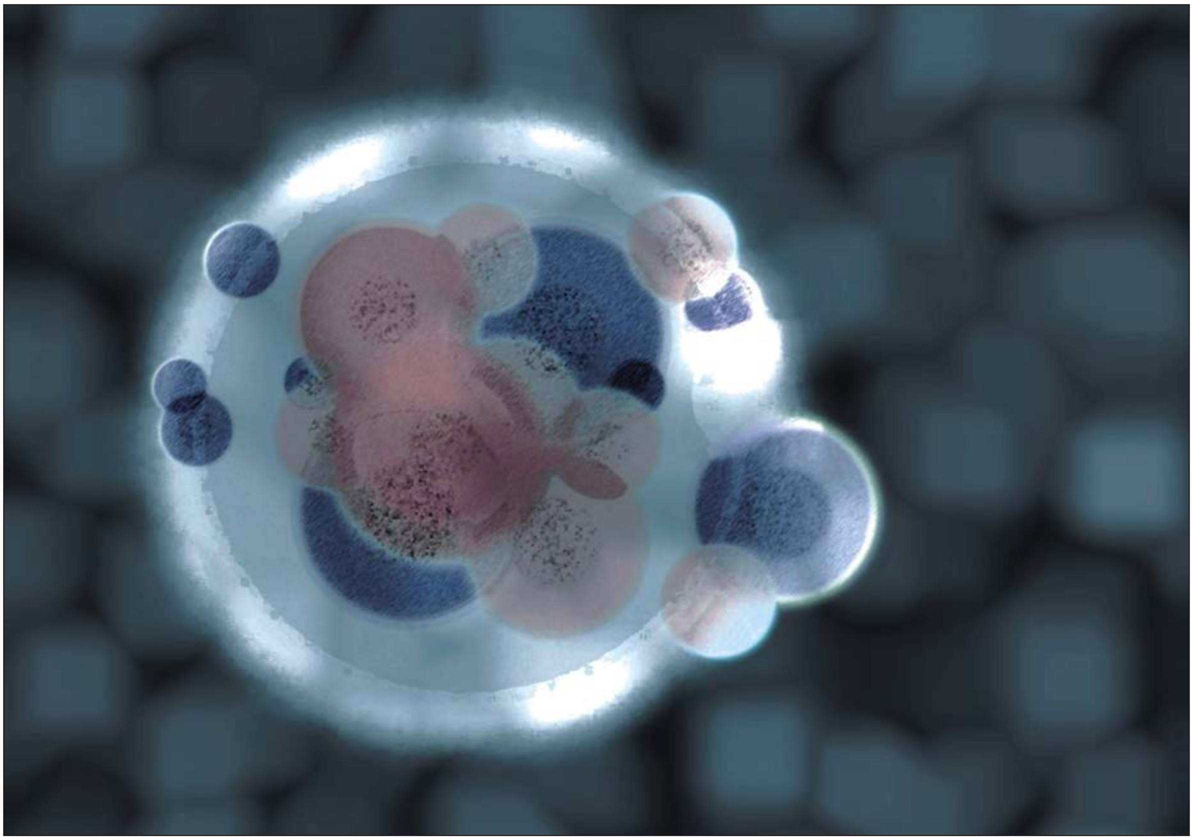

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Ecological Species Groups of Hornbeam Forest Ecosystems in Southern Caspian (North of Iran)

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Abstract: Ecological species group were developed for hornbeam forest ecosystems in North of Iran that had been moderately disturbed. Species groups were determined from field observations and sample plot data arranged and analyzed in association tables. The groups were defined on the basis of species patterns of presence, absence and coverage values. Vegetation was sampled with randomized-systematic method. Vegetation data including density and cover percentage were estimated quantitatively within each quadrate and using the two-way indicator species analysis (TWINSPAN). The objectives of the study were to develop ecological species groups for lowland ecosystems types dominated by hornbeam in north of Iran, describe the site indicator values of species groups and increase our understanding of site-species relationships in moderately disturbed landscape in Khanikan lowland forests of Mazandaran province. Five vegetation groups were identified after the application of TWINSPAN programs. They are named after the characterizing species as follows: *Menta aquatica* (I), *Oplismenus undulatifolius* (II), *Carex grioletia* (III), *Viola odarata* (IV) and *Rubus caesius* (V). Result have showed that II, III vegetation groups and I, II vegetation groups had the most (65.5%) and the least (30%) of Sorenson similarity coefficient, respectively. Apparently, similarity coefficient of differentiated vegetation groups was high.

Key words: Ecological species groups, hornbeam forest ecosystems, TWINSPAN, Iran

INTRODUCTION

In ecology of vegetation have used of relation between species combination and environmental factors to determine ecological species groups (Monier and Abd, 2000; White and Hood, 2004). Species groups have used to identify different ecosystems in Neka midland forests (North of Iran) (Zahedi and Limayee, 2002), Michigan oak forests (Vandvik and John, 2002), Ghamishleh Marivan forests (West of Iran) (Basiri *et al*., 2004), Poshtkouh ranglands of Yazd province (Iran) (Jafari *et al*., 2004), Kelarabad plain forest (North of Iran) (Mahmoodi *et al*., 2005) and Kheiroodkenar forests (North of Iran) (Salehi *et al*., 2005). The first time, assessment of groups have presented by Spies and Barnes (1985).

Ecological species groups helps to identify ecosystems and theirs classification using absent and presence or relative cover. This indicator species are useful in local scales (Vanderschaaf *et al*., 2004; Verlinden and Dayot, 2005). Application of ecological species groups is presentable in ecological classification. With together application of ecological species groups and environmental factors have been differentiate units that are nominated ecosystems units (Barnes, 1982). Philips *et al*. (2002) gives a detailed description of the approach, including the field and statistical methods and the utility of the method to classify and to create forest maps in Kalimantan (Indonesian Borneo).

Vegetation and particularly ground-cover vegetation, because of its ability to integrate the effects of climate, soil and physiographic has been utilized to indicate habitat conditions and forest productivity potential for many years (Dahdouh *et al*., 2002). Some approaches identify sites using field keys based upon a few indicator plants, often a small subset of the total ground flora (Ajbilou *et al*., 2006). However, when a few plants are used, identification of sites may be difficult. The absence of the key species can be due to factors unrelated to site quality such as disturbance, past forest history, or chance events. Instead of single species as indicators, species groups have been used to alleviate this problem.

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The concept of ecological species groups is attributed to Duvigneaud (1946) and first applied to intensive forest management in the southern German state of Baden-Wuttemberg (Phillips *et al.*, 2002; Ramon and Fernandez, 2005). Ground-cover species indicating similar site conditions-for example, soil moisture, nutrients, pH, local climate, etc. are grouped together named for characteristics species and termed ecological species group. The groups are used simultaneously with physiographic and soil characters primarily to make rapid field based assessments of site quality in classifying and mapping forestlands and helping to determine silvicultural practices.

It is well known that vegetation presents significant problems (Corney *et al.*, 2006) because of its sensitivity to disturbance and difficulty in objective quantification. Nevertheless, vegetation is a key ecosystem component that is not only easily recognizable but also can be used to measure, through its integrative ability, the response to climate, physiographic and soil factors (Basiri *et al.*, 2004).

The present study is, however the first comparatively extensive one on the botany of Khanikan lowland forest (North of Iran) which seems to be interesting from the biodiversity viewpoint. The present study, therefore deals with the species composition and life form structure of this forest. It also aims at to identify the prevailing plant communities using technique of multivariate analyses (TWINSPAN).

The objectives of this study were to develop ecological species groups for lowland ecosystems types dominated by hornbeam in north of Iran, to describe the site indicator values of species groups and to increase our understanding of site-species relationships in moderately disturbed landscape that might provide a model for other disturbed areas.

MATERIALS AND METHODS

Study area: Khanikan forests are located in the lowland and midland of Mazandaran province in north of Iran with the area of 2807 ha^{-1} (Between 36° 33′ 15″, 36° 37′ 45w latitude and between 51° 23′ 45″, 51° 27′ 45″ longitude). The maximum elevation is 1400 m and the minimum elevation is 50 m. Minimum temperature in December (7.5°C) and the highest temperature in June (24.6°C) are recorded, respectively. Mean annual precipitation of the study area were from 698.2-102.5 mm at the Noushahr city meteorological station, which is 10 km far from the study area. This research was performed in the summer of 2006.

Data collection: In lowland region 268.7 ha^{-1} of this forest was selected. For investigation of tree and shrub covers sixty quadrates (20×20 m AR.) (Hedman *et al.*, 2000; Grant and Loneragan, 2001; Mesdaghi, 2001) and subquadrate (1 m^2 AR.) in each quadrate for investigation of herbaceous covers (Mesdaghi, 2001, 2005), were taken by systematic-randomized method. Quadrate size was determined for each vegetation type using the minimal area method (Cain, 1959). Considering variation of vegetation, floristic list and canopy cover percentage were determined in each quadrate. Vegetation cover data were recorded using ordinal scale of Van-der-Marel (1979).

Data analysis method: Data matrix of quadrates number and vegetation type was made. The windows (Ver. 3.0) of PC-ORD (McCune and Mefford, 1999) were used for classification of vegetation types. Data were analyzed by multivariate techniques as the Two-way indicator species analysis (TWINSPAN). Due to lack of statistical analysis, understanding the structure of plant species is associated with considerable mistake, therefore, in the first step, vegetation of data study area was classified using TWINSPAN analysis. TWINSPAN analysis is a numerical method for classification of vegetation belonging to similar groups. This allows the investigator to recognize the homogenous groups. Two-way indicator species analysis using the computer program TWINSPAN (Hill, 1979), a commonly used program in ecological studies. It is a robust technique, fairly impermeable to sampling errors or noise (Gauch and Whittaker, 1981). Currently, TWINSPAN is probably the most frequently used procedure for the classification of community data sets (Kent and Coker, 1996). An ordered two-way table, which expresses the relationships of the samples and species within the data set, is constructed. Dufrene and Legendre (1979) method have used to determination of indicator species in classified groups (McCune and Mefford, 1999). Also, for determine similarity value of ecological species groups have used Sorenson similarity Index (Mesdaghi, 2005).

RESULTS AND DISCUSSION

In studied area, 56 species of 36 families were recognized that the number of woody species and herbaceous species were 14 and 42, respectively (Table 1). Life forms were determined by Raunkiaer system and according to the biological spectrum, phanerophytes and cryptophytes (35.71%) and hemicriptophytes (28.57%) were dominant life forms of the studied area. Also, vegetation chorology showed hyrcamian elements with 55.35% was dominant chorotype of khanikan lowland forests. Number of 8 species (14.287%) was endemic of Iran Flores (Table 1). Five vegetation groups were identified after the application of TWINSPAN programs

Table 1: Species, life form, endemic, family, and mean cover values (%) of the recorded species in the five vegetation groups derived after application of TWINSPAN

Vegetation group Species	Life form[1]	Cerotype[2]	Endemic	Family	I	II	III	IV	V
Carpinus betulus L.	Ph	H		Betulaceae	85.9	120.2	89.1	96.1	37.3
Parrotia persica (dc.)	Ph	H	*	Hamameliadaceae	0.0	50.6	47.2	62.5	16.6
Cratagus Pentagyna Waldst and kit.	Ph	H,M,IT		Rosaceae	0.0	5.7	2.2	15.5	1.1
Querecus castanifolia c.a.m.	Ph	H,M,IT		Fagaceae	0.0	0.0	0.0	4.0	4.0
Buxus hyrcana pojark.	Ph	H	*	Buxaceae	0.0	24.6	1.8	0.0	0.0
Diospyrus lotus L.	Ph	H,IT		Ebenaceae	1.8	0.0	0.1	0.0	0.0
Ilex aquifolium L.	Ph	H	*	Aquifoliaceae	0.0	0.0	0.2	0.0	0.0
Ulmus glabra huds.	Ph	H		Ulmaceae	0.0	0.0	0.1	0.0	0.0
Mespilus germanica L.	Ph	H,M,IT		Rosaceae	0.0	0.4	0.0	0.7	0.0
Alnus glutinosa (L.)	Ph	H	*	Betulaceae	11.4	0.0	0.0	0.0	0.0
Pterocarya fraxinifolia (lam.)	Ph	H	*	Juglandaceae	2.4	0.0	0.0	0.0	0.0
Acer insign boiss.	Ph	H		Acearaceae	4.4	0.0	2.2	0.0	0.0
Ficus carica L.	Ph	POL		Moraceae	0.0	0.0	0.9	0.0	0.0
Ruscus hyrcanus L.	Ph	H	*	liliaceae	0.0	15.5	6.8	8.7	0.0
Carex grioletia L.	Cr	H,M,IT		Cyperaceae	0.0	13.2	19.6	14.9	5.4
Smilax exelsa L.	Ph	H,IT		Asparaginaceae	0.0	0.0	19.9	2.2	0.0
Primula heterocliroma stapf.	He	H	*	primulaceae	0.0	4.0	3.1	7.4	0.0
Brachypodium pinnatum (L.)	He	H,M,IT		Gramineae	0.0	3.7	2.8	10.8	2.0
Pteris cretica L.	Cr	POL		Pteridaceae	0.0	9.0	9.7	3.4	6.0
Scutellaria tournefortii benth.	He	H,IT		Labiatae	0.0	1.4	3.5	1.2	0.8
Viola odarata L.	He	H,M		Violaceae	24.5	10.5	8.8	17.6	0.7
Asplenium adiantum-nigrum	Cr	H		aspleniaceae	0.0	0.7	14.9	0.0	0.0
Equisetum ramossisimum desf.	Cr	H		Equisetaceae	0.0	8.0	0.2	0.0	0.0
Conyza bonarieusis L.	He	POL		Compositae	0.0	0.0	0.6	0.0	0.0
Aspelenium trichomanes L.	Cr	H,IT		aspleniaceae	0.0	0.0	1.4	0.0	0.0
Phylitis scdopendrium L.	Cr	H		aspleniaceae	0.0	3.5	10.1	2.2	0.0
Pteridium aquilinum L.	Cr	H,M		Hypolepidaceae	0.0	0.0	6.1	0.0	0.0
Hedra pustuchovii woron.ex	Ph	H		araliaceae	4.0	4.3	15.9	0.0	0.0
Pteris dentate forssk.	Cr	H		Pteridaceae	0.0	0.0	0.0	0.6	0.0
Circeae lutetiana L.	He	H		onagraceae	0.0	0.0	2.0	0.0	0.0
Oplismenus undulatifolius (ard.)p.	Cr	H,M,IT		Graminaceae	55.0	96.7	8.4	8.9	17.0
Calystesia sepium (L.)r.br.	He	H		umbelliferae	0.0	0.3	0.0	0.0	0.0
Hypericum androsaemus L.	Ph	H,M		Hypericaceae	0.0	3.6	0.8	0.0	0.0
Fragaria vesca L.	Ph	H		Rosaceae	0.0	8.0	0.1	1.0	0.4
Prunlla vulgaris L.	He	H		Labiatae	0.0	0.0	0.0	2.0	0.0
Euphorbia amygdaloides L.	He	H		Gramineae	0.0	16.0	4.6	0.0	0.0
Tamus communis L.	Cr	M		Dioscoraceae	0.0	0.0	2.1	0.2	0.0
Sanicula europaea L.	He	H,M		Umbelliferae	0.0	0.0	0.0	0.8	0.0
Danae racemosa (L.) moench	Ph	H	*	Liliaceae	0.0	0.0	0.4	0.0	0.0
Solanum kieseritzkii c.a.mey.	Cr	H		Umbelliferae	0.0	0.0	0.9	0.0	0.0
Festuca drymeia mert, koch	Cr	H		Gramineae	10.0	16.5	0.0	0.0	0.0
Dryopteris filix-mas (L.) schott	Cr	H		Aspidiaceae	0.0	6.5	0.0	0.0	0.0
Microstegium vimenium (trin.)	He	H,M		Gramineae	0.0	1.5	0.0	0.0	0.0
Ophioglossum vulgatum L.	Cr	H		ophioglossaceae	0.0	0.0	0.0	0.2	0.0
Parietaria officinalis L.	Cr	H,M		urticaceae	15.0	0.0	0.0	0.0	0.0
Geum urbanum L.	He	H,M,IT		Rosaceae	11.5	0.0	0.0	0.0	0.0
Meuthe aquatica L.	He	POL		Labiatae	90.0	0.0	0.0	0.0	0.0
Plantago major L.	He	POL		Plantaginaceae	0.0	0.0	0.0	0.0	2.0
Pimpinella affinis ledeb.	Cr	H		Umbeliferae	0.0	0.0	0.0	0.0	0.1
Oxalis corniculata L.	He	H		Oxalidaceae	15.0	0.0	0.4	0.0	0.0
Lamium album L.	Cr	H		Labiatae	4.0	0.0	0.0	0.0	0.0
Mercurialis preunis L.	He	H		Euphorbiaceae	0.0	0.0	6.0	0.0	0.0
Cardamin impatieus L.	Cr	H		Cruciferae	0.0	0.0	0.0	0.1	0.0
Rubus caesius L.	Ph	H		Rosaceae	27.0	31.0	7.0	20.0	50.0
Urtica dioica L. var. dioica.	Cr	POL		urticaceae	0.0	0.0	0.8	0.0	0.0
Carex acutiformis L.	Cr	H,M		cyperaceae	0.0	0.0	0.0	0.0	17.5

Life form[1] : Ph: Phanerophyte, Cr: Cryptophyte, He: Hemicriptophyte, Chorotype[2]: H: Hyrcanian, M: Mediteranian, It: Irano-Touranian, Pol: Poly zonal

(Fig. 1, 2). They are named after the characterizing species as follows: *Menta aquatica*, *Oplismenus undulatifolius*, *Carex grioletia*, *Viola odarata* and *Rubus caesius*. Condition of vegetation groups have showed in Table 2. The most number of plant species (36) is relation to III vegetation group and the least of it (15) is relation to I, IV vegetation groups (Fig. 3). Also, III vegetation group and I vegetation group had the most (23.7) and the least (8.3) mean of cover (%), respectively (Fig. 4). Result have showed that II, III vegetation groups and I, II vegetation groups had the most (65.5%) and the least (30%) of Sorenson similarity coefficient, respectively (Table 3).

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Fig. 1: TWINSPAN of the vegetation cover in 60 quadrates and 56 species

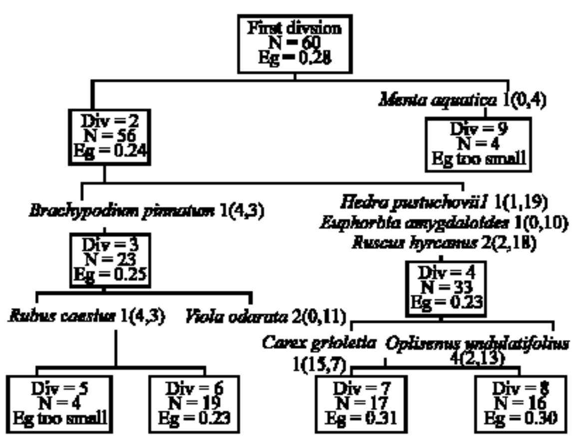

Fig. 2: Relationship between the five vegetation groups generated after the application of TWINSPAN classification technique. Number after of species name, and inside bracket indicating of species value in division and presence in right and left directions of division, respectively

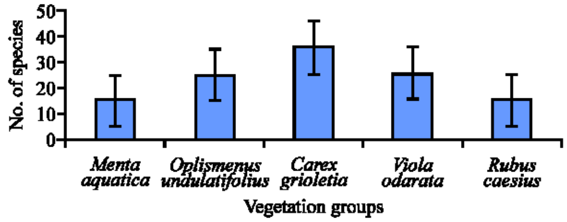

Fig. 3: Number of plant species in vegetation groups

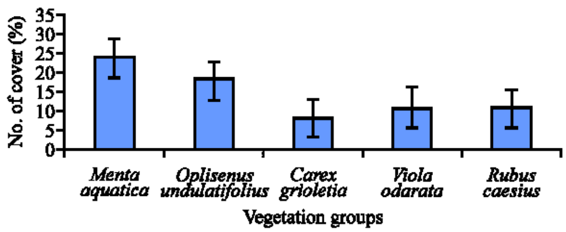

Fig. 4: Mean of cover (%) in vegetation groups

Table 2: Conditions of ecological species groups in relation with physiographical factors in study area

Vegetation groups	Elevation (m)	Aspects of slope	Slope (%)
1	180-190	Mostly, in north and east aspects	10-20
2	150-260	Mostly, in northeast and northwest aspects	10-70
3	100-260	Mostly, in west and southwest aspects	10-80
4	170-260	Mostly, in northeast and northwest aspects	10-80
5	170-200	Mostly, in north and northeast aspects	5-20

Table 3: Percent of Sorenson Index in ecological species groups

Vegetation groups	1	2	3	4	5
1	-	30.0	31.3	32.4	26.6
2	30.0	-	65.5	65.3	59.4
3	31.3	65.5	-	64.1	44.0
4	32.4	65.3	64.1	-	61.5
5	26.6	59.4	44.0	61.5	-

The ecological species group were defined for the hornbeam ecosystems in north of Iran. It was the first attempt to develop such species groups in this area, thus making it impossible to compare this study with other studies. Five vegetation groups are generated, in the present study, after application of two-way indicator species analysis (TWINSPAN) to the cover estimates of 56 species in 60 quadrates (Table 1). Cluster analysis has performed for data of species covering (Fig. 1).

The first division, 60 quadrates have divided to two clusters that in left direction exists 56 quadrates and exists no indicator species. Four quadrates with *Menta aquatica* indicator species in right direction exists. The second division, 56 quadrates have divided to two clusters that in left direction exists 23 quadrates with *Brachypodium pinnatum* indicator species and right direction exists 33 quadrates with *Hedra pustuchovii*, *Euphorbia amygdaloides* and *Ruscus hyrcanus* indicator species. The third division, 23 quadrates have divided to two clusters that in left direction exists 4 quadrates with *Rubus caesius* indicator species and right direction exists 19 quadrates with *Viola odarata* indicator species. The fourth division, 33 quadrates have divided to two clusters that in left direction exists 17 quadrates with *Carex grioletia* indicator species and right direction exists 16 quadrates with *Oplismenus undulatifolius* indicator species.

Dufrene and Legendre (1979) method have used for determination of indicator species in classified groups (McCune and Mefford, 1999). Thus, 5 vegetation groups are named as follows: 1 vegetation group includes *Menta aquatica* with *Carpinus betulus* woody indicator species. 2 vegetation group includes *Hedra pustuchovii*, *Euphorbia amygdaloides* and *Ruscus hyrcanus* with *Oplismenus undulatifolius*. 3 vegetation group includes *Hedra pustuchovii*, *Euphorbia amygdaloides* and *Ruscus hyrcanus* with *Carex grioletia*. 4 vegetation group includes *Viola odarata*, *Brachypodium pinnatum* with *Parottia persica* and *Cratagus* sp. Woody indicator species. 5 vegetation group includes *Rubus caesius*, *Brachypodium pinnatum* with *Parottia persica*, *Cratagus sp* and *Quercus castanifolia.*

Result of this research have showed that III vegetation group had the most number of plant species (36) and I, V vegetation groups had the least of it (15) (Fig. 2). Also, have showed that III vegetation group and I vegetation group had the most (23.7) and the least (8.3) mean of cover (%), respectively (Fig. 3).

Sorenson similarity coefficient have showed that similarity value of 1, 2 vegetation groups and 1, 3 vegetation groups was 30% and 31.3%, respectively. Similarity value of 1, 4 and 1, 5 vegetation groups was 32.4 and 26.6%, respectively. Similarity value of 1, 3 and 2, 4 and 2, 5 vegetation groups was 65.5, 65.3 and 59.4%, respectively. Similarity value of 4, 5 vegetation groups was 61.5%. Apparently, similarity coefficient of differentiated vegetation groups was high (Table 4).

All species groups were found in more than one ecosystem, but the relative abundance of the groups varied considerably between ecosystems. Therefore the use of quantitative values (coverage values) was essential in defining and using ecological species groups. There was a certain degree of overlap among the groups; in almost all cases more than one group occurred in a given ecosystem. Such over lapping was observed in northern Michigan ecosystem studies (Host and Pregitzer, 1991; Spies and Barnes, 1985) and in West Germany (Sebald, 1964). Nevertheless, some species groups were more characteristic than others of certain types of ecosystems.

Ecological classification and grouping of forest habitats was the main subject of forest management since of 1980 decade (Barnes, 1982). Many methods had used in order to classification of forest habitat (Bairley, 1978) but, they couldn't show the relation of ecosystem components very well. Since, the most of them have been used in one component similar to soil or plant vegetations alone (Dahdouh *et al*., 2002).

Now, multivariate methods in systems of ecological classification have extensively been used (Monier and Abd, 2000; White and Hood, 2004). Traditional systems of classification, had used on the basis dominant species or species similarity that its basis was subjective (Barbour, 1999) but, the new systems of classification is on the basis objective methods that has high precision and researchers reaches to some results with this systems (Hill, 1979).

The ecological profiles typically showed that each species of a group had similar responses over the range of ecosystems. This confirms the usefulness of species-group approach where the user may rely on more than one species to help determine site quality or identify ecosystem types in the field. Therefore, errors due to the occurrence or absence of species caused by factors not related to site characteristics are less likely to occur.

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