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Ecological Species Group's Description of Oak Site (Case Study: West Azerbaijan, Iran)

Reza Basiri

Member of Behbahan high educational complex, Behbahan, Iran

Abstract: A combination of field and tabular methods and multivariate analyses were used to develop groups of herb layer species (i.e., ecological species groups) that describe and characterize ecosystems dominated by oak in West Azerbaijan, Iran. Six such ecological species groups were created using 117 woody and herbaceous species sampled in 76 plots within a 320 ha region. We developed ecological species groups both for herb layer and tree strata in a Q-mode analysis using a combination of two types of hierarchical cluster analysis, TWINSPAN and Cluster analysis. Species groups were corroborated using detrended correspondence analysis and the environmental conditions indicated by each were described and contrasted based upon field observation. Two of the six species groups indicated relatively light conditions to moderate shade, north aspect and fertile soils within the set of plants dominated by Quercus libani Olive. The remaining four groups reflected very dry to dry, infertile sites, very light to light conditions, south aspect and disturbed sites. Our results demonstrated that ecological species groups may also provide the ecological basis for distinguishing ecosystems at broader scales for better management of forest.

Key words: Ecological classification · Herb layer · Indicator species · Oak · Iran

INTRODUCTION

Distinguishing species assemblage has been at the heart of vegetation science for centuries, with a traditional focus on the distribution, composition and classification of plant communities Kashian *et al*. [1]. These floristic concepts of plant sociology, particularly as they involve herb layer, have their roots in many schools of community ecology, both European [2-4] and North American [5-8]. The use of vegetation in describing and distinguishing species assemblage and communities has proved applicable to practical problems of site classification and the relationship of plant species and communities to site factors has been the subject of extensive study [1,3,9-11] The importance of herb layer as indicator species has a long history in ecology [11-15]. Because they are responsive to site conditions, understory plants act as phytometers that integrate many environmental factors that are difficult to measure directly (e.g., macroclimate, microclimate, physiography, soil and light conditions) [14-17]. Perhaps most importantly, abundance of herb layer species is less affected by disturbances than are tree species [18-20] a factor important for indicator species in heavily disturbed forests such as those in the southern slopes of the region. Ecological species groups are groups of plants that repeatedly occur together in areas with similar combinations of site factors and that are perceived to have similar ecological requirements or tolerances [10,11,16,17]. The concept of ecological species groups is attributed to Duvigneaud [21], although several methods have been developed and utilized [13,15,22-25]. The method used in this study was an unconventional approach to distinguishing ecological groups and their classification by combination of TWINSPAN results and cluster analysis. Our objective were to develop ecological species groups as part of an ecosystem classification of a northern Zagrosian mountains landscape and to quantify associations among species groups by testing statistical methods new to ecological species group research.

MATERIALS AND METHODS

Study Area: The study area is located in North West of Iran in West Azerbaijan; between (45° 16′ 52′′) and (45° 29′ 58′′) eastern longitude and (36° 9′ 45′′) and

Corresponding Author: Reza Basiri, Department of Forest Ecology, Faculty of Natural Resources, At the Beginning of Deilam Road, Behbahan, Postal Code: 6361877568, Khoozestan Province, Iran. Tel: +9806714223947, Fax: +9806712229969.

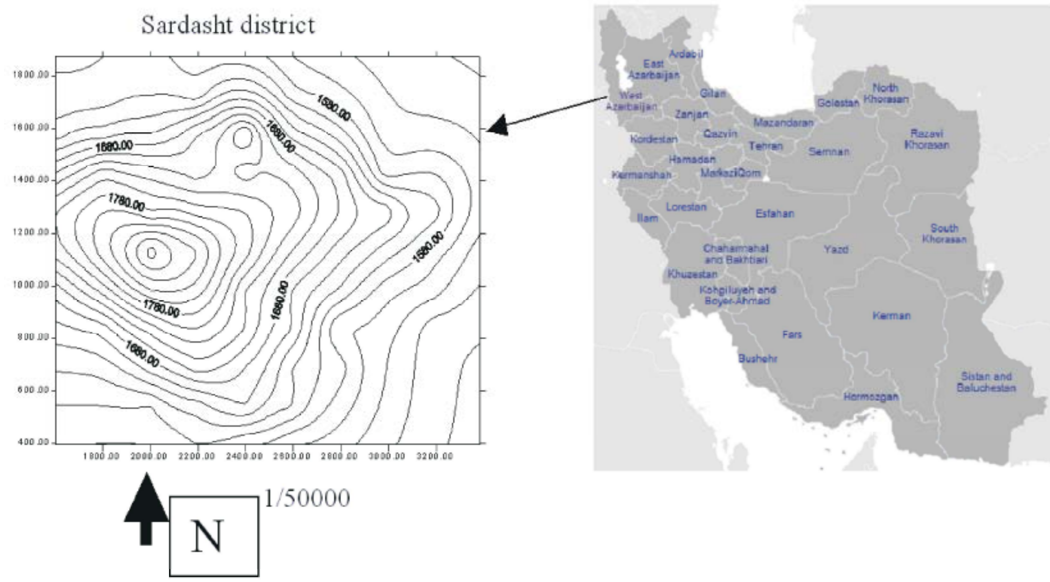

Fig. 1: Situation of the study area

(36° 25′ 45′′) northern latitude (Figure1). The considered study site covers an area of 320 hectares. The altitude of the study area is from 1400 to 1950 meters above sea level.

Basiri *et al*. [26]. were found vegetation types in the entire area. The *Quercus libani* Oliv. type in the northern aspect and *Quercus brantii* Lindl type in the southern aspect.

Filed Procedure: To develop the ecosystem classification, we sampled trees on 76, 256 m^2 (16m × 16m) plots distributed across the landscape in all forests sections. Herb layer sampled on 4 transect, 16m in each plots. The sample was taken from the study area in the systematic two-dimensional method by random starting point [27]. All plots were placed on a topography map in 1/50000 scale by a grid (150m × 280m). The minimal area of samples (256) was obtained by the species-area curve [28]. Species and abundance were considered as measuring standards for cover. Based on Okland [27], estimation of cover was considered as abundance. In this method, abundance data was transformed to qualitative presence-absence values for analysis. This procedure has often produced results comparable with those obtained from quantitative cover abundance values [29].

Statistical Analysis: We developed ecological species groups both for herb layer and tree strata in a Q-mode analysis [30] using a combination of two types of hierarchical cluster analysis, TWINSPAN [31] and Cluster analysis (Euclidean distance) [25]. Data for analysis in TWINSPAN were standardized by adjustment to standard Deviate. Presence/absence TWINSPAN cut levels was used. TWINSPAN uses a divisive method of a cluster analysis that Gauch and Whittaker [32] found useful. In Cluster analysis Ward's method, also known as minimum variance clustering was selected to compute distance between clusters. Ward's method is a widely used type of agglomerative cluster analysis reported as effective in several studies [33].

The stopping point of cluster formation was based on experience and set at the third level for TWINSPAN, which could produce up to 8 clusters. An equivalent level (cut level) for Cluster analysis selected which showed the most similar with TWINSPAN grouping.

The next step in classification of ecological species groups, we computed Jaccard index as a measure of ecological resemblance between all pairs of samples in order to quantify their dissimilarity and make a distinction finally groups [34]. Ludwig and Reynolds [34] have recommended Jaccard similarity coefficient when the data consists of species presence-absence data. A very common goal in community analysis is to detect and describe the value of different species for indicating environmental conditions [35]. On the bases of this goal, we were calculated species indicator values for each species on the bases of Dufrene and Legendre's Method [35] in PC-ORD [36]. We were tested for statistical significance of species indicator values with a randomization Monte Carlo test.

RESULTS

To simplify the continuum of vegetation composition present in the study area and to aid our understanding of vegetation and environment relationships, plots with generally similar vegetation were classified into a few groups. Seventy-six sample plots were established and 117 species were recorded. The redundant cluster analyses using binary transformed data indicated that the 76 sample plots could be combined into 8 groups of similar vegetative composition (Figure 2).

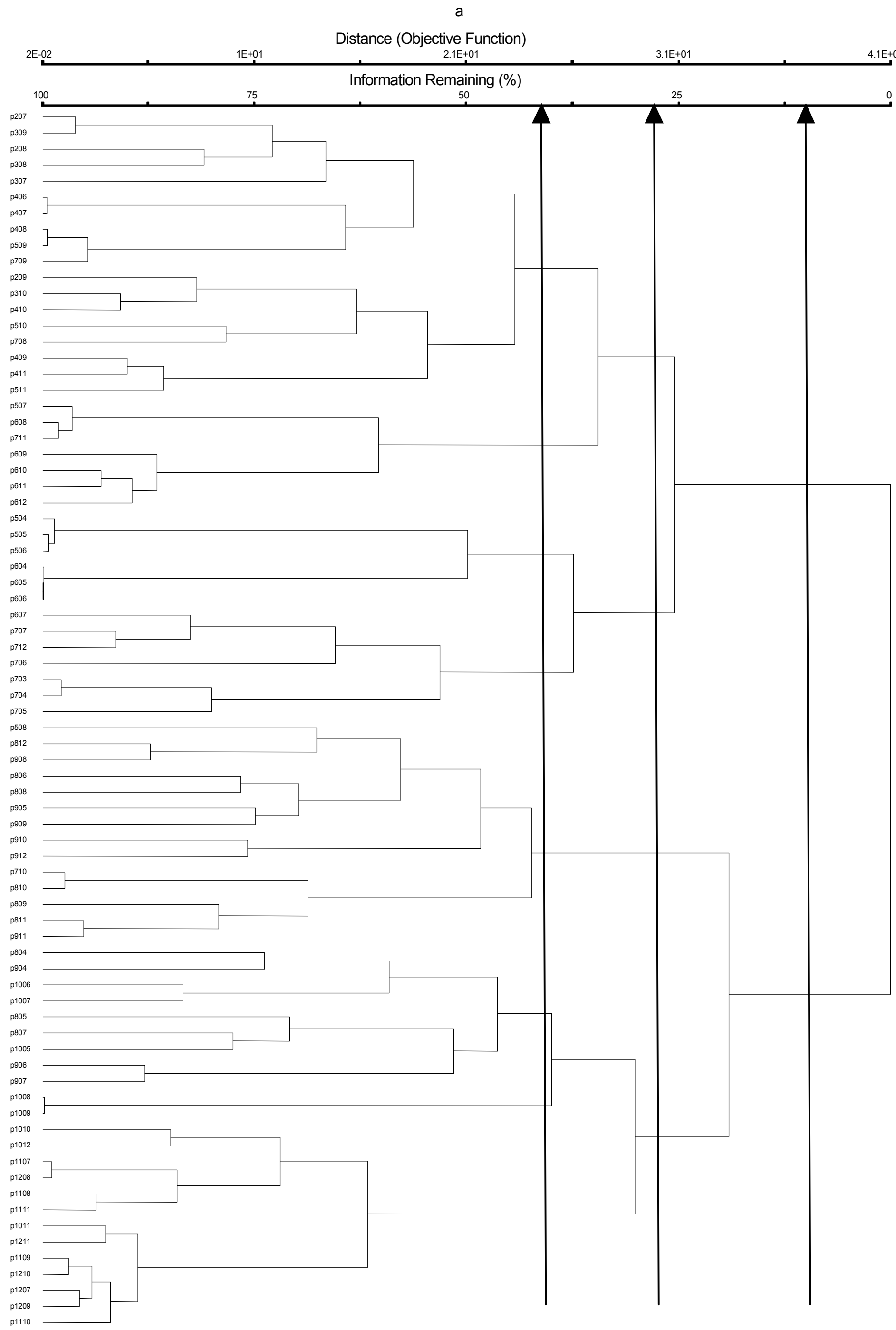

Fig. 2: Dendrogram of classification groups formed by cluster analyses on 76 sample plots in the West Azarbaijan area.

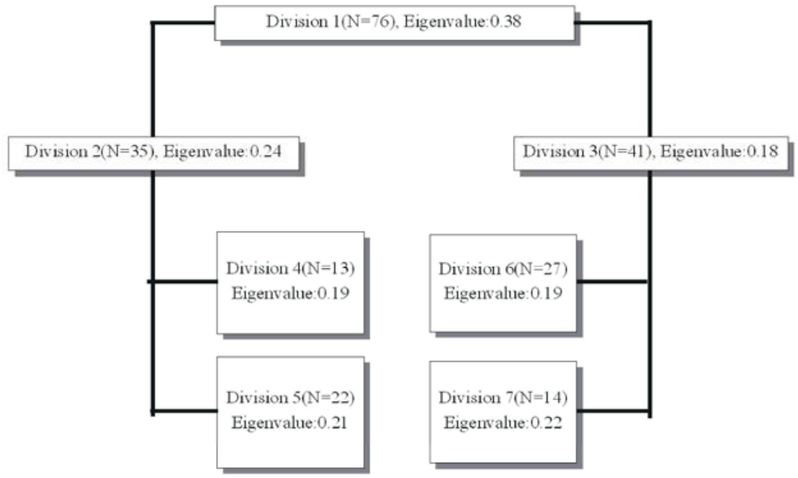

Fig. 3: Dendrogram of classification groups formed by TWINSPAN on 76 sample plots in the study area.

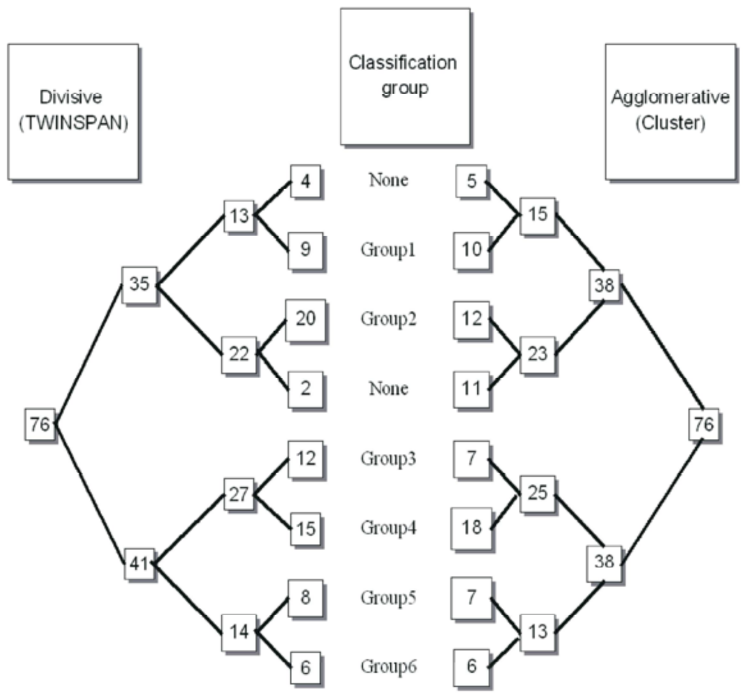

Fig. 4: Dendrograms of major divisions and similar classification groups formed by two methods of cluster analyses on 76 sample plots in the study area.

Three cut levels were considered on the based on experience. Third cut level created 8 clusters. The results of TWINSPAN for classification of samples showed 7 divisions (Figure3).

Classification of 56 plots agreed between the two cluster methods and formed the core plots. Since vegetative composition of the other 20 plots were assigned to the other existing core group based on experience and phytosociological information (Figure 4).

Ecological Groups Descriptions: Six ecological groups were developed (Figure4) using 54 of the 117 species observed (46% of all species observed) in 76 plots in the study area. Each group was named with a characteristic member of the group based on their observed maximum indicator value. Most species not included in the groups were their indicator value no significant.

The *Lepyrodiclis holosteoides* group (group1) consists of *Quercus libani* Oliv., *Lepyrodiclis holosteoides* (C.A.Mey.) Fenzl ex Fish. and C.A.May.,

Table 1: Species and indicator values of ecological species groups occupied by the study area in the West Azarbaijan. p-values are for the MONTE CARLO test of significance of observed maximum indicator value for species with

Species	Ecological species groups	Indicator values	P-value
Lepyrodiclis holosteoides (C.A.Mey.) Fenzl ex Fish. and C.A.May.	1	69.4	0.001
Veronica polita Fries	1	62.5	0.001
Hesperis kurdica Dvorak et Hadac	1	56.9	0.001
Dactylis glomerata L. *subsp. Glomerata*	1	53.1	0.001
Cruciata taurica (Pallas ex Willd.) Ehrend.	1	50.2	0.001
Thalictrum sultanabadense Stapf	1	45.1	0.001
Chaerophyllum macrospermum (Spreng) Fisch. and C.A.Mey.	1	44.2	0.001
Viola odorata L.	1	43.8	0.001
Comperia involucrata	1	42.0	0.001
Sonchus asper (L.) Hill *subsp. Glaucescens* (Jordan) Ball.	1	42.0	0.001
Quercus libani Oliv.	1	41.0	0.001
Hypericum scabrum L.	1	36.1	0.003
Aethionema membranaceum DC.	1	35.5	0.003
Tragopogon graminifolius DC.	1	28.8	0.008
Rumex conglomeratus Murr.	2	77.3	0.001
Mentha longifolia (L.) Hudson	2	67.8	0.001
Ferula orientalis L.	2	65.3	0.001
Symphytum kurdicum Boiss. and Hausskn.	2	61.3	0.001
Euphorbia condylocarpa M.B.	2	60.8	0.001
Milium pedicellare (Bornm.) Roshev. Ex Melderis	2	51.4	0.001
Dactylorhiza umbrosa (Kar. and kir.) Nevski	2	50.8	0.001
Prangos ferulacea (L.) Lindl.	2	38.9	0.006
Ranunculus pinardi (Stev.) Boiss.	2	37.5	0.001
Silene chlorifolia Sm.	2	36.2	0.003
Quercus infectoria Oliv. *subsp. Boissieri* (Reut.) O. Schwartz	2	34.7	0.004
Lamium album L. *subsp. Album*	2	33.7	0.002
Centaurea behen L.	2	33.2	0.006
Ficaria kochii (Ledeb.) Iranshahr and Rech. f.	2	32.2	0.001
Ferulago stellata Boiss.	2	31.8	0.008
Orobanche aegyptiaca Pers	2	30.0	0.009
Rhaponticum insigne (Boiss.) Wagenitz	2	27.3	0.006
Gentiana olivieri Griseb.	3	50.6	0.001
Euphorbia azerbajdzhanica	3	50.0	0.001
Salvia suffruticosa Montbr. and Auch. Ex Benth	3	36.5	0.001
Pyrus syriaca Boiss.	3	30.4	0.007
Helianthemum ledifolium (L.) Miller *var. ledifolium*	3	27.3	0.013
Picnomon acarna (L.) Cass.	4	46.1	0.001
Holosteum umbellatum L.	4	35.2	0.005
Arabis caucasica Willd. *subsp. Caucasica*	4	30.2	0.003
Smyrnium cordifolium Boiss.	4	29.5	0.014
Pistacia atlantica Desf.	4	26.7	0.008
Anemone coronaria L.	4	25.9	0.017
Trifolium campestre Schreb.	5	47.0	0.001
Geranium rotundifolium L.	5	46.3	0.002
Trifolium pilulare Boiss.	5	38.0	0.003
Bryonia aspera Stev. Ex Ledeb.	5	31.9	0.006
Echinops orientalis Trautv.	5	31.1	0.004
Geranium tuberosum L. *subsp. micranthum* Schonbeck-Teme	5	20.8	0.002
Teucrium polium L.	6	87.0	0.001
Alcea kurdica (Schlecht.) Alef	6	82.8	0.001
Colchicum speciosum Steven	6	53.7	0.001
Anthemis haussknechtii Boiss. and Reut. *Var. calva* Eig	6	30.5	0.007
Gundelia tournefortii L.	6	26.8	0.025
Aristolochia bottae Jaub. and Spach	6	21.2	0.031

Veronica polita Fries, *Hesperis kurdica* Dvorak et Hadac and so on (Table 1). The group is on north aspect, upper slope and is nearly restricted to moist and moderately fertile soils. Although the members of the group require relatively light conditions to moderate shade.

The *Rumex conglomeratus* group (group2) is the largest of the six groups and includes *Quercus infectoria* Oliv. *subsp. Boissieri* (Reut.) O. Schwartz, *Rumex conglomeratus* Murr., *Mentha longifolia* (L.) Hudson, *Ferula orientalis* L., *Symphytum kurdicum* Boiss.

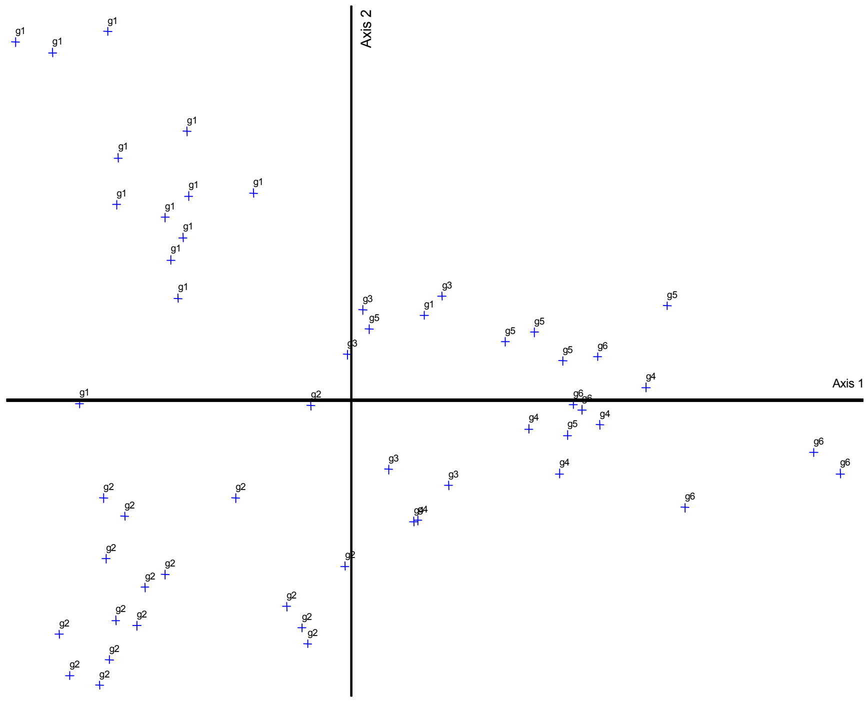

Fig. 5: Detrended correspondence analysis of 31 species used to construct six ecological species groups in the West Azarbaijan area. Letters represent ecological species groups: g1: *Lepyrodiclis holosteoides* group, g2: *Rumex conglomeratus* group, g3: *Gentiana olivieri* group, g4: *Picnomon acarna* group, g5: *Trifolium campestre* group and g6: *Teucrium polium* group.

and Hausskn. and so on (Table1). The group is found on the sites in which water table are high. The group is observed on north aspect, lower slope, very fertile, very moist and relatively light to moderate shade. Ecosystems in which these species occur typically are characterized by very fertile soils.

The *Gentiana olivieri* group (group3) is characterized by *Pyrus syriaca* Boiss., *Gentiana olivieri* Griseb., *Euphorbia azerbajdzhanica* and so on (Table1). The group is widespread and is found on disturbed sites and alkaline soils. The group is on lower slope and all aspects. This group occurs in a very wide range of light intensities.

The *Picnomon acarna* group (group4) is characterized by *Pistacia atlantica* Desf., *Anemone coronaria* L., *Picnomon acarna* (L.) and so on (Table1). The group is characteristic of moderately dry and infertile soils. It is common on the driest sites. The group is commonly found under light conditions. The group is most often grown on stony soils and erosive sites. This group is observed on south and west aspects and middle slopes.

The *Trifolium campestre* group (group5) consists of *Trifolium campestre* Schreb., *Geranium rotundifolium* L., *Trifolium pilulare* Boiss. and so on (Table1). The group is found in dry, relatively infertile soils and under open to light canopy coverage. It is commonly occurred on south aspect and dispersed in all position slopes.

The *Teucrium polium* group (group6) is most commonly represented by *Teucrium polium* L., *Alcea kurdica* (Schlecht.) Alef, *Colchicum speciosum* Steven and so on (Table1). The group is found in very dry to dry, very infertile to infertile soils and is most commonly found in disturbed sites. It is also common on south aspect and lower to middle slopes. Although similar to the *Trifolium campestre* group in site requirements, it is observed in open light conditions.

DCA Ordination: The DCA ordination was performed for distinguishing of gradient in ecological species groups on the bases of vegetation composition. The species groups developed with tabular methods were substantiated with the results of detrended correspondence analysis (Figure 5). The first DCA axis explains much of the variation in the data set and represents a gradient of aspect, moist fertile soils and moderate shade. Species characteristic of fertile, moist, moderately shade and northern sites have negative axis scores

(*Lepyrodiclis holosteoides* and *Rumex conglomeratus* groups), whereas infertile, dry, open light and southern sites (*Teucrium polium* and *Picnomon acarna* groups) have high positive first-axis scores. The second DCA axis represents slope position gradient and fertility. Species found in lower slope (e.g., *Rumex conglomeratus*) received low Axis 2 scores and are located near the bottom of the diagram, whereas those found in upper slope (e.g., *Lepyrodiclis holosteoides*) received lower second-axis scores and are located near the top of the diagram.

DISCUSSION

Site classification is an essential part of forest management [16,37]. Classification can provide the foundation for collecting and interpreting research results as well as for extrapolating management techniques to the appropriate new site Zahedi Amiri [38]. Now a day, multivariate approaches were widely applied in ecological classification systems Palmer [39]. The original grouping of species based on field observations and tabular analysis of presence/absence and abundance data was confirmed by multivariate analyses Kashian *et al*. [1]. The traditional systems of classification were either on the bases of dominant species or species similarity in which, their foundation were subjective [4,41] but, the new approaches of classification to prove to be true on the bases of objective methods that have high precision hence the researchers by applying these methods, take similar results McNab *et al*. [25]. On the other hand, different numerical techniques on a data set are caused variable results Kent and Coker [33]. Because of this, it is used combination of different classification methods. In general, the hierarchical classification approach presented in this study allows for a more precise definition of environmental conditions than those simple classifications by plant communities Zahedi Amiri [38]. TWINSPAN usually considers more than one species (or pseudospecies) as indicators, hence reducing the probability for misclassification Zahedi Amiri [38].

Study results produced a logical classification of major ecological groups in the study area and suggest that vegetation provides a suitable means for identifying ecological grouping. In our study, the six species groups appear to be useful in our area.

We demonstrated, as Fattahi [42] and Zohary [43] reported that group1 occurring at north aspect and dominated by tree species such as *Quercus libani.*

Davis [43] and Zohary [44] found that group2 with tree species such as *Quercus infectoria* Oliv. *subsp. Boissieri* on north aspect and fertile soils.

Axis I in DCA ordination indicated that the distribution of species is mainly associated with variable: aspect and fertile soil that demonstrated this matter.

Working in Kordestan province, Fattahi [42] and Maaroofi [45] found that the herb layer scattered on all of aspect and very wide range of light intensity.

Group4 constructed in this study was found by Basiri *et al*. [26] to be common on south aspect and erosive areas which coincide with our results.

We demonstrated, as Davis [44] and Fattahi [42] reported, that group5 occurring on south aspect and open light canopy and dominated by *Trifolium campestre*. However, we did not encounter any tree species.

Disturbance is a well-known limiting factor to the use of vegetation for ecological classification, especially where grazing and agriculture may have dramatically altered the native vegetation in a manner that may not reflect site conditions Albert *et al*. [46]. In our study, the species group 6 appears to be useful in site where the plant communities have been heavily disturbed by grazing. Several studies showed that the most of indicator species in this group, developed in disturbed area [42,43,47-54].

In this research, our efforts to reduce subjectivity in classification of ecological species groups in the study area have been a qualified, success. Using binary data transformation, redundant clustering analyses and resemblance function, we developed a conservative, logical classification of primary ecological species groups. Testing of other data transformations, such as importance values and other classification methods will be done in subsequent studies using the West Azerbaijan area dataset to evaluate and extend results reported here.

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Generally, ecology studies are very hard and in temporal and spatial point of view, they require a great effort; therefore, such researches cannot be made by one person and in any phase of performance, guidance and cooperation of specialists, scientists and relevant authorities in different centers appear as great assistance. As a result, I find it necessary to express sincere gratitude and thanks to all those who have provided me with their help and dedication.

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