENIZED AND LICHENICOLOUS FUNGI FROM ALACADAĞ NATURE RESERVE (FİNİKE-ANTALYA) IN THE MEDITERRANEAN REGION OF TURKEY

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Abstract. Alacadağ, due its different vegetation composition, has been declared as Nature Protection Area in Antalya in Turkey. The special vegetation composition may sign that special lichen taxa can be found in the area. Therefore, the richness of the lichenized and lichenicolous fungi of the area was determined. According to results, a total of 125 taxa belonging to 9 orders, 27 families and 66 genera were identified. Three of these taxa are lichenicolous fungi living parasitically on lichens. Of these three, *Abrothallus welwitschii* Tul. ex Mont. is newly recorded from Turkey. In addition, lichenized fungi *Calicium pinicola* (Tibell) M. Prieto & Wedin, *Catapyrenium psoromoides* (Borrer) R. Sant., *Parmelia ernstiae* Feuerer & A. Thell., *Sticta limbata* (Sm.) Ach. were reported firstly in Turkey with this research. Of all determined taxa for the area and thirty-three taxa for Antalya Province are new. Fourteen taxa that had been known as specific to different geographical regions of Turkey before, were first record from Mediterranean region of the country. In addition, it is concluded that the species richness composition of Alacadağ Nature Protection Area showed low similarity to nearby compared areas. It was determined that many of these dissimilar taxa are only species that can live in good environmental conditions.

Keywords: biodiversity, lichen, lichen systematic, systematic

Introduction

Lichens are symbiotic association of fungi and algae and/or cyanobacteria (Hawksworth, 1991; Yuan et al., 2005; Tripp, 2017). This complex association makes it difficult to classify these organisms. However, photobiont partners have their own classifications. For this reason, the identification of “lichen species” is carried out by the classification of the fungus that can form lichen (lichenized fungi). In the world and Turkey, many studies on the classification of these interesting organisms have been done. In addition, parasitic fungi taxa on lichens (lichenicolous fungi) were also included in these studies. Feuerer and Hawksworth (2007) reported that a total of 18.882 lichenized and lichenicolous fungi were recorded worldwide. A book entitled “Türkiye Likenleri Listesi- A Checklist of the Lichens of Turkey” (John and Turk, 2017), based on previous studies, reported that totally 1898 taxa of lichenized and lichenicolous fungi had been determined in Turkey.

Lichens are highly diverse in protected areas without human intervention (Hilmo and Sæstad, 2001; Gauslaa et al., 2007; Knapp et al., 2008). Therefore, protected areas are very valuable in terms of lichens. Protected areas in Turkey are divided into four statuses: national parks, nature parks, nature monuments and nature protection area

(MPK, 1983). Nature protection areas are the least destructed of these areas by human intervention. Nature protection areas are defined as;

- A part of nature which contains rare examples of ecosystems.
- Species and natural phenomena that are rare.
- Endangered ecosystems which are important for science and education.
- Require absolute protection and are reserved for science use only and educational purposes (MPK, 1983).

Of the IUCN protected area categories (Dudley, 2008; Mitchell et al., 2018), the Absolute Nature Reserve and Wilderness category is equivalent to the Nature Protection Area (Eroğlu, 2014). Alacadağ Nature Protection Area is one of the rare areas that is located in Antalya Province in the Mediterranean Region of Anatolia. It is a special forest formed of more than 20 tree species that are rare, old and/or monumental. *Cedrus libani* A. Rich., *Pinus brutia* Ten., *Juniperus oxycedrus* L., *Quercus coccifera* L., *Fraxinus angustifolia* Wahl., *Acer platanoides* L., *Pistacia terebinthus* L., *Ostrya carpinifolia* Scop., *Fraxinus ornus* L., *Sorbus torminalis* (L.) Crantz. are some of these tree species. The vegetation composition of the area is even different than its near surroundings. Due to this feature, the area was declared a nature protection area in 01.10.1990. This special vegetation composition suggests that the area is rich in terms of lichen richness. Thus, the lichenized and lichenicolous fungi richness of the Alacadağ Nature Protection Area is found to be worth investigating and this formed the purpose of this study.

Materials and methods

Study area

Alacadağ Nature Protection Area is located in the Mediterranean Region of Anatolia at the western slopes of Alacadağ Mountain, with the Neighborhood of Alacadağ, District of Finike, Antalya Province Area which is 15 km away from the district of Finike and 128 km away from Antalya, between the coordinates: 36°21'31"N 30°02'14"E, 36°21'24"N 30°03'04"E - 36°23'27"N 30°03'04"E, 36°23'41"N 30°03'49"E. The total area is 427 hectares and the altitude varies between 884 - 1809 m (*Figure 1*).

Collecting of samples

The lichen samples had been collected from all substrates in Alacadağ Nature Protection Area in 2016 and deposited in the private fungarium Dr. Özge Tufan-Çetin. 398 lichen samples were collected. Field studies were carried out in selected 8 random localities that have different vegetation cover types, topographic structure, micro-climate characteristics and altitudes (*Table 1, Figure 1, Figure 2, Figure 3*).

Identification of samples

Dried samples were examined by using a light microscope (Nikon Eclipse E100) for microscopic characters; and a stereoscopic zoom microscope (Nikon SMZ745T) for macroscopic characters. For identification of the species, the following literature has been used: Clauzade and Roux (1985), Wirth et al. (1995), Smith et al. (2009), Moberg (1977), Tucker and Thiers (1998), Ihlen and Wedin (2008), Arup et al. (2013), Otálora et al. (2014). When required, spot tests, UV tests and TLC has also been carried out. Index Fungorum (2018) website was used in order to update the names of lichens taxa.

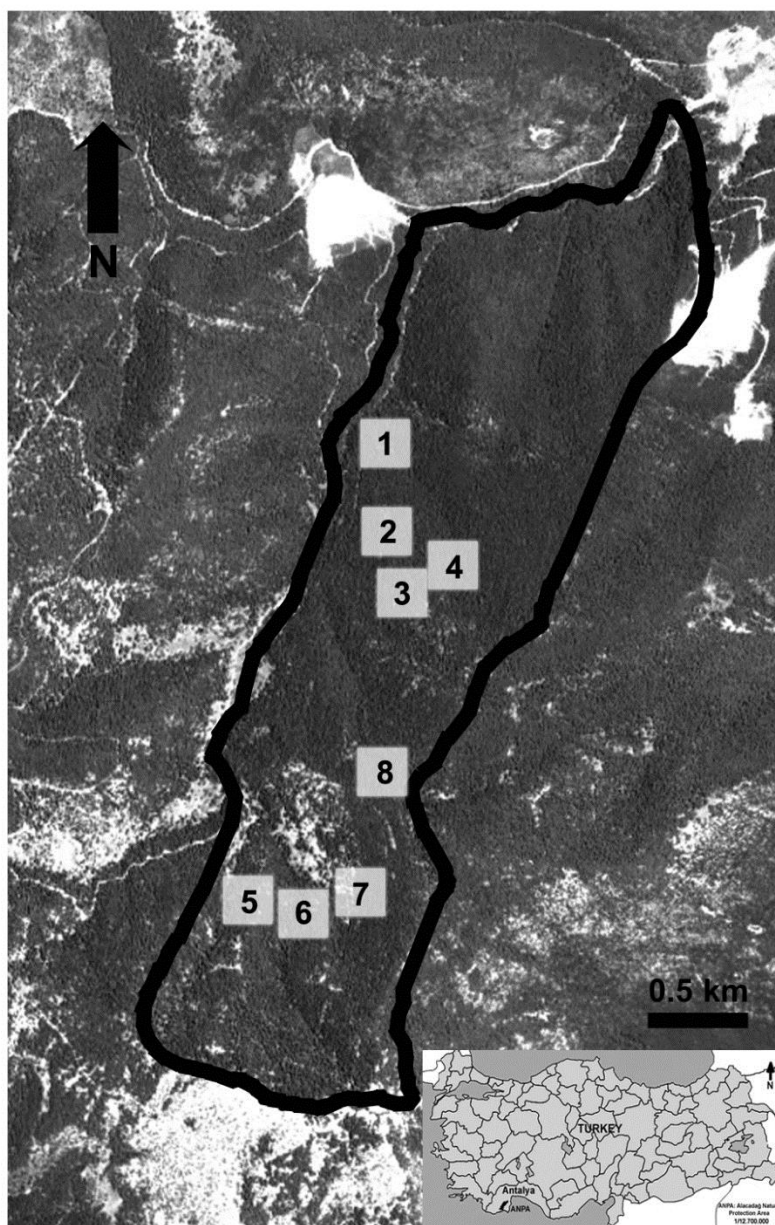


Figure 1. The map of Alacadağ Nature Area and the localities where the fieldwork was performed (The map was created with Adobe Photoshop 7.0 via data obtained from Google Earth Pro 7.3 program)

Table 1. Information about localities in Alacadağ Nature Protection Area

Localites	Coordinates	Altitudes	Dates
Loc 1	36°22,855' N 30°02,822' E	1185 m	18.6.2016
Loc 2	36°22,667' N 30°02,854' E	1343 m	18.6.2016
Loc 3	36°22,577' N 30°03,008' E	1494 m	18.6.2016
Loc 4	36°22,533' N 30°02,915' E	1449 m	18.6.2016
Loc 5	36°21,868' N 30°02,490' E	1547 m	19.6.2016
Loc 6	36°21,862' N 30°02,638' E	1516 m	19.6.2016
Loc 7	36°21,895' N 30°02,781' E	1528 m	19.6.2016
Loc 8	36°22,153' N 30°02,855' E	1609 m	19.6.2016



Figure 2. Entrance of Alacada  Nature Protection Area (Nature Reserve) Finike-Antalya

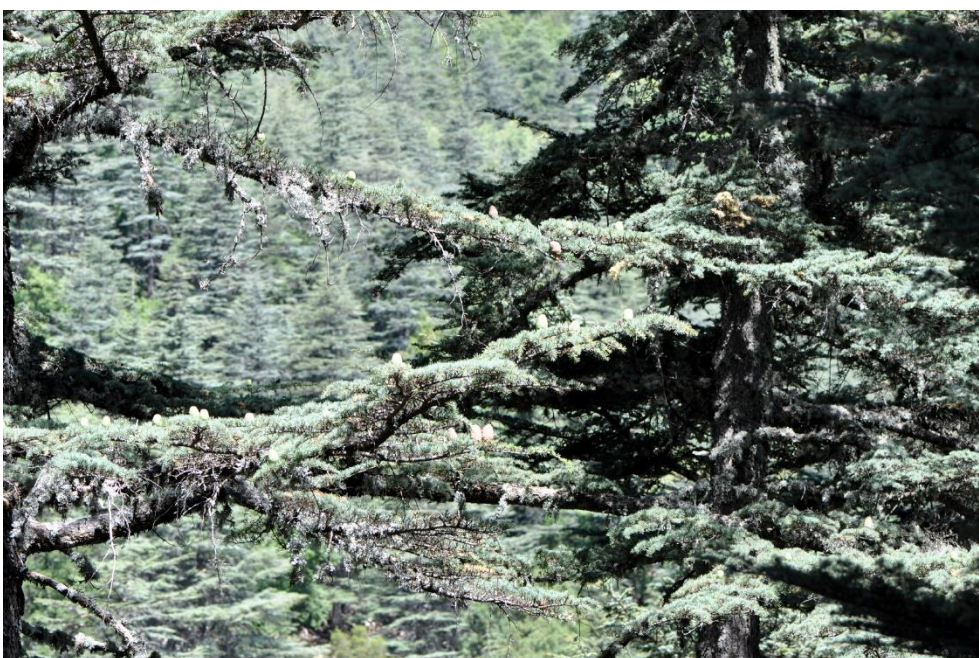


Figure 3. A view from Alacada  Nature Protection Area (Nature Reserve) Finike-Antalya

Data analysis

The lichen richness data obtained from Alacada  Nature Protection Area and the data obtained from near and previously studied areas were compared. These areas are the Elmal  Cedar Research Forest and Termessos National Park. The data from Elmal  Cedar Research Forest with altitudes from 1300 to 1880, approximately 23 km away from Alacada , were recorded by  obano lu and Sevgi (2006). Data of Termessos

National Park with altitudes from 360 to 1665 m, approximately 75 km away from Alacadağ, were determined by Tufan et al. (2005). The similarities of these three areas were calculated using Sorensen similarity index (Sørensen, 1948) with PAST 3.14. Since the richness of lichenicolous fungi had not been found in previous studies, these taxa were not included in the similarity assessment. In addition by Çobanoğlu and Sevgi (2006), the richness of epiphytic lichens had been investigated in the Elmalı Cedar Research Forest. Therefore, the similarity study for this area was applied only for epiphytic lichens.

Results

Results of taxa identification

This study is the first comprehensive study to determine the lichenized and the lichenicolous fungi species in the Alacadağ Nature Protection Area (Antalya-Finike). As a result of the field studies, 398 specimens collected and identified. A total of 125 taxa belonging to 9 orders, 27 families and 66 genera were determined with laboratory studies. They are listed in alphabetic order below. Taxa new for Turkey are marked by a plus (+) and taxa new for Antalya province are highlighted by an asterisk (*) in the list. In addition, lichenicolous fungi are indicated with a hash (#):

Abrothallus parmeliarum (Sommerf.) Arnold, Loc 3 on lichen on *Cedrus libani*.

+ # * *Abrothallus welwitschii* Tul. ex Mont, Loc 1 on lichen on *Acer* sp.

Acarospora cervina A.Massal., Loc 5 on calcareous rock.

Acarospora glaucocarpa (Ach.) Körb., Loc 5 on calcareous rock.

Acarospora macrospora (Hepp) Bagl., Loc 5 on calcareous rock.

Amandinea punctata (Hoffm.) Coppins & Scheid., Loc 2 on *Cedrus libani*.

Anaptychia ciliaris (L.) Körb. ex A.Massal., Loc 1, Loc 2, Loc 3 on *Cedrus libani*; Loc 3, Loc 8 on *Juniperus excelsa*; Loc 8 on *Acer* sp.; Loc 4 on dead tree.

* *Arthonia didyma* Körb., Loc 2 on *Acer* sp.

* *Arthonia mediella* Nyl., Loc 2 on *Cedrus libani*.

Bagliettoa calciseda (DC.) Gueidan & Cl.Roux, Loc 4, Loc 5 on calcareous rock.

Bagliettoa cazzae (Zahlbr.) Vězda & Poelt, Loc 2 on calcareous rock.

Bagliettoa marmorea (Scop.) Gueidan & Cl.Roux, Loc 5 on calcareous rock.

Bagliettoa parmigera (J.Steiner) Vězda & Poelt, Loc 4, Loc 5 on calcareous rock.

Bagliettoa parmigerella (Zahlbr.) Vězda & Poelt, Loc 5 on calcareous rock.

Bilimbia sabuletorum (Schreb.) Arnold, Loc 4 on moss on calcareous rock.

Blastenia ferruginea (Huds.) A.Massal., Loc 3 on *Cedrus libani*.

Bryoria fuscescens (Gyelnik) Brodo & D.Hawksw., Loc 5, Loc 6, Loc 7 on *Cedrus libani*.

* *Bryoria nadvornikiana* (Gyeln.) Brodo & D.Hawksw., Loc 1 on *Cedrus libani*.

+ * *Calicium pinicola* (Tibell) M. Prieto & Wedin, Loc 3 on death tree.

* *Calicium trabinellum* (Ach.) Ach, Loc 3 on dead tree.

Caloplaca adriatica (Zahlbr.) Servit, Loc 5 on calcareous rock.

Caloplaca cerina (Ehrh. ex Hedw.) Th.Fr., Loc 1 on *Fraxinus ornus*, on *Juniperus oxycedrus*; Loc 4, Loc 5 on *Sorbus torminalis*; Loc 8 on *Acer* sp.

Candelariella aurella (Hoffm.) Zahlbr., Loc 1 on *Fraxinus ornus*.

Candelariella vitellina (Hoffm.) Müll.Arg., Loc 1 on *Fraxinus ornus*.

+ * *Catapyrenium psoromoides* (Borrer) R. Sant., Loc 3 on moss on calcareous rock.

Circinaria calcarea (L.) Mudd, Loc 1, Loc 5 on calcareous rock.

Circinaria contorta subsp. *hoffmanniana* S.Ekman & Fröberg ex R.Sant., Loc 4, Loc 5 on calcareous rock.

Cladonia fimbriata (L.) Fr., Loc 1, Loc 5 on dead tree; Loc 2 on moss on dead tree; Loc 7 on soil.

* *Cladonia parasitica* (Hoffm.) Hoffm., Loc 1 on dead tree; on *Cedrus libani*.

* *Clauzadea chondrodes* (A.Massal.) Clauzade & Cl.Roux, Loc 2 on calcareous rock.

Clauzadea immersa (Weber) Hafellner & Bellem., Loc 1, Loc 2 on calcareous rock.

* *Clauzadea monticola* (Ach.) Hafellner & Bellem., Loc 5 on calcareous rock.

Collema furfuraceum (Arnold) Du Rietz, Loc 4 on *Sorbus torminalis*.

Collema nigrescens (Huds.) DC., Loc 1 on *Acer* sp.; Loc 5 on *Sorbus torminalis*; Loc 8 on *Cedrus libani*.

Evernia prunastri (L.) Ach., Loc 1, Loc 5 on *Cedrus libani*.

* *Fuscopannaria mediterranea* (C.Tav.) P.M.Jørg., Loc 5 on *Acer* sp.

Fuscopannaria olivacea (P.M.Jørg.) P.M.Jørg., Loc 4 on dead tree.

Gyalolechia flavorubescens (Huds.) Söchting, Frödén & Arup, Loc 1 on *Fraxinus ornus*; Loc 5 on *Sorbus torminalis*.

Hypocenomyce scalaris (Ach. ex Lilj.) M.Choisy, Loc 3 on dead tree.

Hypogymnia tubulosa (Schaer.) Hav., Loc 1, Loc 2, Loc 3, Loc 4, Loc 7 on *Cedrus libani*; Loc 1 on dead tree.

* *Hypogymnia vittata* (Ach.) Parrique, Loc 2 on *Cedrus libani*.

* *Lathagrium auriforme* (With.) Otálora, P.M.Jørg. & Wedin, Loc 4 on moss on calcareous rock.

Lathagrium cristatum (L.) Otálora, P.M.Jørg. & Wedin, Loc 5 on calcareous rock.

* *Lecania cuprea* (A.Massal.) van den Boom & Coppins, Loc 2 on calcareous rock.

Lecania cyrtella (Ach.) Th.Fr., Loc 1 on *Cedrus libani*.

* *Lecania naegelii* (Hepp) Diederich & P. Boom, Loc 1 on *Cedrus libani*; on *Juniperus oxycedrus*.

Lecanora carpinea (L.) Vain., Loc 1 on *Fraxinus ornus*; Loc 2 on *Cedrus libani*; Loc 5 on *Sorbus torminalis*; Loc 6 on *Acer* sp..

Lecanora chlarotera Nyl., Loc 1 on *Fraxinus ornus*; Loc 2 on *Cedrus libani*; Loc 4, Loc 5 on *Sorbus torminalis*; Loc 6 on *Acer* sp.

Lecanora pulicaris (Pers.) Ach., Loc 2 on *Cedrus libani*.

Lecanora saligna (Schrader.) Zahlbr., Loc 1 on *Fraxinus ornus*.

Lecanora varia (Hoffm.) Ach., Loc 3 on dead tree.

Lecidella carpathica Körb., Loc 3 on calcareous rock.

Lecidella elaeochroma (Ach.) M.Choisy, Loc 1 on *Fraxinus ornus*; Loc 1, Loc 2, Loc 6 on *Cedrus libani*; Loc 3 on *Juniperus excelsa*; Loc 5, Loc 6 on *Acer* sp.; Loc 8 on *Juniperus excelsa*, on *Fraxinus ornus*, on *Acer* sp; Loc 4, Loc 5 on *Sorbus torminalis*.

* *Lecidella scabra* (Taylor) Hertel & Leuckert, Loc 5 on dead tree.

Lecidella stigmatea (Ach.) Hertel & Leuckert, Loc 2, Loc 4, Loc 5 on calcareous rock.

Lepra albescens (Huds.) Choisy & Werner, Loc 1 on dead tree, Loc 1, Loc 3, Loc 4, Loc 5, Loc 6, Loc 7 on *Cedrus libani*; Loc 1 on *Juniperus oxycedrus*; Loc 3 on *Juniperus excelsa*; Loc 5 on *Fraxinus ornus*, on *Acer* sp; Loc 5 on *Sorbus torminalis*.

* *Lepraria umbricola* Tønsberg, Loc 3 on dead tree.

Lepraria vouauxii (Hue) R.C.Harris, Loc 5 on moss on calcareous rock.

Leproplaca xantholyta (Nyl.) Hue, Loc 2, Loc 5 on calcareous rock.

Leptogium saturninum (Dicks.) Nyl., Loc 1 on *Acer* sp.

- Letharia vulpina* (L.) Hue, Loc 1 on dead tree; Loc 3, Loc 6, Loc 7 on *Cedrus libani*, on dead tree.
- * *Lobaria pulmonaria* (L.) Hoffm., Loc 1 on *Cedrus libani*.
- Lobothallia radiosa* (Hoffm.) Hafellner, Loc 5 on calcareous rock.
- Megaspora verrucosa* (Ach.) Hafellner & V.Wirth, Loc 3 on *Juniperus excelsa*; Loc 8 on *Acer* sp., on *Cedrus libani*.
- Melanohalea elegantula* (Zahlbr.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Loc 1, Loc 2, Loc 3 on *Cedrus libani*, on *Juniperus excelsa*.
- Melanohalea exasperata* (De Not.) O. Blanco et al., Loc 4 on *Sorbus torminalis*, Loc 6 on *Acer* sp.
- Melanohalea exasperatula* (Nyl.) O. Blanco et al., Loc 8 on *Acer* sp.
- * *Mycobilimbia tetramera* (De Not.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen, Loc 5 on moss on calcareous rock.
- Myriolecis pruinosa* (Chaub.) Sliwa, Zhao Xin & Lumbsch Loc 5 on calcareous rock.
- Nephroma laevigatum* Ach., Loc 4 on *Cedrus libani*; Loc 5 on *Acer* sp., on dead tree.
- Nephroma tangeriense* (Maheu & A. Gillet) Zahlbr., Loc 1 on *Acer* sp.
- Ochrolechia balcanica* Vers., Loc 1, Loc 2, Loc 3 on *Cedrus libani*; Loc 4 on dead tree; Loc 4, Loc 5 on *Sorbus torminalis*; Loc 5, Loc 8 on *Acer* sp.
- Ochrolechia pallescens* (L.) A. Massal., Loc 2, Loc 3, Loc 8 on *Cedrus libani*; Loc 5, Loc 8 on *Acer* sp.
- * *Ochrolechia parella* (L.) A. Massal., Loc 1 on *Acer* sp.; Loc 8 on *Cedrus libani*.
- * *Ochrolechia tartarea* (L.) A. Massal., Loc 5 on *Acer* sp.
- Ochrolechia turneri* (Sm.) Hasselrot, Loc 3 on *Cedrus libani*; Loc 8 on *Juniperus excelsa*.
- * *Pannaria conoplea* (Ach.) Bory, Loc 8 on *Cedrus libani*.
- + * *Parmelia ernstiae* Feuerer & A. Thell., Loc 3 on *Cedrus libani*.
- Parmelia saxatilis* (L.) Ach., Loc 1, Loc 2, Loc 4, Loc 5 on *Cedrus libani*; Loc 1, Loc 4, Loc 5 on dead tree; Loc 1, Loc 5 on *Acer* sp.
- Parmelia* sp. (young individual), Loc 1 on *Juniperus oxycedrus*.
- Parmelia submontana* Nadv. ex Hale, Loc 2, Loc 8 on *Cedrus libani*; Loc 4 on *Sorbus torminalis*.
- Parmelia sulcata* Taylor, Loc 1, Loc 6 on *Cedrus libani*.
- Parmelina pastillifera* (Harm.) Hale, Loc 1 on *Cedrus libani*, on *Fraxinus ornus*; Loc 5 on *Acer* sp.
- Parmelina tiliacea* (Hoffm.) Hale, Loc 1 on *Cedrus libani*; Loc 5 on dead tree.
- Pectenidia atlantica* (Degel.) P.M. Jørg., L. Lindblom, Wedin & S. Ekman, Loc 1, Loc 8 on *Acer* sp.; Loc 3, Loc 8 on *Cedrus libani*, Loc 4 on dead tree.
- Peltigera canina* (L.) Willd., Loc 4, Loc 5 on moss on calcareous rock, Loc 5 on dead tree, on moss on *Acer* sp.
- Peltigera collina* (Ach.) Schrad., Loc 2 on moss on dead tree; Loc 4 on moss on soil; Loc 5 on dead tree, on *Acer* sp.; Loc 8 on *Cedrus libani*.
- Peltigera membranacea* (Ach.) Nyl. Loc 1 on soil on moss
- Peltigera rufescens* (Weiss) Humb., Loc 1 on dead tree.
- Pertusaria pertusa* (Weigel) Tuck., Loc 1 on *Acer* sp.
- Phlyctis agelaea* (Ach.) Flot., Loc 1 on *Acer* sp., on *Cedrus libani*.
- Phlyctis argena* (Sprengel) Flot., Loc 1, Loc 8 on *Fraxinus ornus*, on *Juniperus oxycedrus*; Loc 2, Loc 6, Loc 8 on *Cedrus libani*.
- Physcia adscendens* (Fr.) H. Olivier, Loc 1 on *Fraxinus ornus*; Loc 1, Loc 8 on

- Cedrus libani*; Loc 8 on *Acer* sp.; Loc 3 on *Juniperus excelsa*.
Physconia distorta (With.) J.R.Laundon, Loc 1, Loc 3 on *Cedrus libani*; Loc 1 on *Fraxinus ornus*; Loc 3 on *Juniperus excelsa*; Loc 4, Loc 5 on *Sorbus torminalis*, Loc 5, Loc 8 on *Acer* sp.; Loc 4 on dead tree.
Physconia venusta (Ach.) Poelt, Loc 3 on *Cedrus libani*, on *Juniperus excelsa*; Loc 4 on dead tree.
Placynthium nigrum (Huds.) Gray, Loc 3, Loc 5 on calcareous rock.
Platismatia glauca (L.) W.L.Culb. & C.F.Culb., Loc 1, Loc 2, Loc 3, Loc 4, Loc 5, Loc 6, Loc 7 on *Cedrus libani*; Loc 1, Loc 5 on dead tree; Loc 1 on *Acer* sp.
* *Protoblastenia calva* (Dicks.) Zahlbr., Loc 2 on calcareous rock.
Pseudevernia furfuracea (L.) Zopf var. *ceratea*, Loc 1 on *Acer* sp.; Loc 8 on *Juniperus excelsa*; Loc 2, Loc 3 on *Cedrus libani*.
* *Pseudevernia furfuracea* (L.) Zopf var. *furfuracea*, Loc 1 on *Juniperus oxycedrus*; Loc 1, Loc 2, Loc 3, Loc 4, Loc 5, Loc 6, Loc 7 on *Cedrus libani*; Loc 6 on *Acer* sp.
Psora vallesiaca (Schaer.) Timdal, Loc 5 on calcareous rock.
Pyrenodesmia chalybaea (Fr.) A.Massal., Loc 4 on calcareous rock.
Pyrenodesmia variabilis (Pers.) A.Massal., Loc 1, Loc 4 on calcareous rock.
* *Ramalina calicaris* (L.) Fr., Loc 1 on *Fraxinus ornus*; Loc 5 on *Acer* sp.
Ramalina farinacea (L.) Ach., Loc 1 on *Acer* sp., on *Cedrus libani*, on *Juniperus oxycedrus*, on *Fraxinus ornus*; Loc 2 on *Cedrus libani*.
Ramalina fastigiata (Pers.) Ach., Loc 1 on *Fraxinus ornus*.
Ramalina fraxinea (L.) Ach., Loc 1 on *Acer* sp., on *Fraxinus ornus*; Loc 2, Loc 3 on *Cedrus libani*.
* *Ricasolia amplissima* (Scop.) De Not., Loc 1 on *Cedrus libani*.
Rinodina capensis Hampe in A.Massal., Loc 1 on *Fraxinus ornus*.
* *Rinodina oleae* Bagl., Loc 4 on *Sorbus torminalis*; Loc 8 on *Acer* sp.
* *Rinodina pyrina* (Ach.) Arnold, Loc 6 on *Acer* sp.
* *Rinodina sophodes* (Ach.) A.Massal., Loc 4 on *Sorbus torminalis*.
Scytinium gelatinosum (With.) Otálora, P.M.Jörg. & Wedin, Loc 4, Loc 5 on moss on calcareous rock; Loc 5 on calcareous rock.
Scytinium lichenoides (L.) Otálora, P.M.Jörg. & Wedin, Loc 5 on moss on calcareous rock.
Scytinium teretiusculum (Wallr.) Otálora, P.M.Jörg. & Wedin, Loc 8 on *Cedrus libani*.
Squamarina cartilaginea (With.) P.James, Loc 3, Loc 5 on calcareous rock.
Squamarina gypsacea (Sm.) Poelt, Loc 3 on calcareous rock.
+ * *Sticta limbata* (Sm.) Ach., Loc 1 on *Cedrus libani*.
* *Toninia subfuscae* (Arnold) Timdal, Loc 5 on *Lecidella scabra*.
Variospora aurantia (Pers.) Arup, Frödén & Söchting, Loc 2 on calcareous rock.
Variospora flavescens (Huds.) Arup, Söchting & Frödén, Loc 2 on calcareous rock.
Variospora velana (A.Massal.) Arup, Söchting & Frödén, Loc 2 on calcareous rock.
Verrucaria nigrescens Pers., Loc 3, Loc 4, Loc 5 on calcareous rock.
Verruculopsis lecideoides (A.Massal.) Gueidan & Cl. Roux, Loc 2 on calcareous rock.
Xanthocarpia lactea (A.Massal.) A.Massal., Loc 5 on calcareous rock.
* *Xanthoria isidioidea* (Beltram.) Szatala, Loc 4 on *Cedrus libani*.

Results of data analysis

The results obtained from this study and the results obtained from Elmalı Cedar Research Forest (Çobanoğlu and Sevgi, 2006) and Termessos National Park (Tufan et al., 2005) were compared. In Elmalı Cedar Research Forest (Çobanoğlu and Sevgi, 2006), only the richness of epiphytic lichenized fungi had been investigated. Therefore, the similarity study for this area was applied only for epiphytic lichens. 54 epiphytic lichenized fungi taxa had been determined from Elmalı Cedar Research Forest and 77 epiphytic lichenized fungi taxa (without lichenicolous fungi) were identified in the Alacadağ Nature Protection Area. The epiphytic lichenized fungi taxa of the Elmalı Cedar Research Forest and the Alacadağ Nature Protection Area were found to be 0.4122% similar (27 common taxa) according to the Sorensen similarity index. 160 lichenized fungi taxa had been determined from Termessos National Park (Tufan et al., 2005). 39.007% similarity (55 common taxa) was determined between the lichenized fungi richness of Alacadağ Nature Protection Area and the lichenized fungi richness of Termessos National Park.

Discussion

Antalya, in Southern-west of Turkey, has been visited many times by lichen systematic researchers. A total of 402 lichenized and lichenicolous fungi taxa had been identified including the center city and districts of Antalya (Fellows, 1841; Pišút, 1970; Ayaşlıgil, 1987; Lumbsch, 1989; John, 1992, 1995, 1996, 2000, 2007; Zeybek et al., 1993; Vězda, 1996; Nimis and John, 1998; Schindler, 1998; Litterski and Otte, 2002; Meyer, 2002; Halda, 2003; Breuss and John, 2004; Çobanoğlu, 2005; Tufan et al., 2005; Schiefelbein, 2006; Mayrhofer and Sheard, 2007; Yavuz and Çobanoğlu, 2007; Pišút and Guttová, 2008; Kocakaya et al., 2009; Tufan-Cetin and Sümbül, 2011; Halici et al., 2012; Kocakaya et al., 2014; Özdemir Turk et al., 2015; Tufan-Çetin, 2015, 2019; Vondrák et al., 2016; John and Turk, 2017). In this study, 124 taxa belong to 9 orders, 27 families and 66 genera were determined. 33 of these were recorded for the first time in Antalya and the number of lichenized and lichenicolous fungi taxa of Antalya reach to 435.

Three of the taxa identified in the research area are lichenicolous fungi that live parasitically on lichens. A lichenicolous fungus species, *Abrothallus welwitschia*, is newly recorded for Turkey. *Abrotallus* is a genus that does not have a clear similarity to other genera of Ascomycetes and has many hypotheses about its phylogenetic relations (Pérez-Ortega et al., 2014). It is mostly composed of parasitic fungi living on lichens. World distribution of *Abrothallus welwitschii* is Europe (France, England, Ireland, Spain, Portugal), New Zealand, Africa (Kenya), North America (America), South America (Chile). *Abrothallus welwitschii* mostly chooses species belonging to the genus *Sticta* as host (Suija et al., 2015). In this study, this species was determined over *Sticta limbata*. *Sticta limbata* was determined first time in Turkey from Alacadağ Nature Protection Area. Also *Sticta limbata* is found in the Northern Hemisphere, South Africa, South America, Australia, New Zealand and East Asia (Japan, China, Korea) (Jayalal et al., 2014). Also the taxon in red list was categorized as “vulnerable” in Italy (Nascimbene et al., 2013). This species was reported living on mossy tree bark in the old forests by Smith et al. (2009). Similarly, in our research area, the species was identified from old *Cedrus libani* trees.

Calicium pinicola which had been defined as new combination with *Cyphelium pinicola* Tibell, Svensk Bot. Tidskr by Prieto et al. (2016), was reported as a new record for Turkey from this research area. This species which is located in Austria, Macedonia, USA (Obermayer, 1998) and the Swiss Alps (Nimis et al., 2018), is threatened with extinction in Switzerland (Bürgi-Meyer and Dietrich, 2011), categorized as “vulnerable” in Italy (Nascimbene et al., 2013).

Of the new records for Turkey *Catapyrenium psoromoides* is a species found in the Southwest of Asia Temperate, East Africa, Europe, New Zealand and North America. It is near threatened with extinction in Italy according to Nascimbene et al. (2013). The taxon lives on trees or on mosses (Breuss, 2002; Prieto et al., 2010). In our study, it was determined also over the moss.

Parmelia ernstia which has a wide distribution in Europe (Austria, Belgium, Bosnia and Herzegovina, Britain, Bulgaria, Czechia, Denmark, Estonia, France, Germany, Greece, Ireland, Lithuania, Luxembourg, Netherlands, Slovenia, Spain, Poland, Sweden), have been recorded from Turkey for the first time by this research. This species is also distributed in Algeria and Canary Islands in Africa (Kukwa et al., 2012). According to Kukwa et al. (2012) this species is rarely seen in coniferous deciduous trees. In Italy, *Parmelia ernstia* was identified from *Quercus* and *Pinus* species (Nimis and Martellos, 2017). Also in this study, the species was recorded on *Cedrus libani*.

In the Italian red list of epiphytic lichens *Calicium pinicola*, *Hypogymnia vittata*, *Sticta limbata* are categorized as “vulnerable” and *Catapyrenium psoromoides*; *Pannaria conoplea*; *Ricasolia amplissima* are classified as “near threatened” (Nascimbene et al., 2013). The Alacadağ Nature Protection Area is home to these sensitive species.

Most of the new records for Antalya in this study, have limited distribution in Turkey. In Figure 4, Turkey distribution maps of some taxa are given. The maps were created using the information of John and Türk (2017). There are also maps showing the biogeographical regions and phytogeographical regions of Turkey in Figure 4g and 4h. *Arthonia didyma* (Figure 4a), *Arthonia medulla*, *Lecania cuprea*, *Lepraria umbiricola*, *Mycobilimbia tetramera* (Figure 4c), *Ramalina calicaris*, *Ricasolia amplissima* (Figure 4e), that had been defined as specific to the Euro-Siberian Phytogeographical Region (P.R.) (Black Sea Biogeographical Region (B.R.)) of Turkey (John and Türk, 2017), have been found newly in Mediterranean Region of Turkey with this study. *Protoblastenia calva* that was defined only from Irano-Turanian P.R. (Anatolian B.R.) of Turkey have been found in our research area (John and Türk, 2017). Similarly, *Bryoria nadvornikiana*, *Calicium trabinellum*, *Hypogymnia vittata* (Figure 4b), *Pannaria conoplea* (Figure 4d), *Ochrolechia tartarea*, *Xanthoria isidioidea* were known in both Euro-Siberian P.R. (Black Sea B.R.) and Iran-Turanian P.R. (Anatolia B.R.) of Turkey (John and Türk, 2017). With our study these taxa have been recorded in Turkey's Mediterranean B.R. (Mediterranean P.R.). In addition, *Cladonia parasitica* which was defined as a lichen of the Euro-Siberian P.R. (Black Sea B.R.) in Turkey, had been found before in the south of Anatolia (in Hatay) same as with our study (John and Türk, 2017). The reason for this species to be found in Hatay may be due to the fact that this region is an enclave of Euro-Siberian P.R. (Black Sea B.R.) (Atalay, 1986). The presence of this species also in the research area may show that the area has a special ecological structure. On the other hand, *Rinodina oleae* (Figure 4f), *Lathagrium auriforme*, *Lobaria pulmonaria* (Figure 5), *Ochrolechia parella*, *Rinodina pyrina* which

are the new record taxa for Antalya, have a wide geographical distribution in Turkey and have been found in this research area.

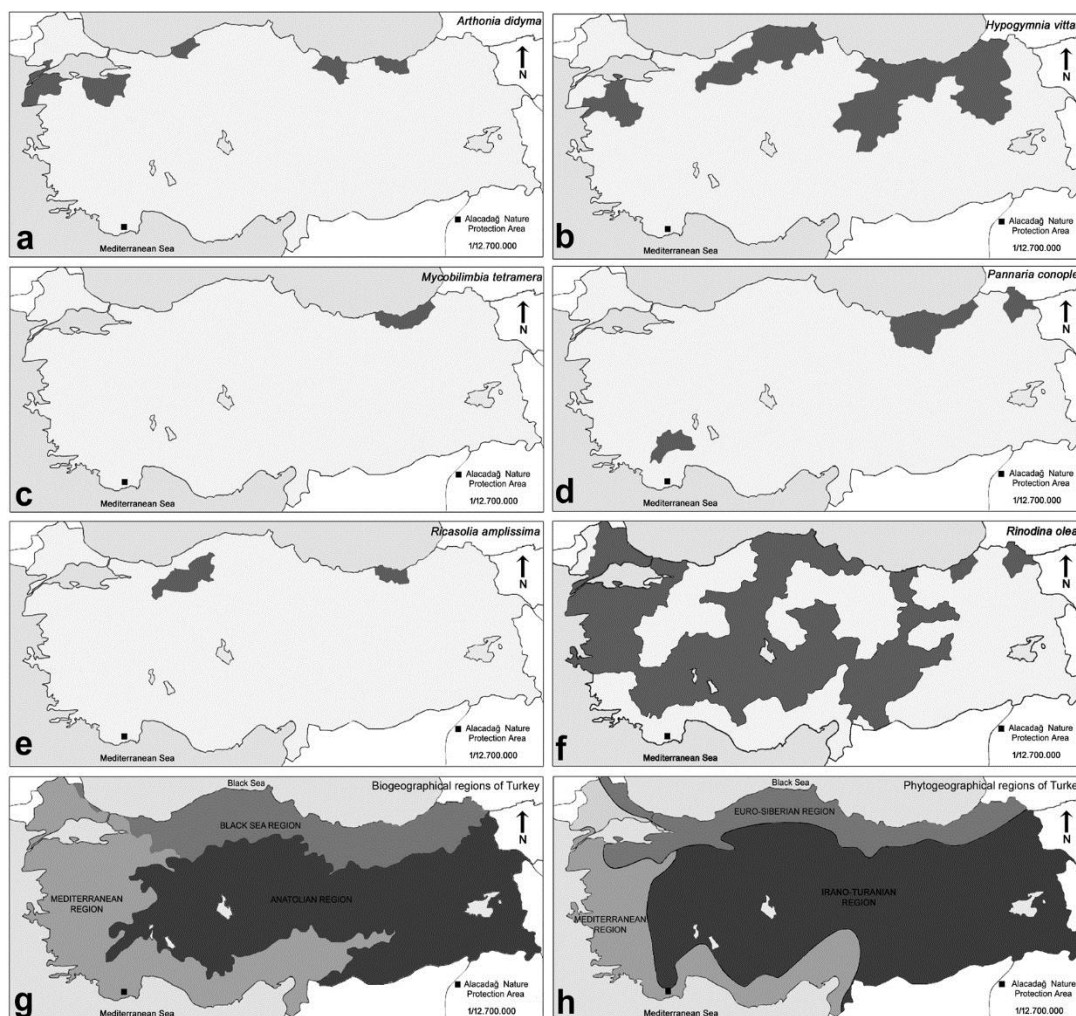


Figure 4. a-f. Turkey distribution map of some lichen taxa from Alacadağ Nature Protection Area (a. *Arthonia didyma*, b. *Hypogymnia vittata*, c. *Mycobilimbia tetramera*, d. *Pannaria conoplea*, e. *Ricasolia amplissima*, f. *Rinodina oleae*) g. Biogeographical regions of Turkey h. Phytogeographical regions of Turkey

When our richness data were compared with data of the nearby areas, with data of Termessos National Park, one of the compared area, 39.007% similarity rate were found. In addition, the epiphytic lichenized fungi richness data of the Alacadağ Nature Protection Area were found 0.4122% similarity with data of Elmalı Cedar Research Forest according to the Sorensen similarity index. However, according to Tufan-Çetin (2019), the richness of Termessos National Park is 55.52% (according to Sorensen similarity index) similar with the richness of Altınbeşik Cave National Park which is one of the protected areas of Antalya. In addition, Tufan-Çetin and Sumbul (2011) reported that Köprülü Canyon, another national park of Antalya, showed 58.29% similarity with Termessos National Park (according to Sorensen similarity index). According to these reference comparisons, it is concluded that the species richness

composition of Alacadağ Nature Protection Area showed low similarity to other areas. Furthermore, it was determined that many of dissimilar taxa (according to compared area) are only species that can live in good environmental conditions and in old forests (Figure 6) (Nimis and Martellos, 2017). Comparison area data dating back 13-14 years before may be the result of the better environmental quality than today. But the fact that these dissimilar taxa in the area can live in good environmental quality may indicate that the environmental change has not occurred in the area.



Figure 5. Some lichenized fungi taxa on *Cedrus libani* stem in Alacadağ Nature Protection Area (Nature Reserve) Finike-Antalya



Figure 6. Some old forest lichenized fungi taxa on dead tree in Alacadağ Nature Protection Area (Nature Reserve) Finike-Antalya

Conclusion

This study is the first comprehensive study to determine the lichenized and lichenicolous fungi taxa in the Alacadağ Nature Protection Area (Nature Reserve). Many taxa were newly recorded from Turkey, Turkey's Mediterranean region and Antalya Province with this study. Taxa that had been known as specific to different geographical regions of Turkey before, were firstly determined from the area. Furthermore, species richness composition of Alacadağ Nature Protection Area was found low similarity to other areas. All these noteworthy species findings indicate a different species composition structure in the Alacadağ Nature Protection Area compared to the Mediterranean lichen composition. In fact, Alacadağ has been declared as nature protection area (Nature Reserve) due to its rich plant diversity. In this study, it was also determined that the area has a different ecological structure in terms of lichens like plant diversity.

Nowadays, on three sides of Alacadağ Nature Protection Area are surrounded by marble quarries (Figure 1). It is obligatory to protect the area, which is emphasized as having a special structure also in this study, from the pressure of marble quarries. It has been observed that the density of sensitive species (*Catapyrenium psoromoides*, *Calicium pinicola*, *Hypogymnia vittata*; *Sticta limbata*, *Pannaria conoplea*; *Ricasolia amplissima*) in the area decreases when it was approached the marble quarries. For this reason, the density of the species in the area should be examined with a further study.

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