

Contribution to the epiphytic flora and vegetation of the Lakes District in the Burdur region (Turkey)

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Abstract: In this study the epiphytic bryophyte flora and vegetation of the Bucak Sweetgum Forest Nature Park and Karacaören Dams Environment (Burdur, Turkey) were investigated between 2012 and 2013. We identified 221 bryophyte specimens collected from tree trunks; a total of 37 bryophyte taxa (8 liverworts and 29 mosses) belonging to 19 genera and 15 families were identified. As a result of the evaluation of 29 relevés of different sizes taken from trunks using the Braun-Blanquet method, *Leptodonto smithii-Leucodontetum sciuroidis* and *Cryphaetum arborae* (with both subassociation *typicum* and subassociation *orthotrichetosum diaphani*) belonging to the *Fabronion pusillae* alliance were recorded for the first time from Turkey. The life forms and life strategies of the syntaxa were analyzed.

Key words: Bryophyte, epiphytes, bryosociology, life forms, life strategies, Turkey

1. Introduction

The floristic diversity of Turkey is very rich thanks to its different climatic types (terrestrial, oceanic, and Mediterranean), geological and geomorphological variety, rich water resources (seas, lakes, and rivers), huge differences in altitude (between sea level and 5000 m), wide range of habitats, and its location, where three phytogeographic regions (Euro-Siberian, Mediterranean, and Irano-Turanian) meet. Until recently this abundance was perceived only in terms of flowering plants; however, recent studies on algae, fungi, lichens, and bryophytes have also shown the abundance of cryptogamic plants in Turkey (Düzenli et al., 2009).

Studies on bryophytes in Turkey have rapidly advanced in bryofloristic terms, but not in bryosociologic terms. There are very few studies on epiphytic bryophyte vegetation (Kürschner et al., 1998; Kürschner et al., 2006; Düzenli et al., 2009; Ezer et al., 2009; Kara et al., 2011; Kürschner et al., 2012; Ezer and Kara, 2013) in Turkey, and there is a need for more studies on the subject. The aim of the present paper was to perform phytosociological investigations of the epiphytic bryophyte vegetation of the Bucak (Burdur) Sweetgum Forest Nature Park and the Karacaören Dams Environment.

2. Materials and methods

2.1. Study area

The study area, located in the C12 square according to Henderson's (1961) grid system, falls within the Mediterranean phytogeographic region of Turkey (Zohary, 1973; Figure 1). Bucak, located in Antalya of the Lakes District, is 45 km away from the largest district of Burdur. The district has a large area of 1436 km².

The main vegetation in the study area is of the maquis, forest, rocky, and riparian types. The dominant taxa within the vegetation types in the study site are: *Arbutus andrachne* L., *Ceratonia siliqua* L., *Cotinus coggygia* Scop., *Juniperus oxycedrus* L., *Olea europaea* L. var. *sylvestris* (Miller) Lehr., *Phillyrea latifolia* L., *Pistacia terebinthus* L. subsp. *palaestina* (Boiss.) Engler, and *Quercus coccifera* L., which are members of maquis vegetation; *Cedrus libani* A. Rich., *Juniperus excelsa* M. Bieb. subsp. *excelsa*, *Liquidambar orientalis* Miller, *Pinus brutia* Ten., and *Pinus nigra* Arn. subsp. *pallasiana* (Lamb.) Holmboe, which are members of forest vegetation; and *Alnus orientalis* Decne., *Equisetum ramosissimum* Desf., *Erica manipuliflora* Salisb., *Liquidambar orientalis* Miller, *Nerium oleander* L., *Platanus orientalis* L., and *Vitex agnus-castus* L., which are members of riparian vegetation (Fakir, 2006).

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Figure 1. The grid system of Turkey by Henderson (1961), adopted for the study area.

The mean annual precipitation in the area was 1052 mm. The most arid and hottest month was August, with a mean temperature of 28 °C. The annual mean temperature was 18.48 °C. Typical Mediterranean climate predominates, characterized by hot and dry summers and rainy winters. The research area had a Mediterranean humid climate. It can be seen that heavy rain occurred in November, December, January, and February, while the dry period extended from the beginning of June until the end of October (Akman, 1999).

2.2. Vegetation sampling and data sources

The research materials consisted of 29 relevés and 221 bryophyte specimens, which were collected from the trunks of trees in different localities of the Bucak Sweetgum Forest Nature Park and the Karacaören Dams Environment with varying ecological characteristics between 2012 and 2013 (Table 1). For the relevés, trees with different diameters were selected. The relevés were collected from the base and middle part of the trunk. The dimensions of the relevés were determined according to the Braun-Blanquet (1964) method, according the following scale: + (<1%), 1 (1.1%–6.0%), 2 (6.1%–12.0%), 3 (12.1%–25.0%), 4 (25.1%–50.0%), and 5 (50.1%–100%) (Frey and Kürschner, 1991a). In addition, statistical (diameter, height, coverage, etc.) data were recorded for each sampled relevé.

Bryophyte specimens were identified by consulting keys (Paton, 1999; Smith, 2004). The nomenclature and systematic arrangement of the taxa in the floristic list follow Ros et al. (2007) for liverworts and Ros et al. (2013) for mosses. Diagnosed specimens were stored in the Herbarium of the Department of Biology, Faculty of Science, Karadeniz Technical University, Turkey.

The nomenclature of syntaxa follows Marstaller (2006); the denomination follows Weber et al. (2000). The ecological preferences of the species are taken from Dierßen (2001). The life forms of the species were determined according to Magdefrau (1982) and During (1979); the life strategies of the species were determined according to During (1979) and Frey and Kürschner (1991b); and the habitat affinities of the taxa were determined according to Draper et al. (2003).

3. Results and discussion

3.1. Epiphytic flora

A total of 37 epiphytic taxa were determined (29 mosses and 8 liverworts) (Table 2). The *Platanus orientalis* is the most species-rich host tree in the study site with 26 taxa, while the *Pinus brutia* is the poorest tree with 3 taxa. *Frullania dilatata*, *Leucodon sciuroides*, *Hypnum cupressiforme*, *Radula complanata*, *Cryphaea*

Table 1. List of localities.

Number of relevés	Localities (Bucak)	Altitude (m)	Date	GPS coordinates
1, 2	Karacaören dam edge, sweetgum forest	300	25.06.2012	N 37°21'35.14" E 30°50'05.80"
3, 4, 5, 6	Karacaören dam road	305	25.06.2012	N 37°22'30.49" E 30°48'54.07"
7, 10, 11	Burdur–Bucak road, Beşkonak	945	25.06.2012	N 37°27'01.73" E 30°38'44.41"
8, 9	Isparta–Antalya road–Pamucak, Çobanpınar	600	17.07.2012	N 37°23'39.42" E 30°46'50.60"
13, 14	Between Beşkonak and Kocaaliler	846	17.07.2012	N 37°20'52.64" E 30°44'12.45"
12, 15, 17	Karacaören village	455	18.07.2012	N 37°23'17.60" E 30°49'58.76"
18, 19	Kızıllı village	485	18.07.2012	N 37°23'07.11" E 30°53'34.29"
16, 20	Yukarı Kuyubaşı valley	975	24.08.2012	N 37°21'51.07" E 30°42'15.03"
21, 23	Gündoğdu	960	24.08.2012	N 37°19'13.86" E 30°33'26.46"
22	Kuyubaşı	990	24.08.2012	N 37°22'12.25" E 30°39'22.76"
24, 29	Kargı village	241	26.06.2013	N 37°17'21.23" E 30°48'38.30"
26, 27	Kızıllı village road and roadside in forest	394	22.08.2013	N 37°21'54.34" E 30°52'56.52"
28	Kocaaliler	625	10.06.2013	N 37°18'33.36" E 30°44'36.03"
25	Çamlık	1010	28.06.2012	N 37°29'18.21" E 30°41'40.79"

heteromalla, *Habrodon perpusillus*, *Leptodon smithii*, and *Homalothecium sericeum* were the most collected taxa. *Radula lindenbergiana*, *Homalothecium aureum*, *Hypnum cupressiforme* var. *lacunosum*, *Orthotrichum anomalum*, *O. cupulatum*, *O. obtusifolium*, *O. rupestre*, *O. sordidum*, *O. urnigerum*, and *Pseudoleskeella tectorum* were rarely collected.

The most species-rich families in the study site are Orthotrichaceae (with 13 taxa), Hypnaceae (with 3 taxa), and Leucodontaceae (with 3 taxa). The other families were represented by one or two taxa (Table 2). Orthotrichaceae members are ranked first due to their epiphytic characters in the study site. The Hypnaceae and Leucodontaceae

members are wide-spread on the more humid, lower parts of the trunks.

In terms of humidity preference of the taxa, mesophytes (36%) are dominant in the study site, followed by xerophytes (32%) and hygrophytes (32%). The high rate of mesophytes found in the study site is meaningful because the investigated area, placed in the Mediterranean region, has semiarid habitats as well as humid and xerophytic habitats. Considering the habitat affinity of the taxa, cortico-saxicolous taxa are dominant with 49%, followed by customary epiphyte taxa (32%) and indifferent taxa (19%) (Figure 2).

Table 2. Floristic list (LN: Locality number, TN: Number of taxa. h: Hygrophyte, m: Mesophyte, x: Xerophyte, L.o.: *Liquidambar orientalis*, P.o.: *Platanus orientalis*, A.p.: *Acer platanoides*, Q.c.: *Quercus coccifera*, A.o.: *Alnus orientalis*, J.o.: *Juniperus oxycedrus*, C.l.: *Cedrus libani*, P.b.: *Pinus brutia*).

Families	LN	Taxa	Habitat affinity	Humidity	Substrata							Pb.	NT	
					L.o	P.o.	Q.c.	A.p.	A.o.	J.o	C.l.			
		Marchantiopsida												
Metzgeriaceae	6,9	<i>Metzgeria conjugata</i> Lindb.	Indifferent	h		+		+						2
	2,3,4,8,9,14	<i>Metzgeria furcata</i> (L.) Dumort.	Indifferent	m	+	+								6
Porellaceae	1,2,3,9,13	<i>Porella platyphylla</i> (L.) Pfeiff.	Cortico-saxicolous	m	+	+								5
Radulaceae	1,2,3,5,6,7,8,9,11,12	<i>Radula complanata</i> (L.) Dumort.	Customary epiphyte	h	+	+		+	+		+			18
	6	<i>Radula lindenberghiana</i> Gottsche ex C. Hartm.	Customary epiphyte	h							+			1
Frullaniaceae	1,2,3,4,5,6,7,8,9,10,12,13,14	<i>Frullania dilatata</i> (L.) Dumort.	Customary epiphyte	h	+	+		+	+		+			22
	7,12	<i>Frullania tamarisci</i> (L.) Dumort.	Cortico-saxicolous	m		+					+			2
Lejeuneaceae	3,4,5,9	<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	Cortico-saxicolous	h	+						+			4
		Bryopsida												
Cryphaeaceae	2,3,4,5,6,7,8,9,10,11,12	<i>Cryphaea heteromalla</i> (Hedw.) D.Mohr.	Cortico-saxicolous	h	+	+		+	+					17
Fabroniaceae	2,5,9	<i>Fabronia ciliaris</i> (Brid.) Brid.	Cortico-saxicolous	m	+									3
	4,9	<i>Fabronia pusilla</i> Raddi.	Cortico-saxicolous	x	+			+						2
Pterigynandraceae	1,2,3,4,6,7,8,9,11,12,13,14	<i>Habrodon perpusillus</i> (De Not.) Lindb.	Customary epiphyte	h	+	+		+	+					17
Brachytheciaceae	9	<i>Homalothecium aureum</i> (Spruce) H.Rob.	Indifferent	x				+						1
	1,2,4,5,6,7,8,9,11,13,14	<i>Homalothecium sericeum</i> (Hedw.) Schimp.	Indifferent	x	+	+		+	+			+		14
Hypnaceae	1,2,4,5,6,7,8,10,11,12	<i>Hypnum cupressiforme</i> var. <i>cupressiforme</i> Hedw.	Indifferent	m	+	+		+	+		+	+		19
	3	<i>Hypnum cupressiforme</i> var. <i>lacunosum</i> Brid.	Indifferent	x				+						1

Table 2. (Continued).

	8,13		<i>Hypnum cupressiforme</i> var. <i>subjulaceum</i> Molendo.	Indifferent	m																	2
Leptodontaceae	1,2,3,4,5,6,7,10,11,12		<i>Leptodon smithii</i> (Hedw.) F.Weber & D.Mohr.	Cortico-saxicolous	m	+	+	+	+	+	+											15
Leucodontaceae	1,2,3,4,5,6,7,8,9,11,12,13,14		<i>Leucodon sciuroides</i> (Hedw.) Schwägr.	Cortico-saxicolous	m	+	+	+	+	+	+											20
	2,3,6		<i>Leucodon immersus</i> Lindb.	Cortico-saxicolous	x	+																4
	1,2,8,14		<i>Nogopterium gracile</i> (Hedw.) Crosby & W.R. Buck.	Cortico-saxicolous	h	+	+															4
Orthotrichaceae	2,3		<i>Orthotrichum acuminatum</i> H.Philib.	Customary epiphyte	x	+	+															2
	1,5,12		<i>Orthotrichum affine</i> Schrad. ex Brid.	Customary epiphyte	m	+																3
	14		<i>Orthotrichum anomalum</i> Hedw.	Cortico-saxicolous	x	+																1
	13		<i>Orthotrichum cupulatum</i> Hoffm. ex Brid.	Cortico-saxicolous	h	+																1
	6,7,8,9,10,12,14		<i>Orthotrichum diaphanum</i> Schrad. ex Brid.	Customary epiphyte	x	+	+															9
	2,5		<i>Orthotrichum lyellii</i> Schrad. ex Brid.	Customary epiphyte	h	+																2
	7		<i>Orthotrichum obtusifolium</i> Brid.	Cortico-saxicolous	x	+																1
	5		<i>Orthotrichum rupestre</i> Schleich. ex Schwägr.	Cortico-saxicolous	x	+																1
	6		<i>Orthotrichum sordidum</i> Lesq. & James.	Customary epiphyte	m	+																1
	4,1		<i>Orthotrichum speciosum</i> Nees.	Customary epiphyte	m	+																3
	6		<i>Orthotrichum urnigerum</i> Myrin.	Cortico-saxicolous	h	+																1
Leskeaceae	1		<i>Pseudolekeella tectorum</i> (Funct ex Brid.) Kindb.ex Broth.	Cortico-saxicolous	x	+																1
Pterigynandraceae	11,13		<i>Pterigynandrum filiforme</i> Hedw.	Cortico-saxicolous	m	+																3
Pottiaceae	5,6		<i>Syntrichia papillosa</i> (Wilson) Jur.	Cortico-saxicolous	m	+																2
Orthotrichaceae	2,11		<i>Ulota crispa</i> (Hedw.) Brid.	Customary epiphyte	h	+																2
	1,2,3,7,11,12		<i>Zygodon rupestris</i> Schimp. ex Lorentz.	Customary epiphyte	x	+	+															9

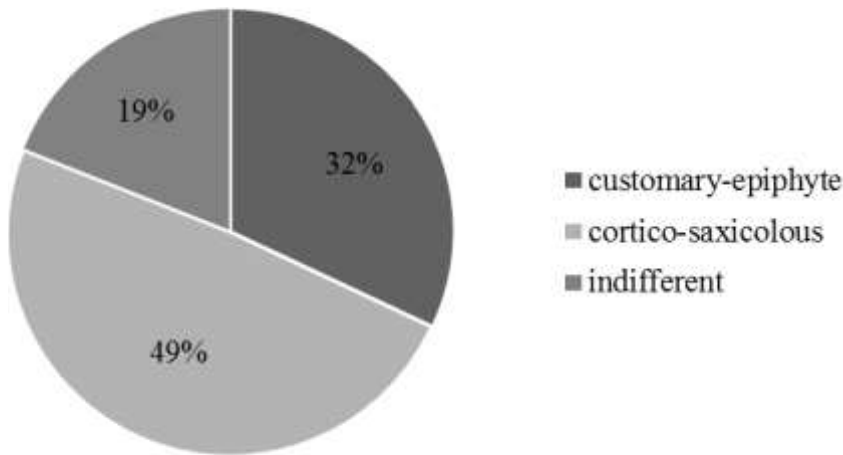


Figure 2. Percentages of habitat affinity of the taxa.

3.2. Epiphytic vegetation

As a result of the examination of the 29 phytosociological relevés, two epiphytic bryophyte associations and one subassociation belonging to the order *Orthotrichetalia* Hadàc in Klika & Hadàc 1944 of the class *Frullania dilatatae-Leucodontetea sciurooidis* Mohan 1978 are determined. They are: *Leptodonto smithii-Leucodontetum sciurooidis* Priv. & Pug. 1997, *Cryphaetum arborae* Barkman 1958, and *Cryphaetum heteromallae* Barkman 1958 -*orthotrichetosum diaphani* Lecoince 1975. All of them are reported for the first time from Turkey.

3.2.1. *Leptodonto smithii-Leucodontetum sciurooidis* Privitera & Puglisi 1997 (Table 3)

Leptodonto smithii-Leucodontetum sciurooidis, described from some sites of Mt Etna (eastern Sicily) (Privitera and Puglisi, 1997), includes the association *Leptodontetum smithii* Jaeggli 1933, invalidly described by the author. The association is at present known from Jordan, Sardinia, Sicily, and many localities in peninsular Italy (Cortini Pedrotti, 1988; Frey and Kürschner, 1995; Privitera and Puglisi, 2012).

The association was determined within 9 relevés taken from tree trunks. It is wide-spread between 300 and 975 m, especially on the northern slope of the study site. It grows frequently on old *P. orientalis* (Figure 3).

The number of taxa per relevé varies from 5 to 8. The general cover of the association ranges from 70% to 95%; the canopy closure of the vegetation ranges from 70% to 90%. Five of the 20 taxa that form the association are liverworts and 15 taxa are mosses; 7 taxa of the mosses are acrocarpous and the other 8 are pleurocarpous. The affinity of the acrocarpous and pleurocarpous rates and the abundance of liverworts show that the association is a mesophytic syntaxon with mesophytic characteristics wide-spread in semiarid and less humid habitats.

The character species of the association are *L. smithii* (with 78% constancy) and *L. sciurooides*, xerophytic or mesophytic species in open woodlands and semineutral environments with the highest constancy (89%).

According to the habitat affinity of the taxa within the association, customary epiphytes (45%) are dominant. These are followed by cortico-saxicolous taxa (30%) and indifferent taxa (25%) (Figure 4).

Syntaxonomically, the association can be classified within the *Fabronion pusillae* alliance of the order *Orthotrichetalia* and class *Frullania dilatatae-Leucodontetea sciurooidis*. The occurrence of the higher-ranked character species *Frullania dilatata*, *Radula complanata*, *Zygodon rupestris*, *Orthotrichum affine*, *Habrodon perpusillus*, and *Nogopterium gracile* support the classification within the above mentioned syntaxa.

In addition, the association in our study site matches that found in the Umbria region of Italy (Cortini Pedrotti, 1988) in terms of alliance, order, and class characteristics. The Turkish association was determined on different host species (*Q. coccifera*, *L. orientalis*, *P. orientalis*, and *A. orientalis*), as was the Italian association (*Quercus congesta*, *Q. ilex*, *Q. cerris*, *Fagus sylvatica*, *Castanea sativa*, *Juniperus oxycedrus*, etc.).

3.2.2. *Cryphaetum arborae* Barkman 1958 *typicum* (Table 4)

The *Cryphaetum arborae typicum* is recorded within the 12 relevés taken from the tree trunks. It is wide-spread between 241 and 945 m, especially on the northern and northeast slopes of study site. It grows frequently on *Liquidambar orientalis* (Figure 3).

The number of taxa per relevé varies from 6 to 8. The general bryophyte cover of the *typicum* varies from 70% to 95%, the canopy closure of the vascular vegetation ranges from 70% to 90%.

Table 3. *Leptodonto smithii*-*Leucodontetum sciuroidis* Privitera & Puglisi 1997.

Number of relevés	1	2	9	12	18	20	24	27	28	Frequency
Altitude (m)	300	300	600	455	485	975	241	394	625	
Size of relevés (dm ²)	12	20	15	20	16	6	20	4	8	
Phorophyte	L.o	P.o.	P.o.	P.o.	P.o.	Q.c.	P.o.	A.o.	Q.c.	
Diameter of trunk (m)	0.8	1.7	1.6	1.7	1.8	0.7	1.6	0.6	0.8	
Exposition	N	N	N	N	N	N	N	N	N	
Position of relevés	N	NE	N	N	N	NE	NW	N	NE	
Cover (%)	85	95	85	88	80	78	82	75	70	
Canopy closure of vegetation (%)	90	70	80	80	80	90	80	80	90	
Base (B) / trunk (T)	T	T	T	T	T	B	T	B	B	
Number of species	7	8	7	8	7	6	7	5	6	
Ch Ass.										
<i>Leptodon smithii</i>	2	1	3	2	1	.	2	2	.	7
<i>Leucodon sciuroides</i>	3	5	4	.	4	4	1	4	3	8
Ch All. <i>Fabronion pusillae</i>										
<i>Habrodon perpusillus</i>	2	.	1	.	1	2	.	.	1	5
<i>Nogopterium gracile</i>	.	1	.	.	.	1	.	.	.	2
Ch All. <i>Ulotion crispae</i> alliance										
<i>Metzgeria furcata</i>	.	.	2	.	.	.	.	.	.	1
<i>Orthotrichum sordidum</i> 2.	.	.	.	1	.	.	.	.	.	1
<i>Ulota crispa</i>	.	.	.	.	.	.	1	.	.	1
Ch Cl. <i>Frullania dilatatae</i> - <i>Leucodontetum sciuroidis</i> and Ch O. <i>Orthotrichetalia</i>										
<i>Frullania dilatata</i>	2	1	1	2	.	1	.	.	1	6
<i>Zygodon rupestris</i>	.	1	.	.	1	.	1	.	.	3
<i>Radula complanata</i>	1	2	.	2	1	.	2	2	.	6
<i>Orthotrichum affine</i>	1	.	.	.	.	.	.	1	.	2
<i>Orthotrichum diaphanum</i>	.	.	.	.	.	1	.	.	.	1
<i>Orthotrichum speciosum</i>	.	.	1	.	.	.	.	.	.	1
<i>Pterigynandrum filiforme</i>	.	.	.	.	.	.	1	.	.	1
Others										
<i>Hypnum cupressiforme</i> var. <i>cupressiforme</i>	.	2	2	3	1	.	4	2	.	6
<i>Homalothecium sericeum</i>	3	.	.	4	2	.	.	.	3	4
<i>Porella platyphylla</i>	.	1	.	.	.	.	.	.	3	2
<i>Hypnum cupressiforme</i> var. <i>subjulaceum</i>	.	.	.	.	.	1	.	.	1	2
<i>Metzgeria conjugata</i>	.	.	.	1	.	.	.	.	.	1
<i>Orthotrichum urnigerum</i>	.	.	.	1	.	.	.	.	.	1

L.o.: *Liquidambar orientalis*, P.o.: *Platanus orientalis*, Q.c.: *Quercus coccifera*,
A.o.: *Alnus orientalis*.

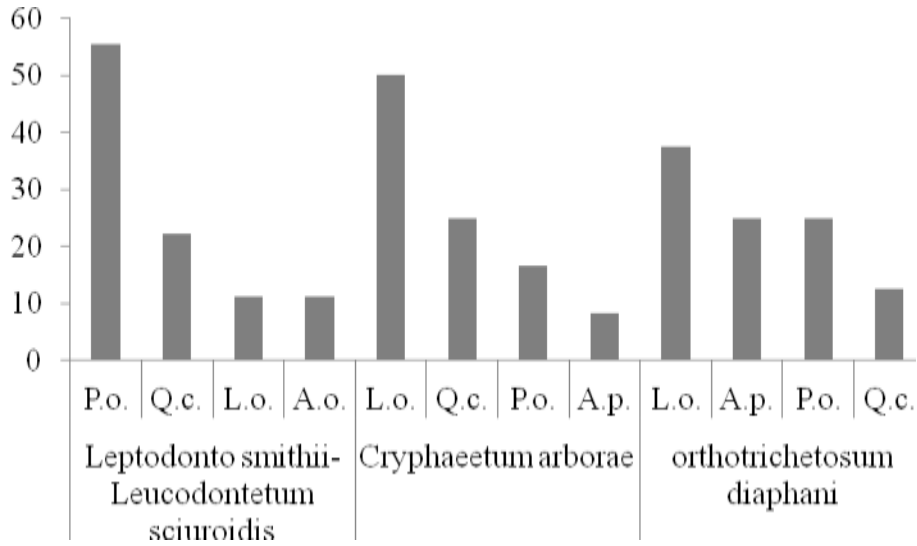


Figure 3. The tree preferences of the syntaxa.

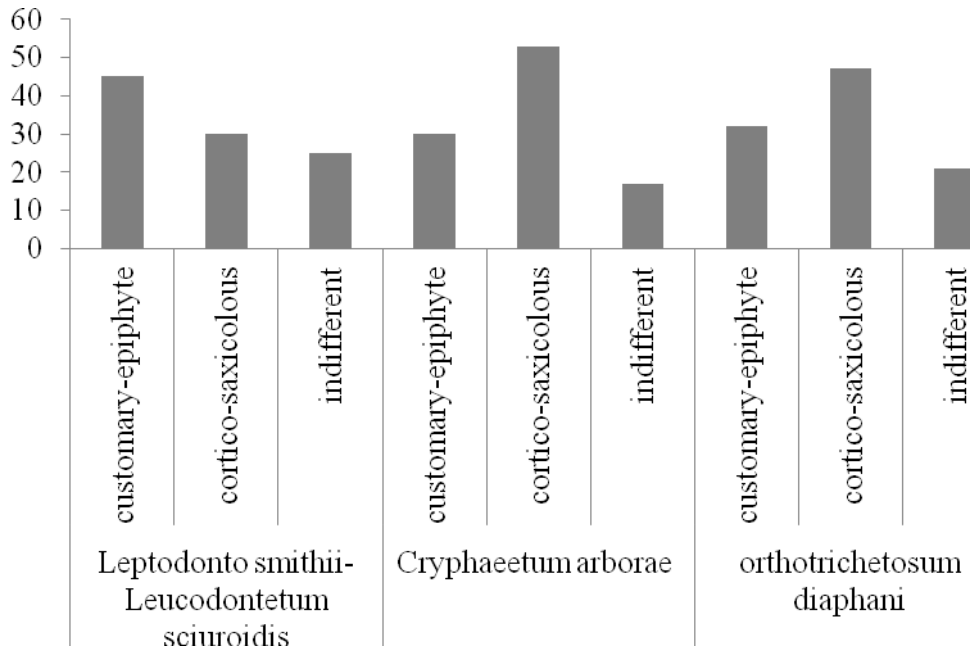


Figure 4. The spectrum of habitat affinities in the syntaxa.

Five taxa are liverworts and 17 are mosses (12 of them pleurocarpous and 5 acrocarpous). The number of pleurocarpous taxa is higher than that of acrocarpous taxa within the *typicum*, but the majority of the pleurocarpous taxa are xerophytic or mesophytic (e.g. *Leptodon smithii*, *Fabronia pusilla*, *Leucodon immersus*, *L. sciuroides*, and *Pseudoleskeella tectorum*). Thus, the epiphytic community *typicum* is wide-spread on semiarid tree trunks and the humid lower base in mesic environments.

The character species of the subassociation *typicum* is *C. heteromalla*; it grows on the mossy bark of trees and

shrubs in woodlands with the highest constancy (100%).

In terms of the habitat affinity of the taxa within this community, cortico-saxicolous taxa prevail (53%), followed by customary epiphytes (30%) and indifferent taxa (25%), (Figure 4).

Syntaxonomically, the community can be classified within the *Fabronion pusillae* alliance of the *Orthotrichetalia* order. Higher-ranked character species are *Frullania dilatata*, *Leucodon sciuroides*, *L. immersus*, *Radula complanata*, *Zygodon rupestris*, *Leptodon smithii*, *Habrodon repusillus*, and *Fabronia ciliaris*.

Table 4. *Cryphaeetum arborae* Barkman 1958 and *Cryphaeetum heteromallae orthotrichetosum diaphani* Lec. 1975.

	3	4	5	6	7	8	10	11	13	14	15	16	17	19	21	22	23	25	26	
Number of relevés	305	305	305	305	945	600	945	945	846	846	455	975	455	485	960	990	960	1010	394	
Altitude (m)	16	12	9	24	6	8	9	8	6	8	9	12	12	8	20	12	16	6	8	6
Size of relevés (dm ²)	L.o	L.o	L.o	P.o.	Q.c.	L.o.	Q.c.	Q.c.	L.o.	L.o.	A.p.	Q.c.	L.o.	P.o.	L.o.	P.o.	A.p.	L.o.	A.p.	
Phorophyte	0.9	0.8	0.7	1.9	0.8	0.7	0.7	0.8	0.6	0.7	0.7	0.7	0.8	1.9	0.9	1.4	0.7	0.8	0.7	
Diameter of trunk (m)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Exposition	N	N	N	NE	NE	N	N	N	NW	N	N	N	N	N	NE	N	N	NW	N	
Position of relevés	95	80	95	90	80	75	95	80	80	80	70	88	90	75	80	85	80	85	80	
Cover (%)	90	90	80	70	80	80	70	70	80	80	70	80	90	80	80	70	80	90	90	
Canopy closure of vegetation (%)	T	T	T	T	T	B	T	B	T	T	B	T	B	T	T	T	T	T	B	
Base (B) / trunk (T)	7	7	6	8	7	6	6	7	7	6	6	8	6	8	8	6	7	7	6	
Number of species							a									b				
Ch Ass.	3	2	4	4	3	3	4	3	3	3	1	2	.	3	2	2	.	.	1	17
<i>Cryphaea heteromalla</i>												1	1	1	2	1	1	1	1	8
<i>Orthotrichum diaphanum</i>																				
Ch All. <i>Fabronion pusillae</i>																				
<i>Habrodon perpusillus</i>	.	.	1	1	1	.	2	1	.	.	1	2	.	1	2	.	.	1	2	12
<i>Leptodon smithii</i>	.	1	.	2	.	.	.	1	.	1	.	.	2	1	.	2	.	.	.	8
<i>Fabronia ciliaris</i>	1	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	3
<i>Nogopterium gracile</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2
<i>Fabronia pusilla</i>	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	2
Ch All. <i>Ulotion crispae</i> alliance																				
<i>Metzgeria furcata</i>	1	.	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	1	.	5
<i>Orthotrichum acuminatum</i>	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Ulotia crispa</i>	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
Ch All. <i>Syntrichion laevipilae</i> alliance																				
<i>Syntrichia papillosa</i>	.	.	.	.	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	2

The association is recorded from Germany (Hübschmann 1986; Marstaller 2006) and Italy (Sicily) (Puglisi and Privitera, 2012).

3.2.3. *Cryphaetum heteromallae* Barkman 1958 -*orthotrichetosum diaphani* Lecointe 1975 (Table 4)

The subassociation -*orthotrichetosum diaphani* was recognized at 394–1010 m of altitude in the study site. It mostly spreads on *Liquidambar orientalis*, *Platanus orientalis*, *Quercus coccifera*, and *Acer platanoides* growing on semiarid slopes in the study site (Figure 3, Table 4).

The species number per relevé varies from 6 to 8. The bryophyte cover ranges from 75% to 95% and the canopy closure of the vascular vegetation varies from 70% to 90%.

Six taxa are liverworts and 15 are mosses. Although the pleurocarpous taxa are dominant (10 taxa), the xerophytic and drought-tolerant characteristics of the taxa composing the subassociation (such as *Orthotrichum* spp.) make it possible to find them in sunny and semiarid habitats, and generally on the upper part of the trees in the study site.

The character species of the -*orthotrichetosum diaphani* is *Orthotrichum diaphanum*, a species growing on the nutrient-rich bark of trees.

Regarding the habitat affinity of the taxa within the community, the cortico-saxicolous taxa prevail (47%), followed by customary epiphytes (32%) and indifferent taxa (21%), (Figure 4).

Syntaxonomically, the subassociation can be classified within the *Fabronion pusillae* (order Orthotrichetalia, class *Frullanio dilatatae-Leucodontetea sciuroidis*).

3.3. Life forms and life strategies

In the present study life form and life strategy analyses of the *Leptodonto smithii-Leucodontetum sciuroidis*, *Cryphaetum heteromallae typicum*, and *Cryphaetum heteromallae-orthotrichetosum diaphani* were carried out. The percentages of each life form and life strategy of the species are reported in Table 5. The main characters of the species reported in the communities (life form, life strategy, spore dimension, sexual and asexual reproduction, life interval, and diffusion strategies) are given in Table 6.

3.3.1. Life forms

The life form reflects the ecological features of the environment (Magdefrau, 1982; Kürschner et al., 1998). Generally, species with cushion and short turf life forms grow under xerophytic, sun-exposed conditions, whereas species with mat, weft, tail, and fan life forms grow under more humid, shady, and hygrophytic conditions (Kürschner, 2004; Düzenli et al., 2009; Kürschner et al., 2012).

Our life form analysis indicates that all epiphytic syntaxa are wide-spread on the semiarid and sun-exposed slope in the study site as a xeromesophytic community (Table 6).

3.3.2. Life strategies

According to the analysis of the life strategies within the studied epiphytic syntaxa, two main categories, perennial shuttle species and perennial stayers, were determined. The perennial stayers with high sexual reproductive efforts are clearly dominant in the entire community in this study due to the high constancy and cover of the *Fabronion pusillae* alliance and the order *Orthotrichetalia* members such as *C. heteromalla*, *H. cupressiforme*, *O. affine*, *O. sordidum*, *Ulota crispa*, *F. ciliaris*, and *F. pusilla* (Table 6). Consequently, the dominating life strategy is perennial stayers within all epiphytic syntaxa. Thus, we can say that the epiphytic communities in this study became climax communities in successional stages due to a high proportion of perennial stayers with high sexual reproductive efforts.

As a result of the present study, two epiphytic bryophyte associations and one subassociation (*Leptodonto smithii-Leucodontetum sciuroidis*, *Cryphaetum heteromallae typicum*, and *Cryphaetum heteromallae-orthotrichetosum diaphani*) were determined as new to Turkey. The number of epiphytic syntaxa reached 15 with the addition of these new records in Turkey.

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Table 5. Life form and life strategy rates of the taxa in the bryophyte communities.

Syntaxa			<i>Leptodonto smithii- Leucodontetum sciuroidis</i>	<i>Cryphaeetum arborae</i>	<i>Cryphaeetum heteromallae orthotrichetosum diaphani</i>
			%	%	%
Life form	Weft (We)		25	36	32
	Cushion (Cu)		35	18	21
	Mat (Ma)		25	23	32
	Tail (Ta)		10	14	11
	Fan (Fa)		5	5	5
	Short turf (sT)		-	5	-
Life strategies	Perennial shuttle species	Perennial shuttle species with high sexual reproductive effort (Pg)	15	9	15
		Perennial shuttle species with high asexual reproductive effort (Pv)	15	14	15
		Perennial shuttle species with moderately or low sexual and asexual reproductive effort (Pp)	5	9	11
	Perennial stayers	Perennial stayers with high sexual reproductive effort (Ag)	30	36	21
		Perennial stayers with high asexual reproductive effort (Av)	20	18	16
		Perennial stayers with high sexual and asexual reproductive effort (Av,g)	5	-	11
		Perennial stayers with high sexual and asexual reproductive effort (Ap)	10	14	11

Table 6. Characters and life strategies of the species [+ present; - absent; D - dioecious; ge - gemma; ac - achorous strategy; l - long; lr - long-range dispersal; fd - flagelliform diaspores; red - reduced; sc - shoots creeping; M - monoecious; P - paroicous; s - short; sr - short range-dispersal; rbg - rhizooidal gemma; Cu - cushion; Ag-Pg life strategies].

Syntaxonomy	Species	Life form	Life cycle		Sexual reproduction				Spores (μ in μ m)		Asexual reproduction		Innovation shoots	Dispersal strategy	Seta	Peristome	Life strategy
			Annual / biannual	Paucennial / perennial	Frequent within the 1st year	Frequent within the 2nd - 4th year	Rare	Monocious, dioecious	Large (> 25 μ m)	Small (< 25 μ m)	Lacking or rare	Rare or frequent					
Characteristic species	<i>Cryphaea heteromalla</i>	Ta	-	+	-	-	M	-	+	-	fd	sc	sr, lr	s	l	Ag	
	<i>Orthotrichum diaphanum</i>	Cu	-	+	-	-	A	-	+	-	ge	-	sr, lr	s	l	Av,g	
	<i>Leptodon smithii</i>	Fa	-	+	-	-	D	-	+	-	-	sc	sr, lr	s	red	Av	
	<i>Leucodon sciurioides</i>	Ta	-	+	-	-	D	-	+	fd	-	sc	sr, lr, ac	l	l	Pv	
Characteristic species of the <i>Fabronia pusillae</i> alliance	<i>Habrodon perpusillus</i>	We	-	+	-	-	D	-	+	-	ge	-	sr, lr	s	-	Av	
	<i>Nogopterium gracile</i>	We	+	-	-	-	D	+	-	fd	sc	sr, lr, ac	l	l	l	Pp	
	<i>Fabronia ciliaris</i>	We	+	-	-	-	M	-	+	-	-	-	sr, lr	l	l	Ag	
	<i>Fabronia pusilla</i>	We	+	-	-	-	M	-	+	-	-	-	sr, lr	l	l	Ag	
Characteristic species of the <i>Syntrichion laevipila</i> alliance	<i>Orthotrichum obtusifolium</i>	Cu	-	+	-	-	D	-	+	-	-	-	sr, lr	s	l	Av,g	
	<i>Syntrichia papillosa</i>	sT	-	+	-	-	D	-	+	-	-	-	sr, lr	l	l	Av	
Characteristic species of the <i>Ulotia crispae</i> alliance	<i>Metzgeria furcata</i>	Ma	-	+	-	-	D	+	-	-	ge	-	sr, lr	s	-	Pv	
	<i>Ulotia crispae</i>	Cu	-	+	-	-	A	-	+	-	-	-	sr, lr	l	l	Ag	
	<i>Orthotrichum sordidum</i>	Cu	-	+	-	-	A	-	+	-	-	-	sr, lr	s	l	Ag	
	<i>Orthotrichum acuminatum</i>	Cu	-	+	-	-	A	-	+	-	-	-	sr, lr	s	l	Ag	
Characteristic species of the <i>Orthotrichetalia</i> order and <i>Frullania dilatatae</i> - <i>Leucodontetata sciurioidis</i> class	<i>Frullania dilatata</i>	Ma	-	+	-	-	D	+	-	ge	-	-	sr, lr, ac	s	-	Pg	
	<i>Radula complanata</i>	Ma	-	+	-	-	P	+	-	-	ge	-	sr, lr	s	-	Pv	
	<i>Zygodon rupestris</i>	Cu	-	+	-	-	D	-	+	-	ge	-	sr, lr	l	red	Av	
	<i>Leucodon immersus</i>	Ta	-	+	-	-	D	+	-	fd	-	sc	sr, lr, ac	l	l	Pv	
	<i>Orthotrichum affine</i>	Cu	-	+	-	-	A	-	+	-	-	-	sr, lr	s	l	Ag	
	<i>Orthotrichum speciosum</i>	Cu	-	+	-	-	A	+	-	+	-	sc	sr, lr, ac	s	l	Pg	
<i>Pterigynandrum filiforme</i>	Ta	-	+	-	-	D	+	-	-	ge	-	sr, lr	l	l	Av		

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