

PHYTOSOCIOLOGY OF THE HILLS OF QUETTA DISTRICT

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Abstract

Fifty seven plant communities were recognized in the hills of Quetta district. Forty five communities were grouped into 8 steppe types viz., *Artemisia maritima* steppe: *Nepeta juncea* steppe: *Salvia cabulica* steppe: *Cymbopogon commutatus* steppe: *Chrysopogon aucheri* steppe: *Sophora mollis* steppe: *Astragalus stocksii* steppe: *Prunus brahuica* steppe: Individual communities in each steppe type also segregated on the basis of edaphic factors. The remaining 12 communities could not be classified because they were disjunct types. The total coverage as well as species diversity tended to be high in protected areas as compared to un-protected areas. Twenty eight species were found to be indicator species of specific soil conditions.

Introduction

Preliminary accounts of the vegetation of Quetta (Beg, 1966), its wastelands (Changezi, 1982), graveyards (Khilji, 1982) of Quetta - Pishin area (Kayani *et al.*, 1984) and Hazarganji (Khan & Hussain, 1963; Nissar, 1982; Majeed, 1984; Ahmed, 1984) have been reported. From these works a clear picture of the vegetation of the hills of Quetta district does not emerge. An attempt was therefore made to carry-out a comprehensive study of the vegetation and soils of the hills of Quetta district which is reported in this paper.

Materials and Methods

Location: A total of 112 sites occupying considerable area covering diverse hills in Quetta district (Lat. 29° 52' - 30° 18' Long. 66° 55' - 67° 48') were studied (Table 1). The climate of the area is generally dry and cool, mean annual precipitation 250 to 320 mm and confined to winter and spring, snow falls may occur any time during December to February, mean maximum temperature for the hottest month 35.5°C and mean minimum temperature for the coldest month -2.7°C. According to Holdridge's (1947) system, the whole area falls under temperate Desert Bush type of bioclimate (Qadir, 1968).

Vegetation analysis: The vegetation was studied by "line intercept method" (Canfield, 1941). In each site three lines of 30 meter length were laid at random. Name of the species and their cover intercepting the line was noted and phytosociological attributes (relative cover and importance values) were calculated. Species diversity was calculated by Menhinick (1964) index.

Soil analysis: Two soil samples were collected in each stand, one from surface (0-15 cm) and another from subsurface (30-60 cm) depth. These were analysed for physical

Table 1. Location of Sampled Sites.

Site No.	Locality	Location
* * *		
1-25, 67-73, 84	Hazarganji	about 14 miles from Quetta towards West.
26-40	Zarghun	about 35 miles from Quetta towards East.
41-44, 46-49	Kach Dam	about 16 miles from Quetta towards East.
* * * *		
50-56, 74-81, 85, 86	Chiltan	about 18 miles from Quetta towards West.
57-63	Hanna Lake	about 8 miles from Quetta towards East.
64, 65	Gaza Band	about 19 miles from Quetta towards North.
66	Baleli	about 3 miles from Baleli towards East.
82, 87, 88	Kohi murdar	about 3 miles from Quetta towards South.
83	Kolli	about 28 miles from Quetta towards North.
89, 90, 100-103	Spin Karez	about 8 miles from Quetta on Sorange Road.
91-99	Zaree Cheshma	about 3 miles from Spin Karez towards South.
104, 105	Sorange	near Sorange Coal Mines.
* *		
106, 109	Karkhasa	near Brewery towards North.
107, 108, 110	Brewery	near Brewery T.B. Santorium.
*		
111-113	Walitangi	about 7 miles from Urak towards East.

* Protected areas

and chemical characteristics. Soil texture was determined by hydrometer method (Bouyoucos, 1951). Organic matter by the method described by Hussain & Qadir (1970), maximum water holding capacity by (Keen & Raczkowski method as in Piper, 1942), pH (saturated paste) with glass electrode pH meter, electrical conductivity by Beckman conductivity meter, alkaline earth carbonate with acid neutralization method (Anon., 1954) and soluble ions, HCO_3^- , Cl^- , Ca^{++} and Mg^{++} by titration methods (Anon., 1954).

Results

Of the 112 stands studied on the hills of Quetta district 57 plant communities were recognized on the basis of index of simianity (Bray & Curtis, 1957) similar to procedure adopted by Tareen & Qadir (1987) for plant communities of plains of Quetta district. These communities on the basis of first dominant were further grouped into 9 types of steppes (Table 3), which are as follows:

1. *Artemisia maritima* steppe
Consisting of 16 communities.
2. *Nepeta juncea* steppe.
Composed of 5 communities.
3. *Salvia cabulica* steppe.
Consisting of 2 communities.
4. *Cymbopogon commutatus* steppe.
Composed of 7 communities.
5. *Chrysopogon aucheri* steppe.
Contains 7 communities.
6. *Sophora mollis* steppe.
Consisting of 4 communities.
7. *Astragalus stocksii* steppe.
Composed of 4 communities.
8. *Prunus brahuica* steppe.
Consisting of 1 community.
9. *Disjunct steppe*
Consisting of 14 communities.

There are a number of disjunct stands which could not be classified into broad steppe categories. They probably represent various primary and secondary successional stages and in some cases they indicate certain peculiar habitat conditions of hills.

The phytosociological data have been summarized in Table 2. The most common and widespread steppe was *Artemisia maritima* steppe.

Topographic Relations of Plant Communities: Topography was found to exert some influence on the distribution of some vegetational types. The following 13 communities show preference for a particular type of aspect:-

Artemisia maritima - *Cymbopogon commutatus* (West).

Chrysopogon aucheri - *Artemisia maritima* (West).

Artemisia maritima - *Salvia bucharica* (East).

Table 2. Summary of Relative Phytosociological Data.

S.No.	Plant Name	Presence No. of Stands	Average I.V.	Maximum I.V.	Minimum I.V.	No. of Stands 1st dominant	No. of Stands 2nd dominant
1	2	3	4	5	6	7	8
1.	<i>Artemisia martima</i> L.	85	36.26	93.09	0.79	50	16
2.	<i>A. scoparia</i> Waldst. & Kit.	1	7.07	7.07	7.07	--	--
3.	<i>Carduus pycnocephalus</i> L.	2	0.72	0.94	0.50	--	--
4.	<i>Cousinia heterophylla</i> Boiss.	12	2.25	6.96	0.39	--	--
5.	<i>C. minuta</i> Boiss.	8	3.63	6.54	0.69	--	--
6.	<i>C. stocksii</i> C. Winkler	5	15.09	30.80	1.74	--	3
7.	<i>Filago arvensis</i> L.	1	0.91	0.91	0.91	--	--
8.	<i>Hertia intermedia</i> (Boiss.) O. Ktze.	8	9.56	24.81	0.9	--	2
9.	<i>Jurinea carduiiformis</i> Boiss.	1	0.38	0.38	0.38	--	--
10.	<i>Koelipinia linearis</i> Pallas	2	2.14	3.31	0.98	--	--
11.	<i>Phagnalon acuminatum</i> Boiss.	2	7.56	13.40	1.72	--	--
12.	<i>Pulicaria crispa</i> (Forssk.) Bth.	10	2.13	5.28	0.75	--	--
13.	<i>Senecio decaisnei</i> DC.	2	2.54	4.1	0.98	--	--
14.	<i>Sonchus asper</i> (L.) Hill	1	1.15	1.15	1.15	--	--
15.	<i>Achillea santolina</i> L.	3	22.37	51.36	1.01	1	1
16.	<i>Pistacia khinjuk</i> Stocks	7	2.85	7.04	0.62	--	--
17.	<i>Berberis baluchistanica</i> Ahrendt	1	32.14	32.14	32.14	1	--
18.	<i>Arnebia linearifolia</i> DC.	1	2.32	2.32	2.32	--	--
19.	<i>Paracaryum rugulosum</i> (DC.) Boiss.	1	0.48	0.48	0.48	--	--
20.	<i>Caccinia macranthera</i> (Banks & Soland.) Brand	1	0.60	0.60	0.60	--	--
21.	<i>Buddleja crispa</i> Bth.	3	2.89	5.12	1.01	--	--
22.	<i>Campanula leucoclada</i> Boiss.	2	1.83	2.11	1.55	--	--
23.	<i>Abelia triflora</i> R. Br.	1	6.01	6.01	6.01	--	--
24.	<i>Acanthophyllum squarrosus</i> Boiss.	3	1.97	4.22	0.58	--	--
25.	<i>Gypsophila lignosa</i> Hemal. & Lace.	1	1.27	1.27	1.27	--	--
26.	<i>Lepyrodiclis paniculata</i> Stapf.	1	1.75	1.75	1.75	--	--

27.	<i>Minuartia meyeri</i> (Boiss.) Bornm.	4	3.42	7.28	1.08	--	--
28.	<i>Silene brahuica</i> Boiss.	10	4.66	9.37	0.82	--	--
29.	<i>Haloxylon griffithii</i> (Moq.) Bunge ex Boiss.	24	12.80	75.57	0.71	1	5
30.	<i>Halocharis hispida</i> (C.A. Mey.) Bunge.	10	20.53	89.66	1.07	1	5
31.	<i>Kochia stellaris</i> Moq.	2	12.30	23.81	0.80	--	1
32.	<i>Convolvulus arvensis</i> L.	1	0.34	0.34	0.34	--	--
33.	<i>C. leiocalycinus</i> Boiss.	35	0.37	0.66	39.81	2	4
34.	<i>Alyssum desertorum</i> Stapf	1	0.51	0.51	0.51	--	--
35.	<i>Conringia planisiligua</i> Fisch & Mey.	1	0.94	0.94	0.94	--	--
36.	<i>Crambe cordifolia</i> Steven	1	1.12	1.12	1.12	--	--
37.	<i>Malcolmia africana</i> (Linn.) R.Br.	2	0.97	1.56	0.38	--	--
38.	<i>Juniperus polycarpus</i> C. Koch.	11	13.98	45.99	0.77	2	2
39.	<i>Scabiosa olivieri</i> Coult	11	1.82	7.43	0.62	--	1
40.	<i>Euphorbia granulata</i> Forssk.	14	1.69	2.74	0.64	--	--
41.	<i>E. osyridea</i> Boiss.	14	1.91	8.36	0.51	--	--
42.	<i>Ephedra gerardiana</i> Wall. ex Stapf.	20	5.88	17.20	0.36	--	1
43.	<i>Gentiana oliveri</i> Griseb.	1	0.46	0.46	0.46	--	--
44.	<i>Iris falcifolia</i> Bunge	1	4.04	4.04	4.04	--	--
45.	<i>I. sisyrinchium</i> L.	2	1.22	1.19	1.25	--	--
46.	<i>Callipeltis cucularis</i> (juvl.) Rothm.	3	1.35	1.72	1.70	--	--
47.	<i>Eremostachys thyrsoflora</i> Bth.	1	0.73	0.73	0.73	--	--
48.	<i>Hymenocrater sessilifolius</i> Bth.	1	1.37	1.37	1.37	--	--
49.	<i>Marrubium vulgare</i> L.	2	2.10	3.6	0.61	--	--
50.	<i>Nepeta juncea</i> Bth.	53	13.23	72.43	0.61	5	10
51.	<i>Perovskia abrotanoides</i> Karel.	18	12.49	42.10	0.60	2	4
52.	<i>P. ariplicifolia</i> Bth.	7	9.23	31.22	0.46	--	1
53.	<i>Salvia bucharica</i> M. Pop.	4	19.34	40.01	2.72	1	1
54.	<i>S. cabulica</i> Bth.	38	11.24	43.13	0.88	5	5
55.	<i>Teucrium stocksianum</i> Hedge & Lamond.	1	1.11	1.11	1.11	--	--
56.	<i>Zataria multiflora</i> Boiss.	1	1.91	1.91	1.91	--	--
57.	<i>Zizyphora tenuio</i> L.	11	1.34	5.65	0.32	--	--
58.	<i>Asparagus monophyllos</i> Baker	2	11.51	20.94	2.09	--	1
59.	<i>Erenurus persicus</i> (Jaub. & Spash) Boiss.	1	0.6	0.6	0.6	--	--
60.	<i>Ficus religiosa</i> L.	1	3.99	3.99	3.99	--	--
61.	<i>Fraxinus xanthoxyloides</i> (G. Don) Dc.	5	4.00	10.96	1.29	--	--
62.	<i>Alhagi maurorum</i> Medic.	1	13.95	13.95	13.95	--	--

Table 2. (Contd.)

1	2	3	4	5	6	7	8
63.	<i>Argyrolobium roseum</i> (Camb.) Jaub. & Spach	1	0.51	0.51	0.51	--	--
64.	<i>Astragalus brahuicus</i> Bunge	1	4.49	4.49	4.49	--	--
65.	<i>A. anisacanthus</i> Boiss.	7	2.79	5.54	0.88	--	--
66.	<i>A. stocksii</i> Bunge	62	13.99	52.21	1.21	6	12
67.	<i>A. zarghumensis</i> Rech.f.	2	2.13	3.41	0.86	--	--
68.	<i>Caragana ambigua</i> Stocks	25	6.27	27.49	0.50	--	1
69.	<i>Colutea armata</i> Hemsl. & Lace	2	4.57	7.43	1.72	--	--
70.	<i>Ebenus stellata</i> Boiss.	7	9.10	0.58	43.54	1	--
71.	<i>Sophora mollis</i> subsp <i>griffithii</i> (Stocks) Ali.	79	10.15	45.65	0.72	5	13
72.	<i>Trigonella gharuensis</i> Rech.f.	2	36.79	71.13	2.46	1	--
73.	<i>Acantholimon longiflorum</i> Boiss.	18	4.45	26.17	0.32	-	1
74.	<i>Bunium persicum</i> (Boiss.) Fedtsch	1	0.61	0.61	0.61	--	--
75.	<i>Ferula baluchistanica</i> Kitam.	4	5.99	16.57	1.73	--	--
76.	<i>F. oopoda</i> (Boiss. & Buhse) Boiss.	9	2.22	3.95	0.33	--	--
77.	<i>Psammogeton canescens</i> (DC.) Vatke.	2	0.56	0.79	0.33	--	--
78.	<i>Polygonum afghanicum</i> Meissn.	5	0.70	1.1	0.61	--	--
79.	<i>Clematis graveolens</i> Lindl.	1	1.49	1.49	1.49	--	--
80.	<i>Plectranthus rugosus</i> Wall. ex Bth.	3	4.69	8.92	0.83	--	--
81.	<i>Cotoneaster nummularia</i> Fisch. & Mey.	5	16.75	54.70	1.94	1	--
82.	<i>Prunus brahuica</i> (Boiss.) Aitch. & Hemsl.	14	8.27	40.89	0.64	1	1
83.	<i>P. microcarpa</i> C.A. Mey.	3	2.59	3.86	1.00	--	--
84.	<i>Rosa lacerans</i> Boiss.	2	4.14	5.97	2.32	--	--
85.	<i>Spiraea boissieri</i> Schneider	3	28.21	51.68	2.74	2	--
86.	<i>Gaillonia eriantha</i> Jub. & Spach	13	6.84	29.90	0.72	1	--
87.	<i>Rubia infundibularis</i> Hemsl. & Lace.	1	1.19	1.19	1.19	--	--
88.	<i>Haplophyllum pedicellatum</i> Bunge.	2	3.51	4.85	2.18	--	--
89.	<i>Verbascum erianthum</i> Bth.	1	2.42	2.42	2.42	--	--
90.	<i>Veronica biloba</i> L.	1	0.8	0.8	0.8	--	--

91.	<i>Daphne mucronata</i> Royle	29	8.46	38.65	0.72	1	2
92.	<i>Ampelopsis vitifolia</i> (Boiss.) Planch.	1	50.46	50.46	50.46	1	--
93.	<i>Pegānūn harmala</i> L.	6	3.48	8.93	0.99	--	--
94.	<i>Ceratocarpus arenarius</i> L.	1	0.43	0.43	0.43	--	--
95.	<i>Cymbolaena griffithii</i> (A. Gray) Wagentiz.	1	1.23	1.23	1.23	--	--
96.	<i>Lactuca viminea</i> (L.) F.W. Schmidt.	8	0.95	1.69	0.33	--	--
97.	<i>Boissiera squarrosa</i> (Bank & Soland) Nevski.	1	0.78	0.78	0.78	--	--
98.	<i>Bromus japonicus</i> Thumb	1	0.64	0.64	0.64	--	--
99.	<i>B. sericeus</i> Drobov	7	0.77	1.71	0.32	--	--
100.	<i>Chrysopogon aucheri</i> (Boiss.) Stapf.	53	11.86	61.27	0.14	8	6
101.	<i>Cymbopogon commutatus</i> (Steud.) Stapf.	44	18.48	75.09	0.42	11	5
102.	<i>Enneapogon persicus</i> Boiss.	1	2.02	2.02	2.02	--	--
103.	<i>Festuca pratensis</i> Huds.	1	1.33	1.33	1.33	--	--
104.	<i>Henrardia persica</i> (Boiss.) C.E. Hubb.	2	0.81	1.30	0.33	--	--
105.	<i>Heteranthelium piliferum</i> (Banks & Soland) Hochst.	4	2.19	4.33	0.54	--	--
106.	<i>Hordeum murinum</i> L.	1	0.85	0.85	0.85	--	--
107.	<i>Lolium perenne</i> L.	1	0.76	0.76	0.76	--	--
108.	<i>Melica persica</i> Kunth.	1	12.3	12.3	12.3	--	--
109.	<i>Piptatherum baluchistanicum</i> Freitag	8	3.82	20.04	0.5	1	--
110.	<i>Pennisetum orientale</i> L.C. Rich.	5	4.53	12.13	0.96	--	--
111.	<i>Poa sinaica</i> Steud.	3	0.52	0.55	0.48	--	--
112.	<i>Saccharum griffithii</i> Munro ex Boiss.	1	11.90	11.90	11.90	--	--
113.	<i>Stipa arabica</i> Trin. & Pupr.	45	7.09	29.72	0.41	--	7
114.	<i>Taeniatherum crinitum</i> (Schreb) Nevski.	1	0.61	0.61	0.61	--	--
115.	<i>Tetrapogon villosus</i> Desf.	3	7.51	37.33	0.73	--	--
116.	<i>Vulpia persica</i> (Boiss. & Buhse) Kreez. & Bobrov.	1	0.33	0.33	0.33	--	--
117.	<i>Tanacetum fruticosum</i> Ledeb.	2	40.78	51.36	30.21	1	1

Artemisia maritima - *Haloxylon griffithii* (East).
Artemisia maritima - *Astragalus stocksii* (East predominately sometimes West).
Nepeta juncea - *Haloxylon griffithii* (East and South East).
Nepeta juncea - *Chrysopogon aucheri* (East and North East).
Prunus brahuica - *Artemisia maritima* (East and North East).
Artemisia maritima - *Nepeta juncea* (East and South East, sometimes West).
Artemisia maritima - *Juniperus polycarpus* (North East).
Cymbopogon commutatus - *Sophora mollis* (North West and West).
Astragalus stocksii - *Convolvulus leiocalycinus* (South West).
Astragalus stocksii - *Daphne mucronata* (West and South West).

The other communities do not show preference for any particular type of aspect. The occurrence of more than one plant communities on a given aspect appears to be complicated by the degree of soil formation and development and by a number of edaphic factors. Moreover, some communities have different developmental sequence due to protection e.g., Hazarganji and Walitangi. In these areas there is a distinct difference both in quantity as well as quality (Table 4).

Vegetational Cover: Vegetation cover percentage varied from 18.31 to 50.11%. The highest vegetation cover was found in Walitangi (50.11%), followed by Hazarganji (43.74%), Spin karez (42.12%), Hanna lake area (34.53%), Zarghun (32.65%), Kach dam (32.27%), Brewery (28.62%) and Kohi Murdar (26.57%). The lowest vegetation cover percentage (18.31%) was found in Ghaza band.

Species Diversity: Species diversity as measured by the method of Menhinick (1974) ranged from 0.16 to 2.33. The following communities had high (>1.5) diversity. *Cymbopogon commutatus* - *Scabiosa oliveri* - *Pistacia khinjuk* (2.33).

Nepeta juncea - *Astragalus stocksii* (2.10).
Piptatherum baluchistanicum - *Juniperus polycarpus* - *Caragana ambigua* (1.85).
Cymbopogon commutatus - *Chrysopogon aucheri* (1.63).
Astragalus stocksii - *Salvia cabulica* - *Fraxinus xanthoxyloides* (1.61).
Gaillonia eriantha - *Chrysopogon aucheri* (1.59).
Astragalus stocksii - *Convolvulus leiocalycinus* (1.56).
Ampelopsis vitifolia - *Perovskia abrotanoides* (1.54).

The rest of the communities had moderate (1.0 - 1.5) to low (<1.0) species diversity. The lowest (0.16) species diversity was observed in *Halocharis hispida* community (Table 3)

Edaphology of Plant Communities: Soil texture varied from loamy sand to loam. *Artemisia maritima* - *Acantholimon longiflorum* was found on loamy soil. Ten communities were found on sandy clay loam and the remaining communities were found on the loamy sand to sandy loam soils (Table 4). Organic matter ranged between 0.33 to 9.83%. Seventeen communities were found on the soils having high (> 3.0) percent organic matter. The rest of the communities had moderate (1.5-3.0) to low (< 1.5) percentage of organic matter (Table 4).

Maximum water holding capacity ranged between 15.67 to 54.30%. Twenty four plant communities were found on soils having high (>40.0%) maximum water holding capacity. The rest of the communities had moderate to low water holding capacity. The lowest percentage (15.67 surface, 22.32 subsurface) of water holding capacity

Table 3. Total Cover percentage and species diversity of different plant Communities.

Site No.	Plant Communities	Cover %	Species diversity
1	2	3	4
1. <i>Artemisia maritima</i> steppe.			
3,5,15,31,35,47,89,91,92.	<i>Artemisia maritima</i> - <i>Sophora mollis</i>	47.26	1.0
7,22,42,44	<i>Artemisia maritima</i> - <i>Cymbopogon commutatus</i>	33.83	1.0
27,32,33,34,37,40	<i>Artemisia maritima</i>	28.63	0.63
57,64,65	<i>Artemisia maritima</i> - <i>Cousima stockau</i>	23.21	0.48
41,48,58,61,63,100,110	<i>Artemisia maritima</i> - <i>Nepeta juncea</i>	34.53	0.96
26,36	<i>Artemisia maritima</i> - <i>Salvia bucharica</i>	26.96	0.77
62,97	<i>Artemisia maritima</i> - <i>Haloxylon griffithii</i>	38.52	1.0
29,30,55,56,60,84,87,95,105	<i>Artemisia maritima</i> - <i>Astragalus stocksii</i>	41.01	0.80
28,90	<i>Artemisia maritima</i> - <i>Juniperus polycarpus</i>	54.96	1.30
93,112	<i>Artemisia maritima</i> - <i>Salvia cabulica</i>	49.34	0.75
8,94	<i>Artemisia maritima</i> - <i>Convolvulus leiocalycinus</i>	43.03	0.51
20	<i>Artemisia maritima</i> - <i>Kochia stellaris</i>	41.49	0.87
2	<i>Ebenus stellata</i> - <i>Artemisia maritima</i>	46.05	0.81
46	<i>Artemisia maritima</i> - <i>Acantholimon longiflorum</i>	26.84	0.54
99	<i>Artemisia maritima</i> - <i>Hertia intermedia</i>	37.66	0.94
103	<i>Artemisia maritima</i> - <i>Stipa arabica</i>	52.29	0.72
2. <i>Nepeta juncea</i> steppe			
83,108	<i>Nepeta juncea</i> - <i>Haloxylon griffithii</i>	29.98	1.35
4,75	<i>Nepeta juncea</i> - <i>Chrysopogon aucheri</i>	40.27	1.17
1	<i>Nepeta juncea</i>	41.92	0.64
6	<i>Nepeta juncea</i> - <i>Astragalus stocksii</i>	56.29	2.10
43	<i>Convolvulus leiocalycinus</i> - <i>Nepeta juncea</i>	26.00	1.21.
3. <i>Salvia cabulica</i> steppe			
54,76,86	<i>Salvia cabulica</i> - <i>Stipa arabica</i>	59.42	1.08
4. <i>Cymbopogon commutatus</i> steppe.			
10,17,106,109	<i>Cymbopogon commutatus</i> - <i>Artemisia maritima</i>	47.04	0.74
11,24	<i>Cymbopogon commutatus</i> - <i>Salvia cabulica</i>	46.68	1.07
18,23	<i>Cymbopogon commutatus</i> - <i>Sophora mollis</i>	44.93	1.42
14	<i>Cymbopogon commutatus</i> - <i>Chrysopogon aucheri</i>	29.58	1.63

Table 3. (Contd.)

1	2	3	4
16	<i>Cymbopogon commutatus</i> - <i>Scabiosa oliveri</i> - <i>Pistacia khinjuk</i>	43.6	2.33
88	<i>Cymbopogon commutatus</i>	30.22	0.75
21.	<i>Cymbopogon commutatus</i> - <i>Astragalus</i> <i>stocksii</i> - <i>Artemisia maritima</i>	45.18	1.20
5. <i>Chrysopogon aucheri</i> steppe			
82,101	<i>Chrysopogon aucheri</i> - <i>Artemisia maritima</i>	20.27	1.42
12,80,81	<i>Chrysopogon aucheri</i> - <i>Perovskia abrotanoides</i>	40.84	0.85
9	<i>Gaillonia eriantha</i> - <i>Chrysopogon aucheri</i>	36.33	1.59
52	<i>Spiraea boissieri</i> - <i>Chrysopogon aucheri</i>	40.13	0.98
13	<i>Chrysopogon aucheri</i> - <i>Perovskia atriplicifolia</i>	67.29	0.76
79	<i>Chrysopogon aucheri</i> - <i>Astragalus stocksii</i>	69.85	0.63
107	<i>Chrysopogon aucheri</i> - <i>Haloxylon griffithii</i>	32.49	0.90
6. <i>Sophora mollis</i> steppe.			
59,66	<i>Sophora mollis</i> - <i>Artemisia maritima</i>	26.56	1.04
53	<i>Sophora mollis</i> - <i>Salvia cabulica</i>	38.81	0.96
72	<i>Sophora mollis</i> - <i>Stipa arabica</i>	47.94	0.88
87	<i>Sophora mollis</i> - <i>Nepeta juncea</i>	28.28	0.79
7. <i>Astragalus stocksii</i> steppe.			
49,74,77	<i>Astragalus stocksii</i> - <i>Convolvulus leicalycinus</i>	21.16	1.56
69,85	<i>Astragalus stocksii</i> - <i>Daphne mucronata</i>	55.15	1.33
51	<i>Astragalus stocksii</i> - <i>Salvia cabulica</i> - <i>Fraxinus</i> <i>xanthoxyloides</i>	46.86	1.61
70	<i>Astragalus stocksii</i> - <i>Sophora mollis</i> - <i>Artemisia</i> <i>maritima</i> .	33.58	0.89
8. <i>Prunus brahuica</i> steppe.			
25,39	<i>Prunus brahuica</i> - <i>Artemisia maritima</i>	38.14	1.16
9. Disjunct steppe.			
78	<i>Juniperus polycarpus</i> - <i>Ephedra gerardiana</i> - <i>Nepeta juncea</i>	30.43	1.73

104	<i>Spiraea boissieri</i> - <i>Tanacetum fruticosum</i>	34.73	0.35
73	<i>Perovskia abrotanoides</i> - <i>Stipa arabica</i>	64.36	0.70
96	<i>Perovskia abrotanoides</i> - <i>Hertia intermedia</i>	52.36	0.92
98	<i>Haloxylon griffithii</i>	43.8	1.0
102	<i>Trigonella gharuensis</i>	32.33	0.56
111	<i>Berberis baluchistanica</i> - <i>Chrysopogon aucheri</i>	57.4	1.07
113	<i>Piptatherum baluchistanicum</i> - <i>Juniperus polycarpos</i> - <i>Caragana ambigua</i>	49.91	1.85
19	<i>Cotoneaster nummularia</i> - <i>Caragana ambigua</i>	30.75	0.64
50	<i>Ampelopsis vitifolia</i> - <i>Perovskia abrotanoides</i>	45.86	1.54
38	<i>Halocharis hispida</i>	15.43	0.16
71	<i>Tanacetum fruticosum</i> - <i>Stipa arabica</i>	49.22	0.76

* Protected areas

was found in the soil of *Cotoneaster nummularia*- *Caragana ambigua* community (Table 4).

pH was found to vary from 7.5 to 8.4: Electrical conductivity was found to vary between 0.4 to 8.0 mmhos/cm. The highest E.C. (4.0, 8.0) was found in the soil of *Halocharis hispida* community. The rest of the communities were found on the soils having moderate to low E.C. The lowest (0.4) E.C. was found in the following three communities.

Spiraea boissieri - *Chrysopogon aucheri* (0.4, subsurface).

Spiraea boissieri - *Tanacetum fruticosum* (0.4, subsurface).

Artemisia maritima - *Hertia intermedia* (0.4, subsurface).

Calcium carbonate varied from 4.09 to 44.79%. Twenty eight communities were found on the soils having high (> 30.0%) calcium carbonate content, and remaining communities had moderate to low calcium carbonate content. The lowest percentage (4.09, subsurface) of calcium carbonate was found in the soils of *Berberis baluchistanica* - *Chrysopogon aucheri* community (Table 5).

The soils did not differ much with respect to soil bicarbonate, varying from 1.0 to 4.0 meq./liter. The soils of the following seven communities had moderate (>3.0) bicarbonate content.

Convolvulus leiocalycinus - *Nepeta juncea* (4.0).

Perovskia abrotanoides - *Stipa arabica* (4.0).

Piptatherum baluchistanicum - *Juniperus polycarpos*- *Caragana ambigua* (4.0).

Artemisia maritima - *Acantholimon longiflorum* (4.0, subsurface).

Berberis baluchistanica - *Chrysopogon aucheri* (4.0, subsurface).

Artemisia maritima- *Salvia cabulica* (3.25, subsurface).

The rest of the communities had low bicarbonate content (Table 5).

The soil chlorides were found varying from 5.0 to 48.0 meq./liter. The soils of eleven communities had high chloride content (> 15.0). The highest chlorides content (30.0, 48.0) was found in the soils of *Halocharis hispida* community. The remaining communities had moderate (10.0 - 15.0 meq./liter) to low (< 10.0 meq./liter)

Table 4. Topographic and soil (Physical) Characteristics of the Communities of Hills.

Name of Communities	Total No. of stands	Topography	Sand % (Range)	Silt % (Range)	Clay % (Range)	Taxtural Class (Range)	Organic matter % (Range)	Maximu Water Holding capacity (Range)	
	1	2	3	4	5	6	7	8	9
I. <i>Artemisia maritima</i> steppe									
<i>Artemisia maritima-</i>									
<i>Sophora mollis</i> -T	9	E.E,W,W	78.88-85.76	2.72-7.28	8.4-15.05	L.S-S.L.	0.33-3.00	24.20-46	
		W,NW,N.E.	71.6-86.48	1.36-14.42	1.76-14.8	L.S-S.L	1.0-2.37	23.50-44	
<i>Artemisia maritima-</i>	4	W,W,W,W	67.12-87.84	3.04-14.32	9.12-18.8	L.S-S.L	0.33-12.35	27.09-47	
<i>Cymbopogon comnutatus</i>			67.36-88.32	2.56-13.84	9.12-18.8	L.S-S.L.	0.33-1.0	26.68-49	
<i>Artemisia maritima</i>	6	W,W,E,NW	58.88-79.12	2.8-26.32	14.56-22.08	S.L-S.C.L.	0.33-4.6	24.5-39	
		NW,SE.	66.16-82.88	1.84-15.52	15.28-21.62	S.L-S.C.L.	0.33-4.9	22.5-40.	
<i>Artemisia maritima-</i>	7	E.E,W,W,W.	66.88-86.48	1.36-14.80	10.08-18.32	L.S-S.L.	0.39-2.26	14.75-36	
<i>Nepeta juncea</i>		SE,SE.	68.64-83.86	1.6-12.8	13.12-22.32	L.S-S.L.	0.33-9.02	22.13-34	
<i>Artemisia maritima-</i>	3	E.E,W.	85.76-89.04	2.56-4.16	8.4-10.08	L.S-L.S.	0.85-3.5	10.83-28	
<i>Cousinia stocksii</i>			75.36-78.88	2.32-5.6	18.8-19.04	S.L-S.L.	0.33-0.66	17.53-25	
<i>Artemisia maritima-</i>	2	E.E.	76.32-81.92	1.84-3.28	14.8-21.84	L.S-S.L.	0.66-3.62	37.86-43	
<i>Salvia bucharica</i>			74.4-83.12	2.72-7.04	14.16-18.56	S.L-L.S.	0.33-3.65	34.32-45	
<i>Artemisia maritima</i>	2	E.E.	78.76-82.84	2.32-7.16	14.08-15.08	S.L-S.L.	0.66-4.62	25.93-50	
<i>Haloxylon griffithii</i>			82.76-83.36	1.6-3.16	14.08-15.64	S.L-S.L.	0.33-3.65	12.08-46	
<i>Artemisia maritima-</i>	9	E.E.E.E.E.	64.80-82.76	2.56-10.32	14.56-25.6	S.L-L.S	1.66-3.37	28.64-47	

<i>Astragalus stocksii</i>		E. W. W. SW.	52.56-82.76	3.16-29.12	10.56-25.6	S.C.L-L.S.	1.16-9.7	31.95-52
<i>Artemisia maritima-</i>	2	NE, NE.	78.64-78.76	2.8-7.16	14.08-18.56	S.L.-S.L.	2.90-3.5	34.37-34
<i>Juniperus polycarpus</i>			71.6-74.76	7.6-11.16	14.08-21.62	S.L.-S.L.	5.12-6.12	34.14-41
<i>Artemisia maritima-Salvia</i>	2	SW, NE.	76.0-78.0	4.0-4.0	18.0-20.0	S.L.-S.L.	1.5-3.05	29.40-48
<i>cabulica</i>			72.0-78.0	4.0-6.0	16.0-24.0	S.L.-S.C.L.	1.85-2.80	30.83-34
<i>Artemisia maritima-</i>	2	SE, NE.	83.6-83.84	1.6-3.28	12.36-14.56	L.S-L.S.	1.0-2.26	29.06-37
<i>Convulvulus leiocalycinus</i>			83.36-83.84	1.6-3.04	13.6-14.56	L.S-L.S	1.33-9.02	34.11-42
<i>Artemisia maritima-Kochia</i>	1	E.	85.82	2.08	12.4	L.S.	1.33	43.64
<i>stellaris</i>			84.8	8.4	6.8	L.S.	2.66	46.39
<i>Ebenus stellata-Artemisia</i>	1	W.	88.56	3.04	8.4	L.S.	0.33	20.96
<i>maritima</i>			82.00	7.92	10.08	L.S.	0.66	39.00
<i>Artemisia maritima-</i>	1	NE	68.88	6.56	24.56	S.C.L.	1.33	33.91
<i>Acantholimon longiflorum</i>			50.88	30.8	18.31	Loam	1.86	51.46
<i>Artemisia maritima-</i>	1	W.	83.36	3.04	13.6	L.S.	3.05	29.40
<i>Hertia intermedia</i>			83.12	3.28	13.6	L.S.	2.80	30.83
<i>Artemisia maritima-</i>	1	SE.	85.92	3.4	10.68	L.S.	2.72	41.57
<i>Stipa arabica</i>			85.92	0.48	13.6	L.S.	4.67	42.99

2. *Nepeta juncea steppe*

<i>Nepeta juncea-</i>	2	E., SE.	79.36-82.84	1.6-2.32	15.04-19.04	S.L-S.L.	0.66-1.00	25.93-31
<i>Haloxylon griffithii</i>			79.36-83.36	1.6-5.6	15.04-15.04	S.L-S.L.	0.33-0.66	22.08-27
<i>Nepeta juncea-</i>	2	E., NE.	72.32-83.36	1.84-5.36	14.8-22.32	S.L-L.S.	1.66-9.70	40.66-41
<i>Chrysopogon aucheri</i>			82.4-86.00	2.8-3.92	10.08-14.8	L.S-L.S.	1.13-3.00	19.48-37
<i>Nepeta juncea-</i>	1	E.	89.52	2.32	8.16	L.S.	0.66	22.51
			84.56	7.52	7.92	L.S.	1.33	27.52
<i>Nepeta juncea</i>	1	W	82.88	5.12	12.00	L.S.	1.0	47.74
<i>Astragalus stocksii</i>			83.84	3.04	13.12	L.S.	1.0	38.76
<i>Convulvulus leiocalycinus-</i>	1	NE.	89.52	2.08	8.4	L.S.	0.66	40.27
<i>Nepeta juncea</i>			73.04	18.56	8.4	L.S.	1.33	41.03

5 *Chrysopogon aucheri* steppe

<i>Chrysopogon aucheri-</i>	2	W., W.	79.36-81.64	3.28-3.76	12.88-14.8	L.S.-L.S.	1.6-1.99	28.15-30
<i>Artemisia maritima</i>			83.36-85.44	3.28-3.76	10.8-13.36	L.S.-L.S.	1.37-2.06	31.68-34
<i>Chrysopogon aucheri-</i>	3	NE., S., NW.	63.6-84.56	0.88-13.84	14.56-22.56	S.C.L.-L.S.	1.00-4.16	37.71-41
<i>Perovskia abrotanoides</i>			67.36-83.84	1.6-10.08	14.32-22.56	S.C.L.-L.S.	1.03-2.03	34.20-40
<i>Gaillonia eriantha-</i>	1	SW.	85.52	2.08	12.4	L.S.	0.33	32.90
<i>Chrysopogon aucheri</i>			59.6	17.12	23.28	S.C.L.	0.66	33.21
<i>Spiraea boissieri-</i>	1	NW.,	83.12	14.08	2.8	L.S.	4.06	42.04
<i>Chrysopogon aucheri</i>			83.12	14.08	2.8	L.S.	1.73	37.59
<i>Chrysopogon aucheri-</i>	1	W.	86.48	1.36	12.16	L.S.	4.33	42.36
<i>Perovskia arpicifolia</i>			84.08	3.04	12.88	L.S.	1.00	41.46
<i>Chrysopogon aucheri-</i>	1	NW.	79.36	1.6	19.04	S.L.	1.00	31.05
<i>Astragalus stocksii</i>			79.36	5.6	15.04	S.L.	0.66	27.94
<i>Chrysopogon aucheri-</i>	1	E.	79.36	1.6	19.04	S.L.	1.00	31.05
<i>Haloxylon griffithii</i>			79.36	5.6	15.04	S.L.	0.66	27.94

6 *Sophora mollis* steppe

<i>Sophora mollis-</i>	2	E., NW.	71.12-84.32	1.12-6.08	14.56-22.8	S.L.-L.S.	0.33-1.33	21.96-23
<i>Artemisia maritima</i>			80.08-86.24	3.68-5.36	10.08-14.56	L.S.-S.L.	0.33-1.66	27.18-33
<i>Sophora mollis-Savva</i>	1	W.,	79.12	2.8	18.08	S.L.	1.13	35.21
<i>cabulica</i>			78.88	3.04	18.08	S.L.	0.73	35.27
<i>Sophora mollis-</i>	1	NE.,	60.0	12.0	28.0	S.C.L.	1.65	44.38
<i>Supa arabica</i>			60.0	8.0	32.00	S.C.L.	2.85	29.59
<i>Sophora mollis-</i>	1	E.	60.0	8.0	32.00	S.C.L.	1.33	35.71
<i>Nepeta juncea</i>			56.0	16.0	28.00	S.C.L.	1.45	37.59

Table 4. (Contd.)

1	2	3	4	5	6	7	8	9
7. <i>Astragalus stocksii</i> steppe								
<i>Astragalus stocksii</i>	3	SW., SW., E.	67.6-79.48	5.48-13.6	15.04-18.8	S.L.-S.L.	1.23-2.06	39.00-45
<i>Convolvulus leiocalyceus</i>			67.36-79.6	1.48-13.84	14.52-18.92	S.L.-S.L.	0.43-1.80	33.03-35
<i>Astragalus stocksii</i>	2	W., SW.	79.36-83.12	1.84-2.56	15.04-18.08	S.L.-S.L.	0.83-2.03	30.30-30
<i>Daphne mucronata</i>			71.36-79.48	1.72-10.8	17.84-18.8	S.L.-S.L.	1.73-2.36	32.98-35
<i>Astragalus stocksii</i> - <i>Sabia</i>	1	SW.	83.12	2.32	14.56	L.S.	9.83	41.85
<i>cabulica</i> - <i>Fraxinus xanthoxy-</i> <i>loides</i> .			83.6	1.84	14.56	L.S.	4.80	28.38
<i>Astragalus stocksii</i> - <i>Sophora</i>	1	E.	60.00	12.0	28.00	S.C.L.	1.3	40.47
<i>mollis</i> - <i>Aremisia maritima</i>			56.0	20.0	24.00	S.C.L.	2.00	41.23
8. <i>Prunus brahuica</i> steppe								
<i>Prunus brahuica</i>	2	NE., N.	72.32-86.48	1.36-5.36	12.16-22.32	L.S.-S.L.	0.33-1.33	16.79-44
<i>Aremisia maritima</i>			78.88-86.24	1.36-6.08	12.4-15.04	L.S.-S.L.	1.33-1.66	36.68-45
<i>Disjunct stands</i>	1	W	75.12	6.08	18.8	S.L.	0.90	39.40
<i>Juniperus polycarpus</i>			74.88	2.08	23.04	S.C.L.	4.1	46.72
<i>Ephedra Gerardiana</i>								
<i>Nepeta juncea</i>								
<i>Spiraea boissiera</i>	1	SW.	85.4	1.24	13.36	L.S.	3.25	31.23
<i>Tanacetum fruticosum</i>			83.6	2.8	13.6	L.S.	3.27	37.36

<i>Perovskia abrotanoides-</i>	1	SE.	60.00	12.00	28.00	S.C.L.	2.05	54.38
<i>Supa arabica</i>			60.00	8.00	32.00	S.C.L.	2.3	50.21
<i>Perovskia abrotanoides-</i>	1	E.	83.6	2.56	13.84	L.S.	0.7	35.80
<i>Hertia intermedia</i>			79.84	2.56	17.6	L.S.	2.42	27.28
<i>Haloxylon griffithii</i>	1	W	80.08	6.32	13.6	S.L.	3.2	43.59
			80.08	1.96	17.96	S.L.	4.37	38.64
<i>Trigonella gharuensis</i>	1	NE.	85.68	3.52	10.8	L.S.	3.00	46.94
			82.16	3.04	14.8	L.S.	2.37	31.6
<i>Berberis baluchistanica-</i>	1	E.	76.0	8.0	16.00	S.L.	1.85	32.80
<i>Chrysopogon aucheri</i>			68.0	8.0	24.00	S.C.L.	2.4	35.07
<i>Piptatherum baluchis-</i>	1	SW.	72.0	4.0	24.00	S.C.L.	1.35	31.54
<i>tanicum-Juniperus poly-</i>			72.0	4.0	24.00	S.C.L.	6.3	41.67
<i>carpos-Caragana ambigua</i>								
<i>Cotoneaster nummularia-</i>	1	NE.	81.76	5.84	12.4	L.S.	1.00	15.67
<i>Caragana ambigua</i>			79.84	7.04	13.12	S.L.	1.00	22.32
<i>Ampelopsis vitifolia-</i>	1	NW.	76.32	9.12	14.56	S.L.	6.8	40.14
<i>Perovskia abrotanoides</i>			72.32	9.6	18.08	S.L.	4.1	29.08
<i>Halocharis hispida</i>	1	E.	64.08	14.32	21.6	S.C.L.	2.3	48.41
			68.56	13.12	18.32	S.L.	1.80	44.48
<i>Tanacetum fruticosum-</i>	1	SE.	56.00	16.00	28.00	S.C.L.	1.3	35.76
<i>Supa arabica</i>			60.00	8.00	32.00	S.C.L.	1.95	46.29

L.S. = Loamy sand

S.L. = Sandy loam

S.C.L. = Sandy clay loam

Table 5. Chemical Characteristics of the Communities of Hills.

Name of Communities	pH	E.C. mmhos/cm	CaCO ₃ %	HCO ₃ meq./l.	Cl meq./l.	Ca + Mg meq./l.
	1	2	3	4	5	6
1. <i>Artemisia maritima</i> steppe						
<i>Artemisia maritima</i> - <i>Sophora mollis</i>	7.6-8.2 7.5-8.4	0.5-1.8 0.5-2.3	24.46-35.6 18.18-40.31	1.0-3.0 1.0-2.5	5.0-18.0 5.0-31.0	7.0-8.0 6.0-8.0
<i>Artemisia maritima</i> - <i>Cymbopogon commutatus</i>	7.9-8.00 7.9-8.2	0.5-1.0 0.6-2.1	40.47-8.64 29.33-43.20	1.5-1.5 1.5-1.5	6.0-11.5 7.0-25.0	7.0-8.0 7.0-7.0
<i>Artemisia maritima</i>	7.5-8.0 7.6-8.2	0.4-1.2 0.4-2.0	15.0-58.44 11.59-25.11	1.0-2.0 1.0-3.0	7.0-14.0 9.0-12.0	5.0-9.0 6.0-8.0
<i>Artemisia maritima</i> - <i>Nepeta</i> <i>juncea</i>	7.8-8.2 7.9-8.3	0.4-2.4 0.4-2.0	16.73-29.85 21.94-41.04	1.0-1.5 1.0-1.5	8.0-27.5 5.0-27.0	6.0-9.0 6.0-9.0
<i>Artemisia maritima</i> - <i>Cousinia stocksii</i>	7.6-7.7 7.7-7.9	0.7-0.8 0.6-0.7	29.69-35.95 12.23-36.27	1.0-1.5 1.0-1.5	12.0-20.0 12.0-14.0	5.7-8.0 7.2-9.0
<i>Artemisia maritima</i> - <i>Salvia bucharica</i>	7.4-7.8 7.5-7.8	0.6-1.0 0.3-0.6	20.01-26.15 21.7-23.19	1.5-2.0 1.0-1.5	8.0-10.0 7.5-8.5	5.0-8.0 8.0-9.0
<i>Artemisia maritima</i> - <i>Haloxylon griffithii</i>	7.9-8.0 8.1-8.3	0.7-0.8 0.6-1.9	15.30-41.81 11.37-29.83	1.0-1.0 1.5-1.5	7.0-9.0 7.5-8.5	7.0-9.0 8.0-8.0
<i>Artemisia maritima</i> - <i>Astragalus stocksii</i>	7.7-8.8 7.9-8.6	0.3-0.5 0.4-0.6	4.61-36.92 17.73-28.42	1.5-2.0 1.0-1.5	6.0-9.0 7.0-9.5	6.0-11.0 6.0-10.0
<i>Artemisia maritima</i> - <i>Juniperus polycarpus</i>	7.5-7.7 7.6-7.9	0.4-0.8 0.4-0.5	24.55-35.92 25.01-32.06	1.0-1.5 1.5-1.5	6.0-8.0 8.0-9.0	5.0-9.0 6.0-8.0
<i>Artemisia maritima</i> - <i>Salvia cabulica</i>	7.8-8.0 7.8-8.1	0.6-0.8 0.4-0.8	15.30-26.15 16.37-21.37	1.0-5.0 1.0-5.0	10.0-16.0 8.0-16.0	10.0-12.0 11.0-13.0
<i>Artemisia maritima</i> - <i>Convolvulus leiocalycinus</i>	7.9-7.9 8.0-8.1	0.6-0.8 0.5-0.6	25.35-31.32 26.38-32.35	1.0-1.0 1.0-1.0	8.0-10.0 8.5-10.0	8.0-9.0 9.0-9.0

Table 5 (Cont'd)

	1	2	3	4	5	6
<i>Artemisia maritima</i> -	7.7	0.8	11.82	1.0	7.0	6.0
<i>Kochia stellaris</i>	7.8	1.00	15.23	1.5	7.0	8.0
<i>Ebenus stellata</i> -	7.7	0.9	34.75	1.5	10.0	7.0
<i>Artemisia maritima</i>	7.8	1.4	33.40	1.5	8.0	8.0
<i>Artemisia maritima</i> -	8.1	0.6	25.46	3.0	20.0	15.0
<i>Acantholimon longiflorum</i>	8.3	0.7	25.01	4.0	20.0	15.0
<i>Artemisia maritima</i> -	8.0	0.6	15.30	1.0	13.0	12.0
<i>Hertia intermedia</i>	8.1	0.4	16.36	1.5	14.0	13.0
<i>Artemisia maritima</i> -	8.1	0.6	43.20	1.5	9.0	8.0
<i>Stipa arabica</i>	8.2	0.6	27.06	2.0	9.0	8.0

2. *Nepeta juncea* steppe

<i>Nepeta juncea</i> -	8.0-8.0	0.6-0.7	34.67-41.81	1.5-1.5	9.0-11.0	7.0-9.0
<i>Haloxylon griffithii</i>	8.1-8.3	0.6-0.6	29.83-31.54	1.5-1.5	10.0-12.0	8.5-9.5
<i>Nepeta juncea</i> -	7.7-7.8	0.7-0.9	15.37-34.20	1.5-1.5	8.0-8.0	6.0-8.0
<i>Chrysopogon aucheri</i>	7.8-7.9	0.6-1.4	22.33-35.10	1.5-1.5	7.5-8.5	8.0-8.0
<i>Nepeta juncea</i>	7.7	0.8	37.5	1.5	10.0	6.0
	7.7	0.5	35.6	1.5	8.0	8.0
<i>Nepeta juncea</i> -	8.0	0.6	43.29	1.5	9.0	7.0
<i>Astragalus stocksii</i>	8.2	0.6	34.38	1.5	8.0	8.0
<i>Convolvulus leiocalycinus</i> -	7.8	1.1	14.32	4.0	10.0	2.0
<i>Nepeta juncea</i>	8.0	0.9	7.27	4.0	10.0	2.0

3 *Salvia cabulica* steppe

<i>Salvia cabulica</i> -	7.7-7.8	0.5-0.6	25.35-36.81	1.5-2.0	6.0-8.0	7.0-10.0
<i>Stipa arabica</i>	7.9-8.0	0.4-0.6	27.17-39.2	1.0-1.5	7.0-10.0	8.0-9.0

4 *Cymbopogon commutatus* steppe

<i>Cymbopogon commutatus</i> -	7.7-8.1	0.7-1.1	13.87-41.81	1.0-1.5	6.0-10.0	6.0-8.0
<i>Artemisia maritima</i>	7.9-8.1	0.5-0.9	29.17-35.31	1.0-1.5	6.0-10.0	6.0-8.0
<i>Cymbopogon commutatus</i> -	7.7-8.1	0.6-0.8	17.05-35.06	1.0-1.5	8.0-10.0	8.0-8.0
<i>Salvia cabulica</i>	7.7-8.2	0.6-0.7	24.10-40.49	1.5-1.5	7.0-10.0	7.0-7.0

Table 5 (Cont'd)

	1	2	3	4	5	6
<i>Cymbopogon commutatus</i> - <i>Sophora mollis</i>	7.8-8.0 7.9-8.2	0.6-1.0 0.5-0.9	22.77-29.34 23.64-29.72	1.0-1.5 1.5-1.5	5.0-10.0 4.5-9.5	6.0-7.0 7.0-8.0
<i>Cymbopogon commutatus</i> - <i>Chrysopogon aucheri</i>	7.7 7.8	0.9 0.7	32.72 31.10	1.5 1.0	6.5 8.0	7.0 5.0
<i>Cymbopogon commutatus</i> - <i>Scabiosa oliveri</i> - <i>Pistacia khinjuk</i>	7.8 7.9	0.6 0.8	31.99 28.92	1.5 1.0	7.5 7.0	8.0 7.0
<i>Cymbopogon commutatus</i>	8.00 7.9	1.7 1.9	25.10 26.8	3.0 1.5	16.0 18.0	16.00 14.0
<i>Cymbopogon commutatus</i> - <i>Astragalus stocksii</i> - <i>Artemisia mariitima</i>	7.9 8.3	0.7 0.9	9.55 13.87	1.5 2.0	8.0 6.5	7.0 8.0
5. <i>Chrysopogon aucheri</i> steppe						
<i>Chrysopogon aucheri</i> - <i>Artemisia mariitima</i>	7.8-7.9 7.9-8.0	0.7-0.8 0.6-0.7	20.46-24.56 26.15-28.25	1.5-2.5 1.0-1.5	11.0-12.0 10.0-12.0	8.0-11.0 8.0-13.0
<i>Chrysopogon aucheri</i> - <i>Perovskia abrotanoides</i>	7.7-8.2 7.7-8.8	0.5-0.8 0.5-0.7	23.46-42.29 33.42-39.40	1.5-1.5 1.0-1.5	9.0-13.0 10.33-13.5	8.0-14.0 7.0-15.0
<i>Gaillonia eriantha</i> - <i>Chrysopogon aucheri</i>	7.8 7.9	0.9 0.9	35.65 40.95	1.0 1.0	8.0 9.0	8.0 8.0
<i>Spiraea boissieri</i> - <i>Chrysopogon aucheri</i>	7.6 7.8	0.6 0.4	34.38 17.46	2.0 1.0	8.0 8.0	8.0 7.0
<i>Chrysopogon aucheri</i> - <i>Perovskia atriplicifolia</i>	7.8 7.9	0.8 0.6	22.78 14.68	1.0 1.5	7.0 7.5	6.0 8.0
<i>Chrysopogon aucheri</i> - <i>Astragalus stocksii</i>	8.0 8.1	0.6 0.6	34.67 31.54	1.5 1.5	7.5 8.0	7.0 7.0
<i>Chrysopogon aucheri</i> - <i>Haloxylon griffithii</i>	8.0 8.1	0.6 0.6	34.67 31.54	1.5 1.5	7.5 8.0	7.0 7.0
6. <i>Sophora mollis</i> steppe						
<i>Sophora mollis</i> - <i>Artemisia</i> <i>mariitima</i>	7.6-7.7 7.7-7.8	0.5-0.5 0.4-0.6	28.60-31.17 14.46-17.03	1.5-1.5 1.0-1.5	15.0-16.5 15.5-18.0	7.0-22.0 7.0-23.0

Table 5 (Cont'd)

	1	2	3	4	5	6
<i>Sophora mollis</i> -	7.9	0.5	26.99	1.0	8.0	8.0
<i>Salvia cabulica</i>	7.8	0.5	30.83	1.0	7.5	8.0
<i>Sophora mollis</i> -	8.0	0.6	28.65	3.0	14.0	15.0
<i>Stipa arabica</i>	8.1	0.8	20.46	3.0	15.0	17.0
<i>Sophora mollis</i> -	8.0	1.5	22.6	1.5	16.0	16.0
<i>Nepeta juncea</i>	7.9	1.3	23.5	1.5	12.0	13.0
7. <i>Astragalus stocksii</i> steppe						
<i>Astragalus stocksii</i> -	7.9-8.0	0.7-0.9	3.40-40.47	1.5-1.5	8.5-9.5	7.0-10.5
<i>Convolvulus leiocalycinus</i>	7.9-7.9	0.5-0.9	25.65-45.48	1.0-1.5	8.0-16.5	8.0-9.0
<i>Astragalus stocksii</i> -	7.7-8.0	0.5-0.6	14.61-25.35	1.5-1.5	8.0-8.0	7.0-9.0
<i>Daphne mucronata</i>	7.9-8.0	0.4-0.5	23.53-39.02	1.0-1.5	8.0-9.0	8.0-9.0
<i>Astragalus stocksii</i> -	7.9	1.0	22.03	1.0	7.5	8.0
<i>Salvia cabulica</i> -	7.8	0.6	18.89	1.5	9.5	9.0
<i>Fraxinus xanthoxyloides</i>						
<i>Astragalus stocksii</i> -	7.5	0.9	23.19	2.0	16.0	15.0
<i>Sophora mollis</i> -	7.9	1.2	30.69	2.0	17.0	15.0
<i>Artemisia maritima</i>						
8. <i>Prunus brahuica</i> steppe						
<i>Prunus brahuica</i> -	7.6-8.1	0.5-0.7	20.28-20.94	1.5-2.5	10.0-10.0	8.0-10.0
<i>Artemisia maritima</i>	7.9-8.2	0.5-0.6	19.78-24.90	1.0-2.0	11.0-13.0	7.0-9.0
9. Disjunct stands						
<i>Juniperus polycarpus</i> -	8.0	0.5	22.21	1.5	8.5	9.0
<i>Ephedra gerardiana</i> -	7.8	0.6	33.20	1.5	9.0	9.0
<i>Nepeta juncea</i>						
<i>Spirasea boissieri</i> -	8.2	0.6	22.74	1.5	8.0	9.0
<i>Tanacetum fruticosum</i>	8.4	0.4	6.18	1.5	7.59	8.0
<i>Perovskia abrotanoides</i> -	7.9	1.3	20.45	4.0	13.0	16.0
<i>Stipa arabica</i>	7.9	0.9	17.73	4.0	9.0	11.0
<i>Perovskia abrotanoides</i> -	7.9	2.2	12.96	1.5	8.0	8.0
<i>Herua intermedia</i>	7.8	1.7	22.05	1.5	9.0	9.0

Table 5 (Cont'd)

	1	2	3	4	5	6
<i>Haloxylon griffithii</i>	7.5	1.1	34.56	1.0	19.0	9.0
	7.7	0.9	14.09	1.5	10.0	9.0
<i>Trigonella gharuensis</i>	7.9	0.9	35.46	2.0	11.0	8.0
	7.8	1.0	36.44	2.0	21.0	8.0
<i>Berberis baluchistanica-</i>	7.9	0.6	26.83	3.0	28.0	24.0
<i>Chrysopogon aucheri</i>	7.8	0.7	4.09	4.0	23.0	19.0
<i>Piptatherum baluchis-</i>	7.9	0.5	27.51	4.0	13.0	6.0
<i>tanicum-Juniperus</i>	7.9	0.6	18.64	4.0	15.0	6.0
<i>polycarpus-Caragana ambigua</i>						
<i>Cotoneaster nummularia-</i>	7.9	0.8	33.85	1.5	5.0	5.0
<i>Caragana ambigua</i>	7.0	0.7	32.06	1.5	6.0	6.0
<i>Ampelopsis vibifolia-</i>	7.7	0.8	28.22	1.0	8.0	9.0
<i>Perovskia abrotanoides</i>	8.1	1.0	30.92	1.0	8.0	7.0
<i>Halocharis hispida</i>	7.6	4.0	44.45	1.5	30.0	10.0
	7.7	8.0	44.79	2.0	48.0	10.0
<i>Tanaceum fruticosum-</i>	7.9	1.0	16.82	3.0	10.0	11.0
<i>Stipa arabica</i>	8.0	0.9	20.01	3.0	10.0	11.0

chloride content. The lowest chloride (5.0, surface) was found in *Cotoneaster nummularia - Caragana ambigua* community (Table 5).

The combined content of calcium plus magnesium varied from 2.0 to 24.0 meq./liter. Five communities had high (> 15.0 meq./liter) calcium plus magnesium content. The highest percentage (24.9, 19.0) of calcium plus magnesium was found in *Berberis baluchistanica - Chrysopogon aucheri* community. Eight communities had moderate (10.0 - 15.0) calcium plus magnesium content and the remaining communities had low (< 10.0 meq./liter) calcium plus magnesium content.

The lowest (2.0 meq./liter) calcium plus magnesium content was found in *Convolvulus leiocalycinus - Nepeta juncea* community (Table 5).

* = Surface

** = Subsurface

Discussion

The plant communities on the hills of Quetta district have been classified into 9 broad vegetation types, *Artemisia maritima* steppe is the most prevalent steppe on the hills of Quetta district followed by *Cymbopogon commutatus*, *Chrysopogon aucheri*, *Nepeta juncea* and *Astragalus stocksii*. In the protected areas like Hazarganji, Karkhasa, however, *Cymbopogon commutatus* steppe is more common.

Out of 57 communities of the hills, 30 communities were found in the protected areas of Chiltan, Hazarganji, Walitangi and Karkhasa. 19 communities were found in unprotected areas, whereas 8 communities are common to both protected and unprotected areas.

The species common in protected areas were: *Artemisia maritima*, *Ebenus stellata*, *Nepeta juncea*, *Salvia cabulica*, *Cymbopogon commutatus*, *Chrysopogon aucheri*, *Gaillonia eriantha*, *Ferula oopoda*, *Ferula bahuchistanica*, *Spiraea boissieri*, *Sophora mollis*, *Astragalus stocksii*, *Prunus brahuica*, *Fraxinus xanthoxyloides*, *Pistacia khinjuk*, *Juniperus polycarpus* and *Ephedra gerardiana*.

The species common in both protected and unprotected areas were *Artemisia maritima*, *Convolvulus leiocalycinus*, *Chrysopogon aucheri*, *Sophora mollis*, *Spiraea boissieri*, *Perovskia abrotanoides*, *Haloxylon griffithii*, *Trigonella gharuensis*, *Halocharis hispida* and *Prunus brahuica*.

Vegetation cover was quite high in the protected areas as compared to unprotected areas because of lack of human disturbance and grazing pressure in protected areas. Several workers (Repp & Khan, 1958; Said & Hussain, 1959; Irshad, 1961; Beg & Repp, 1966 and Khan, 1977) have reported increased total coverage in a number of enclosures in Balochistan.

Only 13 communities show some correlations with certain aspects of the hills. *Artemisia maritima* - *Cymbopogon commutatus* (protected and unprotected), *Chrysopogon aucheri* - *Artemisia maritima* (unprotected) and *Cymbopogon commutatus* - *Sophora mollis* (protected), communities were found on the West and North-Western aspect.

Artemisia maritima - *Salvia bucharica* (unprotected), *Artemisia maritima* - *Haloxylon griffithii* (unprotected) and *Artemisia maritima* - *Astragalus stocksii* (protected and unprotected), communities were found on the Eastern aspect only. *Nepeta juncea* - *Haloxylon griffithii* (unprotected) and *Artemisia maritima* - *Nepeta juncea* (unprotected) communities were found on the East and South-East. *Nepeta juncea* - *Chrysopogon aucheri* - *Haloxylon griffithii* (unprotected) and *Prunus brahuica* - *Artemisia maritima* (protected and unprotected) communities were found on North - East. *Astragalus stocksii* - *Convolvulus leiocalycinus* (protected and unprotected) and *Astragalus stocksii* - *Daphne mucronate* (protected) communities were found on the West and South - West.

It may be mentioned that no previous work has evaluated the topographic correlation of communities of hills.

Diagnostic edaphic features of various steppe types found in the hills of Quetta district are as under:-

1. *Artemisia maritima* steppe: Low E.C., HCO₃ and Ca + Mg, medium to high organic matter.
2. *Nepeta juncea* steppe: Low Ca + Mg, HCO₃, E.C. and organic matter, medium to high CaCO₃.
3. *Salvia cabulica* steppe: Low organic matter, maximum water holding capacity, E.C., HCO₃, Cl and Ca + Mg. High CaCO₃.
4. *Cymbopogon commutatus*: Low maximum water steppe: holding capacity. E.C. HCO₃, Cl and Ca + Mg. Medium organic matter, and high to medium CaCO₃.
5. *Chrysopogon aucheri* steppe: Low E.C., low to medium HCO₃, Cl and CaCO₃.
6. *Sophora mollis* steppe: Low organic matter, E.C. and HCO₃. Medium maximum water holding capacity, Cl, Ca + Mg. and CaCO₃.
7. *Astragalus stocksii* steppe: Medium organic matter, maximum water holding capacity and CaCO₃. Low E.C., HCO₃, and Ca + Mg.
8. *Prunus brahuica* steppe: Low organic matter, E.C. CaCO₃, HCO₃ and Ca + Mg, Medium maximum water holding capacity and Cl.

A number of dominant species of hills in Quetta district may be considered as "indicator species". Their dominance in certain areas most probably indicates specific environmental conditions. The occurrence of such species with low dominance or abundance has no indicator value. The species in question are as under:

High CaCO₃: *Haloxylon griffithii*. *Trigonella gharuensis*. *Cousinia stocksii* and *Convolvulus leiocalycinus*.

High CaCO₃ and low Cl: *Nepeta juncea*. *Cymbopogon commutatus*, *Ebenus stellata* and *Gaillonia eriantha* *Scabiosa oliveri* and *Pistacia khinjuk*, (with high organic matter too).

High CaCO₃ high Cl and high E.C.: *Halocharis hispida*. *Low CaCO₃ Hertia intermedia*. *Berberis baluchistanica* (high Ca + Mg too).

Low CaCO₃ and low Cl: *Kochia stellaris* and *Perovskia atriplicifolia* - *Salvia bucharica* with high MWHC too.

High Cl: *Acantholimon longiflorum*.

Low Cl: *Stipa arabica*. *Daphne mucronata*, *Cotoneaster nummularia* and *Caragana ambigua*. Also *Astragalus stocksii* (mostly).

High Organic matter and low Cl: *Juniperus polycarpus* and *Tanacetum fruticosum*. *Spiraea boissieri* with high MWHC and low E.C.

Low organic matter: *Sophora mollis*

Fine - textured soil: (Sandy clay loam):- *Piptatherum baluchistanicum*.

Previous work on the indicator species is very scanty. However the conclusions drawn herein appear to be in conformity with Majeed (1984) for such species as *Cymbopogon commutatus*. *Nepeta juncea*, *Chrysopogon aucheri*, etc. and Ahmed (1984) for *Pistacia khinjuk*, etc.

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