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Lichens to monitor afforestation effects in Çanakkale, Turkey

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Abstract – The lichen flora of two mountains in western Turkey was investigated: of 124 species recorded, seven were new for Turkey: *Aspicilia mastrucata*, *Calicium quercinum*, *Chaenotheca phaeocephala*, *Fuscidea praeruptorum*, *Psilolechia lucida*, *Rhizocarpon badioatrum* and *Trapelia obtegens*, and 70 taxa were new for the Çanakkale province. For 6 of 7 indicator values figures, it is clear that the lichen floras of an old forested mountain and a freshly afforestated mountain are significantly different, with only the temperature values showing no apparent difference. Lichens are therefore good indicators to follow the effects of forest management.

lichen / indicator values / afforestation / Şap Mountain / Karadağ / Turkey

Résumé – La flore lichénique de deux montagnes de l'ouest de la Turquie a été étudié : 124 espèces ont été répertoriées trouvées sont sept sont nouvelles pour la Turquie (*Aspicilia mastrucata*, *Calicium quercinum*, *Chaenotheca phaeocephala*, *Fuscidea praeruptorum*, *Psilolechia lucida*, *Rhizocarpon badioatrum* et *Trapelia obtegens*) et 70 taxons sont nouveaux pour la province de Çanakkale. Sur 7 indices écologiques utilisables, 6 démontrent que la flore lichénique d'une forêt ancienne diffère nettement de celle d'une forêt récemment exploitée. Les valeurs indicatrices de température ne pas montrent pas de différence significative. Les lichens sont de bons indicateurs pour suivre les impacts de l'exploitation forestière.

INTRODUCTION

Lichens can be used in many ways to monitor the environment, particularly the impact of air pollution and heavy metals, and more recently in the detection of climate change (van Herk *et al.* 2002). Such monitoring has proved important for environmental management programmes, and, not surprisingly, for political debate on environmental issues.

The lichen flora of the Mediterranean phytogeographical region of Turkey is more intensively studied than other regions of Turkey (John 1996a). Most of these studies have been focussed on lichen diversity (John & Nimis 1998, Nimis & John 1998), but some work has been carried out on lichen chemistry (Huneck & John 1987, Huneck *et al.* 1994, Zeybek *et al.* 1993a) and air pollution

monitoring (John 1989, Sommerfeldt & John 2001, Topçuoğlu *et al.* 1992). However, little work has been undertaken to date on the ecology of lichens in Turkey. A detailed study of the lichen floras of two mountains in the undercollected province of Çanakkale provided an ideal opportunity to examine the effects of afforestation in the important historical area near to Troja linking the Egean and Marmara regions.

Because of the suitable geographical and climatic location, Çanakkale province has been inhabited for thousand years, during which time it has been significantly influenced by anthropological effects. Although our two study areas are in relatively undisturbed natural locations, they are nevertheless near to urban and industrial zones and there are heavy mining and tourism activities in their neighbourhood. The study areas are located in the Karadağ and Şap Mountains within the Biga Mountains which extend southwest to northeast in the Biga Peninsula.

Some data on the lichens in Çanakkale province are to be found in studies carried out in Gökçeada (Özdemir Türk, 1997) and Bozcaada (Öztürk, 1999), two islands in the Egean Sea, the Gelibolu Peninsula (Özdemir Türk & Güner, 1998), Lapseki (Güner & Özdemir, 1986), Küçükkuyu (Huneck & John 1987, John 1996b, Nimis & John, 1998, Zeybek *et al.* 1993b) and Bayramic (Topçuoğlu *et al.* 1992). A further aim of the present study was to increase our knowledge of the lichen flora of this still under-recorded region of Turkey.

STUDY AREA

The Anatolian part of the Çanakkale province located in the Biga Peninsula contains two mountain ranges: the Biga Mountains extending from SW to NE in the north and the Kaz (Ida) Mountains from W to E in the south. The Biga Mountains are plateau-like in appearance, being composed of several hills with elevations lower than 1000 m divided by streams and creeks. Volcanic eruptions of the Biga Peninsula since the pre-Eocene have laid down andesitic and dasitic lava and tuff, each modified over time, as well as incorporating rich metallic deposits that have been locally mined.

Karadağ Mountain, located to the northwest of Çan village, rises to an elevation of 749 m (40° 15' 58" N 26° 54' 22" E), and Şap Mountain, 15 km west of Umurbey village, has an altitude of 767 m (40° 04' 37" N 26° 40' 50" E).

Karadağ has a forest formation of *Quercus* spp. and *Pinus brutia*, *Arbutus unedo*, *Spartium junceum*, *Styrax officinalis*, *Nerium oleander*, *Pyrus eleagrifolia*, *Crataegus* sp., *Erica* sp., *Cistus* spp., *Smilax* sp., *Arbutus andrachne*, *Phillyrea latifolia* and *Rubus canescens*, with *Platanus* sp., *Alnus* sp. and *Castanea sativa* found in humid habitats bordering creek banks. On the other hand, Şap Mountain supports less forest cover of mainly young trees dominated by *Quercus* spp. and *Pinus nigra* subsp. *pallasiana*.

Climatic data obtained from the meteorological station in Çanakkale are provided in Figure 2. According to the precipitation-temperature coefficient ($Q_2 = 79.2$) and aridity indices ($S = 1.3$) of Emberger (1955), Çanakkale has a low precipitation-cool Meditteranean climate (Akman, 1990).

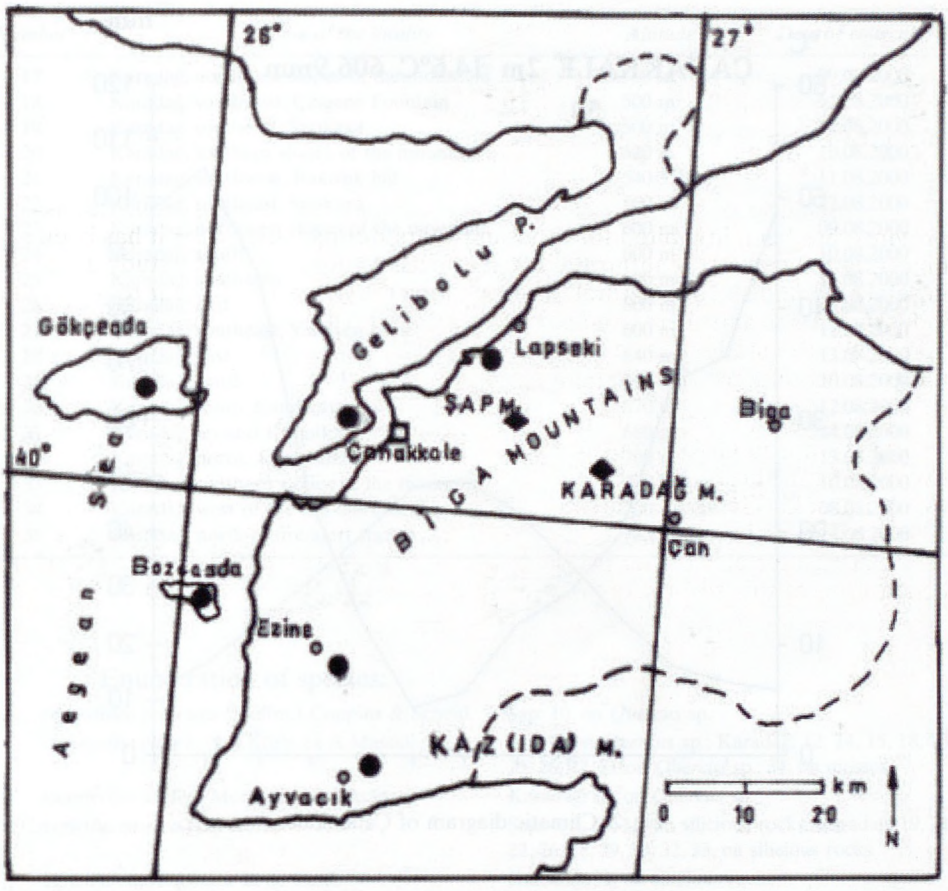

Fig. 1. Map of the study area. ● Shows the sites of the previous studies. ◆ Shows the positions of Karadağ and Şap Mountains.

RESULTS

Floristic data

The localities from which lichen samples were collected during 5-14 August 2000 from Şap Mountain and Karadağ Mountain (Çanakkale) are listed in Table 1. Herbarium samples are stored in the Herbarium of Anadolu University, Department of Biology (ANES).

The taxa are given in alphabetical order, followed by locality numbers and substrata; indicator values are those proposed by Wirth (2001). The names of authors are given according to Brummit and Powell (1992). * indicates a new record for Turkey, # indicates a new record for the Çanakkale province.

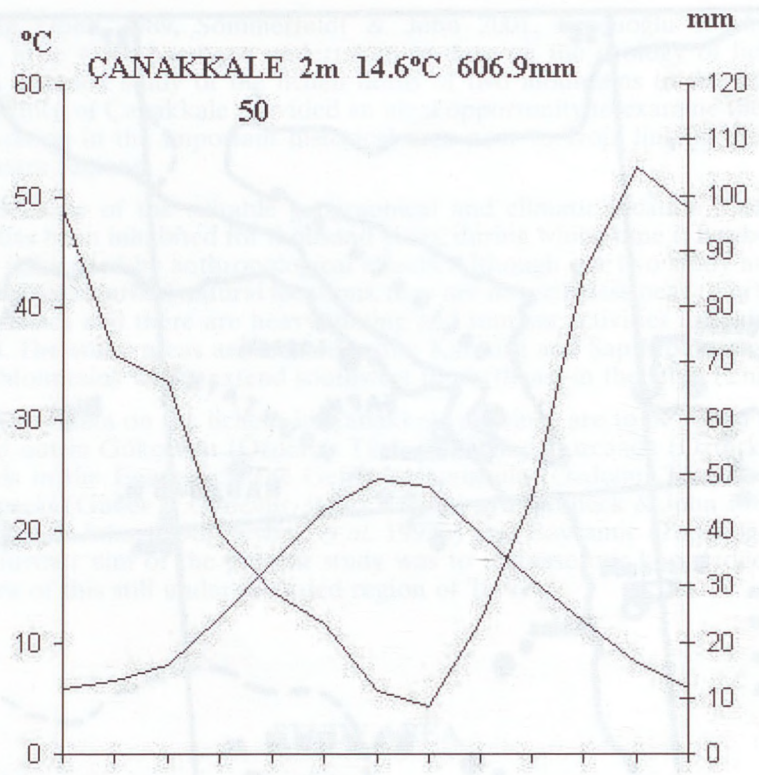

Fig. 2. Climatic diagram of Çanakkale.

Table 1. List of the Localities.

Number	*Name of the locality*	*Altitude*	*Date of collection*
1	Şap Mountain; southwest, bank of Şap Stream	450 m	06.08.2000
2	Şap Mountain; southwest, Kadıkonağı place	500 m	06.08.2000
3	Şap Mountain; south, Ağı Mountain road	540 m	06.08.2000
4	Şap Mountain; southeast, rocky field	550 m	07.08.2000
5	Şap Mountain; southeast, Ağı Mountain road	600 m	06.08.2000
6	Şap Mountain; northeast, Akbaba Rock	600 m	07.08.2000
7	Şap Mountain; north, Aptal Taşı	600 m	07.08.2000
8	Şap Mountain; north Göller place	650 m	06.08.2000
9	Şap Mountain; east, around Sakartepe	650 m	07.08.2000
10	Şap Mountain; north, around Kızılcıklı Rock	700 m	05.08.2000
11	Şap Mountain, vicinity of fire alert station	760 m	05.08.2000
12	Karadağ; northwest, Ikizler fountain	350 m	09.08.2000
13	Karadağ; north, Dondurma junction	350 m	09.08.2000
14	Karadağ; between Kurukabaç -Sıtma fountains	400 m	14.08.2000
15	Karadağ; north, Karadağ village junction	415 m	09.08.2000
16	Karadağ; southern slopes of the mountain	440 m	10.08.2000

Number	*Name of the locality*	*Altitude*	*Date of collection*
17	Karadağ; northwest slopes of the mountain	500 m	09.08.2000
18	Karadağ; southwest, Çingene Fountain	500 m	11.08.2000
19	Karadağ; southeast, Sarıkaya	500 m	12.08.2000
20	Karadağ; southern slopes of the mountain	520 m	10.08.2000
21	Karadağ; southwest, Bakırlık hill	540-550 m	11.08.2000
22	Karadağ; southeast, Sarıkaya	560 m	12.08.2000
23	Karadağ; northwest slopes of the mountain	600 m	09.08.2000
24	Karadağ; south	600 m	10.08.2000
25	Karadağ; southwest	600 m	11.08.2000
26	Karadağ; east	600 m	13.08.2000
27	Karadağ; southeast, Yemişen kaya	600 m	12.08.2000
28	Karadağ; east	640 m	13.08.2000
29	Karadağ, south	650 m	10.08.2000
30	Karadağ, south, Çamlıkaya	670 m	12.08.2000
31	Karadağ; around Kartalkaya	680 m	14.08.2000
32	Karadağ; north, Ayıkayalığı	700 m	13.08.2000
33	Karadağ, southern slopes of the mountain	700-730 m	10.08.2000
34	Karadağ, west of the fire alert station	700-730 m	08.08.2000
35	Karadağ, north of fire alert station	745 m	14.08.2000

Enumeration of species:

Amandinea punctata (Hoffm.) Coppins & Scheid. Şap: 10, on *Quercus* sp.

Anaptychia ciliaris (L.) Körb. ex A.Massal. Şap: 2, on *Quercus* sp.; Karadağ: 12, 14, 15, 18, 23, 25, 26, 27, 31 on *Quercus* sp.; 34, on mosses

\# *Anaptychia setifera* Mereschk. ex Räsänen Karadağ: 20, on *Quercus* sp.

\# *Aspicilia cinerea* (L.) Körb. Şap: 4, 8, 10, 11, on silicious rocks. Karadağ; 19, 21, 22, 26, 28, 29, 30, 32, 33, on silicious rocks.

Aspicilia cupreoglauca B. de Lesd. Karadağ: 31, on silicious rocks

\# *Aspicilia laevata* (Ach.) Arnold Şap: 10, on silicious rocks

*# *Aspicilia mastrucata* (Wahlenb.) Th.Fr. Karadağ: 35, on silicious rocks

\# *Bryoria fuscescens* (Gyeln.) Brodo & D.Hawksw. Şap: 3, on *Pinus nigra*, Karadağ: 16, 17, 28, 31, 33, on *Quercus* sp.

\# *Buellia spuria* (Schaer.) Anzi Karadağ: 34, on silicious rocks

\# *Buellia subdisciformis* (Leighton) Vain. Karadağ: 14 on *Quercus* sp.; 22, 29, on silicious rocks

\# *Calicium glaucellum* Ach. Şap: 1, 8, 10, on *Pinus nigra*, Karadağ: 18, 23, 28, 31 34, on decaying wood

*# *Calicium quercinum* Pers. Şap: 8, on *Pinus nigra*, Karadağ: 18, on decaying wood

\# *Calicium salicinum* Pers. Karadağ: 17, 34, 31, on decaying wood

Caloplaca atroflava (Turner) Mong. Şap: 5, on silicious rocks

Caloplaca citrina (Hoffm.) Th.Fr. Karadağ: 34, on *Quercus* sp.

Caloplaca holocarpa (Hoffm. ex Ach.) Wade Şap: 4, on *Quercus* sp.; Karadağ: 14, on *Quercus* sp.

Candelariella aurella (Hoffm.) Zahlbr. Karadağ: 29, on silicious rocks

\# *Candelariella coralliza* (Nyl.) H.Magn. Şap: 10, on silicious rocks

Candelariella vitellina (Hoffm.) Müll.Arg. Şap: 8 on silicious rocks, 10 on mosses; Karadağ: 21, 35, on silicious rocks

Cetraria aculeata (Schreber) Fr. Şap: 4, on soil

\# *Cetraria muricata* (Ach.) Eckfeldt Şap: 10, on mosses; Karadağ: 31, 33, on soil

\# *Chaenotheca brunneola* (Ach.) Müll.Arg. Karadağ: 18, on decaying wood

*#	*Chaenotheca phaeocephala* (Turner) Th.Fr.	Karadağ: 15, on decaying wood
	Chrysothrix candelaris (L.) J.R.Laundon	Karadağ: 17, 31, on *Quercus* sp.
	Cladonia cervicornis (Ach.) Flotow subsp. *verticillata* (Hoffm.) Ahti	Şap: 1, on soil; Karadağ: 33, on soil
#	*Cladonia coniocraea* (Flörke ex Sommerf.) Sprengel	Şap: 1, on soil
	Cladonia convoluta (Lam.) Anders	Şap: 4, on soil
#	*Cladonia fimbriata* (L.) Fr.	Şap: 1, on mosses, 5, 8, 9, 11, on soil; 7, on *Quercus* sp.; Karadağ: 18, on *Quercus* sp.; 26, 34, on mosses; 17, 23, 33 on soil
	Cladonia firma (Nyl.) Nyl.	Şap: 8, on soil
	Cladonia foliacea (Huds.) Willd.	Şap: 1, 2, 4, 8, 11, on soil; Karadağ: 21, 29, 31, 33, on soil.
#	*Cladonia furcata* (Huds.) Schrader subsp. *furcata*	Şap: 2, 4, on soil
#	*Cladonia pyxidata* (L.) Hoffm.	Şap: 1, 8, on soil; Karadağ: 13, 14, 15, on soil, 28, on mosses
#	*Cladonia ramulosa* (With.) J.R.Laundon	Şap: 1, on soil.
	Cladonia rangiformis Hoffm.	Şap: 1, 2, 4, 8, 10, 11, on soil; Karadağ: 13, 21, on soil, 31 on mosses
#	*Cladonia squamosa* (Scop.) Hoffm.	Karadağ: 33, on soil.
	Diploschistes scruposus (Schreber) Norman	Şap: 10, on silicious rocks; Karadağ; 14, 19, 21, 22, on silicious rocks
	Evernia prunastri (L.) Ach.	Şap: 10, on *Pinus nigra*, 1, 2, 4, 5, 8, on *Quercus* sp.; Karadağ: 14, 15, 16, 17, 18, 19, 21, 23, 24, 25, 27, 28, 29, 30, 31, 32, 33, 34, on *Quercus* sp. 14, on *Pinus nigra*
	Fuscidea cyathoides (Ach.) V.Wirth & Vězda	Karadağ: 32, on silicious rocks
*#	*Fuscidea praeruptorum* (Du Rietz & H.Magn.) V. Wirth & Vězda	Karadağ: 34, on silicious rocks
#	*Graphis scripta* (L.) Ach.	Karadağ: 34, on *Quercus* sp.
	Haematomma nemetzii J.Steiner	Şap: 10, on silicious rocks; Karadağ: 27, 33, 34, on silicious rocks
#	*Haematomma ochroleucum* (Neck.) J.R.Laundon	Karadağ: 23, on silicious rocks
#	*Hafellia disciformis* (Fr.) Mudd	Şap: 2, 5, 8, 10, on *Quercus* sp.; Karadağ: 12, 17, 19, 21, 23, 31, 34, on *Quercus* sp., 15, on *Castanea sativa*, 27, on *Carpinus sativa*.
#	*Hypocenomyce scalaris* (Ach. ex Lilj.) M.Choisy	Şap: 8, 10, on *Pinus nigra*
	Hypogymnia farinacea Zopf	Şap: 4, on *Pinus nigra*
#	*Hypogymnia physodes* (L.) Nyl.	Şap: 3, 7, 8, 10 on *Pinus nigra*, 1, 4, on *Quercus* sp.; Karadağ: 13 on mosses, 16, 17, 20, 21, 23, 27, 28, 31, 32, 33, 34, on *Quercus* sp., 19, 28, 30, 35 on silicious rocks
	Hypogymnia tubulosa (Schaer.) Havaas	Şap: 1, 2, 10, on *Quercus* sp.; Karadağ: 14, 19, 23, 26, 28, 31 on *Quercus* sp., 27, on silicious rocks
#	*Icmadophila ericetorum* (L.) Zahlbr.	Karadağ: 14, on *Quercus* sp.
	Lasallia pustulata (L.) Mérat	Şap: 5, on silicious rocks; Karadağ: 21, 30, 33, on silicious rocks.
#	*Lecanora carpinea* (L.) Vain.	Şap: 8, 10, on *Quercus* sp.; Karadağ: 12, 17, 19, 21, 26, 29, 31, on *Quercus* sp., 15, on *Castanea sativa*.
#	*Lecanora chlarotera* Nyl.	Şap: 8, 10, on *Quercus* sp.; Karadağ: 21, 28, 31, 34, on *Quercus* sp.
	Lecanora pulicaris (Pers.) Ach.	Şap: 10, *Quercus* sp.
#	*Lecanora rupicola* (L.) Zahlbr. ssp *subplanata* (Nyl.) Leuckert & Poelt	Karadağ: 30, 33, on silicious rocks.

	Lecanora saligna (Schrad.) Zahlbr.	Karadağ: 22, on decaying wood.
#	*Lecanora subcarnea* (Lilj.) Ach.	Karadağ: 19, 30, on silicious rocks.
	Lecanora sulphurea (Hoffm.) Ach.	Şap: 10, on silicious rocks.
#	*Lecidea atrobrunnea* (Ramond) Schaer.	Şap: 2, on silicious rocks.
#	*Lecidea fuscoatra* (L.) Ach.	Şap: 2, on silicious rocks; Karadağ: 21, on silicious rocks.
	Lecidella elaeochroma (Ach.) M.Choisy	Şap: 10, on *Quercus* sp., 4, on *Pinus nigra*; Karadağ: 14, 17, 20, 23, 24, 26, 27, 31, on *Quercus* sp.
#	*Lethariella intricata* (Moris) Krog	Şap: 10, on *Quercus* sp.
#	*Lobaria pulmonaria* (L.) Hoffm.	Şap: 8, on *Quercus* sp.; Karadağ: 12, 15, 16, 17, 18, 20, 21, 23, 24, 25, 28, 29, 30, 31, 32, 33, 34, on *Quercus* sp.
	Melanelia elegantula (Zahlbr.) Essl.	Karadağ: 15, 31, on *Quercus* sp.
#	*Melanelia glabratula* (Lamy) Essl.	Karadağ: 19, 21, 22 on silicious rocks.
#	*Melanelia septentrionalis* (Lynge) Essl.	Şap: 8, on silicious rocks.
#	*Melanelia subaurifera* (Nyl.) Essl.	Şap: 11, on silicious rocks, 4, on *Quercus* sp.
	Neofuscelia pulla Ach. var. *pulla*	Şap: 4, 8, 11, on silicious rocks; Karadağ: 19, 21, 27, 29, 33, on silicious rocks.
#	*Nephroma laevigatum* Ach.	Karadağ: 14, 15, 26, on *Quercus* sp., 26, on mosses.
#	*Ochrolechia balcanica* Verseghy	Karadağ: 12, on *Quercus* sp.
#	*Ochrolechia pallescens* (L.) A.Massal.	Karadağ: 25, 34, on *Quercus* sp.
#	*Ochrolechia szatalaensis* Vers.	Karadağ: 15, on *Quercus* sp.
#	*Parmelina carporrhizans* (Taylor) Poelt & Vezda	Şap: 3, on *Pinus nigra*; Karadağ: 18, 20, on *Quercus* sp.
#	*Parmelina pastillifera* (Harm.) Hale	Şap: 10, on *Quercus* sp.
#	*Parmelina quercina* (Willd.) Hale	Şap: 2, 4, 10, on *Quercus* sp.; Karadağ: 16, 26, 29, on *Quercus* sp.
	Parmelia saxatilis (L.) Ach.	Şap: 3, 6, 10, on *Pinus nigra*, 8, *Quercus* sp., 5, 9, on silicious rocks; Karadağ: 13, 30, on silicious rocks; 34, on mosses, 14, 19, 21, on *Quercus* sp.
	Parmelia sulcata Taylor	Şap: 1, 2, 5, 8, 10, on *Quercus* sp., 7, on *Pinus nigra* and *Quercus* sp., 4, on *Pinus nigra*; Karadağ: 12, 15, 17, 18, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, *Quercus* sp., 14, on *Pinus nigra*.
	Parmelina tiliacea (Hoffm.) Hale	Şap: 10, on *Quercus* sp.; Karadağ: 12, 23, 33, on *Quercus* sp.
#	*Peltigera canina* (L.) Willd.	Şap: 1, on mosses.
#	*Peltigera neckeri* Hepp ex Müll. Arg.	Şap: 1, on mosses.
#	*Peltigera praetextata* (Flörke ex Sommerf.) Zopf	Şap: 1, on mosses.
#	*Pertusaria albescens* (Huds.) M.Choisy & Werner	Şap: 1, 10, on *Quercus* sp.; Karadağ: 14, 17, 18, 20, 21, 28, 29, 31, 34, on *Quercus* sp.
#	*Pertusaria amara* (Ach.) Nyl.	Şap: 10, on silicious rocks; Karadağ: 15, 17, 18, 19, 24, 25, 27, 28, 29, 30, 31 32, 34, on *Quercus* sp.
#	*Pertusaria hemisphaerica* (Flörke) Erichsen	Şap: 10, on *Quercus* sp.; Karadağ: 28, 29, 31, 33, on *Quercus* sp.
#	*Pertusaria hymenea* (Ach.) Schaer.	Karadağ: 34 on *Quercus* sp.
#	*Pertusaria leucosora* Nyl.	Şap: 10, on silicious rocks.
	Pertusaria pertusa (Weigel) Tuck.	Şap: 3, on *Pinus nigra*, 7, 10, on *Quercus* sp.; Karadağ: 12, 15, 16, 17, 19, 20, 21, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, on *Quercus* sp.
#	*Phlyctis argena* (Sprengel) Flotow	Karadağ: 25, on *Quercus* sp.
	Physcia adscendens (Fr.) Oliv.	Şap: 10, on mosses.
	Physcia stellaris (L.) Nyl.	Şap: 2, 10, on *Quercus* sp.

#	*Physconia distorta* (With.) J.R.Laundon	Şap: 10, on *Quercus* sp.; Karadağ: 12, 29, on *Quercus* sp.
	Physconia enteroxantha (Nyl.) Poelt	Şap: 10, on *Quercus* sp.; Karadağ: 34, on mosses, 15, 20, 22, 23, on *Quercus* sp.
#	*Physconia grisea* (Lam.) Poelt	Şap: 10, on *Quercus* sp.
#	*Physconia perisidiosa* (Erichsen) Moberg	Karadağ: 12, 22, 23, 24, on *Quercus* sp.
#	*Placolecis opaca* (Fr.) Hafellner	Karadağ: 27, on silicious rocks.
	Platismatia glauca (L.) W.Culb. & C.Culb.	Şap: 1, 10, on *Quercus* sp., 2, 6, 7, 9, on *Pinus nigra*; Karadağ: 14, 21, on *Quercus* sp.
	Pleurosticta acetabulum (Necker) Elix & Lumbsch	Şap: 2, 4, 10, on *Quercus* sp.; Karadağ: 12, 14, 23, 34, on *Quercus* sp.
#	*Porpidia crustulata* (Ach.) Hertel & Knoph	Karadağ: 26, 28, 32, on silicious rocks.
#	*Porpidia speirea* (Ach.) Kremp.	Karadağ: 26, on silicious rocks.
	Protoparmelia badia (Hoffm.) Hafellner	Şap: 5, 10, on silicious rocks; Karadağ: 21, 30, 33, 35 on silicious rocks.
	Protoparmelia picea (Dicks.) Hafellner	Şap: 4, on silicious rocks
	Protoparmeliopsis muralis (Schreb.) M.Choisy	Şap: 8, 10, on silicious rocks; Karadağ: 30, 33, on silicious rocks.
	Pseudevernia furfuracea (L.) Zopf var. *ceratea* (Ach.) D. Hawksw.	Şap: 11, on *Pinus nigra*; Karadağ: 14, on *Pinus nigra*
	P. furfuracea (L.) Zopf var.*furfuracea*	Şap: 4, 5, 6, 8, 10, on *Pinus nigra*, 1, 2, on *Quercus* sp; Karadağ: 14, 21, on *Quercus* sp.
*#	*Psilolechia lucida* (Ach.) M.Choisy	Karadağ: 33, on silicious rocks.
	Ramalina farinacea (L.) Ach.	Şap: 1, 11, on *Quercus* sp.; Karadağ: 15, 16, 17, 18, 20, 21, 23, 24, 25, 28, 29, 31, 34, on *Quercus sp.*
#	*Ramalina fastigiata* (Pers.) Ach.	Şap: 2, 4, 8, 10, on *Quercus* sp.; Karadağ: 12, 16, 18, 20, 21, 23, 25, 31, 34, on *Quercus* sp.
	Ramalina fraxinea (L.) Ach.	Şap: 4, on *Quercus* sp.
*#	*Rhizocarpon badioatrum* (Flörke ex Sprengel) Th.Fr.	Şap: 11, on silicious rocks.
	Rhizocarpon geographicum (L.) DC.	Şap: 5, 10, 11, on silicious rocks ; Karadağ: 13, 19, 21, 26, 27, 30, 31, 33, on silicious rocks.
	Rhizocarpon obscuratum (Ach.) A.Massal.	Karadağ: 19, on silicious rocks.
#	*Rhizocarpon polycarpum* (Hepp) Th.Fr.	Şap: 2, on silicious rocks.
#	*Rhizocarpon subgeminatum* Eitner	Şap: 4, on silicious rocks.
	Rhizocarpon viridiatrum (Wulfen) Körb.	Karadağ: 19, on silicious rocks.
	Rimularia insularis (Nyl.) Rambold & Hertel	Şap: 10, on silicious rocks.
	Tephromela atra (Huds.) Hafellner	Şap: 9, 10, on silicious rocks; Karadağ: 13, 19, 30, 32, 34, 35, on silicious rocks.
#	*Trapelia involuta* (Taylor) Hertel	Karadağ: 32, on silicious rocks.
*#	*Trapelia obtogens* (Th.Fr.) Hertel	Karadağ: 32, on silicious rocks.
	Umbilicaria crustulosa *(Ach.) Frey*	Şap: 5, 9, 10, on silicious rocks; Karadağ: 21, on silicious rocks.
#	*Umbilicaria nylanderiana* (Zahlbr.) H.Magn.	Şap: 10, 11, on silicious rocks.
#	*Umbilicaria polyphylla* (L.) Baumg.	Şap: 10, on silicious rocks.
#	*Verrucaria muralis* Ach.	Şap: 10, on silicious rocks.
	Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	Karadağ: 13, 19, 26, 27, 33, on silicious rocks.
	Xanthoparmelia somlensis (Gyeln.) Hale	Karadağ: 29, 22, 31, 35, on silicious rocks ; Şap: 10, silicious rocks.
	Xanthoparmelia tinctina (Maheu & A.Gillet) Hale	Şap, 11, on silicious rocks; Karadağ: 19, on silicious rocks
	Xanthoria parietina (L.) Th.Fr.	Şap: 2, 4, 10, on *Quercus* sp.; Karadağ: 15, 31, on *Quercus* sp.

Ecological data

Seven factors according to Wirth (2001) have been used to test the differences between the lichen floras of Şap and Karadağ Mountains, namely light, temperature, continentality, moisture, pH of substratum, nutrification and toxitolerance. Only epiphytic lichens have been used in the final analysis since 41.2% of the non-epiphytic species of the area do not have indicator values (cf. Wirth 2001); preliminary analysis of those non-epiphytic lichens which did have indicator values did not show a significant difference between the two lichen floras.

The results of the analysis of the epiphytic lichens provided in Figures 3-9 are expressed as a percentage of the total number of species on each mountain for which indicator values are available. Although temperature showed no apparent difference (Figure 4), all of the other factors analysed revealed significant differences between the two floras.

Indicator values

Light

In the case of light (Figure 3), there is a distinct switch in the percentage ratios between values 5 and 6, the lower values (5 and less) demonstrating that there are more shade-loving lichens on Karadağ and the higher values (6 and more) showing the increase in light-demanding species on Şap.

Temperature

Temperature is the only environmental factor which shows no apparent difference in the two localities studied (Figure 4).

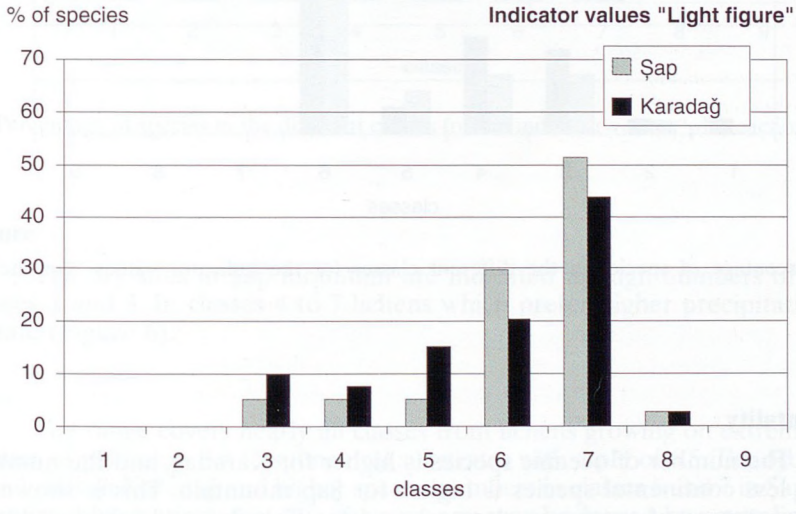

Fig. 3. Percentage of species in the different classes for the indicator values "light figure".

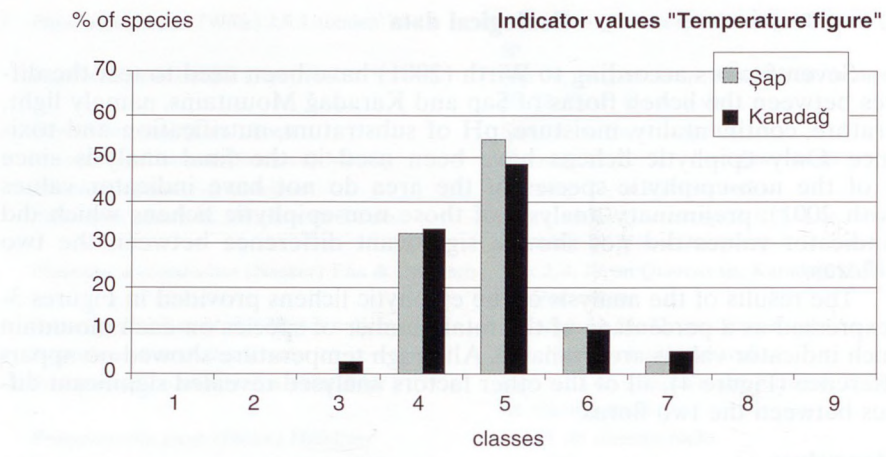

Fig. 4. Percentage of species in the different classes for the indicator values "temperature figure".

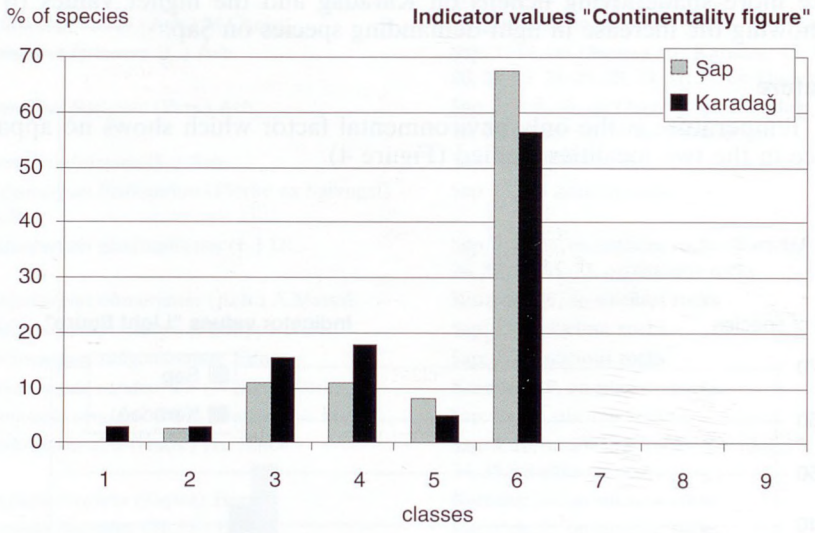

Fig. 5. Percentage of species in the different classes for the indicator values "continentality figure".

Continentality

The number of oceanic species is higher for Karadağ, and the number of more or less continental species is higher for Şap mountain. This is shown by a higher percentage of species in classes 1 to 4 for Karadağ and a higher percentage of species in classes 5 to 6 respectively for Şap mountain (Figure 5).

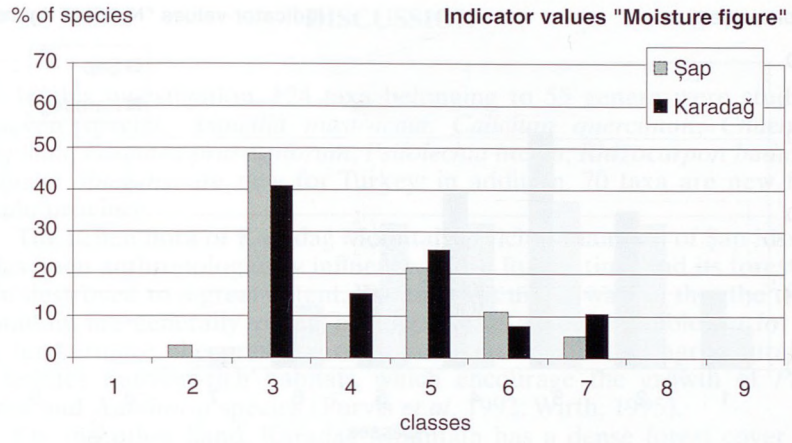

Fig. 6. Percentage of species in the different classes for the indicator values "moisture figure".

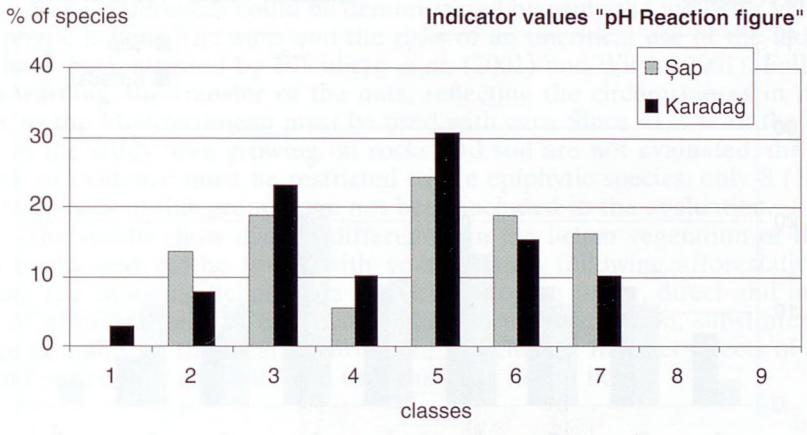

Fig. 7. Percentage of species in the different classes for the indicator values "pH reaction figure".

Moisture

The dry sites in Şap mountain are indicated by high numbers of species in classes 2 and 3. In classes 4 to 7 lichens which prefer higher precipitation predominate (Figure 6).

pH

The range covers nearly all classes from lichens growing on extremely acid substrates of pH below 3.4 to subneutral substrates with a pH of 6.5. The occurrence of class 1 only in Karadağ and higher species numbers in classes 6 and 7 in Şap mountain confirm observations that this phenomenon may be caused by neutralization of acid bark in Şap mountain due to the influence of agricultural activities (Figure 7).

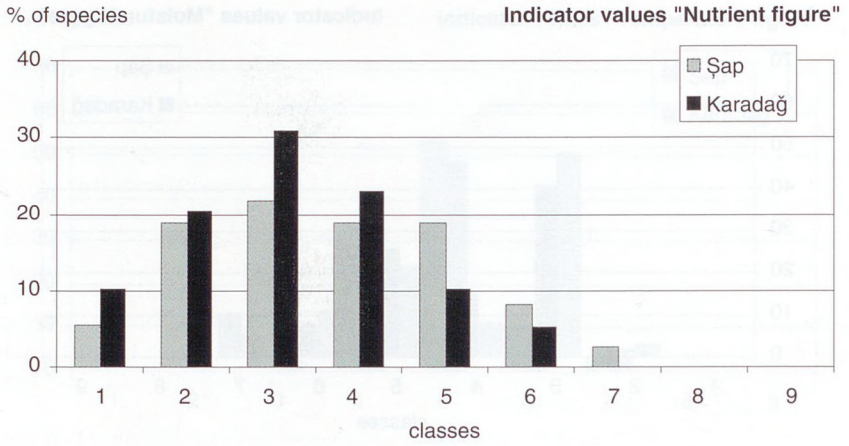

Fig. 8. Percentage of species in the different classes for the indicator values "nutrient figure".

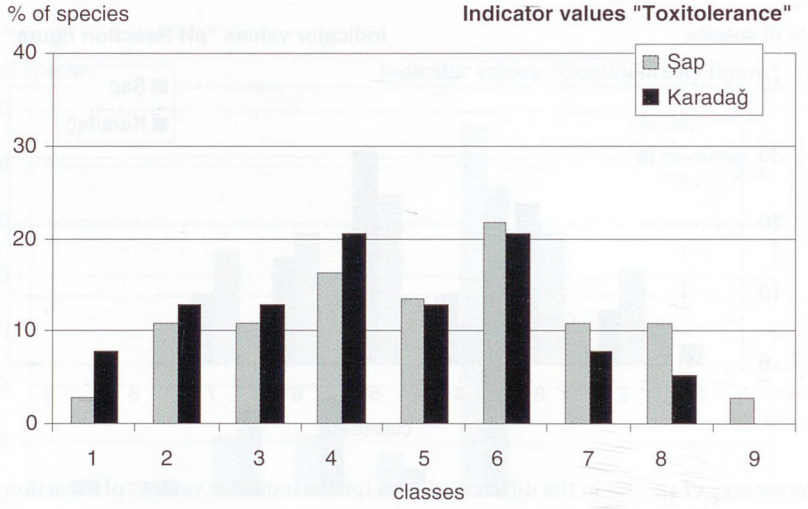

Fig. 9. Percentage of species in the different classes for the indicator values "toxitolerance".

Nutrients

Classes 1 to 4 predominate for Karadağ, the lichens living on bark poor in minerals or at best moderately rich in minerals and with no or very low eutrophication. Those lichens in classes 5 to 7 on bark rich in minerals and moderately impregnated with dust rich in nutrients prevail for Şap mountain (Figure 8).

Toxitolerance

Classes 1 to 4, namely sensitive species with very low to intermediate toxitolerance, clearly predominate at Karadağ, but classes 5 to 9, lichens with moderately to very high tolerance, are prevalent on Şap mountain (Figure 9).

DISCUSSION

In this investigation, 124 taxa belonging to 55 genera were studied, of which seven species, *Aspicilia mastrucata*, *Calicium quercinum*, *Chaenotheca phaeocephala*, *Fuscidea praeruptorum*, *Psilolechia lucida*, *Rhizocarpon badioatrum* and *Trapelia obtegens*, are new for Turkey; in addition, 70 taxa are new for the Çanakkale province.

The lichen flora of Karadağ Mountain is richer than that of Şap Mountain which has been anthropologically influenced for a longer time and its forest cover has been destroyed to a great extent. Plantation is under way, so that the trees on Şap Mountain are generally young, but their barks are not suitable yet for lichen growth; furthermore, the presence of human settlements and agricultural fields nearby creates nutrient-rich habitats, which encourage the growth of *Physcia*, *Physconia* and *Xanthoria* species (Purvis *et al.* 1992; Wirth, 1995).

On the other hand, Karadağ Mountain has a dense forest cover of old trees, as well as decayed trunks, which provides a shaded and humid habitat for lichens such as *Calicium* spp., *Chaenotheca* spp., *Chrysothrix candelaris* and *Lobaria pulmonaria*, which are good indicators of that type of habitat (Purvis *et al.* 1992; Wirth, 1995).

These differences could be demonstrated by using the indicator values of the epiphytic lichens. The aims and the risks of an uncritical use of the indicator values have been stressed by Ellenberg *et al.* (2001) and Wirth (2001). Following Wirth's warning, the transfer of the data, reflecting the circumstances in middle Europe, to the Mediterranean must be used with care. Since 41,2 % of the lichen species in the study area growing on rocks and soil are not evaluated, the interpretation of evidence must be restricted to the epiphytic species; only 8 (14,5%) of the 55 species in this group have not been included in the evaluation.

The results show distinct differences in the lichen vegetation of the old growth forest and of the forest with young stands following afforestation. By observing the changing lichen flora in the developing forest, direct and indirect effects of afforestation can be documented, since precipitation, substrates, light and continentality of the local environment will change. Indirect effects of settlement and agriculture also will lead to a changing lichen flora.

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