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Epiphytic lichen diversity on *Quercus pubescens* Willd. in Bursa province

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Abstract

The aim of this study is determined to compare the epiphytic lichen diversity of *Quercus pubescens* found in the center of the city or village, and away from the center. The ordination graph based on the settlements of species diversity located in the center of the city or village and away from the center were obtained with a detrended correspondence analysis (DCA). Differences in the species diversity and composition of the epiphytic lichens on *Q. pubescens* in the center of the city or village, and away from the center were evaluated using the TWINSPAN program. In this study, a total of 28 epiphytic lichen species were found on the *Quercus pubescens*. *Eopyrenula leucoplaca* was found in all the localities in the study area. The other common species were *Hyperphyscia adglutinata*, *Physconia grisea* and *Xanthoria parietina*. The epiphytic lichen diversity on *Q. pubescens* obtained from the localities in Bursa city center, and village center from Karacabey Plain comparative to the localities in the peripheral zone of Bursa city center and Karacabey Plain has shown variations.

Key words: epiphytic lichen, biodiversity, *Quercus pubescens*, Bursa, Turkey

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Bursa İlindeki *Quercus pubescens* Willd. üzerindeki epifitik liken çeşitliliği

Özet

Bu çalışmanın amacı, şehir ya da köy merkezinde ve merkezden uzakta bulunan *Quercus pubescens* üzerindeki epifitik liken çeşitliliğini karşılaştırmaktır. Kentin veya köyün merkezinde bulunan ve merkezden uzakta bulunan yerleşim yerlerinin tür çeşitliliğine dayanan koordinasyon grafiği, DCA analizi ile elde edildi. *Q. pubescens* üzerindeki epifitik likenlerin tür çeşitliliği ve bileşiminin yapısı Bursa şehir merkezinde ve Karacabey ovasındaki köy merkezinde bulunanlar ile çevre bölgelerde bulunanlar arasındaki farklar TWINSPAN programı kullanılarak değerlendirildi. Bu çalışmada *Quercus pubescens* üzerinden toplam 28 epifitik liken türü bulunmuştur. *Eopyrenula leucoplaca* çalışma alanındaki tüm lokalitelerde bulunmuştur. Diğer yaygın türler ise *Hyperphyscia adglutinata*, *Physconia grisea* ve *Xanthoria parietina*'dır. *Quercus pubescens* üzerindeki epifitik liken çeşitliliğinin, Bursa şehir merkezindeki ve Karacabey Ovası'ndaki köy merkezlerinden, Bursa şehir merkezindeki ve Karacabey Ovası'ndaki çevre bölgelerdeki yerlere göre değiştiği bulunmuştur.

Anahtar kelimeler: epifitik liken, biyoçeşitlilik, Quercus pubescens, Bursa, Türkiye

1. Introduction

Q. pubescens Willd., known as downy or pubescent oak, is a middle-sized (15-20 m, rarely 25 m tall) deciduous or semi deciduous tree. Downy oaks show a very wide altitudinal range, especially in the southern countries. It has a wide distribution range, occupying almost all of central and southern Europe from western Spain to Ukraine and Anatolia. Although they are more common on hillsides having a general height ranging between 200 and 800 m, they can grow up to 1200 - 1300 m in the coastal plains. It is perfectly adapted to stand both moderate summer drought stress and lower winter temperatures [1]. *Q. pubescens* is found mixed with other oak species in Central Anatolia, Marmara, Aegean

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regions and the western Black Sea region. It can show a growth upto 1700 meters in Anatolia. It is widely found in parks and gardens because it is resistant to air pollution and wind [2].

Gül and Güvenç indicated that 550 taxa have been given in 42 studies from Bursa province and along with 27 additionl records, this number has reached 577 [3]. In addition, three new records has been added from Bursa province very recently [4]. A total number of 27 lichen taxa were recorded on *Quercus pubescens* from the Çanakkale, Kırklareli and Tekirdağ provinces situated in the Marmara region of Turkey.

Loppi et al. investigated the distribution of epiphytic lichens of *Q. pubescens* along with an altitudinal gradient in Tuscany (Central Italy), and 77 epiphytic lichen species were added into the record [5]. Great differences were found in the community structure between the lower sampling belts (< 500 m) and higher ones (> 500 m). In another study, the epiphytic lichen vegetation of *Q. pubescens* in Tuscany was investigated in agricultural and non-agricultural areas along with an altitudinal transect characterized by different climatic conditions [6]. The epiphytic lichen diversity in central European oak forest were strongly affected by an altered microclimate, resulting from changes in forest structure by forestry, agriculture and livestock activities [7].

This study is aimed to determine the epiphytic lichen diversity on *Quercus pubescens* in Bursa city center and its peripheral zones

2. Materials and methods

2.1. The study area

This study was conducted at nine localities of Karacabey plain, and Bursa city center and its peripheral zones. Bursa Province is located between 39°30'-40°37'N and 28°06'-29°58'E in the southeast part of Marmara Region of Turkey. Bursa is known as an industrial city and is the fifth largest city in Turkey. Bursa is usually dominated by a Mediterranean climate and has a transitional region between the Mediterranean and Black Sea climates [8]. The mean annual temperature and rainfall (1987-2012) in Bursa province (alt. 155 m) is 14.6 °C, and 691 mm. Similarly at Mudanya district (alt. 13 m) of the Bursa province it is 16.7 °C and 614 mm and at Karacabey (alt. 15 m) it is 14.7 °C and 585 mm, respectively [9].

2.2. Collection of samples

Epiphytic lichen samples were collected from the trunk of *Q. pubescens* in each of the nine localities of Bursa Province between 2014 and 2015 years (Figure 1). The epiphytic lichen samples were collected according to the methods specified by Asta et al. [10]. The sampling grid were placed on the north, east, south and west sides of the trunk with the lowest quadrat of 100 cm above ground level. The specimens were examined with a Leica EZ4 model stereomicroscope, and an Olympus CH-2 light microscope for external morphology and anatomical observations. Ascospore measurements were carried out in water. Identifications were determined according to the literatures [11, 12]. All lichen species found in each quadrat of sampling grid were recorded and listed. The frequency of each species was computed as the number of quadrat squares of the sampling grid in which it occurred. The sum of the frequency of all species found within the sampling grid for each aspect (north, east, south, and west) on the sampling tree was calculated.

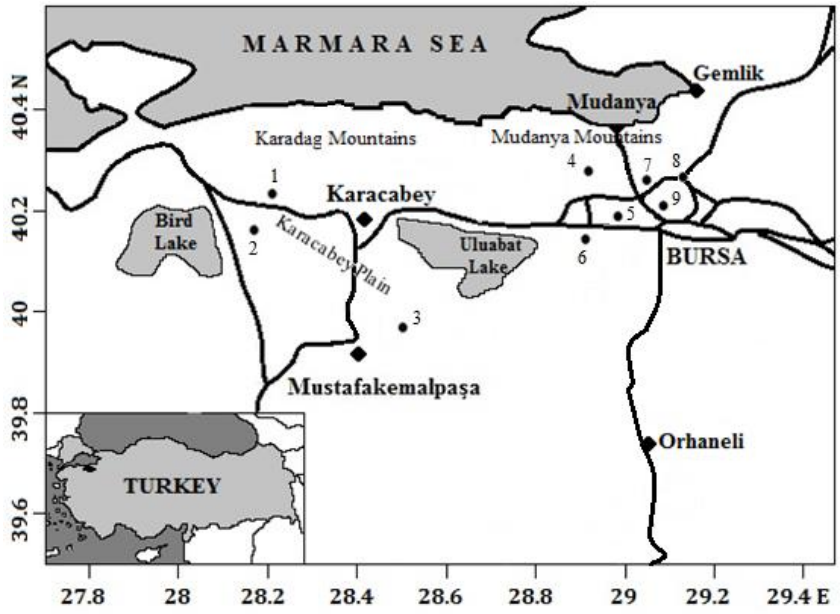


Figure 1. Map of the study area and sampling sites.

The lichen sampling sites:

1. Bursa: Karacabey: Dağkadı village; on the trees near the cemetery, 40°15′40″ N - 28°11′31″ E, alt. 66 m, 07.08.2014.
2. Bursa: Karacabey; Danişment village, on trees near to chicken farm facility (BANVIT), 40°12′46″ N - 28°07′39″ E, alt. 98 m, 21.08.2014.
3. Bursa: Mustafakemalpaşa; İncilipınar village, on the trees in the village center, 40°05′30″ N- 28°28′18″ E, alt. 41 m, 16.10.2014.
4. Bursa: Mudanya; Ülkü village, roadside of Ülkü – Dede village, on the trees at the agricultural area in the peripheral zone of Bursa city center, 40°18′32″ N - 28°51′48″ E, alt. 110 m, 07.11.2014.
5. Bursa: Nilüfer; on the trees near Metro supermarket in the peripheral zone of Bursa city center, 40°12′53″ N - 28°56′45″ E, alt. 81 m, 06.10.2014.
6. Bursa: Nilüfer; Görükle, the north-east slopes on along the Kayapa road, on the trees at the agricultural area in the peripheral zone of Bursa city center, 40°12′42″ N – 28°51′08″ E, alt. 130 m, 12.05.2015.
7. Bursa: Nilüfer; Aksungur village, on the trees in village cemetery surrounded by walls in Bursa city center, 40°17′02″ N – 28°58′46″ E, alt. 103 m, 21.05.2015.
8. Bursa: Osmangazi; Ovaakça village, on the trees in the cemetery surrounded by walls in Bursa city center, 40°18′00″ N – 29°03′33″ E, alt. 127 m, 21.05.2015.
9. Bursa: Osmangazi; Hamitler, on the trees at the Hamitler park in between houses in the city center, 40°14′26″ N – 28°59′09″ E, alt. 125 m, 08.09.2015

2.3. Statistical analysis

The data matrix of 28 species × 24 samples and the sum of the frequency values of lichens were used for statistical evaluation. Total frequency of epiphytic lichen species was used for statistical evaluation. The total frequency was calculated as the sum of the frequencies of a species on the north, south, east and west side of each sample tree. The ordination chart of a total of 24 sampling trees in nine localities was obtained with a detrended correspondence analysis (DCA) as indirect unimodal gradient analysis method, using the CANOCO 4.5 package [13]. Indicator species analysis was conducted with multivariate classification techniques (TWINSPAN) for Windows Version 2.3 [14].

3. Results

A total of 28 epiphytic lichen species were found on the *Quercus pubescens* (Table 1). *Eopyrenula leucoplaca* was found in all the localities ofthe study area. The other common species were *Hyperphyscia adglutinata, Physconia grisea* and *Xanthoria parietina*. Recently, a total of 40 epiphytic lichen species on *Q. pubescens* in Bursa province has been recorded [15]. In another study, 77 epiphytic lichen species on *Q. pubescens* were recorded in Tuscany (Central Italy). Among them *H. adglutinata, Ph. grisea* and *X. parietina* were common [5].

Alyxoria varia, Amandinea punctata, Caloplaca cerina, Diplotomma alboatrum, E. leucoplaca, H. adglutinata, Opegrapha herbarum, Phlyctis argena, Physcia adscendens, P. stellaris, Ph. grisea and *X. parietina* were found on oak trees located in the villages of Karacabey Plain. The great majority of these species were nitrophytic. The localities around the settlement and agricultural areas in Bursa province were mainly characterized by the indicator species such as *Lecidella elaeochroma, Phaeophyscia orbicularis P. adscendens, P. stellaris* and *X. parietina* [16].

The species determined on oak trees in the peripheral locality zones of Bursa city centre were *A. varia, Athallia cerinella, Buellia disciformis, Candelariella vitellina, D. alboatrum, E. leucoplaca, H. adglutinata, Lecanora carpinea, L. chlarotera, L. elaeochroma, Myriolecis hagenii, O. herbarum, P. orbicularis, P. argena, P. adscendens, P. stellaris, Ph. grisea* and *X. parietina*. Out of these, 4 species were mesotrophic, 6 species were oligotrophic, and 8 were nitrophytic.

H. adglutinata, L. elaeochroma, P. adscendens and *X. parietina* were abundant in oak trees located near to the agricultural area [17] and surroundings of the settlement [18]. Similarly *H. adglutinata, P. orbicularis, Ph. grisea* and *X. parietina* were also commonly found in the settlement and agricultural areas in various cities of Europe [19-22].

The species determined on oak trees in the localities of Bursa city center (localities 7, 8 and 9) were *Acrocordia cavata, A. varia, A. punctata, Buellia griseovirens, C. cerina, Candelaria concolor, E. leucoplaca, H. adglutinata, Lecania fuscella, O. herbarum, Pertusaria albescens, Ph. grisea, Ph. perisidiosa, Pleurosticta acetabulum, Scoliciosporum chlorococcum,* and *X. parietina*. Out of these, 4 species were mesotrophic, 6 were oligotrophic, and 6 were nitrophytic. The Bursa city center was characterized by the *C. concolor* indicator species. Other characteristic species were *Ph. grisea* and *Ph. perisidiosa* [16]. *P. orbicularis* and *C. concolor* were found on trees across the boundaries of the "lichen desert" in city centers [23]. Our results corraborate with the results of the above mentioned study.

Table 1. Mean frequency of species in the localities and the functional group classification according to Nimis and Martellos [24]

Localities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Scale of environmental quality (Güvenç, 2017)	**LA**	**LA**	**MA**	**LN**	**LA**	**LA**	**HA**	**HA**	**HA**	
Number of sampling trees	2	3	3	2	3	3	3	2	3	
Acrocordia cavata (Ach.) R.C. Harris	-	-	-	-	-	-	3.7	-	-	O
Alyxoria varia (Pers.) Ertz & Tehler	-	-	1.7	0.6	-	-	2.0	0.7	-	O
Amandinea punctata (Hoffm.) Coppins & Scheid.	2.0	-	-	-	-	-	4.3	1.4	-	N
Athallia cerinella (Nyl.) Arup, Frödén & Søchting	-	-	-	0.3	-	-	-	-	-	N
Buellia disciformis (Fr.) Mudd	-	-	-	1.0	-	-	-	-	-	O
Buellia griseovirens (Turner & Borrer ex Sm.) Almb.	-	-	-	-	-	-	1.3	0.4	-	O
Caloplaca cerina (Hedw.) Th. Fr.	1.0	-	-	-	-	-	0.7	0.2	-	N
Candelaria concolor (Dicks.) Arnold	-	-	-	-	-	-	2.7	6.6	-	N
Candelariella vitellina (Hoffm.) Müll. Arg.	-	-	-	6.0	1.7	-	-	-	-	N
Diplotomma alboatrum (Hoffm.) Flot.	-	-	0.7	0.2	-	-	-	-	-	N
Eopyrenula leucoplaca (Wallr.) R.C. Harris	4.5	0.3	13.3	7.1	2.3	14.7	1.0	0.3	15.0	O
Hyperphyscia adglutinata (Flörke) H. Mayrhofer & Poelt	3.5	14.0	6.0	8.7	-	-	2.3	0.8	-	N
Lecania fuscella (Schaer.) A. Massal.	-	-	-	-	-	-	0.7	0.2	-	M
Lecanora carpinea (L.) Vain.	-	-	-	-	-	0.3	-	-	-	O
Lecanora chlarotera Nyl.	-	-	1.0	1.3	0.3	3.0	-	-	-	M
Lecidella elaeochroma (Ach.) M. Choisy	-	-	-	0.7	-	3.7	-	-	-	M
Myriolecis hagenii (Ach.) Śliwa, Zhao Xin & Lumbsch	-	-	-	-	1.7	-	-	-	-	M
Opegrapha herbarum Mont.	0.5	-	-	-	-	0.7	-	1.0	-	O
Pertusaria albescens (Huds.) M. Choisy & Werner	-	-	-	-	-	-	2.3	0.8	0.7	O
Phaeophyscia orbicularis (Neck.) Moberg	-	-	-	-	6.3	-	-	-	-	N
Phlyctis argena (Ach.) Flot.	-	-	10.7	3.6	-	10.0	-	-	-	O
Physcia adscendens (Fr.) H. Olivier	-	1.3	-	0.3	2.0	5.0	-	-	-	N
Physcia stellaris (L.) Nyl.	19.0	3.7	-	-	7.0	-	-	-	-	M
Physconia grisea (Lam.) Poelt	-	17.0	13.0	6.3	13.7	-	-	3.0	11.7	N
Physconia perisidiosa (Erichsen) Moberg	-	-	-	-	-	-	4.0	1.7	-	M
Pleurosticta acetabulum (Neck.) Elix & Lumbsch	-	-	-	-	-	-	-	-	0.7	M
Scoliciosporum chlorococcum (Graewe ex Stenh.) Vězda	-	-	-	-	-	-	2.7	0.9	-	M
Xanthoria parietina (L.) Beltr.	1.0	3.7	1.0	1.7	1.3	-	2.3	0.8	-	N

M: Mesotrophic **N:** Nitrophytic **O:** Oligotrophic
LA: Low Alteration **MA:** Medium Alteration **HA:** High Alteration **LN:** Low Naturality

Due to the epiphytic lichen diversity, localities were divided into four groups as a result of Twinspan analysis (Figure 2). At first level, the localities in Bursa city center were distinguished by indicator species such as *C. concolor* and *Ph. perisidiosa* from the localities in Karacabey Plain and peripheral zone of Bursa city center. On the second level, the localities in Karacabey Plain and peripheral zone of Bursa city center were seperated into two groups. Similarly, the DCA ordination result of sampled trees was similar to the result of Twinspan analysis (Figure 3).

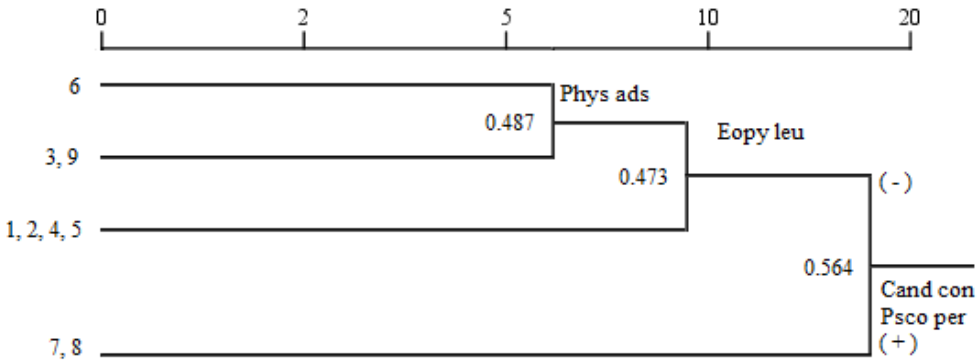


Figure 2. Dendrograms of the localities according to the result of Twinspan analysis

Loc. 1, 2 : Peripheral zone of Karacabey Plain
Loc. 3 : Village center of Karacabey Plain
Cand con : *Candelaria concolor*
Phys ads : *Physcia adscendens*
Loc. 4, 5, 6 : Peripheral zone of Bursa City Center
Loc. 7, 8, 9 : Bursa City Center
Eopy leu : *Eopyrenula leucoplaca*
Psco per : *Physconia perisidiosa*

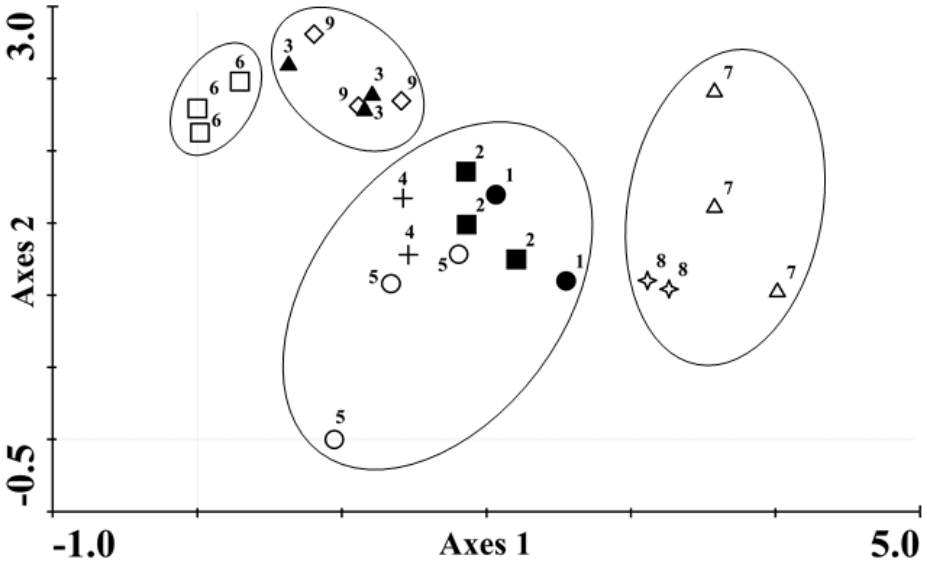


Figure 3. DCA ordination of 24 sampling oak trees in 9 localities

The first two axes of the DCA represented 27.5 % of the total variance in the species data (the value for the first axis was 18.1 % and the value for the second axis was 9.4 %). Recently, four environmental quality zones have been determined for the Bursa province. The highest alteration zone was observed at Bursa City Center and a semi-alteration zone was observed along the surroundings of the Bursa City Center (Güvenç, 2017).

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References

[1] Pasta, S., de Rigo, D., & Caudullo, G. (2016). Quercus pubescens in Europe: distribution, habitat, usage and threats. In: J. San-MiguelAyanz, D. de Rigo, G. Caudullo, T. Houston Durrant, & A. Mauri (Eds.), *European Atlas of Forest Tree Species* (pp.156-157). Luxembourg: Publ. Off. EU.

[2] Öztürk, S. (2013). *The diagnosis and diagnostic manual of Turkey oak*. Ankara: Forestry and Water Affairs Ministry, General Directorate of Forestry, Department of Forest Pests Combating Presidency.

[3] Gül, M., & Güvenç, Ş. (2016). Lichenized fungi of Karadağ Mountain (Karacabey-Bursa). *J Biol Environ Sci*, 10(29), 89-99.

[4] Güvenç, Ş. (2018). Two lichenized fungi (*Bactrospora corticola*, *Pycnora sorophora*) from Bursa province new to Turkey. *Biological Diversity and Conservation*, 11(3), 145-148.

[5] Loppi, S., Pirintsos, S. A, Olivieri, N., & Pacioni, G. (1999). Distribution of epiphytic lichens on *Quercus pubescens* along an altitudinal gradient on the Adriatic side of Central Italy. *Studia Geobotanica*, 17, 85-90.

[6] Loppi, S., Pirintsos, S. A, Sforzf, B., & De Dominicis, V. (1998). Effects of climate and agriculture on epiphytic lichen vegetation in the mediterranean area (Tuscany, Central Italy). *Acta Bot Croat*, 55/56, 17-27.

[7] Svoboda, D., Peksa, O., & Veselá, J. (2010). Epiphytic lichen diversity in central European oak forests: Assessment of the effects of natural environmental factors and human influences. *Environ Pollut*, 158, 812–819 . https://doi: 10.1016/j.envpol.2009.10.001

[8] Öztürk, M.Z. (2010). Comparative climate of Uludağ (Zirve) and Bursa Meteorology Stations. *Türk Coğrafya Dergisi*, 55, 13-24.

[9] *Climate data of Bandırma, Mudanya and Karacabey (Period of 1987-2012)*. Ankara, TR: Turkish State Meteorological Service.

[10] Asta, J., Erhardt, W., Ferretti, M., Fornasier, F., Kirschbaum, U., Nimis, P. L., … Wirth, V. (2002). Mapping lichen diversity as an indicator of environmental quality. In: P. L. Nimis, C. Scheidegger, & P. A. Wolseley (Eds.), *Monitoring with Lichens- Monitoring Lichens*, (Vol. VII, pp. 273-279). The Netherlands: Kluwer Academic Publisher.

[11] Smith, C. W., Aptroot, A., Coppins, B. J., Fletcher, A., Gilbert, O. L., James, P. W., & Wolseley, P.A. (Eds.) (2009). *The lichens of Great Britain and Ireland*. London, UK: British Lichen Society.

[12] Wirth, V., Hauck, M., & Schultz, M. (2013). *Die Flechten Deutschlands*, Stuttgart,GR: Ulmer.

[13] Ter Braak, C. J. F. (1995). Ordination. In: R. H. G. Jongman, C. J. F. ter Braak, & O. F. R. van Tongeren (Eds.), *Data Analysis in Community and Landscape Ecology*, (pp. 91-173), Cambridge, UK: Cambridge University Press.

[14] Hill, M. O., & Šmilauer, P. (2005). *TWINSPAN for Windows version 2.3*. Czech Republic: Huntingdon & Ceske Budejovice.

[15] Oran, S., & Öztürk, Ş. (2011). The diversity of lichen and lichenicolous fungi on *Quercus* taxa found in the Marmara region (Turkey). *Biological Diversity and Conservation*, 4(2), 204-223.

[16] Güvenç, Ş. (2017). Detection of the environmental quality of Bursa Province (Turkey) with epiphytic lichen diversity. *J Environ Prot Ecol*, 18(4), 1481-1487.

[17] Garrido-Benavent, I., Llop, E., & Gómez-Bolea, A. (2015). The effect of agriculture management and fire on epiphytic lichens on holm oak trees in the eastern Iberian Peninsula. *Lichenol*, 47, 59–68. . https://doi: 10.1017/S002428291400053X

[18] Wolseley, P. A., James, P. W., Theobald, M. R., & Sutton, M. A. (2006). Detecting changes in epiphytic lichen communities at sites affected by atmospheric ammonia from agricultural sources. *Lichenol*, 38, 161-176. . https://doi: 10.1017/S0024282905005487

[19] Davies, L., Bates, J. W., Bell, J. N. B., James, P. W., & Purvis, O. W. (2007). Diversity and sensitivity of epiphytes to oxides of nitrogen in London. *Environ Pollut*, 146, 299–310. https://doi: 10.1016/j.envpol.2006.03.023

[20] Larsen, R. S., Bell, J. N. B., James, P. W., Chimonides, P. J., Rumsey, F. J., Tremper, A., & Purvis, O. W. (2007). Lichen and bryophyte distribution on oak in London in relation to air pollution and bark acidity. *Environ Pollut*, 146, 332–340. . https://doi: 10.1016/j.envpol.2006.03.033

[21] Paoli, L., Guttová, A., & Loppi, S. (2006). Assessment of environmental quality by the diversity of epiphytic lichens in a semi-arid mediterranean area (Val Basento, South Italy). *Biologia*, 61, 353–359. . https://doi: 10.2478/s11756-006-0064-2

[22] Munzi, S., Ravera, S., & Caneva, G. (2007). Epiphytic lichens as indicators of environmental quality in Rome. *Environ Pollut*, 146, 350–358. . https://doi: 10.1016/j.envpol.2006.03.042

[23] Conti, M. E., & Cecchetti, G. (2001). Biological monitoring: lichens as bioindicators of air pollution assessment - A review. *Environ Pollut*, 114, 471–492. . https://doi: 10.1016/S0269-7491(00)00224-4

[24] Nimis, P. L., & Martellos, S. (2018). *ITALIC - The Information System on Italian Lichens (Version 5.0)*. Retrieved from http://dryades.units.it/italic

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