Quantitative Assessment of Vegetation Size and Distribution of Assir Highlands (South-west of Saudi Arabia)

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Dr. Marei Hussain Al-Qahtani*

Abstract:

The findings reveal that floristic diversity of the research area is low. Only 62 perennial species belonging to 49 genera and 28 families were recorded in Assir Highlands. Of these, only 8 species (Acacia arabica, Acacia gerradii, Acacia negrii, Lycium shawii, Dodonaea viscosa, Kleinia odoera, Juniperus procera and Euryops arabicus) or 12.9% of all species recorded, account for 89% of the absolute frequency of species in the research area. Although the vegetation density in this area is low (2.71/100 m^2), it is considered relatively high compared with other areas in Saudi Arabia. Classification of samples and species using the TWINSPAN program led to identification of 14 important plant groups. The floristic composition and distribution of main plant groups were found to reflect the condition of soil and the topographical variety in Assir Highland.

Introduction:

This study aims to investigate and analyze in detail the perennial vegetation of the research area, in terms of the flora, morphology, ecology and distribution and their relationship with habitats and environmental factors. Investigation and analysis of the above points is based on data of vegetation, slope and soil samples that were collected from 300 quadrats from the research area. To facilitate full understanding of this analysis and of the association between the vegetation habitats, first, a brief summary of the previous works on the Arabian Peninsula, with special emphasis on the southwestern territory where the research area is located, is presented as follows:

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The Arabian peninsula is located in the south-west of Asia. It therefore encompasses wide parts of two phytogeographical regions that cover many parts of the Middle East and north Africa. These regions are as follows:

1 - The Arabian-Sahara region;

2 - The Sudanese region.

From the viewpoint of ecologists, phytogeographers and biogeographers, such as Al-Aodat, et al. (1985), and according to the classifications of Eig, (1931-1933), and Takhtajan (1986), the south-western territory of Saudi Arabia, which includes the research area, falls entirely within the east Sudanese region.

The flora and vegetation of the Sudanese region are characterized by hundreds of genera, numerous species and plant communities. The main vegetation types of this region are open woodland, savanna and grassland. The Eritrean-Arabian subregion of the Sudanese, south Arabian province, in the south and south-west of the Arabian peninsula is the richest and the most complex with its latitudinal zonation and species diversity containing about 225 endemic species (Takhtajan, 1986; Zohary, 1973). Also, the same region is characterized climatically by a tropical climate with high temperature in summer and warm temperatures throughout the rest of the year. Precipitation and atmoshperic humidity are normally high, with the average rainfall exceeding 400 mm per year. Due to the monsoon, it is evenly distributed through the rainy season and takes place mainly during the spring months (Al-Qahtani, 1991). High mountains in the area receive rainfall throughout the year but rainfall reaches its peak in the spring season. The Sudanese region in the Arabian Peninsula is mainly characterized by temperatures that are high enough to support a tropical vegetation.

Although there have not been many vegetation studies in the Arabian Peninsula and most writings have been at the level of general information, there are a few studies which have made good contributions in showing some important aspects of classification and distribution of vegetation cover in the Arabian Peninsula. Most of these contributions have come as books and maps, such as Vesey-

Fitzgerald (1955, 1957 a and 1957b), Novikova (1970), Zohary (1973), the Water Atlas of Saudi Arabia (1984), Migahid (1988) and Frey & Kurschner (1989).

In 1988, Migahid, designeted ten phytogeographical regions as comprising the vegetation cover in Saudi Arabia. According to this classification, the research area falls within the southen region, which is affected by the south-western monsoon, and its distinguished by the presence of *Juniperus procera, Olea chrysophylla, Ficus palmata, Acacia neegrii, Acacia gerradii, Dodonaea viscosa, Rumex nervosus, Psiadia arabica, Euryops arabicus, Lavandula dentata* and *Adenium obesum*.

A preliminary vegetation map of Arabia was produced by Novikova (1970). Fifty plant areas were defined in this map according to the presence and abundance of some species and plant communities. Production of this map was based on the botanical work and description of geographers, geologists and travellers. The research area was classified in this map within the tropical types of vegetation.

In 1989 Frey & Kurschner produced a vegetation map for the Middle East. In this map, eight major plant types were grouped in the Arabian Peninsula. Most of the research area was classified as rock desert, but the authors corroborate that a misinterpretation or cartographical error was made with regard to this part of the Arabian Peninsula.

In the vegetation communities map of Saudi Arabia produced by the Ministry of Agriculture and Water (1994), the dominant species were classified into 10 groups. The research area has been reported as having *Juniperus Procera* in the high mountains and *Acacia spp* in the highlands and basins.

According to Abulfatih (1992), who conducted a series of ecological studies in the south-western part of Saudi Arabia, depending on altitude above sea level, the vegetation cover of this region can be divided into six major zones. These vegetation zones are Coastal plains (0-300m), Foothills (300-1000m), Lower escarp-

ments (1000-1600 m), Upper escarpments (1600-2200 m), High mountains (2200-3000 m), Rainshadow slopes (1200-2200 m).

The last two vegetation zones, which form the research area, are characterized by a variety of plant distribution and growth forms. This variety reflects the kind of adaptation found in these plants in response to the environment in which they exist.

Within the study area, ecologists and phytogeogrphers have indicated in brief comments, that this area is an important part of Saudi Arabia, in terms of the magnitude of its vegetation cover. Some of these studies have described the vegetation of this area as follows.

Brooks & Mandil (1983: 357) studied the '' Vegetation Dynamics in Asir Woodlands'' and reported the following:

''In Saudi Arabia, the greatest number of plant species is found in the highlands of the south and south-west where East African vegetation contributes to the character of the region. Forty-four per cent of the flora in southern and south-western Arabia represents Sudanian elements found in the altitudinal zonation of the savanna scrub and the montane woodlands''.

Konig (1988:75) investigated the ''Phytogeography of South-western Saudi Arabia'' and described the vegetation in the study area as follows:

''The vegetation of the study area is climatically influenced and characterized mainly by forest, woodland and xeromorphic woodland communities - in contrast to the central parts of the Arabian peninsula, which are dominated by dwarf-shrub communities, grassland and deserts''.

The Study Area

Asir Highlands occupy a unique position in the south-west of Saudi Arabia. In terms of geographical location, Assir Highlands lay in the zone between 17°20′-21°04′ N latitudes and between 41°40′-44°30′ E longitudes (Fig.1). Geologically, the study area belongs to

the greater Afro-Arabian shield which is a part of the Precambrian crystal plate (Schmidt et al, 1973). The elevation of the area above sea level ranges from 900 m to 3130 m (Al-Shareef, 1984). It contains mountains, escarpments, deep valleys, rolling land and rocky hills (Abulfatih, 1981). The area is distinguished by moderate temperature throughout most months of the year. Although there is a decrease in temperature in winter, it doesn't reach freezing point, because this area is influenced by the warm marine wind. And the important thing is that this area receives a high rainfall. These rains are distributed throughout the year with peaks in spring and summer (Al-Shareef, 1976 & 1994).

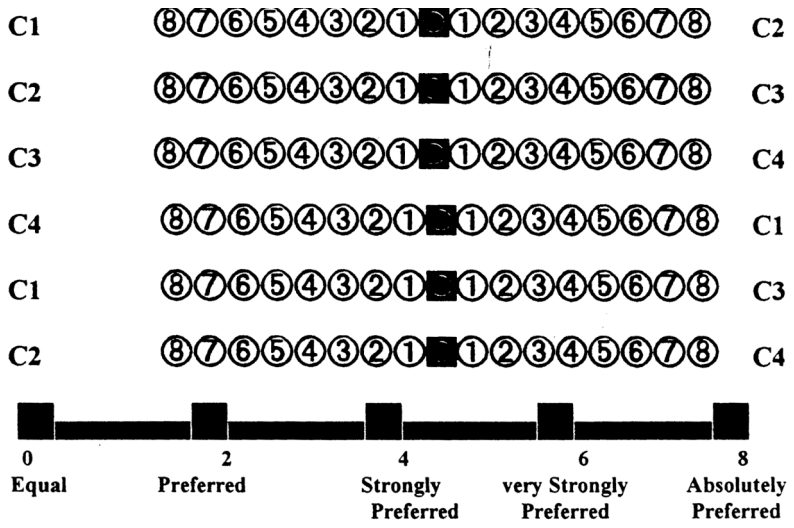


Figure 1 Geographical and Regional Location of Asir Highlands.

Methods and Procedures

Sixty transects were selected systematically as profile lines along slopes in the study area. The slopes were straight in plan and covex-concave in profile. Each transect started from a specific measured point on the lower slope and crossed the facing slope to the edge of the highland. The distance between transects was 5 km. Each transect was subdivided into five slope units from the ridge to the toe: summit, shoulder, mid-slope, foot-slope, and toe-slope. These units covered all the physiographic and physiognomic variations of the region. Selection of these units, which can be seen everywhere, depended on variation of vegetation distribution, slope gradient and form, with soil uniformity. Sample collection sites were established in the centre of each slope unit on each transect. The point-centered quarter method, which is widely used for the sampling of gradient vegetation in forest and woodland ecosystems as well as in sparsely-vegetated areas, was applied at the center of these units. In other words, this technique was used to measure, investigate and analyze 1200 samples of perennial plants in 300 sites. In each site, slope factors (slope angle, slope gradient and slope length) and vegetation components (height, basal diameter, basal area crown area, absolute density, relative covering value, number of points with particular species, total number of individuals, abundance of species/ $100m^2$, absolute dominance, absolute frequency, relative density, relative dominance, relative frequency and importance value) were measured and computed, and soil samples (soil depth, soil moisture, texture class, pH and organic matter) and plants were collected and analysed. This technique has proven to be sufficient and effective in previous investigations of vegetation status and its relationship with slope and soil factors, such as Mueller-Dombois & Ellenberg (1974). Kent & Coker (1992) Martz (1992), Derose et al. (1993), Makhnach (1994) and Simanton et al. (1994). Plant species and nomenclature were identified *in situ* in most of the studied sites by means of the

available scientific references on the flora of Saudi Arabia and its surrounding countries, such as Abulfatih (1984 & 1987), Al-Qahtani (1991), Blatter (1907) and Migahid (1980a, 1980b and 1988). The other species were identified via collecting samples of fresh branches and transferring them to the herbarium. The all procedures suggested by Tarzi (1984) were applied in the collecting and preparation of soil samples, which were analysed according to the procedures that were suggested by soil survey staff (1992), and are applied at laboratories of King Saud University and the National Agriculture and Water Research Center, Saudi Arabia.

Floristic Composition of the Research Area

According to Al-Hubaishi & Hohenstein (1984), the subdivision of the south Arabian phytogeographical region (including Yemen) contains 2000-2500 species of flowering plants. About 20% of the floristic elements of southern Arabia are endemic (Schwartz, 1939). The present study recorded 62 perennial species in the research area. These plant species belong to 49 genera and 28 families. The recorded species were grouped into two Tables (Tables 1 and 2). Each plant species Table was assembled systematically according to divisions, family, genera and species and arranged alphabetically.

Table 1 represents the plant species that were encountered within the sampling sites within the research area. The Table involves 28 perennial species belonging to 24 genera and 12 families. Through this Table, and as can be seen from Fig. 2, *Acacia arabica. Acacia gerradii, Acacia negrii, Lycium shawii, Dodonaea viseosa, Kleinia odora, Juniperus procera* and *Euryops arabicus* species comprise about 89 percent of the frequency of species in the samples, whereas the remaining species (20 species) comprise merely 11 percent. This result indicates that the species diversity of the vegetation in the research area is quite low. Among the identified plants, the *Sageretia thea* species can be considered new to the flora of Saudi Arabia. This species is marked by an asterisk in Table 1.

Table 1 List of Families, Genera and Species Encountered within Sampling Points.
TF = Total Frequency, FC = Frequency Class, AP=Abundance Percentage.

S/ NO	Family	Genera	Species	TF	FC	AP
1	Adenium.	Adenium	Adenium obsesum (Forssk.) Roem & Schullz.	2	22	0.17
2	Asclepiadaceae	Calotropis	Calotropis procera (Ait.) Ait.f.	4	15	0.33
		Leptadenia	Leptadenia pyrotechnica (Forssk.) Decne.	8	12	0.67
		Periploca	Periploca aphylla Decne.	2	23	0.17
3	Compositae	Euryops	Euryops arabicus Steud.	70	8	5.83
		Kleinia	Kleinia odora (Forssk.) DC.	79	6	6.58
		Psiadia	Psiadia arabica Jaub. et Sp.	35	9	2.92
4	Cupressaceae	Juniperus	Juniperus procera Hochst. ex Endl.	71	7	5.92
5	Euphorbiaceae	Cluytia	Cluytia richardiana Muell. Arg. in DC.	2	24	0.17
6	Labiatae	Lavandula	Lavandula dentata L.	3	19	0.25
		Menthal	Mentha lavandulacea Willd.	3	20	0.25
7	Leguminosae.	Acacia	Acacia arabica (Lam.) Willd.	313	1	26.08
		Acacia	Acacia gerradii Benth.	152	3	12.67
		Acacia	Acacia neqrii Pichi-sermolli.	120	4	10.00
		Lagonychium	Laqonychium farctum (Banks & Sol.) Bober.	7	13	0.58
		Tephrosia	Tephrosia apollinia (Del.) Link.	1	26	0.08
8	Polygonaceae.	Rumex	Rumex nervosus Vahi.	4	16	0.33
9	Resedaceae.	Reseda	Reseda sphenocleoidis Deflers.,	3	21	0.25
10	Rhamnaceae.	Phoenix	Phoenix dactylifera L.	1	27	0.08
		Rhamnus	Rhamnus disperma Ehrenb.	4	17	0.33
		Sageretia	*Sageretia thea (Osb.) M.C. Johnst.	6	14	0.50
		Ziziphus	Ziziphus spina-christi (L.) Wild.	1	28	0.08
11	Sapindaceae	Dodonaea	Dodonaea viscosa Jacj.	96	5	8.00
12	Solanacease	Lycium	Lycium barbarum L.	25	10	2.09
		Lycium	Lycium shawii Roem. et Sch.	173	2	14.42
		Solanum	Solanum incanum L.	9	11	0.75
		Solanum	Solanum schimperianum Hochst. ex A. Rich.	4	18	0.33
		Withania	Withania somnitera (L.) Dun. in DC.	2	25	0.17
Total		24	28	1200		100

(See Appendix 1)

Table 2 represents the plant species that were observed outside of the sampling points of the present study, but not within them. As shown in this Table, 34 perennial species were observed, belonging to 29 genera and 24 families. Again, these results confirm what Blatter (1907) and Sankary (1983) indicated, namely, that the south-west of Arabia is distinguished by a general abundance in vegetation families and genera but with a paucity of species.

Table 2 List of Families, Genera and Species Observed Outside of Sampling sites.

NO	Family	Genera	Species
1	Acanthaccae.	Anisoltes	Anisoltes trisulcus (Forssk.) Nees.
2	Amaranthaccae.	Acrva	Aerva javanica (Burmf.) Spreng.
3	Apocynaceae.	Rhazya	Rhazya stricta Decne.
4	Asclepiadaceae.	Gomphcarpus Periploca	Gomphcarpus sinaicus Boiss. Periphloca aphylla Decne.
5	Boraginaceae.	Trichodesma	Trichodesma calathiforme Hochst.
6	Cactaceae.	Opuntia	Opuntia Ficus-Indica (L.) Miller.
7	Capparaceae.	Capparis	Capparis spinosa L.
8	Compositae.	Echinops	Echinops spinosissimus Turra.
9	Cupressaccac	Juniperus	Juniperus polycarpos C. Koch.
10	Euphorbiaceae.	Cluytia Euphorbia Ricinus	Cluytia myricoides Jaub and Spach. Euphorbia schimperiana Scheele. Ricinus communis L.
11	Guttiferae.	Hypericum	Hypericum revolutum Vahl.
12	Labiatae.	Nepeta Otostegia Salvia	Nepeta deflersiana Schwcinf. Otostegia fruticosa (Forssk.) Briq. Salvia aegyntiaca L.
13	Leguminosae.	Cadia	Cadia purpurea (Pice.) Ait.
14	Litiaceae.	Dracaena	Dracaena serrulata Bak.
15	Loganiaccae.	Buddleia	Buddleia polystachya Fres.
16	Moraceae.	Ficus	Ficus carica L. Ficus plamata Forssk. Ficus salicifolia Vahl. Ficus sycomorus Decne. Ficus vasta Forssk.
17	Oleaceae.	Olea	Olea europaea L.
18	Passifloraceae.	Adenia	Adenia venenata Forssk.
19	Resedaceae.	Otchradenus	Otchradenus baceatus Del.
20	Rhamnaceae.	Rhamnus	Rhamnus staddo A. rich. var. deflersii (Schweinf.) Chiev.
21	Rosaccae.	Rosa	Rosa abyssinica R. Br.
22	Rutaceae.	Ruta	Ruta chalepensis L.
23	Tamaricaceae.	Tamarix	Tamarix aphylla (L.) Karst. Tamarix nilotica (Ehrenb.) Bge.
24	Tiliaceae.	Grewia	Grewia mollis Juss.
Total		29	34

(See Appendix 2)

Key to Species (see Table 1).

Eury arab = **Euryops arabicus** Klei odor = **Kleinia odora** Psia arab = **Psiadia arabica**
Juni proc = **Juniperus procera** **Acac arab = Acacia arabica** Acac gerr = **Acacia gerradii**
Acac negr = **Acacia negrii** Dodo visc = **Dodonaca viscosa** Lyci barb = **Lycium barbarum**
Lyci shaw = **Lycium shawii**

Others = **Adenium obesum, Calotropis procera, Leptadenia pyrotechnica, Periploca aphylla, Cluytia richardian, Lavandula dentata, Mentha lavandulacea, Iagonychium farctum, Tephrosia apollinia, Rumex nervosus, Reseda sphenocleoidis, Phoenix dactylifera, Rhamnus disperma, Sageretia thea, Ziziphus spinachristi, Solanum incanum, Solanum schimperianum, Withania somnifera**.

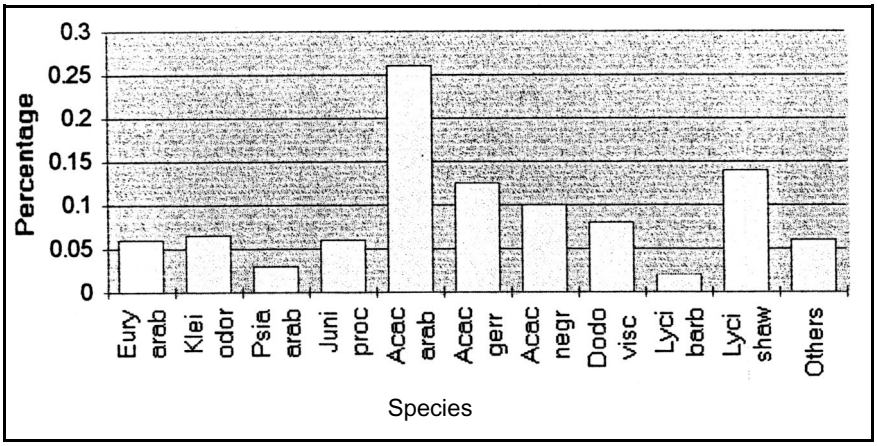


Figure 2 Selected percentage of Sepcies Frequency in the Sampling Points of Study.
(Source: Table 1)

Morphology of Vegetation

Beside spatial variation in the species composition of the plant communities, the composition of life-forms reflects the response of vegetation to variation in certain environmental factors. The life-form spectrum is thought to be either a hereditary adjustment to environment or to represent the residual effects of some historical, topographical, climatic or biotic condition on the plant population (El-Demerdash et al. 1994; and Raunkiaer, 1934). It is clear that the morphology of vegetation composition of the research area is affected by all the factors mentioned above, but in varying degrees. Four plant morphology elements (height, basal diameter, basal area and crown area) were measured, and are summarised in Table 3. *Juniperus procera* recorded the greatest crown area (707.14 m^2), whereas *Phoenix dactylifera* recorded the greatest height (14 m) and the biggest basal diameter (149 cm) in the research area. As can be seen from Table 3, the mean height, basal diameter, basal area and crown area of the perennial species were calculated to be 2.59 m, 12.72 cm, 736.51 cm^2 and 12.04 m^2 respectively. Depending on the mean height and crown area, *Phoenix dactylifera, ziziphus spina-*

christi, Juniperus procera, Acacia gerradii, and *Acacia negrii* are distinguished by a large size compared with the other species, being the five biggest trees, whereas *Lagonychium fartum, Rumex nervosus, Lycium barbarum, Reseda sphenocleoidis* and *Tephrosia apollinia* are charaterised by smaller shrubs. The standard deviation values indicate that there are big variations between the maximum and minimum values in most of these plant morphology elements. Due to the grazing factor that operates in the north-eastern areas, and an inequality of moisture from one place to another, the plants cover value is also particularly varied, reaching 75% in some places in the south-western part and decreasing sharply in the north-eastern part of the research area. The plant cover value ranges from less than 1% to 75%. According to Domin's scale, the mean estimation of plant cover value was computed to be 4.26, which equals 10 to 25%.

Quantitative analysis of the plant species is based on absolute density, relative covering value, number of points with particular species, total number of individuals, abundance of species/100 m^2, absolute frequency, relative density, relative dominance, relative frequency and importance value (Table 4). The absolute density of the perennial plants in the research area is 2.71/100 m^2. This is a low density, yet it may be considered relatively high compared with other areas in Saudi Arabia. Despite the low absolute density, the relative covering value was calculated to be 21.70, indicating that many species are distinguished by their large size. With regard to the abudance of species, *Acacia Arabica* (0.71/100m^2), *Lycium shawii* (0.38/100 m^2), Acacia gerradii (0.34/100 m^2), *Acacia negrii* (0.27/100 m^2), and *Dodonaea viscosa* (0.22/100 m^2) are the most abundant species in the research area as a whole. Absolute dominance values (cm^2 of stem /100m^2) indicated that *Juniperus procera* (190.32 cm^2/ 100 m^2), *Acacia gerradii* (67.68 cm^2/100m^2), *Acacia arabica* (37.17 cm^2/100 m^2), *Phoenix dactylifera* (34.89 cm^2/100m^2) and *Acacia negrii* (29.55 cm^2/100m^2) have bigger stem sizes than the other species. The importance value has confirmed that *Acacia arabica* (IV = 61.68), *Juniperus procera* (IV = 60.54), *Acacia gerradii* (IV = 42.65), *Lycium shawii* (IV = 31.21) and *Acacia negrii* (IV = 27.56) are the most important perennial species in the research area.

Table 3 Summary of Mean Measurements of plant components.

S/NO	Species	Mean height (m)	Mean basal diameter (cm)	Mean basal area (cm^2)	Mean crown area (m^2)
1	Acacia arabica	1.44 *(1.05)	6.46 (5.03)	52.57 (113.40)	3.62 (6.63)
2	Acacia gerradii	2.9 (2.32)	1..73 (10.69)	197.31 (512.05)	15.8 (21.77)
3	Acacia negrii	2.62 (1.48)	10.11 (6.07)	109.03 (146.77)	20.4 (32.14)
4	Lagonychium farctum	0.55 (0.07)	3.43 (0.35)	9.32 (1.87)	0.57 (0.06)
5	Tephrosia apollinia	0.7 (0.00)	2.5 (0.00)	4.91 (0.00)	0.52 (0.00)
6	Lycium shawii	1.01 (0.62)	4.71 (2.80)	23.56 (59.27)	1.67 (3.40)
7	Lycium barbarum	0.65 (0.06)	3.36 (0.51)	9.07 (2.77)	0.59 (0.10)
8	Solanum ineanum	0.64 (0.10)	3.67 (0.430)	10.58 (2.40)	1.31 (2.16)
9	Solanum schimperianum	1.23 (0.18)	3.45 (0.04)	9.35 (0.22)	0.85 (0.31)
10	Withania somnifera	0.71 (0.02)	4 (0.00)	12.57 (0.00)f	0.61 (0.06)
11	Dodonaea viscosa	1.31 (0.79)	5.67 (4.25)	39.29 (129.04)	2.63 (4.38)
12	Kleinia odora	0.77 (0.16)	4.27 (1.10)	15.24 (8.18)	0.88 (0.60)
13	Euryops arabicus	0.9 (0.40)	4.16 (2.35)	17.89 (44.44)	1.04 (1.65)
14	Psiadia arabica	0.74 (0.17)	3.43 (0.67)	9.59 (4.31)	0.76 (0.33)
15	Juniperus procera	4.04 (1.70)	31.72 (22.69)	1189.53 (1603.28)	36.18 (83.70)
16	Leptadenia pyrotechnica	1 (0.47)	4.72 (1.30)	17.87 (9.49)	0.96 (0.66)
17	Calotropis procera	1.87 (1.45)	5.7 (2.77)	30.04 (28.51)	1.65 (1.53)
18	Periploea aphylla	1.21 (0.16)	5.75 (0.35)	26.03 (3.20)	1 (0.18)
19	Sageretia thea	0.7 (0.14)	3.5 (0.55)	9.82 (3.01)	0.65 (0.13)
20	Rhamnus disperma	1.42 (0.64)	12.57 (8.46)	169.91 (169.06)	5.88 (5.15)
21	Phoenix dactylifera	14 (0.00)	149 (0.00)	17443.64 (0.00)	176.79 (0.00)
22	Ziziphus spina-christi	5.5 (0.00)	34 (0.00)	908.29 (0.00)	56.57 (0.00)
23	Rumex nervosus	0.64 (0.15)	3.38 (0.25)	8.88 (1.28)	0.55 (0.07)
24	Reseda sphenocleoidis	0.68 (0.08)	2.83 (0.29)	6.35 (1.25)	0.55 (0.09)
25	Lavandula dentata	0.82 (0.12)	4 (0.00)	12.57 (0.00)	0.84 (0.09)
26	Mentha lavandulacea	1.18 (0.37)	7.33 (0.58)	42.43 (6.81)	3.66 (0.91)
27	Adenium obesum	0.89 (0.25)	17 (1.41)	227.86 (37.78)	0.6 (0.13)
28	Cluytia richardiana	0.88 (1.41)	11.25 (1.87)	0.61 (1.87)	0.61 (0.04)
Mean		2.09	12.72	736.51	12.04

(1.05) Standard Deviation.

Classification of Samples and Species

As was mentioned earlier, the diversity of species in the research area is relatively low; 8 of the 28 species encountered and recorded within the sampling points comprise about 90 percent of the frequency of species. These common and important species are: *Acacia arabic. Acacia gerradii, Acacia negrii, Dodonaea viscosa, Lycium shawii. Juniperus procera, Kleinia odora* and *Euryops arabicus* (Table 1). For investigation of the research area vegetation, 60 transects were distributed in the research area. Five quadrats were determined and investigated in each transect. A total of 1200 plant samples were collected from 300 quadrats. These quadrats and species (28 species) were classified by clustered classification using two-way indicator species analysis (TWINSPAN) (Hill, 1979b). TWINSPAN is a computer program in FORTRAN designed primarily for ecologists and phytosociologists who have collected data on the occurrence of a set of species in a set of samples. Version 1.0 of TWINSPAN, written in 1994, is essentially the same as the original program, but has been redesigned for modern hardware (Hill, 1994). The program first constructs a classification of the samples, and then uses this classification to obtain a classification of the species according to their ecological preferences.

Table 4 Summary of Vegetation Data of the Research Area: NPS = number of point with species, TNI = total number of individuals, AS = abundance of species in $100m^2$, AD = absolute dominance ($cm^2/100\ m^2$), AF = absolute frequency (percent), RDE = relative density, RDO = relative dominance, RF = relative frequency, IV = importance value and IVR = importance value rank.

No. Of Sampling points = 300										Absolute density (per $100m^2$) = .271	
No. Or Species samples = 1200										Relative Covering Value = 21.70	
S/ NO	Species	NPS	TNI	AS	AD	AF	RDE	RDO	RF	IV	IVR
1	Acacia arabica	92	313	0.707	37.17	30.67	26.09	9.514	26.08	61.68	1
2	Acacia gerradii	63	152	0.343	67.68	21.00	12.66	17.324	12.67	42.65	3
3	Acacia negrii	54	120	0.271	29.55	18.00	10.00	7.564	10.00	27.56	5
4	Lagonychium farctum	5	7	0.016	0.15	1.67	0.60	0.038	0.58	1.22	14
5	Tephrosia apollinia	1	1	0.002	0.01	0.33	0.07	0.002	0.09	0.16	28
6	Lycium shawii	84	173	0.381	9.21	28.00	14.43	2.357	14.42	31.21	4
7	Lycium barbarum	14	25	0.056	0.51	4.67	2.07	0.130	2.08	4.28	11
8	Solanum incanum	6	9	0.020	0.21	2.00	0.74	0.053	0.75	1.54	12
9	Solanum schimperianum	2	4	0.009	0.08	0.67	0.33	0.020	0.33	0.68	18
10	Withania somnifera	1	2	0.005	0.06	0.33	0.18	0.066	0.17	0.42	25
11	Dodonaea viscosa	48	96	0.217	8.53	16.00	8.01	2.183	8.00	18.19	6
12	Kleinia odora	36	79	0.178	2.71	12.00	6.57	0.693	6.58	13.84	7
13	Euryops arabicus	36	70	0.158	2.83	12.00	5.83	0.724	5.83	12.38	8
14	Psiadia arabica	23	35	0.079	0.76	7.67	2.92	0.194	2.92	6.03	10
15	Juniperus procea	45	71	0.160	190.32	15.00	5.90	48.719	5.92	60.54	2
16	Leptadenia pyrotechinca	5	8	0.018	0.32	1.67	0.67	0.081	0.67	1.42	13
17	Calotropis procera	3	4	0.009	0.27	1.00	0.33	0.069	0.33	0.73	17
18	Periploca aphyila	1	2	0.005	0.13	0.33	0.18	0.033	0.17	0.38	26
19	Sageretia thea	6	6	0.013	0.13	2.00	0.48	0.033	0.50	1.01	16
20	Rhamnus disperma	2	4	0.009	1.53	0.67	0.33	0.391	0.33	1.05	15
21	Phoenix dactylifera	1	1	0.002	34.89	0.33	0.07	8.931	0.08	9.08	9
22	Ziziphus spina christi	1	1	0.002	1.82	0.33	0.07	0.465	0.08	0.62	21
23	Rumex nervosus	3	4	0.009	0.08	1.00	0.33	0.020	0.33	0.68	19
24	Reseda sphenocicoidis	1	3	0.007	0.04	0.33	0.26	0.010	0.25	0.52	24
25	Lavandula dentata	3	3	0.007	0.09	1.00	0.26	0.023	0.25	0.53	23
26	Mentha lavandulacea	2	3	0.007	0.30	0.67	0.26	0.076	0.25	0.59	22
27	Adenium obesum	1	2	0.005	1.14	0.33	0.18	0.291	0.17	0.64	20
28	Cluytia richardiana	2	2	0.005	0.06	0.67	0.18	0.015	0.17	0.37	27
Total			1200	2.71	390.66	180.34	100	]100	100		

Classification of Samples

Only six levels emerged from running this program (TWIN-SPAN) on the data of samples and species collected from the research area. These levels are illustrated in Fig.3. The classification led to the identification of 14 important groups of plant community types. As can be seen from Fig.3, the important groups emerged from the first three levels, and form the major part of the natural vegetation. Two major groups (0 and 1) have formed in level one. Four medium groups (00, 01, 10, and 11) have formed in level two and eight submedium groups (000, 001, 010, 011, 100, 101, 110 and 111) have formed in level three. Investigation and analysis of these groups are as follows:

Group 0 (Major Group).

Location: mostly, west and south of the research area.

This group is concentrated in particular in the west and south of the research area. These locations are characterised by the abundance of *Dodonaea viscosa* as a main indicator, and presence of *Juniperus procera, Acacia gerradi, Acacia negrii,* and *Lycium shawii*. This group has a wide distribution; therefore it is subdivided and formed two medium groups (00 and 01) in level two.

Group 00 (Medium Group).

Location: west and south-west of the research area.

Group 00 predominates in the west and south-west of the research area. These sites are characterised by the abundance of *Juniperus procera*. This group is subdivided further and formed two submedium groups (000 and 001) in level three.

Group 000 (Submedium Group).

Location: west of the research area.

This group extends in general along the west of the research area. This region is represented by the high western mountains where the *Juniperus procera* is concentrated in a 100 percentage.

Group 001 (Submedium Group).

Location: west of the research area.

This location has been classified as one group due to the presence and abundance of *Psiadia arabica* species. This species is distributed in a 100 percentage within the western parts of the research area.

Group 01 (Medium Group).

Location: south and south-east of the research area.

This group is widely prevalent in the regions, located in the south and south-east of the research area. These regions are distinguished by the dominance of *Acacia gerradii* as a main indicator, and the presence of *Acacia negrii* and *Lycium shawii.* This group is subdivided futher and formed two submedium groups (010 and 011) in level three.

Group 010 (Submedium Group).

Location: south of the research area.

The southern part of the research area has been classified as one group due to the presence and abundance of *Lycium shawii*. This species is present in this part in a 100 percent concentration.

Group 011 (Submedium Group).

Location: south of the research area

This group prevails in the south of the research area. This location is distinguished by dominance of *Acacia negrii* as a main indicator and by the presence of *Lycium shawii* species.

Group 1 (Major Group).

Location: mostly in the north and east of the research area.

This group is prevalent in the north and east of the research area. These locations have been classified as one group due to the abundance of *Acacia arabica*, which is the important species in the research area, but its distribution is not wide. 75% of this species is concentrated in the north-east, whereas the remainder is distributed in the north-west of the research area. *Kleinia odora. Euryops arabicus Juniperus procera* and *Lycium barbarum* are common species in this group. This group has a wide distribution; therefore it is subdivided and formed two medium groups (10 and 11) in level two.

Group 10 (Medium Group).

Location: south and south-east of the research area.

As mentioned earlier, this group was created from the splitting of group I. It appears obviously in the south and south-east of the research area. It is characterised by having abundance of *Kleinia odora, Euryops arabicus, Juniperus procera* and *Lycium barbarum* species. This group is subdivided further and formed two submedium groups (100 and 101) in level three.

Group 100 (Submedium Group).

Location: south-east of the research area.

This group predominates over an important part of the south-eastern of the research area. This part has been classified as one

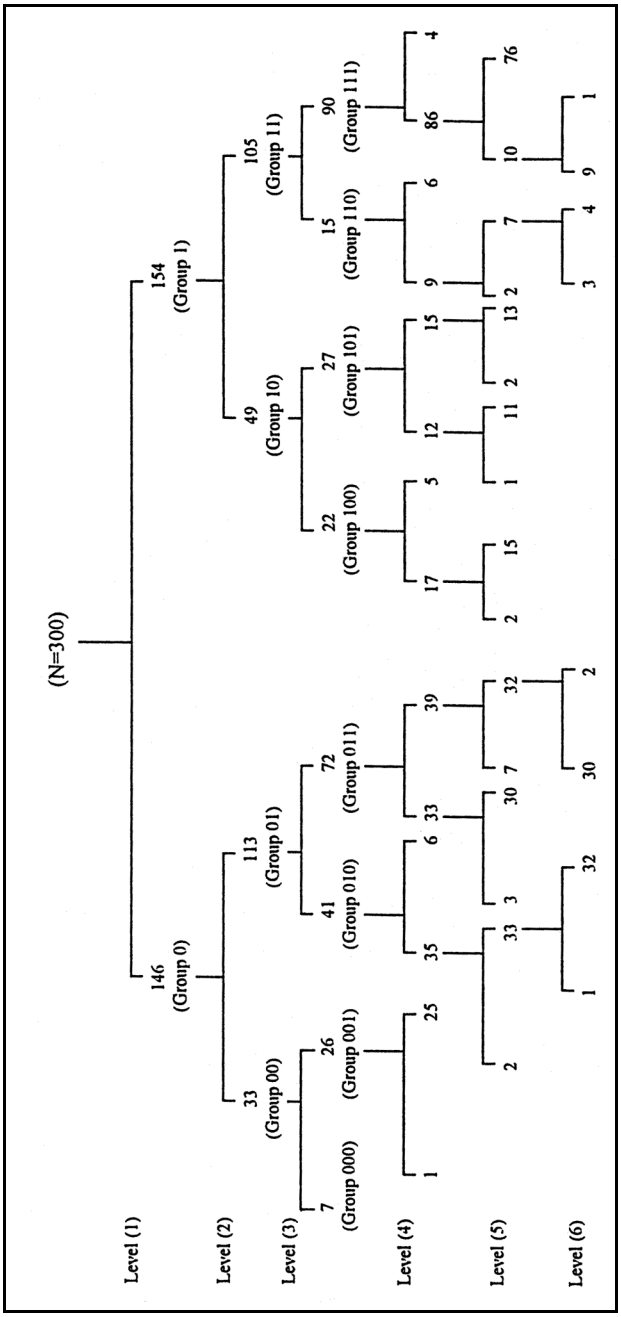


Figure 3 Samples Classification Resulting from an Application of TWINSPAN Hierarchy on the Data Collected from the Research Area.

group due to the abundance of *Kieinia odora* and presence of *Lycium barbarum* species, which are concentrated in this part at 71% and 100% levels, respectively.

Group 101 (Submedium Group).

Location: south-east of the research area.

The south-west of the research area has been classified as one group due to the dominance of *Euryops arabicus* as a main indicator and presence of *Juniperus procera* species. The presence and absence of these two species appear to be associated widely in the research area. They appear together strongly in the south-west and are both absent in other parts of the research area.

Group 11 (Medium Group).

Location: north of the research area.

Group 11 is prevalent in particular in the north of the research area. This part of the research area is classified as one group due to the presence and abundance of *Acaria arabica, Lycium Shawii Psiadia arabica Solanum incanum. Leptadenia pyrotechnica* and *Periploca aphylla*. This group is subdivided further and formed two submedium groups (110 and 111) in level three.

Group 110 (Submedium Group).

Location: mostly east and south-east of the research area.

In view of the dominance of *Acacia arabica, Lycium shawii* as main indicators and the presence of *Psiadia arabica, Solanum incanum, Leptadenia pyrotechnica* and *Periploca aphylla* the east and south-east of the research area have been classified as one group. It is worth noting that *Solanum incanum, Leptadenia pyrotechnica* and *Periploca aphylla* are present in the research area in small numbers (Table 1 and Fig.2), but they are distributed over a wide area.

Group 111 (Submedium Group).

Location: mostly north-east of the research area.

Due to the presence of *Langonychium farctum, Calotropis procera,* and *Rhamnus disperma*, the north-east of the research area has been classified as one group.

The very small groups produced in levels 4,5 and 6 were not analysed further, because they make no ecological sense and they are not important in the vegetation composition of the research area.

Classification of Species

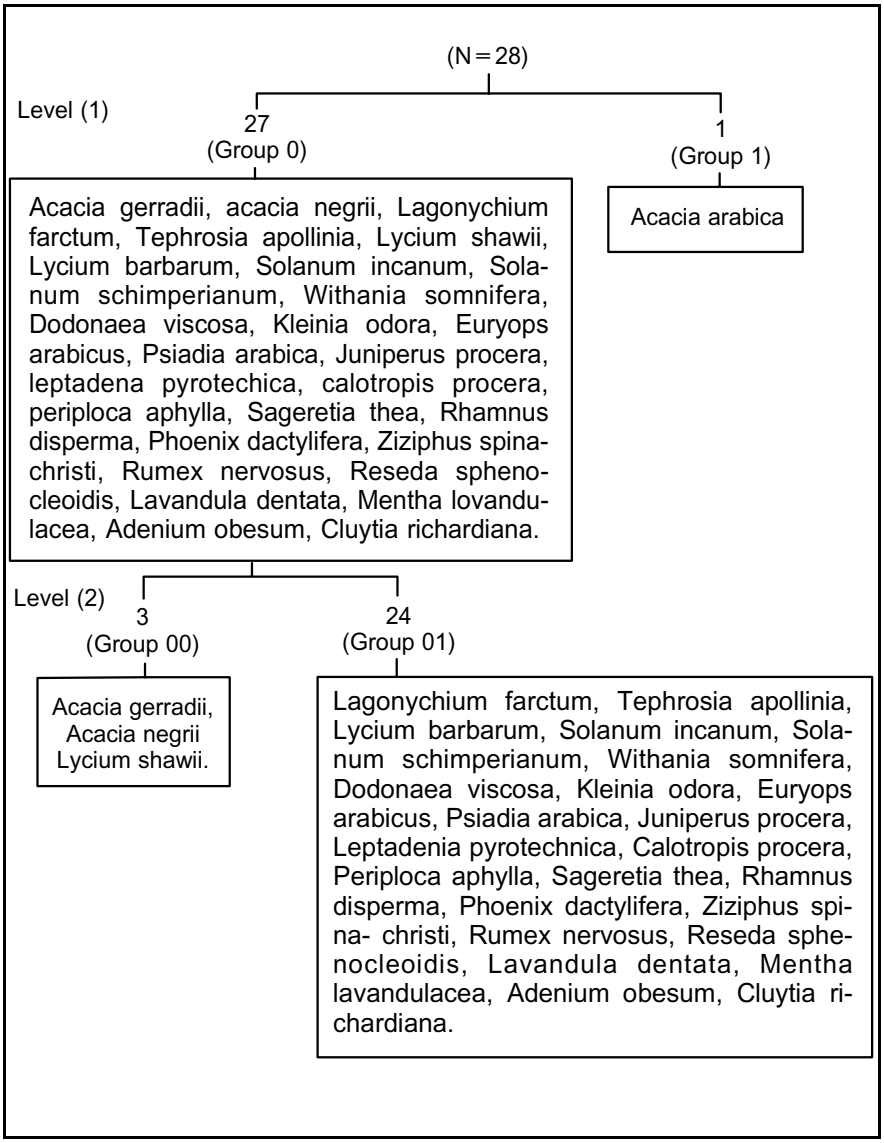
Species classification is an additional classification produced from an application of TWINSPAN program on the species data. The species were classified by TWINSPAN in much the same way as the sample. However, there is an important difference in that the species classification was made in the light of the sample classification, and not using the raw data. In fact, the species classification was made on the basis of fidelity, namely, using the degree to which species are confined to particular groups of sample.

As can be seen from Fig. 4 the 28 species shown in Table 1 divided in level one and comprised two main groups (0 and 1). Group 0 comprises 27 species (*Acacia gerradii, Acacia negrii, Lagonvehium farctum, Tephrosia appllinia. Lycium shawii, Lycium barbarum, Solanum incanum, Solanum incanum, Solanum schimperianum, Withania somnifera, Dodonaea viscosa, Kleinia odora, Euryops arabicus, Psiadia arabica. Juniperus procera, Leptadenia pyrotechnica, Calotropis procera, Periploca aphylla, Sageretia thea, Rhamnus disperma, Phoenix dactylifera, Ziziphus spinachristi, Rumex nervosus, Reseda sphenocleoidis, lavandula dentata, Mentha lavandulacea, Adenium obesum,* and *Cluytia richardiana)*, whereas group I contains one species (*Acacia arabia*), Group 0 subdivided in level two to give a further two groups (00 and 01). Group 00 involves *Acacia gerradii, Acacia negrii* and *Lycium shawii*, where group 01 contains *Lagonychium farctum, Tephrosia apollinia, Lycium barbarum, Solanum incanum, Solanum schimperianum, withania somnifera, Dodonaea viscosa, Kleinia odora, Euryops arabicus, Psiadia arabica, Juniperus procera, Leptadenia pyrotechnica, Calotropis procera, Periploca aphylla, Sageretia thea, Rhamnus disperma, Phoenix dactylifera, Ziziphus spinachristi, Rumex nervosus, Reseda sphenocleoidis, Lavandula dentata, Mentha lavandulacea, Adenium obesum* and *Cluytia richardiana.*

As shown in sample classification, *Acacia gerradii, Acacia negrii, Dodonaea viscosa, Rumex nervosus* and *Adenium obesum* are together completely faithful to group 0 of the sample hierarchy. However, *Dodonaea viscosa* is also completely faithful to group 00 of the sample hierarchy, whereas *Acacia gerradii, Acacia negrii, Rumex nervosus* and *Adenium obesum* are not. *Acacia gerradii* and *Acacia negrii* are both completely faithful to group 01, but *Acacia gerradii* is also very highly faithful to group 010, whereas, *Acacia negrii* is very highly faithful to group 011 of the sample hierarchy.

On the other side, *Lagonychium farctum, Lycium barbarum, Withania somnifera, Leptadenia pyrotechnica, Calotropis procera, Periploca aphylla, Sageretia thea, Rhamnus disperma, Reseda sphenocleoidis, Mentha lavandulacea* and *Acacia arabica* are together completely faithful to group I of the sample hierarchy. However, *Lycium barbarum* is also completely faithful to group 10, whereas *Lagonychium farctum, Withania somnifera, Leptadenia pyrotechnica, Calotropis procera, Perioloca aphylla, Sageretia thea, Rhamnus disperma, Reseda sphenocleoidis, Mentha lavandulacea* and *Acacia arabica* are not. *Withania somnifera, Leptadenia pyrotechnica, Calotropis procera, Periploca aphylla, Sageretia thea, Rhamnus disperma, Reseda sphenocleoidis, Menthal lavandulacea* and *Acacia arabica* are together completely faithful to group 11, but *Periploca aphylla* and *Mentha lavandulaces* are also very highly faithful to group 110, whereas *Calotropis procera, Sageretia thea, Rhamnus disperma* and *Reseda sphenocleoidis* are very highly faithful to group 111 of the sample hierarchy.

Figure 4 Species classification resulting from an application of TWINSPAN program to the research area data.



The Relationship Between Species and Environmental Factors

The classifications of samples and species produced by using the TWINSPAN program make it possible to investigate and discover the relationship between species distribution and the associated environmental variables that have been collected from the research area. The 28 species listed in Table 1 and 8 environmental variables, namely slope angle, slope gradient, slope length, soil depth, soil depth, soil moisture, texture class, pH of soil and organic matter were investigated and included. In order to find out the relations between them, the DECORANA (CANOCO/DECORANA) program was used (Ter Braak, 1988 and Hill, 1994).

The classification of floristic data using the DECORANA program gave strongly similar results to the classification results of the floristic data using TWINSPAN. DECORANA analysis (Fig. 5; eigenvalues: axis 1 = 0.158; axis 2 = 0.040) showed that the floristic composition and distribution of the main plant groups reflected the conditions of soil and topographic variety in the research area. 22 of the 28 species agglomerated to compose 6 clusters. Two species (*Lagonychium farctum* and *Mentha lavandulacea*) were located out of the clusters. Other species, such as *Reseda sphenocleoidis, Lavandula dentata, Adenium obesum* and *Clytia richardiana* were located out of the diagram. The 6 clusters obtained by this analysis were considered vegetation types. Most of these types are associated with one or more of the environmental factors. The environmental factors display variation in species composition. They are represented by arrows in Fig. 5. The arrow for an environmental variable points in the direction of maximum change of the environmental variable across the diagram, and its length is proportional to the rate of change in this direction. Environmental variables with long arrows are more strongly correlated with the ordination axes than those with short arrows. As can be seen from Fig. 5, *Acacia arabica, Acacia gerradii, Acacia negrii, Lycium shawii* and *Rhamnus disperma* were found to have positive

correlation with deep soils, sandy soils and alkali soils. *Sageretia thea, Tephrosia apollinia* and *Solanum schimperianum* are strongly associated with slope angle, slope gradient and moisture and somewhat associated with organic matter. *Juniperus procera, Euryops arabicus, Dodonaea viscosa, Leptadenia pyrotechnica* and *Psiadia arabica* also have correlatation with organic matter.

Despite the few attempts that have been made by ecologists and phytogeographers, such as Vesey-Fitzgerald (1955, 1957a and 1957b), Novikova (1970), Zohary (1973), Migahid (1988) and Frey & Kurschner (1989), as well as the Water Atlas of Saudi Arabia (1984 and 1994), to draw a vegetation map for the research area, many misreadings have been perpetrated in these maps. These misreadings have resulted either from unreliable data or general information. Hence and depending on the data collected from the research area, reconnaissance surveys and the classification of vegetation and samples resulting from an application of the TWINSPAN and DECORANA computer programs, a new perennial vegetation map of the research area has been produced and is depicted in Fig. 6. This map illustrates the actual status of vegetation types in the research area. As can be seen from this map, the vegetation of the research area has been divided into 5 distinct plant groups. In order to avoid the problem of overcrowding in the map, very small plant groups which are of very little importance, have been combined with the nearest dominant group. These groups are as follows:

The first group consists largely of *Acacia arabica*. This species and other perennial minor species spread in the dry north and north-east of the research area, particularly between 1000 and 1500 m a.s.1. Notably, *Acacia arabica* is completely absent from the south of the research area. These species all have long roots that enable them to get the water from deep layers. It should be mentioned that these species are suffering from human activities, such as over-grazing and somewhat wood cutting. This result is consistent with that of Brooks & Mandil (1983).

The second group consists mainly of *Juniperus procera, Euryops arabicus* and *Dodonaea viscosa*. These species are wide-

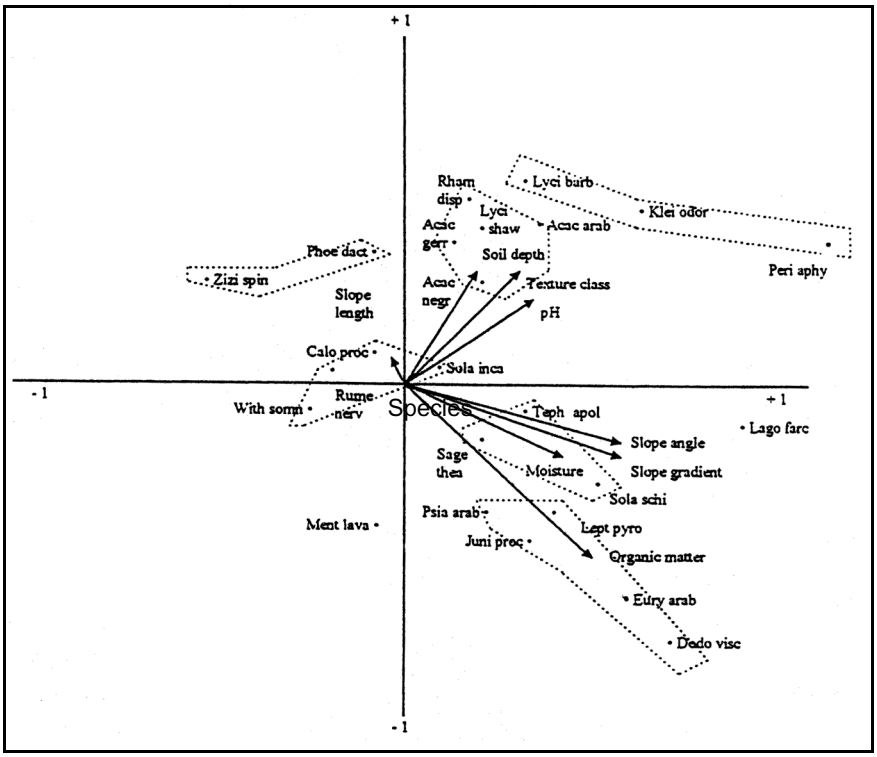


Figure 5 The Research Area Data; CCA Ordination Diagram with Plant Species (*) and Environmental Variables (arrows); First Axis is Horizontal, Second Axis Vertical.

Key to Species:

Eury arab = **Euryops arabicus**
Juni proc = **Juniperus procera**
Acac negr = **Acacia negrii**
Lyci shaw = **Lycium shawii**
Calo proc = **Calotropis procera**
Ment lavan = **Mentha lavandulacea**
Lago farc = **Lagonychium farctum**
Zizi spin = **Ziziphus spina-christi**
Sola schi = **Solanum schimperianum**
Klei odor = **Kleinia odora**
Acac arab = **Acacia arabica**
Dodo visc = **Dodonaca viscosa**
Sage thea = **Sageretia thea**
Sola inca = **Solanum incanum**
Rume nerv = **Rumex nervosus**
Teph apol = **Tephrosia apollinia**
Lept pyro = **Leptadenia pyrotechnica**
With somn = **withania somnifera.**
Psia arab = **Psiadia arabica**
Acac gerr = **Acacia gerradii**
Lyci barb = **Lycium barbarum**
Rume nerv = **Rumex nervosus**
Feri aphy = **Periploca aphylla**
Phoe dact = **Phoenix dactylifera**

spread above 1500m altitude, on the tops and eastern hillsides of the Asir and Al-Hijaz mountains which extend along the wetter west part of the research area. The association of these species with this altitude has also been indicated by Batanouny (1987) and Brooks &

Mandil (1983). One of the main characteristics of the plant species of this group is that they are perennial green trees and shrubs and they are usually festooned with lichens.

The third group appears in most head sources of Wadi Bishah. The famillar species in this group are *Acacia gerradii* and *Dodonaea viscosa*. The main characteristics of the vegetation of this group are that they have big bodies and are concentrated mostly close to water courses.

The fourth group of plants appears to occupy the south-eastern part of the Wadi Bishah catchment area. This botanical group

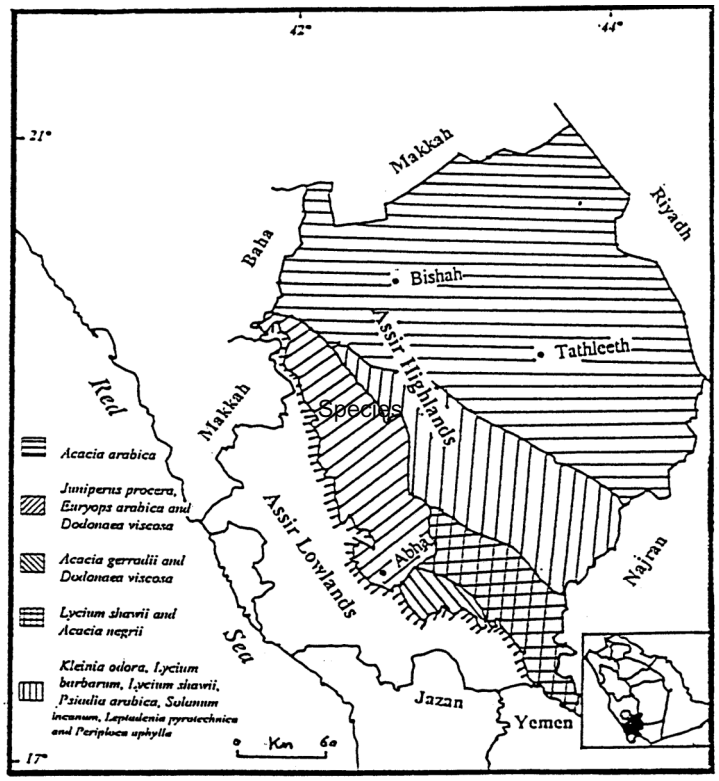


Figure 6 Perennial Vegetation Map of Asir Highlands.

consists of *Lycium shawii* and *Acacia negrii*. Due to the scarcity of water in this part, the vegetation colour of this group appears to be grey, particularly during the winter and autumn seasons.

The fifth group consists of *Kleinia odora, Lycium barbarum, Lycium shawii, Psiadia arabica, Solanum incanum, Leptadenia pyrotechnica* and *Periploca aphylla*. These species are spread in the middle and east of the research area. Most of the plants of these areas are a mixture of succulent plants and needle-bearing plants (Abulfatih, 1984).

Conclusions

Reconnaissance surveys and intensive quantitative analysis of the vegetation of the research area have demonstrated that *Acacia arabica, Juniperus procera, Acacia gerradii, Acacia negrii, Euryops arabicus, Dodonaea vicosa, Lycium shawii Kleinia odora, Lycium barbarum, Psiadia arabica, Solanum incanum, Leptadenia pyrotechnica,* and *Periploca aphylla* are the species that compose and provide the main vegetative characteristics of Asir Highlands. The other plant species that were found within the sampling point of the present study and are listed in Table 1, and the plant species that were observed outside these points (Table 2) have less significance in composition of the vegetation attributes of this area. The assemblage of these species in the research area is little and their distribution is patchy.

From the foregoing analysis, it emerges that the vegetation of the area under study is associated clearly with numerous environmental parameters, such as topography, altitude, soil condition and moisture amount (Alwelaie et al. 1993), as well as other climatic and human factors. These circumstances and factors influence the distribution, establishment, growth and regeneration of the plants (Batanouny, 1987) and have produced different plant shapes inside the research area (Bloot, 1996; El-Demerdash et al. 1994). The following paragraphs summarize the main findings of this research.

Floristic analysis of the flora of Asir highlands has revealed that floristic diversity is higher than elsewhere in Saudi Arabia. This study

recorded 62 perennial species (89% of these species are trees and shrubs while 11% are subshrubs or herbs) in this basin. These plant specics belong to 49 genera and 28 families. The more common species are *Acacia arabica, Acacia gerradii, Acacia negrii, Lycium shawii, Dodonaea viscosa, Kleinia odora, Juniperus procera,* and *Euryops arabicus*, while *Acacia arabica* (IV = 61.68), *Juniperus procera* (IV = 60.54), *Acacia gerradii* (IV = 42.65), *Lycium shawii* (IV = 31.21) and *acacia negrii* (IV = 27.56) are the most important species.

The composition and distribution of vegetation reflect the conditions of the environmental factors in the research area. The soil, topography and climate of the south-western part (or mountainous plant community) differ widely from those of the semi-desert plant community located in the north-eastern part. This is due to the high altitude (2000-3130 m a.s.1) of the former area with its consequences for air temperature, and to relatively high rainfall without a prolonged dry period, as in the semi-desert plant community. The vegetation density in the south-western part (3.01/ $100m^2$) is higher than that in the north-eastern part (2.46/$100m^2$).

Classification of samples and species using the TWINSPAN program led to identification of 14 important plant groups (refer to Fig.3).

Depending on the data collected from Asir Highlands during the field work, reconnaissance surveys and the classification of samples and species resulting from an application of the TWINSPAN and DECORANA computer programs, the perennial vegetation cover of the research area has been divided into five distinct plant groups (refer to Fig. 6). The first group spreads over the north and north-east of the area under study and consists largely of *Acacia arabica*. The second group covers the tops and eastern sides of the hills of the Asir and Al-Hijaz mountains, and consists mainly of *Juniperus procera, Euryops arabicus,* and *Dodonaea viscosa*. The third group is speared in most head sources of Wadi Bishah, and consists mainly of *Acacia gerradii* and *Dodonaea viscosa*. The fourth group occupies the south-castern part of the research area and contains mainly of *Lycium shawii* and *Acacia negrii*. The fifth group occupies the middle

and east of the area and consists of *Kleinia odora, Lycium barbarum, Lycium shawii, Psiadia arabica, Solanum incanum, Leptadenia pyrotechnica* and *Periploca aphylla*.

Investigations of he relationships between vegetation cover and environmental factors (slope angle, slope gradient, slope length, soil depth, soil moisture, texture, soil pH and organic matter) showed that the floristic composition and distribution of the main plant groups reflected the conditions of soil and topographical variety in the research area. The spiny plants (*Acacia arabica, Acacia gerradii, Acacia negrii, Lycium shawii* and *Rhamnus disperma*) were found to have significant positive relationships with deep soils, sandy soils and alkali soils. This result can be related to adaptation of the morphological and physiological characteristics of the species with this kind of soils, particularly in the north-east of Assir highlands.

From the findings of this research, and the review of available literature on the research area and on Saudi Arabia as a whole, it appears that many issues remain to be investigated with regard to the vegetation, soil and their relationship with environmental factors in these areas. Recommendations for conservation and protection of natural vegetation are summarised and offered below:

1 - Road-building should avoid the areas dense in vegetation. Roads could, however, be established across the valley course sides which are usually bare of vegetation cover. Successful projects of this kind can be already seen in the Tehamah region, southwest of Saudi Arabia.

2 - The successful method of conservation (the *hema* system) that was adopted over a very long period of time by the tribes in the Al-Hejaz region to protect the trees, shrubs and pastures should be reapplied, with some modifications to be appropriate to the present time (e.g. cancellation of tribal quality). This system should be carried out under supervision of the Ministry of Agriculture and Water and with the cooperation of the Ministry of Interior.

3 - Reforestation and planting of trees and shrubs that are well adapted to the environmental conditions of Asir highlands, such as *Tamarix aphylla, Olea europaea* and *Acacia negrii* should be

encouraged. Successful attempts of this kind can be found in Dalaghan National Park in the south-west of Asir highlands.

4 - Cutting green trees and shrubs should be prevented completely by enforcement of laws prohibiting it. Alternative sources of fuel (e.g. Gas) should be provided by the Government in the markets. If no alternatives are available, the inhabitants of Asir highlands will be forced to obtain fuel from *Acacia arabica, Acacia gerradii, Acacia negrii* and *Juniperus procera*.

5 - Grazing should be prohibited in the research area, at least for a limited period (e.g. three months after rainfall period), and the numbers of livestock should be reduced, particularly in the north-east of Assir highlands. This would allow the vegetation cover to recover from the intense overgrazing and trampling by animals.

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Appendix 1 List of Families, Genera and Specie Names (arabic and Latin Names)

NO	Family	Genera	Species Names	Arabic Names الاسم العربي
1	Adenium.	Adenium	Adenium obesum	عدنه
2	Ascleplacdaceae	Calotropis	Calotropis procera	عشار – عشر
		Leptadenia	Leptadenia pyrotechnica	مرخ
		Periploca	Peiploca aphylla	سواس
3	Compositea	Euryops	Euryops arabicus	يبر
		Kleinia	Kleinia odora	صبار
		Psiadia	Psiadia arabica	طباق
4	Cupressaceae	Juniperus	Juniperus procera	عرعر
5	Euphorbiaceae	Cluytia	Cluytia richardiana	سعور
6	Labiatae.	Lavandula	Lavandula dentata.	جثجاث – ضرم
		Menthal	Mentha lavandulacea.	حبق
7	Leguminosae.	Acacia	Acacia arabica.	طلح
		Acacia	Acacia gerradii	طلح
		Acacia	Acacia negrii.	طلح
		Lagonychium	Lagonychium farctym.	عاقول
		Tephrosia	Tephrosia apollinia.	دهيبة – صقل
8	Polygonaceae.	Rumex	Rumex nervosus.	ععثرب
9	Resedaceae.	Reseda	Reseda sphenocleoidis.	ذيل الخروف
10	Rhamnaceae.	Phoenix	Phoenix dactylifera.	–
		Rhamnus	Rhamnus disperma.	نيم
		Sageretia	* Sageretia thea	زيتون بري
		Ziziphus	Ziziphus spina-christi.	سدر – نبق
11	Sapindaceae.	Dodonaea	Dodonaea viscosa.	شث
12	Solenaceae.	Lycium	Lycium barbarum.	عوسج
		Lycium	Lycium Shawii.	اوشاز
		Solanum	Solanum incanum.	حدق – شوك العقرب
		Solanum	Solanum schimperianum.	عنب الذيب
		Withania	Withania somnifera.	عبب
Total		24	28	

Appendix 2 List of Families, Genera and Specie Names (Arabic and Latin Names)

NO	Family	Genera	Species Names	Arabic Names الاسم العربي
1	Acanthaceae.	Anisoltes	Anisoltes trisuleus.	-
2	Amaranthaceae.	Aerva	Aerva javanica.	طرف
3	Apocynaceae.	Rhazya	Rhazya stricta.	حرمل
4	Asclepiadaceae.	Gomphcarpus	Comphearpus sinaincus.	-
		Periploca	Periploca aphylla.	سواس – سوسي
5	Boraginaceae.	Trichodesma	Trichodesma calathiforme	حمحم
6	Cactaceae	Opuntia	Opuntia Ficus-Indica	تبن شوكي
7	Capparaceae.	Capparis	Capparis spinosa.	شفلح – لصف
8	Compositae.	Echinops	Echinops spinosissimus.	خرفش
9	Cupressaceae	Jniperus	Juniperus polycarpos	عرعر
10	Euphorbiaceae.	Cluytia	Cluytia myricoides	سعور
		Eurphorbia	Euphorbia schimperiana	رمدة
		Ricinus	Ricinus communis	جار – خروع
11	Guttiferae.	Hypericum	Hypericum revolutum	-
12	Labiatae.	Nepeta	Nepeta deflersiana	قظمة
		Otostegia	Otostegia fruticosa	-
		Salvia	Salvia aegyptiaca	-
13	Leguminosae.	Cadia	Cadia purpurea.	-
14	Litiaceae.	Dracaena	Dracaena serrulata	-
15	Loganiaceae.	Buddleia	Buddleia polystachya	عفار
16	Moraccac.	Ficus	Ficus carica.	حماط
			Ficus plamata	حماط
			Ficus salicifolia.	اثب – زرف
			Ficus sycomorus.	جميز
			Ficus vasta.	تالق
17	Oleaceae.	Olea	Olea europaea.	عتم
18	Passifloraceae	Adenia	Adenia renenata	عدنه
19	Resedaceae.	Otchradenus	Otchradenus baccatus.	قرضي – علندر
20	Rhamnaccac.	Rhamnus	Rhamnus staddo.	نيم
21	Rosaceae	Rosa	Rosa abyssinica.	عبل
22	Rutaceae.	Ruta	Ruta Chalepensis	شذاب – سكب
23	Tamaricaceae.	Tamarix	Tamarix aphylla.	اثل العبل
			Tamarix nilotica.	اثل الطرفة
24	Tiliaceae.	Grewia	Grewia mollis	قضيم
Total		29	34	