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THE EPIPHYTIC BRYOPHYTE FLORA AND VEGETATION OF ZONGULDAK-GÖBÜ VILLAGE (NORTHWEST TURKEY)

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Abstract

The epiphytic bryophyte flora and vegetation of the Zonguldak-Göbü village was investigated in this study. Between the years 2012-2013, as a result of identification of the 236 epiphytic bryophyte samples collected from the trunks of trees; total of 29 taxa (8 liverworts, 21 mosses) belonging to 23 genera and 17 families were determined. As a result of evaluation of the 33 relevés taken from the trunk of trees by Braun-Blanquet method, the *Plagiothecietum neglecti* association, *Pylaisietum polyanthae* typicum and *Pylaisietum polyanthae -lophocoleetosum heterophyllae* subassociation are identified. From these syntaxa, *Plagiothecietum neglecti* has been reported for the first time in Turkey, in addition *Pylaisietum polyanthae -lophocoleetosum heterophyllae* subassociation is new for knowledge. The life forms and life strategies of syntaxa examined in terms of ecological and floristic have been analyzed. Mat and weft are dominant of the life forms while Ag is dominant of the life strategies. In addition, the most taxa of floristic list are determimed mesophytic, sciophyt and acidic as a character.

Key words: Bryophyte, Epiphytic, Zonguldak, *Plagiothecietum neglecti* association.

Introduction

Generally, bryophytes as organisms are not very attractive for botanists. Although their direct benefit for people is much smaller than the benefits of other plants, nonvascular plants form an integral part of ecosystems. In ecosystems they function in many ways, e. g. with respect of their ability to hold large amounts of water, they are the first colonisers of open ground; bryophytes create a more hospitable environment for many other organisms. Among the main factors which cause their vanishing is the rarity of certain species. The most serious threat facing bryophytes is habitat loss through direct site destruction or through the lack of suitable management (Gálusová *et al*., 2014).

For epiphytic bryophytes, the suitable substrate and environmental conditions are more important than the other terrestrial bryophytes (Frahm, 1990; Frahm *et al.,* 2003). The substrate is one of the most important factors in the distribution of the epiphytic bryophytes. Important substrate characteristics are structure, hardness, pH-value and water holding capacity of the bark, as well as chemical properties of exudates from the host tree (Barkman, 1958; Richards *et al.,* 1996; Holz, 2003). Having different features, these substrates host different epiphytic bryophytes.

There are few studies on epiphytic bryophyte flora (Kürschner, 1999; Ezer *et al.,* 2009; 2010; 2013; Düzenli *et al.,* 2009; 2011; Alataş *et al.,* 2012a, 2012b; Ezer & Kara, 2013) and their vegetation (Walther & Leblebici, 1969; Walther, 1975, 1979; Brullo *et al.,* 1991; Kürschner *et al.,* 1998; 2006, 2007; 2012; Kürschner & Parolly, 1999a,b; Kara *et al.,* 2011) in Turkey. Most of these studies were conducted in the Western Anatolia and Mediterranean regions of Turkey. Despite these studies, there are important gaps on the epiphytic bryophyte vegetation in Turkey.

The aim of the present paper was to perform phytosociological investigations of the epiphytic bryophyte vegetation of the Zonguldak-Göbü village (Turkey) and to make contribution to the Turkish and the science world bryosociological studies. It is hoped that this study will be useful as a guide for future studies.

Material and Methods

Study area L: Zonguldak is located in the Western Black Sea region of Turkey at latitudes 41°-27' N and longitudes 31°-49' E (Çıtıroğlu, 2012). The study area which remains in A2 square according to Henderson (1961) grid system is in the Euxinian Zone of the Euro-Siberian phytogeographical region of Turkey (Davis, 1965 Fig. 1). Zonguldak province has different climate types from the coastal areas to the inland areas because of the mountains that run parallel to the coast. Because of the climatic diversity, different types of vegetation such as Oceanic, Sub-Mediterranean and Mediterranean were occurred from the north to the south of the area (Güvenç *et al.,* 2009).

The mean annual rainfall in the coastal areas of Zonguldak is 1231.9 mm and the mean annual temperature is 13.5°C. The maximum mean temperature (M) is 25.1°C in August, while the minimum mean temperature (m) is 3.1°C in February (Fig. 2). The seasonal precipitation regime during the year is winter, autumn, summer and spring (WASS). This is called ocean climate (Akman, 1990).

In the study area, while coniferous *Pinus nigra* Arn. subsp. *pallasiana* (Lamb) Hulmboe is dominant, deciduous *Castanea sativa* Miller is dominant. *Fagus orientalis* Lipsky, *Carpinus betulus* L., *Juglans regia* L. and *Tilia tomentosa* Moench. are other deciduous trees of the area.

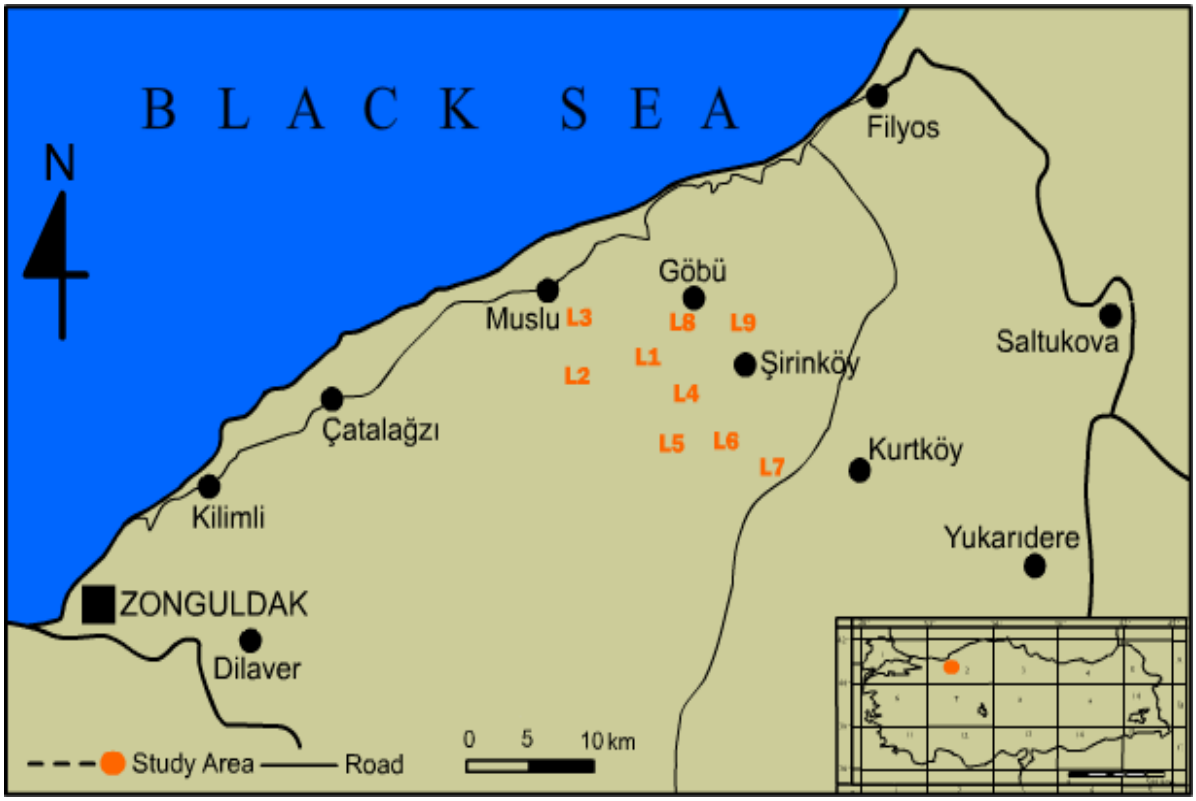

Fig. 1. Grid system of Turkey adopted by Henderson (1961) and the boundaries of the study area.

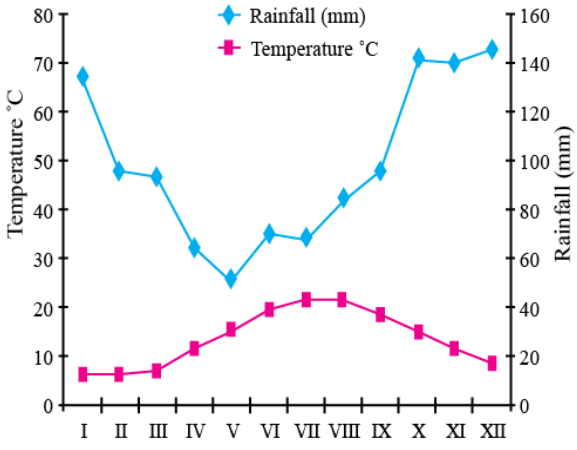

Fig. 2. The climatic diagram of Zonguldak.

Vegetation sampling and data sources: The research materials were composed of 33 phytosociological relevés and 236 bryophyte specimens were collected from the trunks of trees growing in the different localities of the Göbü village with varying ecological characteristics (Table 1). For the relevés, trees with different diameters depending on floristic composition have been selected. The relevés were performed from the base (0.3-0.5 m, 11 relevés) and trunk (0.5-1.2 m, 22 relevés). The bryosociological analysis has been carried out applying the Braun-Blanquet (1964) approach of vegetation investigation and classification method with the scale of Frey & Kürschner (1991a) (Table 2). In addition, ecological (moisture, light etc.) and statistical (diameter, height, coverage etc.) data were recorded for each relevé.

The nomenclature of the taxa in the floristic list follows Goffinet & Shaw (2009) for liverworts and Hill *et al*. (2006) for mosses. Diagnosed specimens were stored in Zonguldak Science and Art Center (Zonguldak-Turkey).

Syntaxonomic arrangement follows Marstaller (2006) and Weber *et al*. (2000). The life forms of the species were determined according to Magdefrau (1982), the life strategies of the species according to during (1979) and Frey & Kürschner (1991b), and the habitat affinities of the taxa according to Draper *et al*. (2003). The ecological characteristics of the taxa such as humidity, light and acidity were regulated in accordance with Dierβen (2001).

Results and Discussion

Epiphytic flora: As a result of the study, 21 moss taxa belonging to 12 families and 17 genera, 8 liverwort taxa belonging to 5 families and 6 genera have been found on epiphytic habitats in Göbü village (Zonguldak) (Table 3). *Castania sativa* is the most species-rich tree in the study site, while the *Tilia tomentosa* is the poorest tree in term of species rishness. *Hypnum cupressiforme, Pylaisia polyantha, Radula complanata, Lophocolea heterophylla, Brachytheciastrum velutinum* and *Plagiothecium nemorale* are the mostly found taxa on the epiphytic habitats. Among them, *R. complanata* is the only species found on all trunks of tree species.

Table 1. The list of localities.

Number of relevés	Localities	Altitude (m)	Phorophyte	Date	GPS Coordinates
1, 2, 3, 31	1	108	*C.s., F.o.*	22.09.2012	N 41º31' 12.26" E 031º57'20.77"
4, 5	2	179	*C.s.*	22.09.2012	N 41º31' 14.57" E 031º57'09.64"
6, 7, 20, 21, 22	3	228	*C.s.*	23.09.2012	N 41º31'23.87" E 031º57'07.44"
8, 9, 10, 23, 24	4	136	*C.s.*	01.05.2013	N 41º31'06.09" E 031º57'26.41"
11, 12, 13, 25, 26, 27, 28	5	176	*C.s.*	01.05.2013	N 41º31'02.93" E 031º57'30.18"
14, 15, 16, 29, 30	6	249	*C.s.*	02.05.2013	N 41º30'59.52" E 031º57'40.72"
17, 18, 19	7	155	*C.s., C.b.*	02.05.2013	N 41º29'39.68" E 031º58'19.51"
33	8	37	*F.o.*	26.07.2013	N 41º31'22.61" E 031º57'34.74"
32	9	82	*T.t.*	26.07.2013	N 41º31'23.28" E 031º57'56.06"

C.s.; Castane sativa, F.o.; Fagus orientalis, C.b.; Carpinus betulus, T.t.; Tilia tomentosa

Table 2. Abundance-coverage scale used for bryophytes.

Scale	Abundance-coverage	scale	Abundance-coverage
+	< % 1	3	% 12, 1-25,0
1	% 1, 1-6,0	4	% 25, 1-50,0
2	% 6,1-12,0	5	% 50, 1-100

The most species-rich families in the study site are Orthotrichaceae and Hypnaceae (with 4 species), which form up to 14 % of the bryophyte species identified in this study. Other families were represented with two and only one taxon (Table 3). In general, while epiphytic Orthotrichaceae members are wide-spread on less humid upper part of trunk, Hypnaceae members are wide-spreads on more humid lower base of the trunk. In addition, high number of family emphasizes richness of the microhabitats.

While considering the taxa in terms of some ecological characteristics, life forms and life strategy, we have considered the land observations in addition to the literature. According to the humidity preference of taxa, mesophytes (48%) are dominant in the study site. These are followed by hygrophytes (41%) and xerophytes (10%). According to the light request of taxa; sciophytes (86%) are dominant in the study site. Considering acidity preference of taxa, acidophytes (55%) are dominant. These are followed by subneutrophytes (41%) and basiphytes (3%) in the study site (Fig. 3). It has been understood that more than half of the samples prefers acidic and shady microhabitats.

Epiphytic vegetation: In the study area, as a result of the classification of 33 relevés taken from the trunks of trees by Braun-Blanquet method, one epiphytic bryophyte associations and two subassociation were identified. These syntaxa are *Plagiothecietum neglecti* Ricek 1968, *Pylaisietum polyanthae* Felf. 1941 typicum and *Pylaisietum polyanthae lophocoleetosum heterophyllae* Kara, Ezer & Alataş subass. nova. From syntaxa, while *Plagiothecietum neglecti* have been recorded for the first time in Turkey, the *Pylaisietum polyanthae lophocoleetosum heterophyllae* is new. Marstaller (2006) according List of syntaxa;

Clas. Cladonio-Lepidozietea reptantis Jez. et Vondr. 1962 em. Marst. 1993
Ord. Cladonio-Lepdozietalia reptantis Jez. et Vondr. 1962 Marst. 1993
All. Nowellion curvifoliae Phil. 1965
All. Tetraphidion pellucidae v. Krus. 1945
Ord. Brachythecietalia rutabulo-salebrosi Marst.1987
All. Bryo-Brachythecion Lec. 1975 em. Marst. 1987
***Ass. Plagiothecietum neglecti* Ricek 1968** (Table 4)
Ord. Diplophzlletalia albicantais Phil. 1963
All. Dicranellion heteromallae (Phil. 1956) Phil. 1963
Ord. Dicranetalia scoparii Barkm. 1958
All. Dicrano scoparii-Hypnion filiformis Barkm. 1958

Class. Frullanio dilatatae-Leucodontetea sciuroidis Mohan 1978 em. Marst.1985
Ord. Orthotrichetalia Had. in Kl. et Had. 1944
All. Ulotion crispae Barkm.1958
Ass. *Pylaisietum polyanthae* Felf. 1941 (Table 5)
subass. *typicum*
subass. *lophocoleetosum heterophyllae* subass. nov.

***Plagiothecietum neglecti* Ricek 1968** (Table 4)

Plagiothecietum neglecti has been described first time with name *Plagiothecietum neglecti* in 1968 by Ricek, later it has been changed as *Plagiothecio nemoralis-Brachythecietum velutini* Vadam 1990 by Vadam (Marstaller, 2006).

The association is identified as epiphytic with 13 relevés taken from the tree trunk between 108-249 meters of the study area. The association shows spread at the north of the area and tree trunk. The tree that is preferred by the association is *C. sativa* (Fig. 4). *C. sativa* is grey and uncracked while tree trunk is young, and it is brown and cracked in later ages (Mamıkoğlu, 2007). The old and cracked trees at the area allow different microhabitats and therefore different epiphytic bryophytes.

While the general cover of the association differs between 65% and 98%, the closure of the vegetation alters 80% and 100%. Seven of the 21 taxa which form the association are liverworts, 14 of them are mosses; 5 of these mosses are acrocarpous and the other 9 are pleurocarpous. In addition, average taxa number is 6 at the association. These data reveal that there are different habitats at the area. However, acrocarpous show appearance of the arid and pleurocarpous show appearance of humid and shady areas.

Table 3. Floristic list and ecological characteristics of taxa.

Families	LN	Taxa	H	L	A	Substrat				
						C.s.	F.o.	J.r.	C.b.	T.r.
		Marchantiopsida								
Metzgeriaceae	3, 4, 5, 6, 7	*Metzgeria furcata* (L.) Dumort.	m	S	a	+				
Radulaceae	1, 2, 3, 4, 5, 6, 7, 8, 9	*Radula complanata* (L.) Dumort.	h	S	s	+	+	+	+	+
	3, 5	*Radula lindenbergiana* Gottsche et C. Hartm.	h	S	s	+				
Frullaniaceae	1, 3, 4, 6, 8, 9	*Frullania dilatata* (L.) Dumort.	h	S	a	+	+			+
	1, 2, 3, 7, 8	*Frullania tamarisci* (L.) Dumort.	m	S	a	+		+	+	
Lejeuneaceae	3, 4, 5, 7	*Lejeunea cavifolia* (Ehrh.) Lindb.	h	S	a	+			+	
Lophocoleaceae	1	*Chiloscyphus polyanthos* (L.) Corda.	h	S	a	+				
	1, 2, 3, 4, 5, 6, 7, 9	*Lophocolea heterophylla* (Schrad.) Dumort.	h	S	a	+			+	+
		Bryopsida								
Grimmiaceae	8	*Grimmia pulvinata* (Hedw.) Sm.	x	P	a			+		
Dicranaceae	1	*Dicranella heteromalla* (Hedw.) Schimp.	m	S	a	+				
	1	*Dicranum scoparium* Hedw.	m	S	a	+				
Leucobryaceae	2, 3, 4, 5	*Dicranodontium denudatum* (Brid.) E.Britton.	h	S	a	+				
Bryaceae	8	*Bryum capillare* Hedw.	m	S	s			+		
	1, 7	*Bryum moravicum* Podp.	m	S	s	+				
Mniaceae	1, 6	*Mnium hornum* Hedw.	h	S	a	+				
Orthotrichaceae	1, 8	*Orthotrichum affine* Schrad. ex Brid.	m	S	s		+	+		
	8	*Orthotrichum diaphanum* Schrad. ex Brid.	x	P	s			+		
	8	*Orthotrichum lyelli* Hook. & Taylor.	m	P	s			+		
	8	*Zygodon rupestris* Schimp. ex Lorentz.	x	P	b			+		
Amblystegiaceae	2, 4, 7	*Amblystegium serpens* (Hedw.) Schimp.	h	S	a	+			+	
Brachytheciaceae	4	*Plasteurhynchium striatulum* (Spruce) M.Fleisch.	m	S	s	+				
	1, 2, 3, 4, 5, 6, 7	*Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen.	m	S	s	+				
Hypnaceae	1, 2, 3, 4, 5, 6, 7, 8	*Hypnum cupressiforme* Hedw.	m	S	s	+	+	+		
	6, 8	*Hypnum resupinatum* (Taylor) Schimp.	m	S	a		+	+		
	1	*Herzogiella seligeri* (Brid.) Z.Iwats.	h	S	a	+				
	3, 4, 5, 6, 7, 8, 9	*Pylaisia polyantha* (Hedw.) Schimp.	h	S	a	+	+		+	+
Pterigynandraceae	6, 7	*Pterigynandrum filiforme* Hedw.	m	S	s	+	+			
Plagiotheciaceae	1, 2, 3, 4, 5, 6, 7	*Plagiothecium nemorale* (Mitt.) A. Jaeger.	h	S	a	+			+	
Lembophyllaceae	1, 2, 5, 7	*Isothecium alopecuroides* (Lam. ex Dubois) Isov.	m	S	s	+			+	

LN: Locality Number, C.s.: *Castane sativa,* F.o.: *Fagus orientalis,* J.r.: *Juglans regia,* C.b.: *Carpinus betulus,* T.r.: *Tilia tomentosa* and certain ecological characteristics, H: humidity (m: mesophyte, h: hygrophyte, x: xerophytes), L: lighting (S: sciophyte, P: photophyte), A: acidity (a: acidophyte, s: subneutrophyte, b: basiphyte

The characteristic of the association hygrophyte *P. nemorale* has highest repeatable taxon, persistence at the relevés is 92%, mesophyte *B. velutinum* is 54%. Our characteristics that show both epiphytic and epilitic distribution are the taxa that like shady environment. *P. nemorale* generally spreads at lower sections; however it can rise up to 460 m in height. Our other characteristic *B. velutinum* spreads in lower sections. The spreading of the defined association in lower sections according to the characteristics of the association supports the validity of the study.

When considering habitat affinity of the taxa at the association, the rates of the epiphytics, epiphytic -epilitic (facultative epiphyte) and generally taxa showing spread at all habitats appears same (Fig. 5). These data shows that syntaxa does not have stable structure and variety of the microhabitats.

Syntaxonomically, the association could classified within the the *Bryo capillaris-Brachythecion rutabuli* alliance of the *Brachythecietalia rutabulo-salebrosi* order. Higher-ranked character species; *F. dilatata*, *R. complanata*, *M. furcata* and *F. tamarisci* support the classification within the class *Cladonio digitatae - Lepidozietea reptantis* (Table 4) Marstaller (2006).

In addition, the association in the study site matches with the associations defined by Ricek (1968), Hübschmann (1986), Marstaller (2006) and Schubert (2009) in terms of alliance, ordo and class characteristics. The matches with our association are as follows: *P. nemorale, M. hornum, D. denudatum, D. scoparium, H. cupressiforme, D. heteromalla, B. velutinum, L. heterophylla, I. alopecuroides*. The high number of the matches' species reveals validity of our defined association.

Pylaisietum polyanthae Felf. 1941 (Table 5)

The epiphytic association is identified with 10 relevés taken from the tree trunks in between 108-249 meter of study area. The association shows spread at the north direction of area and tree trunks. The most preferred tree at the association is *C. sativa* (Fig. 4).

While the general cover of the association differs between 40% and 85%, the closure of the vegetation alters 80% and 100%. Five of the 10 taxa which form the association are liverworts, the other 5 are mosses; 1 of the mosses is acrocarpous and the rest 4 are pleurocarpous. Moreover, average taxa number is 4 at the association.

The characteristic of the association hygrophyte *P. polyantha* is the taxon with the highest repetition and its permanence in the relevés is 100%. *P. polyantha* is a taxon which likes the open forestlands and acidic environments. In our study, most of the tree trunks spread in lower humid part of the tree trunk.

When considering habitat affinity of the taxa at the association, the rates of the epiphytics is 60%, those showing distribution at all habitats and epiphytic-epilitic is 20% (Fig. 5). We can explain that high number of the epiphytic taxa is because of the existence of humid and shady areas close to the sea shore under effect of the oceanic climate.

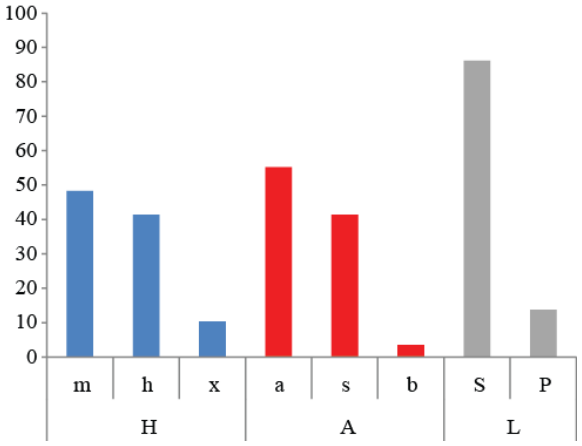

Fig. 3. Humidity (H), acidity (A) and the light (L) preferences of the taxa.

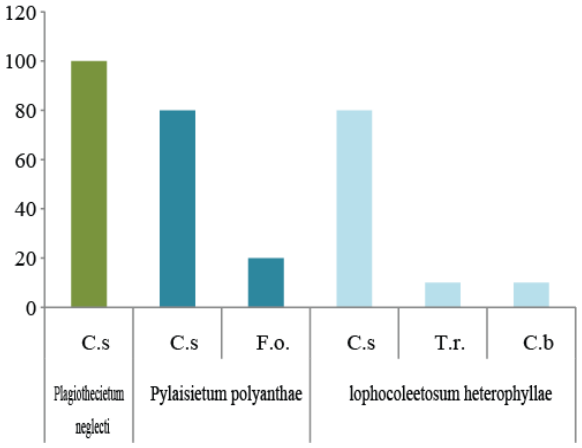

Fig. 4. The tree preferences of the syntaxa.

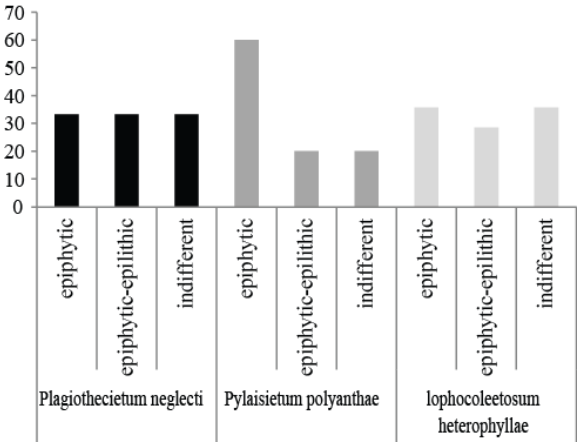

Fig. 5. The habitat affinities spectrum of the species of syntaxa.

Syntaxonomically, the association can be classified within the the *Ulotion crispae* alliance of the *Orthotrichetalia* order. Higher-ranked character species; *F. dilatata*, *R. complanata*, *R. lindenbergiana* and *M. furcata* supports the classification within the epiphytic class *Frullanio dilatatae-Leucodontetea sciuroidis,* wide-spread at the northern hemisphere, phytosociologically (Table 5) Marstaller (2006).

When we compare our association with the associations identified by Goia & Schumacker (2003) in Romania, by Marstaller (2009) in Germany and by Baisheva (2000) in Russia, we see that our association matches with the associations identified in Romania and Germany; in terms of alliance, ordo and class characteristics but it doesn't match with that of Russia. However, the fact that the association is identified in a xeromesophyte atmosphere shows that it matches with our association in terms of environment. Besides, the association identified as epiphytic, was identified on *F. orientalis* and *C. sativa* trees in Turkey, on *Cerasus mahaleb* (L.) Miller trees in Germany, on *Salix sp.* and *F. sylvatica* trees in Romania and on *T. cordata* Mill, *Q. robur* L., *P. tremula* L. trees in Russia.

So far, 3 subassociation have been described for the *Pylaisietum polyanthae* Felf. 1941 association (Marstaller, 2006). These subassociations are -typicum, -*orthotrichetosum obtusifolii* Marst. 1985 and -*amblystegietosum subtilis* Phil. 1965. With this study we made, fourth one is added from the Göbü village chestnut forests.

Pylaisietum polyanthae lophocoleetosum heterophyllae Kara, Ezer & Alataş **subass. nova hoc loco**

Nomenclatural type: Table 5. relevé 30 (orig.). holotypus hoc loco: Prov. Zonguldak (Turkey) Göbü village, alt. 249m a.s.l., *C. sativa* forest: DSubass: *Lophocolea heterophylla.*

Its subassociation is identified as epiphytic with 10 relevés taken from the tree trunks in between 82-249 meter of study area. The subassociation spreads in north direction of the tree trunks and area. The most preferred tree at the subassociation is *C. sativa* (Fig. 4).

While the general cover of the subassociation differs between 60% and 89%, the closure of the vegetation alters 80 % and 100 %. Six of the 14 taxa which form the subassociation are liverworts, 8 are mosses; one of the mosses is acrocarpous and the other 7 are pleurocarpous. In addition, average taxa number is 6 at the subassociation. The high number of liverworts and pleurocarpous shows that the area is mostly humid and shady habitat.

The characteristic of the subassociation hygrophyte *L. heterophylla* is the taxon with the highest repetition and its permanence in the relevés is 100%. It is the taxon that spreads as both epiphytic and epilitic likes shady and acidic environment and is resistant to the air pollution (Dierβen, 2001). The air pollution resistance of our characteristics supports the definition of our subassociation in lower sections.

When considering habitat affinity of the taxa at the subassociation, it appears that the rate of the taxa that spread in all habitats in general and epiphytics are the same (36%) (Fig. 5). The rate of the epiphytic-epilitic taxa are 28 %. The spread of our subassociation characteristic in epiphytic and all habitats in general matches with these data. In addition, these data show presence of different microhabitats in the area that syntaxa spread.

Table 4. ***Plagiothecietum neglecti*** **Ricek 1968.**

Succesive number of relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
Number of relevés in the field	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**13**	**23**	**15**	**18**	
Altitude a.s.l. (m)	108	108	108	179	179	228	228	136	176	176	136	249	155	
Size of relevés (dm^2)	20	12	15	24	18	15	80	9	12	16	20	10	16	
Phorophyte	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	
Trunk (m)	1,4	1,2	1,8	1,7	1,9	1,8	1,7	1,8	1,4	1,6	1,2	1,4	1,6	
Exposition	N	N	N	N	N	N	N	N	N	N	N	N	N	
Position of relevés	N	N	N	N	NE	N	N	NE	N	N	N	N	NE	Frequency
Covering (%)	95	90	91	92	98	92	94	92	90	90	65	91	86	
Closure (%)	80	80	80	90	90	90	90	90	90	90	90	100	80	
Base (B) / Trunk (T)	T	B	T	T	T	B	T	T	T	B	B	T	T	
Number of species	10	8	8	8	10	8	9	7	6	7	4	5	8	
ChAss.														
Plagiothecium nemorale	2	3	3	3	4	4	3	3	3	2	.	3	3	12
Brachytheciastrum velutinum	.	.	3	.	2	2	3	3	2	2	.	.	.	7
ChAll. ***Dicrano scoparii-Hypnion filiformis***														
Hypnum cupressiforme	4	4	4	4	3	4	4	4	4	4	4		4	12
Dicranum scoparium	1	2	.	.	.	.	.	.	.	.	.	.	.	2
ChAll. ***Tetraphidion pellucidae***														
Dicranodontium denudatum	.	.	.	2	2	.	2	2	.	2	.	.	.	5
ChAll. ***Bryo capillaris-Brachythecion rutabuli*** **and ChO.** ***Brachythecietalia rutabulo-salebrosi***														
Bryum moravicum	1	.	.	.	.	.	.	.	.	.	.	.	1	2
Amblystegium serpens	.	.	.	.	1	.	.	.	.	.	.	.	.	1
ChAll. ***Dicranellion heteromallae(*)*** **and ChAll.** ***Nowellion curvifoliae(**)***														
(*)Dicranella heteromalla	2	1	.	.	.	.	.	.	.	.	.	.	.	2
(**)Herzogiella seligeri	.	.	1	.	.	.	.	.	.	.	.	.	.	1
ChCl. ***Cladonio digitatae - Lepidozietea reptantis***														
Lophocolea heterophylla	2	.	.	2	2	1	2	2	3	2	2	.	.	9
Mnium hornum	3	2	.	.	.	.	.	.	.	.	.	.	.	2
Cladonia fimbriata	1	1	2	1	2	1	1	1	2	1	2	1	1	13
Others														
Radula complanata	1	1	2	1	1	1	1	.	.	1	.	2	1	10
Frullania tamarisci	2	2	.	2	2	2	.	.	.	.	.	.	.	5
Isothecium alopecuroides	.	.	2	1	1	.	.	.	1	.	.	.	.	4
Lejeunea cavifolia	.	.	.	.	.	1	1	2	.	.	.	.	1	4
Pylaisia polyantha	.	.	.	.	.	.	.	.	.	.	.	4	1	2
Metzgeria furcata	.	.	.	.	.	.	1	.	.	.	.	.	.	1
Plasteurhynchium striatulum	.	.	.	.	.	.	.	.	.	.	3	.	.	1
Pterigynandrum filiforme	.	.	.	.	.	.	.	.	.	.	.	.	1	1
Frullania dilatata	.	.	.	.	.	.	.	.	.	.	.	2		1
Chiloscyphus polyanthos	.	.	1	.	.	.	.	.	.	.	.	.	.	1

Syntaxonomically, the subassociation can be classified within the *Ulotion crispae* alliance of the *Orthotrichetalia* order. Higher-ranked character species; *F. dilatata*, *R. complanata*, *M. furcata* and *F. tamarisci* support the classification within the epiphytic class *Frullanio dilatatae-Leucodontetea sciuroidis,* wide-spread at the northern hemisphere, phytosociologically (Table 5) Marstaller (2006).

The most typical bryophyte communities were discribed in the Zonguldak-Göbü Village. They are referred to 2 associations and 2 subassociations. Among them one subassociation is discribed as new and one association is new record to the bryophyte vegetation of Turkey. Other is known throughout the Europe and Asia. In the European system of high syntaxa (Marstaller, 2006) plant species of the associations belong to 2 classes, 5 orders and 6 alliances.

Life forms and life strategies: In this study the life form and life strategy analysis of the *Plagiothecietum neglecti*, *Pylaisietum polyanthae* typicum and *Pylaisietum polyanthae -lophocoleetosum heterophyllae* subassociation are studied (Table 6 and 7, Figs. 6 and 7). Additionally, the main characters of the species of the associations and subassociation (life form, life strategy, spore dimension, sexual and asexual reproduction, life interval and diffusion strategies, etc.) are given in Table 7.

Table 5. a: ***Pylaisietum polyanthae*** **typicum Felf. 1941. and b:** ***P. p. lophocoleetosum heterophyllae*** **Kara, Ezer & Alataş subass. nova.**

Succesive number of relevé	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	
Number of relevés in the field	**33**	**31**	**20**	**21**	**22**	**24**	**25**	**26**	**28**	**29**	**32**	**10**	**16**	**17**	**19**	**9**	**11**	**14**	**30**	**27**	
Altitude a.s.l. (m)	249	108	228	228	228	136	176	176	176	249	82	136	249	155	155	136	176	249	249	176	
Size of relevés (dm^2)	12	16	6	9	12	16	8	9	15	12	10	20	16	12	20	12	9	9	15	6	
Phorophyte	F.o.	F.o.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	C.s.	T.t.	C.s.	C.s.	C.s.	C.b.	C.s.	C.s.	C.s.	C.s.	C.s.	
Trunk (m)	1,8	1,4	1,2	1,2	1,3	2	1,6	2,0	1,4	1,4	2.0	1,8	1,2	2,0	1,4	1,8	2,0	1,8	0,9	1,2	
Exposition	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Frequency
Position of relevés	N	N	N	N	NE	N	N	N	N	NE	N	N	N	N	N	NE	NE	N	N	N	
Covering (%)	65	70	65	68	51	40	55	48	75	85	60	85	89	88	85	76	88	78	56	60	
Closure (%)	80	90	90	90	90	90	90	90	90	100	90	90	100	80	80	90	90	100	100	90	
Base (B) / Trunk (T)	T	B	B	T	B	B	T	T	T	T	B	T	B	T	T	T	T	T	B	T	
ber of species	4	4	3	5	4	4	3	7	5	5	5	8	9	7	9	7	6	4	5	3	
ChAss.					**a**											**b**					
Pylaisia polyantha	4	4	3	2	2	2	2	2	2	2	2	1	1	1	1	1	4	4	4	4	20
Lophocolea heterophylla	.	.	.	.	.	.	.	.	.	.	1	2	2	2	2	2	2	2	2	2	10
Plagiothecium nemorale	.	.	.	.	.	.	.	.	.	.	.	3	4	4	4	3	3	3	.	.	7
ChAll. ***Ulotion crispae***																					
Metzgeria furcata	.	.	.	.	.	.	.	.	2	2	.	1	.	1	.	.	.	.	.	.	4
Radula lindenbergiana	.	.	.	.	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
Frullania tamarisci	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1
Pterigynandrum filiforme	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Ch.Cl. Frullanio dilatatae-Leucodontetea sciuroidis and ChO. Orthotrichetalia																					
Radula complanata	.	3	1	2	1	.	1	1	1	3	3	1	1	1	1	.	1	2	1	.	16
Frullania dilatata	2	.	.	2	.	.	.	.	.	2	3	.	1	.	.	.	.	.	2	.	6
Orthotrichum affine	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Others																					
Hypnum cupressiforme	.	.	4	4	4	4	4	3	4	4	.	4	2	.	.	4	.	.	.	.	11
Lejeunea cavifolia	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	1	1	.	.	.	3
Brachytheciastrum velutinum	.	.	.	.	.	.	.	.	.	.	.	2	2	3	.	.	.	.	.	.	3
Amblystegium serpens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	2
Plasteurhynchium striatulum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1
Hypnum resupinatum	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Isothecium alopecuroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1
Mnium hornum	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1
Cladonia fimbriata	.	2	.	2	.	1	.	.	2	.	2	1	1	2	2	.	2	.	1	2	12

Life forms: While, Mat (Ma) life form takes first place (50%) within *Pylaisietum polyanthae* typicum and *Plagiothecietum neglecti* (with 38%), weft (We) life from takes first place (50%) within the new subassociation *P. p. lophocoleetosum heterophyllae*. The other life forms of the life form spectrum have lower percentage in syntaxonomic units (Fig. 6 & Table 6).

As a result of the life forms analysis; mat and weft life forms are dominant in all syntaxonomic units. Because of the high frequency and cover of liverworts such as *L. heterophylla, R. complanata, F. dilatata, F. tamarisci, L. cavifolia* and *M. furcata*, mat life form is dominant. Also, wefts are co-dominant within the all syntaxa due to high frequency and cover of pleurocarpous mosses such as *B. velutinum, H. cupressiforme, H. resupinatum, P. polyantha, A. serpens* and *I. alopecuroides.*

The life form of the taxa of the association reflects the ecological features of the environment (Magdefrau, 1982; Kürschner *et al.,* 1998). While the bryophytes having life form of We, Ma, Ta points out humid and shady areas, the taxa having Cu and sT life forms, an indicator of xerophyte, points out arid area. The high number of humid areas shows it self with either high number of pleurocarpous or habitats spreading syntaxa from the life forms. This situation can be defined as the indicator of the oceanic climate. In addition, from these data, we can say that associations has mesophytic character and subassociation has hygrophyte character.

Life strategies: According to the analysis of the life strategies of taxa belonging to the syntaxa; we determined three categories for *Plagiothecietum neglecti* association, and two main categories for *Pylaisietum polyanthae* typicum and -*lophocoleetosum heterophyllae* subassociation. At the *Plagiothecietum neglecti* association; the perennial stayers (Ag, Av Av,g) represent 62%, perennial shuttle species (Pg, Pv, Pp) represents with 33%, colonists (Bv,g) represent with 5%. At the *Pylaisietum polyanthae* typicum and -*lophocoleetosum heterophyllae* subassociation, the rates of perennial stayers and perennial shuttle species are equal (Fig. 7).

At the *Plagiothecietum neglecti* association, the colonist strategy represents with the presence of colonist species *B. moravicum* having high sexual and asexual reproductive effort (Bv,g). Species which have colonist strategy are primary species in primer succession (Kürschner & Parolly, 1999b). The presence of the colonist strategy shows that association does not reach climax.

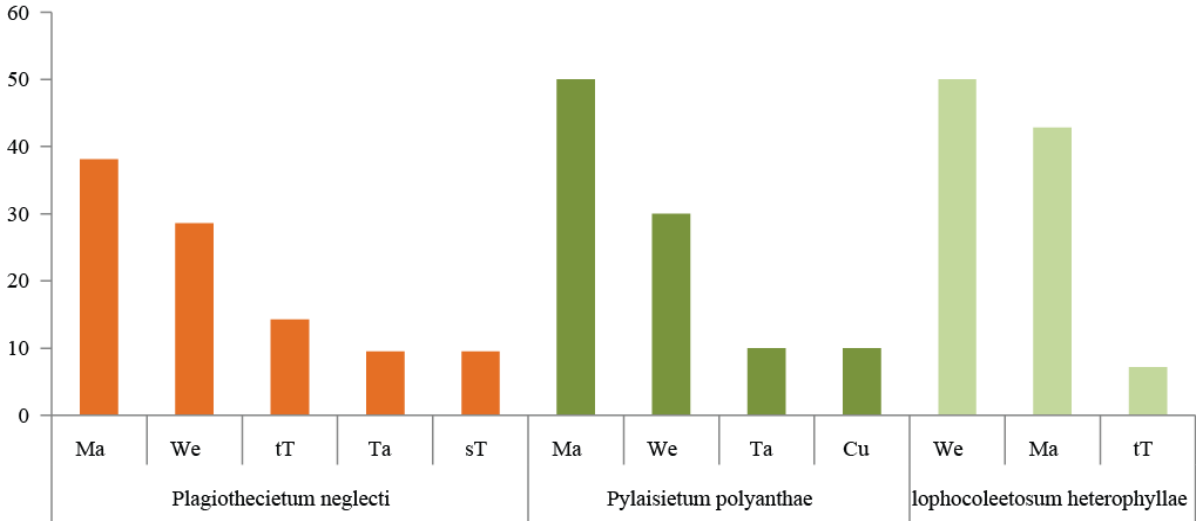

Fig. 6. Life forms spectrum of the syntaxa.

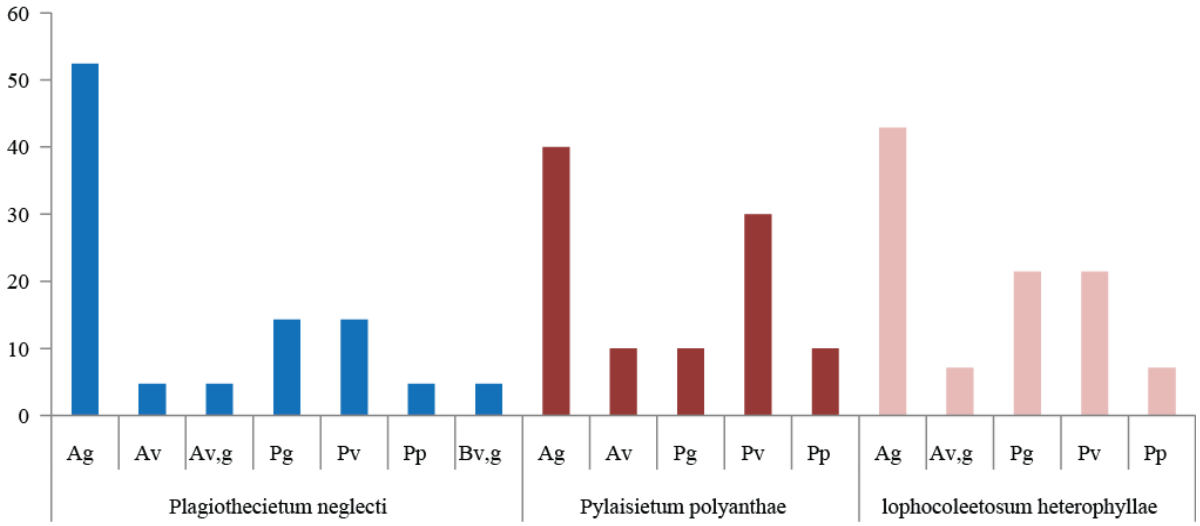

Fig. 7. Life strategies spectrum of the syntaxa.

The perennial shuttle strategy that shows less consistency than the perennial stayers, is the characteristics of the humid micro areas and permanent ecological conditions (Kürschner *et al.,* 1998). The perennial shuttle species at the association is divided into three sub categories according to the reproduction strategy (Pg, Pv, Pp). The rates of perennial shuttle species having high sexual reproductive effort (Pg) and perennial shuttle species having high asexual reproductive effort (Pv) are equal. In the association, Pv represents with the presence of *L. heterophylla, R. complanata, M. furcata* species, Pg represents with presence of *M. hornum, F. tamarisci, F. dilatata*. The passive perennial shuttle species (Pp) having low sexual and asexual reproductive effort (Pp) represent with *L. cavifolia*. The presence of the perennial shuttle strategy shows presence of humid and shady habitats at the study area.

Perennial stayers characterized by a long life span (perennial species); small spores (< 25 µm); high sexual and asexual reproductive effort; facilitating long-range, as well as short-range dispersal (chance dispersal) (During, 1979; Kürschner, 1999). According to the other strategies in the perennial stayers strategy, it shows dominancy with rate 62%; it is divided into 3 sub categories (Ag, Av, Av,g). The perennial stayers having high sexual reproductive (Ag) represents with *B. velutinum, A. serpens, H. cupressiforme, P. polyantha, H. seligeri, D. scoparium, D. denudatum, D. heteromalla,* they rank in first place in the spectrum with 52%. The perennial stayers having high asexual reproductive effort (Av) and the perennial stayers having high sexual and asexual reproductive effort (Av,g) have equal rate with 5%. Av represents with *P. filiforme*, Av,g represents with presence of *P. nemorale*. The high number of perennial stayers and perennial shuttle types at the association shows presence of humid and persistent habitats. This makes us to think that our association reached the climax, however because of the presence of the colonist strategy, it shows that there is epiphytic association close to the climax.

Table 6. Life form and life strategy rates of the species of syntaxa.

Life form and life strategy rates of the species			Syntaxa			
			Plagiothecietum neglecti	Pylaisietum polyanthae	-lophocolectosum heterophyllae	Shortening
			%	%	%	
Life Form	Mat		38	50	43	Ma
	Weft		29	30	50	We
	Cushion		-	10	-	Cu
	Short turf		10	-	-	sT
	Tail		10	10	-	Ta
	Tall turf		14	-	7	tT
Life Strategies	Colonists	Colonists with high sexual and asexual reproductive effort	5	-	-	Bv,g
	Perennial shuttle species	Perennial shuttle species with high sexual reproductive effort	14	10	21	Pg
		Perennial shuttle species with high asexual reproductive effort	14	30	21	Pv
		Perennial shuttle species with moderately or low sexual and asexual reproductive eff ort	5	10	8	Pp
	Perennial stayers	Perennial stayers with high sexual reproductive effort	52	40	43	Ag
		Perennial stayers with high asexual reproductive effort	5	10	-	Av
		Perennial stayers with high sexual and asexual reproductive effort	5	-	7	Av,g

Table 7. Characters and life strategies of the taxa of associations.

Syntaxa	Species	Life form	Life cycle		Sexual reproduction				Spores (¤ in µm)		Asexual reproduction		Innovation shoots	Dispersal strategy	Seta	Peristome	Life strategy
			Annual / Biannual	Paucienial / perennial	Frequent within the 1st year	Frequent within the 2nd – 4th. year	Rare	Monoecious, Dioecious	Large (> 25µm)	Small (< 25µm)	Lacking or rare	Rare or frequent					
Characteristic species	*Plagiothecium nemorale*	Ma	-	+	-	+	-	D	-	+	-	ge	-	sr, lr	s	-	Av, g
	Brachytheciastrum velutinum	We	-	+	-	+	-	A	-	+	+	-	-	sr, lr	l	l	Ag
	Pylaisia polyantha	We	-	+	-	+	-	M	-	+	+	-	-	sr, lr	I	I	Ag
	Lophocolea heterophylla	Ma	-	+	-	-	-	M	-	+	-	ge	-	sr, lr	s	-	Pv
Characteristic species of the Bryo capillaris-Brachythecion rutabuli alliance and Brachythecietalia rutabulo-salebrosi order	*Bryum moravicum*	sT	-	+	-	+	-	D	-	+	-	rhg	-	sr,Ir	l	l	Bv
	Amblystegium serpens	We	-	+	-	+	-	A	-	+	+	-	-	sr, lr	l	l	Ag
Characteristic species of the Cladonio digitatae - Lepidozietea reptantis class	*Lophocolea heterophylla*	Ma	-	+	-	-	-	M	-	+	-	ge	-	sr, lr	s	-	Pv
	Mnium hornum	tT	-	+	-	+	-	D	+	-	-	-	-	sr, lr	l	I	Pg
	Metzgeria furcata	Ma	-	+	-	-	+	D	+	-	-	ge	-	sr, lr	s	-	Pv
	Frullania tamarisci	Ma	-	+	-	+	-	D	-	-	-	-	-	sr, lr, ac	s	-	Pg
Characteristic species of the Frullanio dilatatae-Leucodontetea sciuroidis class., Orthotrichetalia order and *Ulotion crispae* alliance	*Pterigynandrum filiforme*	Ta	-	+	-	-	+	D	-	+	-	ge	-	sr, lr	l	l	Av
	Radula complanata	Ma	-	+	-	-	-	P	+	-	-	ge	-	sr, lr	s	-	Pv
	Radula lindbergiana	Ma	-	+	-	-	-	D	+	-	-	ge	-	sr, lr	s	-	Pv
	Frullania dilatata	Ma	-	+	-	+	-	D	+	-	ge	-	-	sr, lr, ac	s	-	Pg
	Orthotrichum affine	Cu	-	+	-	+	-	A	-	+	+	-	-	sr, lr	s	l	Ag

[+ present; - absent; D - dioecious; ge - gemma; ac - achorous strategy; l - long; lr - long-range dispersal; M - monoecious; P - paroicous; A – autoecious; s - short; sr - short range-dispersal; rhg - rhozoidal gemma; Cu - cushion; Ag-Pg life strategies, Table 6]

According to the analysis of the life strategies of taxa belonging to the *Pylaisietum polyanthae* typicum and -*lophocoleetosum heterophyllae* subassociation, two main categories have been found as perennial shuttle species and perennial stayers. The perennial shuttle species are divided into three sub categories according to the reproduction strategy (Pg, Pv, Pp). While species appears at the rate of Pg 10%, Pv 30%, Pp 10% with subassociation, Pg and Pv has 21%, Pp has 8% with subassociation. These data shows that the perennial shuttle strategy represents with *Pylaisietum polyanthae* typicum and -*lophocoleetosum heterophyllae* subassociation with rate 50%. The same rates can be explained by presence and repeat of *R. complanata, F. dilatata, M. furcata, L. cavifolia* at the both syntaxonomic units. The life forms and life strategies of the taxa that create plant communities are indicator of the ecological factors at that habitat (Kürschner *et al.,* 1998). The presence of the taxa of shuttle types in hygrophyte feature shows presence of oceanic climate.

While perennial stayers represent with *Pylaisietum polyanthae* typicum Ag and Av life strategies, Ag and Av,g life strategies are also represented with subassociation. We can explain 40% of Ag life strategy *Pylaisietum polyanthae* typicum and 43% of it with subassociation is because of presence and repeat of *H. cupressiforme, P. polyantha, B. velutinum*, *P. striatulum, H. resupinatum, O. affine* and *I. alopecuroides*. Av life strategy has rate of 10%, and *P. filiforme* and Av,g has 7% rate; and represents with presence of *P. nemorale*. At the *Pylaisietum polyanthae* typicum and subassociation, occurance same rate of perennial shuttle and perennial stayers' strategies, absence of the colonist strategy can be provided syntaxa with acceptance of community that reached permanent and consistent climax.

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