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ORIGINAL PAPER

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Effect of Plant Protection on the Vegetation of King Khalid Research Center at Thomama, Al-Riyadh, Saudi Arabia

Abstract: This work deals with the study of the vegetation in an area completely protected from camels and an area partially exposed to camels. During the study eighteen species were recorded in the areas. Ten of these species were present outside the fence only while another two were present inside the fence and the rest of the species were present in both areas. Vegetation analysis throughout the three studied seasons revealed that species richness and diversity were higher outside the fence with a significant difference in the first two seasons (winter and autumn) whereas it was insignificant during the third season (spring). Single linkage Euclidean distances were gathered in the studied quadrants in a homogenous matter. The results are discussed and the partial conservation of the plant life rather than complete conservation is recommended as the regular seasonal grazing throughout the three studied seasons appeared to have a positive effect on the vegetation.

Keywords: vegetation, protected area, partially exposed diversity, negative effect, positive effect, Hema system

تأثير الحماية الكلية على الغطاء النباتى فى مركز الملك خالد للبحوث وادى ثمامة بمدينة الرياض ،المملكة العربية السعودية

وفاء كمال طايع و هيفاء عبد الله العليان

المستخلص: تتعلق هذه الدراسة بمقارنة الكساء الخضرى الطبيعى داخل محمية الملك خالد للبحوث الفطرية وخارجها. تم تسجيل ثمانية عشر نوعاً من النبات تنمو عشرة أنواع منها خارج أسوار المحمية، وأثنان (نوعان)ينحصر وجودهما داخل المحمية. باقى الأنواع الستة، علي جانبي خط الحماية . تبين الدراسة أن الحماية الكلية، وعلى مدار عام، للنباتات الطبيعية كانت ذات تأثير سلبى على التنوع. بينما أدت الحماية الجزئية وتنظيم الرعى الى زيادة في التنوع النباتى، خاصةً فى فصلى الخريف والشتاء. عرضت النتائج ضمن جداول الأنواع ودلائل التنوع والعلاقات بين فصول الدراسة والأنواع النباتية داخل وخارج المحميه .

كلمات مدخلية: غطاء نباتي ،محمية، حماية كلية، حماية جزئية، تنوع سلبي، تنوع إيجابي.

Introduction

Saudi Arabia is one of the biggest countries in the world. It possesses four-fifths of the area of the Arabian peninsula. This area has great variations in climate, topography and environmental character. In spite of that, studies relating to plant life are still incomplete to cover these variations (Table 1). Previous studies are mostly in the form of surveys and check lists (Zohary, 1957; De Marco and Dinelli, 1974; Migahid, 1978, 1988, 1989 & 1990; Batanouny and Baeshin, 1982; Chaudhary, 1983, 1989 & 1999; Heemstra *et al.* 1990; Al-Welaie *et al,* 1993; Hassan and Al-Hemaid, 1999; Chaudhary and Al-Jowaid, 1999 and Taia and El-Ghanem, 2001). Although these works have added a lot to the understanding of the type of vegetation in Saudi Arabia, we are still in need more detailed and precise studies to predict how much our vegetation has been affected by the stresses caused from both human impact and animal grazing. Plant and animal protection and conservation have occupied the minds of both scientists and amateurs. Zahran and Younes (1990) have studied the effect of the hema system in the SW mountainous region of Saudi Arabia. Abbas *et al.* (1991) have recorded the species in a protected area in the southern desert of Bahrain. Hajar (1993) made a comparative study on the vegetation of both protected and grazed areas in Al-Baha region. Recently, Al-Moshileh and Kawas (2001) have evaluated the effect of partial protection on natural vegetation cover of the Ghada range reserve in Unayzah.

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Table 1: Variations in the climatic factors from 1990 to 2000

Month / Fac.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp. Min.	6.1 *1992* 10.5 *1994*	9.0 *1992* 13.5 *1999*	12.5 *1992* 15.4 *1996*	18.5 *1997* 20.9 *1994*	24.3 *1991* 26.2 *1998*	25.6 *1990* 29.1 *1998*	27.0 *1991* 30.6 *1996*	26.4 *1990* 30.1 *1991*	22.8 *1997* 28.0 *1998*	18.8 *1992* 22.6 *1994*	12.7 *1995* 17.1 *1994*	9.4 *1994* 12.1 *1991*
Max.	16.2 *1992* 23.5 *1994*	20.4 *1992* 25.8 *1999*	23.4 *1992* 28.1 *1991*	31.3 *1993* 35.8 *1999*	37.2 *1993* 40.8 *1999*	41.6 *1993* 44.4 *1999*	41.7 *1994* 44.4 *1996*	42.0 *1992* 44.9 *1998*	39.1 *1992* 42.6 *1997*	24.7 *1996* 36.2 *1999*	23.6 *1997* 30.2 *1998*	17.8 *1995* 27.0 *1998*
Rain Min.	Trace *1994* *1995*	0.0 *1994* *1997*	1.7 *1990*	1.1 *1991*	0.0	--	--	--	--	--	0.0 *1990* *91,92, 93,94*	0.0 *1990* *1996*
Max.	54.6 *1993*	15.6 *1993*	108.9 *1995*	65.6 *1993*	39.5 *1993*	Trace *1997* *1998*	Trace *1995* *1998*	Trace *1993*	Trace *1998*	11.4 *1997*	30.0 *1997*	63.9 *1995*
Hum. Min.	38 *1995* *1997*	23 *1997*	23 *1990*	18 *1999*	12 *1991* *1999*	8 *1990* *1994*	8 *1990*	10 *1990* *93,94*	12 *1990* *93,99*	13 *1992*	23 *1998*	29 *1998*
Max.	69 *1996*	48 *1993*	44 *1995*	36 *1995*	26 *1993*	12 *1996*	12 *1998*	15 *1998*	16 *1994*	35 *1997*	75 *1997*	76 *1995*
Evap. Min.	5.7 *1992*	3.9 *1997*	5.8 *1990*	6.7 *1999*	5.9 *1999*	4.3 *1990*	4.8 *1990*	5.7 *1990*	5.9 *1990* *1995*	5.0 *1992*	5.3 *1995*	6.2 *1998*
Max.	10.8 *1996*	10.3 *1999*	10.7 *1996*	11.9 *1993*	10.4 *1993*	7.1 *1995*	7.4 *1998*	9.7 *1998*	8.0 *1994* *1998*	11.5 *1997*	16.2 *1997*	11.5 *1995*
Wind Min.	4N *1995*	6SSE *1991* 6SE *1990* *1992*	6SSE *1990*	5WSW *1990*	5ENE *1990* 5N *1991* *1996*	5N *1991*	5NNW *1991*	5N *1991* *1992*	4N *1990* *1991* *1997*	3SSE *1990* *1999*	2SSE *1991*	3SSE *1990* *1998*
Max.	6SSE *1991* *1994* *1996* *1998*	8SSE *1993*	8SSE *1993*	8SSE *1995*	8N *1992*	8N *1994*	9NNW *1994*	7N *1994* *1997* *1999*	7NNW *1992*	5N *1992* 5NE *1993* 5SSE *1994*	8SE *1994*	7SSE *1992* 7SE *1994* 7N *1995*

This work has been undertaken to determine the effect of plant protection on both species diversity and richness. The study has been carried out in King Khalid Research Center at Al-Thomamah, north of Al-Riyadh, during three seasons in 2000/2001; autumn from October to December, winter from January to March and spring from April to June.

The Study Area

King Khalid Research Center for wildlife is located at Al-Thomamah, Long. 47° 06′, Lat. 25° 22′, at the slope of Touwaiq mountain, 70 km north of Al-Riyadh (Figs. 1 & 2). This center was built in 1987 for the establishment and conservation of many plants and animals. Two sites were selected to carry out this study, the first site 5 km. outside the fence where the vegetation was exposed to both human activities and grazing, and the second site in the protected area about 2 km. inside the fence.

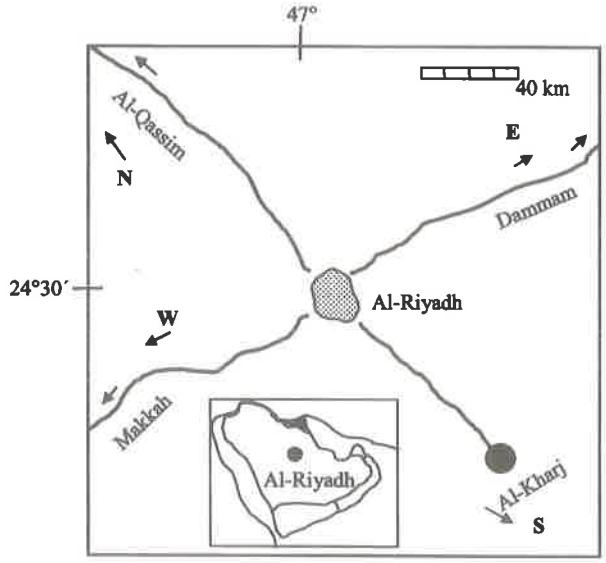

Fig. 1: Map of the Al-Riyad area

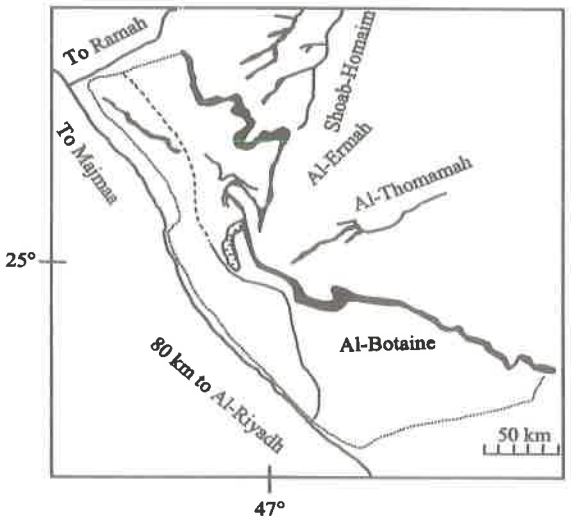

Fig. 2: Location of the Al-Tomamah valley

Methods

Ten sampling quadrants (10 x 10m) were selected in order to cover most of the variations in vegetation at both sites, five quadrants outside the fence and five quadrants inside. A monthly visit to these quadrants was made from October 2000 until June 2001. The number of the individuals of each species was recorded monthly in order to calculate relative frequencies of species, densities, cover and importance value (Ludwig and Reynolds, 1988). Then diversity indices; Shannon, richness and evenness were calculated (Pielou, 1975 and Magurran, 1988). One way ANOVA test was carried out to evaluate the effect of plant protection during the seasons of study.

Results

A total of eighteen species were recorded at the two sites. A list of these species and their taxonomic status is presented in Table 2. Of these species ten species were found outside the enclosure: *Horwoodia diksoniae, Savignya parviflora, Zilla spinosa, Spergula fallax, Lotus halophilus, Arnebia hispidisma, Heliotropium bacciferum, Heliotropium longiflorum, Launea cassiniana* and *Rhanterium epaposum.* Two species were found in the enclosure only: *Ochradenus baccatus* and *Paronychia desertorum.* The other species were present at both sites but differed in their importance values and presence percentage (see Tables 3 & 4). Our observations revealed that the enclosure species were taller and had brighter colors than the species found outside the enclosure. (see Table 5) summarizes the species diversity indices; richness, Shanon and evenness in the ten studied quadrants. From this table, we can notice that the lowest number of individuals was recorded in quadrant number 1 in both the first and third seasons, while in the second season quadrant number 8 was the lowest. In contrast, quadrant number 4 had the largest number of individuals throughout the periods of study. In the same quadrant (no. 4) the highest species richness and Shannon index were recorded. Species evenness had its highest value in quadrants numbers 2 & 3 throughout the three seasons, but generally species evenness was always higher outside the fence. The dendrograms resulted from calculating the single linkage Euclidean distances gathered in quadrants 1 to 5 (outside the fence) always together and the quadrants 6 to 10 (inside the fence) together (see Figs. 3, 4 & 5).

Table 2: Recorded species and their taxonomic status

Taxonomic group	Life Form	Order	Family	Species
Dicotyledon archichlamydeae	Annual	Papaverales	Cruciferae	*Farsetia aegyptiaca* Turr.
				Harwoodia diksoniae Turrill
				Savignya parviflora (Del.)Webb
	Perennial			*Zilla spinosa* (Turr.) Prantl
			Resedaceae	*Ochradenus baccatus* Del.
		Centrospermae	Caryophyllaceae	*Paronychia desertorum* Fres.
	Annual			*Spergula fallax* (Lowe) E.H.L. Krause
			Chenopodiaceae	*Basia eriophora*(Schrad.) Asch.
	Perennial			*Hammada elegans*(Bunge) Botsch.
	Annual	Rosales	Fabaceae	*Lotus halophilus* Boiss et Sprum.
		Umbellales	Umbelliferae	*Pituranthos triradiatus* Hochst.
Dicotyledon sympetalae	Annual	Tubiflorae	Boraginaceae	*Arnebia hispidisma* (Lehm.)DC.
	Perennial			*Heliotropium bacciferum* Forssk.
				Heliotropium longiflorum A.DC.
	Perennial	Plantaginales	Plantaginaceae	*Plantago cylindrica* Forssk.
		Campanulales	Asteraceae	*Echinops spinosissimus* Turra
	Annual			*Launea cassiniana* Kuntze
	Perennial			*Rhanterium epaposum* Oliv.

Table 2 Arranged according to Engler and Prantl evolutionary system for angiosperms.

Table 3: Vegetation characteristics inside the fence

	Autumn, Oct-Dec 2000					Winter, Jan-Mar 2001					Spring, April-June 2001				
Sp.	P.P.	R.F.	R.D.	R.C.	I.V.	P.P.	R.F.	R.D.	R.C.	I.V.	P.P.	R.F.	R.D.	R.C.	I.V.
1	0	0	0	0	0	40	10.3	8.1	8.4	26.8	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1.3	1.3	1.1	2.3	4.7	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	20	1.3	1.6	0.7	3.6
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	40	13.1	8.4	21.3	42.8	20	3.4	3.2	16.4	23	20	6.1	3.9	10.8	20.8
9	40	10.2	18.5	18.1	46.8	40	10.4	15.6	32.3	58.3	40	9.4	13.2	22.9	45.5
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	100	76.7	73.1	60.6	210.4	100	18.2	29.3	27.9	75.4	100	32.1	30.9	32.9	95.9
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	100	46.1	32.9	3.4	82.4	100	40.3	43.7	10.4	94.4
16	0	0	0	0	0	40	10.3	9.8	9.3	29.4	60	10.8	6.7	22.3	39.8
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4: Vegetation characteristics outside the fence

	Autumn, Oct-Dec 2000					Winter, Jan-Mar 2001					Spring, April-June 2001				
Sp.	P.P.	R.F.	R.D.	R.C.	I.V.	P.P.	R.F.	R.D.	R.C.	I.V.	P.P.	R.F.	R.D.	R.C.	I.V.
1	0	0	0	0	0	80	9.8	8.2	3.2	21.2	0	0	0	0	0
2	0	0	0	0	0	40	6.3	2.3	3.1	12.0	0	0	0	0	0
3	0	0	0	0	0	20	3.2	0.9	1.4	5.5	0	0	0	0	0
4	20	17.8	5.5	5.3	28.6	60	2.3	1.2	18.3	21.8	20	12.8	13.2	29.5	55.5
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	20	0.2	0.1	0	0.3	0	0	0	0	0
8	80	10.6	12.1	29.8	52.8	60	8.1	1.7	17.3	27.4	20	14.5	16.3	12.1	42.9
9	60	15.7	24.2	21.2	51.1	60	8.1	16.2	14.9	39.2	20	15.8	12.7	13.5	42.0
10	0	0	0	0	0	80	13.1	5.1	0.3	18.5	0	0	0	0	0
11	40	19.3	20.3	7.6	47.2	40	6.1	3.6	0.8	10.5	0	0	0	0	0
12	0	0	0	0	0	40	5.2	3.31	0.3	8.81	60	7.2	6.2	2.2	15.6
13	20	7.6	7.4	5.2	20.2	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	20	2.6	1.8	0.3	4.7	0	0	0	0	0
15	0	0	0	0	0	100	10.2	2.7	1.7	14.6	100	18.3	13.2	6.3	37.8
16	0	0	0	0	0	20	4.3	2.1	1.6	8.0	0	0	0	0	0
17	20	1.3	1.1	1.8	4.2	80	3.2	2.9	1.2	7.3	0	0	0	0	0
18	100	28.3	29.4	30.9	88.6	100	17.3	18.1	35.6	71.0	100	31.4	38.4	36.4	106.2

Sp. 1=Farssetia aegyptiaca
Sp.2 =Horwoodia diksoniae
Sp.3 =savignya parviflora
Sp.4 =Zilla spinosa
Sp.5 =Ochradenus baccatus
Sp.6 =Paronychia desertorum
Sp.7 =Spergula fallax
Sp.8 =Basia eriophora
Sp.9 =Hammada elegans
Sp.10 =Lotus halophilus
Sp.11 =Pituranthus triradiatus
Sp.12 =Arnebia hispidisma
Sp.13 =Heliotropium bacciferum
Sp.14 =Heliotropium longiflorum
Sp.15 =Plantago cylindrica
Sp.16 =Echinops spinosissimus
Sp.17 =Launea cassiniana
Sp.18 =Rhanterium epaposum

P.P.=Present percentage; R.F.=Relative frequency; R.D.=Relative density; R.C.=Relative cover; I.V.=Importance value

Table 5 : Variations in some diversity indices in the 10 sites

Seasons	Site	Tot. species	Tot. indiv.(indiv/sp.)		Richness	Shannon	Evenness
I	1	3	65	(31.66)	0.479	0.955	0.870
	2	3	112	(37.3)	0.424	0.962	0.875
	3	2	121	(60.5)	0.209	0.486	0.702
	4	6	180	(30.0)	0.963	1.09	0.609
	5	3	147	(39.0)	0.401	0.869	0.791
	6	2	106	(53.0)	0.214	0.190	0.274
	7	2	104	(52.0)	0.215	0.163	0.235
	8	2	84	(42.0)	0.226	0.191	0.276
	9	2	69	(34.5)	0.236	0.260	0.375
	10	1	120	(120.0)	0	0	0.099
II	1	7	190	(28.3)	1.140	1.70	0.876
	2	6	144	(24.0)	1.010	1.53	0.856
	3	8	194	(31.8)	1.330	1.83	0.878
	4	11	302	(27.5)	1.750	2.00	0.834
	5	10	248	(24.8)	1.630	1.91	0.831
	6	4	185	(46.3)	0.575	0.945	0.681
	7	5	191	(38.2)	0.762	0.995	0.618
	8	5	142	(28.4)	0.807	1.190	0.739
	9	3	173	(57.7)	0.388	0.746	0.679
	10	2	224	(112.0)	0.185	0.688	0.993
III	1	3	63	(21.0)	0.483	0.773	0.704
	2	2	76	(38.0)	0.231	0.676	0.975
	3	5	128	(25.6)	0.824	1.570	0.973
	4	4	221	(55.3)	0.556	1.180	0.853
	5	6	136	(22.7)	1.020	1.450	0.810
	6	3	195	(65.0)	0.379	0.778	0.708
	7	4	221	(55.3)	0.556	0.999	0.721
	8	5	155	(31.0)	0.793	1.290	0.802
	9	2	142	(71.0)	0.202	0.653	0.942
	10	3	215	(71.7)	0.372	0.793	0.722

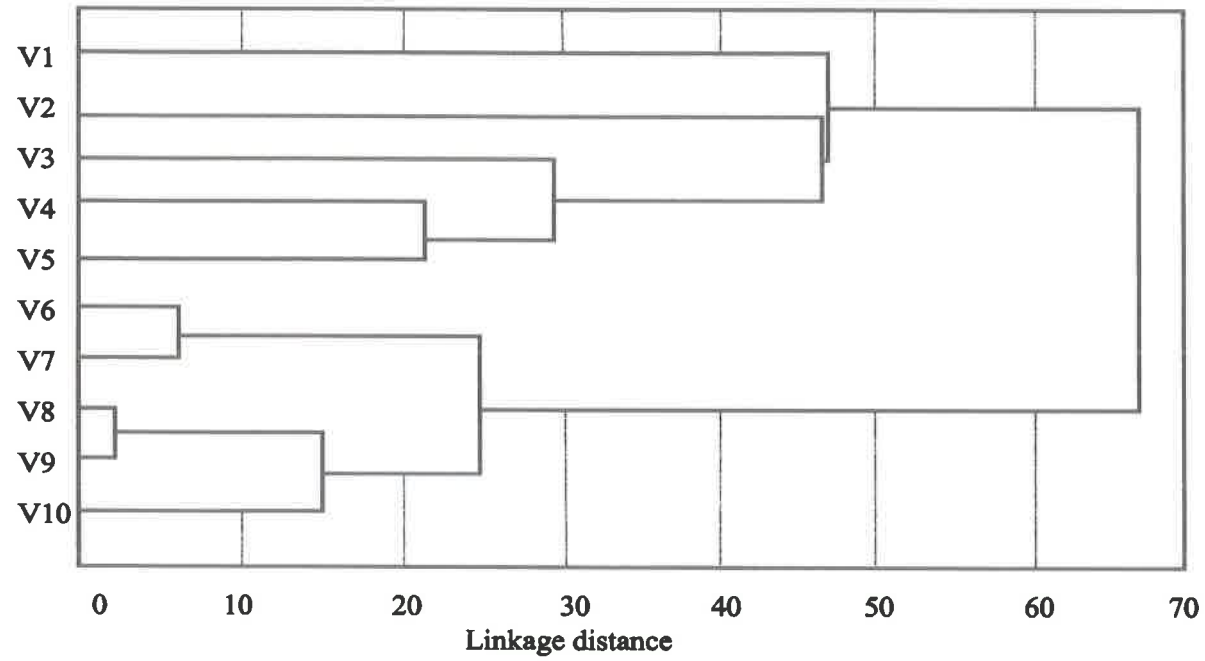

Fig. 3: Single linkage, euclidean distances, Autumn, Oct. - Dec. 2000

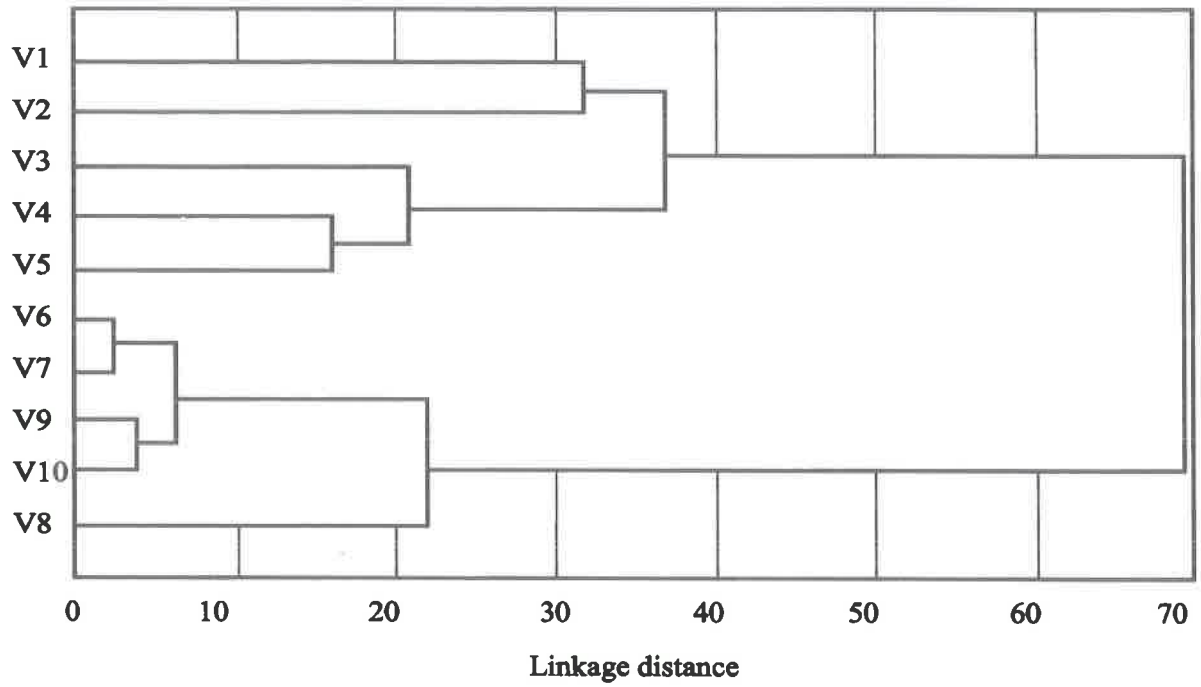

Fig. 4: Single linkage, euclidean distances, Winter, Jan. - March. 2001

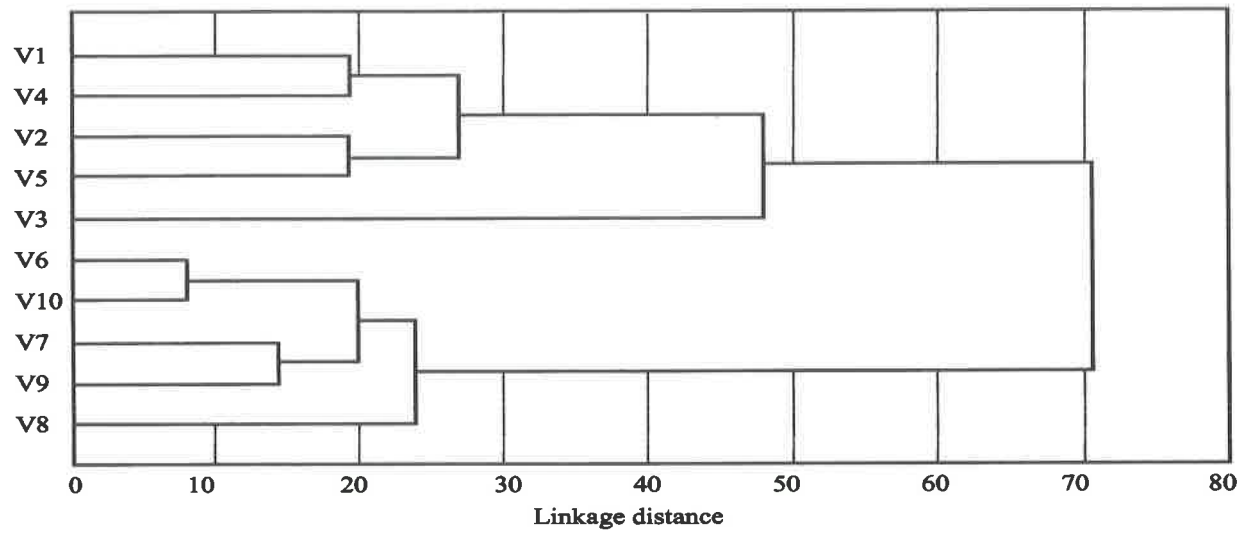

Fig. 5: Single linkage, euclidean distances, Spring, April. - June 2001

The application of the one-way ANOVA test to the recorded species gave a clear evaluation of the effect of plant conservation during the three seasons (Table 6). From this table we can find that during the autumn and winter seasons the vegetation outside the fence was significantly different from that inside it, whereas it became insignificantly different during the third season.

Table 6: The results of the application of the ANOVA test

Autumn Oct-Dec 2000		Winter Jan-Mar 2001		Spring April-Jun. 2001	
in	out	in	out	in	out
40.772417	0	27.82732	0	54.09392	0
20.915809	9.0899	8.913859	1.45435	2.002423	2.123602
7.4445739	87.35842	3.175238	73.30585	0.756596	71.91313
1.2083424	0	0.014286	0	0	0
0	0	1.665822	0	0	0
32.690988	4.551676	22.42142	3.636	7.30169	3.29252
0	0	10.77983	1.090763	0	0
0	0	13.50259	20.74544	30.6886	12.42596
0	0	0.001299	0.202	0	0
1.08548	0	1.768705	0	3.980666	0
0.3685872	0	7.420238	0	0	0
0	0	1.626337	0	0	0
0	0	0.91849	0.565604	0.022128	2.102755
0	0	0.345622	0	1.020545	0
0	0	1.117993	0	0	0
0	0	0.609881	0	3.1633851	0
0	0	0	0	0.002128	0.202033
0	0	0.284577	0	0	0

	Autumn	Winter	Spring
df	17	17	17
F0.365541	0.218669	0.689858	
P (F<=f) one-tail	0.022524	0.001547	0.225993
	sig.	sig.	sig.

Discussion

Nowadays, plant life conservation has evolved in a way which enables us to understand the purposes of vegetation dynamics and how much human activities affect natural life. In Saudi Arabia, there have been many studies regarding the hema system of partial plant conservation. This system had been used before the Islamic era and continues in use at the present time (Allred, 1968; Draz,1969; Kingery,1971; Eighmy and Ghanem, 1982; Batanouny, 1984; Zahran and Younes, 1990; Aba Al-Khail, 1994). These works showed that plant protection not only affected both species richness and vegetation dynamics but also soil character. These results do not contradict our results. In our results the area of complete plant protection was lowest in both species richness and diversity, whereas the non-protected area was richer and the speciation was higher throughout the studied periods. This can be referred to the positive effect of controlled grazing as it activates the buds. At the same time, the completely protected area had low speciation but a higher number of individuals which prevented the introduction of new species and increased the competition. El-Moushileh and Kawas (2001) found that partial protection in Unayzah increased both the number of species and their densities. Abbas *et al.* (1991) and Aba Al-Khail (1994) referred the richness in some protected communities to both the soil character and topography.

From this study, we can conclude that partial protection of vegetation is the best method of plant conservation and more useful than complete protection. In spite of the increase of the number of individuals in the completely protected areas, there is a decrease in plant diversity and less movement in vegetation dynamics. Unprotected areas destroy the plant cover as the result of human impact and overgrazing and cause a severe disturbance of the ecosystem. Meanwhile, controlled grazing and range improvement could save the natural vegetation.

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