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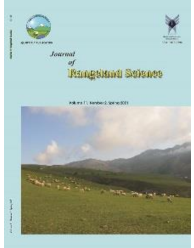

Research and Full Length Article:

The Ecological Factors Effecting the Distribution of *Artemisia melanolepis* Boiss. in Southeast of Sabalan Mt., Iran

Ardavan Ghorbani[A]*, Maryam Molaei ShamAsbi [B]
[A] Professor, University of Mohaghegh Ardabili, Ardabil, Iran
*(Corresponding author) E-mail: a_ghorbani@uma.ac.ir
[B] Ph.D. Candidate of Rangeland Sciences, University of Mohaghegh Ardabili, Ardabil, Iran

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Abstract. *Artemisia melanolepis* Boiss. is an endemic, rare and endangered species inhabiting high altitudes at Sabalan Mt., Iran. This study aimed to identify the effect of environmental variables on the distribution of *A. melanolepis* in southeastern faced slopes of Sabalan Mt., Iran in 2016. In the habitats of *A. melanolepis*, two sites (A and B) were selected with almost the same ecological conditions in the presence and absence of this species. In each site, five 100m transects using the systematically randomized method were established. Canopy cover, density, Litter (Lit), Bare Soil (BS), Stone and Gravel (SG) were recorded in 10 plots (each one square meter along each transect). Thirty-six soil samples were collected from 0-15cm depth (depth of root activates/ three samples from each transect). Soil texture (percent of clay, sand and silt), Organic Materials (OM), Particulate Organic Matter (POM), Water Dispersible Clay (WDC), potassium (K), phosphorous (P), acidity (pH) and Electrical Conductivity (EC) were measured at the lab. Elevation, slope, aspect, and mean annual precipitation and temperature for each plot was calculated. The cluster analysis, one-way ANOVA and Canonical Discriminate Analyses (CDA) were used for data analyses. The cluster analysis based on the presence and absence of species separated groups of A and B into two subgroups. There were significant differences between clusters using multivariate analysis of variance ($P<0.01$). Results showed that high density of *A. melanolepis* was related to increasing OM, POM, WDC, P, elevation and decreasing sand, pH and slope. Results of CDA showed that *A. melanolepis* distribution was more influenced by aspect, Tem, pH, POM, OM, silt, sand, P, slope, Lit, total canopy cover, SG, BS, elevation, WDC, EC and K in the selected sites. These results can be used in protection and restoration of this species.

Key words: Rangeland, Endemic species, Species distribution modeling, Habitat factors

Introduction

Study of the factors that affect the distributions of species in environment lies at the heart of ecology (Heikkinen *et al.*, 2007; Mirzaei Mosivand *et al.*, 2017). The appearance of a species in a given area is not accidental, but it occurs in response to changes in climate, topographic, edaphic and biotic factors (Ghorbani *et al.,* 2015; Cowling *et al.,* 2015; Buri *et al.,* 2017). In fact, the combined effects of a whole range of ecological factors determine the appearance of a species (Korner et al., 2011; Niu et al., 2019). Thus, changes in the topography, climate, soil and grazing factors can lead to species responses in each area of the landscape (Hooper and Vitousek, 1997; Ning *et al.,* 2013). Protection of species and biodiversity within natural ecosystems are intuitively a preparation to achieve reclamation of endangered species and to decrease extinction risk (ZareHesari *et al.,* 2014; Shaltout *et al*., 2015). Scenarios for reclamation, where threats to survival are removed in a manner that ensures long-term survival in nature, were mostly species-specific and single species management proved to be as important as multi-species and ecosystem management plan for valuable conservation strategies (Shaltout *et al*., 2015; Aghajanlou *et al*., 2018). For conservation, monitoring of vegetation dynamic and determination of suitable plant species for restoration in different environmental conditions, it is necessary to understand the relationship between target species and environmental factors (Bennie *et al.,* 2006; Wang *et al.,* 2012; Li *et al.,* 2017). Predicting potential habitats and identification of effective factors on the distribution of endemic species is a suitable method for biodiversity conservation and restoration of rangeland ecosystems (Mirzaei Mosivand *et al.,* 2017; Yilmaz *et al.,* 2017; Kargar *et al*., 2019).

Sabalan Mt. is important from the socio-economic-ecological perspectives and existence of high genetic resources, palatable species, nomadic life, ecotourism, geothermal energy, mineral water and spa (Ghorbani *et al*., 2013; 2015; 2018; Ghafari *et al*., 2018). There is no comprehensive study on the flora of this mountain, however, by considering the conducted studies (Ghorbani *et al*., 2013; 2015; Ahmadauli *et al*., 2015; Nazari Anbaran *et al*., 2016; Sharifi *et al*., 2016; Molaei ShamAsbi *et al.,* 2017; Ghafari *et al*., 2018), Sabalan and adjacent areas is one of the hotspot biodiversity regions in Iran and Caucasian Ecoregion (Ghorbani *et al.,* 2013; 2015; 2018; Ghorbani and Asghari, 2014; Ghafari *et al*., 2018).

Artemisia species such as *A. fragrans* (at lower altitudes), *A. aucheri* and A. *Austraica* (at middle altitudes), and *A. melanolepis* (at high altitudes) are distributed in Sabalan habitats (ZareHesari *et al*., 2014; Ghorbani *et al.*, 2015; Omidi *et al*., 2016; Molaei ShamAsbi *et al*., 2017).

Artemisia melanolepis is a medicinal and aromatic plant, which is important from the soil conservation and livestock feeding perspective (ZareHesari *et al*., 2014; Ghorbani *et al.,* 2015; MolaeiShamAsbi, 2016). In Iran, it is reported from Mazandaran province Kelar-Dasht, Hezarcham, Takht-e Suleiman and Warwatche; Semnan province Kuh-e Kahkashan, Mt. Shahvar, above Hajjillang; Tehran province Mt. Damavand, above Reneh; Qazvin province, Mastechal; Ardabil province, particularly at Sabalan, especially in southeast slopes, which is restricted to the high altitude habitats about 3000-4100masl (Rechinger, 1986; Jalili and Jamzad, 1999; MolaeiShamAsbi, 2016; Hassler, 2017). The presence of this species has been reported in the high elevation of Sabalan by some studies (Noroozi *et al*., 2011; ZareHesari *et al*., 2014; Ghorbani *et al*., 2015).

In Sabalan Mt. Sahsvan nomad’s livestock has extremely overgrazed on the habitat of this species (MolaeiShamAsbi, 2016). In southeastern faced slopes of Sabalan, in addition to the overgrazing, there are increasing threats for its population as it is subjected to severe intensive (Alvars ski resort field) and extensive recreational (unmanaged ecotourism practice) activities (Ghorbani *et al*., 2013; 2015; 2018). Although *A. melanolepis* has not yet been assessed for the IUCN Red List (Jalili and Jamzad, 1999; Hassler, 2017), however by considering local information (MolaeiShamAsbi, 2016) and results of this study, it is a rare and endangered endemic species in the Sabalan Mt.

*A. melanolepis*as the native threatened species is important from the Sabalan rangeland biodiversity standpoint. This species is important in this rangelands, particularly for forage production in late summer and autumn. Regarding the limited information, understanding a relationship between environmental factors and species distribution is necessary. Thus, this study was conducted to identify important and effective ecological factors on the distribution of this species to gain appropriate information for management strategies in order to conservation and restoration of that on the growing areas.

Materials and Methods

Study area

Mt. Sabalan (4,811 m in elevation), a Quaternary volcano, is located in northwestern Iran (Jalilin Asrabady *et al*., 2012). It is the third highest Mt. in Iran. The main selected habitat for this study is in the southeastern faced slopes of Mt. Sabalan in Ardabil province, Iran (Fig. 1). Selected habitat is located in the elevation range from 2900 to 3200 masl, which is the main habitat of *Artemisia melanolepis* in Mt. Sabalan (Ghorbani *et al*., 2013; 2015; 2018; MolaeiShamAsbi, 2016). Mean precipitation ranges from 635 to 681 mm and mean annual temperature ranges from 6.87 to 8.11°C for the selected habitat. It has moderate summer and cold winter, and more than four months of the year covered with snow (Tavosi and Delara, 2010; Ghorbani *et al*., 2018). The soil varies dramatically, but generally in terms of depth and fertility is fair to good rangeland soil with sandy-loamy texture (Ghorbani *et al*., 2013; 2015; 2018; Ghorbani and Asghari, 2014; MolaeiShamAsbi, 2016). Vegetation types of the study area are *Astragalus cardachrum*, *Alopecurus texilis* and *Festuca ovina* (Sharifi *et al*., 2013; 2016), and other species in the selected habitat listed in the Table 1. Current land use of the selected habitat is a rangeland which is grazed (4 to 5 months, May to September) as the summer rangeland of Shahsavan nomad's livestock (sheep about 95%, goat and others about 5%; Ghorbani *et al*., 2013).

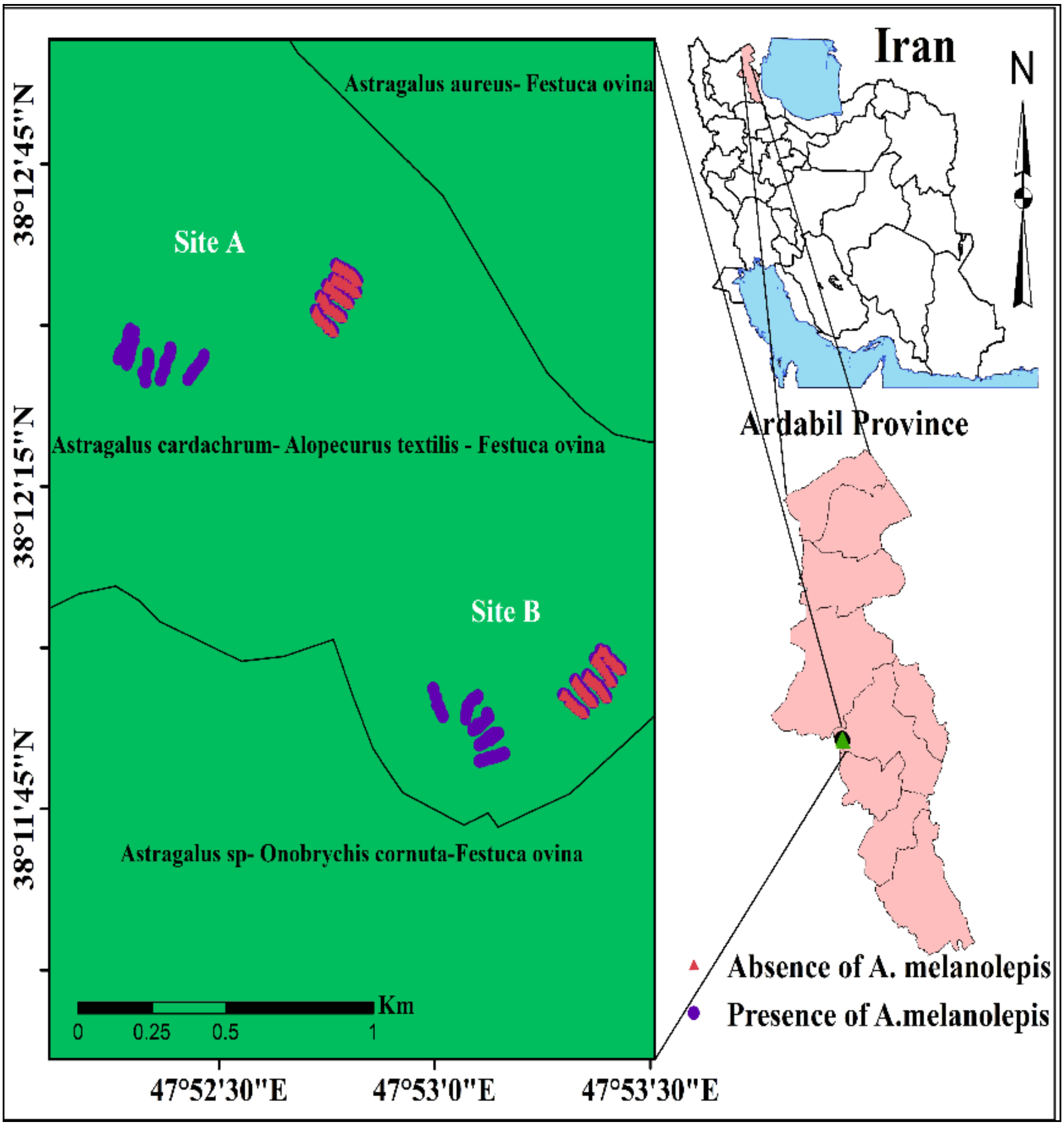

Fig. 1. Location of the study area (sites **A** and **B**), sampling points for presence and absence of the *A. melanolepis* in Ardabil province and Iran

Table1. Characteristics of the selected sites

Sites.	Species No.	Canopy Cover%	Vegetation types*	Rangeland condition	Rangeland trend	Accompanying species
A	29	55	*As.Ca-Al.te-Fe.ov*	Medium	Backward	*Artemisia melanolepis* Boiss., *Veronica orientalis* Mill., *Scorzonera grossheimi* Lipsch., *Thymus kotschyanus* Boiss. & Hohen., *Festuca ovina* L., *Acantholimon sahendicum* Boiss. & Buhse., *Onobrychis cornuta* (L.) Desv., *Tragopongon gylorrhizus* Rech.f., *Alopecurus textilis* Boiss., *Thesium ramosum* Hayne., *Helichrysum psychrophilum* Boiss., *Eryngium bungei* Boiss., *Anthemis atropatana* Iranshahr., *Polygonum aviculare* L., *Arenaria dianthoides* Sm., *Ranunculus sabalanicus* Mobayen & Z. Maleki., *Minuartia brevis* (Boiss.) Parsa., *Oxytropis persica* Boiss., *Poa longifolia* A. Rich., *Trifolium montanum* L., *Eragrostis curvula* (Schrad.) Nees., *Papaver bracteatum* Lindl., *Astragalus rhodosemius* Boiss., *Scutellaria sosnowskyi* Takht. *Potentilla bifurcal* L., *Leontodon asperrimus* (Willd.) Boiss., *Astragalus aegobromus* Boiss. & Hohen., *A. cordachrum*, *Campanula stevenii* M.B.
B	38	53	*As.Ca-Al.te-Fe.ov*	Medium	Stable	*Linaria grandiflora* Desf., *Euphorbia descipiens* Boiss. &. Buhse., *Artemisia melanolepis* Boiss., *Polygonum aviculare* L., *Agropyron tauri* Boiss & Balansa., *Poa compressa* L., *Papaver rhoeas* L., *Galium verum* L., *Arenaria dianthoides* Sm., *Thymus kotschanus* Boiss.& Hohen., *Potentilla bifurcal* L., *Tanacetum polycephalum* Sch. Bip., *Inula helenium* L., *Tragopongon gylorrhizus* Rech.f., *Campanula stevenii* M.B., *Onobrychis cornuta* (L.) Desv., *Festuca ovina* L., *Allium monophyllum* Vved., *Nonnea persica* Boiss.,*Acantholimon sahendicum* Boiss. & Buhse., *Veronica orientalis* Mill., *Alyssum bracteatum* Boiss. & Buhse., *Poa longifolia* A.Rich., *Onosma sp.*, *Erysimum crassipes* Fisch. & C.A., *Anthemis atropatana* Iranshahr., *Lamium album* L., *Eryngium bungei* Boiss.,*Apium nodiflorum* (L.) Lag., *Astragalus peristerus* Bunge., *A. cordachrum, Stachys iberica* M.B., *Ballota nigra* subsp *anatolica* P.H.Davis., *Pedicularis sibthorpii* Boiss., *Trifolium pretense* L., *Eragrostis curvula* (Schrad.) Nees., *Linaria dalmatica* (L.) Mill. *Minuartia brevis* (Boiss.) Parsa., *Alopecurus textilis* Boiss.

* *As.Ca-Al.te-Fe.ov*= *Astragalus cardachrum- Alopecurus textilis- Festuca ovina*

Sampling Method and Data collection

Initially, in order to recognize the distribution of the genus *Artemisia*, an overall study was conducted by literature review (Rechinger, 1986; Mozaffarian, 1996; AzimiMotem *et al*., 2011; Teimoorzadeh *et al.*, 2015; Ghorbani *et al.*, 2015; 2018; Omidi *et al.*, 2016). Moreover, fieldworks were conducted in Ardabil province to select the habitat of the *A. melanolepis*. Finally, two sites (**A** and **B**/ Fig., 1) were selected. In each site, two groups of sampling sub sites: the first group (two sites) with the presence and the second group (two sites) with the absence of *A. melanolepis* were selected. In each site, five 100m transects were established. At each site, the first transect was established randomly, and the others were established by 50m from each other. Based on previous studies (Ghorbani *et al*., 2013; 2015; Ahmadauli *et al*., 2015) and distribution of plant communities, size of the sampling plot for vegetation and land surface properties were selected as one square meter. Ten plots were established along each transects with 10m intervals. Density, canopy cover and aboveground net primary production of *A. melanolepis* and percentage of total vegetation cover, litter, stone and gravel, and bare soil were recorded in each plot. Four-factor method and scoring to range characteristics were used to determine the range condition and trend of study sites, respectively (Moghadam, 2007).

In three out of five transects (one, three and five), three soil samples from 0-15 cm depth (according to the *A. melanolepis* root activates) at the starting, middle and ending points of each transect were taken (nine samples from each site). A total number of 36 soil samples were taken and the geographical coordinates of each plot were recorded using a handheld Garmin Oregon 550 Global Positioning System (Garmin, 2011).

Soil samples were air-dried at room temperature and passed through a 2 mm sieve. Soil texture was determined by the hydrometer method; OM by the Walkley and Black's method; POM by physical separation; WDC by hydrometer method; K by flame photometry method; P by Olsen method; pH and EC in a saturation extract by pH meter and EC meter (Table 2). To map soil properties, spatial statistical methods were used. Initially, variogram analysis was performed and then interpolated using Kriging by GS^+ Ver.5.1.1, software (Gamma Design Software), and the value of each soil properties extracted for each plot. Digital topographic maps of the study area on the scale of 1:25000 from the National Cartographic Center of Iran were used for creating a digital elevation model (DEM, pixel size 30m×30m). Using DEM, elevation, slope and aspect values were extracted for each sampling plot, and precipitation and temperature value for each plot were extracted from derived relevant gradient equations (Tavosi and Delara, 2010; Ghorbani *et al.*, 2013; 2015; Ahmadauli *et al*., 2015) using DEM by Spatial Analyst Tool in ArcGIS Ver.10.4/ ESRI, 2017). Aspect data changed to quantitative value using the Equation 1 (Beers *et al*., 1966). All selected variables, code, unit and mean of them are presented in Table 2.

$A' = Cos\,(45\text{-}A) + 1$ Equation (1)

Where:

A'= converted value of aspect

A= the azimuth value of aspect.

Data Analysis

Kolmogorov-Smirnov test was used to assess the normality of the data. Pearson correlation and principal component analysis (PCA) was used to investigate the most susceptible variances, multi collinearity and to identify the importance of components explaining the highest portion of the variances in the dataset (Dai *et al.*, 2013). If the pair variables had a correlation coefficient above 0.8, one of them would be removed. Accordingly, as there was no one above 0.8 correlation between the 21 environment variables, all were used in statistical analysis. Sampling points were classified by Average Linkage (Between Groups) method using cluster analysis based on the environmental variables. The optimal number of groups on the dendrogram was extracted, in where there was a long gap between the integration of the two clusters. After grouping the sites, multivariate analysis of variance was used to determine significant differences between groups. To determine the variables which had significant influence on group's discrimination, analyses of variance and Duncan test were used to compare means. To determine the degree of importance of measured variables in the distribution of *A. melanolepis* and confirm it, the taken grouping was conducted using canonical discriminant analysis (CDA). Statistical analysis was conducted using $SPSS_{24}$ (SPSS Inc., Chicago, USA, 2016).

Table 2. List of variables in the dataset

Variable	Code	Unit	Total	Site **A**	Site **B**
			Mean ± SD	Mean ± SD	Mean ± SD
Density of *A. melanolepis* (dependent variable)	DS	n/m^{-2}	10.05 ± 20.12	14.45 ± 26.05	5.66 ± 9.78
Elevation	Elev	m	3023.51 ± 85.68	3016.04 ± 92.08	3030 ± 78.51
Slope	Slope	%	19.88 ± 9.53	25.40 ± 9.95	14.37 ± 4.71
Aspect	Aspect	-	0.53 ± 0.37	0.60 ± 0.34	0.46 ± 0.38
Precipitation	Pre	mm	656.83 ± 6.34	655.41 ± 17.56	658.26 ± 14.98
Mean temperature	Tem	°C	7.78 ± 0.90	7.12 ± 0.20	7.94 ± 0.10
Litter	Lit	%	1.85 ± 1.44	2.00 ± 1.44	1.69 ± 1.44
Bare Soil	BS	%	18.32 ± 15.26	22.34 ± 16.59	14.65 ± 12.58
Stone & Gravel	SG	%	18.42 ± 17.38	15.52 ± 14.68	21.61 ± 19.37
Total Canopy Cover	TCC	%	61.12 ± 19.12	60.21 ± 17.14	62.02 ± 20.96
Clay	Clay	%	12.53 ± 3.32	12.95 ± 3.59	12.11 ± 2.99
Sand	Sand	%	68.99 ± 4.82	67.49 ± 4.91	70.50 ± 4.25
Silt	Silt	%	18.48 ± 4.19	19.55 ± 4.61	17.38 ± 3.41
Organic Matter	OM	%	2.22 ± 0.420	2.30 ± 0.45	2.14 ± 0.37
Particulate Organic Matter	POM	%	2.05 ± 0.41	2.16 ± 0.41	1.95 ± 0.39
Water Dispersible Clay	WDC	%	38.19 ± 12.98	40.87 ± 13.79	35.51 ± 11.56
Potassium ion (K^+)	K	meq/l	695.60 ± 265.91	737.10 ± 291.64	654.11 ± 231.52
Phosphorus	P	meq/l	11.46 ± 1.49	11.46 ± 1.60	11.46 ± 1.38
pH (acidity)	pH	-	7.01 ± 0.38	6.90 ± 0.32	7.11 ± 0.41
Electrical Conductivity	EC	ds/m	199.49 ± 42.89	213.07 ± 47.17	185.91 ± 33.17

Results

Derived subgroups from cluster analysis

Results of mean comparisons between grouping sampling plots using cluster analysis (Average Linkage) showed that sampling plots are separable using multivariate analysis of variance in four subgroups which each subgroup covers a sample subsite. Multivariate analysis of variance showed that resulting subgroups in terms of all selected variables had significant differences except TCC (Table 3). Considering the significant difference between the subgroups, the cluster analysis results were interpreted in subgroup's level.

Means comparison of environmental variables for sampling plots in site **A** indicated that most of the selected variables except TCC, BS, WDC, Tem and clay among the sites with the presence and absence of *A. melanolepis* are significantly different ($P<0.01$). In site **B**, all selected variables except TCC, sand, POM, P and K were significantly different in the presence and absence sites ($p<0.01$). The results of the analysis of variance between presence and absence of *A. melanolepis* in habitats demonstrate significant differences for all of the selected attributes except CCT

(P<0.01; Table 3). According to the obtained mean values for environment variables, *A. melanolepis* is distributed at higher elevations, low sloppy area, southeastern faced aspects in the medium to heavy soil texture, low pH, rich from P, POM, OM and soil with more WDC. Sites with the presence of *A. melanolepis* in comparison with the absence sites have more SG, Lit and low BS amount. Results showed that high density of *A. melanolepis* was adapted in habitats with average OM of 2.66%, POM 2.41%, WDC 42.08%, Lit 9.8%, SG 22.56%, slope 16.7% and 3106 masl elevation, clay 13.4%, silt 21.45%, sand 65.08%, and also Pre of 672.6mm (Table 3).

Table 3. Analysis of variance of environmental factors and their effects on the presence or absence of *A.melanolepis* in subgroups derived from cluster analysis

Variables	Site **A**		Site **B**		F test
	Presence	Absence	Presence	Absence	
	Mean ± SD	Mean ±SD	Mean ± SD	Mean ± SD	
DS (n. m^2)	28.90±30.75^{c}	0.00±0.00^{b}	11.31±1.6^{a}	0.00±0.00^{b}	34.70**
Elev (m)	3106.47±19.62^{a}	2925.60±7.45^{b}	3099.64±52.40^{a}	2962±9.50^{c}	529.01**
Slope (%)	16.74±5.00^{b}	34.05±4.72^{c}	10.70±2.86^{a}	18.04±3.02^{b}	307.51**
Aspect	0.73±0.37^{a}	0.48±0.26^{ab}	0.55±0.52^{b}	0.37±0.09^{c}	8.80**
Pre (mm)	672.67±3.74^{c}	638.15±1.42^{a}	645.60±1.81^{b}	671.36±10.00^{c}	529.02**
Tem (°C)	7.11±0.10^{a}	7.14±0.27^{a}	8.03±0.04^{b}	7.85± 0.05^{c}	529.02**
Lit (%)	2.06±1.64^{b}	1.94±1.22^{ab}	2.00±1.58^{b}	1.39±1.23^{a}	0.72*
BS (%)	12.01±9.11^{a}	32.68±15.98^{a}	14.77±13.92^{b}	14.54±11.22^{a}	24.67**
SG (%)	22.56± 13.73^{b}	8.48±12.06^{a}	17.72±19.09^{b}	25.50±19.04^{c}	18.00**
TCC (%)	63.55±16.53^{a}	56.87±17.29^{a}	65.50±20.32^{a}	58.54±20.98^{a}	0.63^{ns}
Clay (%)	13.46±4.51^{b}	12.43±2.28^{b}	10.62±3.14^{a}	13.61±1.92^{b}	9.72**
Sand (%)	65.08±4.15^{a}	69.91±4.42^{b}	69.97±4.99^{b}	71.03±3.33^{b}	19.41**
Silt (%)	21.45±0.33^{a}	17.66±4.37^{b}	19.41±2.96^{a}	15.35±2.52^{b}	26.35**
OM(%)	2.66±0.28^{b}	1.95±0.27^{a}	2.07±0.44^{a}	2.23±0.28^{c}	43.89**
POM (%)	2.41±0.33^{a}	1.91±0.34^{b}	1.91±0.45^{b}	1.99±0.31^{b}	21.84**
WDC (%)	42.08±18.23^{b}	39.65±7.01^{b}	39.66±12.78^{b}	31.36±8.47^{a}	7.14**
K (meq/l)	526.86±160.45^{a}	947.34±236.41^{b}	509.42±193.07^{b}	798.80±168.21^{b}	4.46**
P (meq/l)	12.07±1.37^{c}	10.85±1.59^{a}	11.68±1.17^{bc}	11.24±1.55^{ab}	7.72**
pH	6.83±0.42^{a}	6.98±0.15^{b}	6.85±0.27^{a}	7.38±0.36^{c}	32.58**
EC (ds/m)	204.01±41.88^{b}	222.14±50.74^{c}	193.65±35.28^{ab}	178.17±29.26^{a}	10.59**

**: Significant at p<0.01, *: Significant at P<0.05 and ^{ns}: no significant
Means of rows with the same letter are not significantly different (P<0.05)

Canonical discriminate analysis

Using CDA of sampling points based on environmental variables and results, three functions were justified, respectively 65.00, 27.40 and 7.60% and in total explained 100% of the total variance of data (Table 4). Moreover, the canonical correlation coefficient showed that the Functions 1, 2 and 3 were able to discriminate well between the groups (Table 4). Table 5 indicates the values of Wilks' lambda for functions, which increase from the Function 1 through the Function 3. The index closer to zero shows more fitting to estimate function in the discrimination of groups; thus, Functions 1, 2 and 3 had proper estimation in the discrimination of groups. Regarding the significance of chi-square values (P<0.01), the mean of groups is different. In each function, the selected attributes had different coefficients, consequently variables influencing the grouping of habitats in addition to the distribution of the *A. melanolepis* can be concluded, considering to these coefficients (Table 6). Thus, according to the CDA, the functional equation can be set as Function 1 using discriminant function coefficients, *A. melanolepis* distribution is more influenced by aspect, Tem, pH, POM, OM, silt, sand, P, slope, Lit, total canopy cover, SG, BS, elevation, WDC, EC and K (equation 2). Elevation and aspect, having the highest standardized coefficients, as well as Tem, EC and pH having the lowest standardized coefficients, respectively, which had the maximum and minimum impacts on the first detection function. OM has the greatest effect on Function 2. owing to structural coefficients (Table 6), elevation, K, BS, P and TCC in the first function as well as Pre, Tem and SG in the second function and slope, OM, sand, POM, silt, EC, pH, aspect, clay, WDC and Lit in the third function show the most correlation with functions formed.

The results of the classification of habitat selected by CDA are presented in Table 7. The results given in Table 7 demonstrate the corresponding level of predicted and observed values. If the data of *A. melanolepis* in site **A** is in the Function 1, the function will properly determine membership of the Group 1 in 100% of cases. If the data of absence of *A. melanolepis* in site **A** is in the first function, the function will properly determine membership of the Group 2 in 100% of cases. If the data of *A. melanolepis* in site **B** is in Function 1, it determines the membership of the Group 3 in 100% of cases. If the data of absence of *A. melanolepis* in site **B** is in the first function, the function will properly determine membership of the Group 4 in 100% of cases. Overall, 100% of the main grouped cases have properly classified. Accordingly, the results of this study indicated the effects of environmental factors on the discrimination of habitats of *A. melanolepis* and the sites without the species (Fig. 2). In this Figure, Group 1 represents the habitat of *A. melanolepis* in site **A**, Group 2 reflects the habitats without *A. melanolepis* in site **A**, Group 3 shows the habitats of *A. melanolepis* in site **B** and Group 4 reflects the habitats without *A. melanolepis* in site **B**.

Table 4. Eigenvalue and the percentage of variance explained by the first three functions in CDA

Function	Eigenvalue	Variance (%)	Cumulative variance (%)	Canonical correlation
1	36.34[a]	65.00	65.00	0.98
2	15.33[a]	27.40	92.40	0.97
3	4.25[a]	7.60	100.00	0.90

a. First 3 canonical discriminant functions were used in the analysis.

Table 5. Wilks' Lambda values in CDA

Test of function(s)	Wilks' lambda	Chi-square	df	Sig.
1 through 3	0.00	1521.34	51	0.00**
2 through 3	0.01	838.96	32	0.00**
3	0.19	312.50	15	0.00**

Table 6. Standardized canonical discriminant functions coefficients and structure matrix in the measured variables in the selected sites

Standardized canonical discriminant function coefficients				Structure matrix		
Variables	Function			Function		
	1	2	3	1	2	3
Elev	1.46	-0.39	0.13	0.46*	-0.16	0.05
K	-0.29	0.52	-0.30	-0.16*	0.03	0.04
BS	0.74	1.17	3.64	-0.09*	-0.07	0.06
P	0.26	-0.24	0.26	0.05*	0.00	0.03
CCT	1.37	2.07	5.15	0.03*	-0.02	-0.01
Pre	-	-	-	0.22	0.64*	0.27
Tem	-0.16	-1.03	-0.39	-0.22	-0.64*	-0.27
SG	1.01	1.76	4.20	0.039	0.08*	-0.03
Slop	-0.64	-0.12	0.89	-0.32	0.00	0.48*
OM	0.00	1.66	-0.07	0.09	0.10	0.22*
Sand	-0.80	0.85	-0.83	-0.05	0.00	-0.21*
POM	0.20	-1.00	0.39	0.06	0.05	0.20*
Silt	-0.85	0.25	0.06	0.07	-0.07	0.18*
pH	0.19	0.65	-0.33	-0.06	0.14*	-0.14*
EC	0.19	-0.22	0.34	-0.02	-0.07	0.13*
Aspect	0.77	-0.59	0.17	0.04	-0.03	0.11*
Clay	-	-	-	-0.01	0.08	0.10*
WDC	0.23	-0.23	0.75	0.21	-0.06	0.09*
Lit	0.22	0.08	0.29	0.01	-0.01	0.04*

$$F = 2.20Aspect - 1.22Tem + 0.61pH - 0.55POM - 0.23Silt - 0.18Sand + 0.18P - 0.16Slope + 0.16Lit + 0.07TCC + 0.07OM + 0.06SG + 0.06BS + 0.05Elev + 0.02WDC + 0.005EC - 0.002K$$

(Equation 2)

Table 7. The results of classification using CDA

Classification results [a]								
			Groups	Predicted group membership				Total
				Site **A**		Site **B**		
				Presence	Absence	Presence	Absence	
Original	%	Site **A**	Presence	100.00	0.00	0.00	0.00	100.00
			Absence	0.00	100.00	0.00	0.00	100.00
		Site **B**	Presence	0.00	0.00	100.00	0.00	100.00
			Absence	0.00	0.00	0.00	100.00	100.00

a. 100% of original grouped cases correctly classified

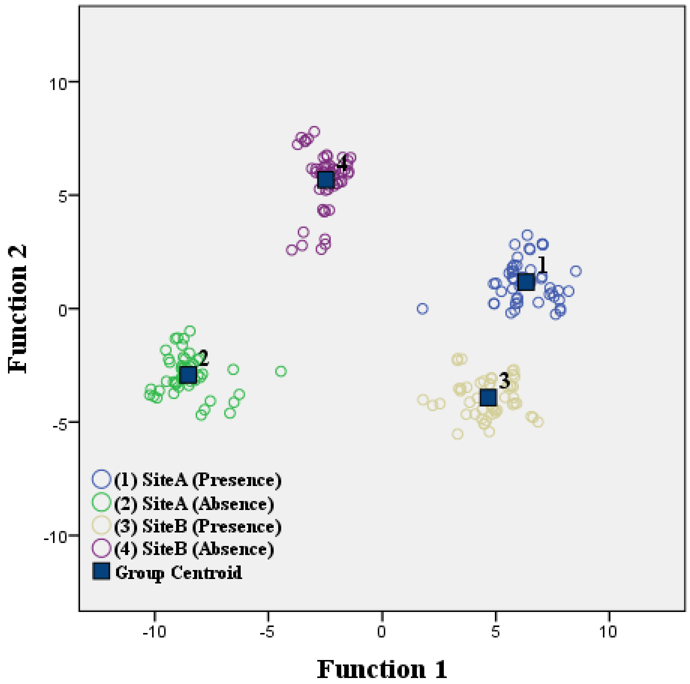

Fig. 2. Canonical discriminant functions in the presence and absence conditions of *A. melanolepis* in subgroups derived from cluster analysis

Discussion

Conservation biologists are often interested in rare species and seek to improve their conservation. These species typically have limited number of available occurrence records, which poses challenges for the creation of accurate species distribution models when compared with models developed with greater numbers of occurrences (McPherson *et al.*, 2004; Hernandez *et al.*, 2006). Sustainable management practices and the preservation of endemic and rare plants are essential for the conservation of global biodiversity because these plants are important not only for local regions but also for global biodiversity. Therefore, endemic species are important targets for global conservation efforts (Myers *et al.*, 2000).
In conservation and management programs of the plant species, determining the effective ecological factors on species distribution and habitat occupied is important (Mirzaei Mosivand *et al.*, 2017; Niu *et al.*, 2019). Vegetation cover of each region is the resultant of its environmental gradients (Ghorbani & Asghari, 2014). Therefore, it can be concluded that a combination of ecological factors such as climate, soil and physiography affect the establishment of plant species (Zare Chahouki *et al.*, 2012; Yilmaz *et al.*, 2017; Aghajanlou *et al.*, 2018). Results of mean comparison of species habitats and sites with absence of *A. melanolepis* based on selected environmental variables in each site show that these habitats in site **A** have significant differences in term of all of the selected variables except for BS, TCC, WDC, Tem, Clay and Lit. Moreover, in site **B**, all the selected variables except for TCC, sand, POM, P and K were significantly different in the presence and absence sites. On the other hand, according to the obtained mean values of environment variables, *A. melanolepis* is distributed on the higher elevations, low sloppy area, southeast faced aspects, in the medium to heavy soil texture, low pH, rich from P, POM, OM soil with more WDC. Sites with the presence of *A. melanolepis* in comparison with the absence sites have more SG, Lit and low BS amount.

According to the results, topographic variables such as elevation, slope and aspect affected the distribution of this species. Mostly distribution of this species was observed around 3100 masl with Pre 672.6mm, Tem 7.11°C, slope 16.7% and more SG, WDC and P. According to Ghorbani *et al*. (2015), the most important factors in the separation of plant species from the study area were reported to be elevation, slope percent, soil texture and depth. The spatial distribution of mountain plants is a direct result of the influence of micro-climate and topography (Cowling *et al.*, 2015). Buri *et al.* (2017) have found a relationship between environmental factors especially topography with species distribution, particularly at the study area (Ghorbani and Asghari, 2014). Aspect affects the amount of available water to plants, soil temperature and amount of receiving light to the plants. On the other hand, differences in light intensity in different directions of hillsides cause mesoclimatic changes in them (Moghadam, 2006). Thus, it can be concluded that aspects showed varying trends along the altitudinal gradient, which could be explained by the "water‑energy dynamics theory" proposed by O'Brien *et al.* (2000). The mutual relation between water and energy controls plant physiological activities and thus determines plant distributions. Some studies (Pinke *et al*., 2010; Motamedi *et al*., 2013; Nodehi *et al*., 2014; Aghajanlou *et al*., 2018) on the impact of the establishment and distribution of plant species found similar results. Other affecting factors on the distribution of selected species are physical properties (distribution of sand, clay and silt, WDC) and soil chemical properties (including pH and EC of the soil, K, OM and POM). Soil is one of the most important natural resources in the world and plays a central role in terrestrial ecology (Okon *et al*., 2014). WDC shows soil resistance to erosion that high level of this feature represents the erodible of soil (Karimi *et al*., 2007). The amount of this variable in site with the high density of *A. melanolepis* was lower than the other selected sites. Thus, erosion of soil in *A. melanolepis* habitats was lower than the habitats without *A. melanolepis*, which field observation confirmed this situation. According to the obtained results, it can be concluded that the *A. melanolepis* prefers habitats with low degradation and more POM and OM. POM defined as fresh or decomposing organic material between 53 and 250mm in diameter, which is a useful index of microbial-important SOM because it consists of recognizable organic matter which can be isolated from mineral soils, and is sensitive to changes in soil management (Wander and Traina, 1996; Kantola *et al*., 2017). The rate of POM turnover also is driven by environmental variables including moisture, temperature, and pH affecting microbial activity (Kantola *et al*., 2017). In the habitats of *A. melanolepis*, in comparison, the level of POM was higher. This study was not incorporated microbial activity; thus, further study is required in this regard. OM is a key component of soil-plant relationship, and is closely associated with soil features and processes (Chen *et al*., 2004). OM can be divided into labile, slow and recalcitrant OM according to its turnover rate (Six *et al*., 2002). Labile OM with a shorter turnover time can respond sensitively to changes in vegetation compared to total OM in ecosystems (Laik *et al*., 2009). Our finding about the effect of OM on the *A. melanolepis* is similar to some studies (such as Oueslati *et al*., 2013). They found that OM is significantly affected by the plant species in the terrestrial vegetation. Additionally, OM affects soil chemicals, physical and biological properties, and this has been suggested as the single most important indicator of soil quality (Ryals *et al*., 2014). By considering the obtained results and derived models for *A. melanolepis* distribution, OM is an effective factor, however, further experimental study is required in this regard.

According to the results, EC, pH and P of soil were other effective factors in the distribution of *A. melanolepis*. The effect of soil salinity and acidity on species distribution was well documented (Youssef and Al-Fredan, 2008; Piri Sahragard and Zare Chahouki, 2016). In relation to the role of P on species distribution, some studies such as Cristofoli *et al.* (2010), particularly at the study area Omidi *et al*. (2016) and MolaeiShamAsbi *et al*. (2017) have emphasized that P of soil was an important determinant for the restoration and conservation of species such as *Festuca ovina* and particularly *Artemisia fragrans, A. aucheri* and *A. austraica*.

Conclusion

Our finding indicates that *A. melanolepis* is distributed on the above 3000 masl, low sloppy area (10 to 16%) and southeastern faced aspects. It is distributed on the lowest acidity, sand and on the highest OM, POM, P and WDC. In other words, habitat suitability of this species increases with the increasing nutrients of soil such as OM, POM and P and decreasing sand and acidity. It should be noted that future studies must focus on mapping the probability of species presence and their distribution patterns in regards to climate change.

References

Aghajanlou, F., Ghorbani, A., ZareChahoki, M.A., Mostafazadeh, R., Hashemi Majd, K., 2018. Ecological survey of the presence and absence of *Ferula ovina* (Boiss.) Boiss. and *Ferula persica* Willd. in north-western rangelands of Iran (case study: Zanjan province). Journal of Rangeland Science, 8(4): 352- 362.

Ahmadauli, V., Ghorbani, A., AzimiMotem, F., Asghari, A., Teymorzadeh, A., Badrzadeh, M., 2015. Study of flora, life form, chrotype, diversity and evenness change under the effect of different grazing pressure from crises centers in south- east of Sabalan. Journal of Taxonomy and Biosystematics, 23: 69-84. (In Persian).

AzimiMotem, F., Talai, R., Asiabizadeh, F., Houshyar, M., 2011. A survey on flora, life forms and geographical distribution of plant species in the protected forests of Fandoghlu (Ardabil province). Journal of Taxonomy and Biosystematics, 9: 75-89. (In Persian).

Beers, T.W., Dress, P.E., Wensel, L.C., 1966. Aspect transformation in productivity research. Journal of Forestry, 64: 691-692.

Bennie, J., Hill, M.O., Baxter, R., Huntley, B., 2006. Influence of slope and aspect on long-term vegetation change in British chalk grasslands. Journal of Ecology, 94: 355–368.

Buri, A., Cianfrani, C., Pinto-Figueroa, E., Yashiro, E., Spangenberg, J.E., Adatte, T., Verrecchia, E., Guisan, A., Pradervand. J.N., 2017. Soil factors improve predictions of plant species distribution in a mountain environment. Progress in Physical Geography: Earth and Environment, 6: 703-722. https://doi.org/10.1177/0309133317738162

Chen, C.R., Xu, Z.H., Mathers, N.J., 2004. Soil carbon pools in adjacent natural and plantation forests of subtropical Australia. Soil Science Society of America Journal, 68: 282–291. https://doi.org/10.2136/sssaj2004.2820

Cowling, R.M., Potts, A.J., Bradshaw, P.L., Colville, J., Margarita, A., Ferrier, S., Forest, F., Fyllas, N.M., Hopper, S.D., Ojeda, F., Proches, S., Smith, R.J., Rundel, P.W., Vassilakis, E., Zutta, B.R., 2015. Variation in plant diversity in Mediterranean-climate ecosystems: the role of climatic and topographical stability. Journal of Biogeography, 42(3): 552–564. https://doi.org/10.1111/jbi.12429

Cristofoli, S., Monty, A., Mahy, G., 2010. Historical landscape structure affects plant species richness in wet heathlands with complex landscape dynamics. Landscape and Urban Planning, 98(2): 92-98. https://doi.org/10.1016/j.landurbplan.2010.07.014.

Dai, Z., Li, N., Muhammad, P.C., Brookes, H., Wang, X., Liu, X., Xu, J., 2013. Principle component and hierarchical cluster analysis of soil properties following biochar incorporation. Soil Science Society of America Journal, 78(1): 205-213. https://doi.org/10.2136/sssaj2013.05.0199.

Garmin, 2011. Oregon Series Owners Manual. Available at: https://www.manualsearcher.com/garmin/oregon-550/manual

Ghafari, S., Ghorbani, A., Moameri, M., Mostafazadeh, R., Bidarlord, M., 2018. Composition and structure of species along altitude gradient in Moghan-Sabalan rangelands, Iran. Journal of Mountain Science, 15(6): 1209-1228. https://doi.org/10.1007/s11629-017-4820-2

Ghorbani, A., Abbasi Khalaki, M., Asghari, A., Omidi, A., ZareHesari, B., 2015. Comparison of some effective environmental factors on the distribution of *Artemisia fragrans* and *Artemisia austriaca* in southeast faced slopes of Sabalan. Iranian Journal of Rangeland, 9(2):129-141. (In Persian).

Ghorbani, A., Asghari, A., 2014. Ecological factors affecting the distribution of *Festuca ovina* in Southeastern rangelands of Sabalan. Iranian Journal of Range and Desert Research, 21(2): 368-381. (In Persian).

Ghorbani, A., Mohammadi Moghaddam, S., Hashemi Majd, K., Dadgar, D., 2018. Spatial variation analysis of soil properties using spatial statistics: a case study in the region of Sabalan Mountain, Iran. Ecomont, 10(1): 70-80. https://doi.org/10.1553/eco.mont-10-1s70

Ghorbani, A., Sharifi, J., Kavianpoor, H., Malekpoor, B., Mirzaei Aghche Gheshlagh, F., 2013. Investigation on ecological characteristics of *Festuca ovina* L. in south-eastern rangelands of Sabalan. Iranian Journal of Range and Desert Research, 20(2): 379-396. (In Persian).

Hassler, M., 2017. World Plants: Synonymic Checklists of the Vascular Plants of the World (version May 2017). In: Roskov, Y., Abucay, L., Orrell, T., Nicolson, D., Bailly, N., Kirk, P.M., Bourgoin, T., DeWalt, R.E., Decock, W., De Wever, A., Nieukerken, E., Zarucchi, J., Penev, L., 2017. Species 2000 and IT IS Catalogue of Life, 26th July 2017. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. https://doi.org/10.15468/7ppkhn

Heikkinen, R.K.L., Kuussaari, M., Toivonen, M., 2007. Modelling the spatial distribution of a threatened butterfly: Impacts of scale and statistical technique. Landscape and Urban Planning, 79: 347–357. https://doi.org/10.1016/j.landurbplan.2006.04.002

Hernandez, P.A., Graham, C.H., Master, L.L., Albert, D.L., 2006. The effect of sample size and species characteristics on performance of different species distribution modelling methods. Ecography, 5: 773-785. https://doi.org/10.1111/j.0906-7590.2006.04700.x

Hooper, D.U., Vitousek, P.M., 1997. The effects of plant composition and diversity on ecosystem processes. Journal of Science, 277:1302–1305. http://dx.doi.org/10.1126/science.277.5330.1302

Jalili, A., Jamzad, Z., 1999. Red data Book of Iran: A preliminary survey of endemic, rare and endangered plant species in Iran. Research Institute of Forests and Rangelands, Tehran. Pages 748.

Jalilin Asrabady, S., Itoi, R., Valdimarsson, P., Saevarsdottir, G., Fujii, H., 2012. Flash cycle optimization of Sabalan geothermal power plant employing the energy concept. Geothermics, 43: 75-82. https://doi.org/10.1016/j.geothermics.2012.02.003

Kantola, I.B., Masters, M.D., DeLucia, E.H., 2017. Soil particulate organic matter increases under perennial bioenergy crop agriculture. Soil Biology and Biochemistry, 113: 184-191. http://dx.doi.org/10.1016/j.soilbio.2017.05.023

Kargar, M., Akhzari, D., Saadatfar, A., 2019. Comparing different modelling techniques for predicting presence-absence of some dominant plant species in mountain rangelands, Mazandaran province. Journal of Rangeland Science, 9(3): 219-233.

Karimi, H., Soofi, M., Haghnia, G.H., Khorasani, R., 2007. Study on the stability of aggregates and soil erosion potential in loamy and sandy clay loam soils (case study: Lamerd plain- Fars province). Iranian Journal of Agricultural Sciences and Natural Resources, 14 (6): 11-21. (In Persian).

Korner, C., Paulsen, J., Spehn, E., 2011. A definition of mountains and their bioclimatic belts for global comparisons of biodiversity data. Alpine Botany, 121: 73–78.

Laik, R., Koushlendra, K., Das, D.K., Chaturvedi, O.P., 2009. Labile soil organic matter poolsin a calciorthent after 18 years of afforestation by different plantations. Applied Soil Ecology, 42: 71–78. https://doi.org/10.1016/j.apsoil.2009.02.004

Li, C., Xiao, B., Wang, Q.H., Zheng, R.L., Wu, J.Y., 2017. Responses of soil seed bank and vegetation to the increasing intensity of human disturbance in a semi-arid region of northern China. Sustainability, 9: 1837. https://doi.org/10.3390/su9101837

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A., Kent, J., 2000. Biodiversity hotspots for conservation priorities. Nature, 403: 853–858.

McPherson, J., Jetz, W., Rogers, D., 2004. The effects of species' range sizes on the accuracy of distribution models: ecological phenomenon or statistical artefact? Journal of Applied Ecology, 41: 811-823. https://doi.org/10.1111/j.0021-8901.2004.00943.x

Mirzaei Mosivand, A., Ghorbani, A., Keivan Behjou, F., 2017. Effects of some ecological factors on distribution of *Prangos uloptera* and *Prangos pabularia* in rangelands of Ardabil province, Iran. Applied Ecology and Environmental Research, 15(4): 957-968. http://dx.doi.org/10.15666/aeer/1504_957968

Moghadam, M.R., 2006. Ecology of Terrestrial Plants. University of Tehran Press. (In Persian).

Moghadam, M.R., 2007. Range and Range Management. University of Tehran Press. (In Persian).

Molaei ShamAsbi, M., 2016. Assessment of some ecological factors effect on spatial variation of *Artemisia aucheri* and *Artemisia melanolepis* species in the southeastern slopes of the Sabalan mountain. Thesis is approved for the degree of M.Sc. In Natural Resources Engineering Range Management. University of Mohaghegh Ardabili, Ardabil, Iran. (In Persian).

Molaei ShamAsbi, M., Ghorbani, A., Sefidi, K., Bahrami, B., Hashemi Majd, K., 2017. Study the effective ecological factors on distribution of *Artemisia aucheri* Boiss. in southeast faced slopes of Sabalan. Iranian Journal of Rangeland, 11(2): 139-151. (In Persian).

Motamedi, J., Alilou, F., Sheidayi, E., Keyvan Behjou, F., Ghoreishi, R., 2013. Relationship between environmental factors and the intensity of grazing in rangeland ecosystems of Khoy. Journal of Plant Ecosystem Conservation, 1(3): 73-90. (In Persian).

Mozaffarian, V., 1996. A Dictionary of Iranian Plant Names, Farhang Moaser Publishers, Tehran, Iran. (In Persian).

Nazari Anbaran, F., Ghorbani, A., AzimiMotem, F., Teymorzadeh, A., Asghari, A., Hashemimajd, K., 2016. Floristic and species diversity in altitudinal gradient of Lahrod-Shabil (North Sabalan). Journal of Plant Ecosystem Conservation, 7: 1-18. (In Persian).

Ning, W., Rawat, G.S., Sharma, E., 2013. High-altitude rangelands and their interfaces in the Hindu Kush Himalayas. International Centre for Integrated Mountain Development (ICIMOD).

Niu, Y., Zhou, J., Yang, S., Chu, B., Ma, S., Zhu, H., Hua, L., 2019. The effects of topographical factors on the distribution of plant communities in a mountain meadow on the Tibetan Plateau as a foundation for target-oriented management. Ecological Indicators, 106: 105532. https://doi.org/10.1016/j.ecolind.2019.105532

Nodehi, N., Akbarlou, M., Sepehry, A., Vahid, H., 2014. Effects of topographical factors on distribution of plant communities in semi-steppe grasslands (case study: Ghorkhud region, northern Khorasan province, Iran). Journal of Rangeland Science, 4(4): 298-305.

Noroozi, J., Pauli, H., Grabherr, G., Breckle, S.W., 2011. The subnival- nival vascular plant species of Iran: a unique high-mountain flora and its threats from climate warming. Journal of Biodiversity and Conservation, 20(6): 1319-1338. https://doi.org/10.1007/s10531-011-0029-9

O'Brien, E.M., Field, R., Whittaker, R.J., 2000. Climatic gradients in woody plant (tree and shrub) diversity: Water-energy dynamics, residual variation and topography. Oikos, 89: 588–600.

Okon, M.A., Osuji, G.E., Uzoho, B.U., Ahukaemere, C.M., 2014. Soil organic carbon storage as affected by physiographic positions on a Caternary landscape in an Ultisol in Owerri, southeastern. International Journal of Research in Agriculture and Forestry, 1(2): 18-22.

Omidi, A., Ghorbani, A., Teymoorzadeh, A., Hashmi Majd, K., 2016. Study the effective environmental factors on the distribution of *Artemisia austriaca* in southeast faced slopes of Sabalan. Iranian Journal of Plant and Ecosystem, 45: 21-37. (In Persian).

Oueslati, I., Allamano, P., Bonifacio, E., Claps, P., 2013. Vegetation and topographic control on spatial variability of soil organic carbon. Pedosphere, 23:48–58. https://doi.org/10.1016/S1002-0160(12)60079-4

Pinke, G., Pal, R., Botta – Dukat, Z., 2010. Effect of environmental factors on weed species composition of cereal and stubble fields in western Hungary. Journal of Biology, 5 (2): 283-292. https://doi.org/10.2478/s11535-009-0079-0

Piri Sahragard, H., Zare Chahouki, M.A., 2016. Modeling of *Artemisia sieberi* Besser. habitat distribution using maximum entropy method in desert rangelands. Journal of Rangeland Science, 6(2): 93-101.

Rechinger, K.H., 1986. *Artemisia* in Flora Iranica. In: Rechinger, K.H. Hedge IC, editors. Compositae, Chapter 158, Akademische Druck and Verlagsanatalt, Graz, Austria. Pages 214.

Ryals, R., Kaiser, M., Torn, M.S., Berhe, A.A., Silver, W. L., 2014. Impacts of organic matter amendments on carbon and nitrogen dynamics in grassland soils. Soil Biology and Biochemistry, 68: 52-61. https://doi.org/10.1016/j.soilbio.2013.09.011

Shaltout, K.H., Ahmed, D.A., Shabana, H.A., 2015. Distribution of the associated species with *Phlomis aurea* Decne along an elevation gradient in Southern Sinai, Egypt. Ecologia Mediterranea, 42(1): 65 –77.

Sharifi, J., Fayaz, M., Azimi, F., Rostami Kia, Y., Eshvari, P., 2013. Identification of ecological region of Iran (vegetation of Ardabil province): Institute Research of Forest and Rangeland Press. Report No. 42183/37. (In Persian).

Sharifi, J., Ghorbani, A., Fayyaz, M., Ashouri, P., 2016. Vegetation types and plant life forms of alpine Sabalan in Ardabil province. Natural Ecosystem of Iran, 7 (2): 65-75. (In Persian).

Six, J., Feller, C., Deneb, K., Ogle, S., Moraes, S.J., Albrecht, A., 2002. Soil organic matter, biota and ggregation in temperate and tropical soils-effects of no tillage. Agronomie, 22: 755–775. https://doi.org/10.1051/agro:2002043

Tavosi, T., Delara, Gh., 2010. Climatic zone of Ardabil province. Nivar, 70: 47-52. (In Persian).

Teimoorzadeh, A., Ghorbani, A., Kavianpoor, A.H., 2015. Study on the flora, life forms and chorology of the southeastern of Namin forests (Asi- Gheran, Fandoghloo, Hasani and Bobini), Ardabil province. Journal of Plant Research, 2: 264-275. (In Persian).

Wander, M.M., Traina, S.J., 1996. Organic matter fractions from organically and conventionally managed soils: II. Characterization of composition. Soil Science Society of America Journal, 60: 1087-1094.

Wang, Z.R., Yang, G.J., Chen, S.Y., Wu, Z., Guan, J.Y., Zhao, C.C., Zhao, Q.D., Ye, B.S., 2012. Effects of environmental factors on the distribution of plant communities in a semi-arid region of the Qinghai-Tibet Plateau. Ecological Research, 27: 667–675.

Yilmaz, H., Yilmaz, O., Akyuz, Y., 2017. Determining the factors affecting the distribution of *Muscari latifolium*, an endemic plant of Turkey, and a mapping species distribution model. Ecology and Evolution, 4: 1112-1124. https://doi.org/10.1002/ece3.2766.

Youssef, A.M., Al-Fredan, M.A., 2008. Community composition of major vegetation in the coastal area of Al- Uqair, Saudi Arabia in response to ecological variations. Journal of Biological Science, 8(4): 713-721. https://doi.org/10.3923/jbs.2008.713.721

Zare Chahouki, M.A., Khojasteh, F., Tavili, A., 2012. Distribution of vegetation type according to edaphic properties and topography in Iran. Polish Journal of Environmental Studies, 4: 1071-1077.

ZareHesari, B., Ghorbani, A., Azimi, F., Hashemi Majd, K., Asghari, A., 2014. Study the effect of ecological factors on *Artemisia fragrans* Willd. distribution in southeast faced slopes of Sabalan. Iranian Journal of Rangeland, 8(3): 238-250. (In Persian).

عوامل بوم‌شناختی مؤثر بر انتشار *Artemisia melanolepis* Boiss. در دامنه‌های جنوب‌شرقی کوه سبلان، ایران

اردوان قربانی[الف*]، مریم مولایی شام اسبی [ب]
[الف] استاد، دانشگاه محقق اردبیلی، اردبیل، ایران *(نگارنده مسئول)، پست الکترونیک: a_ghorbani@uma.ac.ir
[ب] دانشجوی دکتری علوم مرتع، دانشگاه محقق اردبیلی، اردبیل، ایران

چکیده. *Artemisia melanolepis* Boiss گونه‌ای بومی، نادر و در معرض خطر است که در ارتفاعات کوهستان سبلان رویش دارد. این مطالعه با هدف تعیین متغیرهای محیطی مؤثر بر انتشار *A. melanolepis* در دامنه جنوب‌شرقی کوهستان سبلان انجام شد. در رویشگاه‌های *A.melanolepis* دو سایت (A و B) با شرایط اکولوژیکی یکسان با حضور و عدم‌حضور این گونه انتخاب شدند. در هر سایت، پنج ترانسکت ۱۰۰ متری به روش تصادفی- سیستماتیک قرار داده شد. پوشش تاجی، تراکم، لاشبرگ (Lit)، خاک لخت (BS) و سنگ و سنگریزه (SG) در ۱۰ پلات یک متر مربعی در طول هر ترانسکت برداشت شد. ۳۶ نمونه خاک از عمق ۰-۱۵ سانتی‌متری (عمق فعالیت ریشه/ سه نمونه از هر ترانسکت) برداشت شد. پارامترهای بافت خاک (درصد رس، شن و سیلت)، ماده آلی (OM)، ماده آلی ذره‌ای (POM)، رس قابل انتشار (WDC)، پتاسیم (K)، فسفر (P)، اسیدیته (pH)، و هدایت الکتریک (EC) در آزمایشگاه اندازه‌گیری شد. ارتفاع، شیب، جهت جغرافیایی، میانگین بارش و دمای سالانه برای هر پلات محاسبه شد. برای تجزیه و تحلیل داده‌ها از آنالیز تجزیه خوشه‌ای، تجزیه واریانس یکطرفه و آنالیز تشخیص (CDA) استفاده شد. آنالیز تجزیه خوشه‌ای مبتنی بر حضور و عدم‌حضور گونه، هر دو گروه A و B را به دو زیرگروه تقسیم کرد. آنالیز تجزیه واریانس چند متغیره نشان داد که بین خوشه‌ها اختلاف معنی‌داری وجود دارد ($P<0/01$). نتایج نشان داد که تراکم بالای *A.melanolepis* مربوط به افزایش OM، POM، WDC،P، ارتفاع وکاهش شن، اسیدیته و شیب است. نتایج آنالیز تشخیص نشان داد که انتشار *A. melanolepis* بیش‌تر تحت تأثیر جهت جغرافیایی، دما، اسیدیته، ماده ماده آلی ذره‌ای، ماده آلی، درصد سیلت، درصد شن، فسفر، شیب، لاشبرگ، تاج پوشش کل، سنگ و سنگریزه، خاک لخت، ارتفاع، رس قابل انتشار، هدایت الکتریکی و پتاسیم در این سایت‌ها بوده است. این نتایج می‌تواند در حفاظت و احیاء این گونه مورد استفاده قرار گیرد.

کلمات کلیدی: مرتع، گونه‌های بومی، مدل‌سازی توزیع گونه‌ها، عوامل رویشگاهی