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LIFE FORM AND LEAF SIZE SPECTRA OF THE PLANT COMMUNITIES OF DIVERSE AREAS RANGING FROM HARNAI, SINJAWI TO DUKI REGIONS OF PAKISTAN

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Abstract

Life form and leaf size spectra of the plant communities of the study area were constructed according to Raunkiaer. Hemicryptophytes, therophytes and chamaephytes were found to be significantly higher, and geophytes were found to be significantly lower than the "Normal spectrum". Life form spectrum of different altitudinal zones shows that phanerophytes decrease gradually from lower elevation to higher elevations, but in lower middle zone, upper middle zone and upper zone they remain more or less constant around 30%. Chamaephytes were slightly lower than the normal spectrum, hemicryptophytes are more or less constant in all zones and therophytes show no consistency. Microphyll leaf size class was found to be the highest percentage, followed by nannophylls. Leaf size spectrum of different altitudinal zones shows that microphylls increase gradually from lower to upper zones. Nanophylls were slightly high in the lower zone, leptophyll and mesophyll did not show much variation.

Introduction

The vegetation of the study area were classified into 102 communities, 50 communities on the hills, 21 communities in the plains and 31 communities in the water courses, which will be reported elsewhere. No previous work has been done on life form and leaf size spectra of the study area. However, Beg (1966) classified some dominant species of Quetta into life form class es. Khan (1980) described life form spectra of some plant commu nities of Juniper forest at Khalifat. Qadir & Tareen (1987) constructed the life form and leaf size spectra of the flora of Quetta district.

Materials and Methods

The study area lies between 29° 48' and 30° 25' latitudes and 67° 50' and 69° 15' longitudes. The elevation ranges from 600 meters to 3490 meters. The climate of study area varies with the elevation. It ranges from cold temperate to semi-arid warm tem perate and semi-arid subtropical. The climate of the highlands (Kasa sar, Loua ghar and Pan sar) is pleasantly cool in summer and extremely cold in winter. The greater part is characterized by excessive cold winter. In Harnai and Spintangi areas the heat in summer is severe.

A complete list of the plant communities of the study area was compiled on the basis of plant collection. The life form and leaf size spectra were constructed according to Raunkiaer (1905, 1918) using the complete list of the plant communities collected from the study area, consisting of 183 species (Table 1). Leaf area of species was calculated according to Cain & Castro (1959).

Table 1. Plant list of the Communities of Hills, Plains and Water courses.

Sr. No.	Name of Species	Life Form	Leaf size Class	Hills	Plains	Water courses
1.	*Abelia triflora* ssp. *parviflora* (Clarke) Wend.	PH	Micro.	+	+	+
2.	*Acacia modesta* Wall.	PH	Nano.	+	-	+
3.	*A. jacquemontii* Benth.	PH	Nano.	+	-	-
4.	*Acantholimon munroanum* Aitch. & Hemsl.	CH	Nano.	+	+	-
5.	*A. polystachyum* Boiss.	CH	Nano.	+	+	+
6.	*Achillea santolina* L.	H	Lepto.	-	+	-
7.	*Aeluropus macrostachyus* Hack.	H	Nano.	+	-	+
8.	*Aerva persica* (Burm. f.) Merrill.	PH	Micro.	-	-	+
9.	*Alhagi maurorum* Medic.	H	Nano.	-	-	+
10.	*Alopecurus arundinaceus* Poir.	H	Meso.	+	-	+
11.	*Amaranthus spinosus* L.	TH	Meso.	-	+	-
12.	*Ampelopsis vitifolia* (Boiss.) Planch.	PH	Meso.	+	-	-
13.	*Andrachne rotundifolia* C.A. Mey.	H	Nano.	+	+	+
14.	*Argyrolobium roseum* (Camb.) Jaub. & Spach.	TH	Nano.	+	-	+
15.	*Aristida adscensionis* L.	TH	Micro.	+	+	+
16.	*Artemisia stricta* Edgew.	CH	Lepto	+	+	+
17.	*Arundo donax* L.	PH	Macro.	-	-	+
18.	*Asparagus capitatus* Baker	PH	Lepto.	+	-	+
19.	*Astragalus afghanus* Boiss.	TH	Lepto.	+	-	-
20.	*A. ammophilus* Boiss.	TH	Lepto.	+	+	-
21.	*A. anisacanthus* Boiss.	H	Lepto.	-	+	+
22.	*A. auganus* Bunge	H	Nano.	-	+	-
23.	*A. stocksii* Bunge	PH	Lepto.	+	+	+
24.	*A. zarghumensis* Rech. f.	CH	Nano.	+	+	+
25.	*Avena fatua* L.	TH	Meso.	-	-	+
26.	*Berberis baluchistanica* Ahrendt	PH	Micro.	+	+	-
27.	*B. calliobotrys* Aitch. ex Koehne	PH	Micro.	+	+	+
28.	*Berchemia pakistanica* Bowicz	PH	Nano	+	+	+
29.	*Bromus scoparius* L.	TH	Micro.	+	+	-
30.	*Buddleja crispa* Bth.	PH	Micro.	+	+	+
31.	*Bupleurum gracillimum* Kl.	H	Nano.	+	-	-
32.	*B. stewartianum* Nasir	H	Nano.	+	+	-
33.	*Callipeltis cucullaris* (Jusl.) Rothm.	TH	Lepto	-	-	+
34.	*Calotropis procera* (Willd.) R.Br.	PH	Meso.	-	-	+
35.	*Capillipedium parviflorum* (R.Br.) Stapf.	H	Micro.	+	-	+
36.	*Capparis decidua* (Forssk.) Edgew.	PH	Lepto.	+	-	+
37.	*C. spinosa* L.	CH	Micro.	-	-	+
38.	*Caragana ambigua* Stocks	PH	Lepto.	+	+	+
39.	*C. ulcina* Stocks	PH	Lepto.	+	-	+
40.	*Caralluma tuberculata* N.E. Brown.	CH	Lepto.	+	-	+

Table 1 (Cont'd)

Sr. No.	Name of Species	Life Form	Leaf size Class	Hills	Plains	Water courses
41.	*Carthamus oxycantha* M.B.	TH	Micro.	-	-	+
42.	*Celtis australis* L.	PH	Meso.	+	-	-
43.	*Cenchrus biflorus* Roxb.	TH	Nano.	+	+	+
44.	*Centaurea iberica* Trev. ex Spreng.	TH	Micro.	-	-	+
45.	*Chenopodium album* L.	TH	Micro.	+	-	+
46.	*C. vulvaria* L.	TH	Micro.	-	-	+
47.	*Chrysopogon aucheri* (Boiss.) Stapf.	H	Micro.	+	+	+
48.	*C. serrulatus* Trin.	H.	Micro.	+	+	+
49.	*Convolvulus arvensis* L.	H	Micro	-	+	-
50.	*C. kotschyanus* Boiss.	T	Micro.	+	+	-
51.	*C. spinosus* Burm.	CH	Nano.	+	+	+
52.	*Corchorus trilocularis* L.	TH	Micro.	-	-	+
53.	*Cotoneaster nummularia* Fisch. & Mey.	PH	Nano.	+	+	+
54.	*Cousinia bipinnata* Boiss.	TH	Micro.	+	+	-
55.	*C. hetero-phylla* Boiss.	TH	Micro.	+	-	+
56.	*Cucumis prophetarum* L.	H	Meso.	-	-	+
57.	*Cymbopogon jawarancusa* (Tones) Schult.	H	Micro	+	+	+
58.	*C. martinii* (Roxb) Wats.	H	Micro.	+	+	+
59.	*Cynoglossum glochidiatum* Wall. ex Benth.	TH	Meso.	+	-	+
60.	*Dalbergia sissoo* Roxb.	PH	Meso.	-	-	+
61.	*Danthoniopsis stocksii* (Boiss.) C.E. Hub.	H	Micro.	+	-	+
62.	*Daphne mucronata* Royle	PH	Micro.	+	+	+
63.	*Diarthron vesiculosum* (Fisch. & Mey) C.A. Mey.	TH	Nano.	+	+	-
64.	*Dichanthium foveolatum* (Del.) Roberty	H	Micro.	+	+	+
65.	*Dodonaea viscosa* (L.) Jacq.	PH	Micro.	+	-	+
66.	*Ebenus stellata* Boiss.	CH	Nano.	+	+	+
67.	*Echinops griffithianus* Boiss.	TH	Micro.	-	-	+
68.	*Eleusine indica* (Linn.) Gaertn.	TH	Nano.	+	+	+
69.	*Ephedra gerardiana* Wall. ex. Stapf.	PH	Lepto.	+	-	-
70.	*E. intermedia* Schrehk	PH	Lepto.	+	+	-
71.	*Ergrostis interrupta* Stapf	TH	Micro.	+	-	+
72.	*E. pilosa* (L.) O.Beauv.	TH	Micro.	+	+	+
73.	*Eremerus persicus* (Jaub. & Spach) Boiss.	Geo.	Meso.	+	+	-
74.	*E. stenophyllus* (Boiss. & Buhse) Baker	Geo.	Meso.	+	-	-
75.	*Eremostachys thyrsiflora* Bth.	H	Meso.	-	-	+
76.	*Saccharum bengalense* (Munro) HK.f.	H	Meso.	-	-	+
77.	*Eulaliopsis binata* (Retz.) C.E. Hubb.	H	Micro.	+	+	+
78.	*Euphorbia clarkeana* HK.f.	TH	Nano.	-	+	-
79.	*E. granulata* Forssk.	TH	Nano.	-	-	+
80.	*Fagonia arabica* L.	CH	Nano.	-	+	+

Table 1 (Cont'd)

Sr. No.	Name of Species	Life Form	Leaf size Class	Hills	Plains	Water courses
81.	*Ficus johannis* Boiss.	PH	Meso.	-	-	+
82.	*F. palmata* Forssk.	PH	Meso.	-	-	+
83.	*Filago pyramidata* L.	TH	Micro.	+	-	-
84.	*Fraxinus xanthoxyloides* (Wall.ex G.Don) DC.	PH	Micro.	+	+	+
85.	*Fumaria indica* (Hausskn.) H.N.	TH	Nano.	-	-	+
86.	*Gaillonia aucheri* Jaub. & Spach.	PH	Nano.	-	-	+
87.	*G. macrantha* Blatt. & Hallb.	CH	Nano.	-	+	+
88.	*Glycyrrhiza triphylla* Fisch. & Mey.	H	Micro.	-	-	+
89.	*Gymnocarpos decander* Forssk.	H	Nano.	-	+	-
90.	*Gypsophila lignosa* Hemsl. & Lace	H	Lepto.	+	+	-
91.	*Haloxylon griffithii* (Moq.) Bunge ex Boiss.	H	Lepto.	-	+	+
92.	*H. salicornicum* (Moq.) Bunge ex Boiss.	H	Lepto	-	+	+
93.	*Hertia intermedia* (Boiss.) O.Ktze.	CH	Micro.	+	+	+
94.	*Heteropappus altaicus* (Willd.) Novopork.	H	Micro.	-	+	-
95.	*Iris tenuifolia* Pall.	Geo	Micro.	+	+	-
96.	*Jasminum humile* L.	PH	Micro.	+	-	-
97.	*Juniperus excelsa* M. Bieb.	PH	Lepto.	+	+	+
98.	*Jurinea carduiformis* Boiss.	TH	Micro.	-	-	+
99.	*Lactuca orientalis* (Boiss.) Boiss.	TH	Micro.	+	+	+
100.	*Lallemantia royleana* (Bth.) Bth.	TH	Lepto.	-	-	+
101.	*Leptorhabdos parviflora* (Bth.) Bth.	TH	Micro.	+	+	-
102.	*Limonium cabulicum* (Boiss.) O.Ktze.	H	Micro.	+	-	+
103.	*Linum perenne* L.	TH	Nano.	+	-	-
104.	*Lithospermum arvense* L.	TH	Micro.	+	-	-
105.	*Lonicera hypoleuca* Dcne.	PH	Micro.	+	-	+
106.	*Lycium depressum* Stocks	PH	Micro.	+	-	+
107.	*Malva neglecta* Wallr.	TH	Micro.	-	+	+
108.	*M. parviflora* L.	TH	Micro.	+	+	+
109.	*Marrubium* anisodon C. Koch.	CH	Micro.	+	-	+
110.	*Mattiastrum asperum* (Stocks) Brand	TH	Nano.	-	-	+
111.	*Medicago sativa* L.	H	Nano.	-	+	+
112.	*Melica persica* Kunth.	H	Micro.	+	+	+
113.	*Mentha longifolia* (L.) Huds.	H	Micro.	-	-	+
114.	*Minuartia meyeri* (Boiss.) Bornm.	TH	Lepto.	-	-	+
115.	*Nannorrhops ritchieana* H. Wendle.	PH	Macro.	-	-	+
116.	*Nepeta praetervisa* Rech.f.	H	Nano.	+	+	+
117.	*Nerium indica* Mill.	PH	Meso.	-	-	+
118.	*Olea ferruginea* Royle	PH	Micro.	+	+	+
119.	*Onobrychus cornuta* (L.) Desv.	CH	Lepto.	+	+	-
120.	*O. dealbata* Stocks	H	Nano.	+	+	-

Table 1 (Cont'd)

Sr. No.	Name of Species	Life Form	Leaf size Class	Hills	Plains	Water courses
121.	*Onosma dichroanthum* Boiss.	TH	Meso.	+	-	-
122.	*Otostegia aucheri* Boiss.	H	Micro.	+	-	-
123.	*Panicum antidotale* Retz.	H	Meso.	+	-	-
124.	*Paspalum dilatatum* Poir.	H	Meso.	+	-	+
125.	*Peganum harmala* L.	H	Micro.	-	+	+
126.	*Pennisetum orientale* L.C. Rich.	CH	Meso.	+	-	+
127.	*Periploca aphylla* Dcne.	PH	Lepto.	+	+	+
128.	*Perovskia abrotanoides* Karel.	PH	Nano.	+	+	+
129.	*Phlomis stewartii* HK.f.	H.	Meso.	+	+	+
130.	*Phyla nudiflora* (L.) Greene	TH	Micro.	-	-	+
131.	*Piptatherum baluchistanicum* Freitag	TH	Micro.	+	-	-
132.	*P. hilariae* Pazij.	H	Micro.	+	+	-
133.	*P. vicarium* (Grig.) Rozhev.	H	Micro.	+	+	+
134.	*Pistacia khinjuk* Stocks	PH	Micro.	+	+	+
135.	*P. mutica* Fisch & Mey	PH	Meso.	+	-	+
136.	*Isodon rugosus* (Wall. ex Benth.) Codd.	CH	Micro.	+	+	+
137.	*Polygonum afghanicus* Meissn.	H	Nano.	-	+	+
138.	*P. persicaria* L.	TH	Nano.	+	+	+
139.	*Prunus brahuica* (Boiss.) Aitch & Hemsl.	PH	Micro.	+	+	+
140.	*P. jacquemontii* HK.f.	PH	Micro.	-	-	+
141.	*Pteropyrum olivieri* J. & S.	PH	Nano.	-	-	-
142.	*Pulicaria crispa* (Forssk.) Bth.	TH	Nano.	+	+	-
143.	*Punica granatum* L.	PH	Micro.	+	-	+
144.	*Rhamnus persica* Boiss.	PH	Nano.	+	+	+
145.	*Rhazya stricta* Dcne.	PH	Micro.	+	+	+
146.	*Rosa lacerans* Boiss. & Buhse	PH	Micro.	+	+	-
147.	*Rubia infundibularis* Hemsl. & Lace	TH	Nano	+	-	-
148.	*Saccharum ravennae* (Linn.) Murr.	H	Meso.	+	-	+
149.	*S. spontaneum* L.	H	Meso.	+	-	+
150.	*Sageretia thea* (Osbeck) M.C. Johnston	PH	Nano.	+	+	+
151.	*Salvia cabulica* Bth.	PH	Micro.	+	+	+
152.	*S. macrosiphon* Boiss.	TH	Meso.	+	-	-
153.	*S. moorcroftiana* Wall. ex Bth.	TH	Meso.	-	-	+
154.	*S. nubicola* Wall. ex Sweet.	H	Meso.	+	+	+
155.	*S. santolinifolia* Boiss.	H	Nano.	-	-	+
156.	*Scabiosa oliveri* Coult.	TH	Nano.	+	+	-
157.	*Scorzonera laciniata* L.	Geo.	Micro.	-	-	+
158.	*Scrophularia striata* Boiss.	H	Nano.	+	+	+
159.	*Scutellaria petiolata* Hemsl. ex Lace & Prain	H	Nano	+	+	+
160.	*Silene citrina* Buser	TH	Nano.	+	+	-

Table 1 (Cont'd)

Sr. No.	Name of Species	Life Form	Leaf size Class	Hills	Plains	Water courses
161.	*Solanum miniatum* Bernh. ex Wild.	TH	Meso.	-	-	+
162.	*S. surattense* Burm. f.	TH	Micro	-	-	+
163.	*Sophora mollis* subsp *griffithii* (Stock) Ali	PH	Nano.	+	+	+
164.	*Spiraea boissieri* Schneider	PH	Nano.	+	+	+
165.	*Stachys parviflora* Bth.	H	Micro.	+	+	+
166.	*Stipagrostis plumosa* (Linn.) Munro ex T. Anders	H	Micro.	+	-	+
167.	*Tamarix ramosissimia* Ledeb.	PH	Lepto.	-	-	+
168.	*Tanacetum fruticulosum* Ledeb.	H	Lepto.	+	+	-
169.	*Tecomella undulata* (Sm.) Seem	PH	Micro.	-	-	+
170.	*Tetrapogon villosus* Desf.	H	Nano.	+	+	+
171.	*Teucrium stocksianum* Boiss.	H	Nano.	+	-	+
172.	*Themeda anathera* (Nees) Hack.	TH	Micro.	+	+	+
173.	*Zizyphora clinopodiodes* Lam.	H	Nano.	-	+	-
174.	*Thymus linearis* subsp *linearis* Jalas	H	Nano.	+	+	+
175.	*Trachysperumum baluchistanicum* Nasir	H	Micro.	+	-	-
176.	*Trigonella monantha* C.A. Mey.	TH	Nano.	-	+	-
177.	*Verbascum erianthum* Bth.	TH	Meso.	+	-	+
178.	*Viola turkestanica* Regel & Schm.	TH	Micro.	+	-	+
179.	*Vitex pseudonegundo* (Hausskn.) Hand Mazz.	PH	Micro.	-	-	+
180.	*Withania coagulans* Dunal	CH	Micro.	+	+	+
181.	*Zizyphora tenuior* L.	TH	Nano.	+	+	+
182.	*Zizyphus nummularia* (Burm.f.) Wight	PH	Micro.	-	+	+
183.	*Z. oxyphylla* Edgew.	PH	Micro.	-	-	+

PH = Phanerophytes, CH = Chamaephytes, H = Hemicrptophytes, Geo = Geophytes, TH = Therophytes, Lepto = Leptophyll, Nano = Nanophyll, Micro = Microphyll, Meso = Mesophyll, Macro = Macrophyll, + = Present, - = Absent.

Results

The life form spectra of the plant communities of hills, plains and water courses of study area revealed that hemicryptophytes were significantly higher than normal spectrum (26.0, 13.0, 9.0) of Raunkiaer, but comparatively low (27.86%) in hills and high in plains (37.11%). Therophytes are higher than normal spectrum but comparatively slightly less (21.64%) in plains. They are higher than normal spectrum in all topo-units. Chamaephytes are higher than normal spectrum, but slightly higher (12.37%) in plains. Phanerophytes are lower than normal spectrum but slightly higher (31.14 & 32.33%) in hills and water courses and low (26.8%) in plains. Geophytes are lower than normal spectrum but very low in water courses (0.75%).

Leaf size spectrum of the communities of the hills, plains and water courses revealed that microphylls were found to be more or less constantly high (42.0 - 44.0%) in all topo-units. Nanophylls were next high class ranging from 26-38%. Leptophylls range from 11.9 to 14.7% but comparatively slightly high (14.7%) in plains. Mesophylls range from 4.0-15.6% the low being in plains and high being (15.6%) in water courses and (13.6%) in hills (Table 2).

Life form spectra constructed for different altitudinal zones show minor changes. Phanerophytes decrease from lower elevation (44%) to higher elevation (30%). In zones 2,3 & 4 they remain more or less constant around 30%. Chamaephytes gradually increase from 8.0% at low elevations to 13.75% at the upper most zone. Hemicryptophytes are more or less constant around 30% in all zones. Therophytes show no consistency with regard to change in altitude. They are higher than the normal spectrum through out all zones. Geophytes were consistently lower than normal spectrum in all zones. However they were about 5% in zone 3 and totally absent in zone 1 (Table 3).

Leaf size spectrum of different altitudinal zones shows that microphylls increase gradually from 40% in the lower zone to 46% in the upper most zone. Nanophylls were slightly higher (34%) in the lower zone then more or less constant around 31%. Leptophylls did not show much variation but were slightly lower (10%) at upper most zone. Mesophylls did not show much variation but were slightly lower 9.5% at upper middle zone.

Total number of species were the lowest (50) in the lower zone but the number abruptly jumped to more than 100% (120) at zone 2 and then decreased to 63 in zone 3 and zone 4 (Table 3). It may be concluded that the number of species increased at all higher elevations in zones 2,3 & 4.

Discussion

Life form spectrum of all the plant communities of the study area indicated interesting trends, which reflect the pecu lair climatic features of the study area. Hemicryptophytes, therophytes and chamaephytes were found to be high, phanerophytes (lower than normal spectrum) were found to be high in the commu nities of hills and water courses and low in the communities of plains, and geophytes were found to be low than the normal spec trum. According to Cain & Castro (1959) and Shimwell (1971) hemicryptophytes are characteristics of temperate regions and therophytes are characteristics of deserts climate. The study area has cold temperate, to warm temperate and subtropical climate and the life form spectrum clearly indicates these important features of climate having high percentage of hemicrytophytes, therophytes and chamaephytes.

Phanerophytes decrease gradually from lower elevation to higher elevations. Chamaephytes increase gradually from lower elevation to higher elevation and found to be high in upper most zone. Geophytes were found to be slightly high at upper middle zone and therophytes show no consistency with regards to change in altitudes. Braun-Blanquet (1932) discussed that in the Alps the vegetation on snowless ridges consisted of two thirds of chamaephytes and one third of hemicryptophytes, while the adjoining snow covered ridges contained 64% hemicryptophytes and only 30% chamaephytes. Chamaephytes are indicators of high altitudes and high latitudes (Cain, 1950, Cain & Castro 1959). Qadir & Shetvy (1986) considered chamaephytes and therophytes indicators of unfavourable environment. Regarding therophytes, Cain (1950) has stated that these develop especially in an area where the native vegetation has been disturbed.

Table 2. Life Form and Leaf Size Spectra of the communities of Hills, Plains and Water courses.

Life form class %	Hills %	Plains %	Water courses %	Leaf size class	Hills %	Plains %	Water courses
Phanerophytes	31.14	26.80	32.33	Leptophyll	12.8	14.73	11.94
Chamaephytes	10.65	12.37	10.52	Nanophyll	29.6	38.93	26.86
Hemicryptophytes	27.86	37.11	30.07	Microphyll	44.0	42.10	44.02
Geophytes	02.45	02.06	00.75	Mesophyll	13.6	04.21	15.67
Therophytes	27.86	21.64	26.31	Macrophyll	00.00	00.00	01.49

Table 3. Biological Spectrum (% all life form and leaf size classes) of various ecological zones of study area.

Sr.	Ecological Zone	Total No.	PH %	CH %	H %	Geo %	TH %	Lepto. %	Nano. %	Micro. %	Meso. %	Macro. %
1.	600 - 1350 m	50	44.0	08.0	30.0	---	18.0	12.0	34.0	40.0	12.0	2.0
2.	1350 - 2000 m	120	30.83	10.0	32.5	0.83	25.83	12.5	31.66	41.66	13.33	0.83
3.	2000 - 2400 m	63	31.74	12.69	31.74	4.76	19.04	14.28	31.74	44.44	9.52	---
4.	above 2400 m	80	30.00	13.75	30.00	1.25	25.00	10.00	31.25	46.25	12.5	---

Since the climate of the study area is dry, so the area has high representation of therophytes, distrubance and grazing may also be responsible partly and to minor extent. Deschnes (1969) in Northern New Jersey also found the hemicryptophytic habit as the prevailing type in the grazing pastures. Sapru *et al.*, (1975) stated that chamaephytes are able to flourish in areas which are subjected to heavy disturbance especially grazing by animals. Kavi & Sarin (1976), through life form classification and the biological spectrum of the flora of Bhaderwah, found a geo-chamae-phytic climate for the area. There was a decrcase in Phanerophytes and therophytes from lower to higher elevation and this decrease was accompanied by a gradual increase in chamaephytes and hemicryptophytes upto an elevation of 3500 m.

The present study supports the concept of Cain (1950) and Dechenes (1969) that dry climate, overgrazing and trampling which is so prevalent on grasslands, tend to increase the percentage of therophytes through the introduction and spread of weedy grasses and forbs of this life form. Gupta & Kachroo (1983) also reported for the flora of Yusmarg, Kashmir that between 2400 m to 2650m, the biological spectrum indicates a geo-therophytic type of climate. The results obtained in this study reveals that hemicryptophytes and therophytes are the largest life form class in the flora of study area. Cain & Castro (1959) compiled life form spectra of many climatic regions of the world and when the life form spectra of the communities of study area was compared with these spectra, it was found to very closely approach the spectra of the cold deserts (Joppen's BWK bio-climate type) regions. These facts further support the above conclusions regarding the high therophytes. Qadir & Tareen (1987) also reported high percentage of hemicryptophytes and therophytes for the flora of Quetta district. But in Quetta district cryptophytes were found to be high than the normal spectrum, whereas in the study area cryptophytes were found to be lower than the normal spectrum. Quetta district has some Mediterranean influence, whereas the study area does not have such a trend. Chameephytes were found to be lower in Quetta district than the study area. Because of the area having higher elevation than Quetta district, phanerophytes were more or less similar in the study area as well as Quetta district (Qadir & Tareen, 1987).

As regards the leaf size spectra, microphylls were found to be high followed by nanophylls. Microphylls are usually characteristics of steppes, nanophylls and leptophylls are characteristics of hot deserts (Cain & Castro, 1959). Leptophylls did not show much variation but slightly lower at upper most zones. Nanophylls show minor changes between different zones. Microphylls increase gradually from lower to upper most zone. Mesophylls were slightly high at lower middle zone. So elevational differences in leaf size are correlated with climatic warmth; large leaves occur in warmer climates than smaller leaves. This relationship appears to be a universal characteristics of humid to prehumid moisture regimes. Observed relationships between small leaves and cold may be due to the advantage of small leaves in retaining moisture. Moisture retention is critical when root sensitivity to low temperatures results in a decreased rate of water absorption from the soil, as may be the case in a large segment of thé tropical flora (Greller, 1988). Dolph & Dilcher (1980a) recognized three altitudinal zones of forest in Costa Rica as "foliar belts". The lower belt was characterized by 82.2% species with large leaves, the next higher belt by 45% species with large leaves; and the next higher belt had fewer than 5% species with large leaves. Dolph & Dilcher (1980 b) concluded that leaf size alone cannot be used to identify specific life zones or climates either extant or fossil flora. The high percentage of microphylls is the result of mostly temperate climate in the study areas. The next high percentage was, that of nanophylls which reflects the semi-arid nature of the study areas. Qadir & Tareen (1987) also reported high percentage of microphylls and nanophylls for the flora of Quetta district. Mesophylls were found to be high as compared to leptophylls which however were found to be high in the flora of Quetta district. This is because the study area is mostly more moist and colder than Quetta district.

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