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Life form and Leaf Size Spectra of Plant Communities Harbouring Ganga Chotti and Bedori Hills During 1999-2000

Z.H. MALIK[1], F. HUSSAIN AND N.Z. MALIK
Department of Botany, University of Azad Jammu and Kashmir, Muzaffarabad, Azad Kashmir
Department of Botany University of Peshawar, Peshawar, Pakistan
[1]Corresponding author's e-mail: malikzh51@yahoo.com

ABSTRACT

Life form and leaf size spectra of 15 ecologically different plant communities were studied by Raunkiaerian and quantitative ecological method. These communities were grouped in to four plant associations. Hemicryphtophytes and Therophytes were dominant during spring and monsoon quantitatively hemicryphtophytes were dominant both in spring and monsoon, while Therophytes appeared as a major group in the monsoon. Similarly microphyllous species followed by nanophyllous species were dominant in spring and monsoon in the investigated area.

Key Words: Leaf size; Plant communities; Harbouring; Ganga chotti

INTRODUCTION

The life form and leaf size spectra are important physiognomic attributes that have been widely used in vegetation studies. The life form spectra are said to be the indicators of micro and macroclimate (Shimwell, 1971). Similarly leaf size classes have been found to be very useful for associations. The leaf size knowledge may help in the understanding of physiological processes of plants and plant communities (Oosting, 1956). Literature dealing with the plant ecology of Azad Jammu and Kashmir shows that very little work has been done on the life form and leaf size spectra. The only reference for Azad Jammu and Kashmir is that of Malik (1986) and Malik and Malik (2004) who gave spectra for Kotli Azad Jammu and Kashmir. In view of the above applications of Raunkiaerian concepts, an attempt was made to ascertain variation of life form and leaf size spectra in 15 different plant communities of four associations in various climatic zones. The second objective was to evaluate the Raunkiaerian spectra based on species list with the quantitative data (importance value) of species. Since importance value is an index of all the quantitative parameters, it appears to be the most suitable species quantity for this purpose.

MATERIALS AND METHODS

Life form reflects the adaptation of plants to climate. The relative proportion of different life form for a given region or area is called its biospectrum. The plants were classified into different life form classes as follows after Raunkiaer (1934) and Muller and Ellenberg (1974).

Leaf size spectra. The leaf size knowledge helps in understanding physiological process of plants and plant communities and is useful in classifying the associations. The plants were divided into: (a) Leptophyll (L.), (b) Nanophyll (N) (c) Microphyll (Mi), (d) Mesophyll (Me) and (e) Megaphyll (Ma). However, for a rapid estimation of the leaves in the field Raunkiaer (1934) diagram was used.

RESULTS

Spring Aspect

***Themeda-Cyperus-Pinus* community (*TCP*).** The major life form was nanophanerophytic (33.33%) that was followed by megaphanerophytic and hemicryptophytic species (20% each). Therophytes and geophytes were 13.33% each. On quantitative basis, hemicryptophytes were 32.38%, megaphanarophytes 24.12%, nanophanerphytes 20.69%, geophytes 15.88% and therophytes 6.89% (Table I). The leaf spectra consisted of microphylls (53.33%), leptophylls (26.66%) and nanophylls (20%) (Table II).

***Themeda-Pinus-Desmodium* community (*TPD*).** The vegetation was predominantly nanophanerophytic (40%) followed by hemicryptophytes (26.66%), megaphanerophytes and geophytes (13.33% each) and therophytes (6.66%). Quantitatively, hemicryptophytes were dominant (39.03%). They were followed by nanophanerophytes (31.67%), megaphanerophytes (20.87%), geophytes and therophytes (4.00 & 4.40%). The leaf spectra consisted of microphylls (60%), leptophyll (26.66%) and nanophylls (13.33%).

***Andropogon-Pinus-Berberis* community (*APB*).** Hemicryptophytic species were dominant with a share of 42.85%. They were followed by nanophanerophytes (28.57%), megaphanerophytes (14.28%), therophytes and geophytes (7.14% each). Quantitatively, nanophanerophytes were dominant (25.13%). They were followed by hemicryptophytes (24.25%), megaphanerophytes (20.25%), geophytes (15.45%) and therophytes (14.90%). The leaf spectra were composed of microphylls (50%), leptophylls

Table I. The life form spectra of plant of Ganga Choti and Bedori Hills

Life form	Spring Aspect				Monsoon Aspect			
	Ganga		Bedori		Ganga		Bedori	
	No.	%	No.	%	No.	%	No.	%
Megaphanerophytes	9	8	-	-	9	8	-	-
Nanophanerophytes	12	10	3	8	12	10	5	6
Chamaephytes	3	3	1	3	1	1	-	-
Hemicryptophytes	54	45	25	64	46	39	51	62
Geophytes	11	9	5	13	20	17	14	17
Therophytes	28	23	5	13	29	24	11	14
Lianas	1	1	-	-	2	2	-	-
Total	118		39		119		81	

Table II. Leaf spectra of plants of Ganga and Bedori Hills

	Spring aspect				Monsoon aspect			
	Ganga		Bedori		Ganga		Bedori	
Leaf spectra	No	%	No	%	No	%	No	%
Leptophyll	26	22	8	20	21	18	17	21
Nanophyll	39	32	16	41	44	37	27	33
Microphyll	48	40	13	33	43	36	33	41
Mesophyll	05	06	2	5	11	9	4	5
Total	118		39		119		81	

(28.57%) and nanophylls (21.42%).

***Pinus-Cyperus-Gerbera* community (*PCG*).** The community was hemicryptophytic (43.75%) that was followed by therophytes (25%), nanophanerophytes(18.75%), while megaphanerophytes and geophytes had equal share of (6.25% each). Quantitatively, hemicryptophytic species were dominant (37.75%). They were followed by megaphanerophytes (26.31%), nanophanerophytes (16.92%), therophytes (16.82%) and geophytes (2.16%). There were 43.75% microphylls, 31.25% nanophylls and 25% leptophylls.

***Abies–Pinus-Viburnum* community (*APV*).** On Raunkiaerian scale, hemicryptophytic species were dominant (47.36%) followed by nanophanerophytes and therophytes (15.78% each). Megaphanerophytes and geophytes contributed 10.52% each, while quantitatively, megaphanerophyte (39.67%), hemicryptophytes (24.43%), nanophanerophytes (16.37%), therophytes (13.75%), geophytes (5.43%), were recorded. The leaf size spectra consisted of microphylls (42.10%), leptophylls and nanophylls (26.31% each) and mesophylls (5.26%).

***Abies-Viburnum-Medicago* community (*AVM*).** Hemicryptophytic (54.44%) were dominant followed by therophytes (26.15%). Megaphanerophytes and nanophanerophytes (8.39%) each and geophytes (2.63%). Microphylls (37.17%), nanophylls (31.40%), leptophylls (23.02%) and mesophylls (8.39%) were the major leaf forms.

***Picea-Epilobium-Bromus* community (*PEB*).** Hemicryptophytic species dominated (64.28%), which were followed by therophytes (14.28%), megaphanerophytes, nanophanerophytes and chamaephytes each having an equal share of 7.14%. Quantitatively, hemicryphtophytic species were 59.45%, megaphanerophytes 21.38%, therophytes 10.40% nanophanerophytes 4.18% and chamaephytes 4%. The community consisted of microphylls (37.50%), nanophylls (31.25%), leptophylls (21.42%) and mesophylls (7.14%).

***Veronica-Sibbaldea-Poa* community (*VSP*).** The leaf spectra, was composed of nanophylls (42.85%), microphylls (35.71%), leptophylls (14.28%) and mesophylls (7.14%).

***Sibbaldea-Aster-Rumex* community (*SAR*).** Hemicryptophytic species dominated (78%). They were followed by nanophanerophytes and therophytes (11.11% each). Quantitatively, hemicryptophytic were 79%, nanophanerophytes 11% and therophytes 9%. The community consisted of nanophylls 77.77%, leptophylls and microphylls 11.11% each.

***Euphorbia-Phleum-Artemesia* community (*EPA*).** Hemicryptophytic species were dominant (73.68%), which were followed by nanophanerophytes (10.52%), therophytes and geophytes had equal share of 5.26%. Quantitatively, hemicryptophytic (76.08%), geophytes (10.85%), megaphanerophytes (7.75%), therophytes (2.77%) and nanophanerophytes (2.52%) were evident. Nanophylls and microphylls (36.84%), leptophylls (21.05%) and mesophylls (5.26%) were the leaf size spectra.

***Potentilla-Geranium-Achillea* community (*PGA*).** The hemicryphtophytes were dominant both qualitatively (84%) and quantitatively (87%). The leaf spectra consisted of microphylls 47%, nanophylls 32% and leptophylls 21%.

***Potentilla-Juniperus-Phleum* community (*PJP*).** Qualitatively, hemicryptophytes was dominant (80%) followed by geophytes (13%) and nanophanerophytes (7%). Quantitatively, hemicryptophytes followed the same pattern as Raunkiaerian. The leaf spectra consisted of microphylls (66.66%), nanophanerophytes (22.22%) and mesophylls (11.11%).

***Potentilla-Phleum-Achillea* community (*PPA*).** Hemicryptophytic species dominated (80%), which were

Table IIIa. Raunkiaerian and quantitative biological spectra of plants of Ganga Choti and Bedori Hill during spring

Altitude (m.)	Mp		Np		Ch		H		G		Th	
	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q
a. 1700	20	24.12	33.33	20.69	-	-	20	32.38	13.33	15.88	13.33	6.89
1800	13.33	20.87	40.00	31.67	-	-	26.66	39.03	13.33	4.00	6.66	4.40
1900	14.28	20.25	28.57	25.13	-	-	42.85	24.25	7.14	15.45	7.14	14.19
2000	6.25	26.31	18.75	16.92	-	-	43.75	37.75	6.25	2.16	25.00	16.82
b. 2400	10.52	39.67	15.78	16.37	-	-	47.36	24.43	10.52	5.43	15.78	13.75
2600	8.39	29.30	8.38	14.75	-	-	54.45	30.69	2.63	0.24	26.15	24.74
2800	7.14	21.38	7.14	4.18	7.14	4.0	64.20	59.45	-	-	14.20	10.90
2900	-	-	2.85	2.88	-	-	71.42	71.06	.62	8.62	17.45	17.45
3000	-	-	11.11	11.35	-	-	77.77	79.35	-	-	11.11	9.29
c. 3050	5.26	7.75	10.52	2.52	-	-	73.68	76.08	5.26	10.85	5.26	2.77
3250	-	-	5.26	2.69	-	-	84.21	8.74	5.26	6.54	5.26	3.00
3350	-	-	6.66	17.56	-	-	80.00	58.68	13.33	24.75	-	-
d. 3505	-	-	-	-	-	-	80.00	76.10	6.66	16.30	13.33	6.90
3650	-	-	-	-	-	-	63.63	79.57	27.27	15.23	9.09	5.18
3750	-	-	-	-	-	-	66.66	77.09	11.11	20.44	22.22	2.45

Key: Mp = Megaphanerophytes Ch = Chamaephytes G = Geophytes
Np = Nanophanerophytes H = Hemicryptophytes Th = Therophytes
R = Raunkiaerian value Q = Quantitative value from importance value

Table 3b. Raunkiaerian and quantitative biological spectra of plants of Ganga Choti and Bedori Hill during monsoon

Altitude (m.)	Mp		Np		H		G		Th		L		Ch	
	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q
a. 1700	9.52	16.51	19.04	14.72	33.33	37.75	9.52	2.49	28.57	28.50	-	-	-	-
1800	8.69	12.97	13.04	21.78	30.43	27.11			43.47	37.10	-	-	4.34	1.01
1900	11.53	14.49	19.23	31.28	38.46	42.97	3.84	1.37	19.23	6.59	3.84	0.75	3.84	2.52
2000	15	9.50	20	27.97	35	43.99	5	2.33	20	15.37	5	.81	-	-
b. 2400	4	15.94	12	17.69	40	37.52	12	7.07	2	21.22	4	.54	-	-
2500	4.16	33.01	16.66	5.96	37.50	29.51	16.66	4.64	20.83	6.13	4.16	.72	-	-
2600	4.76	34.57	4.76	11.57	38.09	30.89	9.52	0.80	38.09	21.75	-	-	4.76	0.34
2800	5.55	22.61	5.55	15.26	55.55	39.76	22.22	5.06	11.11	17.27	-	-	-	-
2900	-	-	5.26	10.96	57.89	46.82	21.05	9.82	15.78	32.38	-	-	-	-
3000	10.52	33.01	5.26	2.35	42.18	40.44	31.57	5.23	10.52	18.94	-	-	-	-
c. 3050	-	-	11.11	7.81	55.55	68.29	11.11	11.27	22.22	12.61	-	-	-	-
3250	-	-	-	0.96	72.60	70.64	-	-	27.39	27.39	-	-	-	-
3350	-	-	11.11	9.12	55.55	61.84	11.11	11.41	22.22	17.61	-	-	-	
d. 3505	-	-	11.11	8.58	55.55	55.13	-	-	33.33	36.28	-	-	-	-
3650	-	-	16.16	10.66	41.66	46.52	25.00	29.51	16.66	13.21	-	-	-	-
3750	-	-	27.27	30.65	54.54	54.39	9.09	7.51	9.09	7.43	-	-	-	-

Key: Mp = Megaphanerophytes Ch = Chamaephytes G = Geophytes
Np = Nanophanerophytes H = Hemicryptophytes Th = Therophytes
R = Raunkiaerian value Q = Quantitative value from importance value
L= Lianas

1. Woodland temperate association (17-2000m)
2. Woodland alpine association (2000-3000m)
3. Shrubland alpine association (3050-3400m)
4. Alpine grassland association (3500-3750m)

followed by therophytes (13.33%) and geophytes (6.66%). Quantitatively, hemicryptophytic (76.70%) were dominant followed by geophytes (16.30%) and therophytes (6.98%). The leaf spectra consisted of microphylls (47%), nanophylls (33%) and leptophylls (20%).

***Potentilla-Androsace-Polygonum* community (*PAP*).** Hemicryptophytic species dominated (63.63%), followed by geophytes (27.27%) and therophytes (9.09%). Quantitatively, hemicryptophytes were dominant (79.57%) with geophytes(15.23%) and therophytes (5.18%). Raunkiaerian and quantitative data in this community are alike. The leaf spectra consisted of nanophylls (46%), microphylls (36%), leptophylls and mesophyll (9% each).

***Polygonum-Phleum-Leontopodium* community (*PPL*).** Hemicryptophytic species were dominant (67%) both qualitatively and quantitatively. The leaf spectra consisted of nanophylls (56%), microphylls (33%) and leptophylls (11%).

Monsoon Aspect

***Imperata-Pinus–Sonchus* community (*IPS*).** Hemicryptophytic species dominated (33.33%), which were followed by therophytes (28.57%), nanophanerophytes (19.04%), megaphanerophytes and geophytes (9.52). Quantitatively, the order of importance was hemicryptophytes (37.75%), therophytes (28.50%), megaphanerophytes (16.51%), nanophanerophytes (14.72%) and geophytes (2.49%). The leaf spectra was composed of nanophylls (48.%), microphylls (38.%) and leptophylls (14.%).

***Desmodium-Pinus-Lespediza* community (*DPL*).** Therophytic species dominated (43.47%), which were followed by hemicryptophytes (30.43%), nanophanerophytes (13.04%), megaphanerophytes (8.69%) and chamaephytes (4.34%). Quantitatively, a similar pattern was achieved. It was therophytes (37.10%), hemicryptophytes (27.11%), nanophanerophytes (21.78%), megaphanerophtes (12.97%) and chamaephytes (1.01%). The leaf size was predominantly microphyllous type (42.%) followed by nanophylls (31.%) and leptophylls (27%).

***Berberis-Desmodium-Agrostis* community (*BDA*).** Hemicryptophytic species dominanted (38.46%), which was followed by nanophanerophytes and therophytes having share of 19.23% each. Megaphanerophytes (11.53%), geophytes, chamaephytes and lianas had equal share of 3.84% each. Quantitatively, hemicryptophytic species dominated (42.97%), which was followed by nanophanerophytes (31.28%), megaphanerophytes (14.49%), therophytes (6.59%), chamaephytes (2.52%), geophytes (1.37%) and lianas (0.75%). There were of (38%) nanophylls, (31%) leptophylls, (27%) microphylls and (4%) mesophylls.

***Desmodium-Berberis-Cynodon* community (*DBC*).** Hemicryptophytic (35%) dominated the community. They were followed by nanophanerophytes and therophytes (20% each), magaphanerophytes (15%), geophytes and lianas (5% each). Quantitatively hemicryptophytic species had 43.99% share, nanophanerophytes 27.97%, magaphanerpphytes 9.50%, therophytes 15.37%, geophytes and lianas had 2.33 and 0.81%. Nanophylls (50%), microphylls (25%), leptophylls (20%) and mesophylls (5%) were the major leaf sizes.

***Abies–Viburnum–Poa* community (*AVP*).** The community was dominated by hemicryptophytic species (40%), followed by therophytes (28%), geophytes and nanophanerophytes (12%) each, while megaphanerophytes and lianas had 4% shares. Quantitatively, hemicryptophytic species were dominated (37.52%) which was followed by therophytic (21.22%), nanophanerophytes (17.69%), megaphanerophytes (15.94%), geophytes (7.07%) and lianas (.54%). The major leaf forms were nanophylls (40%) and microphylls (32%) followed by leptophylls (16%) and mesophylls (12%).

***Pinus-Fragaria-Cenchrus* community (*PFC*).** Hemicryphotophic species (37.50%) dominated the community. They were followed by therophytes (20.83%), nanophanerophytes and geophytes (16.66% each), megaphanerophytes and lianas (4.16% each). Quantitatively, megaphanerophytes were dominant (33.01%), followed by hemicryptophytes (29.51%), therophtytes (6.13%), nanophanerophytes (5.96%), geophytes (4.64%) and lianas (0.72%). Microphylls (38%), nanophylls (29%), leptophylls (21%) and mesophylls (12%) were the important leaf forms.

***Abies-Viburnum-Cenchrus* community (*AVC*).** Hemicryptophytic and therophytic species were dominants (38.09%). They were followed by geophytes (9.52%). Megaphanerophytes, nanophanerophytes and chamaephytes showed equal share of (4.76%). Megaphanerophytes were dominant quantitatively (34.57%). It was followed by hemicryptophytes (30.89%), therophytes (21.75%), nanophanerophytes (11.57%) and chamephytes (0.34%). Microphylls (38%), leptophylls and manophylls (24% each) and mesophyll (14%) were the major leaf sizes.

***Lespediza-Poa-Fragaria* community (*LPF*).** Hemicryptophytic (58.%) were dominants, which were followed by geophytes (21.05%), therophytes (15.78%) and nanophanerophytes (5.26%). Quantitatively, hemicryptophytes were dominant (46.82%). They were followed by therophytes (32.38%), nanophanerophytes (10.96%) and geophytes (9.82%). Nanophylls species were dominant (42%), followed by microphylls (26%), leptophylls and mesophylls (16% each).

***Poa-Salix-Abies* community (*PSA*).** The life form spectra consisted of hemicryptophytic speices (42.10%), geophytes (31.57%), therophytes and magaphanerophytes (10.52%) each and nanophanerophytes (5.26%). While quantitatively, hemicryptophytes had 40.44%, magaphanerophytes 3.01%, therophytes 18.94%, geophytes 5.23% and nanopanerophytes 2.35% were in order of importance. The dominant leaf spectra, was microphyllous-nanophyllous type (each with 37%), followed by mesophyll (16%) and leptophylls (10%).

***Pseudomertensia-Potentilla-Pedicularis* community (*PPP*).** It is dominated by hemicryptophytes (55.55%). Next were therophytes (22.22%), nanophanerophytes and geophytes (11.11% each). Quantitatively, hemicryptophytic species (68.29%), therophytes (12.61%), geophytes (11.27%) and nanophanerophytes (7.81%) were important life form classes. The species with large leaves (microphylls) were dominant (55%), followed by nanophylls (33%) and mesophylls (11%).

***Parnasia-Agrostis-Polypogon* community (*PAP*).** Hemicryptophytes had 73% and therophytes 27% share. Quantitatively, hemicryptophytes (71%), therophytes (27%) and nanophanerophytes (1%) were important. There were 67% microphylls, 22% nanophylls and 11% mesophylls.

***Senecio-Bupleurum* community (*SB*).** Hemicryptophytic species were dominant (56%), followed by therophytes (22%), geophytes and nanophaneropytes (11% each). While quantitatively, hemicryptophytes (62%), therophytes (18%), geophytes (11%) and nanophanerophytes (9%) were important. Microphylls (55.55%), nanophylls (33.33%) and mesophylls (11.11%) were the important leaf size spectra.

***Lavetra-Leucas-Ranunculus* community (*LLR*).** Hemicryptophytes were dominated (80%), followed by therophytes (13%) and geophytes (7%). Quantitatively, hemicryptophytes (76%) followed by geophytes (16%) and therophytes (7%) were significant. The leaf spectra, was composed of microphylls (67%) and mesophylls (33.%).

***Primula-Oxalis-Phleum* community (*POP*).** Hemicroyptophytic species dominated (42%). They were followed by geophytes (25%). Nanophanerophytes and therophytes contributed 16.66% each. Quantitiatively, hemicryptophytes were (46.52%), geophytes (29.15%), therophytes (13.21%) and nanophanerophytes (10.66%). The leaf spectra consisted of microphylls (67%), nanophylls (17%), mesophylls and leptophylls (8% each).

***Juniperus-Malva-Lespediza* community (*JML*).** Hemicryptoptyies species dominated (54.54%). They were followed by nanophanerophytes (27.27%), therophytes and geophytes (9.09% each). On the basis of quantitative analysis, hemicryptophytes were 54.39%, nanophanerophytes 30.65%, geopytes 7.51% and therophytes 7.43%.

DISCUSSION

Life forms of various species recorded from Ganga and Bedori Hills were classified into major life forms. A biospectrum is formed when all the species of higher plants of a community are classified into life forms and their ratio expressed in number or percentage (Saxina *et al*., 1987). Biological spectra are useful in comparing geographically widely separated plant communities and are also regarded as an indicator of prevailing environment. Occurrence of similar biological spectrum in different regions indicates similar climatic conditions. According to Raunkiaer (1934) the climate of a region, is characterized by life form, while in biological spectrum of the region exceeds the percentage of the same life form. However, due to biological disturbance, the proportion of life forms may be altered. Biological spectrum may be materially changed due to introduction of therophytes like annual weeds, due to biotic influences like agricultural practices and grazing, deforestation and trampling etc.

The life form spectra of flora and different plant communities in the present study indicated that hemicryptophytes and therophytes were dominant during spring and monsoon seasons. Quantitatively, hemicryptophytes were dominant both in spring and monsoon, while therophytes appeared as a major group in the monsoon. Cain and Castro (1959) and Shimwell (1971) reported that hemicryptophytes are indicator of temperate zone, while therophytes are characteristic of desert climate and geophytes are indicator of mediterranean climate.

The climate of study area varies with regard to moist temperate, subalpine to alpine types at different altitudes. The biological spectrum obtained in the present study reflects the existing environmental conditions. The Ganga Chotti and Bedori hills are climatically cool with scattered trees and shrubs. Malik *et al*. (1994, 1998) observed that in the moist temperate part of Dhirkot, hemicryptophytes and therophytes were the major life form classes. The present findings regarding the dominance of hemicryptophytes and therophytes agree with them. Although the area has potential to support the growth of trees and shrubs, megaphanerophytes and nanophanerophytes decreased due to human activity. Deforestation is one of the major factors that has dwindled the regeneration of woody species. The lower percentage of phanerophytes and chamaephytes indicate the condition that deforestation is conducive for the development of these life forms.

Therophytes were generally high in almost all the altitudinal zones, which might be due to disturbed habitat, because of deforestation, overgrazing and trampling. Generally, they were more abundant in the spring as it reflected spring aspect. During spring there is always a flush of annuals, which gives a outlook to the community. Similar trend regarding prevalence of therophytes was observed by Hussain *et al*. (1997 a, b) in Girbanr and Dabargai hills. The dominance of therophytes occurs due to un-favorable habitat conditions, as confirmed by many studies (Shimwell, 1971; Malik & Hussain, 1987, 1988, 1990).

Barik and Misra (1998) reported that the biological spectrum of grassland ecosystem of South Orissa consisted of therophytes, chamaephytes, hemicryptophytes and cryptophytes in order of 51.61, 22.58, 16.13 and 9.68, respectively. The predominance of therophytes was similar to the present study. In alpine habitat cushion and chamaephytes became more prominent, because of adverse soil and climatic conditions. Ram and Arya (1991) reported 36% short forbs, 27% cushion and spreading forbs 17% each in the alpine vegetation at Rudranth. In our case too chamaephytes were more dominant than other life forms in the alpine part of the study area.

Qadir and Shetvy (1986) considered chamaephytes and therophytes as the major life form in unfavorable environment in desert region. In the investigated area cold conditions, low temperature, wind and biotic factors result in un-favourable conditions paving way for chamaephytes. Saxina *et al*. (1987) stated that hemicryptophytes dominated temperate and alpine zones in overlapping and loose continuum. The present findings in this regard also agree with them. The findings of Qadir and Tareen (1987) and Tareen and Qadir (1993) are also in line with our findings as they reported the dominance of hermicryptophytes in temperate vegetation of Balochistan. Therophytes survive under adverse condition through seeds production. The predominance of therophytes in variable conditions such as dry, hot or cold met for low to higher elevation might be the reason for their higher percentage in the present study.

Raunkiaerian life form spectra fails to explain the numerical status of plants in the field, whereas quantitative characters such as density, frequency and canopy cover are more useful parameters in depicting the existing quantitative vegetation structure and related climatic conditions. Khan *et al*. (1999) stated similar importance of quantitative feature as compared to qualitative feature.

Leaf size spectrum of the plant and their communities revealed that microphyllous species followed by nanophyllous species were dominant in spring and monsoon in the investigated area. Microphylls are usually characteristic of steppes, while nanophylls and leptophylls are characteristic of hot deserts (Cain & Castro, 1959; Tareen & Qadir, 1993). The present study shows that leptophylls were high at the foot hills, while microphylls and nanophylls were present in high altitudes (2800 m). Species with large leaves occur in warmer moist climates while smaller leaves are characteristic of cold and dry climates and degraded habitats.

Malik and Hussain (1990) reported higher percentage of leptophyll and nanophyll in the dry subtropical semi-ever-green from Kotli Azad Jammu and Kashmir. Species with small leaves are generally characteristics of dry and adverse habitat conditions. Though the area of Kotli falls within subtropical mountain belt but the adverse habitat conditions exist due to deforestation and overgrazing in the area. The observed relationship between small leaves and cold or hot desert climates are adaptive features in retaining moisture. Moisture retention is critical when root sensitive to low temperatures result in a decreased rate of water absorption from the soil (Greller, 1988). The soil is generally poor in the mountainous area where roots feel difficulty in absorbing soil moisture.

A high percentage of microphylls might be due to cool climate in subalpine and alpine. Here the soil was poorly developed with thin sheet that prevented root penetration. Furthermore, roots absorb low moisture and nutrients under cold conditions. In alpine regions the plant face drought during winter especially in frozen soil. The species with microphyllous and nanophyllous leaves were abundant due to ecological adaptation for these arid conditions. The present findings agree with those of Qadir and Tareen (1987) who reported high percentage of microphylls and nanophylls in the dry temperate climate (wind, snowfall & aridity) of Quetta district. These data indicated that the percentage of various leaf form classes varied with increasing altitude. Saxina *et al*. (1987) also observed that the percentage of microphylls was positively related with the increasing altitude and this also support our findings. However, in the tropical wet forest, as reported by Dolph and Dilcher (1980a, b), large leaved species were dominant. This disagreement is mainly due to climatic variation such as temperature and wet tropical condition. The situation in our case is far more xeric than in the wet tropics. The size of leaves alone could not be used to identify specific leaf zone or climates. Other features of plants such as habit and root system might also play important role.

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