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Species diversity in relation to physiographic factors in Lashgerdar protected region, Malayer, Iran

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Abstract

Rangeland is a natural ecosystem including large sources of genetic resources and diverse plant species which always guarantees the rangeland stability against environmental and biological factors. Objective of the present study is to investigate relationship of species diversity and richness to topographic factors. In this regard, the study was conducted in Lashgerdar protected region in Malayer city located in Hamedan province. After determination of work unit with specific characteristics of slope, direction and elevation, the sampling was conducted as random-systematic. Coverage measurement was carried out by establishment of four perpendicular transects with a length of 100 m in each of them. Then, ten 2 m^2 plots were established along each transect, and then, diversity, species richness and uniformity were determined in each plot after determination of plant cover. Correlation analysis and multi-variable regression were used in SPSS software to determine relationship of diversity, species richness and uniformity to topography. The results showed that, there is a relationship with confidence level of 99% between topographic factors and species diversity and richness. No relationship was seen between uniformity and topographic factors. Diversity was reduced between the elevations 2000 to 2600 and the elevation class of 2000-2200 had the maximum diversity and richness. Among the studied directions, the southern slope had the maximum species diversity and richness.

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Introduction

Rangelands are considered as the human life bed and economic sustainable development (Rezvanian, 2012). Awareness about importance and value of genetic resources in rangeland ecosystems and their undeniable role in sequences of ecosystem, makes understanding these resources more important. Undoubtedly, the loss of any plant and animal species can be an irreparable tragedy for all people of the earth. Hence, preservation and supporting the available species can be an obstacle in the way of occurrence of the mentioned irreparable damages. In the recent years, considering the increasing rate of endangered species and the Convention on Biological Diversity, studies and researches on species diversity have been considered (Smith *et al*., 1999).

Basically, any habitat with higher biological diversity, obviously has higher ecological stability and fertility and is a stable and dynamic ecosystem. Plant stability and diversity is used widely in the studies on plant coverage and environmental assessment as an important fast and important indices to determine situation of ecosystem, and it has been formed by two components. The first component is related to the number of species which is called species richness. The second component is the uniformity which is related to the species distribution (Wilson & Tilman, 2002). Dynamics of the plant society can be investigated through studying the mentioned index, and management recommendations can be proposed by measurement and investigating the species distribution Physiographic factors have an important role in distribution of plant species and their diversity by affecting the amount of soil moisture, chemistry and its other characteristics. The impact ofthese factor is due to playing the role in the presence and absence of the species. In this regard, various researchers have studied biological diversity considering the physiography or any physiographic factors separately such as elevation from sea level, slope and direction (Enright *et al*., 2005). Elevation and slope have a strong positive correlation to coverage variations (Jiang & Kang, 2007). Elevation and geographic direction are the most effective factors on species diversity (Elsheikh *et al.,* 2010). Fatthi and Ildoromi (2011) investigated the impact of environmental factors on diversity in grasslands of Hamedan.

Their results showed that, soil and direction factors have a significant impact on species diversity. Asaadi and Dadkhah (2011) studied a floristic composition and species richness of Asadly summer rangelands in conservative and destructive rangelands. He indicated that, species richness in western and northern slopes is higher than eastern and southern slopes.

Rezvanian (2012) investigated the physiographic factors in summer rangelands of Chaharbagh and he concluded that, species richness and diversity have a significant relationship to slope and elevation and have no relationship to direction.

Considering that the rangelands are one of the important biological resources in the world, investigating the relationship between species diversity and richness to the changes in earth's form can be considered as a suitable tool to determine the best habitat conditions to preserve species diversity in these ecosystems. So, stability and healthy of these ecosystems is related to richness and diversity. The evidences show that normal conditions of the rangelands ecosystems are disturbed by several interventions and reduced biodiversity and environmental capacities.

Topography is one of the effective factors on diversity indices especially in the west of Iran due to changes in slope, aspect and elevation. In the studied area (Lashgerdar protected rangelands) that is one of the important rangelands for environmental managers, there was no study about the environmental parameters effects on diversity. Due to topographic changes in this region and its importance in plant diversity, this study examined the relationship between these parameters. This is important for managers that who can appoint best topographic conditions for plant diversity conservation. The issue of diversity to evaluate rangeland function has considerable importance as biological resources

which could be considered for the decision and management in the western rangelands of Iran.

Materials and methods

Study area

Lashgerdar protected region is among mountainous rangelands of Hamedan in the south eastern of Malayer city with an area of 16000 ha and is located between longitudes 48^0 51′ 34" and 49^0 16′ 53" and latitudes 34^0 9′ 17 and 34^0 19′ 58". The region elevation is 2178-2734 m, the mean annual temperature is 11.2 ^{0}C and mean annual precipitation of 316 mm. the study area includes a 2000 ha area in Lashgerdar rangelands.

Research method

After overlaying the base maps including elevation classes, slope and direction of the studied area, the work units were determined including elevations classes of 2000-220, 2200-2400 and 2400-2600 and the slope directions as northern, southern, western and eastern and with a constant slope class (30-40%). In order to take vegetation cover and environmental factors, two perpendicular transects were established in each work unit with a length of 100 m, and the samples were taken as systematic-randomly on them. Area and number of the plots were determined using minimum area method and statistical method (Mesdaghi, 2005). Totally, 240 square plots with dimensions of 2 m were determined in the studied area. In each plot, the species were identified and canopy percentage, frequency and percentage of bare soil and litter were recorded. After collecting the plant information, the species diversity, richness and uniformity were determined using the following equations:

Calculation of species richness using Menhink equation (Menhink, 1964):

$$R=\frac{S}{\sqrt{N}} \quad (1)$$

Where, N is the number of total people in the sample, S is the number of species, R is the species richness.

Calculation of species diversity using Shannon-Weaner index (Shannon & Weaner, 1949):

$$H'=-\sum_{i=1}^{S}(P_i)\,.\,(\mathrm{Ln}\,P_i) \quad (2)$$

Where, H′ is the Shannon-Weaner index, P_i is relative frequency of the i^{th} species in the considered sample, s is the number of species.

Calculation of uniformity index (explaining the people distribution among the species) using j Pielou index:

$$j=\frac{H}{H_{MAX}} \quad (3)$$

Where, j is the value of Pielou uniformity, H is the Shannon-Weaner index, H_{max} is the maximum Shannon-Weaner index of which value is equal to = ln(s)H_{MAX}

After achievement of primary data, their normality was checked in each elevation class and direction using Kolmogorov-Smirnov test. Considering the normality of the data, Pearson correlation was used to investigate the relationship of elevation classes and geographical direction, diversity, uniformity and species richness. Also, multiple regression analysis was used to determine the relationship of species diversity and richness as independent variable and the variables of elevation classes as dependent variable. R coefficient in regression table represents the amount of correlation between the observed value of dependent variable and predicted value considering the regression model. Rs coefficient states the value of the variance of dependent variable (Y) which is explained based on independent variables (X). Variation range of the both coefficients is between 0 and 1 (Fotohi, 2008). Adjusted Rs coefficient is a ratio of the dependent variable distribution which is justified by linear regression and is an estimation which states how much the data fit to the other data from the same population. The general equation of multiple regression is as below (Kalantari, 2004):

$$\hat{Y} = a + b\,x + b\,x + \ldots + bn\,xn \quad (4)$$

Where Y′ is the predicted value of dependent variable (Y), a: Constant, b: Regression coefficient, x: values of independent variables. All the analyses were conducted using Excel and SPSS software.

Results

Floristic list of the studied area includes 25 families, 50 genera and 105 species (Fig.1). Compositae family with 27 species had the maximum number of species. Gramineae family and Labaiteae family were at the

second and third place with 18 and 14 species respectively.

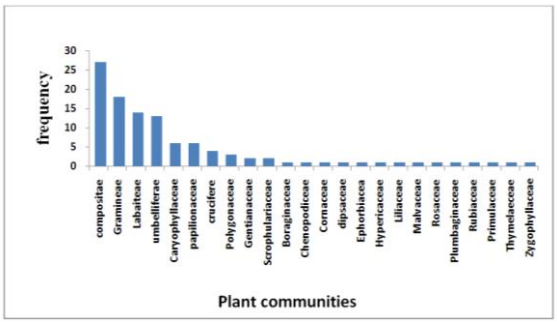

Fig. 1. Plant families in the region.

According to the investigations on the existent work units in the region, the minimum, maximum and mean values of diversity, species richness and uniformity in the studied elevation classes and directions are as below:

Table 1. Mean, maximum and minimum values of uniformity, richness and diversity in the studied region.

Range	Range	Indices	
Geographical direction	Elevation class	Shannon diversity uniformityrichness	
Eastern Southern	2400-2600 2000-2200	1.34 1.010.54 1.094.01 2.62 1.770.78932.37	Minimum Maximum Mean

Determination of correlation among species diversity, richness, uniformity and topographic factors

Results of Pearson correlation between species diversity and topographic factors (Table 2) showed that, there is a significant negative correlation at probability level of 1% between species diversity and elevation classes of 2000-2200, 2200-2400 and 2400-2600, and also, there is a significant positive correlation between the southern, northern directions and species diversity at 1% significance level and western, eastern directions and species diversity at 5% significance level. Also, the results of correlation of species diversity and topographic factors indicated that, there is a negative significant correlation between species diversity and elevation classes of 2000-2200 and 2400-2600 at 1% significance level as well as at 5% significance level for the elevation class of 2200-2400. Also, there is a significant positive correlation between southern and northern directions at 1% probability level; but, this correlation was at 5% significance level between the western and eastern directions. The results of correlation between uniformity and topography states that, there is no significant correlation between uniformity and any topographic factors.

Determination of regression relationships among topographic factors and species diversity and richness

Considering the existence of correlation between species diversity and richness and topographic factors, a regression relationship was determined among the mentioned factors. The regression relationship of species diversity and richness to the topographic factors has been shown in Table 3. Rs is determination coefficient of regression relationship which indicated the amount of variations of diversity, richness and uniformity affected by topographic factors.

Table 2. Correlation coefficient between species diversity and richness and topographic factors.

Uniformity	Species richness	Species diversity	Topographic factor		No.
-0.202^{ns}	-0.456**	-0.387**	2000-2200 (E1)		1
-0.263^{ns}	-0.223*	-0.387**	(E2) 2200-2400	Elevation classes	2
-0.326^{ns}	-0.681**	-0.302**	(E3)2400-2600		3
0.115^{ns}	0.373**	0.691**	(S)Southern		4
0.309^{ns}	0.251*	0.268*	(W)Western	Slope direction	5
0.200^{ns}	0.413**	0.387**	(N)Northern		6
0.215^{ns}	0.213*	0.399*	(E)Eastern		7

** Significant at 1% level * significant at 5% level ns: insignificant

Table 3. Summary of regression models of species diversity and richness to the topographic factors.

Adjusted Rs	Rs	R	Estimated standard error	Independent variable	Dependent variable
0.732	0.742	0.861	0.214	Topographic factors	Diversity
0.473	0.482	0.694	0.510	Topographic factors	Species richness

** Significant at 1% level* significant at 5% level ns: insignificant

According to Table 4 and the obtained significance level, it can be mentioned that, there is a linear relationship between species diversity and richness, and topographic factors.

Table 4. Variance analysis of regression models between species diversity and richness, and topographic factors.

F	Mean squares	Degree of (df) freedom	Sum of squares	statistic	Independent variable	Dependent variable
65.05**	1.878	13	9.38	regression	Topographic factor	
	0.029	226	3.26	remaining		Species diversity
		239	12.651	Total		
**54.45	1.417	5	38.30	regression	Topographic factor	
	0.260	234	10.465	Remaining		Species richness
		239	58.82	Total		

Table 5. Main results and coefficients of regression models of species diversity and richness to the topographic factors.

P	Beta	Std.Error	B	statistic	Independent variable	Dependent variable
				Model	Topographic factor	
0.000**		5.30	58.54	(Constant)		Species diversity
	-1.340	1.58	-16.88	(E1) 2000-2200	Elevation classes	
	0.306	0.23	-0.63	(E2)2200-2400		
	0.33	0.31	-0.67	(E3) 2400-2600		
0.000**	0.435	0.77	0.35	(S)Southern	Slope direction	
0.091ns	0.103	0.112	0.192	(N)Northern		
0.000**				Model	Independent variable	Dependent variable
0.000**	-0.70	0.81	2.830	(Constant)	Topographic factor	Species richness
0.000**	-0.25	0.31	-0.335	(E1) 2000-2200	Elevation class	
0.000**	-0.75	0.34	-0.332	(E2)2200-2400		
0.043**	-0.157	0.34	-0.069	(E3) 2400-2600		
0.030**	-0.89	0.27	0.23	(S) southern	Geographical direction	

** Significant at 1% level * significant at 5% level ns: insignificant

According to Table 5 which shows the results of regression model of species diversity and richness to the topographic factors, B values for species diversity and richness at elevation classes of 2000-220, 2200-2400 and 2400-2600 of the southern direction is not zero, so, they have a significant impact on species

diversity. The impacts of the other variables on species diversity and richness is not significant; consequently, they have a very weak impact on prediction of the dependent variable.

According to table 4, the regression equation of species diversity and richness to the topographic factors is as below:

Y′=58.54-16.88E1-0.63E2-0.67E3+0.35 Sequation (2)

And the regression equation of species richness to the topographic factors is as below:

Y= 2.83-0.335E1-0.332E2-0.69E3+0.23S

Discussion and conclusion

Results fo the present study show that, the impact of elevation from sea level is significant on species diversity and richness. Also, species diversity is high at low elevations (2000-2200) and it is reduced from the elevation of 2200m to top. High diversity at low elevations is probably due to appropriate conditions and high temperature as well as precipitation. According to the thermal principle, every plant reaches its certain growth stage when a certain amount of heat has been taken from the environment; therefore, growth speed of every plant has a positive correlation to the temperature. So, the plant grows slower at higher elevations since, the temperature varies by the elevation. Then, plant diversity is reduced by increasing the elevation; since, hard climatic conditions and particularly extreme cold and harsh environmental conditions at higher elevations reduce plant species diversity. Fisher *et al*., 2004 2011 ;Hedari & Mahdavi, 2009; Hossini *et al*., 2008; Fahymypur *et al*., 2013 *et al*., and Michalet Telwala, 2013 found similar results in their researches. Hossini *et al.* (2008) investigated the impact of variations of elevation from sea level in Hianan forests of Ilam city and concluded that, by increasing the elevation from sea level, the species diversity reduces. In this regard, Heydari and Mahdavi (2009) investigated the species diversity in relation to the physiographic factors of the region of Gava Mela located in the north western of Ilam province. They concluded that, species diversity is reduced by increasing the elevation. Michalet *et al.* (2013) states that, in Mediterranean areas and at low elevations, the coverage percentage is moderate and high and it is decreased at higher elevations affected by climatic variations. *Telwala et al.* (2013) investigated 124 native species in Himalaya region and indicated that, the elevation area of 993-23 which is the lowest elevation area, has the maximum species diversity and richness.

Fisher also studied an elevation gradient in Arizona and concluded that, low elevations have high species richness due to higher temperature. According to the present study, slope direction has a significant impact on species diversity and richness. Geographical direction factor affects plant-available water, soil temperature and amount of received light by the plant. On the other hand, difference in light intensity in various directions of a slope causes climatic changes in the slope (Moghadam, 2005). Species richness and diversity in the southern slopes in the studied area is higher than the northern, western and eastern directions. The mentioned impact is probably due to high temperature and dryness of the southern slopes compared to the northern, western and eastern slopes. The southern slopes are always warmer than the northern slopes; therefore, they have less moisture than the northern slopes and it causes that, the species placed in the two slopes, to be different in terms of ecological traits. Nevertheless, the southern slopes are not always unfavorable and are suitable for establishment of grass species which has led to increase of diversity in this direction due to the existence of several grass species in the region which are adaptable to the existent thermal conditions in the mentioned slopes. Badano *et al*., 2005; Mirzeai *et al*.,, 2007 Asaadi & Dadkhah, 2010 also have mentioned similar results. Also, Enright *et al.* (2005) investigated the plant cover of desert areas in Kithar National Park in Pakistan.

They showed that, temperature and sun light radiation assist to increase species diversity. Badano *et al.* (2005) studied some regions with Mediterranean climate and found a significant difference in the

northern and southern slopes. The higher species diversity and richness in the southern slopes was due to being drier than the northern slopes and consequently, species competition. The mentioned study indicated that, topographic factors have no impact on the uniformity because, it could not show its impact in the studied area and probably, the uniformity variations are more sensible in a higher scale and can show its impact in larger areas. In this regard, Ghehsareh Ardestani *et al.* (2010) and Rezvanian (2012) studied the plant cover traits on the uniformity and indicated that, the topographic factors have no significant impact on the uniformity. According to the mentioned contents, it can be stated that, species diversity in any region varies by the human and environmental factors. Identification of the factors affecting the species diversity and richness can help us to select appropriate management methods, and also, assessment of the applied management becomes possible by assessment of diversity indices variations.

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