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Investigation of lichen populations and their similarity analysis in Serif Yuksel Forest, Turkey

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Abstract: *Sorensen similarity indices of lichen species in Serif Yuksal forest ranged between 0.29 and 0.84. A linear relation was found between species number sum of two lichen populations and their similarity indices. The linear equation is Y=0.0076x + 0.1467 and the R^2 of the equation is 0.2476 which is significant at p<0.001. There has been identified a linear relation between the average similarity index of the sites and fir participation percentage. The obtained equation is Y=0,0009x + 0,5271 and the R^2 of the equation is 0,2853 which is significant at p<0.002. In the pure fir stands there has been found a linear relation between the altitude difference and similarity index. The obtained equation is Y= -0.0011x + 0.6962 and the R^2 of the equation is 0.1755 which as significant at p<0.001.*

Key words: *Sorensen similarity index, Altitude, Bolu, Lichen*
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Introduction

The most common similarity coefficient built on the existence of species in two populations is Jaccard's coefficient proposed in 1900, 1901 and 1908. Another similar coefficient was published by Sorensen in 1948 (Legendre and Legendre, 1998). The most striking difference between calculations of these two coefficients is the evaluation of the sharing species in both populations. While the sharing species are participated in the calculation by being multiplied by 2 in the Sorensen's coefficient, in Jaccard's calculation they are participated without being multiplied by 2. As a result of that, Jaccard's coefficient has generally a less value than Sorensen's. The Sorensen's similarity index has been used in comparison of fauna (Pavanelli and Caramaschi, 2003), soil microfungi (Kara, 2007a, 2007b), alga populations (Hruby, 1975) and lichen populations (Brodekova *et al*., 2006) successively. Presence/absence date sets is the most efficient measurement method at similarity analysis (Magurran, 2004).

The classical method of calculation of these two coefficients is widely used in the ecological studies (Magurran, 2004; Chao *et al*., 2005). As well in the proceeded periods the other methods developed from that method are still being used (Legendre and Legendre, 1998; Chao *et al*., 2006). In this study, the Sorensen similarity indices of lichen populations in Serif Yüksel Research Forest were analyzed. With the similarity values, the relations between the number of lichen species of two populations and fir participation percentages, and the altitudinal differences were investigated.

Materials and Methods

Study area: Serif Yuksel Research Forest is differentiated from Aladag Forestry Management. It is located between 40°35' 00" - 40° 39' 00" N latitudes and 25° 33' 00"-25° 38' 00" E longitudes. It has totally 1544 ha covering area with the highest attitude of 1640 m and the lowest altitude of 1330 m (Tosun, 2003). The average annual mean temperature is 5.7°C (1975-1995) and the annual precipitation is about 882.6 mm according to Serif Yuksel Research Forest Meteorological Station. The climate type is symbolized as $B_4C_2'rb_2'$ according to Thornthwait, that is humid, micro thermal, not or very few water, partly under sea impact. The number of days with snow cover is 144 and with fog is 60 (Serin, 1998). The region is Mesozoic Tertiary geologically (Irmak *et al*., 1962). The main rock is Andesite and its derivatives. Soil profile skeleton is medium and well-permeable. The pH values of soil are between 4.80-6.85 (Akgul and Aksoy, 1976; Kantarci, 1979). Dominant tree species in the study area are Scotch pine (*Pinus sylvestris* L.) and Uludag fir (*Abies bornmulleriana* Mattf.) (Bozakman, 1976).

Samples collection and evaluation: Epiphytic lichen specimens were collected from August 2004 to July 2005 on tree substrata from 31 sampling sites in Serif Yuksel Research Forest in Bolu (Table 1). Tree species on which lichens collected were *Abies bornmülleriana* Mattf. and *Pinus sylvestris* L. Lichen material was picked on stems and branches at 2 m height of the selected trees. The samples were taken together with bark substrates and put into paper bags in the field. They were then left to air drying and were put into herbarium envelopes. The specimens were determined at species level with

the help of flora books and keys (Clauzade and Roux, 1985; Purvis *et al*., 1992; Wirth, 1995).

The formula 1 was used to calculate the Sorensen similarity indices (Magurran, 1988, 2004; Legendra and Legendra, 1998). In the formula, A refers to number of species sharing in two populations, B refers to number of species which own only to first population and C refers to number of species which own only to second population (Magurran, 1988, 2004; Legendre and Legendre, 1998). The average similarity of the sites was estimated by division of similarity of one site to the number of sites. In the rest of the article similarity indices will refer to Sorensen similarity indices.

Sorensen similarity index= 2A / (2A + B + C) (formula 1)

To find out the relation between the similarity – number of species existing in two populations and the altitude, the matching matrix values of them were used by SPSS 11.0 program. Fir participation percentage is the division of number of trees from the stand to the total number of fir trees.

Results and Discussion

Similarity index: The maximum similarity indices were observed between the sites 9-10 and 10-12 with the similarity index value of 0.84 (Table 2). It could be submitted that the similar topography and the tree species composition might be caused to the high similarity indices. The minimum similarity was detected between the sites 6 and 20 with the similarity index value of 0.29. The different tree species composition between those two sites should reflect the effect to the lichen species composition. Because it is commonly known that there exists a close relationship between tree and lichen species. The average similarity index was detected at the site 31 with the similarity value of 0.44. In the site 31 the only tree species was *Pinus sylvestris* where it established a pure tree species stand and it also sheltered very less number of lichen species (Table 1). The highest average similarity index was found at site 10 with the similarity index value 0.68.

Similarity index - Total species number of two populations: It was implied that the sum of number of species of two populations in the formula formed as 2A + B + C. A linear relation has been found between the sum of total number of species of two populations and the similarity indices. The linear equation is like Y=0.0076x + 0.1467 with the R^2 value 0.2476 which is significant at $p<0.001$ (Fig. 1). The increase in the number of species of two populations provides the possibility of increase in similarity. Besides the R^2 has not been found so high since it does not grant the existence of the species at the both populations while the total number increased. It might be assumed that the striking number of lichen species could limit the similarity.

Similarity index - fir participation percentage (%): There has been observed a linear relationship between the average similarity indices of the sites and the fir participation percentages. The established equation is like y=0.0009x + 0.5271 with the R^2 value 0.2853 which is significant at $p<0.002$ (Fig. 2). The decreasing

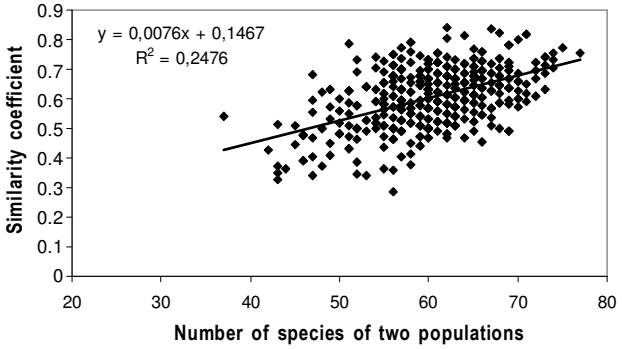

Fig. 1: Relationship between the similarity coefficient and the number of species of two populations

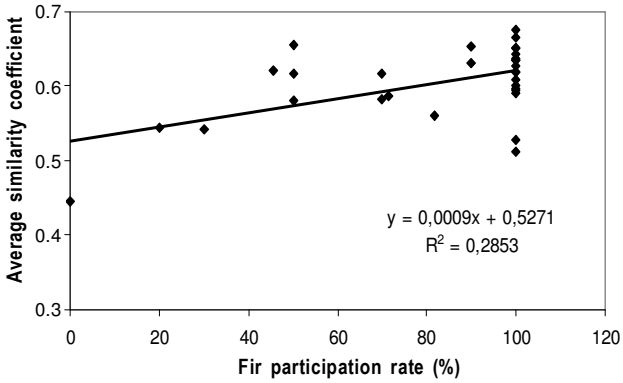

Fig. 2: Relationship between the average similarity coefficient and the fir participation percentage (%)

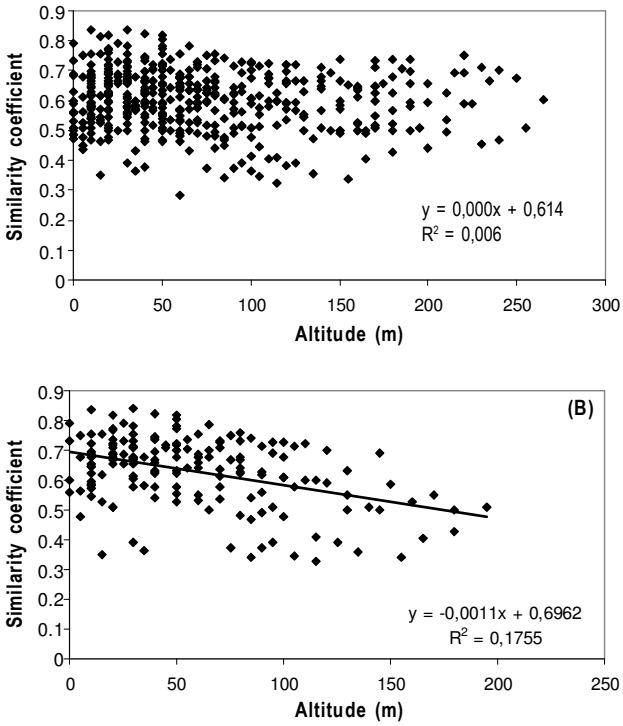

Fig. 3: Relationship between the similarity coefficient and the altitude difference of (A) = All stand and (B) Fir stand

Table - 1: Characteristics of the sampling sites

Site number	Eastern longitudes	Northern latitudes	Altitude (m)	Aspect	Slope (%)	Sampled tree*	Number of lichen species
1	25º 35' 54"	40º 36' 47"	1530	NE	8	A(9), P(2)	33
2	25º 35' 48"	40º 36' 27"	1560	NW	4	A(7), P(3)	28
3	25º 36' 06"	40º 37' 00"	1540	NE-N	6	A(10)	20
4	25º 35' 26"	40º 35' 58"	1540	SW	6	A(3), P(7)	29
6	25º 34' 19"	40º 35' 44"	1380	-	-	A(2), P(8)	30
7	25º 33' 57"	40º 36' 24"	1420	SE	3	A(9), P(1)	34
8	25º 34' 35"	40º 36' 51"	1530	-	-	A(10)	31
9	25º 35' 17"	40º 36' 42"	1540	SW	12	A(10)	30
10	25º 35' 45"	40º 37' 24"	1570	W	2	A(10)	32
11	25º 35' 38"	40º 37' 20"	1580	SE	6	A(10)	29
12	25º 36' 28"	40º 37' 16"	1560	E	13	A(10)	35
13	25º 36' 29"	40º 37' 56"	1610	NW	4	A(10)	36
14	25º 36' 50"	40º 37' 20"	1590	-	-	A(9), P(1)	34
15	25º 36' 17"	40º 36' 41"	1560	SE	15	A(5), P(5)	26
16	25º 37' 01"	40º 36' 57"	1540	SE	2	A(7), P(3)	32
17	25º 34' 23"	40º 37' 41"	1590	SE	14	A(10)	39
18	25º 35' 16"	40º 36' 24"	1520	S	16	A(5)	35
19	25º 34' 44"	40º 36' 14"	1480	S	18	A(5), P(5)	30
20	25º 34' 30"	40º 35' 20"	1440	SW	24	A(5)	26
21	25º 34' 02"	40º 35' 48"	1370	W	27	A(5), P(5)	38
22	25º 33' 53"	40º 36' 49"	1490	S	4	A(5)	27
23	25º 33' 34"	40º 37' 05"	1550	SE	13	A(5)	29
24	25º 34' 28"	40º 37' 29"	1545	W	9	A(5)	26
25	25º 35' 07"	40º 37' 38"	1600	NW	10	A(5)	31
26	25º 35' 34"	40º 38' 05"	1620	E	15	A(5)	30
27	25º 36' 05"	40º 37' 33"	1635	-	0	A(5)	25
28	25º 35' 06"	40º 37' 06"	1570	S	2	A(5)	26
29	25º 34' 57"	40º 36' 39"	1540	E	8	A(5)	30
30	25º 36' 00"	40º 36' 19"	1495	S	14	A(5), P(6)	34
31	25º 37' 00"	40º 36' 27"	1455	S	17	P(5)	17
32	25º 36' 31"	40º 36' 48"	1605	S	19	A(5), P(2)	31
Total						254	

*A= *Abies bornmülleriana* Mattf. P=*Pinus sylvestris* L., m = Meter, NE = North East, NW = North West, NE-N = North East-North, SW = South West, SE = South East, W = West, E = East

participation of fir to the main stand tree species causes to a less similarity of the two different main tree species settled stands. The result also is parallel to the low similarity existence between oak and ash stands (Brodekova *et al*., 2006). In accordance, the average similarity indices of the sites 4 and 6 are the stands where fir participation percentages are the lowest. As the study sites are mainly characterized with the fir species; the more the fir participate the more the similarity index increases. It can also be confirmed that scotch pine participation causes increase in similarity. As an example, the site 31 which has a pure scotch pine stand also has the highest similarity indices showing high similarities with the sites 6, 19 and 30. However, while the sites 3 and 20 have the stands purely established with fir, their average similarity indices were found low (Table 2). The lichen species number was found very low in comparison to the other sites, which might be as a result of existence of lichen species excluded by the other sites.

Similarity index - altitude: No relation could be observed between the similarity indices of the sites and the altitude (Fig. 3A). Though to highlight the effect of altitude when the pure fir stands has been subjected to analysis there has been a linear relationship between the similarity indices of the sites and the altitude (Fig. 3B). The linear equation is Y= -0.0011x + 0.6962 and the R^2 of the equation is 0.1755 which is significant at $p<0.001$. The effect of altitude should have been obstructed by the species composition of forest. As the altitude became greater, some of lichen species has appeared or disappeared from the site (Cobanoglu and Sevgi, 2009). So, it can be concluded that as the altitude increased the similarity of the lichen populations is decreased.

The increase at both the number of lichen species and the total number of lichen species of two populations is caused to the possibility of similarity of lichen populations. Besides, tree species mixture has also affected the similarities of the populations, sites chosen from pure fir stands and dominantly scotch pine stands had higher similarity indices. That should be sourced from the relations of tree species and lichen populations. Altitude mainly has significant

Table - 2: Similarity matrix based on Sorensen index for the sites sampled

	Sampling sites																													
	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
2	0.62																														
3	0.49	0.63																													
4	0.58	0.60	0.53																												
6	0.57	0.57	0.52	0.64																											
7	0.66	0.71	0.59	0.57	0.59																										
8	0.56	0.66	0.59	0.47	0.49	0.68																									
9	0.51	0.66	0.60	0.47	0.50	0.72	0.72																								
10	0.55	0.62	0.58	0.56	0.58	0.67	0.67	0.84																							
11	0.47	0.63	0.63	0.38	0.44	0.63	0.70	0.75	0.66																						
12	0.50	0.51	0.51	0.47	0.52	0.64	0.61	0.74	0.84	0.69																					
13	0.49	0.59	0.54	0.49	0.45	0.66	0.63	0.73	0.82	0.68	0.82																				
14	0.57	0.58	0.50	0.54	0.63	0.65	0.65	0.66	0.70	0.67	0.70	0.66																			
15	0.54	0.63	0.48	0.62	0.68	0.67	0.56	0.50	0.55	0.55	0.59	0.55	0.73																		
16	0.62	0.65	0.50	0.69	0.61	0.67	0.54	0.48	0.59	0.52	0.57	0.59	0.76	0.76																	
17	0.61	0.69	0.58	0.59	0.49	0.71	0.66	0.78	0.82	0.65	0.76	0.77	0.68	0.52	0.59																
18	0.68	0.70	0.51	0.59	0.65	0.72	0.55	0.71	0.72	0.53	0.63	0.62	0.64	0.59	0.63	0.73															
19	0.65	0.57	0.48	0.68	0.70	0.66	0.56	0.53	0.65	0.51	0.62	0.55	0.69	0.66	0.68	0.58	0.68														
20	0.59	0.54	0.48	0.36	0.29	0.57	0.49	0.61	0.55	0.51	0.59	0.55	0.50	0.38	0.41	0.58	0.62	0.46													
21	0.65	0.70	0.52	0.63	0.62	0.72	0.64	0.74	0.80	0.54	0.74	0.70	0.69	0.59	0.60	0.75	0.74	0.68	0.59												
22	0.50	0.65	0.55	0.46	0.40	0.72	0.62	0.77	0.68	0.71	0.71	0.70	0.59	0.53	0.51	0.73	0.61	0.53	0.53	0.66											
23	0.52	0.63	0.57	0.59	0.51	0.67	0.72	0.68	0.69	0.67	0.59	0.68	0.67	0.58	0.62	0.74	0.66	0.58	0.60	0.63	0.64										
24	0.54	0.54	0.48	0.44	0.50	0.57	0.53	0.75	0.79	0.58	0.75	0.68	0.57	0.46	0.45	0.71	0.69	0.57	0.58	0.66	0.64	0.56									
25	0.59	0.64	0.55	0.50	0.59	0.74	0.61	0.75	0.73	0.67	0.70	0.69	0.68	0.60	0.57	0.69	0.76	0.66	0.53	0.71	0.72	0.63	0.74								
26	0.51	0.57	0.48	0.44	0.47	0.59	0.56	0.73	0.81	0.54	0.68	0.70	0.59	0.46	0.52	0.78	0.68	0.57	0.50	0.68	0.63	0.58	0.75	0.72							
27	0.55	0.64	0.51	0.52	0.51	0.69	0.71	0.69	0.70	0.70	0.67	0.66	0.64	0.63	0.56	0.72	0.60	0.65	0.51	0.60	0.69	0.74	0.63	0.68	0.62						
28	0.47	0.59	0.39	0.58	0.50	0.60	0.58	0.71	0.79	0.58	0.75	0.74	0.67	0.58	0.55	0.77	0.62	0.57	0.50	0.66	0.64	0.65	0.73	0.67	0.68	0.78					
29	0.54	0.62	0.56	0.51	0.50	0.72	0.62	0.73	0.71	0.66	0.69	0.64	0.66	0.57	0.48	0.72	0.68	0.63	0.61	0.65	0.70	0.64	0.68	0.69	0.67	0.73	0.68				
30	0.57	0.68	0.52	0.67	0.63	0.71	0.58	0.59	0.64	0.60	0.59	0.60	0.65	0.63	0.67	0.63	0.67	0.81	0.50	0.67	0.52	0.60	0.50	0.62	0.59	0.68	0.60	0.63			
31	0.48	0.44	0.54	0.48	0.60	0.43	0.38	0.34	0.41	0.39	0.35	0.34	0.47	0.51	0.45	0.36	0.50	0.68	0.35	0.47	0.36	0.39	0.37	0.50	0.40	0.43	0.33	0.47	0.63		
32	0.63	0.64	0.43	0.63	0.59	0.71	0.52	0.52	0.57	0.50	0.58	0.51	0.62	0.70	0.63	0.57	0.61	0.72	0.49	0.67	0.52	0.53	0.49	0.61	0.52	0.68	0.60	0.66	0.68	0.50	
*	0.56	0.62	0.53	0.54	0.54	0.65	0.59	0.65	0.68	0.59	0.64	0.63	0.63	0.58	0.58	0.67	0.64	0.62	0.51	0.66	0.61	0.62	0.60	0.65	0.60	0.64	0.62	0.63	0.62	0.44	0.59

* = Average similarities

effect on the pure stands of fir where the altitude is increased the similarity is decreased.

References

Akgül, E. and C. Aksoy: General soil characteristics and the soil maps of Serif Yüksel Research Forest near Bolu. *For. Res. Inst. Tech. Bulletin,* **95**, 1-52 (1976).

Bozakman, I.Ü.: Vegetation analysis of Bolu Serif Yüksel Research Forest and researches on natural stand types. *For. Res. Inst. Tech. Bulletin,* **86**, 1-38 (1976).

Brodekova, L., A. Gilmer, P. Dowding, H. Fox and A. Guttova: An assessment of epiphytic lichen diversity and environmental quality in Knocksink Wood Nature Reserve. Ireland. Biology and Environment: Proceedings of the Royal Irish Academy, Vol. 106b, No.3. pp. 215-223 (2006).

Chao, A., R.L. Chazdon, R.K. Colwell and T. Shen: Abundance-based similarity indices and their estimation when there are unseen species in samples. *Biometrics,* **62**, 361-371 (2006).

Chao, A., R.L. Chazdon, R.K. Colwell and T. Shen: A new statistical approach for assessing similarity of species composition with incidence and abundance data. *Ecol. Letters*, **8**, 148-159 (2005).

Clauzede, G. and C. Roux: Illustrated Descriptions of Lichens From Western Europe, Bulletin of Central-Quest Novvelle Serie Botanical Society Special Issue. 7, Royan, France (1985).

Cobanoglu, G. and O. Sevgi: Analysis of the distribution of epiphytic lichens on *Cedrus libani* in Elmali Research Forest (Antalya, Turkey). *J. Environ. Biol.*, **30**, 205-212 (2009).

Hruby, T.: Seasonal changes in two algal populations from the coastal waters of Washington. *J. Ecol.*, **63**, 881-889 (1975).

Irmak, A., M. Sevim and F. Gülçur: Pedological researches at forest land in Aladag-mountain. *Bolu. Rev. Facul. For.*, **12**, 1-13 (1962).

Kantarci, D.M.: Analytical research of soil and forest floor properties in relation with altitude-climate belts at fir forests on the northern slopes of Aladag-mountainous mass, Bolu. Matbaa Teknisyenler Publisher, Istanbul (1979).

Kara, O.: Microfungal community structure from forest soils in northern thrace region, Turkey. *Ann. Microbiol.*, **57**, 149-155 (2007a).

Kara, O.: Influence of soil compaction on microfungal community structure in two soil types in Bartin Province, Turkey. *J. Basic Microbiol.,* **47**, 394-399 (2007b).

Legendre, P. and L. Legendre: Numerical ecology. Elsevier Press, Developments in Environmental Modeling 20. p. 851 (1998).

Magurran, A.E.: Ecological diversity and its measurement. Princeton University Press. p. 179 (1988).

Magurran, A.E.: Measuring biological diversity. Blackwell Publishing Company. p. 257 (2004).

Pavanelli, C.S. and E.P. Caramaschi: Temporal and Spatial distribution of the Ichthyofauna in two streams of the upper Rio Paraná basin. *Brazilian Arch. Biol. Technol.,* **46**, 271-280 (2003).

Purvis, O.W., B.J. Coppins, D.L. Hawksworth, P.W. James and D.M. Moore: The Lichen Flora of Great Britain and Ireland. London: Natural History Museum Publications in Association with the British Lichen Society (1992).

Serin, M.: Meteorological observation values between 1975 – 1995 years of the meteorology station belongs to Bolu - Serif Yüksel Research Forest. *J. Southwest Anatolia For. Res. Inst.,* **1**, 25-36 (1998).

Tosun, S.: 15-year (1986-2000) seed productivity mid-research results of Scotch pine (*Pinus sylvestris* L.) and Uludag fir (*Abies bornmülleriana* Mattf.) stands at Bolu Serif Yüksel Research forest. *Technical Bulletin,* **9**, 1-51 (2003).

Wirth, V.: Die Flechten Baden-Württembergs. Teil 1-2. Stuttgart: Eugen Ulmer, (1995).