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PHYTOSOCIOLOGY OF WOODLAND COMMUNITIES OF HAZARGANJI NATIONAL PARK, QUETTA

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Abstract

On the basis of Bray and Curtis 1957 index of similarity, two plant communities were recognized. Both the stand density as well as stand cover per hectare values were higher in *Pistacia-Cymbopogon-Chrysopogon* community than in *Pistacia-Fraxinus-Cymbopogon* community. The latter community was homogenous. While species diversity was moderate, community maturity index was low. Grasses particularly *Cymbopogon commutatus* and *Chrysopogon aucheri* were regenerating very well and as such they are likely to increase in future. Among trees, *Pistacia khinjuk* was the only species with weak to fair degree of regeneration. Total coverage of the communities was 32.42%, out of which trees occupied 23.68%, shrubs 0.5% and herbs/undershrubs 8.24%. An increase of 15% in total coverage of tree species is noted since Khan and Hussain's (1963) work. Among the individual species, *P. khinjuk* has the highest coverage (13.72%). The soils of the communities were coarse-textured, calcarious and non-saline.

Introduction

Hazarganji National Park, located at a distance of 20 Km from Quetta on Quetta - Mastung road, is one of the oldest and most important enclosed areas of Baluchistan. Since the pioneering work of Khan & Hussain (1963), no work has been done on the woodland vegetation of Hazarganji. This vegetation is well preserved and occurs on the banks and terraces of water courses and along run-off channels on the hill slopes. The whole area is sloping with coarse-textured soil having lot of stones and even boulders.

The climate of Hazarganji is similar to that of Quetta with about 8-10" of rain fall per year (Khan & Hussain 1963). The precipitation is mostly confined to winter and spring seasons. The peaks of hills in Hazarganji are covered with snow. Run-off water (rain as well as melting snow) flows down the hill slopes into the sloping plains as a result of which a number of water courses have developed which remain dry for the greater part of the year. According to Holdridge's (1947) bio-climatic system, the region falls under the warm temperate desert bush type of bio-climate (Qadir, 1968). The climate of the region indicates a mediterranean trend due to restriction of precipitation to winter and spring months.

Studies were carried out to analyse and describe the woodland communities and their soils and to evaluate the quantitative changes in the vegetation that have occurred since the report of Khan & Hussain (1963). Besides the homogeneity, species diversity, maturity and regeneration capacity of vegetation are also described.

Materials and Methods

The vegetation was sampled randomly by the "Point-Centered Quarter" method (Cottam & Curtis, 1956). Each stand depending upon its size was sampled by 30-50 sampling points. Phytosociological attributes were computed according to Lindsey (1955). Index of similarity (Bray & Curtis, 1957) between the stands were calculated using cover per ha values of species and the stands having 60% or more similarity were grouped together.

Homogeneity of community was determined following Raunkiaer's (1934) law of frequency. Community maturity was found out by Pichi-Sermolli's (1948) index. Species diversity was determined by Menhinick's (1964) index.

Cain's (1932) density-size class table was used to study regeneration of vegetation. The following size classes were employed:

(a) Herbs/undershrubs

Size class 1 upto 15cm circumference
Size class 2 16-30cm circumference
Size class 3 31-60 cm circumference
Size class 4 61-90cm circumference
Size class 5 91-120cm circumference
Size class 6 121-150cm circumference

(b) Shrubs/trees

Size class 1 upto 60cm circumference
Size class 2 61-180cm circumference
Size class 3 181-300cm circumference
Size class 4 301-420cm circumference
Size class 5 421-450cm circumference
Size class 6 541-660cm circumference
Size class 7 661 and above cm circumference

Two soils samples were collected from each site, one from surface (0-15cm) and another from sub-surface (30-60cm) depths. Soil texture of these samples was determined by Buoyocous (1951) hydrometer method. A rough estimation of organic matter was made by treating soil sample with H_2O_2 on a hot plate. Loss in weight of the sample indicated the amount of organic matter. Calcium carbonate was roughly estimated by treating the soil sample with HCl on a hot plate. Loss in weight of the sample constituted $CaCO_3$ content. Electrical conductivity of saturated soil extract was measured by Beckman (Model 26) conductivity meter. Soil pH was determined by Philips (9418) pH meter. Soil chlorides, bicarbonates and Ca plus Mg content were determined by titration methods

(Anon., 1954). Nomenclature of plants followed is that of Stewart (1972) and Cope (1982).

Results

Plant Communities: Of the 5 stands of woodland vegetation studied, 4 stands exhibited high index of similarity (> 65%), therefore, they were merged together. The fifth stand was quite distinct in having greater dominance of herbaceous plants. The communities delineated are as under:

1. *Pistacia khinjuk-Fraxinus xanthoxyloides-Cymbopogon commutatus.*
2. *Pistacia khinjuk-Cymbopogon comutatus-Chrysopogon aucheri.*

P. khinjuk and *C. commutatus* were the predominant species being dominant in both the communities (Table 1 & 2). The percentage of similarity between the communities was 52.2%. *C. aucheri* although not dominat in community 1, yet it appears to be an upcoming species with 11% importance value.

Stand Density: The stand density per ha was higher (37653.13) in *Pistacia-Cymbopogon-Chrysopogon* community than the other community (8010.82). The ratio of density between trees plus shrubs with herbs was in the order of 1:125 in *Pistacia-Cymbopogon-Chrysopogon* community while it was 1:36 in *Pistacia-Fraxinus-Cymbopogon* community.

Stand Cover: The cover per ha was also higher (47209.28) in *Pistacia-Cymbopogon-Chrysopogon* community than the other community (30303.23) but the difference was of small magnitude as compared to the stand density. The ratio of cover between trees plus shrubs with herbs was 1.6:1 in *Pistacia-Cymbopogon-Chrysopogon* community and 5:1 in the other community (Tables 1 & 2).

*Total coverage of species**:* The individual species showed a great variation in their total coverage with highest coverage in *P. khinjuk* (13.7% of the area, followed by *F. xanthoxyloides* (9.9%). The total for tree stratum therefore was 23.68%. Herbs and shrubs together covered 8.74% area. Total coverage of all plants was 32.42% of the area studied. Among the herbs and under shrubs, *C. commutatus* (1.3%), *S. mollis* (0.82%), *A. maritima* (1.48%) were the most noteworthy species. Species like *B. obliqua* 0.47%), *C. aucheri* (0.58%), *P. atriplicifolia* (0.5%), *P. brahuica* (0.41%), *S. griffithii* (0.58) and *P. abrotanoides* (0.42%) were next in importance occupying about 3% of the area (Tables 1 & 2).

*Weighted average of all stands

Table 1. Phytosociological attributes of *Pistacia khinjuk-Fraxinus xanthoxyloides-Cymbopogon commutatus* community.

Name of Species	D_2	C_2	C_1	Y_3
A. Trees and Shrubs				
Pistacia khinjuk Stocks	107.78	12513.68	11.63	20.81
Fraxinus xanthoxyloides (Wall ex G. Don) D.C.	97.24	12282.96	11.42	20.7
Prunus brahuica (Boiss) Aitch.	7.57	251.32	0.23	1.37
Prunus microcarpa C.A. Mey.	3.29	130.20	0.12	0.763
Juniperus polycarpos C. Koch.	0.67	107.97	0.10	0.24
	D = 214.55	Ca = 25286.13	23.5	
B. Herbs/Undershrubs				
Cymbopogon commutatus (Steud) Stapf.	2127.58	735.45	0.68	13.75
Chrysopogon aucheri (Boiss) Stapf.	1809.64	388.75	0.36	11.23
Saccharum griffithi Munro ex Boiss	606.81	779.13	0.72	5.41
Artemisia maritima L.	646.37	1100.65	1.02	5.14
Limonium cabulicum (Boiss) O. Ketze.	601.02	17.26	0.02	4.12
Sophora mollis (Royle) Baker	569.02	191.22	0.18	3.82
Perovskia atriplicifolia Bth.	255.43	676.84	0.63	2.65
Perovskia abrotanoides Karel.	215.56	300.42	0.28	2.04
Blumea obliqua (L) Druce	334.97	54.94	0.05	1.99
Ferula oopoda Boiss	182.37	135.89	0.13	1.51
Nepeta Juncea Bth.	145.59	108.26	0.10	1.08
Paraphalis incurva (L) C.E. Hubb	78.56	6.74	0.006	0.78
Ephedra gerardiana Wall ex Stapf.	36.48	418.08	0.39	0.73
Verbascum erianthum Bth.	109.32	8.18	0.007	0.70
Astragalus Stocksii Bunge	72.53	59.88	0.55	0.49
Gaillonia eriantha Jaub & Spach.	36.48	29.12	0.027	0.30
Haloxylon griffithii (Moq) Bunge	26.18	0.24	0.0002	0.26
	D9 = 7796.27	C9 = 5017.1	5.15	

Legend: D2 = Density per hectare; C2 = Cover per hectare; C1 = Total cover (%); Y3 = Importance value; D9 = Stand density per hectare; C9 = Stand cover per hectare

Homogeneity: Out of 4 stands of *P. khinjuk-F. xanthoxyloides-C. commutatus* community, 2 stands (2 & 3) were quite homogenous corresponding to Raunkiaer's law of frequency. Stand 4 represented by ABCE type of frequency distribution was nearly homogenous while stand 1 was quite heterogenous. The community as a whole (with the 4 stands merged together) was homogenous. The *P. khinjuk-C. commutants-C. aucheri* community represented by ABCD type of frequency distribution, was not homogenous but appears to be progressing towards homogeneity (Table 3).

Table 2. Phytosociological attributes table of *Pistacia khinjuk-Cymbopogon commutants-Chrysopogon aucheri* community.

Name of Species	D_2	C_2	C_1	Y_3
A. Trees and shrubs				
Pistacia khinjuk stocks	219.68	23755.39	22.08	25.88
Fraxinus xanthoxyloides (Wall ex G. Don) D.C.	26.13	4031.85	3.74	5.84
Prunus brahuica (Boiss) Aitch & Hemsl.	52.26	1194.19	1.11	3.08
	D9 = 298.01	28981.45	26.93	
B. Herbs and under Shrubs				
Cymbopogon commutatus (Steud) Stapf.	13840.0	4074.19	3.79	21.81
Chrysopogon aucheri (Boiss) Stapf.	9687.61	1582.28	1.47	12.66
Sophora mollis (Royle) Baker	3458.96	3651.27	3.39	7.12
Blumea obliqua (L) Druce	3458.96	2324.19	2.16	6.93
Artemisia maritima L.	1382.75	3556.50	3.30	5.22
Paraphalis incurva (L) C.E. Hubb.	1382.75	103.44	0.096	2.78
Perovskia abrotanoides karel	1382.75	1068.22	0.99	2.72
Perovskia atriplicifolia Bth.	1382.75	975.25	0.91	2.65
Gaillonia eriantha Jaub & Spach.	689.28	878.17	0.81	1.97
Polygonum afghanicum Meissn.	689.28	19.21	0.02	1.36
	D9 = 37355.12	C9 = 18227.83	16.94	

Table 3. Homogeneity, Species Diversity and Maturity of Communities.

	Frequency classes (%)					Species diversity	Community maturity index
	A	B	C	D	E		
Pistacia-Fraxinus-Cymbopogon community	49.12	28.07	10.52	3.51	8.77	1.24	30.74
Stand 1	46.66	40.0	13.37	0	0	1.42	21.42
Stand 2	25.0	25.0	12.5	12.5	12.5	0.76	47.96
Stand 3	50.0	31.25	6.25	6.25	6.25	1.26	27.81
Stand 4	61.11	16.66	11.11	0	11.11	1.54	25.81
Pistacia-Cymbopogon-Chrysopogon community							
Stand 5	69.23	15.38	7.69	7.69	0	1.22	23.02

Table 4. Density-Size Structure of Woodland Communities.

Name of species	Community	Size classes 1	2	3	4	5	6	7
A. Trees & Shrubs								
Pistacia khinjuk	I	8	9	12	2	8	3	73
	II	4	3	2	–	2	–	19
Fraxinus xanthoxyloides	I	–	5	14	8	4	7	76
	II	–	2	3	-	1	1	16
Prunus brahuica	I	6	2	3	–	–	1	3
	II	3	1	1	–	–	–	1
B. Herbs and undershrubs								
Cymbopogon commutatus	I	37	11	10	5	4	–	
	II	9	4	2	4	–	–	
Chrysopogon aucheri	I	39	8	9	5	–	1	
	II	5	3	2	–	–	–	
Saccharum griffithii	I	7	3	4	2	1	3	
	II	–	–	–	–	–	–	
Artemisia maritima	I	4	6	3	2	1	2	
	II	1	1	–	–	–	1	
Perovskia abrotanoides	I	7	5	3	1	1	1	
	II	–	–	–	–	–	–	
Limonium cabulicum	I	17	1	–	–	1	–	
	II	–	–	–	–	–	–	
Sophora mollis	I	10	4	1	1	–	1	
	II	3	–	–	1	–	1	
Blumea obliqua	I	7	4	2	–	–	–	
	II	–	–	2	2	–	–	
Paraphalis incurva	I	2	1	–	–	–	–	
	II	8	–	–	–	–	–	

I = *Pistacia-Fraxinus-Cymbopogon;* II = *Pistacia-Cymbopogon-Chrysopogon.*

Species Diversity: With the exception of stand 2, the species diversity was moderate ranging from 1.22 to 1.5. Even in stand 2, it was not low (Table 3).

Community Maturity. The community maturity index was generally at the lower scale but it was moderate in stand 2 (48%) and ranged between 21 to 30% in other stands (Table 3).

Regeneration of Vegetation: In community I (*Pistacia-Fraxinus-Cympopogon*), *P. khinjuk* was the only tree species which showed signs of weak to fair amount of regeneration. The largest size class (class 7) was better represented than all the size classes combined together. Out of 125 total number of individuals, 73 belonged to class 7, whereas classes 1 and 2 contained only 14 individuals. Similarly, *F. xanthoxyloides* was better represented by large size classes but the reproduction class was totally missing with poor representation in class 2.

Among the herbs and undershrubs, *C. commutatus* and *C. aucheri* indicate remarkable regenerative capacity. Next in importance with good regeneration are *S. griffithii, A. maritima, P. abrotanoides* and *S. mollis. B. obliqua* has fair degree of regeneration (Table 4). The 4 individual stands of this community showed more or less similar trend (Ahmed, 1984). In community II (*Pistacia-Cymbopogon-Chrysopogon*), none of the tree species was regenerating satisfactorily. While *P. khinjuk* was reproducing weakly, *F. xanthoxyloides* was not at all reproducing. Both the species, like community I, have better representation in class 7. *P. brahuica* (shrub) also shows very weak regeneration.

C. commutatus, the second dominant of the community exhibited fairly good regenerative capacity, next in importance being *C. aucheri*, with fair regeneration. Species like *S. obliqua, A. maritima P. atriplicifolia* and even *S. mollis*, unlike community I, tend to be diminishing in this community (Table 4). In future in both the communities *C. commutatus* and *C. aucheri* will increase steadily. Tree species are likely to enconter tough competition from these grasses.

Edaphology of Communities: The soils of the study area were generally coarse-textured, calcarious ($CaCO_3$: 28.9 to 34.5%) and non-saline (very low E.C. and Cl), pH varied from 7.56 to 8.0 and very low bicarbonates (0.16 to 2.03 meq/litre). Edaphically the two communities were similar. *Pistacia-Fraxinus-Cymbopogon* community occurred on basic soil having slightly higher organic matter and bicarbonates than *Pistacia-Cymbopogon-Chrysopogon* the community, which had high maximum water holding capacity and slightly higher $CaCO_3$ (Table 5).

Discussion

The vast area of Hazarganji is occupied by steppe formation but on relatively mesic sites (water courses and run-off channels) open woodland communities give a savanna type of landscape. From mono-climax point of view, they may be considered as post-climax and under poly-climax interpretation, they may be designated as "Topo-edaphic climax".

The two communities described herein were differentiated from one another in the proportion of trees and herbs/undershrubs. *Pistacia-Cymbopogon-Chrysopogon* is characterised with herbs and shrubs that constitute 125 times higher density than the tree density. In *Pistacia-Fraxinus-Cymbopogon* community although the ratio of tree density

Table 5. Soil Relations of Plant Communities.

Community	Soil depth	Sand %	Silt %	Clay %	Soil texture	Organic matter %	M.W.H.C. %	pH	E.C. mmhos/cm	$CaCO_3$ %	HCO_3	Cl	Ca+Mg %
Pistacia-praxinus-Cymbopogon	Surface	73 ± 3.41	18 ± 3.53	9 ± 3.46	Loamy sand	2.29 ± 4.44	41.30 ± 2.8	7.84 ± 2.13	0.015 ± 0.008	28.95 ± 0.41	0.65 ± 0.44	1.0 ± 0.0	12.65 ± 1.00
	Subsurface	80 ± 2.8	14 ± 2.0	6 ± 1.15	Loamy sand	2.18 ± 0.26	36..26 ± 3.42	8.0 ± 0.28	0.22 ± 0.01	31.37 ± 1.70	0.83 ± 0.28	1.0 ± 0.0	12.24 ± 0.31
Pistacia-Cymbopogon-Chrysopogon	Surface	76	12	12	Loamy sand	1.60	49.49 ± 0.14	7.9 ± 0.05	0.0	34.5	0.23 ± 0.03	1.0 ± 0.0	14.66 ± 0.03
	Sub-Surface	72	20	8	Loamy sand	1.99	59.26 ± 3.23	7.56 ± 0.03	0.0	33.5	0.16 ± 0.03	1.0 ± 0.0	8.0 ± 0.57

*HCO_3 and Cl in meq/1.

with the herbs/undershrubs was of the order of 1:36, yet the coverage appears to make a significant difference with a ratio of 5:1. It would appear that in the first community, herbs and undershrubs occupy important position, while in the second community, trees predominate. Both the communities, however, have considerable number of species of steppe formation common to them, which illustrates the continuity of vegetation. In the newly enclosed area of Hazarganji, on the other hand, Majeed (1984) found high stand density and low stand cover in the steppe vegetation.

Khan & Hussain (1963) reported about 8.7% total coverage of tree species in Hazarganji enclosure. The total coverage now is 23.7% (Tables 1 & 2). Khan & Hussain (1963) stated that the tree species were bushy and did not attain much height. Now the woodlands comprise of small-sized trees. It is not surprising to find an increase of 15% in the total cover of tree species. Khan & Hussain (1963) did not mention about the herbs/undershrubs associated with the tree species. Presumably they were very scarce. Now the total coverage of trees, shrubs, herbs and undershrubs works out to be 32.42% which means that the area has undergone tremendous quantitative as well as qualitative change. There might have been an increase in the density of the vegetation also during the last 25 years but Khan & Hussain (1963) did not collect density data which could be compared.

Only *Pistacia-Fraximus-Cymbopogon* community was homogenous. The other community is represented by only one stand and it reflects an intergrading situation between steppe and woodland vegetation types, which probably explains for its heterogeneity. On the other hand, the *Pistacia-Fraxinus-Cymbopogon* community appears to be a true woodland community having probably attained climax stage as well as homogenous stage. Shafi & Yarranton (1973) also found homogeneity in the advanced stages of succession and climax. Majeed (1984) observed homogeneity in one of the water course communities in the newly enclosed area of Hazarganji.

While a number of ecologists (Costing, 1956; Hanson & Churchill, 1961; Braun-Blanquet, 1951; Poore, 1955,) consider Raunkiaer's law of frequency as a measure of homogeneity, there are others (Preston 1948; Curtis & McIntosh, 1950; Greig-Smith, 1957; Cain & Castro, 1959; McIntosh, 1957, 1962) who observed that the law of frequency was dependent upon the size, number and distribution of quadrats. Since in the present work, quadrats were not employed but the point-centered quarter method was used, the above objections do not appear to be important as the point to plant distances varied not only from one sampling point to another but at each sampling point.

The moderate level of species diversity found in the present study appears to be related to the mesic type of habitat on which the woodland communities occur. This is in conformity with the results of Majeed (1984), and Tareen (1986) for the water course communities and Daubenmire & Daubenmire (1968) and Whittaker (1965) for the vegetation of moist sites. It may be mentioned that the species diversity was relatively higher in heterogenous stands of *Pistacia-Fraxinus-Cymbopogon* community (Table 3). The number of species in homogenous situations probably becomes stabilized while it may not be so in heterogenous conditions. Glitzenstein *et al.*, (1986) observed that disturbance helped preserve species diversity. Majeed (1984) also found high diversity in the recently protected area of Hazarganji.

Higher level of species diversity at the climax stage than the seral ones has been reported (Margalef, 1963 a & b; Whittaker, 1965; Monk, 1967; Daubenmire *et al.*, 1968; Shaukat *et al.*, 1981). The diversity found in the woodland vegetation which represents climax stage supports these observations.

The low level of community maturity and medium species diversity observed in the woodland communities appears to be in agreement with a number of workers (May, 1973; Shafi *et. al.*, 1973, Shaukat *et. al.*, 1981; Majeed, 1984; Qadir & Fawaris, 1986). However, maturity seems to be comparatively higher in an homogenous stand (stand 2 in Table 3). Qadir & Shetvy (1986) on the other hand observed high maturity in heterogenous communities but having better representation of frequency class E.

The future trends in the communities evaluated on the basis of regeneration of species indicate that grasses particularly *C. commutatus* and *C. aucheri* are very promising. With the present level of reproduction they are most likely to gain more ground and overtake the tree species. *P. khinjuk* is the only tree species with its slow and steady regeneration capacity, likely to maintain its dominance. *F. xanthoxyloides* is placed in a very disadvantageous position.

Lack of good regeneration of tree species may be due to seeds and seedlings destruction/consumption by the herbivores and the tough competition between tree seedlings and the dominant grasses which needs investigation. The grasses associated with the trees exhibit great adaptability and with their present level of regeneration, appear to be the most successful species. They occupy large areas of not only Hazarganji but also other protected areas like Karkhasa, Wali Tangi, etc. Majeed (1984) too found good regeneration of these species in the newly enclosed area of Hazarganji.

The other species like *Saccharum griffithii, Artemisia maritima, Perovskia abrotanoides* and *Sophora mollis* in *Pistacia-Fraxinus-Cymbopogon* commuity atleast seem to have a fair chance of survival in future though they have to face a very tough competition from the dominant grasses. The soils of the woodland communities are coarse-textured, calcarious and non-saline. Similar results have been reported by Majeed (1984) and Tareen (1986) for similar areas of Hazarganji.

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