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STUDYING BIODIVERSITY OF PLANT ASSOCIATIONS IN SUTAN-CHAY BASIN IN ARASBARAN, NORTHWEST OF IRAN

SUMMARY

Investigation on plant biodiversity in associations (ecosystems) is necessary for understanding their stability. This study aimed to investigate biodiversity in the plant associations in Sutan-Chay Basin, and relationship of these associations with different biodiversity indices. The recognition of plant Associations in the study area was carried out based on Braun Blanquette method. The biodiversity of the relives comprising plant associations was calculated on the basis of different indices including richness, Shannon, Simpson, Margalef and Fisher. Canonical Corresponding Analysis (CCA) was used to study relationship between relevels distributions and indices of biodiversity, and to determine the most important biodiversity indices. The results show that the plant associations in the study area are completely differentiated from each other based on biodiversity indices. Pearson Correlations coefficient indicated the plant associations are correlated with each of ecological variables. Based on these correlation coefficients, species dominance are positively associated with soil pH and clay percentage, while negatively correlated with altitude. Studying of relationship between environmental factors and biodiversity variables and determining the most important factors on biodiversity of plant associations in a given region are essential for management of conservation programs.

Keywords: biodiversity indices, plant association, phytosociology, Arasbaran, vegetation analysis.

INTRODUCTION

The studying of environmental heterogeneity is crucial in the biodiversity conservation and ecological management (Statzner and Moss 2004, Sarr et al. 2005). The impact of environmental heterogeneity on species richness and plant vegetations has been shown through both simulation studies (Steiner and Kohler 2003) and empirical studies (Williams et al. 2002, Lundholm and Larson 2003). However, the effects of environmental heterogeneity on species richness have been less examined using field data, especially at local scale (Statzner and Moss 2004).

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Studying the relationships between biodiversity of different areas is one of the main objectives of historical biogeography. In biogeography, areas of endemism were suggested as important units of ecology, and defined as areas having numerous endemic species (Szumik & Goloboff, 2004). The biotic elements approach is considered as an alternative to areas of endemism (Hausdorf, 2002), and includes a group of taxa whose ranges are dramatically more similar to each other than to those of taxa of other similar groups.

Habitat loss, destruction and fragmentation are the main environmental cause for declining biodiversity at local, regional and global scales (Ledig, 1992, Dirzo & Raven 2003, Balmford et al. 2005, Hanski 2005, Piessens et al 2005, Strantford & Robinson 2005), although some researchers believe that fragmentation has secondary importance (e.g. Fahrig, 2003).

Patterns of species richness and endemism, which have been used in identification of priority areas for biodiversity conservation are strongly biased by both differential knowledge of taxonomic groups and contrasts in the data among geographical and ecological areas (Isaac et al. 2004, Lawler et al. 2006). Richness dependence on species diversity, frequency and eveness (= equability) (Krebs, 1989). The higher numbers of plant species in a given region produces complexity in the ecosystems, and as a result, ecosystems will have high ability to adapt to environmental changes so the stability of the ecosystem will increase (Jenkins & Parker, 1998).

The number of plant species, association and plots in a region indicates its richness, which is mostly considered as biodiversity. When ecologist discuss on diversity, often they mean the high number of species within an association. However, most of the methods measuring species diversity include species richness and evenness. For example, in a plot with 100% cover comprising of five species, if each of these five species has 20% coverage, the evenness is complete (Kent & Caker 2001).

The two sorts of diversities have been recognized: alpha and beta. Alpha diversity is the species diversity in a region, while beta indicates the change in species diversity against the environmental changes. In other words, alpha diversity is the species number in a region, grassland and association, while beta is the differences between two regions or associations. The beta diversity is also called habitat diversity because it shows the species differences in different regions, and the rate of diversity changes can be compared between different habitats. The beta diversity is also related to the musaic plant associations. Therefore, the smaller in size and greater in number the musaics, the higher the beta diversity (Whittaker 1972).

Among different indices of biodiversity used in ecological studies, richness is the most well-known index (Maguran, 1988). Similarly, Shannon diversity index is also the most used among the indices used in measuring richness level along with evenness (Maguran, 1988). In addition, Twinspan and DCA methods were used in a study to recognized three different groups of plants, which widely overlapping each other (Brosofske et al, 1999).

A study measuring richness on the basis of Shannon diversity and Simpson Dominance in pine forests in Visconsin, USA showed that diversity may be related to aspect, altitude and canopy (Hill, 1979). In a study on sandy grasslands in Hungry showed that grazing decreased eveness and negatively affected on species diversity (Matus & Tothmeresz, 1990). Studies on climetic effects on species richness in rangelands in Gorge-Range indicated that the decrease in richness in lowlands of subtropical mountains has resulted from high temperature and low rainfall. Among climetic variables, real evaporation and water level are strongly correlated with richness, where species density is similar to the species richness, both of which were associated with the altitude (Liu et al, 2007).

A study on vegetation and flora in Sutan-Chay Basin (Arasbaran Protected Area, East-Azerbaijan, Iran) based on different methods showed that Ward (1963) based on Jaccard similarity was the best method, and that based on Braun Blanquet method (1983) there were six associations of *Astragaleto aureus - Thymetum kotschyanus, Poeto bulbosa - Festucetum ovina, Carpinetum betulus, Quercetum macranthera, Paliuretum spina-christii, Juniperetum foetidissima* (Ebrahimi et al. 2010).

Multivariate analysis is one of the methods used frequently in analyzing the ecological aspects of plant vegetations (Gauch, 1982). Using this method, different plots and species can be classified, and their similarities can be compared. In addition, the impact of the most important environmental factors on vegetation can be recognized, and the relationship of ecological factors with the plots and plant species can be determined. Canonical Corresponding Analysis (CCA) is the most recent method frequently used in ordination investigations (Ter Braak, 1987, Ter Braak, & Prentice, 1988). Moreover, Detrended Corresponding Analysis (DCA) and CCA are frequently used methods of ordination studies. CCA is also one of the best methods in ordination analyses when data are available for both species and environment. However, in the absence of these data, DCA is the best choice of study (Kent & Caker, 2001).

In this study we used different methods of vegetation analysis including Margalef (1985) Menhinick (1964), Simpson (1949), Shannon (1964) and Fisher (1964) indices to estimate the level of diversity and evenness in East-Azerbaijan Province, Iran in order to investigate the relationship between plant vegetations and biodiversity indices and to determine the most important indices in separating vegetation.

MATERIAL AND METHODS

The Arasbaran forests has transitional position between Hyrcanian Forest in North of Iran and Zagros Forest in West of Iran, having similarities with both of these forests, and with 785 plant species has higher species richness in Iran (Asadi, 1989). The study area, covering an area of 13335h, is located in Arasbaran forest, which is the southern part of the Caucasus, and has been widely distracted and fragmented due to human activities (Nosrati et al. 2011). The study area is located in North West of Iran in latitude between 38˚ 52' - 39˚ and 46˚ 41'

- 46˚ 55', with altitude ranging from 450 to 2400 m, with average of 1300m. The rainfall ranges from 190 to 540 mm, with average annual rainfall of 377.8 mm, and based on DeMartin Climatic classification the area is semi-dry cold. The indices of biodiversity were estimated on the basis of presence and absence; and eveness (cover percentage) of species within each releves.

The eveness index indicates the distribution of individuals of a given species in a population. The greater value of this index shows that the species within each releve has similar cover percentage. Consequently, the stability of the ecosystem is higher, and as a result, biodiversity will be higher as the following equation: J=h/h max (evenness index), where h is Shannon. For eveness index we used Shannon - Weaner (equation 1) and Simpson (equation 2)

$$E_H=H/Hmax = -\sum pi\ lnpi/Ln\ (s) \quad 1$$

$$E_D=1/\sum(pi)^2 * S \quad 2$$

where S= the number of species and pi = the proportional of a given species number to total number of species or percentage cover of a species to total cover value. For estimating the dominance index we used Simpson dominance index which indicates frequency of a species compared to all other species using the following equation $Dd=\sum(pi)^2$ (Barnes, 1998).

Species diversity index in a region is influenced by two factors; either low level of richness and high level of eveness, or conversely, region with high richness and low eveness, and cannot show biodiversity of a region alone.

We used direct ordination of CCA for studying the relationship of releves' distributions with both biodiversity indices and the most important indices in recognizing associations, and species distribution. CCA also shows correlations between the environmental and vegetations variations (Ter Braak & Prentice.1988; Jangman et al, 1987). In this study the biodiversity indices were used as environmental variations using PC-ORD for Win 4.17 following McCune and Mefford (1999), and Peasron correlation coefficient was used for investigating correlation beteeen associations and ecological variables following Kent & Caker (2001).

RESULTS AND DISCUSSION

Evaluation of each of 60 releves showed that releves number 27 and 34 had respectively maximum (39) and minimum (19) species number. The average species number in all 60 releves was 27. Releves number 4 and 26 had respectively lowest (57) and highest (148) individual plants with average individual numbers of 96 for all 60 releves.

Figure 1 shows the special distribution of releves and their relationship with environmental indices in comparison with vectors 1 and 2. Those releves which are located close together have high similarity in species composition and biodiversity statues, and vice versa. The correlation of each biodiversity variables with vectors 1 and 2 is shown in Table 1.

Table 1. Correlation of each biodiversity variables with vectors 1 and 2. Intraset correlations between env. variables and constrained site scores

Biodiversity variables (indices)	Envi.Axis1	Envi.Axis2
C_2	0.811	0.047
C_3	-0.439	0.844
C_4	0.725	-0.594
C_5	0.439	-0.844
C_6	0.979	-0.032
C_7	0.924	0.005
C_8	0.585	-0.777
C_9	0.977	0.079

C6 = Menhinick, C7 = Margalef and C9= Fisher biodiversity indices are correlated with vector 1, while C3= Simpson dominance and C5= Simpson biodiversity index are correlated with vector 2.

Comparison the position of biodiversity variables with the vectors of the ordination shows that
Fisher and Margalef diversity, Simpson dominance and Species Richness indices are situated in the right hand side of the vector 1, and the other diversity indices on the left hand side of the vector 1. However, for the vector 2, all indices except Simpson dominance are located on the right hand side of the vector.

Table 2 shows that vectors 1 and 2 account for 89.717 and 6.303 percentage of total variations, respectively. Eigenvalues of vectors 1 and 2 were 0.018 and 0.001, respectively. This shows that vector 1 explains the majority of the variations in vegetations. It also indicates that correlations of the environmental variables with vectors 1 and 2 were significant ($P < 0.01$).

Table 2. Eigenvalues of vectors 1 and 2 showing correlation between environmental variables and species.

Eigenvalues	Axis1	Axis2
Eigenvalues	0.018	0.001
Percentage	89.717	6.303
Cum.percentage	89.717	96.020
Cum.Constr.Percentage	90.018	96.342
Spec.Env.Correlations	0.999	0.997

The relationship between biodiversity variables and releves based on vectors 1 and 2 is shown in Figure 1.

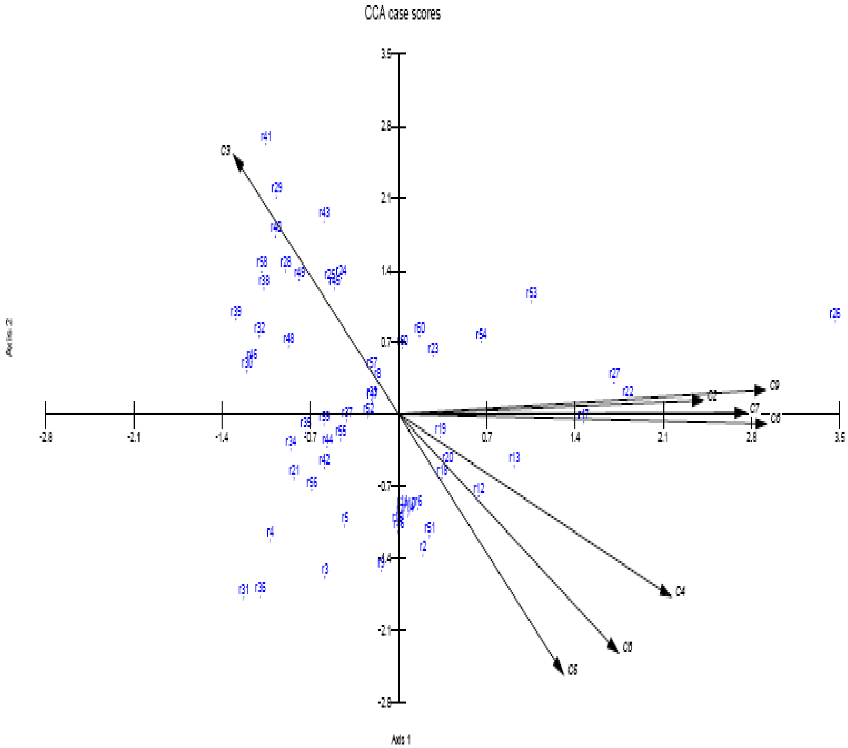

Figure 1. Relationship between biodiversity variables and relives based on vectors 1 and 2.

The Figure shows that distances between the points representing the releves indicate the amount of similarity, in which short distance means high similarity, while long distance shows low similarity between releves. According to Figure 1, Shannon (C4), Simpson (C5), Menhinick (C6) biodiversity and eveness (C8) indices are directly associated with rangeland associations of *Astragaleto aureus* - *Thymetum kotschyanus* and *Poeto bulbosa* - *Festucetum ovina*.

Among vectors of biodiversity indices having correlations with axis 1, Menhinick diversity index (C6) was the greast vector as its angle with x axis was the lowest and its correlation with vector 1 was the highest (0.978). The next important index was Fisher (C9, with 0.976), then Margalaf (C7, with 0.923), richness (C2, with 0.810), Shannon-Weaner (C4, with 0.725), and eveness (C8, with 0.585), Simpson diversity (C5, with 0.439) and Simpson dominance (C3, with -0.439) indices. The correlation of dominance and diversity Simpson indices with axis 2 had the greatest importance (C3, with 0.844) and (C5, with -0.844) respectively.

Table 3. One Way ANOVA analysis showing biodiversity indices in 6 plant associations recognized in the study area.

Index		Sum of Squares	df	Mean Square	F	Sig
DOMINANCE	Between Groups	.275	5	5.496E-02	15.562	.000
	Within Groups	.191	54	3.532E-03		
	Total	.466	59			
SHANNON	Between Groups	5.334	5	1.067	21.976	.000
	Within Groups	2.621	54	4.855E-02		
	Total	7.956	59			
SIMPSON	Between Groups	.275	5	5.496E-02	15.562	.000
	Within Groups	.191	54	3.532E-03		
	Total	.466	59			
EQUITABI	Between Groups	.304	5	6.070E-02	20.189	.000
	Within Groups	.162	54	3.007E-03		
	Total	.466	59			
MARGALEF	Between Groups	41.042	5	8.208	13.003	.000
	Within Groups	34.087	54	.631		
	Total	75.130	59			
MENHINICK	Between Groups	16.076	5	3.215	17.869	.000
	Within Groups	9.716	54	.180		
	Total	25.793	59			
FISHER	Between Groups	1621.566	5	324.313	13.978	.000
	Within Groups	1252.929	54	23.202		
	Total	2874.495	59			

*groups means associations

One Way ANOVA analysis showed that diversity indices were significantly different among the 6 plant associations recognized in the study area (Table 3). Based on this analysis the associations were separated into six groups.

Comparison the biodiversity indices average of the groups confirms the existence of these six groups already recognized in this study area (Table 4).

Table 5 shows Pearson Correlation between ecological (e.g. soils texture, pH, altitude, aspect, organic matters) and biodiversity variables (e.g. richness, eveness). The analysis indicated that these ecological variables had important impact on the separation of associations from each other. Table 5 shows that there was a positive correlation between Simpson dominance coefficient and pH and soil clay percentage, while this correlation was negative for altitude. In addition, eveness, Shannon and Simpson biodiversity coefficients had negative correlation with soil pH and clay percentage, while they showed positive correlation with altitude.

Table 4. Comparison the biodiversity indices average among the six plant associations (six groups) recognized in this study area.

A		Taxa	Individu	Dominance	Shannon	Simpson	Equitabi
A1	Mean	28.4000	81.4000	.1202	2.6968	.8798	.8066
	Std.Deviation	2.4129	15.2840	2.228E-02	.1280	2.228E-02	2.898E-02
	Minimum	24.00	62.00	.08	2.44	.85	.76
	Maximum	31.00	116.00	.15	2.87	.92	.85
A2	Mean	28.7000	91.2000	.1325	2.6146	.8675	.7789
	Std.Deviation	1.7029	21.6836	4.206E-02	.1559	4.206E-02	3.902E-02
	Minimum	26.00	68.00	.11	2.20	.75	.68
	Maximum	32.00	148.00	.25	2.76	.89	.81
A3	Mean	33.6000	71.6000	.1524	2.7540	.8476	.7843
	Std.Deviation	5.0299	10.8766	6.120E-02	.3309	6.120E-02	7.306E-02
	Minimum	28.00	57.00	.10	2.20	.75	.65
	Maximum	39.00	84.00	.25	3.01	.90	.82
A4	Mean	30.5000	83.5000	.2421	2.3845	.7579	.6983
	Std.Deviation	3.5119	8.1035	3.321E-02	.1515	3.321E-02	2538E-02
	Minimum	27.00	76.00	.20	2.18	.73	.66
	Maximum	34.00	95.00	.27	2.52	.80	.72
A5	Mean	24.3913	109.6957	.2781	2.0296	.7219	.6374
	Std.Deviation	3.8582	15.6305	7.650E-02	.2376	7.650E-02	6.688E-02
	Minimum	19.00	80.00	.16	1.53	.56	.51
	Maximum	34.00	136.00	.44	2.42	.84	.77
A6	Mean	25.7500	102.0000	.2391	2.1716	.7609	.6692
	Std.Deviation	4.3671	16.3183	5.768E-02	.2691	5.768E-02	5.265E-02
	Minimum	20.00	80.00	.15	1.79	.67	.58
	Maximum	32.00	124.00	.33	2.51	.85	.74
Total	Mean	27.1333	95.9500	.2094	2.3413	.7906	.7097
	Std.Deviation	4.4359	20.5058	8.883E-02	.3672	8.883E-02	8.886E-02
	Minimum	19.00	57.00	.08	1.53	.56	.51
	Maximum	39.00	148.00	.44	3.01	.92	.85

A= plant association: A1= *Astragaleto aureus - Thymetum kotschyanus*, A2= *Poeto bulbosa - Festucetum ovina*, A3= *Juniperetum foetidissima*, A4= *Paliuretum spina-christii*, A5= *Carpinetum betulus*, A6= *Quercetum macranthera*.

The results of the current study show that different plant associations with diverse species composition and environmental differences differed significantly in terms of biological diversity. The releves with similar ecological conditions, species diversity and composition form a determine plant association, which each association is different from the other association in terms of floristic, biodiversity and ecological characters.

Comparison biodiversity indices in the plant associations in the region studied show that the diversity indices values of Fisher, Margalef, Shannon, Menhinick and Simpson, Richness increased by increasing altitude, while by increasing the altitude, the Simpson dominance index decreased.

Table 5: Pearson Correlation coefficients between ecological and biodiversity variables in plant associations in Sutan-Chay Basin.

	EC	%T.N.V	Ph	%Total N	%0C	P(ppm)	K(ppm)	%silt	%clay	%sand	aspect	Alt(m)	Simpson D	Shannon	Simpson	Menhinick	Margalef	Eveness	Fisher
Ec	1																		
%T.N.V	.123	1																	
Ph	-.195	.269*	1																
%Total N	.075	.516**	.475**	1															
%0C	.359**	.013	-.319*	-.132	1														
P(aya.)ppm	.571**	.239	-.258*	.128	.669**	1													
K(aya.)ppm	.050	.161	.125	.068	.080	.239	1												
%Silt	.205	.538**	.364**	.428**	.279*	.265*	.561**	1											
%Clay	.279*	.104	.415**	.123	-.233	-.313*	-.200	.189	1										
%Sand	.209	-.179	-.457**	-.250	.129	.008	-.077	-.053	.064	1									
Aspect	-.341**	.010	-.099	.033	.117	.247	.204	-.127	-.854**	-.573**	1								
altitude(m)	.225	-.191	-.677**	-.567**	.501**	.334**	.039	-.138	-.308*	.373**	.053	1							
Simpson(D) (dominance	-.061	-.206	.510**	.208	-.109	-.017	-.020	.009	.344**	-.248	-.157	-.348**	1						
Shannon	-.093	.160	-.469**	-.193	.015	-.096	-.024	-.060	-.375**	.242	.187	.217	-.930**	1					
Simpson	.061	.206	-.510**	-.208	.109	.017	.020	-.009	-.344**	.248	.157	.348**	-1.000**	.930**	1				
Menhinick	-.294*	-.023	-.266*	-.065	-.178	-.257*	-.090	-.144	-.312*	.142	.188	-.129	-.550**	.782**	.550	1			
Margalef	-.312*	-.022	-.228	-.086	-.164	-.285*	-.081	-.132	-.278*	.124	.170	-.161	-.548**	.785**	.548**	.974**	1		
Eveness	.013	.216	-.514**	-.189	.075	.006	-.002	-.030	-[illegible]	.253	.186	.330**	-.968**	.965**	.968**	.632**	.606**	1	
Fisher	-.290*	-.029	-.172	-.055	-.203	-.259*	-.100	-.138	-.277*	.032	.214	-.202	-.427**	.682**	.427**	.945**	.913**	.533**	1

This means that by increasing altitude, the ecological conditions of the site improve, and as a result the species diversity and richness increase. While by decreasing altitude the ecological conditions get harsh resulting in decrease of the species diversity and richness. This is why a few numbers of dominant species are situated in this locations and the Simpson dominance index is high.

Analysis of ecological variables on the basis of Pearson correlation coefficients shows that the plant associations in the study area are differentiated based on floristic characteristic and biodiversity as well as ecological characteristics. Therefore, the habitat classification of the study region based on cluster analysis and CCA ordination indicated there is 6 associations in the region. Our data (Table 5) indicate that biodiversity variables of plant associations are correlated with different ecological factors. This means that these ecological factors and consequently biodiversity indices play an important role on differentiation of the plant associations.

Simpson dominance index was positively correlated with soil pH and clay percentage, but negatively correlated with altitude. There was negative correlation of Shannon 's and Simpson diversity and evenness with soil pH and clay percentage, while Shannon diversity and eveness indices had positive correlation with altitude.

This study showed that there were 303 plant species in the study area with 13335 h, belonging to 211 genera and 60 families. This high richness in a relatively small area resulted from climatic and edaphic diversity.

The results of the current study show that environmental factors had important role on the distribution of the plant species. Among the indices, Fisher (C9), Margalef (C7), Shannon (C4) and Simpson (C5) diversities as well as Simpson (C3) dominant and richness (C2) had the highest impact on the plant associations (Fig. 1). CCA ordination was used to find out the most important biodiversity indices in recognizing plant associations. Those environmental factors with long vectors had positive correlation and greatest impact on the diversity of plant associations.

The points representing releves or species with closest vertical distance to the environmental vectors had greatest and positive relationship with environmental factors, and these points were strongly influenced by these environmental factors, and *vice versa*, these points of bigger distance had lower correlations.

Mont Carlo test on correlation between environmental factors and plant species showed that the correlation between these variables and X axis was significant ($P < 0.01$). These results show that there is relationship between biodiversity indices and recognition of plant associations, ant that these indices and ecological factors play important role on distribution of the associations in the study area. Similar results obtained in the current study on assessment of impact of environmental factors on plant vegetations and separation of associations using biodiversity variables (indices) have already been reported by other researchers (Esmailzade & Hosseini, 2007, Marini et al, 2007, Yang et al, 2007).

In addition, in the study area the presence of species belonging to the rangeland associations increases by increasing silt in the soil and also when texture trends to intermediate. The two associations of *Astaragaleto eureous - Thymetum kotschianus* and *Poeto bulbosa- Festucetum ovina* had direct positive relationship with biodiversity indices of Shannon, Simpson, Menhinick and evenness. This means that by increasing each of these components, the number of the indicator species increases, while the forestland associations of *Carpinetum betulus* and *Quercetum macranthera* had direct positive correlations with Simpson dominance index. In other words, by increasing these factors values, the species of these associations were easily distributed. However, these associations and their indicator species showed negative correlations with biodiversity indices of Shannon, Simpson, Menhinick and evenness. This means that by increasing these indices, the species number of these forestland associations decreases, and *vice versa,* by decreasing indices, the species number increases, and the relevant associations established in the sites.

The longer vectors of Fisher and Menhinick biodiversity indices and their smallest angle with X axis indicate that these indices had greater impact on plant distribution compared to the other indices (see Table 1).

The associations of *Paliuretum spinia chrisiti* and *Juniperetum foetidissima* and their indicator species had positive correlations with Fisher and Margalef biodiversity indices. Meaning that by increasing the value of these factors, their species get distributed.

Studying the relationship between these biodiversity indices and plant associations can be used to establish a conservation action in the study areas and to revival the destructed area.

CONCLUSIONS

Our results show that altitude, pH and clay percent had the most important effect on biodiversity of plant associations. Therefore, compared to forestland associations, rangeland associations occupied higher altitude, where altitude, pH, clay percent and Simpson dominance index were lower while Shannon, Simpson biodiversity and Eveness indices were higher. These factors provide high stability in rangeland associations.

The studying of relationship between environmental factors and biodiversity variables, and determining of the most affecting factors on biodiversity in plant associations are essential for designing and management of the conservation programs.

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PROUČAVANJE BIODIVERZITETA BILJNIH ZAJEDNICA U SLIVU SUTAN-ČEJA U ARASBARANU, SJEVEROISTOČNI IRAN

SAŽETAK

Istraživanje biodiverziteta biljnih zajednica (ekosistema) je neophodno za razumijevanje njihove stabilnosti. Ova studija za cilj ima da ispita biodiverzitet biljnih zajednica u slivu Sutan-Čeja, kao i odnose ovih zajednica sa različitim indikatorima biodiverziteta. Prepoznavanje zajednica biljaka u proučavanoj oblasti izvršeno je metodom Braun Blanket. Biodiverzitet biljnih zajednica izračunat je na osnovu različitih indikatora, uključujući i bogastvo, Šenon, Simpson, Margalef i Fišer. Rezultati pokazuju da su zajednice biljaka u proučavanoj oblasti sasvim različite jedna od druge na osnovu indeksa biodiverziteta. Pearsonov koeficijent korelacije ukazuje da biljne zajednice koreliraju sa svakom od ekoloških varijabli. Na osnovu ovog koeficijenta korelacije, dominantnost vrsta je u pozitivnoj vezi sa pH vrijednošću zemljišta i procentom gline, dok je u negativnoj korelaciji sa nadmorskom visinom. Proučavanje odnosa između ekoloških faktora i varijabli biodiverziteta i utvrđivanje najznačajnijih faktora biodiverziteta zajednica biljaka u datom području neophodni su za upravljanje programima očuvanja. Biljne zajednice, fitosociologija, ekološke varijable, indikatori biodiverziteta, Arasbaran, kakonska korelacijska analiza.

Ključne riječi: indikatori biodiverziteta, zajednice biljaka, fitosociologija, Arasbaran, analiza vegetacije