

## A new bryophyte community and three new records for the epiphytic bryophyte vegetation of Turkey \*

Mevlüt ALATAŞ<sup>1\*</sup>, Güray UYAR<sup>2</sup>

<sup>1</sup>Department of Bioengineering, Faculty of Engineering, Munzur University, Tunceli, Turkey

<sup>2</sup>Department of Biology, Polatlı Faculty of Science and Arts, Gazi University, Ankara, Turkey

Received: 10.11.2016 • Accepted/Published Online: 09.02.2017 • Final Version: 24.05.2017

**Abstract:** Based on 38 relevés, the *Lewinskyetum affinis* ass. nov. (*Ulotion crispae* alliance) was described and characterized as a new epiphytic association from the Abant Mountains (Northwest Turkey). To the best of our knowledge, this is the first report about three epiphytic bryophyte associations, namely *Dicranetum taurici*, *Pterigynandretum filiformis*, and *Orthotricho straminei*-*Pterigynandretum filiformis*, in Turkey. In addition, multivariate analysis techniques such as two-way indicator species analysis (TWINSPAN) and detrended correspondence analysis (DECORANA) were used to examine epiphytic bryophyte communities for cluster analysis and ordination analysis, respectively.

**Key words:** Abant Mountains, bryophyte, Bolu, epiphytic vegetation, Turkey

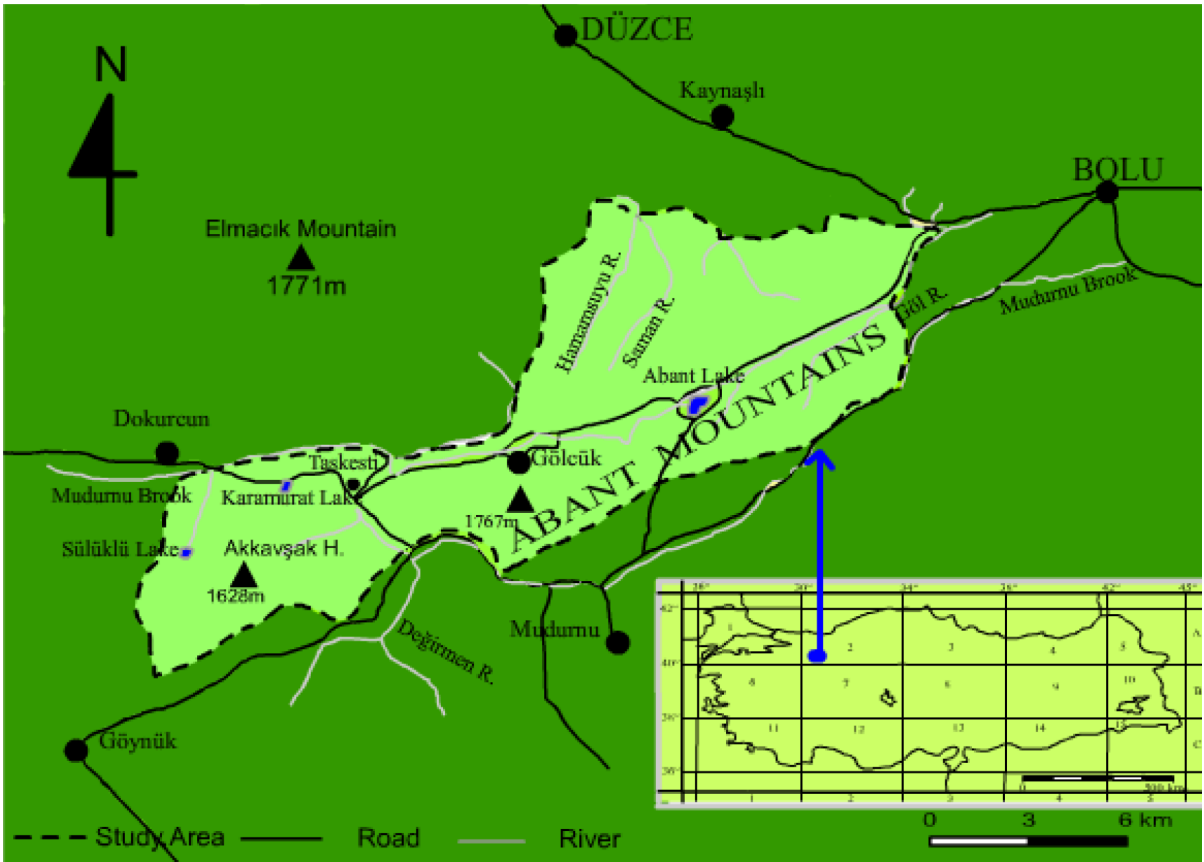
### 1. Introduction

Plants are divided into two main groups. The largest group contains the plants that produce seeds. These are flowering plants (angiosperms) and conifers, Ginkgos, cycads, Gnetum, Ephedra, and Welwitschia (gymnosperms). The other group contains seedless plants, which reproduce by spores. It includes liverworts, hornworts, mosses, whisk ferns, club mosses, horsetails, and ferns (Bidlack and Jansky, 2011). Unfortunately, tracheophytes such as flowering plants and ferns were studied as priority groups by Turkish botanists until the last part of the 1980s, as their greater size than that of bryophytes makes them more visible. In fact, most mosses and liverworts, like other small plants, seem very alike until they are examined closely. Despite their small size and simple structures, bryophytes can survive under a wide variety of environmental conditions, growing in forests, wetlands, and terrestrial and rock habitats. Furthermore, they often form a strong part of the ecosystems where they appear. It is known that when habitat diversity increases it also becomes possible for diverse plant taxa to emerge, including bryophytes, along with the development of ecologically specialized plant communities. Thus, in our view, the forest areas in Turkey should be chosen as priority areas for bryophyte vegetation studies. For this reason, the Abant Mountains were selected as the research study area; they are 34 km southwest of the city of Bolu, have rich plant cover, and

represent a very special region for the ecology of Turkey (Figure 1). Moreover, no previous information about epiphytic bryophyte vegetation in this area has been published. On account of this gap in the literature, this study contributes to the field by providing a catalogue of the epiphytic taxa and describes the communities that grow on tree trunks.

In the literature summary about Turkish epiphytic bryophyte vegetation studies, apparently 16 syntaxa have been determined. These epiphytic bryophyte associations are given as follows: *Orthotricho franzoniani*-*Antitrichietum breidlerianae* Walther 1969 (Walther and Leblebici, 1969; Walther, 1979), *Scorpiurio sendtneri*-*Zygodontetum vulgaris* Walther 1975 (Walther, 1975), *Scorpiurio sendtneri*-*Zygodontetum vulgaris*, -*cinclidotosum mucronati* Kürschner 1998 (Kürschner et al., 1998), *Brachythecio olympici*-*Dicranoweisietum cirratae* Walther 1969 (Walther and Leblebici, 1969; Kürschner, 1999), *Orthotrichetum lyellii* Lecoq 1975 (Walther, 1979), *Orthotrichetum striati* (Gams, 1927) Marst. 1985 (Kürschner et al., 2006), *Anomodonto-Leucodontetum sciuroidis*, -*palamocladietosum euchloronis* Kürschner & Düzenli 2009 (Düzenli et al., 2009), *Palamocladio euchloronis*-*Leucodontetum immersi* Kürschner, Kırmacı & Parolly 2012, *neckeretosum crispae* Kürschner, Kırmacı & Parolly 2012 and *Pseudoleskeello nervosae*-*Leucodontetum immersi* Kürschner, Kırmacı & Parolly 2012 (Kürschner et

\* Correspondence: mevlutalatas@hotmail.com



**Figure 1.** Grid system of Turkey adopted by Henderson (1961) and the boundaries of the study area.

al., 2012), *Plagiothecium neglecti* Ricek 1968, *Pylaisietum polyanthae* Felf. 1941 –*lophocoleotum heterophyllae* Kara, Ezer & Alataş 2015 (Alataş et al., 2015), *Leptodonto smithii*–*Leucodontetum sciuroidis* Priv. & Pug. 1997, *Cryphaetum arborae* Barkman 1958, –*orthotrichetum diaphani* Lecoite 1975 (Alataş et al., 2016).

### 1.1. Research area

The Abant Mountains have a surface area of 67.315 ha and are located between 31°12' eastern longitude and 40°04' northern latitude. According to Henderson's (1961) Turkish grid system, this area is within the square A2. At the same time, this mountain chain is one of the 122 important plant areas identified by the World Wide Fund for Nature (WWF) and formed on limestone ridges during the Kretase–Jura periods. Furthermore, this region seems to be in the euxine part of the Euro-Siberian phytogeographic region between the submontane and montane zones. Such transitional zones have interesting characteristics, with pure and mixed forests of broad-leaved and coniferous species. The submontane zone is distinguished mainly by *Fagus orientalis* Lipsky and *Carpinus betulus* L. dominated forests, and above these forests, a distinctive montane zone is seen with *Pinus sylvestris* L., *Abies nordmanniana* (Stev.)

Spach. subsp. *bornmuelleriana* (Mattf.) Coode & Cullen, and *Ostrya carpinifolia* Scop. mixed forests. Generally, pure *Quercus cerris* L. forests occur on southern aspects at lower altitudes (800–1200 m). The height of the area ranges between 1000 m and 1784 m, where many large or small streams are located, as well as a few medium-sized lakes, including Abant Lake, Sülüklü Lake, Karamurat Lake, and Mudurnu Stream (Özhatay et al., 2005).

The study area has semiarid and humid regions under the influence of the Mediterranean climate, where the average annual precipitation is 543.2 mm and the maximum amount of rainfall occurs in the spring. The average annual temperature is 10.42 °C. When the average temperature is between 1 and 5 °C, excessive snowfall can be observed in the region during December and March (TSMS, 2010). According to this climatic information, Bolu Province exhibits Eastern Mediterranean Precipitation type 1 (Akman, 2011).

### 2. Materials and methods

The bryophyte vegetation of the study area was studied and evaluated using the plant sociology methods of Braun-Blanquet (1964) according to the following scale: +

(<1%), 1 (1.1%–6.0%), 2 (6.1%–12.0%), 3 (12.1%–25.0%), 4 (25.1%–50.0%), 5 (50.1%–100%) (Frey and Kürschner, 1991). One hundred and ninety-four plots were selected depending on the minimal area concept from different localities and habitats (Table 1). In addition, multivariate analysis techniques such as two-way indicator species analysis (TWINSPAN; Hill, 1979b) and detrended correspondence analysis (DECORANA; Hill, 1979a) were used for cluster analysis and ordination analysis, respectively.

The materials of the study were collected from tree trunks, which were divided into two parts, namely a basal zone (10–100 cm above the ground) and an upper zone (100–200 cm). Plant associations were arranged by diagnostic species (Braun-Blanquet, 1964) and named according to Weber et al. (2000).

In the present study, the determination of the associations was carried out via comparison with related associations in Marstaller (2006) and classified with

the aid of published studies. For the identification of the bryophyte samples, different floras, monographies, and revisions were used (Nyholm, 1981; Hedenäs, 1992; Zander, 1993; Paton, 1999; Cortini Pedrotti, 2001, 2006; Heyn and Herrstadt, 2004; Smith, 2004; Frey et al., 2006; Guerra and Cros, 2007; Casas et al., 2009; Kürschner and Frey, 2011; Plášek et al., 2015; Lara et al., 2016).

### 3. Results and discussion

In this study, 194 phytosociological relevés, eight epiphytic bryophyte associations, and one subassociation were determined as a result of the examination. In accordance with the literature information given above, this is the first report of three epiphytic bryophyte associations, namely *Dicranetum taurici* Neu ex v. Hübschm. 1978, *Pterigynandretum filiformis* Hil. 1925, and *Orthotricho straminei-Pterigynandrum filiformis* Gillet 1986, in Turkey. Moreover, *Lewinskyetum affinis* as a new association was described and classified in the study. Floristic and

**Table 1.** The list of localities.

Station no.	Altitude (m)	Localities	Date	GPS coordinates	Number of relevés
1	1250	Karapınar Kavağı District	07.04.2011	N 40°32'59.2" E 031°06'29.3"	2, 3, 4, 8, 7, 9, 10, 12, 13, 14, 15, 16, 18, 19
2	1102	Edge of Sülüklü Lake	08.04.2011	N 40°31'20.9" E 030°52'33.4"	26
3	1074	Road of Sülüklü Lake	08.04.2011	N 40°31'20.1" E 030°52'38.9"	29, 32, 34, 30, 35, 39, 40, 41
4	1450	Abant Second Forest Depot District	15.06.2011	N 40°38'39.0" E 031°18'53.3"	82, 83, 84, 85, 86, 87, 88, 75, 76, 77, 78, 79
5	1410	Erelti Plateau	15.06.2011	N 40°38'59.9" E 031°19'11.8"	92, 93, 94, 95, 96, 97, 98, 110
6	1380	Erelti Plateau	15.06.2011	N 40°38'58.9" E 031°20'38.7"	104, 107
7	1366	Abant-Taşkesti District	06.07.2011	N 40°36'20.5" E 031°14'02.9"	111, 113, 114, 115, 116, 117, 119
8	1235	Elmacık District	06.07.2011	N 40°36'12.9" E 031°13'09.5"	120, 123, 124
9	940	Abant - Taşkesti District	06.07.2011	N 40°35'46.1" E 031°11'10.2"	126, 129
10	1411	Sinekli Plateau	07.07.2011	N 40°38'14.0" E 031°17'00.0"	143, 144, 146, 147, 148, 149, 150
11	1415	Çakırsayvan District	07.07.2011	N 40°39'52.5" E 031°17'43.0"	160, 161, 162, 164, 165, 166
12	1550	Yeni yurt Plateau	07.07.2011	N 40°39'23.8" E 031°18'19.2"	168, 169, 170
13	1450	Samat Plateau	08.07.2011	N 40°36'56.5" E 031°19'07.2"	175
14	1420	Samat Plateau	08.07.2011	N 40°37'03.5" E 031°19'13.7"	176
15	755	Güveytepe Village	16.09.2011	N 40°31'39.2" E 031°03'17.4"	186, 188
16	747	Taşkesti-Sülüklü Lake District	09.04.2011	N 40°34'05.4" E 030°58'08.9"	46, 48, 54, 55
17	1073	Kilözü District	14.06.2011	N 40°32'21.8" E 031°10'42.1"	61, 63, 64, 65, 66
18	1200	Sümeli-Delice Villages District	14.06.2011	N 40°33'32.0" E 031°12'20.2"	69
19	1120	Örencik Village road	14.06.2011	N 40°34'36.8" E 031°16'21.7"	71, 72
20	750	Gölcük road	06.07.2011	N 40°35'13.2" E 031°08'49.8"	131, 133, 134
21	680	Ekinören Village District	16.09.2011	N 40°32'16.9" E 031°01'48.0"	181,182,183,184
22	805	Güveytepe District	17.09.2011	N 40°29'05.4" E 031°01'14.0"	189, 190, 191
23	865	Ömerler District	18.09.2011	N 40°41'24.6" E 031°26'35.5"	194, 196
24	1005	Dipsizgöl District	18.09.2011	N 40°43'12.6" E 031°22'59.5"	200, 201

ecological features of these new syntaxa are given below by using Marstaller's (2006) sequence.

**Class:** *Cladonio digitatae-Lepidozietea reptantis* Jez. and Vondr. 1962

**Order:** *Cladonio digitatae-Lepidozietalia reptantis* Jez. and Vondr. 1962

**Alliance:** *Nowellion curvifoliae* Phil. 1965

**Association:** *Dicranetum taurici* Neu ex v. Hübschm. 1978

**Class:** *Neckeretea complanatae* Marst. 1986

**Order:** *Neckeretalia complanatae* Jez. and Vondr. 1962

**Alliance:** *Neckerion complanatae* Sm. and Had. ex Kl. 1948

**Associations:** *Pterigynandretum filiformis* Hil. 1925  
*Homalothecio sericei-Porelletum platyphyllae* Storm. ex Duda 1951

**Subassociation:** *-leucodontetosum sciuroidis* Marst. 1992

**Class:** *Frullanio dilatatae-Leucodontetea sciuroidis* Mohan 1978

**Order:** *Orthotrichetalia* Had. in Kl. and Had. 1944

**Alliance:** *Ulotion crispae* Barkm. 1958

**Associations:** *Orthotrichetum lyellii* All. ex Lec. 1975

*Orthotrichetum striati* (Gams 1927) Marst. 1985

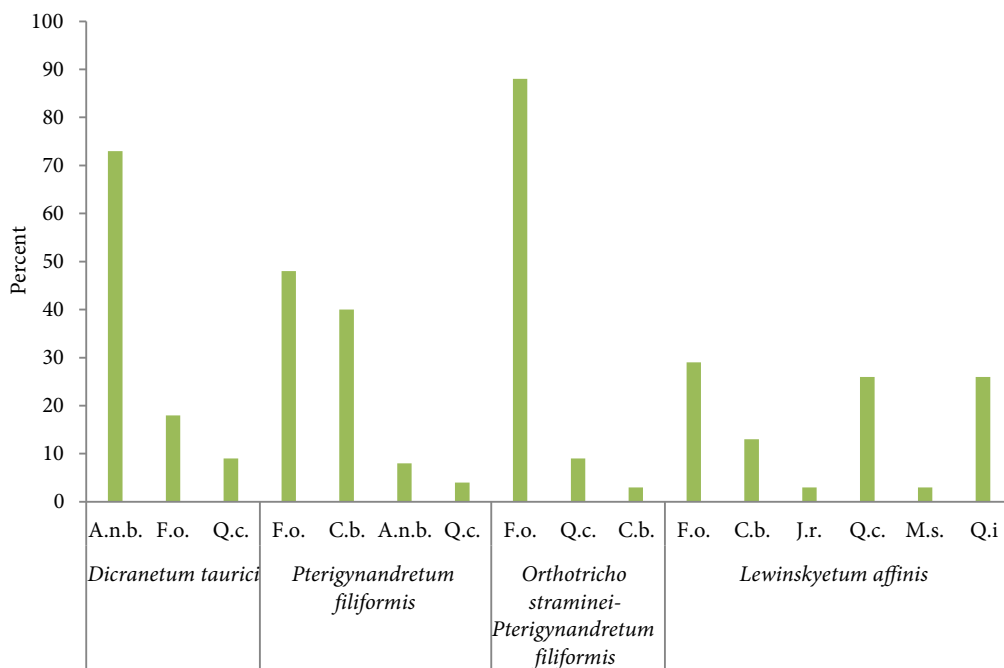
*Lewinskyetum affinis* ass. nova

*Orthotricho straminei-Pterigynandretum filiformis* Gillet 1986

*Pterigynandro filiformis-Orthotrichetum speciosi* Guerra 1982

**3.1. *Dicranetum taurici* Neu ex v. Hübschm. 1978 (Table 2)**  
*Dicranetum taurici* was first defined by Neu in 1963, and later reported by Hebrar (1973) under the name of *Tetraphido pellucidae-Orthodicranetum stricti*. With the changes in the syntaxonomic nomenclature, the association was reorganized by Hübschman (1978) under the name *Dicranetum taurici* Neu ex v. Hübschm. 1978 and introduced to the world of science (Marstaller, 2006).

The association was determined within the 11 relevés taken from the tree trunks. It was widespread between 1250 and 1450 m, especially on the northern slope of the study site. It grew frequently on old *Abies nordmanniana* subsp. *bornmuelleriana* (Figure 2). The number of taxa per sampling relevé in the association varied from 3 to 8. While the general covering of the association differed between 65% and 98%, the canopy closure of the vegetation was 80% to 100%. In addition, 2 of the 12 taxa that form the association were liverworts and the remaining taxa were mosses; two of the moss taxa were acrocarpous, while the other eight were pleurocarpous. The affinity of the acrocarpous and pleurocarpous rates showed that the association is a syntaxon with hygrophytic characteristics widespread in shady and humid habitats. The character species of the association was acrocarpous



The tree preferences of associations

**Figure 2.** The tree preferences of the syntaxa (A.n.b.: *Abies nordmanniana* subsp. *bornmuelleriana*, F.o.: *Fagus orientalis*, Q.c.: *Quercus cerris*, C.b.: *Carpinus betulus*, Q.i.: *Quercus infectoria*, J.r.: *Juglans regia*, M.s.: *Malus sylvestris*).

*Dicranum tauricum*, a mesophytic or xerophytic species in high mountain forests, showing a higher constancy (73%). According to the habitat affinity of the taxa within the association, indifferent taxa (46%) were dominant. Ratios of the epiphytics and facultative epiphytes were equal (27%) within the community (Figure 3).

Syntaxonomically, the association could be classified within the *Nowellion curvifoliae* alliance of the *Cladonio digitatae*-*Lepidozietalia reptantis* order and phytosociologically in the class *Cladonio digitatae*-*Lepidozietea reptantis* on wood and raw humus (Table 2).

### 3.2. *Pterigynandretum filiformis* Hil. 1925 (Table 3)

While in 1925, the association was defined as *Pterigynandretum filiformis* by Hilitzer, it was defined as epiphytic on beech trees by Goia and Schumaker (2004) in Romania. The association was determined within the 25 relevés on tree trunks. It was widespread between 1102 and 1450 m, especially on the northern and northwestern slopes of the study site. It was found to grow frequently on *Fagus orientalis* and *Carpinus betulus* (Figure 2).

The number of taxa per sampling relevé varied from three to six in the association. While the general covering of the association differed between 75% and 100%, the canopy closure of the vegetation shifted between 10% and 40%. Seven of the 25 taxa forming the association were liverworts, while 18 were mosses; 6 of the moss taxa were acrocarpous, while the other 12 taxa were pleurocarpous. The numbers of pleurocarpous taxa were higher than those of acrocarpous taxa within the association, but most of the

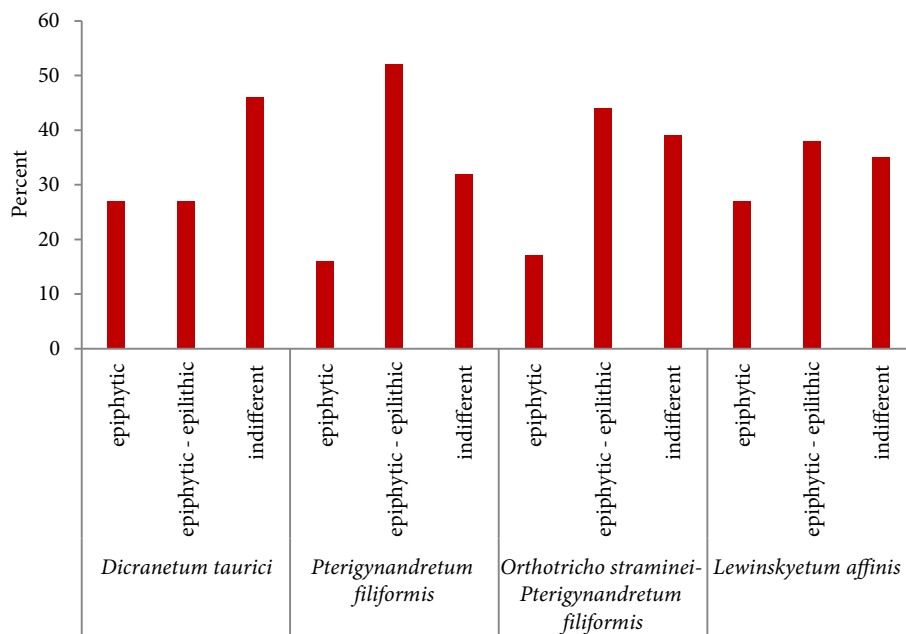
pleurocarpous taxa were xerophytic or mesophytic, such as *Pterigynandrum filiforme*, *Homalothecium sericeum*, and *Hypnum cupressiforme*. Therefore, this epiphytic community is widespread on humid lower and semiarid tree trunks on the northwestern slopes and in open areas of the Abant Mountains.

The character species of the community was pleurocarpous *Pterigynandrum filiforme*, which grows as an epiphytic or epilithic on mesophytic substrates, and showed the highest constancy (100%). In terms of the habitat affinity of the taxa within *Pterigynandretum filiformis*, epiphytic taxa comprised 16%, epiphytic/epilithic taxa represented 52%, and indifferent taxa made up 32% (Figure 3).

Syntaxonomically, the association could be classified within the alliance *Neckerion complanatae* of the order *Neckeratalia complanatae*. Higher-ranked character species, namely *Neckera complanata*, *Radula complanata*, and *Porella platyphylla*, supported the classification within the epiphytic/epilithic class *Neckeretea complanatae*, phytosociologically (Table 3).

### 3.3. *Orthotricho straminei*-*Pterigynandretum filiformis* Gillet 1986 (Table 4)

In 1928, the association was defined as *Ulotetum crispae* by Ochsner. With the changes occurring in the syntaxonomic nomenclature, the association was reorganized and defined as *Orthotricho straminei*-*Pterigynandretum filiformis* Gillet 1986 and introduced to the world of science by Gillet (1986).



The habitat affinities of the species of associations

**Figure 3.** The habitat affinities spectrum of the species of syntaxa.

**Table 2.** *Dicranetum taurici* Neu ex v. Hübschm. 1978.

Number of sampling area	82	83	76	78	84	86	87	88	85	15	79	Frequency	
Altitude (m)	1450	1450	1450	1450	1450	1450	1450	1450	1450	1250	1450		
Size of sampling area (dm <sup>2</sup> )	12	20	77	20	30	10	9	30	8	20	60		
Phorophyte	F.o.	F.o.	A.n.b.	A.n.b.	A.n.b.	A.n.b.	A.n.b.	A.n.b.	A.n.b.	Q.c.	A.n.b.		
Trunk (m)	0.9	2.2	1.9	1.8	1.6	1.8	1.4	2.0	2.0	1.4	1.9		
Exposition	N	N	N	N	N	N	N	N	N	NE	N		
Position of sampling area	NE	NE	N	NE	NE	N	N	N	NE	SE	NE		
Covering (%)	65	83	98	95	98	98	89	93	93	93	73		
Canopy closure of vegetation (%)	100	100	100	100	100	100	100	100	100	80	100		
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	B	T		
Number of species	3	6	6	4	6	5	8	7	6	4	4		
ChAss.													
<i>Dicranum tauricum</i>	3	3	5	4	5	5	4	4	.	.	.		8
ChAll. <i>Nowellion curvifoliae</i>													
<i>Lophocolea heterophylla</i>	.	.	1	.	3	1	1	1	1	.	.	6	
Ch.Cl. <i>Cladonio digitatae</i> - <i>Lepidozietea reptantis</i> and ChO. <i>Cladonio digitatae</i> - <i>Lepidozietalia reptantis</i> order													
<i>Cladonia</i> sp.	2	1	2	3	3	2	1	1	2	1	1	11	
<i>Plagiothecium curvifolium</i>	.	.	.	.	.	.	.	2	.	.	.	1	
Others													
<i>Pterigynandrum filiforme</i>	4	4	1	3	1	2	3	3	3	5	4	11	
<i>Radula complanata</i>	.	1	.	.	1	.	1	1	1	3	2	7	
<i>Hypnum cupressiforme</i>	.	.	1	2	2	1	1		4	.	.	6	
<i>Dicranum scoparium</i>	.	.	1	.	.	.	1	.	3	.	.	3	
<i>Neckera complanata</i>	.	.	.	.	.	.	.	1	.	.	.	1	
<i>Isothecium myosuroides</i>	.	2	.	.	.	.	.	.	.	.	.	1	
<i>Isothecium alopecuroides</i>	.	.	.	.	.	.	2	.	.	.	.	1	
<i>Sanionia uncinata</i>	.	1	.	.	.	.	.	.	.	.	.	1	
<i>Homalothecium sericeum</i>	.	.	.	.	.	.	.	.	.	3	.	1	
Lichens													
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	.	.	.	2	1	

A.n.b.: *Abies nordmanniana* subsp. *bornmuelleriana*, F.o.: *Fagus orientalis*, Q.c.: *Quercus cerris*.

*Orthotricho straminei*–*Pterigynandretum filiformis* was determined within the 29 relevés taken from tree trunks. It was widespread between 755 and 1550 m, especially on the northern slopes of the study site. This association frequently grew on old *Fagus orientalis* (Figure 2).

The number of taxa per sampling relevé varied in the association from 4 to 10 (the average number of taxa was 7). While the general covering of the association differed between 80% and 98%, the canopy closure of the vegetation was between 10% and 100%. Five of the 18 taxa forming the association were liverworts, while 13 were mosses; four of the moss taxa were acrocarpous and the

other nine were pleurocarpous. The epiphytic community, with its mesophytic/xerophytic characteristics, grows on semiarid and less humid upper parts of tree trunks.

The character species of the association was pleurocarpous *Pterigynandrum filiforme* with 100% constancy and co-dominant *O. stramineum*, an acrocarpous species in open woodlands, with the highest constancy (100%). According to the habitat affinity of the taxa within the association, epiphytic/epilithic (facultative epiphyte) taxa were dominant, at 45%. These were followed by indifferent taxa (39%) and epiphytic taxa (17%; Figure 3).

**Table 3.** *Pterigynandretum filiformis* Hil. 1925.

Number of sampling area	2	3	4	8	9	12	13	14	16	26	29	32	34
Altitude (m)	1250	1250	1250	1250	1250	1250	1250	1250	1250	1102	1074	1074	1170
Size of sampling area (dm <sup>2</sup> )	33	36	18	22	60	21	36	20	24	54	36	20	50
Phorophyte	F.o	F.o	F.o	F.o	F.o	C.b	C.b	C.b	Q.c	C.b	C.b	C.b	C.b
Trunk (m)	0.7	3.0	3.0	1.6	1.2	2.0	1.8	1.0	1.2	2.3	3.2	2.5	2.6
Exposition	NE	NE	NE	NE	NE	NE	NE	NE	NE	N	NE	NE	S
Position of sampling area	N	N	NE	E	E	S	S	E	S	S	W	W	E
Covering (%)	85	95	100	90	95	75	95	85	80	97	95	100	90
Canopy closure of vegetation (%)	30	30	30	35	40	30	40	30	30	30	10	30	30
Base (B)/Trunk (T)	B	T	T	T	T	T	B	B	B	B	B	B	T
Number of species	5	4	4	5	4	5	4	3	4	5	4	3	6
ChAss.													
<i>Pterigynandrum filiforme</i>	5	3	3	1	3	1	3	2	1	2	2	2	3
ChAll. <i>Neckerion complanatae</i>													
<i>Metzgeria furcata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anomodon viticulosus</i>	.	.	.	.	.	.	.	.	.	5	.	.	.
Ch.Cl. <i>Neckeretea complanatae</i> and ChO. <i>Neckeratalia complanatae</i>													
<i>Neckera complanata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Radula complanata</i>	1	.	.	3	.	.	.	.	1	.	.	.	.
<i>Homalothecium sericeum</i>	1	.	.	.	1	.	2	.	3	1	5	.	.
<i>Porella platyphylla</i>	.	1	4	5	.	3	.	4	.	.	.	.	2
<i>Orthotrichum pumilum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
Others													
<i>Leucodon sciuroides</i>	2	4	4	.	3	4	.	.	.	1	1	.	5
<i>Radula lindbergiana</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Frullania tamarisci</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ulota crispa</i>	.	.	.	.	.	1	.	.	.	.	.	.	.
<i>Frullania dilatata</i>	.	.	.	1	.	.	.	.	.	.	.	.	.
<i>Orthotrichum tenellum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Brachytheciastrum velutinum</i>	.	.	.	.	.	.	.	3	5	.	.	.	.
<i>Isothecium alopecuroides</i>	.	.	.	.	.	.	5	.	.	.	.	5	.
<i>Hypnum andoi</i>	.	.	.	.	.	.	.	.	.	.	.	3	.
<i>Plagiothecium nemorale</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Antitrichia curtipendula</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Syntrichia ruralis</i>	1	3	1	.	5	2	.	.	.	2	3	.	1
<i>Bryum moravicum</i>	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Orthotrichum anomalum</i>	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Homalothecium lutescens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Porella cordaena</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
Lichens													
<i>Lobaria pulmonaria</i>	.	.	.	1	.	.	2	.	.	.	.	.	.
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Peltigera praetextata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.

F.o.: *Fagus orientalis*, Q.c.: *Quercus cerris*, C.b.: *Carpinus betulus*.

Table 3. (Continued).

Number of sampling area	35	39	40	41	77	104	115	117	120	162	165	175	Frequency	
Altitude (m)	1170	1170	1170	1170	1450	1380	1366	1366	1235	1415	1415	1450		
Size of sampling area (dm <sup>2</sup> )	63	21	35	28	63	88	45	60	18	40	12	18		
Phorophyte	C.b	A.n.b	C.b	C.b	A.n.b	F.o	F.o	F.o	F.o	F.o.	F.o.	F.o.		
Trunk (m)	2.7	0.6	2.0	1.6	2.1	3.5	1.6	1.9	1.0	3.4	1.6	1.9		
Exposition	S	S	S	S	N	N	N	N	N	N	N	N		
Position of sampling area	W	NW	NW	E	NE	N	E	N	NE	N	NW	N		
Covering (%)	77	100	85	84	71	93	91	95	93	98	80	73		
Canopy closure of vegetation (%)	10	20	10	20	100	0	100	100	80	70	70	80		
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	T		
Number of species	5	5	4	5	7	7	6	7	8	9	5	5		
ChAss.														
<i>Pterigynandrum filiforme</i>	1	2	5	1	4	1	4	4	1	4	3	3		25
ChAll. <i>Neckerion complanatae</i>														
<i>Metzgeria furcata</i>	.	3	.	.	1	.	4	2	4	1	2	.	7	
<i>Anomodon viticulosus</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
Ch.Cl. <i>Neckeretea complanatae</i> and ChO. <i>Neckeratalia complanatae</i>														
<i>Radula complanata</i>	.	3	.	.	1	.	1	2	2	1	.	1	10	
<i>Porella platyphylla</i>	1	.	1	.	.	1	.	.	.	.	.	4	10	
<i>Homalothecium sericeum</i>	2	.	.	1	.	.	.	.	.	.	.	.	8	
<i>Orthotrichum pumilum</i>	1	.	.	.	.	3	1	1	1	1	.	1	7	
<i>Neckera complanata</i>	.	4	1	5	1	.	.	.	.	3	.	.	5	
<i>Hypnum cupressiforme</i>	.	.	.	.	.	1	.	.	.	.	.	.	1	
Others														
<i>Leucodon sciuroides</i>	5	.	.	3	.	4	.	.	.	2	.	.	12	
<i>Syntrichia ruralis</i>	.	.	.	.	.	.	.	.	.	.	.	.	8	
<i>Frullania dilatata</i>	.	2	.	.	3	3	.	3	.	.	.	2	6	
<i>Isothecium alopecuroides</i>	.	.	3	.	.	.	+	.	.	.	.	.	4	
<i>Bryum moravicum</i>	.	.	.	.	.	1	.	.	.	1	.	.	3	
<i>Brachytheciastrum velutinum</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	
<i>Radula lindbergiana</i>	.	.	.	.	.	.	.	.	.	.	1	.	1	
<i>Frullania tamarisci</i>	.	.	.	.	.	.	.	.	.	1	.	.	1	
<i>Ulotia crispa</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Orthotrichum tenellum</i>	.	.	.	.	1	.	.	.	.	.	.	.	1	
<i>Hypnum andoi</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Plagiothecium nemorale</i>	.	.	.	.	.	.	.	.	.	1	.	.	1	
<i>Antitrichia curtipendula</i>	.	.	.	.	.	.	.	.	.	.	4	.	1	
<i>Orthotrichum anomalum</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Homalothecium lutescens</i>	.	.	.	.	.	.	3	.	.	.	.	.	1	
<i>Porella cordaena</i>	.	.	.	.	.	.	.	.	2	.	.	.	1	
Lichens														
<i>Lobaria pulmonaria</i>	.	.	.	1	2	.	.	3	2	.	.	.	6	
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	.	1	.	2	.	2	
<i>Peltigera praetextata</i>	.	.	.	.	.	.	.	2	2	.	.	.	2	

A.n.b.: *Abies nordmanniana* subsp. *bornmuelleriana*, F.o.: *Fagus orientalis*, C.b.: *Carpinus betulus*.



Syntaxonomically, the association could be classified within the alliance *Ulotion crispae* of the order *Orthotrichetalia*. Higher-ranked character species *Frullania dilatata*, *Radula complanata*, and *Leucodon sciuroides* supported phytosociological classification within the epiphytic class *Frullanio dilatatae–Leucodontetea sciuroidis*, which is widespread in the northern hemisphere (Table 4).

**3.4. *Lewinskyetum affinis* Alataş & Uyar ass. nova. (Table 5)**  
Holotypus: Prov. Bolu, Abant Mountains, 940 m, *Fagus orientalis* forest, tab. 7, no. 126.

Differential species: *Lewinskya affinis* (Lara et al., 2016).

The new association frequently occurred epiphytically on the less humid upper parts of the trunks of trees. Physiognomically, this association involved a mix of pleurocarpous and small cushions of acrocarpous species. This represents the first such report from the Abant Mountains (Bolu, Turkey). This new association especially occurred epiphytically on the tree trunks of semishade and mesic environments of the Abant Mountains. The differential species was *Lewinskya affinis*, which showed acidophytic/subneutrophytic and mesophytic characteristics and is widespread in the Abant Mountains (680–1415 m).

The new association was determined within the 38 relevés taken from tree trunks. It was widespread between 680 and 1415 m, especially on the northern and southern slopes of the study site. It grew frequently on *Fagus orientalis* and *Quercus* sp. (Figure 2).

The number of taxa per sampling relevé varied in the new association from 3 to 11. While the general covering of the new association differed between 65% and 100%, the canopy closure of the vegetation shifted between 10% and 100%. Five of the 26 taxa forming the association were liverworts, while 21 were mosses; 10 of the moss taxa were acrocarpous and the other 11 were pleurocarpous. The mesophytic and xerotolerant characteristics of the species composing the association made it possible to find them in mesic habitats and generally on the upper parts of the trees.

According to the habitat affinity of the taxa within the association, facultative epiphytes (38%) were dominant. These were followed by indifferent taxa (35%) and

epiphytic taxa (27%; Figure 3). Syntaxonomically, the new association could be classified within the alliance *Ulotion crispae* of the order *Orthotrichetalia*. Higher-ranked character species, such as *Leucodon sciuroides*, *Frullania dilatata*, *Homalothecium sericeum*, and *Radula complanata*, supported the classification within the class *Frullanio dilatatae–Leucodontetea sciuroidis* (Table 5).

### 3.5. Analysis of epiphytic bryophytes vegetation with multivariate methods

The determination of numerical distinguishing species and the correspondingly attached groups was done by indicator type analysis method; results from the TWINSpan program are shown in Figure 4. In addition, Figure 5 indicated plots that come together to introduce unions (groups) by using DECORANA software, which contains a unifying analysis method.

After using Community Analysis Package version 3.2 software, which contains DECORANA and TWINSpan analysis methods, nine groups are separated due to indicator species analysis (TWINSpan) (Figure 4).

In these groups, it was determined that while in groups 2, 3, and 4 syntaxa belong to the class *Neckereta complanatae*, which has a humid character, the syntaxa in groups 5, 6, 7, 8, and 9 belong to the class *Frullanio dilatatae–Leucodontetea sciuroidis*, having a xeric character. In addition, the syntaxa in group 1 belong to the class *Cladonio digitatae–Lepidozietea reptantis*, also showing a xeric character.

The proximity of the plots that constitute the above groups was shown on the two-dimensional diagram of DCA according to axis 1 and 2 abscissa-ordinate system (Figure 5). The first axis of the diagram was divided into 3 classes depending on the humidity, and the tags that belong to these classes are *Ulotion crispae* (*Frullanio dilatatae–Leucodontetea sciuroidis*), *Neckerion complanatae* (*Neckereta complanatae*), and *Nowellion curvifoliae* (*Cladonio digitatae–Lepidozietea reptantis*). On the axis 2 there was no distinction depending on ecological factors.

### Acknowledgments

This work was supported by the Research Fund of Bülent Ecevit University under Grant Project Number: 2011-10-06-06.

**Table 4.** *Orthotricho straminei*-*Pterigynandretum filiformis* Gillet 1986.

Number of sampling area	93	94	96	97	107	146	148	168	176	144	75	98	123	164	124	143
Altitude (m)	1410	1410	1410	1410	1380	1411	1411	1550	1420	1411	1450	1410	1235	1415	1235	1411
Size of sampling area (dm <sup>2</sup> )	81	63	40	35	88	45	40	28	21	48	60	63	18	28	35	63
Phorophyte	F.o	F.o	F.o	F.o	F.o	F.o.	F.o.	F.o.	F.o.	F.o.	F.o	F.o	F.o	F.o.	F.o	F.o.
Trunk (m)	3.4	3.0	1.5	1.3	3.2	3.2	2.2	3.4	2.3	2.6	1.9	3.2	1.8	2.8	1.7	2.6
Exposition	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Position of sampling area	N	NE	NE	N	NE	N	N	NW	N	N	NE	NE	N	N	NE	N
Covering (%)	95	90	98	95	90	95	90	85	75	90	90	90	95	95	98	95
Canopy closure of vegetation (%)	80	80	80	80	80	90	90	70	80	90	100	80	80	70	80	90
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Number of species	9	9	5	8	8	10	10	6	5	8	8	7	7	6	6	5
ChAss.																
<i>Pterigynandrum filiforme</i>	4	4	5	4	4	4	4	4	4	4	4	4	4	5	1	3
<i>Orthotrichum stramineum</i>	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
ChAll. <i>Ulotion crispae</i>																
<i>Metzgeria furcata</i>	1	2	.	1	.	1	1	.	.	2	.	2	3	1	2	.
<i>Pulviger a lyellii</i>	2	1	1	1	1	1	1	2	2	.	.	.	.	.	.	1
<i>Frullania tamarisci</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch.Cl. <i>Frullania dilatatae</i> - <i>Leucodontetea sciuroidis</i> and ChO <i>Orthotrichetalia</i>																
<i>Radula complanata</i>	1	1	1	1	1	1	2			1	1	1	1	2	4	2
<i>Frullania dilatata</i>	3	2	2	2	3	1	2	.	3	.	1	2	1	1	4	.
<i>Leucodon sciuroides</i>	.	.	.	3	3	2	2	3	2	.	.	1	.	.	.	5
<i>Homalothecium sericeum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Others																
<i>Porella platyphylla</i>	.	1	.	2	1	2	.	.	.	.	.	3	2	.	.	.
<i>Bryum moravicum</i>	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.
<i>Neckera complanata</i>	1	.	.	.	.	.	2	.	.	2	.	.	.	.	.	.
<i>Antitrichia curtipendula</i>	1	3	.	.	.	.	.	.	.	2	2	.	.	.	.	.
<i>Syntrichia ruralis</i>	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
<i>Pseudoleskeella nervosa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hypnum resupinatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Homalothecium lutescens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lichens																
<i>Lobaria pulmonaria</i>	2	2	.	.	.	2	1	.	.	.	3	.	3	.	2	.
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	2	.	.	2	.	.	.	.	.
<i>Ramalina farinacea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
<i>Cladonia</i> sp.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.

F.o.: *Fagus orientalis*.

Table 4. (Continued).

Number of sampling area	149	150	147	169	170	160	166	188	10	186	129	92	95	Frequency	
Altitude (m)	1411	1411	1411	1550	1550	1415	1415	755	1250	755	940	1410	1410		
Size of sampling area (dm <sup>2</sup> )	36	54	35	15	28	48	28	4	70	8	24	99	85		
Phorophyte	F.o.	F.o.	F.o.	F.o.	F.o.	F.o.	F.o.	Q.c.	C.b	Q.c.	F.o	F.o	F.o		
Trunk (m)	2.2	2.6	2.1	2.6	2.4	2.9	2.8	0.8	1.4	1.5	0.9	3.0	3.7		
Exposition	N	N	N	N	N	N	N	NW	NE	NW	N	N	N		
Position of sampling area	N	N	N	N	NW	N	N	W	N	NE	N	N	NE		
Covering (%)	98	95	85	85	90	95	90	85	90	95	98	95	90		
Canopy closure of vegetation (%)	90	90	90	70	70	70	70	10	40	10	90	80	80		
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	T	T		
Number of species	9	8	7	6	5	7	8	4	7	7	8	7	7		
ChAss.															
<i>Pterigynandrum filiforme</i>	3	3	3	3	3	3	1	.	.	.	2	4	3		26
<i>Orthotrichum stramineum</i>	1	1	1	1	1	1	1	1	1	1	1	1	1		29
ChAll. <i>Ulotion crispae</i>															
<i>Metzgeria furcata</i>	1	.	1	.	2	1	1	.	1	.	.	2	1	18	
<i>Pulviger a lyellii</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	11	
<i>Frullania tamarisci</i>	.	.	.	.	.	.	.	.	.	.	.	.	3	1	
Ch.Cl. <i>Frullania dilatatae</i> - <i>Leucodontetea sciuroidis</i> and ChO <i>Orthotrichetalia</i>															
<i>Radula complanata</i>	1	1	1	2	2	1	1	.	.	.	1	1	1	24	
<i>Frullania dilatata</i>	2	1	1	.	.	.	.	2	1	2	1	3	.	21	
<i>Leucodon sciuroides</i>	4	4	4	4	4	2	2	.	5	4	.	.	.	17	
<i>Homalothecium sericeum</i>	.	.	.	.	.	.	.	.	.	3	4	.	.	2	
Others															
<i>Porella platyphylla</i>	.	2	2	.	.	.	.	.	1	2	2	.	.	11	
<i>Bryum moravicum</i>	1	1	.	1	.	.	.	2	.	3	1	.	.	10	
<i>Neckera complanata</i>	.	2	.	.	.	4	5	.	.	.	.	.	.	6	
<i>Antitrichia curtipendula</i>	.	.	.	.	.	.	.	.	.	.	.	3	4	6	
<i>Syntrichia ruralis</i>	.	.	.	.	.	.	1	.	2	.	.	.	.	3	
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	.	2	.	.	.	2	
<i>Pseudoleskeella nervosa</i>	.	.	.	.	.	.	.	.	1	.	.	.	.	1	
<i>Hypnum resupinatum</i>	.	.	.	.	.	.	.	5	.	.	.	.	.	1	
<i>Homalothecium lutescens</i>	.	.	.	.	.	.	1	.	.	.	.	.	.	1	
Lichens															
<i>Lobaria pulmonaria</i>	2	.	.	.	.	2	.	.	.	.	2	1	1	12	
<i>Parmelia sulcata</i>	.	.	.	2	.	.	.	.	.	.	.	.	.	3	
<i>Ramalina farinacea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Cladonia</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	

F.o.: *Fagus orientalis*, Q.c.: *Quercus cerris*, C.b.: *Carpinus betulus*.

**Table 5.** *Lewinskyetum affinis* Alataş & Uyar ass. nova.

Number of sampling area	55	72	69	201	126	181	189	182	190	191	63	184	48
Altitude (m)	747	1120	1200	1005	940	680	805	680	805	805	1073	680	747
Size of sampling area (dm <sup>2</sup> )	90	10	4	6	56	20	18	24	10	18	8	20	12
Phorophyte	Q.c	Q.i.	O.c.	F.o.	F.o	Q.c.	J.r.	Q.c.	M.s.	Q.c.	Q.i	Q.c.	Q.c
Trunk (m)	1.8	0.3	0.5	1.4	2.2	1.2	1.1	1.7	1.3	1.2	1.2	1.9	0.2
Exposition	E	S	S	N	N	NW	SW	NW	SW	SW	S	NW	E
Position of sampling area	N	N	NE	N	NW	N	N	N	N	N	N	E	N
Covering (%)	85	75	60	85	100	85	65	65	85	75	75	80	70
Canopy closure of vegetation (%)	15	60	80	80	90	20	20	20	20	20	70	20	15
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	T	T
Number of species	6	4	4	6	8	6	5	4	5	4	5	5	4
ChAss.													
<i>Lewinskya affinis</i>	4	4	4	1	1	1	1	1	1	1	1	1	1
ChAll. <i>Ulotion crispae</i>													
<i>Pulviger a lyellii</i>	.	.	.	.	1	1	1	2	2	2	3	3	.
<i>Metzgeria furcata</i>	.	.	.	.	2	.	.	.	.	.	.	.	.
<i>Ulota crispa</i>	.	.	.	2	.	.	.	.	.	.	.	.	.
<i>Lewinskya striata</i>	.	.	.	.	.	.	.	.	.	.	.	.	1
Ch SubAll. <i>Pterigynandrenion filiformis</i>													
<i>Pterigynandrum filiforme</i>	.	.	1	4	3	.	.	.	.	.	.	.	.
ChAll. <i>Syntrichion laevipilae</i>													
<i>Orthotrichum pumilum</i>	.	.	.	.	.	.	.	.	.	.	.	1	.
<i>Syntrichia laevipila</i>	.	.	.	.	.	.	.	.	3	2	.	.	.
<i>Orthotrichum diaphanum</i>	4	.	.	.	.	.	.	.	.	.	.	.	.
Ch.Cl. <i>Frullania dilatatae-Leucodontetea sciuroidis</i> and ChO <i>Orthotrichetalia</i>													
<i>Leucodon sciuroides</i>	1	3	.	.	4	4	4	4	4	4	4	4	4
<i>Homalothecium sericeum</i>	1	1	2	.	.	2	.	.	3	.	2	.	.
<i>Frullania dilatata</i>	.	.	.	1	2	.	.	2	.	.	.	.	.
<i>Radula complanata</i>	.	.	3	2	1	.	.	.	.	.	.	.	.
<i>Radula lindbergiana</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
Others													
<i>Porella platyphylla</i>	.	.	.	.	3	.	.	.	.	.	1	.	3
<i>Syntrichia ruralis</i>	.	.	.	.	.	.	3	.	.	.	.	.	.
<i>Bryum moravicum</i>	.	.	.	.	.	2	.	.	.	.	.	.	.
<i>Hypnum resupinatum</i>	.	.	.	3	.	.	.	.	.	.	.	.	.
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Antitrichia curtipendula</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Homalothecium lutescens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Neckera complanata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anomodon attenuatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anomodon viticulosus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Brachytheciastrum velutinum</i>	.	.	.	.	.	.	1	.	.	.	.	.	.
<i>Orthotrichum anomalum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
Lichens													
<i>Lobaria pulmonaria</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Parmelia sulcata</i>	.	.	.	.	.	3	.	.	.	.	.	3	.
<i>Xanthoria parietina</i>	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anapthychia ciliaris</i>	.	2	.	.	.	.	.	.	.	.	.	.	.
<i>Parmelia</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Collema</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Physcia adscendens</i>	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Peltigera praetextata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.

F.o.: *Fagus orientalis*, Q.c.: *Quercus cerris*, C.b.: *Carpinus betulus*, Q.i.: *Quercus infectoria*, J.r.: *Juglans regia*, M.s.: *Malus sylvestris*.

Table 5. (Continued).

Number of sampling area	54	7	19	46	71	110	111	61	196	131	134	18	133
Altitude (m)	747	1250	1250	747	1120	1410	1366	1073	865	750	750	1250	750
Size of sampling area (dm <sup>2</sup> )	12	55	24	30	8	28	24	8	40	24	10	100	18
Phorophyte	Q.c	F.o	C.b	Q.c	Q.i.	F.o	F.o	Q.i	C.b	Q.i	Q.i	C.b	Q.i
Trunk (m)	2.3	1.3	2.5	1.8	0.5	1.4	2.7	0.6	2	1.2	0.9	2.5	0.8
Exposition	E	NE	NE	E	S	N	N	S	NE	N	N	NE	N
Position of sampling area	N	S	N	S	N	N	NE	NE	N	NE	NE	NE	NW
Covering (%)	75	85	65	70	60	80	90	95	100	95	90	80	95
Canopy closure of vegetation (%)	10	40	30	10	60	80	100	70	100	80	80	30	80
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	B	T
Number of species	5	5	6	4	4	6	6	6	11	6	8	3	6
ChAss.													
<i>Lewinskya affinis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1
ChAll. <i>Ulotion crispae</i>													
<i>Pulviger a lyellii</i>	.	.	.	.	.	.	.	4	.	.	.	.	.
<i>Metzgeria furcata</i>	.	.	.	.	.	2	1	.	1	.	2	.	.
<i>Ulot a crispa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lewinskya striata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
Ch SubAll. <i>Pterigynandrenion filiformis</i>													
<i>Pterigynandrum filiforme</i>	.	3	.	.	.	3	3	.	.	3	.	.	.
ChAll. <i>Syntrichion laevipilae</i>													
<i>Orthotrichum pumilum</i>	.	.	.	.	2	.	.	.	.	.	.	.	.
<i>Syntrichia laevipila</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Orthotrichum diaphanum</i>	.	.	.	1	.	.	.	.	.	.	.	.	.
Ch.Cl. <i>Frullania dilatatae</i> - <i>Leucodontetea sciurooidis</i> and ChO <i>Orthotrichetalia</i>													
<i>Leucodon sciurooides</i>	4	4	4	5	4	4	3	3	.	3	3	.	3
<i>Homalothecium sericeum</i>	3	.	.	.	.	.	.	4	4	4	4	5	5
<i>Frullania dilatata</i>	.	.	.	.	.	2	.	.	1	2	1	.	.
<i>Radula complanata</i>	.	.	1	.	.	1	.	.	1	.	1	.	1
<i>Radula lindbergiana</i>	.	.	.	.	.	.	4	.	.	.	.	.	.
Others													
<i>Porella platyphylla</i>	.	3	2	.	.	.	.	.	1	.	1	2	.
<i>Syntrichia ruralis</i>	2	1	1	1	.	.	.	.	.	.	.	.	.
<i>Bryum moravicum</i>	.	.	.	.	.	.	2	.	1	.	.	.	1
<i>Neckera complanata</i>	.	.	.	.	.	.	.	.	3	.	.	.	.
<i>Hypnum resupinatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	2	2	.	.	.
<i>Antitrichia curtispindula</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Homalothecium lutescens</i>	.	.	.	.	1	.	.	.	.	.	.	.	.
<i>Anomodon attenuatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anomodon viticulosus</i>	.	.	.	.	.	.	.	.	2	.	.	.	.
<i>Brachytheciastrum velutinum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Orthotrichum anomalum</i>	1	.	.	.	.	.	.	.	.	.	.	.	.
Lichens													
<i>Lobaria pulmonaria</i>	.	.	2	.	.	.	.	.	2	.	2	.	1
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	1	.	.	.	.	.
<i>Xanthoria parietina</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anaphthychia ciliaris</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Parmelia</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Collema</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Physcia adscendens</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Peltigera praetextata</i>	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 5. (Continued).

Number of sampling area	183	65	119	200	113	114	161	64	66	30	116	194	Frequency	
Altitude (m)	680	1073	1366	1005	1366	1366	1415	1073	1073	1074	1366	865		
Size of sampling area (dm <sup>2</sup> )	6	8	90	8	80	72	21	8	15	8	50	18		
Phorophyte	Q.c	Q.i	F.o	F.o.	F.o	F.o	F.o.	Q.i	Q.i	C.b	F.o	C.b.		
Trunk (m)	1.1	0.7	1.8	1.1	2.2	1.9	1.1	0.7	0.6	3.2	1.6	1.8		
Exposition	NW	S	N	N	N	N	N	S	S	NE	N	NE		
Position of sampling area	E	NE	N	N	NE	NE	N	NE	N	W	NE	N		
Covering (%)	78	93	88	78	85	95	84	48	87	79	88	93		
Canopy closure of vegetation (%)	20	70	100	80	100	100	70	70	70	10	100	100		
Base (B)/Trunk (T)	T	T	T	T	T	T	T	T	T	T	T	T		
Number of species	3	6	7	5	6	7	7	5	7	5	7	9		
ChAss.														
<i>Lewinskya affinis</i>	1	1	1	1	1	1	1	1	1	1	1	1		38
ChAll. <i>Ulotion crispae</i>														
<i>Pulviger a lyellii</i>	.	4	.	.	2	1	1	2	3	.	.	.	15	
<i>Metzgeria furcata</i>	.	.	2	.	.	.	2	.	.	.	.	1	8	
<i>Ulota crispa</i>	.	.	.	1	.	.	.	.	.	.	.	.	2	
<i>Lewinskya striata</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
Ch SubAll. <i>Pterigynandrenion filiformis</i>														
<i>Pterigynandrum filiforme</i>	.	2	4	.	4	5	4	2	1	5	4	.	16	
ChAll. <i>Syntrichion laevipilae</i>														
<i>Orthotrichum pumilum</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	
<i>Syntrichia laevipila</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	
<i>Orthotrichum diaphanum</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	
Ch.Cl. <i>Frullania dilatatae-Leucodontetea sciuroidis</i> and ChO <i>Orthotrichetalia</i>														
<i>Leucodon sciuroides</i>	3	3	2	.	3	.	.	3	4	.	.	.	28	
<i>Homalothecium sericeum</i>	5	.	.	.	.	.	.	.	3	.	.	1	16	
<i>Frullania dilatata</i>	.	.	1	2	1	1	3	.	3	.	3	.	14	
<i>Radula complanata</i>	.	.	1	3	1	1	1	.	.	.	1	.	14	
<i>Radula lindbergiana</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
Others														
<i>Porella platyphylla</i>	.	.	.	.	.	.	.	.	.	2	2	.	10	
<i>Syntrichia ruralis</i>	.	.	.	.	.	.	.	.	.	1	.	1	7	
<i>Bryum moravicum</i>	.	.	.	.	.	.	.	.	1	.	.	1	6	
<i>Neckera complanata</i>	.	.	.	.	.	.	2	.	.	1	2	3	5	
<i>Hypnum resupinatum</i>	.	.	.	4	.	.	.	.	.	.	.	.	2	
<i>Hypnum cupressiforme</i>	.	.	.	.	.	.	.	.	.	.	.	.	2	
<i>Antitrichia curtipendula</i>	.	.	.	.	.	3	.	.	.	.	.	4	2	
<i>Homalothecium lutescens</i>	.	1	.	.	.	.	.	.	.	.	.	.	2	
<i>Anomodon attenuatus</i>	.	.	.	.	.	.	.	.	.	.	.	2	1	
<i>Anomodon viticulosus</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Brachytheciastrum velutinum</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Orthotrichum anomalum</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
Lichens														
<i>Lobaria pulmonaria</i>	.	.	.	.	.	.	.	.	.	.	1	.	5	
<i>Parmelia sulcata</i>	.	.	.	.	.	.	.	.	.	.	.	1	4	
<i>Xanthoria parietina</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Anaptychia ciliaris</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Parmelia</i> sp.	.	.	3	.	.	.	.	.	.	.	.	.	1	
<i>Collema</i> sp.	.	1	.	.	.	.	.	.	.	.	.	.	1	
<i>Physcia adscendens</i>	.	.	.	.	.	.	.	.	.	.	.	.	1	
<i>Peltigera praetextata</i>	.	.	.	.	.	1	.	.	.	.	.	.	1	

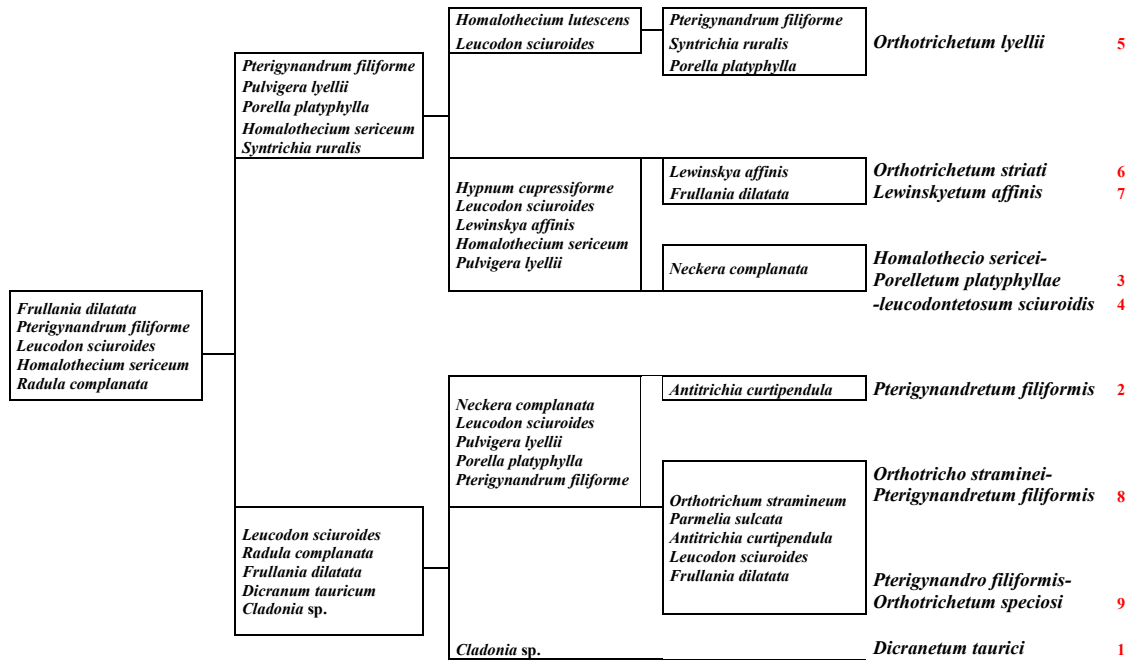


Figure 4. Discrimination of 194 plots of research area by differential analysis (indicator species analysis) method (TWINSPAN).

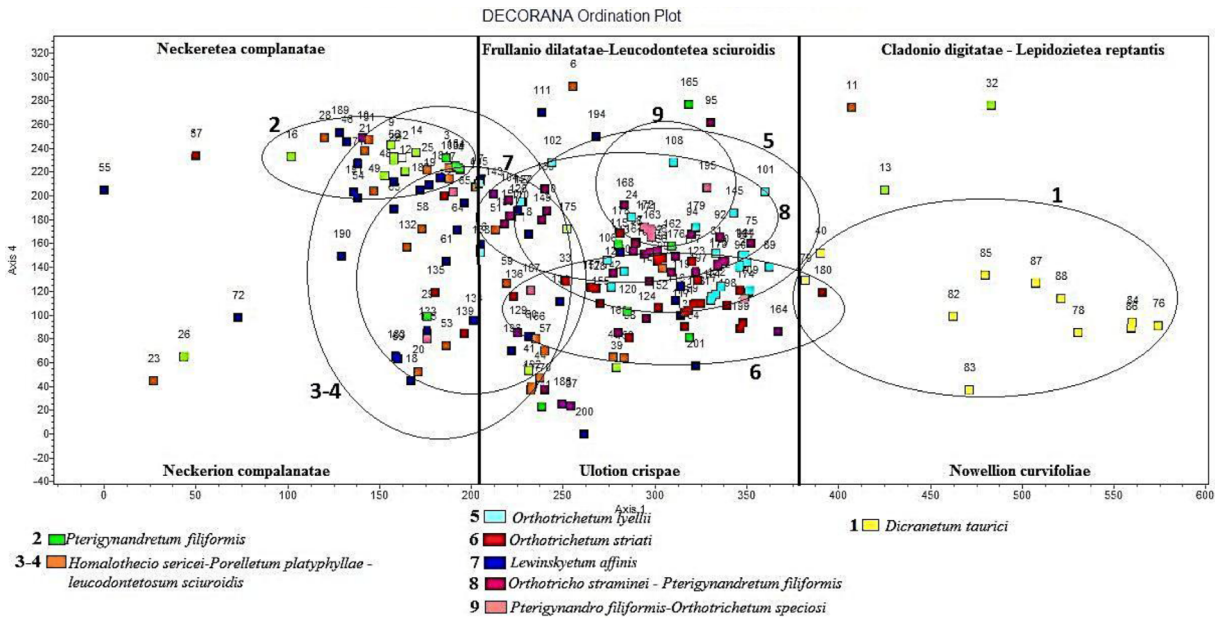


Figure 5. The demonstration of 194 plots on DCA ordination diagram (1–9: detected subassociation and associations).

## References

- Akman Y (2011). İklim ve Biyoiklim (Biyoiklim metodları ve Türkiye iklimleri). Ankara, Turkey: Palme Yayıncılık.
- Alataş M, Kara R, Ezer T, Uyar G, Batan N (2015). The epiphytic bryophyte flora and vegetation of Zonguldak-Göbü village (Northwest Turkey). *Pakistan J Bot* 47: 1439-449.
- Alataş M, Kara R, Ezer T, Batan N, Özdemir T (2016). Contribution to the epiphytic flora and vegetation of the Lakes District in the Burdur region (Turkey). *Turk J Bot* 40: 329-342.
- Bidlack JE, Jansky SH (2011). *Stern's Introductory Plant Biology*, 12th ed. New York, NY, USA: McGraw-Hill.
- Braun Blanquet J (1964). *Pflanzensoziologie Grundzüge der Vegetationskunde*. 3. Aufl. New York, NY, USA: Springer.
- Casas C, Brugués M, Cros MR, Sérgio C, Infante M (2009). *Handbook of Liverworts and Hornworts of the Iberian Peninsula and the Balearic Islands*. Barcelona, Spain: Institut d'Estudis Catalans.
- Cortini Pedrotti C (2001). *Flora dei muschi d'Italia, Sphagnopsida, Andreaopsida, Bryopsida (I parte)*. Rome, Italy: Antonio Delfino Editore Medicina-Scienze.
- Cortini Pedrotti C (2006). *Flora dei muschi d'Italia, Bryopsida (II parte)*. Rome, Italy: Antonio Delfino Editore Medicina-Scienze.
- Düzenli A, Ezer T, Kara R (2009). The *Anomodonto-Leucodontetum Sciuroidis* Wiśn. 1930 - an epiphytic bryophyte community new for Turkey. *Botanika-Steciana* 13: 145-154.
- Frey W, Kürschner H (1991). *Crossidium laevipilum* ther. et trab. (Pottiaceae, Musci), ein eigenständiges, morphologisch und standortökologisch deutlich unterscheidbares taxon der Saharo-Arabischen floren region. *Cryptogam Bryol* 12: 441-450.
- Frey W, Frahm JP, Fischer E, Lobin W (2006). *The Liverworts, Mosses and Ferns of Europe*. Colchester, UK: Harley Books.
- Gillet F (1986). *Les Phytocoenoses forestieres du Jura nord-occidental*. Besançon, France: These Univ. Essai de Phytosociologie intégrée.
- Goia I, Schumacker R (2004). The study of corticolous bryophytes communities from the Arişul Mare Basin. *Contribuții Botanice* 39: 105-114.
- Guerra J, Cros M (2007). *Flora Briofítica Ibérica*. Vol. 1. Murcia, Spain: Universidad de Murcia Sociedad Española de Briología.
- Hedenäs L (1992). *Flora of Maderian Pleurocarpous Mosses (Isobryales, Hypnobryales, Hookeriales)*. Stuttgart, Germany: Bryophytorum Bibliotheca Band 44.
- Henderson DM (1961). Contribution to the bryophyte flora of Turkey IV. Notes from the Royal Botanic Garden, Edinburgh 23: 263-278.
- Heyn CC, Herrnstadt I (2004). The bryophyte flora of Israel and Adjacent Regions. Jerusalem, Israel: The Israel Academy of Sciences and Humanities.
- Hill MO (1979a) DECORANA - a FORTRAN program for detrended correspondence analysis and reciprocal averaging. Ithaca, NY, USA: Cornell University.
- Hill MO (1979b) TWINSpan - a FORTRAN program for arranging multivariate data in an ordered two way table by classification of individual and attributes. Ithaca, NY, USA: Cornell University.
- Hübschman A (1978). Über moosvegetation und moosgesellschaften zentraleuropas. *Phytocoenologia* 5: 80-123.
- Kürschner H, Tonguç Ö, Yayıntaş A (1998). Life strategies in epiphytic bryophyte communities of the Southwest Anatolian *Liquidambar orientalis* forest. *Nova Hedwigia* 66: 435-450.
- Kürschner H (1999). Life strategies of epiphytic bryophytes in Mediterranean *Pinus woodlands* and *Platanus orientalis* alluvial forests of Turkey. *Cryptogam Bryol* 20: 17-33.
- Kürschner H, Parolly G, Erdağ A (2006). Life forms and life strategies of epiphytic bryophytes in *Quercus vulcanica* forest of Turkey. *Nova Hedwigia* 82: 331-347.
- Kürschner H, Frey W (2011). *Liverworts, Mosses and Hornworts of Southwest Asia*. Stuttgart, Germany: Beiheft 139.
- Kürschner H, Kırmacı M, Erdağ A, Batsatsashvili K, Parolly G (2012). Ecology and life strategies of epiphytic bryophyte communities from the Arcto-Tertiary relict forests of the Black and Caspian Sea areas. *Nova Hedwigia* 94: 31-65.
- Lara F, Garilleti R, Goffinet B, Draper I, Medina R, Vigalondo B, Mazimpaka V (2016). *Lewinskya*, a new genus to accommodate the phaneroporous and monoicous taxa of *Orthotrichum* (Bryophyta, Orthotrichaceae). *Cryptogam Bryol* 37: 361-382.
- Marstaller R (2006). *Syntaxonomischer Konspekt der Moosgesellschaften Europas und angrenzender Gebiete*. Jena, Germany: Haussknechtia Beiheft 13.
- Nyholm E (1981). *Illustrated Moss Flora of Fennoscandia*. Fasc. 1-6. Lund, Sweden: Nordic Bryological Society.
- Özhatay N, Byfield A, Atay S (2005). Türkiye'nin 122 Önemli Bitki Alanı. İstanbul, Turkey: Mas Matbaacılık.
- Paton J (1999). *The Liverwort Flora of the British Isles*. Colchester, UK: Harley Books.
- Plášek V, Sawicki J, Ochyra R, Szczecińska M, Kulik T (2015). New taxonomical arrangement of the traditionally conceived genera *Orthotrichum* and *Uloa* (Orthotrichaceae, Bryophyta). *Acta Musei Silesiae, Scientiae Naturales* 64: 169-174.
- Smith AJE (2004). *The Moss Flora of Britain and Ireland*. Cambridge, UK: Cambridge University Press.
- TSMS (Turkish State Meteorological Service) (2010). İl ve ilçelerimize ait istatistiki veriler [more or less continuously updated]. Website <http://www.meteor.gov.tr> [30.11.2010].
- Walther K, Leblebici E (1969). Die moosvegetation des Karagöl-Gebietes im Yamanlar Dağ nördlich İzmir. *Ege University Journal of the Faculty of Science* 10: 1-48.
- Walther K (1975). Zur moosvegetation der Liquidambar-walder Südwest-Anatoliens. *Phytocoenologia* 2: 13-18.
- Walther K (1979). Die epifitischen moosgesellschaften des Nif Dag bei Izmir, Westanatolien. *Doc Phytosociol* 4: 943-950.
- Weber HE, Moravec J, Theurillat JP (2000). International code of phytosociological nomenclature. *Vegetation Science* 3: 739-768.
- Zander RH (1993). *Genera of the Pottiaceae: Mosses of Harsh Environments*. New York, NY, USA: Bulletin of the Buffalo Society of Natural Sciences 32.