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Epiphytic lichen diversity on *Quercus cerris* and *Q. frainetto* in the Marmara region (Turkey)

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Abstract: The epiphytic diversity of lichens associated with *Quercus cerris* L. and *Quercus frainetto* Ten. were investigated in 21 localities of the Marmara region. A total of 106 taxa belonging to 49 genera were reported on *Q. cerris* and *Q. frainetto*, and 16 of those taxa were recorded for the first time in the Marmara region. The number of lichen species found on *Q. cerris* was 83, while 85 taxa were found on *Q. frainetto*. Several differences regarding the lichen taxa were found in these 2 oaks species even though they were growing in the same habitat and in the same locality. Furthermore, some morphological, anatomical, and ecological peculiarities, as well as the phytogeographical patterns of the recorded lichen taxa, were evaluated. The majority of the lichen species were hygrophytic and mesophytic. In addition, nitrophytic species were more frequently observed than acidophytes. Temperate and suboceanic species were the most common.

Key words: Biodiversity, ecology, epiphytic lichens, *Quercus*, Turkey

Marmara Bölgesi'ndeki *Quercus cerris* ve *Q. frainetto* üzerindeki epifitik liken çeşitliliği

Özet: *Quercus cerris* L. ve *Quercus frainetto* Ten. ağaçlarının birlikte bulunduğu Marmara Bölgesi'ndeki 21 lokalitedeki epifitik likenlerin çeşitililiği araştırılmıştır. *Q. cerris* and *Q. frainetto* üzerinden 49 cinse ait toplam 106 takson bulunmuştur ve bunlardan 16 tanesi Marmara Bölgesi'nden ilk kez kaydedilmiştir. *Q. cerris* üzerinden 83, *Q. frainetto* üzerinden ise 85 takson bulunmuştur. Aynı lokalitede ve benzer habitat şartlarında bulunmalarına rağmen iki meşe türü üzerinde gelişen liken türleri açısından bazı farklılıklar olduğu görülmüştür. Ayrıca, belirlenen liken taksonlarının bazı morfolojik, anatomik ve ekolojik özellikleri ile fitocoğrafik bölgeleri de değerlendirilmiştir. Çoğu liken türü higrofitik ve mezofitik olarak belirlenmiştir. Ayrıca, nitrotifik türlerin asidofitik türlerden daha fazla olduğu gözlenmiştir. En yaygın olarak ılıman ve suboseyanik türlere rastlanmıştır.

Anahtar sözcükler: Biyoçeşitlilik, ekoloji, epifitik likenler, *Quercus*, Türkiye

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Introduction

It is known that the biodiversity and distribution of lichens are related to substrate features and habitat conditions such as the age and history of the woodland, forest productivity, aspect, and climate. In substrate selection, the substrate chemistry, bark texture, and age of the tree are important for epiphytic lichens (Ihlen et al., 2001; Mežaka et al., 2008).

Lichenological studies in Turkey are based on large-scale floristic studies. Only a few detailed studies consider the epiphytic lichens and their substrate preferences in Turkey (Çobanoğlu et al., 2008; Öztürk & Güvenç, 2010; Ozturk et al., 2010).

The lichen biota of the Marmara region, including the epiphytic species, has been profusely documented (Rigler, 1852; Steiner, 1899; Pisut, 1970; Özdemir, 1990; Öztürk, 1990; Özdemir, 1992; Özdemir & Öztürk, 1992; Öztürk, 1992; Güvenç & Aslan, 1994; Güvenç et al., 1996; Öztürk, 1997; Öztürk et al., 1997; Çiçek & Özdemir Türk, 1998; Özdemir Türk & Güner, 1998; Yazıcı, 1999; Karabulut et al., 2004; Çobanoğlu, 2005; Çobanoğlu & Sevgi, 2006; Çobanoğlu, 2007; Dogru & Guvenc, 2007).

Quercus cerris and *Quercus frainetto* cover a very large area in the Marmara region. These 2 species occur together within many habitats. However, these 2 oak species show a difference in terms of bark features. Thus, the epiphytic lichen diversity of *Quercus cerris* and *Quercus frainetto* was evaluated in this context. We aimed to increase the knowledge about the substrate preferences of the lichen species in the Marmara region.

Materials and methods

The lichen specimens were collected from 21 localities in the Balıkesir, Bursa, Çanakkale, İstanbul, Kırklareli, and Tekirdağ provinces in 2005 and 2006 (Table 1). In each locality, lichen samples from *Q. cerris* were collected separately from those of *Q. frainetto*. The oak tree with the highest number of lichen specimens was selected for taking the samples from that oak species. All of the lichen samples were taken from a height of up to 2 m from the base of the trunks and from all directions of the 2 oak species. The names of authors were abbreviated according to the work of Brummitt and Powell (1992), and the nomenclature follows a modern system including recent literature (e.g., Blanco et al., 2004a, 2004b). The specimens are kept in the herbarium of Uludağ University (BULU) in Bursa.

Study area

The Marmara region is located in the north-west of Turkey, surrounding the Marmara Sea (Figure 1). This region consists of 2 parts, namely the peninsulas of Anatolia and Thrace. Uludağ Mountain (2543 m) is the highest point in the study area, located south of Bursa in the Anatolian Peninsula. Another mountainous area is the Yıldız Mountains (1031 m) in the Thracian Peninsula.

The Marmara region experiences different types of climate. The oceanic climate dominates on the coast of the Black Sea, while the Mediterranean climate influences the Marmara Sea and the Aegean Sea coasts as well as the inland areas. The average annual precipitation is 500-1000 mm and the temperature is 14-16 °C. The rainiest months are December, January, and February, while the driest months are June, July, and August. The average temperature in the dry months is 23-25 °C, and the average temperature in the rainy months is 5-6 °C (Akman, 1990).

The vegetation is diverse in the Marmara region. Rich maquis with *Q. coccifera* L., *Phillyrea latifolia* L., *Cercis siliquastrum* L., *Nerium oleander* L., *Olea europea* L., *Spartium junceum* L., *Pistacia lentiscus* L., *Erica arborea* L., *Cistus* spp., and other species is found along the coasts of the Aegean, Marmara, and Black seas from sea level up to 200 m. At higher altitudes, deciduous forests are dominated by *Quercus cerris* L. and *Q. frainetto* Ten., accompanied by *Q. ithaburensis* Decne subsp. *macrolepis* (Kotschy) Hedge, *Q. trojana* Webb., *Q. pubescens* Willd., *Q. infectoria* Olivier, *Q. petraea* (Mattuschka) Liebl., *Carpinus betulus* L., *Fagus orientalis* Lipsky, *Castanea sativa* Mill., *Tilia* sp., and *Acer* spp.

From 1000 to 1500 m, evergreen forests with *Pinus nigra* Arnold subsp. *pallasiana* predominate. *Abies nordmanniana* (Stev.) Spach subsp. *bornmuelleriana* (Mattf.) Coode & Cullen is found between 1500 and 2000 m on Uludağ Mountain. The Ergene basin of the Thracian Peninsula is covered by an anthropogenic steppe (Akman, 1995; Asan & Yarcı, 1993).

Table 1. Collection localities.

No.	Date	Locality	Elevation	Coordinates
1	27.07.2006	Balıkesir/Savaştepe; vicinity of Beyköy	490 m	39°28′47″N 27°38′50″E
2	27.07.2006	Balıkesir/İvrindi; vicinity of Küçükyenice	499 m	39°31′52″N 27°32′46″E
3	27.07.2006	Balıkesir/Balya; road of Danişment and Ilıca	174 m	39°50′47″N 27°42′03″E
4	28.07.2006	Balıkesir/centre; road of Yeşilova and Taşkesiği, 5 km before Taşkesiği	345 m	39°53′52″N 27°58′05″E
5	14.08.2005	Bursa/Mustafakemalpaşa; road of Nilüfer and Mustafakemalpaşa, vicinity of Akçapınar	181 m	40°06′41″N 28°38′47″E
6	14.08.2005	Bursa/Mustafakemalpaşa; between Kabulbaba and Killik, 4 km from Kabulbaba	488 m	40°02′04″N 28°35′40″E
7	28.05.2006	Bursa/İnegöl; vicinity of Tekkeköy	650 m	40°07′06″N 29°39′39″E
8	15.05.2005	Çanakkale/Bayramiç; Ayazma, entrance of Kaz Dağı National Park	456 m	39°44′44″N 26°50′41″E
9	15.05.2005	Çanakkale/Bayramiç; between Çavuşlu and Bayramiç, road junction of Akçakıl	183 m	39°46′41″N 26°41′54″E
10	06.07.2005	Çanakkale/Çan; between Bayramiç and Çan, vicinity of Hacıkasım	297 m	39°56′46″N 26°48′53″E
11	06.07.2005	Çanakkale/centre; between Çan and Çanakkale, road junction of Kocalar village	469 m	40°02′03″N 26°46′57″E
12	25.07.2006	Çanakkale/Lapseki; between Şahinli and Karaömerler, exit of Şahinli	210 m	40°17′51″N 26°45′00″E
13	25.07.2006	Çanakkale/Lapseki; Dede Tepe	575 m	40°13′28″N 26°48′26″E
14	26.07.2006	Çanakkale/Çan; between Çeltik and Bozguş, 3 km before Bozguş	341 m	40°07′18″N 27°04′13″E
15	26.07.2006	Çanakkale/Yenice; betweenYenice and Balya, around Mustafa Kemal Paşa fountain	402 m	39°56′02″N 27°21′08″E
16	13.06.2006	İstanbul/Çatalca; between Ormanlı and Karacaköy, 3 km from Ormanlı	30 m	41°23′42″N 28°26′10″E
17	15.06.2006	Kırklareli/centre; vicinity of Kızılcıkdere	216 m	41°41′49″N 27°20′32″E
18	16.06.2006	Kırklareli/Kofçaz; between Kofçaz and Kırklareli, 5 km before Elmacık	418 m	41°55′56″N 27°09′32″E
19	24.07.2006	Kırklareli/Pınarhisar; between Çayırdere and Akören, 2 km from Çayırdere	269 m	41°42′19″N 27°31′15″E
20	24.07.2006	Kırklareli/Demirköy; between Demirköy and Sivriler, 7 km from Demirköy	195 m	41°48′19″N 27°49′01″E
21	14.06.2006	Tekirdağ/Saray; between Saray and Ayvacık, vicinity of Saray	182 m	41°27′44″N 27°56′44″E

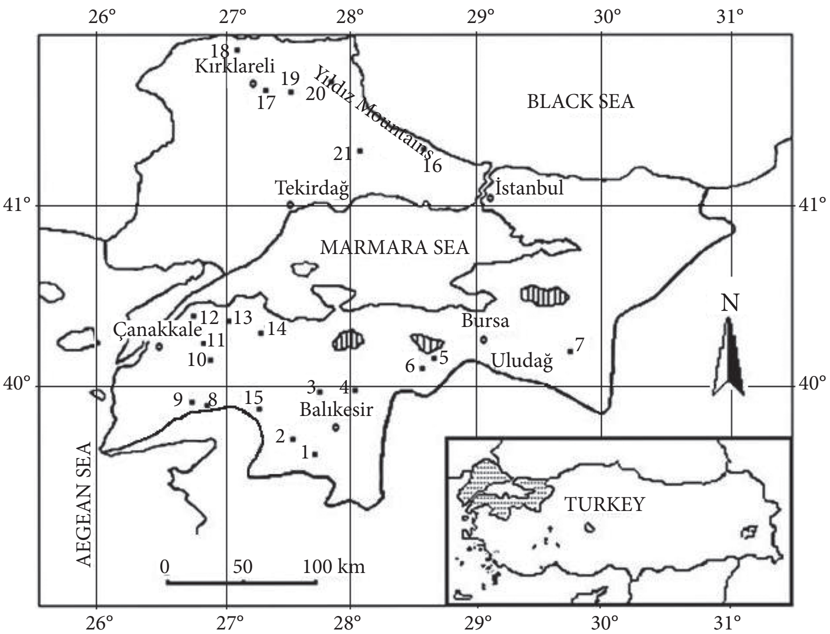

Figure 1. Map of the study area; collection sites are indicated by numbers.

Results and discussion

Floristic database

The lichen and lichenicolous species are arranged alphabetically with the locality numbers and tree species (Table 2). The herbarium numbers of the species (BULU) are also given in parentheses after the locality numbers. New records for the Marmara region are indicated with a "+" symbol.

A total of 106 taxa (105 lichen and 1 lichenicolous fungus) were recorded from the study area; 83 taxa were found on *Q. cerris* and 85 on *Q. frainetto.* A total of 21 species were found exclusively on *Q. cerris* and 23 species were found only on *Q. frainetto*, while 62 taxa were recorded on both oak species.

With only 5 species (*Bacidia naegelii*, *Lecidella elaeochroma*, *Melanelixia subaurifera*, *Physcia adscendens*, and *Xanthoria parietina*), locality 16 near İstanbul represents an area destroyed by city settlement and air pollution at a low altitude. In contrast, locality 11, in Çanakkale, exhibited the highest number of lichen taxa (42 species). This locality (a part of the Biga Mountains) and its surroundings have several hills with relatively well-protected forests.

Dactylospora parasitica, a lichenicolous fungus, grows on the thallus of *Pertusaria* or *Ochrolechia* species (Wirth, 1995), and it has been recorded on the thallus of *Ochrolechia* sp. in the province of Çanakkale. This lichenicolous fungus was recorded for the first time on the thallus of *Pertusaria albescens* from the province of Bursa (Dogru & Guvenc, 2007), and it was new record for the province of Çanakkale.

Nephroma laevigatum mainly grows on the barks of mossy trees in humid communities and in relict woodlands (Purvis et al., 1992). It was also found on the trunks of *Q. frainetto* in this study 3 times. Similarly, *Schismatomma pericleum*, a very rare species, usually grows on smooth barks of deciduous trees (e.g., *Fagus* sp.) and rarely on rough barks (e.g., *Acer* sp.; Wirth, 1995; Zedda, 2002). This nonnitrophytic species was observed on an old *Q. cerris* tree in a well-preserved forest. Zedda (2002) also recorded this species from old *Q. pubescens* trunks. These 2 species preferred to grow on only 1 oak species.

At locality 15, all of the *Usnea* Dill. ex Adans. species were found on *Q. cerris*. The *Usnea* species usually grow in mountainous, humid, or well-preserved areas (Purvis et al., 1992; Wirth, 1995). Locality 15 is a rather damp and well-protected area; therefore, these habitat features have likely

Table 2. Lichen and lichenicolous taxa found on *Q. cerris* and *Q. frainetto*.

Taxa	Localities and BULU numbers	
	Q. cerris	***Q. frainetto***
Amandinea punctata (Hoffm.) Coppins & Scheid.	**7** (12592), **14** (14197), **15** (14246)	
Anaptychia ciliaris (L.) Körb.	**2** (11814), **3** (11908), **7** (12596), **12** (13870), **13** (13930), **17** (14862), **19** (15261)	**2** (11828), **3** (11928), **4** (12106), **7** (12628), **10** (13607), **13** (13946), **14** (14202), **15** (14265), **17** (14892), **18** (15146)
Aplotomma turgidum (A.Massal.) A.Massal. ex Beltr.	**10** (13577), **11** (13700)	**10** (13598)
Arthonia radiata (Pers.) Ach.	**6** (12540), **17** (14877)	
+ *Bacidia fraxinea* Lönnr.		**3** (11946), **4** (12121), **15** (14263), **18** (15151)
+ *Bacidia naegelii* (Hepp) Zahlbr.	**16** (14726)	**16** (14731)
Bacidia rosella (Pers.) De Not.		**4** (12120), **13** (13964), **14** (14212)
Buellia disciformis (Fr.) Mudd	**8** (13388), **10** (13581), **11** (13699), **13** (13933), **15** (14244), **21** (15465)	**11** (13726), **13** (13963)
+ *Buellia erubescens* Arnold	**8** (13383), **11** (13689)	
Caloplaca cerinella (Nyl.) Flagey		**5** (12476)
Caloplaca ferruginea (Huds.) Th.Fr.	**8** (13376), **10** (13586), **11** (13704), **12** (13882), **15** (14245), **19** (15255)	**7** (12632), **10** (13610), **11** (13723)
Caloplaca holocarpa (Hoffm.) A.E.Wade		**7** (12634), **12** (13899)
Candelariella vitellina (Hoffm.) Müll.Arg.	**7** (12604), **8** (13378), **19** (15257)	
Candelariella xanthostigma (Pers.) Lettau	**3** (11923), **14** (14198)	**2** (11832), **3** (11935), **4** (12118), **14** (14211), **17** (14902)
Catillaria nigroclavata (Nyl.) Schuler		**10** (13600)
Chrysothrix candelaris (L.) J.R.Laundon	**20** (15329)	
Cladonia fimbriata (L.) Fr.	**15** (11747), **18** (15133)	**19** (15277)
Cladonia foliacea (Huds.) Willd.		**19** (15274)
Cladonia pyxidata (L.) Hoffm.	**6** (12530)	**2** (11840), **20** (15335)
Collema flaccidum (Ach.) Ach.	**8** (13380)	
Collema furfuraceum Du Rietz		**13** (13971)
Collema subflaccidum Degel.	**8** (13392)	**3** (11945), **12** (13904), **15** (14274)
Dactylospora parasitica (Flörke ex Spreng.) Zopf		**11** (13736)
Diplotomma alboatrum (Hoffm.) Flot.		**17** (14900)
Evernia prunastri (L.) Ach.	**2** (11810), **3** (11906), **4** (12092), **8** (13385), **10** (13570), **11** (13695), **12** (13873), **13** (13926), **14** (14190), **15** (14231), **17** (14871), **18** (15132), **19** (15259), **20** (15324)	**2** (11834), **3** (11932), **7** (12614), **11** (13710), **13** (13950), **15** (14257), **18** (15154), **20** (15330), **21** (15469)
Hyperphyscia adglutinata (Flörke) H.Mayrhofer & Poelt		**17** (14897)

Table 2. Continued.

Taxa	Localities and BULU numbers	
	Q. cerris	***Q. frainetto***
Hypogymnia farinacea Zopf		**7** (12625)
Hypogymnia physodes (L.) Nyl.	**4** (12097), **6** (12538), **11** (13684), **13** (13924), **14** (14193), **15** (14235), **18** (15137)	**2** (11830), **7** (12626), **10** (13611), **15** (14256)
Hypogymnia tubulosa (Schaer.) Hav.	**11** (13703), **13** (13925), **15** (14240)	**7** (12627), **20** (15333)
Lecania cyrtella (Ach.) Th.Fr.	**15** (14249)	**7** (12622)
Lecanora argentata (Ach.) Malme		**11** (13712)
Lecanora carpinea (L.) Vain.	**1** (11788), **6** (12536), **7** (12591), **8** (13377), **10** (13574), **11** (13697), **13** (13935), **15** (14241), **17** (14876), **18** (15140), **19** (15250), **21** (15458)	**4** (12112), **6** (12544), **7** (12617), **10** (13608), **11** (13707), **13** (13969), **18** (15149), **19** (15281), **21** (15472)
Lecanora chlarotera Nyl.	**1** (11791), **3** (11922), **5** (12466), **6** (12537), **7** (12587), **8** (13374), **10** (13588), **11** (13691), **12** (13877), **13** (13941), **15** (14242), **17** (14875), **19** (15265)	**1** (11805), **2** (11836), **5** (12472), **7** (12630), **8** (13396), **9** (13436), **10** (13605), **11** (13722), **13** (13962), **19** (15280)
Lecanora expallens Ach.	**3** (11917), **6** (12541), **8** (13389), **11** (13692), **12** (13888), **14** (14199), **20** (15323), **21** (15462)	**2** (11843), **14** (14224)
+ *Lecanora glabrata* (Ach.) Malme	**7** (12590)	**3** (11944)
Lecanora hagenii (Ach.) Ach.		**12** (13906)
Lecanora intumescens (Rebent.) Rabenh.	**11** (13701)	
Lecanora saligna (Schrad.) Zahlbr.	**4** (12104), **13** (13943)	**7** (12639)
Lecanora subcarpinea Szatala	**19** (15266)	
+ *Lecanora subrugosa* Nyl.	**7** (12594)	
Lecanora symmicta (Ach.) Ach.	**21** (15464)	**21** (15473)
Lecidella elaeochroma (Ach.) M.Choisy	**1** (11792), **2** (11823), **3** (11924), **4** (12101), **5** (12465), **6** (12539), **7** (12586), **8** (13375), **10** (13578), **11** (13690), **12** (13880), **13** (13938), **15** (14243), **16** (14722), **17** (14881), **18** (15142), **19** (15251), **20** (15321)	**1** (11804), **2** (11837), **3** (11943), **4** (12114), **5** (12471), **6** (12543), **7** (12616), **8** (13395), **10** (13594), **11** (13706), **13** (13966), **14** (14210), **16** (14729), **18** (15159), **19** (15276), **21** (15468)
+ *Lepraria eburnea* J.R.Laundon		**20** (15339)
Lepraria incana (L.) Ach.	**8** (13394), **10** (13576), **14** (14200)	**1** (11808), **2** (11839), **10** (13599), **14** (14213), **20** (15337)
Lepraria lobificans Nyl.	**8** (13379)	
Lobaria pulmonaria (L.) Hoffm.		**11** (13730)
Melanelia fuliginosa subsp. *glabratula* (Lamy) J.R.Laundon	**4** (12099), **7** (12600), **8** (13387), **18** (15141), **20** (15317)	**4** (12119)
Melanelixia glabra (Schaer.) O.Blanco et al.	**7** (12609), **17** (14879)	**7** (12631), **15** (14273)

Table 2. Continued.

Taxa	Localities and BULU numbers	
	Q. cerris	***Q. frainetto***
Melanelixia subargentifera (Nyl.) O.Blanco et al.	**7** (12595), **17** (14874)	**17** (14889)
Melanelixia subaurifera (Nyl.) O.Blanco et al.	**1** (11781), **2** (11819), **4** (12103), **5** (12469), **6** (12535), **7** (12607), **10** (13575), **11** (13687), **12** (13885), **13** (13929), **14** (14196), **15** (14238), **16** (14725), **21** (15463)	**1** (11803), **2** (11831), **5** (12475), **7** (12623), **10** (13609), **11** (13721), **13** (13968), **15** (14271), **16** (14730), **18** (15160), **19** (15275), **21** (15467)
Melanohalea exasperata (De Not.) O.Blanco et al.	**5** (12470), **8** (13384), **13** (13936), **19** (15262)	**7** (12636), **9** (13434), **11** (13729), **13** (13956)
Melanohalea exasperatula (Nyl.) O.Blanco et al.	**3** (11913), **7** (12593)	**2** (11833), **4** (12122), **20** (15336)
Nephroma laevigatum Ach.		
+ *Ochrolechia arborea* (Kreyer) Almb.	**12** (13868), **20** (15320)	
Ochrolechia pallescens (L.) A.Massal.	**13** (13942)	**13** (13965)
Ochrolechia turneri (Sm.) Hasselrot	**3** (11919), **12** (13883)	**3** (11936), **4** (12108), **9** (13431), **11** (13735), **12** (13902), **17** (14891), **18** (15152)
Parmelia sulcata Taylor	**1** (11782), **2** (11812), **3** (11912), **4** (12095), **6** (12534), **7** (12584), **8** (13386), **10** (13571), **11** (13686), **12** (13872), **13** (13923), **14** (14186), **15** (14234), **17** (14872), **18** (15130), **19** (15254), **20** (15325), **21** (15459)	**1** (11798), **2** (11826), **4** (12107), **7** (12611), **10** (13589), **11** (13705), **12** (13907), **13** (13948), **14** (142205), **15** (14255), **18** (15153), **19** (15269), **20** (15338), **21** (15466)
Parmelina carporrhizans (Taylor) Poelt & Vězda	**8** (13381), **11** (13702), **12** (13871), **13** (13927), **15** (14237)	**7** (12624), **9** (13433), **11** (13713), **13** (13953), **15** (14266)
Parmelina quercina (Willd.) Hale	**1** (11783), **7** (12605), **10** (13582), **19** (15253)	**7** (12638), **10** (13606)
Parmelina tiliacea (Hoffm.) Hale	**2** (11813), **3** (11910), **4** (12096), **7** (12588), **9** (13415), **10** (13580), **11** (13693), **12** (13869), **13** (13934), **14** (14194), **17** (14863), **18** (15139)	**3** (11934), **4** (12110), **9** (13422), **10** (13604), **11** (13711), **13** (13947), **14** (14204), **17** (14885), **18** (15144), **19** (15272)
Parmotrema perlatum (Huds.) M.Choisy		**10** (13590)
Peltigera praetextata (Flörke) Wain.		**19** (15271)
Pertusaria albescens (Huds.) M.Choisy & Werner	**3** (11914), **6** (12533), **7** (12585), **8** (13391), **9** (13418), **10** (13573), **12** (13876), **17** (14867), **20** (15319)	**2** (11841), **3** (11940), **6** (12545), **9** (13423), **10** (13591), **11** (13708), **12** (13901), **13** (13960), **15** (14261), **17** (14894)
Pertusaria amara (Ach.) Nyl.	**4** (12100), **18** (15138)	**4** (12109), **20** (15331)
Pertusaria hymenea (Ach.) Schaer.	**9** (13420)	**9** (13438), **11** (13734)
+ *Pertusaria leioplaca* DC.	**11** (13694)	
Pertusaria pertusa (Weigel) Tuck.	**3** (11915), **12** (13881), **20** (15327)	**3** (11933), **4** (12113)
+ *Phaeophyscia nigricans* (Flörke) Moberg	**3** (11921), **7** (12599), **17** (14868), **19** (15264)	**17** (14901)

Table 2. Continued.

Taxa	Localities and BULU numbers	
	Q. cerris	***Q. frainetto***
Phaeophyscia orbicularis (Neck.) Moberg		**3** (11938), **4** (12117), **9** (13430), **11** (13728), **12** (13903), **14** (14209), **17** (14898)
Phlyctis agelaea (Ach.) Flot.	**4** (12102)	**10** (13612)
Phlyctis argena (Spreng.) Flot.	**2** (11818), **3** (11925), **6** (12531), **10** (13572), **11** (13683), **14** (14191), **17** (14869), **20** (15318)	**3** (11927), **6** (12542), **10** (13593), **11** (13716), **13** (13955), **14** (14203), **15** (14262), **18** (15158), **19** (15279), **20** (15332)
Physcia adscendens (Th.Fr.) H.Olivier	**1** (11784), **5** (12463), **7** (12606), **6** (14724), **17** (14883), **19** (15256)	**1** (11806), **2** (11816), **3** (11842), **5** (12473), **7** (12620), **11** (13714), **13** (13959), **16** (14729), **17** (14886), **19** (15278), **21** (15471)
Physcia aipolia (Ehrh. ex Humb.) Fürnr.	**3** (11920), **7** (12603), **9** (13416), **17** (14880), **19** (15252)	**7** (12629), **9** (13426), **11** (13731), **15** (14268), **17** (14895), **18** (15147)
+ *Physcia dimidiata* (Arnold) Nyl.		**9** (13432)
Physcia leptalea (Ach.) DC.	**1** (11785), **2** (11817)	**1** (11801)
Physcia stellaris (L.) Nyl.	**1** (11790), **5** (12464), **13** (13937), **19** (15268)	**1** (11802), **5** (12474), **11** (13727), **13** (13957), **19** (15283)
Physcia tenella (Scop.) DC.	**1** (11795), **9** (13417), **10** (13584)	**9** (13428), **13** (13958)
Physconia detersa (Nyl.) Poelt	**8** (13393)	**3** (11929), **4** (12123), **11** (13733), **13** (13970), **17** (14899)
Physconia distorta (With.) J.R.Laundon		**9** (13425), **11** (13717), **14** (14206), **15** (14264), **17** (14890), **18** (15157)
Physconia enteroxantha (Nyl.) Poelt	**2** (11820), **3** (11911), **7** (12589), **14** (14192), **17** (14864), **18** (15134)	**3** (11941), **4** (12116), **7** (12613), **10** (13592), **11** (13719), **14** (14207), **17** (14996), **18** (15145), **19** (15273)
Physconia grisea (Lam.) Poelt	**17** (14866), **19** (15253)	**9** (13429), **17** (14887)
Physconia perisidiosa (Erichsen) Moberg	**3** (11909), **7** (12602), **9** (13419), **12** (13886)	**3** (11930), **4** (12115), **7** (12618), **9** (13424), **10** (13597), **11** (13720) , **14** (14208), **15** (14272), **17** (14888), **18** (15143)
+ *Physconia servitii* (Nádv.) Poelt	**12** (13878), **17** (14882)	**9** (13437), **15** (14270)
+ *Physconia subpulverulenta* (Szatala) Poelt		**13** (13954)
Platismatia glauca (L.) W.L.Culb. & C.F.Culb.	**14** (14189)	
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	**1**(11789) , **2** (11815), **3** (11926), **4** (12098), **7** (12598), **11** (13685), **13** (13932), **14** (14195), **15** (14236), **17** (14865), **19** (15248)	**1** (11797), **2** (11827), **4** (12111), **7** (12612), **10** (13602), **11** (16718), **12** (13900), **13** (13952), **15** (14267), **17** (14893), **18** (15150)
Protoparmeliopsis muralis (Schreb.) M.Choisy	**7** (12583), **19** (15249)	
Pseudevernia furfuracea (L.) Zopf var. *furfuracea*	**7** (12601), **13** (13922)	**7** (12621), **13** (13951)
Ramalina calicaris (L.) Fr.	**2** (11825), **11** (13698), **13** (13944), **15** (14253)	**15** (14254)

Table 2. Continued.

Taxa	Localities and BULU numbers	
	Q. cerris	*Q. frainetto*
Ramalina farinacea (L.) Ach.	**2** (11809), **4** (12093), **11** (13688), **12** (13875), **15** (14239), **18** (15131), **20** (15316), **21** (15460)	**1** (11799), **2** (11829), **3** (11931), **7** (12615), **15** (14258), **17** (14873), **18** (15156), **20** (15334)
Ramalina fastigiata (Pers.) Ach.	**1** (11787), **2** (11821), **3** (11916), **4** (12094), **10** (13583), **11** (13696), **12** (13874), **13** (13928), **14** (14187), **15** (14233), **17** (14878), **18** (15135)	**1** (11800), **10** (13603), **11** (13715), **13** (13949), **15** (14259), **18** (15155)
Ramalina fraxinea (L.) Ach.	**1** (11786), **15** (14232), **18** (15136), **19** (15260), **21** (15461)	**9** (13427), **15** (14260)
Ramalina pollinaria (Westr.) Ach.		**7** (12635)
Rinodina exigua (Ach.) Gray	**3** (11918), **8** (13390), **12** (13884)	**10** (13596), **11** (3732), **12** (13908)
Rinodina pyrina (Ach.) Arnold	**5** (12468), **7** (12608), **10** (13585), **19** (15267)	**5** (12477), **7** (12637), **11** (13725), **19** (15282)
Rinodina sophodes (Ach.) A.Massal.	**1** (11793), **8** (13382), **13** (13940), **15** (14248)	**9** (13435), **13** (13967)
+ *Schismatomma pericleum* (Ach.) Branth & Rostr.	**20** (15322)	
Scoliciosporum umbrinum (Ach.) Arnold	**1** (11794), **2** (11822), **7** (12610), **10** (13579), **13** (13939)	**1** (11807), **2** (11838), **7** (12633), **11** (13724)
+ *Strangospora moriformis* (Ach.) Stein	**10** (13587)	
Tephromela atra (Huds.) Hafellner	**2** (11824), **6** (12532), **12** (13879)	**2** (11835), **6** (12546)
Usnea filipendula Stirt.	**15** (14247)	
Usnea florida (L.) Weber ex F.H.Wigg.	**15** (14252)	
+ *Usnea glabrescens* (Nyl. ex Vain.) Vain.	**15** (14250)	
+ *Usnea subfloridana* Stirt.	**15** (14251)	
Xanthoparmelia tinctina (Maheu & A. Gillet) Hale	**19** (11942)	**3** (15258)
Xanthoria parietina (L.) Th.Fr.	**1** (11780), **2** (11811), **3** (11907), **5** (12467), **7** (12597), **12** (13887), **13** (13931), **14** (14188), **15** (14230), **16** (14723), **17** (14870), **19** (15247)	**1** (11796), **3** (11937), **4** (12105), **7** (12619), **9** (13421), **10** (12619), **11** (13709), **12** (13898), **13** (13961), **14** (14201), **15** (14269), **16** (14727), **17** (14884), **18** (15148), **19** (15270), **21** (15470)
Taxa on *Quercus* species	**83**	**85**
Total taxa	**106**	

Note: New records for the Marmara region are indicated with "+".

encouraged the effective settlement of *Usnea* species there.

Growth forms and photobionts

Some morphological, anatomical, and ecological peculiarities, as well as the phytogeographical patterns of the identified lichen taxa, are given in Table 3 (Wirth, 1995; Zedda, 2002; Nimis & Martellos, 2008).

After analysing the growth forms of all of the lichens, we found that 46 taxa were crustose, 40 taxa

Table 3. Presence and absence status and some ecological characteristics of examined lichen taxa.

Taxa	Presence/absence		Morphoanatomical and ecological characteristics					
	Q. cerris	*Q. frainetto*	Grf	Pho	pH	Hum	Eu	Phytog
Amandinea punctata	+	-	Cr	Ch	1-3	3-4	2-4	Temp
Anaptychia ciliaris	+	+	Fr	Ch	2-3	3	2-3	Temp
Aplotomma turgidum	+	+	Cr	Ch	2	2-3	1	Suboc
Arthonia radiata	+	-	Cr	Tr	2-3	2-3	1-3	Temp
Bacidia fraxinea	-	+	Cr	Ch	3	2	1-2	Suboc
Bacidia naegelii	+	+	Cr	Ch	3	3	3	Temp
Bacidia rosella	-	+	Cr	Ch	2-3	1-2	1-3	Suboc
Buellia disciformis	+	+	Cr	Ch	2	2	1-2	nTemp
Buellia erubescens	+	-	Cr	Ch	1	2	1	Temp
Caloplaca cerinella	-	+	Cr	Ch	3-4	3-4	3-4	Temp
Caloplaca ferruginea	+	+	Cr	Ch	2-3	3	1-3	Suboc
Caloplaca holocarpa	-	+	Cr	Ch	4-5	3-5	3-5	Temp
Candelarilella vitellina	+	-	Gr	Ch	1-3	3-4	2-5	Temp
Candelarilella xanthostigma	+	+	Gr	Ch	2-3	3	2-3	Temp
Catillaria nigroclavata	-	+	Cr	Ch	2-3	3	2-3	Temp
Chrysothrix candelaris	+	-	Lep	Ch	1-2	1-3	1	Temp
Cladonia fimbriata	+	+	Fr	Ch	1-3	2-3	1-3	Temp
Cladonia foliacea	-	+	Fr	Ch	2-3	1	1-2	Temp
Cladonia pyxidata	+	+	Fr	Ch	2-3	2-3	1-3	Temp
Collema flaccidum	+	-	Fol.b	Cy	3	2	1-2	Suboc
Collema furfuraceum	-	+	Fol.b	Cy	2-3	2	1-3	Suboc
Collema subflaccidum	+	+	Fol.b	Cy	2-3	2	2-3	Suboc
Diplotomma alboatrum	-	+	Cr	Ch	3-4	4-5	3-4	Temp
Evernia prunastri	+	+	Fr	Ch	1-3	2-3	1-3	Temp
Hyperphyscia adglutinata	-	+	Fol.n	Ch	3-5	3-4	3-5	Temp
Hypogymnia farinacea	-	+	Fol.b	Ch	1-2	3-4	1	Temp
Hypogymnia physodes	+	+	Fol.b	Ch	1-3	2-3	1-2	Temp
Hypogymnia tubulosa	+	+	Fol.b	Ch	1-2	2-3	1-2	Temp
Lecania cyrtella	+	+	Cr	Ch	3	3-4	2-3	Temp
Lecanora argentata	-	+	Cr	Ch	2-3	3	1-2	Temp
Lecanora carpinea	+	+	Cr	Ch	2-4	3-4	1-3	Temp
Lecanora chlarotera	+	+	Cr	Ch	2-3	3-4	2-5	Temp
Lecanora expallens	+	+	Cr	Ch	1-2	2-3	1-2	Suboc
Lecanora glabrata	+	+	Cr	Ch	3	3	2-3	Temp
Lecanora hagenii	-	+	Cr	Ch	3-5	3-5	2-4	Temp
Lecanora intumescens	+	-	Cr	Ch	2	2	1	Temp
Lecanora saligna	+	+	Cr	Ch	1-2	4	1-2	Temp
Lecanora subcarpinea	+	-	Cr	Ch	3	3-4	1-2	Temp
Lecanora subrugosa	+	-	Cr	Ch	-	-	-	Temp
Lecanora symmicta	+	+	Cr	Ch	1-2	2-3	1-2	Temp
Lecidella elaeochroma	+	+	Cr	Ch	2-4	2-5	2-4	Temp
Lepraria eburnea	-	+	Lep	Ch	2-4	2-3	1-2	sTemp
Lepraria incana	+	+	Lep	Ch	1-2	2-4	1-2	nTemp
Lepraria lobificans	+	-	Lep	Ch	2-4	1-3	1-2	Temp
Lobaria pulmonaria	-	+	Fol.b	Ch	2-3	1-2	1-2	Suboc
Melanelia fuliginosa subsp. *glabratula*	+	+	Fol.n	Ch	1-3	2-3	2-3	Temp
Melanelixia glabra	+	+	Fol.n	Ch	2-3	3-4	3	Suboc
Melanelixia subargentifera	+	+	Fol.b	Ch	3-4	3-4	2-3	Subcon
Melanelixia subaurifera	+	+	Fol.b	Ch	2-3	2-3	1-3	Temp
Melanohalea exasperata	+	+	Fol.n	Ch	2-3	3-4	2-3	Temp
Melanohalea exasperatula	+	-	Fol.n	Ch	2-3	3	3	Temp
Nephroma laevigatum	-	+	Fol.b	Cy	2-3	1-2	1	Suboc

Table 3. Continued.

Taxa	Presence/absence		Morphoanatomical and ecological characteristics					
	Q. cerris	*Q. frainetto*	Grf	Pho	pH	Hum	Eu	Phytog
Ochrolechia arborea	+	-	Cr	Ch	2	3	1-3	Temp
Ochrolechia pallescens	+	+	Cr	Ch	2-3	2-3	1-2	Suboc
Ochrolechia turneri	+	+	Cr	Ch	2-3	2-3	2-3	Temp
Parmelia sulcata	+	+	Fol.b	Ch	1-3	2-3	1-3	Temp
Parmelina carporrhizans	+	+	Fol.b	Ch	2-3	3-4	2-3	Suboc
Parmelina quercina	+	+	Fol.b	Ch	2-3	3-4	2-3	sTemp
Parmelina tiliacea	+	+	Fol.b	Ch	2	3	2-3	Temp
Parmotrema perlatum	-	+	Fol.b	Ch	2	2-3	1-2	Suboc
Peltigera praetextata	-	+	Fol.b	Cy	2-4	3-4	1-2	Temp
Pertusaria albescens	+	+	Cr	Ch	2-3	2-3	1-3	Temp
Pertusaria amara	+	+	Cr	Ch	1-3	2-3	1-3	Temp
Pertusaria hymenea	+	+	Cr	Ch	2-3	2-3	1-2	Suboc
Pertusaria leioplaca	+	-	Cr	Ch	2	2-3	1-2	Temp
Pertusaria pertusa	+	+	Cr	Ch	2	2-3	1-2	Suboc
Phaeophyscia nigricans	-	+	Fol.n	Ch	3-4	3-4	4	Temp
Phaeophyscia orbicularis	+	+	Fol.n	Ch	2-5	3-4	4-5	Temp
Phlyctis agelaea	+	+	Cr	Ch	2-3	2-3	1-2	Suboc
Phlyctis argena	+	+	Cr	Ch	2	2-3	1-2	Suboc
Physcia adscendens	+	+	Fol.n	Ch	3-5	3-4	3-5	Temp
Physcia aipolia	+	+	Fol.n	Ch	2-3	3	3-4	Temp
Physcia dimidiata	-	+	Fol.n	Ch	3-4	4	3-4	Temp
Physcia leptalea	+	+	Fol.n	Ch	2-4	3-4	2-3	Med-Atl
Physcia stellaris	+	+	Fol.n	Ch	2-3	3	2-4	Temp
Physcia tenella	+	+	Fol.n	Ch	2-4	3-4	3-4	Temp
Physconia detersa	+	+	Fol.b	Ch	2-3	2	2-3	North
Physconia distorta	-	+	Fol.b	Ch	3-4	3-4	3-4	Temp
Physconia enteroxantha	+	+	Fol.b	Ch	2-4	3	3-4	Suboc
Physconia grisea	+	+	Fol.b	Ch	3-4	3	4-5	Temp
Physconia perisidiosa	+	+	Fol.b	Ch	2-3	2-3	2-3	Suboc
Physconia servitii	+	+	Fol.b	Ch	2-3	2-3	2-3	Med-Atl
Physconia subpulverulenta	-	+	Fol.b	Ch	3	3	3-4	Med
Platismatia glauca	+	-	Fol.b	Ch	1-2	3	1-2	nTemp
Pleurosticta acetabulum	+	+	Fol.b	Ch	2-3	3-4	2-3	Temp
Protoparmeliopsis muralis	+	-	Cr.pl	Ch	2-5	3-4	3-5	Temp
Pseudevernia furfuracea var. *furfuracea*	+	+	Fr	Ch	1-2	3-4	1-2	nTemp
Ramalina calicaris	+	+	Fr	Ch	1-2	2	1-2	Med-Atl
Ramalina farinacea	+	+	Fr	Ch	2-3	1-2	1-2	Temp
Ramalina fastigiata	+	+	Fr	Ch	2-3	2-3	1-3	Temp
Ramalina fraxinea	+	+	Fr	Ch	2-3	2-3	2-3	Temp
Ramalina pollinaria	-	+	Fr	Ch	2-3	2-3	1-3	Temp
Rinodina exigua	+	+	Cr	Ch	2	3-4	3	Temp
Rinodina pyrina	+	+	Cr	Ch	2-3	3	2-3	Temp
Rinodina sophodes	+	+	Cr	Ch	2-3	3-4	1-2	Temp
Schismatomma pericleum	+	-	Cr	Tr	1-2	2	1	Med-Atl
Scoliciosporum umbrinum	+	+	Cr	Ch	1-3	2-3	1-3	Temp
Strangospora moriformis	+	-	Cr	Ch	2	4	2-3	Suboc
Tephromela atra	+	+	Cr	Ch	2-3	3	1-2	Temp
Usnea filipendula	+	-	Fr.f	Ch	1-2	1-3	1	nTemp
Usnea florida	+	-	Fr.f	Ch	1-2	1-2	1	nTemp
Usnea glabrescens	+	-	Fr.f	Ch	1-2	2	1	Subcon
Usnea subfloridana	+	-	Fr.f	Ch	2	2	1-2	Suboc
Xanthoparmelia tinctina	+	+	Fol.b	Ch	2-3	4	3-4	Med-Atl
Xanthoria parietina	+	+	Fol.b	Ch	2-4	3-4	3-4	Temp

Abbreviations: -- **Grf:** Growth form; **Cr.pl:** crustose placodiomorph, **Cr:** crustose, **Fol.b:** foliose broad-lobed (*Parmelia*-type), **Fol.n:** foliose narrow-lobed (*Physcia*-type), **Fr:** fruticose, **Fr.f:** fruticose filamentous, **Gr:** minutely squamulose to coarsely granular, **Lep:** leprose -- **Pho:** Photobiont; **Ch:** *Chlorophyta* other than *Trentepohlia*, **Cy**: *Cyanobacteria*, **Tr:** *Trentepohlia* -- **pH:** pH of the substrate; **1:** very acidic, **2:** intermediate between very acidic and subneutral, **3:** subneutral, **4:** intermediate between subneutral and basic, **5:** basic -- **Hum:** Humidity requirements; **1:** hygrophytic, **2:** rather hygrophytic, **3:** mesophytic, **4:** xerophytic, **5:** very xerophytic -- **Eu:** Sensitivity to eutrophication; **1:** no eutrophication, **2:** very weak eutrophication, **3:** weak eutrophication, **4:** rather high eutrophication, **5:** very high eutrophication -- **Phytog:** Phytogeographical patterns; **Med:** Mediterranean element with several coastal species restricted to the Mediterranean region, **Med-Atl:** Mediterranean-Atlantic element with species widespread in Europe and in the Mediterranean region, **Temp:** mainly temperate element with species widespread throughout Europe, **nTemp:** northern temperate element with species occurring from Scandinavia to the Mediterranean mountains, **sTemp:** southern temperate element with species extending from central Europe to the lower mountains of the Mediterranean region, **North:** northern element restricted to the highest mountains, **Subcon:** subcontinental element with species occurring from eastern Europe to middle Europe, **Suboc:** suboceanic element with ranges centred in all parts of Europe with a suboceanic climate.

were foliose, 15 taxa were fruticose, and 4 taxa were leprose. On *Q. cerris*, 38 taxa were crustose, 30 foliose, 13 fruticose, and 3 leprose. On *Q. frainetto*, 34 taxa were crustose, 37 foliose, 11 fruticose, and 2 leprose. When comparing the growth forms of the lichen species, crustose lichens were more abundant on *Q. cerris* than on *Q. frainetto*. In contrast, foliose lichens were more common on *Q. frainetto*, and fruticose and leprose species were nearly the same in number. In general, and considering the frequency of the species found, crustose taxa preferred the bark of *Q. cerris* and foliose taxa preferred the bark of *Q. frainetto*.

Regarding the total biota of the *Quercus* species, 95.3% of the lichen species have *Chlorophyta* as the photobiont and 4.7% have *Cyanobacteria*. There was no difference when the frequency of the different photobionts on *Q. cerris* and on *Q. frainetto* was compared.

Ecological features

The acidity, humidity, and eutrophication classes of the identified lichen taxa are given based on the work of Nimis and Martellos (2008) (Table 3).

The pH levels of the substrates were divided into 5 classes (Table 3). In general, the majority of the species belonged to the classes 2 and 3. The other classes had fewer taxa.

We observed differences when examining the number of species found only on *Q. cerris* or on *Q. frainetto* (Figure 2). Classes 1 and 2 were more frequent on the trunks of *Q. cerris*, while classes 3, 4, and 5 were more common on the trunks of *Q. frainetto*. These results were evaluated according to the information in the literature, mainly that from Nimis and Martellos (2008). In a prior study conducted by us, the highest average recorded bark pH was 6.16 from *Q. frainetto* and the lowest average recorded bark pH was 4.76 from *Q. cerris* in the Marmara region (Öztürk & Oran, 2011). As generally shown, the bark of *Q. cerris* is more preferred by the acidic lichen species, while the bark of *Q. frainetto* is more preferred by subneutral and basic lichen species.

Based on the humidity requirements, we divided the species into 5 classes (Table 3). The majority of the species were hygrophytic and mesophytic; 12 taxa were rather hygrophytic (class 2), 29 taxa were hygrophytic-mesophytic (classes 2 and 3), 18 taxa were mesophytic (class 3), and 27 taxa were mesophytic-xerophytic (classes 3 and 4). The other classes were observed less often.

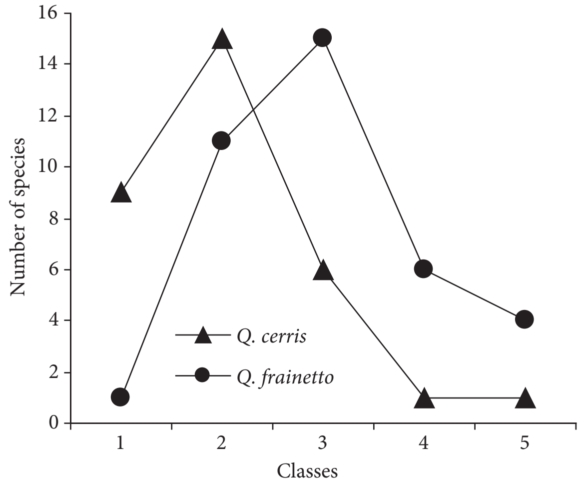

Figure 2. Number of species in different classes for pH found only on *Q. cerris* or *Q. frainetto*.

Regarding the humidity classes, there was a high degree of similitude when comparing the number of species found only on *Q. cerris* or on *Q. frainetto* (Figure 3). There were a few differences only in classes 4 and 5. The very xerophytic lichen species were found only on the trunks of *Q. frainetto*.

It is well known that factors such as bark texture, moisture-holding capacity, and bark chemistry affect the lichen settlement on trees (Brodo et al., 2001). Similarly, the moisture availability of the tree trunks

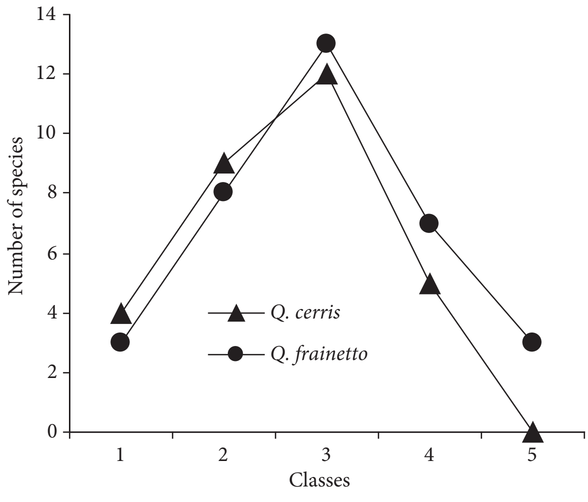

Figure 3. Number of species in different classes for humidity found only on *Q. cerris* or *Q. frainetto*.

affects the diversity and distribution of the corticolous lichen communities (Delphis & Wubbena, 2006). *Q. frainetto* needs more moisture than *Q. cerris*, and moisture is the most important factor determining the geographical distribution of *Q. frainetto* (Yaltırık, 1984; Günal, 1997). For this reason, the trunks of *Q. frainetto* are usually covered with mosses, and, therefore, some foliose species such as *Lobaria pulmonaria* and *Nephroma laevigatum*, which grow in mossy and humid woodland areas, were abundant on the trunks of *Q. frainetto*.

Bark crevice depth is a significant factor affecting epiphytic species distribution (Gustafsson & Eriksson, 1995; Mežaka et al., 2008). The bark textures of *Q. cerris* and *Q. frainetto* are different. The old bark of *Q. cerris* has deep splits and is thick, while the old bark of *Q. frainetto* has narrow strips and is cracked (Günal, 1997; Şen et al., 2011). Therefore, some crustose species grow in the bark splits and some crustose species grow on the bark surface between the bark splits of *Q. cerris*. On the other hand, crustose species are not common on *Q. frainetto* in the bark strips; rather narrow and generally foliose species were found more commonly on *Q. frainetto* than on *Q. cerris* in this study.

We also evaluated the sensitivity to eutrophication, dividing the species into 5 main classes (Table 3). The results suggest that the lichen taxa have a varied tolerance to eutrophication. Overall, 29 taxa preferred from no eutrophication to very weak eutrophication (classes 1 and 2), 17 taxa preferred from no eutrophication to weak eutrophication (classes 1-3), and 21 taxa preferred from very weak eutrophication to weak eutrophication (classes 2 and 3). In addition, 10 taxa preferred no eutrophication (class 1), whereas very high eutrophication levels were not preferred by the lichen species. The other eutrophication classes contained fewer lichen species.

We observed differences regarding the eutrophication classes of the lichen species that were found only on *Q. cerris* or on *Q. frainetto* (Figure 4). Species of classes 1 and 2 were more frequently observed on *Q. cerris* than on *Q. frainetto*, whereas classes 3 and 4 were repeatedly observed on *Q. frainetto*. Accordingly, no or few weakly eutrophicated species prefer the bark of *Q. cerris* over the bark of *Q. frainetto* (Nimis & Martellos, 2008).

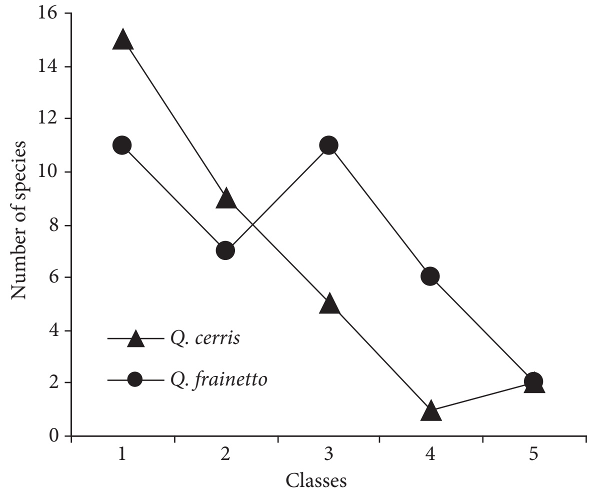

Figure 4. Number of species in different classes for eutrophication found only on *Q. cerris* or *Q. frainetto*.

Eutrophication includes the deposition of dust and nitrogen compounds. Many lichen species grow exclusively on nutrient-poor substrates, others occur on substrates with weak eutrophication, and some of them are rather resistant to high levels of eutrophication or even prefer this condition (Zedda, 2002).

Typically, the oak barks have acidic features and noneutrophicated conditions. Therefore, nitrophytic lichen species are rare on oak trunks (Larsen et al., 2007). Many studies have shown that agriculture and grazing have increased the eutrophication of the substrates, resulting in an increase in the number of nitrophytic species in the lichen communities (Benfield, 1994; Fos, 1998; Pirintsos et al., 1998; Ruoss, 1999). Agricultural practices lead to an increase in the amount of nitrogen. Therefore, this increase in the amount of nitrogen causes eutrophication (Ruoss, 1999). The effect of agriculture on lichen vegetation was demonstrated by a study that found that a high occurrence of nitrophytic lichens corresponded with a high intensity of farming (Ruoss, 1999). In the study area of the aforementioned study, several nitrophytic genera, such as *Parmelia*, *Parmelina*, *Phaeophyscia*, *Physcia*, *Physconia*, *Rinodina*, and *Xanthoria*, were frequently observed.

Phytogeographical patterns

According to Zedda (2002), the identified taxa belong to 8 different phytogeographical elements (Table 3, Figure 5). Based on the analysis of the total identified lichen taxa, temperate and suboceanic species are the most frequent in this study. The temperate species (63%) are found most commonly, while the suboceanic species (21%) rank second. The northern temperate species account for 5.5% and the Mediterranean-Atlantic species account for 4.5% of the identified species. The southern temperate and the subcontinental species are represented by 2%, while the Mediterranean and northern species are represented by 1% each. Comparison of the 2 oak species shows that the suboceanic species are more common on *Q. frainetto*, which generally prefers more humid areas than *Q. cerris*. Northern temperate species are more frequent on *Q. cerris*. We observed that the trunks of *Q. frainetto* were generally covered with moss and moisture, and, therefore, the trunks of *Q. frainetto* are capable of holding more moisture. Due to these characteristic, suboceanic lichen species more typically prefer the bark of *Q. frainetto*. Similarly, Zedda (2002) confirmed that the increase in the number of suboceanic species in epiphytic lichen communities is related to the humidity of the habitat. In contrast, the frequency of other phytogeographic elements is nearly the same for the 2 oak species.

Species diversity according to altitude

The 21 localities in the study area were divided into 3 main groups, each group consisting of 7 localities, depending on their altitude (Figure 6). A total of 62 taxa were found in group 1, which corresponds to 30-210 m; 75 taxa were found in group 2, which corresponds to 211-430 m; and 74 taxa were found in

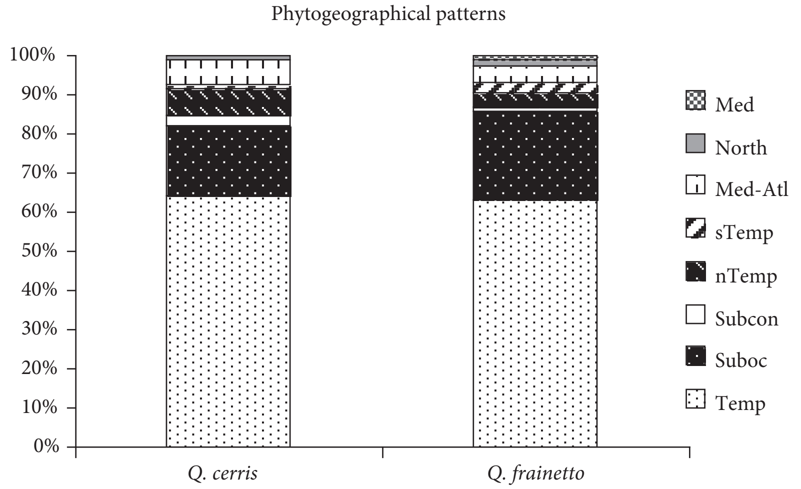

Figure 5. The distribution of lichen taxa according to phytogeographical elements.

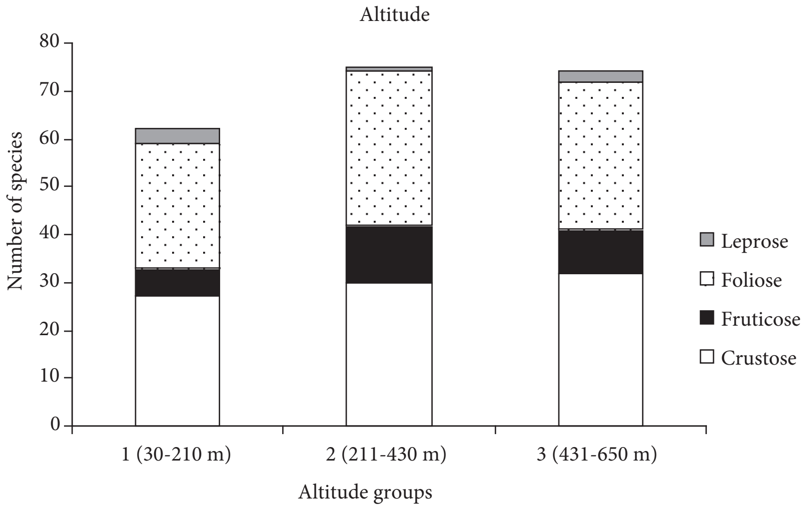

Figure 6. Number of lichen species according to altitude groups.

group 3, which corresponds to 431-650 m. As shown in Figure 6, the number of taxa increased at higher altitudes. Therefore, the habitat conditions at high altitude (humidity, light, etc.) generally support an increase in the number of lichen taxa.

To conclude, we showed that some lichen species and genera preferred only one oak species as a substrate, whereas some lichen species grew on both *Q. cerris* and *Q. frainetto*. Substrate properties such as bark texture, bark chemistry, bark pH, and the age of the tree are important factors determining epiphytic lichen composition. However, we demonstrated that the substrate properties are not the only factors determining the epiphytic lichen composition on trees. The habitat conditions, the climate, and several environmental factors also affect the distribution of epiphytic lichens. Further studies are needed to determine the effect of different factors.

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References

Akman Y (1990). *İklim ve Biyoiklim (Biyoiklim Metodları ve Türkiye İklimleri)*. Ankara: Palme Yayın Dağıtım.

Akman Y (1995). *Türkiye Orman Vejetasyonu*. Ankara: Ankara Üniversitesi, Fen Fakültesi Botanik Anabilim Dalı.

Asan A & Yarcı C (1993). Trakya'da botanik gezileri. *Ekoloji Çevre Dergisi* 2: 26-29.

Benfield B (1994). Impact of agriculture on epiphytic lichens at Plymtree, East Devon. *Lichenologist* 26: 91-96.

Blanco O, Crespo A, Divakar PA, Esslinger TL, Hawksworth DL & Lumbsch HT (2004a). *Melanelixia* and *Melanohalea*, two new genera segregated from *Melanelia* (Parmeliaceae) based on molecular and morphological data. *Mycological Research* 108: 873-884.

Blanco O, Crespo A, Elix JA, Hawksworth DL & Lumbsch HT (2004b). A molecular phylogeny and a new classification of parmelioid lichens containing *Xanthoparmelia*-type lichenan (Ascomycotina: Lecanorales). *Taxon* 53: 959-975.

Brodo IM, Sharnoff SD & Sharnoff S (2001). *Lichens of North America*. New Haven: Yale University Press.

Brummitt RK & Powel CE (1992). *Authors of Plant Names*. Kew: Royal Botanical Gardens.

Çiçek A & Özdemir Türk A (1998). Lichen flora of Sakarya Province. *Turk J Bot* 22: 99-119.

Çobanoğlu G (2005). Lichen collection in the herbarium of the University of İstanbul (ISTF). *Turk J Bot* 29: 69-74.

Çobanoğlu G (2007). Lichens from the Maslak Campus of İstanbul Technical University. *Turk J Bot* 31: 71-74.

Çobanoğlu G, Sevgi E & Sevgi O (2008). Lichen mycota along Uludağ fir (*Abies bornmuelleriana* Mattf.). *Univ of Craiova Biologie* 13: 15-19.

Çobanoğlu G & Sevgi O (2006). Contribution to the lichen flora of Gürgen Dağı (Çanakkale). *Turk J Bot* 30: 47-54.

Delphis FL & Wubbena NP (2006). Vertical variation of bark water storage capacity of *Pinus strobus* L. (Eastern white pine) in southern Illinois. *Northeastern Naturalist* 13: 131-137.

Dogru Z & Guvenc S (2007). Lichenized and lichenicolous fungi from Bursa province new to Turkey. *Mycotaxon* 102: 389-394.

Fos S (1998). Líquenes epífitos de los alcornocales Ibèricos. Correlaciones bioclimáticas, anatòmicas y densimètricas con el corcho de reproducciòn. *Guineana* 4: 1-507.

Gustafsson L & Eriksson I (1995). Factors of importance for the epiphytic vegetation of aspen *Populus tremula* with special emphasis on bark chemistry and soil chemistry. *Journal of Applied Ecology* 32: 412-424.

Günal N (1997). *Türkiye'de Başlıca Ağaç Türlerinin Coğrafi Yayılışları, Ekolojik ve Floristik Özellikleri*. İstanbul: Çantay Kitabevi.

Güvenç Ş & Aslan A (1994). Uludağ Üniversitesi Görükle kampüsü ve çevresi likenleri üzerine taksonomik incelemeler. *Yüzüncü Yıl Üniversitesi Fen-Edebiyat Fakültesi Fen Bilimleri Dergisi* 5: 51-56.

Güvenç Ş, Aslan A & Öztürk Ş (1996). The lichen flora of Kapıdağ Peninsula. *Plant Life in Southwest and Central Asia* 1: 472-478.

Ihlen PG, Gjerde I & Sætersdal M (2001). Structural indicators of richness and rarity of epiphytic lichens on *Corylus avellana* in two different forest types within a nature reserve in south-western Norway. *Lichenologist* 33: 215-229.

Karabulut ŞN, Özdemir Türk A & John V (2004). Lichens to monitor afforestation effects in Çanakkale, Turkey. *Cryptogamie Mycologie* 25: 333-346.

Larsen RS, Bell JNB, James PW, Chimonides PJ, Rumsey FJ, Tremper A & Purvis OW (2007). Lichen and bryophyte distribution on oak in London in relation to air pollution and bark acidity. *Environmental Pollution* 146: 332-340.

Mežaka A, Brūmelis G & Piterāns A (2008). The distribution of epiphytic bryophyte and lichen species in relation to phorophyte characters in Latvian natural old-growth broad leaved forests. *Folia Cryptog Estonica* 44: 89-99.

Nimis PL & Martellos S (2008). *ITALIC - The Information System on Italian Lichens. Version 4.0.* Trieste: University of Trieste, Department of Biology, IN4.0/1.

Özdemir A (1990). Bilecik ili likenleri. *Doğa-Tr J Botany* 14: 165-170.

Özdemir A (1992). Bilecik şehri epifitik likenlerinin kükürtdioksit (SO_2) kirliliğine bağlı olarak dağılışı. *Doğa-Tr J Botany* 16: 177-185.

Özdemir A & Öztürk Ş (1992). Gemlik-Mudanya sahil şeridi likenleri. *Doğa-Tr J Botany* 16: 247-251.

Özdemir Türk A & Güner H (1998). Lichens of the Thrace region of Turkey. *Turk J Bot* 22: 397-407.

Öztürk Ş (1990). Türkiye için yeni liken kayıtları. *Doğa-Tr J Botany* 14: 87-96.

Öztürk Ş (1992). Uludağ'ın kabuksu ve dalsı likenleri üzerinde bir araştırma. *Doğa-Tr J Botany* 16: 405-409.

Öztürk Ş (1997). Armutlu-Gemlik (Bursa) kıyı şeridi likenleri üzerinde taksonomik çalışmalar. *Ot Sistematik Botanik Dergisi* 4: 87-96.

Öztürk Ş & Güvenç Ş (2010). Comparison of the epiphytic lichen communities growing on various tree species on Mt. Uludağ (Bursa, Turkey). *Turk J Bot* 34: 449-456.

Öztürk Ş, Güvenç G & Aslan A (1997). Distribution of epiphytic lichens and sulphur dioxide (SO_2) pollution in the city of Bursa. *Turk J Bot* 21: 211-215.

Öztürk Ş & Oran S (2011). Investigations on the bark pH and epiphytic lichen diversity of *Quercus* taxa found in Marmara Region. *Journal of Applied Biological Sciences* 5: 27-33.

Ozturk Ş, Oran S, Guvenc S & Dalkiran N (2010). Analysis of the distribution of epiphytic lichens in the oriental beech (*Fagus orientalis*) forests along an altitudinal gradient in Uludag Mountain, Bursa, Turkey. *Pakistan Journal of Botany* 42: 2661-2670.

Pirintsos SA, Loppi S, Dalaka A & De Dominicis V (1998). Effects of grazing on epiphytic lichen vegetation in a Mediterranean mixed evergreen sclerophyllous and deciduous shrubland (northern Greece). *Isr J Plant Sci* 46: 303-307.

Pisut I (1970). Interessante Flechtenfunde aus der Türkei. *Preslia (Praha)* 42: 370-383.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (1992). *The Lichen Flora of Great Britain and Ireland.* London: Natural History Museum Publications.

Rigler L (1852). Die Türkei und deren Bewohner in ihren naturhistorischen, physiologischen und pathologischen Verhältnissen vom Standpunkte Constantinopel's. *Wien* 110.

Ruoss E (1999). How agriculture affects lichen vegetation in central Switzerland. *Lichenologist* 31: 63-73.

Steiner J (1899). Flechten. In: Fritsch C (ed). *Beitrag zur Flora von Konstantinopel. I. Kryptogamen*, pp. 222-238. Vienna: Denkschr. K. Akad. Wiss., Math. Naturw. Cl.

Şen A, Quilhó T & Pereira H (2011). Bark anatomy of *Quercus cerris* L. var. *cerris* from Turkey. *Turk J Bot* 35: 45-55.

Wirth V (1995). *Die Flechten Baden-Württembergs*. Vol. 1-2. Stuttgart: Ulmer.

Yaltırık F (1984). *Türkiye Meşeleri Teşhis Kılavuzu*. İstanbul: Yenilik Basımevi.

Yazıcı K (1999). Lichen species in the north of Karacabey County, Bursa Province, Turkey. *Turk J Bot* 23: 271-276.

Zedda L (2002). The epiphytic lichens on *Quercus* in Sardinia (Italy) and their value as ecological indicators. *Englera* 24: 1-457.