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Phytosociology of the Plains of Diverse Areas Ranging from Harnai, Sinjawi to Duki Regions of Pakistan

Rasool Bakhsh Tareen and S.A. Qadir
Department of Botany, University of Balochistan, Quetta, Pakistan

Abstract: Twenty-one plant communities, recognized on the basis of index of similarity, were grouped into four different altitudinal zones i.e. lower zone, lower middle zone, upper middle zone and upper zone. Vegetation composition of different altitudinal zones were also described. Plant communities having first dominant common, were further grouped into four association types (*Ebenus stellata* association, *Artemisia stricta* association, *Cymbopogon jwarancusa* association and *Onobrychus cornuta* association) which correlated with the edaphic factors.

Key words: Plant communities, vegetation composition, altitudinal zones, edaphic factors

Introduction

Study area (Lat. 29°48'-30°25' and Long. 67°50'-69°15' is bounded to the north by Loralai district, to the west by Quetta and Ziarat districts, to the east by Kohlu Agency and Sibi district and to the south by Kachhi district. The main rocks types consists of Siwalik groups, Ghazig formation, Dungan formation, Chiltan, Loralai and Spintangi limestone, Parah group, Recent and sub-recent deposits (Iqbal and Shah, 1980). The climate of the study area ranges from cold temperate to semi arid warm temperate and semi arid subtropical.

The vegetation of the study area is unexplored. However preliminary account of vegetation of some parts of the study area and its surroundings are given by (Tareen and Qadir, 1993). Vegetation account of Juniper forest Chautair (Anjum,1987), Kirby Kuch enclosure (Ilyas,1988) and floral diversity and economic importance of Zarghun Juniper ecosystem (Asif,1999) were described. In the present work an analysis of vegetation and associated soils is described.

Materials and Methods

Vegetation Analysis: The vegetation of twenty-three sites, comparatively undisturbed were studied by point centered quarter method (Cottam and Curtis, 1956) randomly. Each stand was sampled by 30-35 sampling points. All the phytosociological attributes were computed according to Cottam and Curtis (1956) but the importance values were calculated according to Lindsey (1955). Nomenclature follows Stewart (1972) and to-date published Flora of Pakistan, Index of Similarity (Bray and Curtis, 1957) was computed using cover per hectare of species. Species diversity was calculated by Menhinick (1964) index. Community maturity index was obtained by Pichi-Sermolli (1948) method. Community homogeneity was determined by Raunkiaer (1918) law of frequency. Cain (1931) density size table was modified to suit the herbaceous, shruby and trees communities of the study area. The plant communities were grouped into four altitudinal zones viz:-

1. Lower zone (600-1350 m)
2. Lower middle zone (1351-2000 m)
3. Upper middle zone (2001-2400 m)
4. Upper zone (more than 2400 m)

Soil Analysis: Two soil samples were collected in each stand, from surface (0-15 cm) and from subsurface (30-60 cm) depth. These samples were analysed for soil texture, organic matter, maximum water holding capacity and calcium carbonates. Whereas subsurface soil (extract) were used for the analysis of pH, EC, bicarbonates, chlorides, calcium plus magnesium, sodium and potassium. Soil texture was determined by hydrometer method (Bouyoucos, 1951), organic matter (Hussain and Oadir, 1970), maximum water holding capacity (Keen and Raczkowski method) as given in Piper (1942), pH with glass electrode pH meter, EC with Beckman conductivity meter, and alkaline earth carbonates ($CaCO_3$) were determined with acid neutralization method of U.S.D.A. (Anonymous, 1954). Sodium and potassium were determined by flame photometer.

Results and Discussion

Twenty-one plant communities were recognized on the basis of index of similarity. The level of index of similarity used for integration of similar stands was 65%. The phytosociological data have been summarized in Table 1. Four different association types were recognized as under:

1. *Ebenus stellata* association. Consisting of three communities.
2. *Artemisia stricta* association. Consisting of three communities.
3. *Cymbopogon jwarancusa* association. Consisting of two communities.
4. *Onobrychus cornuta* association Consisting of two communities.

Ebenus stellata association was found in Tomagh, Kazaghara, Sirki and Gada. *Artemisia stricta* association was found in Maidangi (Shireen), Khakhan and Kirby Kuch. *Cymbopogon jwarancusa* association covered a large part of the study area. It ranges from Bali, Tani, Churmana, Tomagh, Harnai, Zindapir, Marati, Sivalo, Sirki, Oghozpuzma, Kharshung, Sinjawi and Raghora (Champion *et al*., 1965). *Onobrychus cornuta* association was found in Loua ghar, Sarobi sar, Navo and Kasa sar.

Haloxylon salicornicum and *Zizyphus nummularia* were the common species of lower zone, *Ebenus stellata*, *Olea ferruginea* and *Tetrapogon villosus* were the common species of lower middle zone, *Cotoneaster nummularia*, *Caragana ambigua* and *Dichanthium foveolatum* were the common species of upper middle zone and *Juniperus excelsa*, *Piptatherum hilariae*, *Salvia nubicola*, *Onobrychus cornuta*, *Acantholimon munroanum* and *Thymus linearis* were the common most species of upper zone. *Convolvulus*

Table 1: Summary of relative phytosociological data

Plant Name	Presence No.	Average I.V.	Maximum I.V.	Minimum 1.V.	No. Of stands 1st dominant	No. Of stands 2nd dominant	No. Of stands 3rd dominant
Abelia triflora ssp. *parviflora* (Clarke) Wend	1	0.47	0.47	0.47	-	-	-
Acantholimon munroanum Aitch. and Hemsl.	2	30.44	52.81	8.07	1	-	-
A. polystachyum Boiss.	4	4.25	3.52	0.75	-	-	
Achillea santolina L.	1	1.06	1.06	1.06	-	-	-
Amaranthus spinosus L.	1	5.8	5.8	5.8	-	-	-
Andrachne rotundifolia C.A. Mey	2	2.1	2.64	1.56	-	-	-
Aristida adscensionis L.	6	3.03	8.07	0.69	-	-	-
Artemisia stricta Edgevv.	5	25.37	56.21	1.55	3	1	-
Astragalus ammophilus Boiss.	2	1.07	1.78	0.37	-	-	-
A. anisacanthus Boiss.	3	6.01	9.11	0.89	-	-	-
A. auganus Bunge	3	6.87	13.52	0.76	-	-	1
A. stocksii Bunge	1	0.98	0.98	0.98	-	-	-
A. zarghumensis Rech.f.	3	3.25	6.46	0.78	-	-	-
Berberis balu-chistanica Ahrendt	2	2.14	2.69	1.6	-	-	-
B. calliobotrys Aitch. ex Keehne	3	8.9	10.22	2.17	-	-	-
Berchemia pakistanica Bowicz	1	0.64	0.64	0,64	-	-	-
Bromus scoparius L.	2	3.53	6.30	0.76	-	-	-
Buddleja crispa Bth.	1	1.35	1.35	1.35	-	-	-
Bupleurum stewartianum Nasir.	2	1.513	2.01	1.15	-	-	-
Caragana ambigua. Stocks	5	11.49	19.50	1.57	-	2	-
Cenchrus biflorus Roxb.	1	1.49	1.49	1.49	-	-	-
Chrysopogon aucheri (Boiss.) Stapf	5	10.52	21.94	3.11	-	1	1
C. serrulatus Trin.	7	3.44	9.77	0.84	-	-	-
Convolvulus arvensis L.	1	0.36	0.36	0.36	-	-	-
C. kotschyanus Boiss.	1	5.50	5.50	5.50	-	-	-
C. spinosus Burm.	8	18.30	58.07	3.08	2	-	2
Cotoneaster nummularia Fisch. and Mey.	4	13.71	31.10	1.08	1	-	1
Cousinia bipinnata Boiss.	4	2.68	3.15	2.31	-	-	-
Cymbopogon jwarancusa (Jones) Schult.	12	19.52	64.60	1.07	3	1	-
C. martinii (Roxb.) Wats.	1	2.39	2.39	2.39	-	-	-
Daphne mucronata Royle	5	3.29	8.32	0.97	-	-	-
Diarthron vesicu-losum (Fisch. and Mey.) C.A. Mey.	2	1.76	2.77	0.76	-	-	-
Dichanthium foveolatum (Dof.) Roberty	5	12.07	20.65	5.42	1	1	-
Ebenus stellata Boiss.	8	20.61	54.99	2.97	3	-	-
Eleusine indica (Linn.) Gaertn.	2	4.88	6.11	3.66	-	-	-
Ephedra intermedia Schrenk	2	3.28	3.85	2.71	-	-	-
Eragrostis pilosa (L.) O. Beauv.	5	1.88	4.74	0.37	-	-	-
Eremerus persicus (Jaub.). and Spach) Boiss.	1	1.65	1.65	1.65	-	-	-
Eulaliopsis binata (Retz) C.E.Hubb.	1	6.19	6.19	6.19	-	-	-
Euphornia clarkeana HK.f	1	1.32	1.32	1.32	-	-	-
Fagonia arabica L.	4	4.45	8.48	0.78	-	-	-
Fraxinus xanthoxy-loides (Wall. Ex G.Don) D.C.	2	1.31	2.23	0.40	-	-	-
Gaillonia eriantha Jaub. and Spach.	1	4.18	4.18	4.18	-	-	-
Gymnocarpos decander Forssk.	1	8.52	8.52	8.52	-	-	-
Gypsophila lignosa Hemel. and Lace	5	3.12	6.58	1.87	-	-	-
Haloxylon griffithii (Moq.) Bunge ex Boiss.	1	9.29	9.29	9.29	-	-	-
H. salicornicum (Moq.) Bunge ex Boiss.	1	20.42	20.42	20.42	1	-	-
Hertia intermedia (Boiss.) 0. Ktze.	4	2.26	3.56	1.47	-	-	-
Heteropappus altaicus (Wilid.) Novopork.	1	1.38	1.38	1.38	-	-	-
Iris tenuifolia Pall	4	5.90	5.65	0.78	-	-	-

Juniperus excelsa M. Bleb.	2	14.9	15.54	14.26	-	1	1
Lactuca orientalis (*Boiss.*) *Boiss.*	2	1.03	1.30	0.76	-		-
Leptorhabdos parviflora (Bth.) Bth	1	0.88	0.88	0.88	-	-	
Malva neglecta Wallr.	1	5.53	5.53	5.53	-	-	-
M. parviflora L.	1	3.76	3.76	3.76	-	-	-
Medicago sativa L.	1	8.38	8.38	8.38	-	-	-
Melica persica Kunth	2	0.63	0.81	0.46	-	-	-
Nepeta praetervisa Rech. f.	4	4.09	9.55	1.03	-	-	-
Olea ferruginea Royle	3	19.60	50.39	0.39	1	-	-
Onobrychus comuta. (L.) Desv.	5	22.54	47.38	2.85	2	-	-
O. dealbata Stocks	1	3.30	3.30	3.30	-	-	-
Peganum harmala L.	6	12.32	31.94	3.76	1	1	1
Periploca apbylla Done.	2	1.67	1.80	1.55	-	-	
Perovskia abrotanoides Karel.	6	7.76	31.99	0.37	1	-	-
Phlomis stewartii Hk.f.	6	4.23	6.83	1.14	-	-	-
Piptathetum hilariae Pazij.	2	15.51	33.6	1.42	1	-	-
P. vivarium (Grig.) Rozhev.	4	1.67	4.33	0.40	-	-	
Pistacia khinjuk Stocks	1	0.84	0.84	0.84		-	-
Isodon rugosus (Wall.). ex Benth.) Codd	1	1.52	1.52	1.52	-	-	-
Polygonum afghanicus Meissn.	1	8.82	8.82	8.82	-		-
P. persicaria L.	4	2.65	6.05	0.69	-	-	-
Prunus brahuica (Boiss.) Aitch. and Hemsl.	7	9.96	28.52	0.83	1	1	-
Pulicaria crispa (Forssk) Bth.	4	1.32	2.38	0.73	-	-	-
Rhamnus persica Boiss.	4	1.50	2.04	1.16	-	-	-
Rhazya stricta Done.	1	4.09	4.09	4.09	-	-	-
Rosa lacerans Boiss. and Buhse.	1	2.93	2.93	2.93	-	-	-
Sageratia thea (Osbeck) M.C. Johnston, var. brandrethiana (Altch.) Qaiser and Nazim	2	1.72	2.65	0.79	-	-	-
Salvia cabulica Bth.	1	1.36	1.36	1.36	-	-	-
S. nabicola Wall. ex Sweet	1	69.08	69.08	69.08	1	-	-
Scabiosa oliveri Coult	1	0.77	0.77	0.77	-	-	-
Scrophulana striata Boiss.	1	2.07	2.07	2.07	-	-	-
Scutellaria petiolate Hernsl. ex Lace and Prain	2	1.77	1.84	1.71	-	-	-
Silene citrioa Buser	1	0.76	0.76	0.76	-	-	-
Sophora mollis sub sp. *griffithii* (Stock) Ali	6	2.19	5.81	1.28	-	-	-
Spiraea boissieri Schneider.	1	1.28	1.28	1.28	-	-	-
Stachys parviflora Bth.	3	12.63	16.78	4.96	-	-	-
Tanacetum fruticolosum Ladeb.	2	7.46	9.44	5.48	-	-	-
Tetrapogon viliosos Desl.	14	10.93	35.12	0.98	-	4	-
Tngonella monantha C.A. Mey.	1	3.50	3.50	3.50	-	-	-
Themeda anathera. (Nees) Hack	2	1.52	2.54	0.51	-	-	-
Thymus linearis Bth.	8	12.79	27.18	2.86	-	2	2
Withania coagulans Dunal	2	4.25	6.15	2.35	-	-	-
Ziztyphora tenuior L.	3	1.89	2.61	1.53	-	-	-
Zizyphus nummularia (Burn) f.Wight.	1	17.75	17.75	17.75	-	1	-

spinosus were common in 1 and 2 zones. *Cymbopogon jwarancusa* were mostly common in 1, 2 and 3 zones and *Artemisia stricta* were common in 2, 3 and 4 zones.

Out of twenty-one communities, three communities viz., *Cymbopogon jwarancusa - Prunus brahuica*, *Piptatherum hilariae-Artemisia stricta*, *Prunus brachuica Dichanthium foveolatum - Juniperus excesa* were found in the protected areas of Tomagh and Kirbykuch. The vegetation of protected areas like Tomagh and Kirbykuch was better in respect of total coverage, species richness and abundance of grasses as compared to unprotected areas, because lack of human disturbance and grazing pressure in protected areas. This is in confirmity with the observations of Khan and Hussain (1963), Beg and Repp (1966), Khan (1977) and Tareen and Qadir (1987, 1990, 1991).

Species Diversity: Species diversity ranged from 0.63 to 1.54. *Prunus brahuica-Dichanthium foveolatum-Juniperus*

Table 2: Species diversity, community maturity index and community honevenity of the communities

Name of communities	Species diversity	Community maturity Index	Frequencies of frequency classes A	B	C	D	E
Convolvulus spinosus Tetrapogon villosus	1.16	12.77	88.88	-	-	5.55	5.55
Cymbopogon jwarancusa	0.83	14.35	76.92	15.38	-	-	7.69
Peganum harmala-Cymbopogon Jwarancusa chrysopogon aucheri	0.91	23.32	60.0	20.0	-	20.0	-
Perovskia abrotanoides-Peganum harmala-Astragalus auganus	1.0	23.63	45.45	36.96	18.18	-	-
Ebenus stellata-Chrysopogon aucheri	0.63	35.23	42.85	28.57	-	14.28	14.28
Artemisia stricta. Tetrapogon villosus-Peganum harmala-Astragalus auganus	1.09	23.33	50.00	41.66	-	8.33	
Hatoxyton salicornicum Zizyphus nummularia-Convolvulus spinosus	1.18	19.74	61.53	30.76	7 69	-	-
Ebenus stellata Tetrapogon villosus-Convolvulus sponosus	1.18	20.76	69.23	7.69	15.38	7.69	-
Ebenus stellata	1.27	21.42	78.57	7.14	7.14	-	7.14
Dichanthium foveolatum-Caragana ambigua-Cotoneaster nummularia	1.07	26.22	53.33	20.0	20.0	-	6.66
Cotoneaster nummularia-Caragana ambigua	1.16	26.29	61.11	16.66	5.55	11.11	11.11
Olea ferruginea	1.09	27.46	52.94	35.29	-	-	11.76
Cymbopogon jwarancusa-Prunus brahuica	1.09	16.09	91.66	-	-	-	8.33
Artemisia stricta-Juniperus excelse-Thymus linearis	1.36	18.88	80.0	13.33	-	6.66	-
Onobrychus cornuta-Thymus linearis	0.73	28.72	50.0	25.0	-	25.0	-
Piptatherum hilariae-Artemisia stricta	1.08	19.74	69.23	15.38	7.69	7.69	-
Prunus brahuica-Dicanthium foveolatum-Juniperus excalsa	1.54	20.55	83.33	4.16	4.16	-	8.33
Salvia nubicola	1.00	18.48	81.81	9.09	-	-	9.09
Acantholimon munroanum	0.91	23.99	70.0	10.0	10.0	-	10.0
Onobrychus cornuta-Thymus linearis	0.73	36.24	62.5	12.5	-	-	25.0
Artemisia stricta	0.73	28.74	50.0	25.0	12.5	-	12.5

Table 3: Stand density and stand cover of the plant communities

Name of Communities	Stand density per hectare (D9)	Stand cover per hectare (C9)
Convolvulus spinosus-Tetrapogon villosus	8.68×10^4	5.30×10^4
Cymbopogon jwarancusa	3.71×10^6	3.19×10^5
Peganum harmala-Cymbopogon jwarancusa-Chrysopogon aucheri	2.04×10^4	3.07×10^4
Perovskia abrotanoides-Peganum harmala-Astragahis auganus	5.05×10^4	5.35×10^4
Ebenus stellata-Chrysopogon aucheri	6.11×10^4	5.86×10^4
Artemisia stricta-Tetrapogon villosus-Peganum harmala-Astragalus auganus	9.11×10^4	5.47×10^4
Haloxylon salicornicum-Zizyphus Nummularia-Convolvulus spinosus	4.48×10^4	6.67×10^4
Ebenus stellata-Tetrapogon villosus-Convolvulus spinosus	4.98×10^4	8.51×10^4
Ebenus stellata	4.20×10^4	1.25×10^5
Dichanthium foveolatum-Caragana	1.70×10^4*	6.95×10^4*
ambigua-Cotoneaster nummularia	8.96×10^5**	8.87×10^5**
Cotoneaster nummularia-Caragana	4.83×10^3*	1.15×10^5*
ambigua	5.08×10^4**	4.04×10^4**
Olea ferruginea	1.00×10^3*	1.27×10^5*
	1.04×10^5**	3.41×10^4**
Cymbopogon jwarancusa-Prunus brahuica	1.32×10^5	2.19×10^5
Artemisia stricta-Juniperus excelsa-Thymus linearis	1.31×10^5	3.97×10^5
Onobrycyhus cornuta-Thymus linearis	4.48×10^5	4.21×10^5
Piptatherum hilariae-Artemisia stricta	3.58×10^5	3.40×10^5
Prunus brahuica-Dicanthium	2.45×10^3*	1.51×10^4*
foveolatum-Juniperus excelsa	3.36×10^5**	1.78×10^5**
Salvia nubicola	4.67×10^5	1.24×10^6
Acantholimon munroanum	3.98×10^5	1.61×10^6
Onobrychus cornuta-Thymus linearis	3.58×10^5	8.24×10^5
Artemisia stricta	3.71×10^5	2.96×10^5

* = Trees and shrubs
** = Herbs and under shrubs

Table 4: Density size classes of the dommant plants at communities

Name of Species	Total individuals	Size Classes						
		1	2	3	4	5	6	7
Tetrapogon villosus	111	10	60	34	4	2	1	-
Convolvulus spinosus	80	1	4	2	8	37	20	8
Peganum harmala	12	-	-	5	7	-	-	-
Ebenus stellata	9		-	1	1	5	2	-
Cymbopogon jwarancusa	162	2	2	11	48	92	7	-
Stachys parvillora	28	-	-	1	6	12	8	1
Chrysopogon serrulatus	18	-	-	-	7	10	1	-
Eleusine indica	8	1	4	3	-	-		
Peganum harmala	42	-	1	1	6	22	10	2
Chrysopogon aucheri	30	1	2	3	8	13	2	1
Cymbopogon jwarancusa	23	-	-	-	2	2	12	7
Astragalus auganus	9	4	5	6	-	-	-	-
Peganum harmala	22	1	1	2	8	10	-	-
Astragalus auganus	20	2	13	5	-		-	-
Perovskia abrotanoides	19		-	2	3	2	6	6
Astragalus anisacanthus	16	-	-	4	7	5	-	-
Polygonum afghanicum	13	1	12	-	-		-	-
Phlomus stewartil	11	-	2	2	5	2	-	-
Ebenus stellata	44	-	1	1	3	19	17	4
Chrysopogon aucheri	34	1	16	13	2	2	-	-
Cymhopogon jwarancusa	14	-	1	-	1	12	-	-
Fagnonia arabica	11	2	5	3	-	-	-	-
Gypsophila lignosa	10	1	7	2	-	-	-	-
Artemisia stricta	40	1	12	11	8	9	-	-
Tetrapogon villosus	19	-	3	8	7	1	-	-
Peganum harmala	12	-	-	3	2	4	3	-
Ebenus stellata	9	-	-	1	1	4	2	1
Haloxylon griffithn	9	-	1	2	1	3	2	-
Astragalus amsacnthus	9	-	1	-	2	6	-	-
Haloxylon sancomicum	29	-	1	4	2	18	3	-
Cunvolvulus spmosus	15	-	1	2	2	4	4	-
Gymnocarpos decander	14	-	2	3	4	3	1	-
Fagonia arabica	14	-	8	5	1	-	-	-
Aristida adscensionis	14	4	7	3	-	-	-	-
Zizynhus nummularia	4	-	-	-	3	1	-	-
Tetrapogon villosus	43	-	28	12	2	-	-	-
Ebenus stellata	21	-	-	-	-	7	5	9
Convolvulus spinosus	21	1	1	1	1	10	5	2
Prunus brahuica	12	4	8	-	-	-	-	-
Ebenus stellata	56	2	2	1	4	9	8	3
Convolvulus spinosus	16	-	-	1	1	7	7	-
Tetrapogon villosus	13	1	6	6	-	-	-	-
Caragana ambigua	27	2	16	9	-	-	-	
Cotoneaster nunimularia	29	4	18	6	1	-	-	-
Dichanthium foveolatum	52	-	1	1	10	22	6	13
Thymus lineans	30	-	2	7	11	10	-	-
Phlomis stewartti	14	-	2	8	2	2	-	-
Cotoneaster nummularia	45	-	17	8	11	8	1	-
Caragana ambigua	49	3	15	23	7	1	-	-
Berberis calliobotrys	13	-	3	3	5	1	-	-
Tetrapogon villosus	53	1	20	19	5	8	-	-
Dichanthium foveolatum	20	1	6	2	3	7	1	-
Dlea ferruginea	83	2	11	19	2	16	2	29
Daphne mucronata	14	1	6	6	1	-	-	-
Contoneaster nummlaria	1	-	4	4	3	-	-	-
Polygonum persicana	23	9	13	1	-	-	-	-
Sophora mollis	23	-	9	9	3	2	-	-
Dichanthium toveolatum	20	-	1	5	4	9	1	-
Austida adscensionis	19	14	5	-	-	-	-	-
Corysopogon serrulatus	16	-	2	5	2	5	2	-
Cynbopogon jwarancusa	82	6	4	3	19	50	-	-
Aunus brahuica	4	-	-	-	-	2	1	1
Artemisia stricta	33	4	4	10	11	4	-	-
Dichanthium foveoletum	23	2	4	4	5	8	-	-
Acantholiman polystachyum	15	-	1	4	3	7	-	-
Autatherum hilariae	46	1	1	2	14	24	3	1
Artemisia stricta	24	-	-	2	8	11	2	-
Dichanthium foveoletum	13	-	-	-	1	6	6	-
Thymus linearis	9	-	1	4	2	2	-	-
Prunus brahuica	72	17	40	9	6	-	-	-
Dichanthium foveoletum	56	-	2	17	15	20	2	-

Caragana ambigua	23	5	13	5	-	-	-	-
Perovskia abrotanoides	11	-	-	1	7	3	-	-
Thmus linearis	10	1	2	2	3	2	-	-
Salvia nubicola	75	1	1	1	8	15	17	32
Thymus linearis	13	-	1	3	9	-	-	-
Amaranthus spinosus	9	1	6	2	-	-	-	-
Acantholimon munrcanum	55	3	1	3	2	1	5	43
Thymus linearis	29	-	1	2	2	23	1	-
Onobrychyus cornuta	14	-	-	1	1	4	1	7
Onobrychyus cornuta	49	-	-	-	2	8	14	22
Thymus linearis	29	-	-	1	10	18	-	-
Tanacetum fruticulosum	13	-	-	-	2	6	5	-
Acantholimon munroanum	9	-	-	-	-	3	3	3
Artemisia stricta	70	3	4	10	18	32	3	-
Tetrapogon villosus	14	-	-	1	7	5	1	-
Sophora mollis	11	-	2	3	4	1	1	-
Nepeta praetervisa	12	-	-	4	4	3	1	-

Table 5: Topographic and Soil Characteristics of the Communities

Name of Communities	Height (meters)	Topography	Sand (%)	Silt (%)
Convolvulus spinosus	1614	Sloping	63.9*	18.1
Tetrapogon villosus	1620	plains	±3.7	14 5
			64.2**	12.1
			±1.4	±2.5
Cymbopogon jwarancusa	1536	Flat	56.7	11.3
	1956	plains	±3.7	±2.9
			65.0	10.2
			±7.4	±3.4
Peganum harmala	1812	Flat	69.2	19.4
Cymbopogon jwarancusa Chrysopogon aucheri		Plains	55.2	19.4
Perovskia abrotanoides	1908	Sloping	55.2	19.4
Peganum harmala Astragalus auganus		plains	55.8	18.8
Ebenus stellata	1746	Sloping	67.92	7.04
Chrysopogon aucheri		plains	67.92	7.04
Artemisia stricta	1836	Flat	71.6	8.8
			67.6	14.0
Tetrapogon villosus Peganum harmala				
Astragalus auganus				
Haloxylon salicornicum Zizyphys nummularia	1266	Sloping	69.6	12.0
Convolvulus spinosus		plains	65.6	17.2
Ebenus stellate	1740	Sloping	73.6	1.6
Tetrapogon villosus Canvoivulus spinosus		plains	77.6	1.6
Ebenus stellata	1596	Sloping	61.5	13.0
		plains	58.56	11.68
Dichanthium foveolatum	2334	Sloping	70.4	8.4
Caragana ambigua-Cotoneaster nummularia		plains	66.8	10.00
Contoneaster nummalria	2040	Sloping	61.00	11 8
Caragane ambigua		plains	64.4	13.00
Olea ferruginea	1920	Sloping	69.00	4.4
		plains	69.00	4.4
Cymbopogon jwarancusa	2070	Sloping	56.4	13.84
Prunus brahuica		plains	64.4	5.6
Artemisia stricta	2484	Sloping	52.4	17.84
Juniperus excelsa-Thymus linearis		plains	67.8	6.2
Onoybrychus cornuta-	2797	Sloping	64.4	6.2
Thymus linearis		plains	70.6	4.0
Piptatherum hilariae-	2497	Sloping	57.36	13.84
Artemisia stricta		plains	57.36	13.84
*Prunus braluica**	2556	Sloping	65.36	6.84
Dichanthium foveolatum Juniperus excelsa		plains	61.36	9.84
Slvia nubicola	2553	Sloping	66.8	6.4
		plains	66.2	7.0
Acantholiman munroanum	2940	Flat	58.8	12.4
		Plains	54.2	11.8
Onobrychus comuta-	3084	Sloping	66.20	7 8
Thymus linearis		plains	66.20	3.8
Artemisia stricta	2154	Flat	66.8	16.0
		plains	70.0	10.8

Clay %	Textural Class	Organic matter %	MWHC %	$CaCO_3$	pH	EC mmhos/cm
28.0	S.C.L	0.83	33.47	28.18		
±0.8		±0.11	±0.97	±0.12		
23.7	S.C.L	1.67	39.51	31.9	7.11	0.23
±1.1		±0.1	±6.34	±3.3	±10.08	±0.02
32.0	S.C.L	1.84	37.91	24.98		
±0.8		±0.37	±7.86	±4.25		
24.8	S.C.L	1.9	41.7	23.66	6.94	0.30
±4.0		±0.4	±3.07	±3.09	±0.08	±0.04
21.4	S.C.L	1.32	33.65	26.46		
25.4	S.C.L	2.7	42.33	27.67	7.3	0.25
25.4	S.C.L	1.17	36.50	26.06		
25.4	S.C.L	1.85	43.24	26.96	7.15	0.3
25.04	S.C.L	1.47	33.04	28.65		
25.04	S.C.L	2.6	47.20	29.67	7.2	0.35
19.6	S.L	1.7	26.88	28.51		
18.4	S.L	2.9	25.13	28.62	7.3	0.25
18.4	S.L	1.07	24.06	27.97		
17.2	S.L	1.12	27.49	27.99	7.2	0.3
24.8	S.C.L	3.52	49.67	27.81		
20.8	S.C.L	5.50	55.34	26.19	7.1	0.4
25.4	S.C.L	1.57	37.36	28.37		
29.76	S.C.L	2.27	41.23	27.03	6.8	0.35
21.2	S.C.L	4.22	52.06	7.61		
23.2	S.C.L	9.57	56.01	4.86	7.1	0.5
27.2	S.C.L	6.8	52.13	12.27		
22.6	S.C.L	4.9	50.56	19.60	6.7	0.45
26.6	S.C.L	3.02	39.74	26.60		
26.6	S.C.L	3.6	43.62	18.37	7.0	0.45
29.76	S.C.L	1.52	36.45	15.80		
30.0	5.C.L	2.05	45.11	18.78	6.8	0.3
29.76	S.C.L	3.75	33.64	14.84		
26.00	S.C.L	5.27	49.89	21.69	7.1	0.35
29.4	S.C.L	7.1	58.87	12.05		
25.4	S.C.L	6.1	57.03	8.82	7.4	0.55
28.8	S.C.L	2.45	40.93	11.75		
28.8	S.C.L	3.65	47.63	14.64	7.3	0.25
28.8	S.C.L	1.35	42.03	26.65		
28.8	S.C.L	2.37	43.42	28.63	7.4	0.25
26.8	S.C.L	2.47	37.55	7.21		
26.8	S.C.L	2.85	51.26	24.49	7.5	0.5
28.8	S.C.L	3.77	49.15	4.16		
34.0	S.C.L	2.85	40.06	1.11	7.4	0.2
26.0	S.C.L	2.35	40.91	2.11		
30.0	S.C.L	5.85	49.53	9.69	7.3	0.25
17.2	S.L	3.3	39.06	24.92		
18.4	S.L	2.6	38.96	21.62	7.3	0.35

HCO_3 Meq/l	Cl Meq/l	Ca** + Mg** Meq/l	Na* ppm	K* ppm	SAR Meq/l	PAR Meq/l
4.16	1.84	5.58	Tr	86.66	--	0.05
±0.00	±0.08	±1.05		±2.35		
4.48	2.99	5.66	67.66	669.66	0.03	0.41
±0.12	±1.26	±0.33	±3.77	±21.76	3.75	1.5
3.75	1.5	5.0	600.00	76	0.37	0.04
4.5	1.5	4.5	55	100	0.03	0.06
4.0	2.0	5.25	605	80	0.37	0.04
4.0	1.5	4.25	250	100	0.14	0.06
4.25	1.5	5.0	550	400	0.34	0.25
6.0	2.0	7.5	98	85	0.05	0.04
4.0	1.75	6.0	Tr	197	--	0.11
4.75	1.75	8.0	Tr	100	--	0.05
4.5	2.0	8.25	Tr	460	--	0.22
4.75	3.25	5.25	265	925	0.16	0.57
4.5	2.75	4.0	315	92	0.22	0.06
5.25	2.0	4.75	55	80	0.03	0.05
6.5	2.5	8.25	Tr	115	--	0.05
4.0	1.75	4.5	55	200	0.03	0.13
4.25	3.25	5.0	94	250	0.05	0.15
6.25	2.75	7.25	Tr	830	--	0.43
4.5	2.25	4.0	Tr	95	--	0.06
4.0	2.25	4.75	Tr	85	--	0.05
6.0	2.75	6.5	253	525	0.14	0.29

*: Surface, **: Subsurface, ±: Standard deviation, S.L: Sandy loam, S.C.L: Sandy clay loam, MWHC: Maximum water holding capacity, SAR: Sodium adsorption ratio, PAR: Potassium adsorption

excesa community had high (>1.5) species diversity. Rest of the communities had moderate (1.0-1.5) to low (<1.0) species diversity. The lowest (0.63) species diversity was observed in *Ebenus stellata-Chrysopogon aucheri* community (Table 2).

Species diversity was generally found to be low similar to that obtained by Tareen and Qadir (1987) in the plains of Quetta district. Species diversity was relatively found to be high in *Prunus brahuica-Dichanthium foveolatum-Juniperus excelsa* community of protected areas of Kirbykuch enclosure. This increase in species diversity is related to the increase in number of species due to the absence of grazing in Kirbykuch enclosure. Comparison with the scanty previous work is very much limited. However, this is in confirmity with the observation of Tareen and Qadir (1987) for the communities of Hazarganji and Walitangi, Qadir and Ahmed (1989) for the wood land communities of Hazarganji.

Community Maturity: The community maturity index ranged from 16.09 to 36.24%. Relatively high maturity index (36.24%) was observed in *Onobrychus cornuta-Thymus*

linearis community and low community maturity index (16.09%) was observed in *Cymbopogon jwarancusa Prunus brahuica* community (Table 2).

Community Homogeneity: None of the communities, exhibited a frequency distribution that may be considered as close fit to Raunkiaer's Law, However *Cotoneaster nummularia-Caragana ambigua* community has all the five classes of frequency. Eight communities were represented by four classes, while eleven communities were represented by three classes and *Cymbopogon jwarancusa-Prunus brahuica* community represented only by two classes (A and El (Table 2).

Plant communities are very distinct floristically, therefore, community maturity and community homogeneity are low. The low percentage of the community maturity indices mak be attributed to the fact that communities of the study area represent successional stages. Qadir and Shetvy (1986) also reported low community maturity and low community homogeneity for Libyan plant communities, because these communities are also distinct floristically and differ in their stages of development.

Stand Density: Stand density per hectare values varied from 2.04×10^4 to 9.14×10^5 . The highest 9.14×10^5 values were obtained in *Dichanthium foveolatum-Caragana ambigua-Cotoneaster nummularia* community followed by *Salvia nubicola*, *Onobrychus cornuta-Thymus linearis*, *Acantholimon munroanum*, *Cymbopogon jwarancusa*, *Artemisia stricta*, *Piptatherum hilariae-Artemisia stricta* and *Onobrychus comuta-Thymus linearis* communities.

The lowest 2.04×10^4 values were found in *Peganum harmala-Cymbopogon jwarancusa-Chrysopogon aucheri* community (Table 3).

Stand cover per hectare values varied from 3.07×10^4 to 1.61×10^6 . The highest 1.61×10^6 values were found in *Acantholimon munroanum* community followed by *Salvia nubicola*, *Dichanthium foveolatum-Caragana ambigua-Cotoneaster nummularia*, *Onobrychus cornuta-Thymus linearis* communities (Table 3).

Future trends in the Communities: Density size class table provided some interesting insights about future trends of communities which are discussed below:

Peganum harmala and *Astragalus auganus* were reproducing very well in *Perovskia abrotanoides-Peganum harmala-Astragalus auganus* community, *Chrysopogon aucheri* reproducing very well in *Peganum harmala-Cymbopogon jwarancusa-Chrysopogon aucher* and *Ebenus stellata-Chrysopogon aucheri* communities.

Artemisia stricta reproducing very well in *Artemisia stricta-Tetrapogon villosus-Peganum harmala-Astragalus auganus*, *Artemisia stricta-Juniperus excelsa-Thymus linearis* and *Artemisia stricta* communities. *Haloxylon salicornicum* and *Gymnocarpos decander* reproducing very well in *Haloxylon salicornicurn-Zizyphus nummularia*, *Convolvulus spinosus* community. *Convolvulus spinosus* reproducing very well in *Haloxylon salicornicum-Zizyphus nummularia-Convolvulus spinosus*, *Convolvulus spinosus-Tetrapogon villosus* and *Ebenus stellata-Tetrapogon villosus*, *Convolvulus spinosus communities*. *Tetrapogon villosus* reproducing very well in *Convolvulus spinosus-Tetrapogon villosus*, *Ebenus stellata-Tetrapogon villosus-Convolvulus spinosus* and *Cotoneaster nummularia-Caragana ambigua* communities. *Cymbopogon jwarancusa* reproducing very well in *Cymbopogon jwarancusa*. *Cymbopogon jwarancusa-Prunus brahuica* communities. *Caragana ambigua* reproducing very well in *Cotoneaster nummularia-Caragana ambigua*, *Prunus brahuica-Dichanthium foveolatum-Juniperus excelsa* communities. *Dichanthium foveolatum* reproducing very well in *Cotoneaster nummularia- Caragana ambigua* community.Ofea *teruginea* reproducing very well in *Olea ferruginea* community. *Thymus linearis* reproducing very well in *Artemisia stricta-Juniperus excelsa-Thymus linearis, Onobrychus cornuta-Dichanthium foverlatum Juniperus excelsa* communities. *Onobrychus cornuta* reproducing very well in *Onobrychus cornuta-Thymus linearis* community. *Piptatherarn hilariae* reproducing very well in *Piptatherum hilariae-Artemisia stricta* community. *Prunus brahuica* reproducing very well in *Prunus brahu caDichanthium foveolatum-Juniperus excelsa* community. *Salvia nubicola* reproducing very well in *Salvia nubicola* community. *Acantholimon munroanum* reproducing very well in *Acantholimon munroanum* community (Table 4).

Topography: Five communities viz., *Peganum harmala-Cymbopogon jwarancusa-Chrysopogon aucheri*, *Artemisia stricta-Tetrapogon villosus-Peganum harmala-Astragalus auganus*, *Cymbopogon jwarancusa. Acantholimon munroanum* and *Artemisia stricta* were found on flat plains. The remaining sixteen plant communities were found on the sloping plains (Table 5).

Edaphology of Plant Communities: Soil texture varied from sandy loam to sandy clay loam. *Artemisia stricta-Tetrapogon villosus-Peganum harmala-Astraglus auganus, Haloxylon salicornicum-Zizyphus nummularia-Convolvulus spinosus* and *Artemisia stricta* communities were found on sandy foam soils. Rest of the communities were found on sandy clay loam soils (Table 5) Organic matter in various plant communities ranged between 0.57% to 9.57%. The highest percentage (4.22, 9.57%) was found in *Dichanthium foveolatum-Caragana ambigua-Cotoneaster nummularia* community.

The following plant communities were found to have high organic matter (>3.0%).

Cotoneaster nummularia-Caragana ambigua (6.8%, 4.9%). *Onobrychus cornuta-Thymus linearis* (5.58%, subsurface). *Ebenus stellata-Tetrapogon villosus-Convolvulus spinosus* (3.52%, 5.50%). *Artemisia stricta-Juniperus excelsa-Thymus linearis* (3.75%, 5.27%). *Acantholimon munroanum* (3.77%, surface). *Piptatheru hilariae Artemisia stricta* (3.65%, subsurface). *Olea ferruginea* (3.02%, 3.6%). *Artemisia stricta* (3.3%, surface).

Rest of the communities had moderate (1.5-3.0%) to low (<1.5%) percentage of organic matter. The lowest percentage (0.57% surface) of organic matter was found in the soil of *Ebenus stellata* community.

Maximum water holding capacity of the plant communities varied from (24.06% to 58.87%). Maximum water holding capacity were generally found to be high. Seventeen plant communities had high (>40.0%) percentage of maximum water holding capacity. *Convolvulus spinosus-Tetrapogon villosus* and *Artemisia stricta* communities had moderate (35.0-40.0%) percentage of water holding capacity. *Artemisia strictaTetrapogon villosus-Peganum harmala Astragalus augahus* and *Haloxylon salicornicum-Zizyphus nummularia-Convolvulus spinosus* communities had low (<35.0%) percentage of maximum water holding capacity (Table 5). The electrical conductivity was generally found to he very low, ranging from 0.2 to 0.55 mmhos/cm. *Onobrychus cornuta-Thymus linearis* community has relatively high (0.55) EC. The lowest EC (0.2) was found in the soils of *Acantholimon munroanum* community (Table 5).

Calcium carbonates varied from 1.11% to 31.9%. *Convolvuhis spinosus-Tetrapogaon villosus* community had high (31.9%, subsurface) calcium carbonate content. The rest of the plant communities had moderate (25.0-30.0%) to low (25.0%) percentage of calcium carbonate. The lowest (1.11%, subsurface) percentage of calcium carbonate was found in the soils of *Acantholimon rnunroanurn* community (Table 5).

Bicarbonates varied from 3.75 to 6.5 meq/l. The following plant communities had moderate (>5.0 meq/l bicarbonate content. *Onobrychus cornuta-Thymus linearis* (6.5 meq/l) *Salvia nubicola* (6.25 meq/l). *Ebenus stellata-Tetrapogon villosus-Convolvulus spinosus* (6.0 meq/l), *Artemisia stricta* (6.0 meq/l). *Artemisia stricta-Juniperus excelsa-Thymus linearis* (5.25 meq/l).

The lowest (3.75 meq/l) bicarbonate contents was found in the soils of *Peganum harmala-Cymbopogon jwarancusa-Chrysopogan aucheri* community (Table 5). The soils did not differ much in respect of soil chlorides, varying from 1.5 to 3.25 meq/l. *Olea ferruginea* and *Prunus brahuica-Dichanthium foveolatum-Juniperus excelsa* communities were found on the soils having relatively high 13.25 meq/l) chlorides contents (Table 5).

The combined contents of calcium plus magnesium were comparatively found to he low which varied from 4.0 to 8.25 meq/l.

Contoneaster nummularia-Caragana ambigua (8.25 meq/l), *Onobrychus cornuta-Thymus linearis* (8.25 meq/l) and *Dicanthium foveolatum-Caragana ambigua-Cotoneaster ummularia* (8.0 meq/l) had relatively high calcium plus magnesium. The lowest (4.0 meq/l) content of calcium plus magnesium was found in the soils of *Cymgbopogon jwarancusa-Prunus brahuica* community (Table 5).

Sodium varied from very low (traces) to 605 ppm. The soils of the following communities had moderate (500-605 ppm) sodium content:

Ebenus stellata-Chrysopogon aucheri (605 ppm), *Peganum harmala. Cymbopogon jwarancusa-Chrysopogon aucheri* (600 ppm), *Halox ylon salicornicum-Zizyphus nummularia-Convolvulus spinosus* (550 ppm). The rest of the communities have low (<500 ppm) sodium content (Table 5).

Sodium adsorption ratio varied from 0.03 to 0.43 meq/l. The following three plant communities had moderate (>0.30 meq/l) sadiumadsorption ratio: *Peganum harmala-Cymbopogon jwarancusa-Chrysopogon aucheri* (0.37 meq/l), *Ebenus stellata-Chrysopogon aucheri* (0.37 meq/l and *Haloxylon salicornicum-Zizyphus nummularia-Convolvulus spinosus* (0.34 meq/l). The rest of the communities had low (<0.3 meq/l) sodium adsorption ratio (Table 5).

Potassium contents varied from 76.0 to 925.0 ppm. The following plant communities had moderate (500.0-925.0 ppm) potassium contents:

Olea ferruginea 1925.0 ppm), *Salvia nubicola* (830.0 ppm), *Cymbopogon jwarancusa* (670.0 ppm) and *Artemisia stricta* (525.0 ppm).

Rest of the communities had low (<500.0 ppm) potassium content. The lowest potassium content (76.0 ppm) was found in *Peganum harrnala-Cymbopogon jwarancusa-Chrysopgon aucheri* community (Table 5).

Potassium adsorption ratio varied from 0.04 to 0.57 meq/l. The following plant communities had moderate (>0.3 meq/l) potassium adsorption ratio. The remaining communities had low (<0.3 meq/l) potassium adsorption ration (Table 5).

Olea ferruginea (0.57 meq/l), *Salvia nubicola* (0.43 meq/l) and *Cymbopogon jwarancusa* (0.41 meq/l).

Soil of the study area were generally fine textured. Out of 21 communities, only 3 communities had coarse-textured soil. Similar results were obtained by Sheikh *et al*. (1974) for irrigated soils of Loralai and Sibi districts.

Organic matter were high in the soils of 9 communities (mostly in protected areas). While 17 communities had high maximum water holding capacity. Ilyas (1988) also found the same results for Kirbykuch enclosure. EC, calcium carbonate, bicarbonate, chloride and calcium plus magnesium were generally found to be low. Tareen (1986) reported similar results for Quetta district. Sodium adsorption ratio, potassium amid potassium adsorption ratio ranged low in the present communities.

Diagnostic edaphic features of various association types are as under:

1. *Ehenus stellata* association (3 communities)

Low PAR, low to medium HCO_3, medium $CaCO_3$, low to high organic matter (0.M) and MWHC

2. *Artemisia stricta* association (3 communities)

Low to medium $CaCO_3$, medium HCO_3, medium PAR, low to high MWHC and medium to high O.M.

3. *Cymbopogon jwarancusa* association (2 communities).

Low $CaCO_3$, low HCO_3, low to medium PAR, medium O.M. and high MWHC.

4. *Onobrychus cornuta* association (2 communities)

Low $CaCO_3$, low PAR, low to medium HCO_3, high O.M. and high MWHC

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