www.biodicon.com Biological Diversity and Conservation

ISSN 1308-8084 Online; ISSN 1308-5301 Print 4/1 (2011) 134-143

Epiphytic lichen diversity on *Fagus orientalis* Lipsky and *Fagus sylvatica* L. in the Marmara region (Turkey)

Seyhan ORAN [*1]

[1] Uludag University, Faculty of Arts and Sciences, Department of Biology, 16059 Görükle-Bursa, Turkey

Abstract

In the present study, epiphytic lichens were investigated on *Fagus orientalis* Lipsky and *Fagus sylvatica* L. at 27 localities and a total of 76 lichenized fungi and 1 lichenolous fungi belonging to 39 genera were determined. 76 taxa were found on *F. orientalis* and 8 taxa were found on *F. sylvatica*. *Arthonia stellaris* Kremp. and *Pertusaria leioplaca* DC. were recorded for the first time from Marmara region. In addition, some morphological, anatomical, ecological peculiarities and phytogeographical properties of the recorded lichen taxa were evaluated. The majority of the lichen species were determined rather hygrophytic and mesophytic. Also, rather low tolerance to eutrophication was observed in the lichen taxa recorded on beech trees. Temperate and suboceanic species were the most frequent species in the study area.

Key words: Biodiversity, Ecology, Epiphytic lichens, *Fagus*, Turkey

---------- * ----------

Marmara bölgesinde (Türkiye) *Fagus orientalis* Lipsky ve *Fagus sylvatica* L. üzerindeki epifitik liken çeşitliliği

Özet

Bu çalışmada, toplam 27 lokalitedeki *Fagus orientalis* Lipsky ve *Fagus sylvatica* L. üzerindeki epifitik likenler araştırılmış ve 39 cinse ait 76 likenize mantar ve 1 likenikol mantar taksonu belirlenmiştir. 76 takson *F. orientalis*, 8 takson ise *F. sylvatica* üzerinden bulunmuştur. *Arthonia stellaris* Kremp. ve *Pertusaria leioplaca* DC. Marmara bölgesinden ilk kez kaydedilmiştir. Ayrıca, kaydedilen taksonların bazı morfolojik, anatomik, ekolojik özellikleri ve fitocoğrafik özelllikleri de değerlendirilmiştir. Liken türlerinin büyük çoğunluğunun higrofitik ve mezofitik olduğu belirlenmiştir. Ayrıca, kayın ağaçları üzerinden kaydedilen liken taksonlarının ötrofikasyona duyarlılıklarının oldukça düşük olduğu gözlenmiştir. Çalışma alanında en sık olarak temperate ve suboceanic türlere rastlanmıştır.

Anahtar kelimeler: Biyoçeşitlilik, Ekoloji, Epifitik likenler, *Fagus*, Türkiye

1. Introduction

Lichens are widespread in a range of habitats from extreme conditions of heat or cold, from deserts to tropical rain forests, from natural to managed environments (Nimis et al., 2002). Lichen communities play many ecological roles in forest ecosystems. Nitrogen fixation, nutrient cycling, and provision of food and nesting material for wildlife are important among these roles (Will-Wolf et al., 2002).

Epiphytic lichens are generally considered to be good indicators of environmental quality. Changes in environmental conditions may be reflected in changes to the composition of epiphytic lichen vegetation (Bartók, 1999).

In Turkey, lichenological studies are mostly focused on systematic and taxonomy. Besides, publications on epiphytic lichens based on substrate feature are increased in recent years. Çobanoğlu et al. (2008), investigated distribution of epiphytic lichen taxa on five cut-fir trees and 72 lichen taxa were determined. Besides this, Çobanoğlu and Sevgi (2009), analyzed the distribution of epiphytic lichens on *Cedrus libani* A. Rich. in Elmalı Research Forest

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +902242941854; E-mail: seyhana@uludag.edu.tr
 BioDiCon. 158-0910

along an altitudinal gradient and they found a clear relationship between all parameters such as diameter, altitude and aspect with species richness.

In another study, 20 epiphytic lichens were determined on *Pinus nigra* Arnd. subsp. *pallasiana* (Lamb.) Holmboe in Mount Uludag and some differences were indicated between the altitudes (Güvenç et al., 2009). Öztürk and Güvenç (2010), evaluated the distribution of epiphytic lichens on *Abies nordmanniana* (Steven) Spach subsp. *bornmuelleriana* (Mattf.) Coode & Cullen forests along an altitudinal gradient on Mount Uludag. They recorded 46 taxa at 5 altitudes (1500-1900 m) and observed that the distribution and species composition of epiphytic lichens were related with altitude. Besides, some studies which evaluated the relationships of epiphytic lichens with air pollution have been published. Özdemir (1992), investigated the distribution of epiphytic lichens depending on SO_2 pollution in the city of Bilecik. Similarly, Öztürk et al. (1997), and Yazıcı and Aslan (2006), were published the distribution of epiphytic lichens and sulphur dioxide (SO_2) pollution in the city of Bursa and Trabzon, respectively.

Substrate has an important role in determining distribution of epiphytic bryophyte and lichen species. Epiphytic bryophyte and lichen species composition varies depending on tree species and it is highly related with chemical and physical properties of bark (Mežaka et al., 2008). A study which related to this features of bryophytes, the life strategies of bryophytes which form epiphytic vegetation analyzed and recorded 9 liverworts and 44 mosses (Ezer et al., 2010). The aim of the present study is to investigate epiphytic lichen diversity and obtain informations about some ecolocical features of the epiphytic lichen species on beech trees in Marmara region.

2. Materials and methods

The lichen specimens were collected from 27 localities in Balıkesir, Bilecik, Bursa, Çanakkale, İstanbul, Kırklareli, Sakarya and Yalova provinces (Table 1). The specimens were examined with an Olympus SZ40 stereomicroscope and a Krüss light microscope and then identified with the aid of flora books and identification keys (Clauzade and Roux, 1985; Purvis et al., 1992; Wirth, 1995; Brodo et al., 2001).

Table 1. Lichen collecting localities

Locality	Altitude	Coordinate	Date
1. Balıkesir; Manyas, between Taşkesiği and Peynirkuyusu, 3 km from Taşkesiği	221 m	39°57'13"N 27°57'20"E	28.07.2006
2. Bilecik; Bozüyük, road of İnegöl - Bozüyük, between Mezit 7 - 8 bridges	718 m	39°55'31"N 29°45'14"E	22.07.2007
3. Bursa; İznik, in the vicinity of Sağırhisar village	773 m	40°31'46"N 29°51'49"E	02.07.2006
4. Bursa; Osmangazi, the entrance of Uludağ National Park	1362 m	40°06'39"N 29°04'38"E	16.07.2006
5. Bursa; Osmangazi, Uludağ, Kirazlıyayla	1550 m	40°06'29"N 29°05'47"E	16.07.2006
6. Bursa; Osmangazi, Uludağ, between Hüseyinalan and Kirazlı	1004 m	40°08'03"N 29°02'02"E	16.07.2006
7. Bursa; İnegöl, in the vicinity of Kıran village	1074 m	40°03'34"N 29°21'24"E	22.08.2006
8. Bursa; Kestel, in the vicinity of Saitabat village	885 m	40°08'31"N 29°14'23"E	24.08.2006
9. Bursa; Kestel, between Kestel and Alaçam, before 3 km from Alaçam	1018 m	40°06'58"N 29°17'14"E	26.10.2006
10. Bursa; Kestel, between Alaçam and Sayfiye, 3. km from Alaçam	888 m	40°06'53"N 29°18'36"E	26.10.2006
11. Bursa; İnegöl, road of Bahariye - Saadet	1075 m	39°55'38"N 29°33'25"E	01.07.2007
12. Bursa; İnegöl, between Tahtaköprü and Domaniç, 2 km from Tahtaköprü	753 m	39°56'01"N 29°38'53"E	01.07.2007
13. Bursa; İnegöl, road of Tahtaköprü - Domaniç, 5 km from to Kütahya border	1135 m	39°53'45"N 29°39'30"E	01.07.2007
14. Çanakkale; Bayramiç, Kazdağı, Dalaksuyu place	1300 m	39°46'13"N 26°58'11"E	18.08.2005
15. Çanakkale; Bayramiç, Kazdağı, Tavşanayağı place	1348 m	39°45'53"N 26°58'05"E	18.08.2005
16. Çanakkale; Lapseki, between Beyçayır and Lapseki, north of Dumanlı village	670 m	40°16'27"N 26°54'12"E	06.07.2008
17. İstanbul; Sarıyer, Belgrad Forests, Kömürcü Bendi place	100 m	41°12'08"N 28°57'44"E	12.06.2006
18. İstanbul; Şile, road of Yeniköy - Teke, in the vicinity of Yaylalı	113 m	41°07'00"N 29°40'24"E	29.06.2007
19. Kırklareli; Centre, between Çukurpınar and Armutveren, 3 km from Armutveren	587 m	41°50'20"N 27°28'41"E	15.06.2006
20. Kırklareli; Demirköy, road of Sarpdere - Balaban	351 m	41°52'19"N 27°36'17"E	15.06.2006
21. Kırklareli; Centre, road of Dereköy - Kula, in the vicinity of Geçitağzı village	624 m	41°57'34"N 27°21'43"E	16.06.2006
22. Kırklareli; Kofçaz, in the vicinity of Kula village	615 m	41°58'46"N 27°17'36"E	16.06.2006
23. Kırklareli; Kofçaz, between Kula and Kocayazı, before 9 km from Kocayazı	492 m	41°59'42"N 27°16'30"E	16.06.2006
24. Kırklareli; Demirköy, road of Yenice - Demirköy, Kadınkule place	682 m	41°44'58"N 27°40'03"E	24.07.2006
25. Kırklareli; Demirköy, between Sivriler and Kızılağaç, 3 km from Sivriler	433 m	41°42'19"N 27°31'15"E	24.07.2006
26. Sakarya; Geyve, in the vicinity of Koru village	600 m	40°32'13"N 30°28'39"E	07.10.2007
27. Yalova; Çınarcık, in the vicinty of Delmece plateau	684 m	40°34'54"N 29°01'10"E	30.09.2007

2.1. Study area

The Marmara region is located in the northwest of Turkey surrounding to the Marmara sea (Figure 1). The Uludağ Mountain (2543 m) is the highest point in the study area located south of Bursa.

The Marmara region has different types of climate. The oceanic climate dominates in 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 ^{o}C. The rainiest months are December, January, and February, while the driest months are June, July, and August (Akman, 1990).

Marmara region due to its location and climatic features, has a rich flora. Rich maquis such as *Q. coccifera* L., *Phillyrea latifolia* L., *Cercis siliquastrum* L., *Nerium oleander* L., *Olea europea* L., *Sparteum junceum* L., *Pistacia lentiscus* L., *Erica arborea* L., *Cistus* spp., are found along the coast of the Aegean, the Marmara and the Black seas

from the 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* sp. From 1.000 to 1.500 m evergreen forests with *Pinus nigra* Arnold. subsp. *pallasiana* predominate. *Abies nordmanniana* subsp. *bornmuelleriana* Mattf. is found between 1.500-2.000 m at Uludağ Mountain. Besides, the Ergene basin, in the Thrace peninsula, is covered by an anthropogenic steppe (Asan and Yarcı, 1993, Akman, 1995).

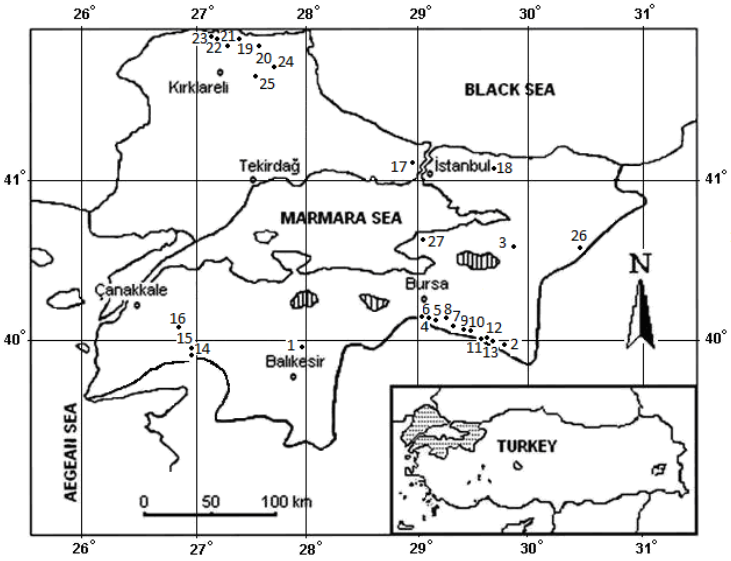

Figure 1. Map of the study area. Localities are indicated by numbers.

3. Results

The taxa are listed in alphabetical order in Table 2, with locality numbers, herbarium numbers and substrates. A herbarium number for specimens (BULU) were indicated in the parenthesis. The names of authors were abbreviated according to Brummitt and Powell (1992). The specimens are kept in BULU (Herbarium of the Faculty of Arts and Sciences, Uludag University, Bursa).

4. Discussion

4.1. Floristic evaluations

As a result of this study, 76 epiphytic and 1 lichenicolous (*Dactylospora parasitica*) taxa belonging to 39 genera were recorded from 27 localities. Among these taxa, 34 were crustose, 27 were foliose, 13 were fruticose, 2 were leprose and 1 was lichenicolous. 76 taxa were determined on *F. orientalis* and 8 taxa were determined on *F. sylvatica*. Also, 2 taxa, *Arthonia stellaris* and *Pertusaria leioplaca* were recorded for the first time from Marmara region.

The genera which include the highest number of lichen taxa; *Lecanora* (7), *Pertusaria* (6), *Cladonia* (4), and *Parmelina* (4). The other genera contains three or fewer taxa. *Lecidella elaeochroma*, *Lecanora carpinea*, *Melanelixia subaurifera*, *Parmelia sulcata*, *Lecanora chlarotera*, *L. intumescens*, and *Pertusaria pertusa* are the most common epiphytic species on the trunks of beech trees.

The bark of beech trees has smooth, gray in color and acidic features which many years do not crack (Mataracı 2004). Therefore, like *Arthonia stellaris*, *Fuscidea cyathoides*, *Graphis scripta*, and *Pyrenula nitida* which mainly grows on smooth bark of trees at decidious forest areas (Purvis et al., 1992), were found in this study at similar habitats (Belgrat Forests, Kazdağı Mountain and Yıldız Mountains).

Pirintsos et al. (1995) investigated the epiphytic lichens on *Fagus sylvatica* stands along an altitudinal gradient and 26 taxa were found. From those taxa, 19 species were found on beech trees at our study.

The 15th locality (Çanakkale, Kazdağı, Tavşanayağı place, 1348 m) was the richest with 28 lichen taxa. The 4th locality (Bursa, Uludağ National Park, 1362 m) was second richest locality with 27 lichen taxa. These localities have very high, moist and protected forest features. Moreover, *F. orientalis*, which is found in the 15th locality, has very old and the most diameter of breast hight (DBH: 80 cm) within the trees which collected on lichen samples. Örjan et al. (2008) indicated that the age of the beech trees are most important variable for species richness and the number of species increase with DBH and tree age. In our study, we observed the same correlation between DBH and species richness.

Table 2. Lichen taxa found on *Fagus orientalis* and *Fagus sylvatica*.

	Substrates, locality numbers and herbarium numbers	
Taxa	***F. orientalis***	***F. sylvatica***
Anaptychia ciliaris (L.) Körb.	**4** (12879)	
Arthonia radiata (Pers.) Ach.	**17** (14633)	
Arthonia stellaris Kremp.	**17** (14634)	
Buellia disciformis (Fr.) Mudd	**3** (12850); **5** (12903); **6** (12917); **9** (13004); **12** (13209); **21** (15089); **22** (15101); **23** (15113)	
Buellia griseovirens (Turner & Borrer ex Sm.) Almb.	**14** (13778); **15** (13795)	
Caloplaca cerinella (Nyl.) Flagey		**16** (14371)
Caloplaca flavorubescens (Huds.) J.R. Laundon	**4** (12880); **24** (15314)	
Candelariella vitellina (Hoffm.) Müll. Arg.	**4** (12874); **5** (12889); **6** (12910); **7** (12923)	
Candelariella xanthostigma (Pers.) Lettau	**2** (12268); **4** (12884); **5** (12900); **15** (13800)	
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.	**15** (13814)	
Cladonia coniocraea (Flörke) Spreng.	**1** (12124)	
Cladonia pyxidata (L.) Hoffm.	**14** (13780)	
Cladonia rangiformis Hoffm.	**14** (13783)	
Dactylospora parasitica (Flörke ex Spreng.) Zopf	**13** (13242) on *Pertusaria* sp.	
Evernia prunastri (L.) Ach.	**3** (12846); **4** (12877); **5** (12887); **12** (13205); **14** (13768); **15** (13809); **17** (14637); **26** (15435)	
Flavoparmelia caperata (L.) Hale	**1** (12125); **17** (14626)	
Fuscidea cyathoides (Ach.) V. Wirth & Vězda	**14** (13787); **15** (13812)	
Graphis scripta (L.) Ach.	**17** (14635); **20** (15006)	
Hypogymnia farinacea Zopf	**5** (12888); **15** (13806)	
Hypogymnia physodes (L.) Nyl.	**11** (13198)	
Hypogymnia tubulosa (Schaer.) Hav.	**4** (12875); **5** (12898); **6** (12911)	
Lecanora argentata (Ach.) Malme	**14** (13774); **15** (13811)	
Lecanora carpinea (L.) Vain.	**2** (12267); **3** (12848); **4** (12873); **5** (12901); **6** (12912); **7** (12918); **8** (12978); **9** (13005); **10** (13040); **12** (13207); **14** (13779); **15** (13794); **19** (14966); **21** (11588); **24** (15306); **26** (15429); **27** (15686)	**16** (14367)
Lecanora chlarotera Nyl.	**1** (12126); **2** (12266); **4** (12872); **5** (12890); **6** (12913); **7** (12920); **9** (13006); **10** (13041); **11** (13192); **15** (13797); **23** (15112); **24** (15307); **27** (15689)	
Lecanora expallens Ach.	**17** (14629)	
Lecanora glabrata (Ach.) Malme	**4** (12886); **11** (13193); **15** (13799); **17** (14628); **19** (14976); **27** (15688)	
Lecanora intumescens (Rebent.) Rabenh.	**4** (12885); **5** (12902); **6** (12914); **7** (12919); **9** (13011); **11** (13194); **12** (13208); **15** (13796); **19** (14968); **26** (15428)	

Table 2. (continued)

Lecanora subrugosa Nyl.	**12** (13206); **13** (13240); **22** (15104)	**16** (14368)
Lecidella elaeochroma (Ach.) M. Choisy	**3** (12849); **4** (12871); **5** (12891); **7** (12921); **8** (12979); **9** (13007); **10** (13042); **11** (13191); **12** (13210); **13** (13234); **14** (13777); **15** (13808); **18** (14801); **19** (14969); **20** (15002); **21** (15087); **22** (15107); **24** (15305); **25** (15342); **26** (15430); **27** (15687)	**16** (14366)
Lepraria incana (L.) Ach.	**5** (12904); **11** (13190); **13** (13241); **15** (13801); **20** (15007); **25** (15343); **26** (15434)	
Lepraria lobificans Nyl.	**26** (15433)	
Lobaria pulmonaria (L.) Hoffm.	**14** (13769); **15** (13789); **19** (14977)	
Megalaria laureri (Hepp ex Th. Fr.) Hafellner	**17** (14630)	
Melanelixia fuliginosa subsp. *glabratula* (Lamy) J.R. Laundon	**4** (12870); **9** (13010); **14** (13772); **23** (15109); **25** (15340)	
Melanelixia glabra (Schaer.) O. Blanco et al.	**4** (12878); **5** (12899); **6** (12909)	
Melanelixia subaurifera (Nyl.) O. Blanco et al.	**1** (12127); **3** (12847); **6** (12915); **7** (12924); **9** (13008); **11** (13189); **12** (13211); **15** (13802); **17** (14632); **19** (14965); **21** (15085); **22** (15100); **24** (15311); **26** (15431)	**16** (14365)
Melanohalea exasperatula (Nyl.) O. Blanco et al.	**4** (12866); **5** (12892); **15** (13803); **19** (14975); **23** (15116)	
Nephroma resupinatum (L.) Ach.	**14** (13781)	
Ochrolechia arborea (Kreyer) Almb.	**15** (13815)	
Ochrolechia szatalaensis Verseghy	**12** (13212)	
Parmelia saxatilis (L.) Ach.	**14** (13771); **15** (13788)	
Parmelia submontana Nádv. ex Hale	**5** (12893); **11** (13199); **15** (13790)	
Parmelia sulcata Taylor	**1** (12128); **3** (12845); **4** (12863); **6** (12906); **9** (13009); **11** (13185); **12** (13215); **13** (13235); **14** (13770); **15** (13792); **17** (14627); **21** (15086); **23** (15108); **26** (15427)	
Parmelina carporrhizans (Taylor) Poelt & Vězda	**4** (12867); **11** (13186)	
Parmelina pastillifera (Harm.) Hale	**4** (12864); **19** (14973); **24** (15304)	
Parmelina quercina (Willd.) Hale	**6** (12908)	
Parmelina tiliacea (Hoffm.) Hale	**11** (13188)	
Parmotrema chinense (Osbeck) Hale & Ahti	**17** (14638)	
Peltigera canina (L.) Willd.	**26** (15426)	
Peltigera collina (Ach.) Röhl.	**15** (13813)	
Peltigera praetextata (Flörke ex Sommerf.) Vain.	**14** (13782); **26** (15425)	
Pertusaria albescens (Huds.) M. Choisy & Werner	**14** (13773); **15** (13793); **24** (15315)	
Pertusaria amara (Ach.) Nyl.	**2** (12263); **12** (13213); **13** (13236); **14** (13776); **17** (14631); **20** (15000); **22** (15105); **23** (15110)	
Pertusaria coccodes (Ach.) Nyl.	**14** (13784)	

Table 2. (continued)

Pertusaria flavida (DC.) J.R. Laundon	**13** (13239)	
Pertusaria leioplaca DC.	**13** (13238); **27** (15690)	
Pertusaria pertusa (Weigel) Tuck.	**2** (12264); **12** (13214); **13** (13237); **14** (13775); **15** (13791); **19** (14972); **20** (15003); **22** (15103); **23** (15114); **24** (15312)	**16** (14369)
Phaeophyscia orbicularis (Neck.) Moberg	**2** (12262); **4** (12881); **19** (14971); **24** (15309)	
Phlyctis agelaea (Ach.) Flot.	**15** (13805); **19** (14974)	
Phlyctis argena (Spreng.) Flot.	**11** (13195); **12** (13216); **15** (13798); **17** (14639); **20** (14999); **25** (15341)	
Physcia adscendens (Th. Fr.) H. Olivier	**2** (12261); **24** (15310)	16 (14370)
Physcia stellaris (L.) Nyl.	**4** (12876); **7** (12925)	
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	**4** (12865); **5** (12894); **6** (12907); **11** (13187)	
Pseudevernia furfuracea var. *furfuracea* (L.) Zopf	**4** (12868); **5** (12896); **6** (12905); **11** (13196); **15** (13807)	
Pyrenula nitida (Weigel) Ach.	**20** (15005)	
Ramalina farinacea (L.) Ach.	**4** (12869); **12** (13219); **14** (13786); **15** (13810); **17** (14636); **26** (15432)	
Ramalina fastigiata (Pers.) Ach.	**4** (12862); **15** (13804)	
Ramalina fraxinea (L.) Ach.	**4** (12861); **5** (12895)	
Rinodina exigua (Ach.) Gray	**4** (12882)	
Rinodina pyrina (Ach.) Arnold	**7** (12922)	
Scoliciosporum umbrinum (Ach.) Arnold	**1** (12129); **2** (12265); **6** (12916); **11** (13197); **12** (13217); **21** (15090)	
Tephromela atra (Huds.) Hafellner	**19** (14970); **20** (15004); **22** (15102); **23** (15111); **24** (15313)	
Tuckermannopsis chlorophylla (Willd.) Hale	**4** (12883)	
Usnea filipendula Stirt.	**12** (13218)	
Usnea rigida Vain.	**4** (12860)	
Usnea scabrata Nyl.	**5** (12897)	
Xanthoria parietina (L.) Th. Fr.	**19** (14967)	**16** (14364)

The 8th (2 taxa) and the 18th (1 taxon) localities had the least numbers of lichen taxa. *F. orientalis* at the 8th locality (Bursa, Kestel, Saitabat, 885 m) are very young and it has a very small trunks diameter (7 cm). So, only 2 lichen taxa were grown on. Due to the city settlement and heavy air pollution, the 18th locality (İstanbul, Şile, Yaylalı, 113 m) have rather poor lichen diversity.

4.2. Growth forms, photobionts, and reproductive strategy

Some morphological, anatomical, ecological peculiarities and phytogeographical patterns of the determined lichen taxa are given in Table 3, according to Nimis and Martellos (2008), Wirth (1995), and Zedda (2002).

Crustose lichens are dominated (45%) in the study area with 34 taxa. Foliose lichens were represented by 27 taxa (35%), fruticose lichens were represented by 13 taxa (17%), and leprose lichens were represented by 2 taxa (3%). In the total biota of *Fagus* species, 5.3% of the lichen species have cyanobacteria as photobiont, 6.6% of the lichen species have *Trentepohlia*, 88.1% have other green algae. Lichens with *Trentepohlia* and cyanobacteria were observed humid habitats and high altitudes in this study. Similarly, Zedda (2002) indicated that lichens with *Trentepohlia* are most frequent where the climate is more humid and most rainy, especially at higher altitudes and lichens with cyanobacteria are most frequent in well-preserved, montane forest in oak forest of Sardinia.

Analysis of the reproductive strategy of species in study area showed that lichens with sexual reproduction account for 55.3%, lichens with asexual reproduction account for 44.7% (31.5%; by soredia or soredia-like structures, 13.2%; by isidia, or isidia-like structures) of the total.

4.3. Ecological features

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

The light requirements of lichen taxa were divided into five classes (Table 3). The majority of the species belonged to the classes 3 and 4, generally. With reference to, lichen taxa prefer in sites with plenty of diffuse light but scarce direct solar irradiation and in sun-exposed sites, but avoiding extreme solar irradiation. The other classes had fewer taxa.

Lichen taxa were divided into 5 five classes, based on the humidity requirements (Table 3). 26 taxa were rather hygrophytic and mesophytic (class 2-3), 14 taxa were mesophytic (class 3), 14 taxa were mesophytic-xerophytic (class 3-4), 9 taxa were rather hygrophytic (class 2), and the other classes were found less often. Only, very common lichen *L. elaeochroma* which has a wide ecological amplitude were rather hygrophytic to very xerophytic (class 2-5).

We also evaluated the sensitivity to eutrophication of lichen taxa. The sensivity to eutrophication were also divided into five classes (Table 3). Tolerance to eutrophication of lichen taxa, grown on beech trunks, was observed rather low. 26 taxa preferred no eutrophication to very weak eutrophication levels (class 1-2), 16 taxa preferred no eutrophication to weak eutrophication levels (class 1-3), 13 taxa preferred very weak eutrophication to weak eutrophication levels (class 2-3), and 9 taxa preferred no eutrophication level (class 1) whereas, high eutrophication levels contained fewer lichen taxa.

Table 3. Some morpho-anatomical, ecological and phytogeographical patterns of examined lichen taxa

Taxa	**Grf**	**Pho**	**Rs**	**Li**	**Hum**	**Eu**	**Phytog**
A. ciliaris	Fr	Ch	S	4-5	3	2-3	Temp
A. radiata	Cr	Tr	S	3-4	2-3	1-3	Temp
A. stellaris	Cr	Tr	S	2-3	2	1	Suboc
B. disciformis	Cr	Ch	S	3-4	2	1-2	nTemp
B. griseovirens	Cr	Ch	S	3-4	2-3	1	Suboc
C. cerinella	Cr	Ch	S	4-5	3-4	3-4	Temp
C. flavorubescens	Cr	Ch	S	4-5	3	2-3	Suboc
C. vitellina	Cr	Ch	S	3-4	3-4	2-5	Temp
C. xanthostigma	Cr	Ch	S	3-5	3	2-3	Temp
C. chlorophaea	Fr	Ch	S	3-5	2-3	1-3	Temp
C. coniocraea	Fr	Ch	As	3-4	2-3	1-3	-
C. pyxidata	Fr	Ch	S	3-5	2-3	1-3	Temp
C. rangiformis	Fr	Ch	S	4-5	3	1-3	Temp
E. prunastri	Fr	Ch	As	3-5	2-3	1-3	Temp
F. caperata	Fol.b	Ch	As	3-4	3	1-3	Temp
F. cyathoides	Cr	Ch	S	3-4	2	1	Suboc
G. scripta	Cr	Tr	S	2-3	2-3	1-2	-
H. farinacea	Fol.b	Ch	As	3-4	3-4	1	Temp
H. physodes	Fol.b	Ch	As	3-4	2-3	1-2	Temp

Table 3. (continued)

H. tubulosa	Fol.b	Ch	As	3	2-3	1-2	Temp
L. argentata	Cr	Ch	S	3-4	3	1-2	Temp
L. carpinea	Cr	Ch	S	3-5	3-4	1-3	Temp
L. chlarotera	Cr	Ch	S	3-5	3-4	2-5	Temp
L. expallens	Cr	Ch	As	3-4	2-3	1-2	Suboc
L. glabrata	Cr	Ch	S	3	3	2-3	Temp
L. intumescens	Cr	Ch	S	3-4	2	1	Temp
L. subrugosa	Cr	Ch	S	2-3	-	1-2	Temp
L. elaeochroma	Cr	Ch	S	3-5	2-5	2-4	Temp
L. incana	Lep	Ch	As	2-4	2-4	1-2	nTemp
L. lobificans	Lep	Ch	As	2-4	1-3	1-2	Temp
L. pulmonaria	Fol.b	Ch	As	3	1-2	1-2	Suboc
M. laureri	Cr	Tr	S	3	1-2	1-2	Suboc
M. fuliginosa subsp. *glabratula*	Fol.n	Ch	Ai	3-4	2-3	2-3	Temp
M. glabra	Fol.n	Ch	S	4-5	3-4	3	Suboc
M. subaurifera	Fol.b	Ch	As	3-4	2-3	1-3	Temp
M. exasperatula	Fol.n	Ch	Ai	3-5	3	3	Temp
N. resupinatum	Fol.b	Cy	Ai	2-3	1-2	1-2	Suboc
O. arborea	Cr	Ch	As	3-4	3	1-3	Temp
O. szatalaensis	Cr	Ch	S	3	2-3	2-3	Temp
P. saxatilis	Fol.b	Ch	Ai	3-4	2-3	1-3	nTemp
P. submontana	Fol.b	Ch	Ai	3	1-2	1-2	Suboc
P. sulcata	Fol.b	Ch	As	3-5	2-3	1-3	Temp
P. carporrhizans	Fol.b	Ch	S	4-5	3-4	2-3	Suboc
P. pastillifera	Fol.b	Ch	Ai	4	2	2-3	Suboc
P. quercina	Fol.b	Ch	S	4-5	3-4	2-3	Suboc
P. tiliacea	Fol.b	Ch	Ai	3-4	3	2-3	Temp
P. chinense	Fol.b	Ch	As	3-4	2-3	1-2	Suboc
P. canina	Fol.b	Cy	S	3	2-3	1	-
P. collina	Fol.b	Cy	As	3	1-2	1-2	Suboc
P. praetextata	Fol.b	Cy	Ai	3-4	3	1-2	Temp
P. albescens	Cr	Ch	As	3-4	2-3	1-3	Temp
P. amara	Cr	Ch	As	2-4	2-3	1-3	Temp
P. coccodes	Cr	Ch	Ai	3-4	2	1-3	Suboc
P. flavida	Cr	Ch	As	3-4	2	1-2	Suboc
P. leioplaca	Cr	Ch	S	3-4	2-3	1-2	Temp
P. pertusa	Cr	Ch	S	3	2-3	1-2	Suboc
P. orbicularis	Fol.n	Ch	As	3-5	3-4	4-5	Temp
P. agelaea	Cr	Ch	S	3	2-3	1-2	Suboc
P. argena	Cr	Ch	As	2-3	2-3	1-2	Suboc
P. adscendens	Fol.n	Ch	As	4-5	3-4	3-5	Temp
P. stellaris	Fol.n	Ch	S	4-5	3	2-4	Temp
P. acetabulum	Fol.b	Ch	S	4-5	3-4	2-3	Temp
P. furfuracea var. *furfuracea*	Fr	Ch	Ai	3-5	3-4	1-2	nTemp
P. nitida	Cr	Tr	S	2-3	1-2	1	-

Table 3. (continued)

R. farinacea	Fr	Ch	As	3-5	1-2	1-2	Temp
R. fastigiata	Fr	Ch	S	3-5	2-3	1-3	Temp
R. fraxinea	Fr	Ch	S	4-5	2-3	2-3	Temp
R. exigua	Cr	Ch	S	3-5	3-4	3	Temp
R. pyrina	Cr	Ch	S	4-5	3	2-3	Temp
S. umbrinum	Cr	Ch	S	3	2-3	1-3	Temp
T. atra	Cr	Ch	S	3-4	3	1-2	Temp
T. chlorophylla	Fol.b	Ch	As	3-4	3	1-2	-
U. filipendula	Fr.f	Ch	As	3-5	1-3	1	nTemp
U. rigida	Fr.f	Ch	S	4-5	2	1	Subcon
U. scabrata	Fr.f	Ch	S	3-4	2	1-2	Suboc
X. parietina	Fol.b	Ch	S	3-5	3-4	3-4	Temp

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:** green algae, other than *Trentepohlia*, **Cy:** cyanobacteria, **Tr:** *Trentepohlia*
Rs: Reproductive strategy; **S:** mainly sexual, **As:** mainly asexual, by soredia or soredia-like structures, (e.g. blastidia), **Ai:** mainly asexual, by isidia, or isidia-like structures (e.g. schizidia)
Li: Light; **1:** in very shaded situations, **2:** in shaded situations, **3:** in sites with plenty of diffuse light but scarce direct solar irradiation, **4:** in sun-exposed sites, but avoiding extreme solar irradiation, **5:** in sites with very high direct solar irradiation
Hum: Humidity requirement; **1:** hygrophytic, **2:** rather hygrophytic, **3:** mesophytic, **4:** xerophytic, **5:** very xerophytic
Eu: Sensivity to eutrophication; **1:** no eutrophication, **2:** very weak eutrophication, **3:** weak eutrophication, **4:** rather high eutrophication, **5:** very high eutrophication
Phytog: Phytogeographical patterns; **Temp:** temperate element, **nTemp:** northern temperate element, **Subcon:** subcontinental element, **Suboc:** suboceanic element
-: unknown

4.4. Phytogeographical patterns

Phytogeographical patterns of the identified taxa were evaluated according to Zedda (2002) (see Table 3). Most lichen taxa belong to the temperate element (42 taxa) in this study. The suboceanic elements (21 taxa) were found in the second place. The northern temperate (4 taxa) and subcontinental (1 taxon) elements were observed less than.

Substrate features have effect the settlement of epiphytic lichen species on trees. Some lichens prefer smooth bark of trees some of them prefer rough bark, alike some lichens prefer deciduous trees while some of them prefer conifers. Although chemical and physical properties of bark are significant, the habitat features are also important too. Thus, all ecological factors which effect the distribution of epiphytic lichens must be examined together.

Acknowledgement

The author thank to the Unit of Scientific Research Projects, Uludag University for their financial support (Project no: 2006/63) and Şule ÖZTÜRK for reading the manuscript.

References

Akman, Y. 1990. İklim ve Biyoiklim (Biyoiklim Metodları ve Türkiye İklimleri). Palme Yayın Dağıtım, Ankara.
Akman, Y. 1995. Türkiye Orman Vejetasyonu. Ankara Üniversitesi, Fen Fakültesi Botanik Anabilim Dalı, Ankara.
Asan, A., Yarcı, C. 1993. Trakya'da Botanik Gezileri. Ekoloji Çevre Dergisi. 2/7: 26-29.
Bartók, K. 1999. Pecticide usage and epiphytic lichen diversity in Romanian orchards. Lichenologist. 31/1: 21-25.
Brodo, I.M., Sharnoff, S.D., Sharnoff, S. 2001. Lichens of North America. Yale University Press, New Haven.
Brummitt, R.K, Powel, C.E. 1992. Authors of plant names. Royal Botanical Gardens, Kew.
Clauzade, G., Roux, C. 1985. Likenoj De Okcidenta Eûropo Ilustrita Determinlibro. Bulletin de la Société Botanique du Centre, Royan.
Çobanoğlu, G., Sevgi, E., Sevgi, O. 2008. Lichen mycota along Uludağ fir (*Abies bornmuelleriana* Mattf.). Univ. of Craiova, Biologie. XIII/XLIX: 15-19.
Çobanoğlu, G., Sevgi, O. 2009. Analysis of the distribution of epiphytic lichens on *Cedrus libani* in Elmali Research Forest (Antalya, Turkey). Journal of Environmental Biology. 30/2: 205-212.
Ezer, T., Kara, R., Düzenli, A. 2010. Musa Dağı'ndaki epifitik vejetasyonu oluşturan briyofitlerin yaşam stratejileri. Biological Diversity and Conservation. 3/3: 75-84.

Güvenç, G., Oran, S., Öztürk, Ş. 2009. The Epiphytic Lichens on Anatolian Black Pine [*Pinus nigra* Arnd. subsp. *pallasiana* (Lamb.) Holmboe] in Mt. Uludag (Bursa-Turkey). Journal of Applied Biological Sciences. 3/2: 143-147.

Mataracı, T. 2004. Ağaçlar. Doğa Severler İçin Rehber Kitap. Marmara Bölgesi Doğal-Egzotik Ağaç ve Çalıları. TEMA Vakfı Yayını No: 39, İstanbul.

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, P.L., Scheidegger, C., Wolseley, P.A. 2002. Monitoring with Lichens-Monitoring Lichens. IV. Earth and Environmental Sciences, Vol. 7, NATO Science Series, Kluwer Academic Publishers, London.

Nimis, P.L., Martellos, S. 2008. *ITALIC* - The Information System on Italian Lichens. Version 4.0. University of Trieste. online at http://dbiodbs.univ.trieste.it/italic/italic02a

Örjan, F., Niklasson, M., Churski, M. 2008. Tree age is a key factor for the conservation of epiphytic lichens and bryophytes in beech forest. Applied Vegetation Science. 12: 93-106.

Özdemir, A. 1992. Bilecik Şehri Epifitik Likenlerinin Kükürtdioksit (SO_2) Kirliliğine Bağlı Olarak Dağılışı. Doğa-Tr. J. of Botany. 16: 177-185.

Öztürk, Ş., Güvenç, G., Aslan, A. 1997. Distribution of Epiphytic Lichens and Sulphur Dioxide (SO_2) Pollution in the City of Bursa. Tr. J. of Botany. 21: 211-215.

Öztürk, Ş., Güvenç, G. 2010. The distribution of epiphytic lichens on Uludag fir (*Abies nordmanniana* (Steven) Spach subsp. *bornmuelleriana* (Mattf.) Coode & Cullen) forests along an altitudinal gradient (Mt. Uludag, Bursa, Turkey). Ekoloji. 19/74: 131-138.

Pirintsos, S.A., Diamantopoulos, J., Stamou, G.M. 1995. Analysis of the distribution of epiphytic lichens within homogeneous *Fagus sylvatica* stands along an altitudinal gradient (Mount Olympos, Greece). Vegetatio. 116: 33-40.

Purvis, O.W., Coppins, B.J., Hawksworth, D.L., James, P.V., Moore, M. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum Publications, London.

Will-Wolf, S., Esseen, P.A., Neitlich, P. 2002. Monitoring Biodiversity and Ecosystem Function: Forests. In (Eds.), Nimis, P.L., Scheidegger, C., Wolseley, P.A., Monitoring with Lichens-Monitoring Lichens. IV. Earth and Environmental Sciences, Vol. 7, NATO Science Series, Kluwer Academic Publishers, London.

Wirth, V. 1995. Die Flechten Baden-Württembergs. Teil 1-2. Ulmer, Stuttgart.

Yazıcı, K., Aslan, A. 2006. Distribution of epiphytic lichens and air pollution in the city of Trabzon, Turkey. Bull. Environ. Contam. Toxicol. 77: 838-845.

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

(Received for publication 19 September 2010; The date of publication 01 April 2011)