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VEGETATION OF SOME FOOTHILLS OF HIMALAYAN RANGE IN PAKISTAN

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Abstract

A quantitative ecological survey was carried out at 17 locations near the road side on the Great Silk Road from Gilgit to Passu. *Ephedra gerardiana* was ecologically similar with *Artemisia scoparia* while *Haloxylon thomsonii* showed similar relationship with *Capparis spinosa*. Six communities have been recognised on the basis of species dominance, importance values and similarity coefficient. In most cases the co-dominant species of one community type was also prominent in other communities indicating similarities between some communities in their species composition. In general communities were homogeneous.

Soil characteristics for each community types are described. Soil texture, sodium, potassium and organic matter appear to have some controlling influence over the vegetation while water holding capacity, pH, carbonate and phosphorus do not show any correlation. In general, soils of study area are fine-textured and basic in nature with low fertility levels.

Introduction

In quantitative investigations of different parts of northern Pakistan various plant communities have been described (Ahmed, 1974). Ahmed (1976) illustrated the vegetation complex of the area around Skardu while Ahmed & Qadir (1976) have recognised several communities near the road side from Gilgit to Shunder. Little is known about the vegetation composition, communities and soils of the areas close to the Great Silk Road from Gilgit to Passu. Ahmed & Qadir (1976) also reported that natural vegetation is being taken over by semi-natural vegetation due to disturbances of anthropogenic nature all along Gilgit to Shunder. The development of Great Silk Road and increasing human population would gradually disturb the natural vegetational pattern of this area. It was therefore necessory to anlayse existing relatively undisturbed vegetation and soils of the area. In present survey information about the vegetation and soils of the area close to the Great Silk Road from Gilgit to Passu is provided.

Materials and Method

The study area lies between latitude 35° to 36°N and longitude 74.0° to 75.0°E, along the Great Silk Road, characterised by rugged mountainous upland with extensive glaciers and contains Rakaposhi with a peak of 7788 m. The mountainous topography has existed since the Tertiary period when the region was subjected to prolonged orogeny caused by the convergence of the continental plates of India and Europe (Shah, 1977). Subsequent glaciation has played an important role in producing the rugged topography.

The study area falls under temperate desert bush type of bio-climate (Qadir, 1968). There is no summer rains and the winter rains last from December to March. This pattern of rainfall closely resembles the Mediterranean climate. The meteorological data of Gilgit shows that September is the hottest month (36.4°C mean maximum), while January is the coldest month (– 2.8°C mean minimum). Rainfall ranges from 1.5 to 15 cm per year (Ahmed & Qadir, 1976). The area is generally arid and the only available moisture for plants or agriculture comes from the springs and streams.

A quadrat of 5m x 5m was used to study the vegetation. Fifteen quadrats were sampled at each stand. Sampling was restricted to least disturbed places. Quantitative phytosociological attributes such as relative cover, relative density, relative frequency and the importance value of each species were calculated following the method described by Mueller-Dombois & Ellenberg (1974). Species were ranked according to importance value and those which attained heighest importance values in the stands were considered the dominant species. Relationships among the leading species were evaluated by the method proposed by Brown & Curtis (1952). Similarity coefficient of Bray & Curtis (1957) was used for comparing stands. Stands showing higher similarity (> 55%) were grouped and community types were recognised. A homogeneity test was carried out as proposed by Raunkiaer (1934).

Soil samples for each stand were collected from the surface (15 cm) and sub-surface (15 to 30 cm). In many stands sub-surface soil did not exist, therefore surface and sub-surface soils were combined to obtain a composite soil sample for each stand.

Soil pH was measured by an ELL (model 23A) glass electrode pH meter preparing the samples according to Peech *et al.*, (1947). Maximum soil moisture retention was determined according to the method described by Keen (1931) and organic matter levels by the method of Jackson (1958). Alkaline earth carbonate was determined by acid neutralisation (Qadir *et al.* 1966), while the concentration of sodium and potassium were obtained using flame photometer following Peech & English (1944). The method of Fogg & Wilkinson (1958) was used to assess exchangeable phosphate and the U.S.D.A. method (Anon., 1951) was employed for testing the soil textural classes.

Results

A summary of 17 different stands is given in Table 1 in which 24 most important of the 41 species found in those stands are listed. Since importance values show the relative ecological importance of each species in a stand (Brown & Curtis, 1952), species are arranged accordingly in the table.

Table 1. Summary of Phytosociological data

Species	Presence in No. of stands	Average I.V.I	Maximum I.V.I	Minimum I.V.I	Number of stand 1st dominant	2nd dominant	3rd dominant
Capparis spinosa L	7	69.87	199.99	30.87	2	–	5
Haloxylon thomsonii Bunge ex Bioss.	12	60.74	186.61	2.94	5	–	5
Ephedra gerardiana Wallex Stapf.	8	138.10	183.84	22.34	7	–	–
Heliotropium dasycarpum var. gymnostomum (Hemst) Kazmi	5	56.57	182.52	39.75	–	5	–
Amaranthus. sp.,	6	36.08	146.10	9.87	–	2	–
Geranium aconitifolium Sensu Edgew.	3	44.72	108.95	6.45	2	–	–
Tribulus terrestris L.	7	36.75	102.12	8.25	–	–	2
Artemisia scoparia Waldst.	8	44.22	85.92	12.21	1	2	–
Clematis alpina (L.) Miller.	5	38.79	71.25	8.10	–	4	–
Artemisia. sp.	12	34.50	70.74	10.92	–	3	–
Cousinia thomsonii Clarke	5	32.07	49.63	18.18	–	–	–
Cymbopogon distans (Nees.) W. Wats.	4	21.04	38.61	6.69	–	–	–
Gnaphalium affine D. Don.	2	20.40	37.71	6.69	–	–	1
Eragrostis pilosa (L.) P. Beauv.	7	42.93	23.82	6.46	–	1	4
Salsola Kali L.	8	13.72	23.10	2.10	–	–	–
Sophora mollis (Royle) Baker ssp. mallis	3	13.27	19.08	9.91	–	–	–
Pegnum hermala L.	2	10.41	12.51	8.31	–	–	–
Alhaji maurorum Medic.	2	5.71	9.09	5.62	–	–	–
Chenopodium. sp.,	2	7.63	8.82	6.45	–	–	–
Medicago falcata L.	2	3.23	6.01	3.65	–	–	–
Lycium ruthenicum Murray	2	2.32	3.78	0.87	–	–	–
Cynodon dactylon L.	1	3.19	3.19	3.19	–	–	–
Saccharum bengalense Retz	1	2.87	2.87	2.87	–	–	–
Solanum nigrum L.	1	1.76	1.76	1.76	–	–	–

Table 2. Mean I.V.I. of species in stands in which a given species occurs as a leading dominant

No. of stands in which the species is leading dominant	Species	Leading dominants				
		E. gerardiana	*H. thomsonii*	*C. spinosa*	*G. aconitifolium*	*A. scoparia*
7	*E. gerardiana*	169.65	47.78	–	–	66.78
5	*H. thomsonii*	–	132.87	57.63	7.91	41.73
2	*G. spinosa*	–	80.64	99.18	–	14.34
2	*G. aconitifolium*	–	9.84	–	119.65	38.75
1	*A. scoparia*	–	36.23	11.30	87.79	118.95

Ephedra gerardiana, Capparis spinosa, Haloxylon thomsonii, Geranium aconitifolium and *Artemisia scoparia* were the most common species present in many stands as the first leading dominant, while *Artemisia* sp., *Heliotropium dasycarpum, Amaranthus* sp., *Clematis alpina* and *Eragastis pilosa* occupy the second leading position in various stands. Species like *Tribulus terrestris* and *Gnaphalium alpine* have the third position in different places. Other species though frequently encountered, do not have any leading positions due to low relative values.

Leading dominants: Five leading dominant species were chosen and mean importance value index of each species was calculated (Table 2). The stands dominanted by *E. gerardiana* show complete absence of *C. spinosa* and *G. aconitifolium*, while *H. thomsonii* and *A. scoparia* show low mean importance value index. *H. thomsonii* grows as a leading dominant in those stands where *C. spinosa*, *G. aconitifolium* and *A. scoparia* have low values with complete absence of *E. gerardiana*. The stands in which *C. spinosa* is the leading dominant, *G. aconitifolium* is absent while *A. scoparia* shows low value, but *H. thomsonii* has relatively higher value. *G. aconitifolium* was found as a leading dominant in two stands, where *C. spinosa* and *E. gerardina* do not exist. Stands in which *A. scoparia* is leading dominant, *G. aconitifolium* shows higher value while *C. spinosa* and *E. gerardiana* are less important.

Homogeneity of communities: The frequency distribution of community type 1 to 3 and 6 is close to homogeneous condition according to the Raunkiaer's law (Table 3). Consequently these communities may be considered homogeneous. Due to absence of D and E classes in community 4 and 5, it is difficult to accept them as homogeneous communities.

Soil characteristics: Chemical properties and textural classes of the composite soil samples are summarised in Table 4. Due to small sample size in various communities,

Table 3. Homogeneity of communities

Community No	Frequencies of frequency classes				
	A 1 to 20%	B 21 to 40%	C 41 to 60%	D 61 to 80%	E 81 to 100%
1.	51.9	21.6	17.4	7.1	9.1
2.	36.7	46.4	6.1	12.5	–
3.	37.7	16.2	10.7	–	34.5
4.	50.0	40.0	5.0	–	–
5.	23.7	20.6	25.5	–	–
6.	62.6	19.8	9.2	–	8.9

values of standard error have not been calculated. All the soils are basic with a pH ranging from 8.1 to 8.4. The amount of phosphorus and carbonate are low. Water holding capacity do not show any marked variation.

Community characteristics: Despite the lack of significant correlation with edaphic factor, it appears that communities have a tendency to favour certain soil conditions. Six communities recognised in the study area are discussed below with reference to their homogenity and some controlling edaphic factors.

1. *Geranium-Artemisia scoparia-Tribulus community:* This community occurs between Gilgit and Hunza at Chalath on coarse sand. Soil contains low sodium and potassium. All the species are abundant, having high importance values. *Artemisia* sp., *Salsola kali* and *Amaranthus* sp. are present as important species. Other associates are *Cynodon dactylon, Lycium ruthenicium, Chenopodium* sp., *Medicago falcata* and *Cousinia thomsonii.* This is an open and homogeneous community.

2. *Capparis-Amaranthus-Haloxylon community:* This type of open, homogeneous and to some extent disturbed community exists near Nomal Valley in which *Capparis spinosa* show prostrate habit. Other members of this community are *Cousinia thomsonii, Artemisia scoparia* and *Peganum harmala.* It also tends to grow on surface soils having coarse sand with low sodium and potassium.

3. *Haloxylon-Heliotropium-Capparis community:* This is the most widespread community, covers the largest area on the study site, and is found near the Nomal, Khasaual and Ganish Valleys. *Artemisia* sp., attains a low importance value. This is also considered as an open and homogeneous community. In many locations ground surface is rocky and gravelly. However in general it appears to grow on silty clay containing low potassium and moderate organic matter.

Table 4. Soil characteristics of community types.

Edaphic variables of communities	Community types 1	2	3	4	5	6
Number of stands	1, 3	2*, 5*	4*, 13, 14, 15, 16	6	7*, 9*, 11	8, 10, 12*, 17*
Sodium (ppm)	3.05 (2.97-3-13)**	4.5 (3.5-5-5)	13.0 (10-14.3)	12.0	19.5 (16.5-21.9)	10.5 (9.1-12.7)
Phosphorus PO_4 (ppm)	0.08 (.08-.08)	0.09 (.09-.09)	0.16 (.14-.20)	0.7	0.16 (.14-.20)	0.11 (9.7-.13)
Potassium K (ppm)	4.05 (2.01-6.1)	5.25 (4.5-6.01)	0.90 (.8-1.0)	4.5	16.5 (12.8-19-3)	11.5 (6.3-19.7)
Carbonate (percent)	0.09 (.07-.11)	0.39 (.39-40)	0.07 (.05-.09)	0.28	0.73 (.70-.84)	0.26 (.24-.29)
pH	8.2 (.8.2-8.2)	8.4 (8.4-8.4)	8.3 (8.2-8.5)	8.4	8.2 (8.2-8.2)	8.2 (8.1-8.3)
Organic matter (percentage)	0.95 (.80-1.10)	0.90 (.8-1.0)	1.2 (.8-1.8)	0.70	2.51 (1.9-3.1)	1.6 (1.2-2.2)
Water holding capacity (Percentage)	24.5 (22.3-26.7)	27.12 (25.15-29.09)	30.43 (28.71-32.81)	24	33.6 (32.61-35.08)	31.1 (29.1-32.1)
Soil textural class	Coarse sand	Coarse sand	Sility clay	Coarse sand	Fine sand	Silty clay

*Analyses based on surface soils only, composite soils if not marked.

**Range of edaphic variables.

4. *Artemisia scoparia – Eragrostis-Gnaphalium community:* It was recorded in only one place between Hunza and Passu. *Artemisia scoparia* is widespread in the study area. However this community has a limited distribution. Alongwith their associates *Cousinia thomsonii, Artemisia* sp., *Lycium ruthenicum* and *Geranium aconitifolium* formed an open and heterogeneous community. It tends to be distributed on coarse sand with low potassium and organic matter.

5. *Ephedra-Artemisia* sp. – *Haloxylon community:* The community was observed near Passu. In some areas clusters of pure stands of *Ephedra gerardiana* were recorded. *Cousinia thomsonii* and *Eragostic pilosa* were the associates forming an open and heterogeneous community. It is confined to the fine sand. The soils show high amount of organic matters, comparatively high sodium and potassium.

6. *Ephedra-Clematis-Eragrostis community:* It was located near Nomal, Passu and Hunza. *Artemisia* sp., *Haloxylon thomsonii, Cousinia thomsonii* and *Artemisia scoparia* were the other associates of this open and homogeneous community. Like community 3 it also grows on rocky and gravelly suface at some places, while silty clay with moderate organic matter is the associated soil of the community.

Discussion

The vegetation of the area is generally disturbed due to the construction of the Great Silk Road and grazing. It consists mostly of herbs and shrubs which are cut and used for fuel. Not only the wild species but even the cultivated fruit trees are cut. The results of the first leading dominant species indicate some correlations among leading species in their sociological context. *E. gerardiana* and *A. scoparia* seem to be ecologically similar while *H. thomsonii* is likely to be associated with *C. spinosa.* Similarly *A. scoparia* also seem to be ecologically similar to *G. aconitifolium.* These plants grow abundantly in dry regions of the northern areas of Pakistan (Ahmed & Qadir 1976). *E. gerardiana, A. socoparia* and *H. thomsonii* are also widely distributed in various part of Baluchistan (Rasool Bakhsh, 1986; Arif, 1984).

The communities in the study area are open unstratified and in most cases homogenous. The absence of certain frequency classes in some communities perhaps are reflected upon either due to biotic disturbance and or the floral poverty of the study area. The results obtained by Runkiaer's (1934) technique may be regarded only as possibilities to be confirmed by other alternative approaches.

Some communities recognised in the study area are also found to occur in other parts of northern Pakistan and Baluchistan. *Ephedra-Artemisia* community type is reported from Skardu (Ahmed, 1976), while *Capparis-Haloxylon-Heliotropium* community is recorded between Gilgit and Shunder (Ahmed & Qadir, 1976). Arif (1984) and Baksh (1986), also reported some community types from various parts of Baluchistan.

In most cases the dominant species of one particular community type was also the prominent species in another community type. Similar results have been found while working on Gharo, Dhabeji, Monghopir industrial areas, (Ahmed, 1973), Gadap area (Shaukat *et al*, 1976) and *Agathis australis* forests in New Zealand (Ahmed, 1984). When the floristic composition was the only criterion, the number of communities were reduced. The overlapping distribution of associated species in some communities suggested that these species occured over a wide range of habitat and there were similarities in species composition and the only difference between some communities was in quantitative composition only.

The soils in the study area were generally fine-textured, basic in nature and in most cases not differentiated into horizons. Sub-surface soil did not exist in many stands. In some locations the surface soill was hardly a few cm in depth. In the case of community type 3 (in stand 4), between Hunza and Passu, even surface soil was not found in many quadrats. In this stand *A. scoparia*, and *G. affine* were growing on the parent material or rock debris from weathering, erosion or glacial action. The same condition was also recorded with stand 17 which was dominated by *E. gerardiana*, *C, alpina* and *E. pilosa*, 15 miles away from Passu. According to Ahmed (1974, 1976) and Ahmed & Qadir (1976) *E. gerardiana* and *C. spinosa* can grow on bare rocks, crevices and cracks as well as sand dunes. These are drought resistant species and hence distributed widely all over the dry portion of northern Pakistan. The wide spread distribution of species in study area suggest that they have become adapted to a wide range of habitat condition. The poor relationship between community types and the edaphic factors gives an additional support to this opinion.

References

Ahmed, M. 1973. Phytosociological studies around Gharo, Dhabeji and Monghopir industrial area. M.Sc. Thesis, Karachi University.

Ahmed, M. 1974. Phytosociological studies of Northern Areas of Pakistan. Unpublished report of Govt. of Pakistan.

Ahmed, M. 1976. Multivariate analysis of the vegetation around Skardu. *Agri. Pak.*, 26: 177-187.

Ahmed, M. and S.A. Qadir. 1976. Phytosociological studies along the way of Gilgit to Gopies, Yasin and Shunder. *Pak. J. Forestry*, 26: 93-104.

Ahmed, M. 1984. Ecological and dendrochronological studies on *Agathis australis* Salisb. (Kauri). Ph.D. thesis, University of Auckland, New Zealand.

Anonymous. 1951. Soil survey manual U.S.D.A. handbook No. 18; Govt. Printing office Washington, D.C.

Arif, M. 1984. An eco-taxonomic study of the plants found on the hills of surrounding Hana Lake. M.Sc. Thesis, Baluchistan University.

Baksh, R. 1986. An eco-taxonomic study of the Quetta District. M.Phil. Thesis, University of Baluchistan, Quetta.

Bray. J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. *Ecol. Monogr.*, 27: 325-349.

Brown, R.T. and J.T. Curtis. 1952. The upland conifer hardwood forest of Northern Wisconsin. *Ecol. Mong.*, 22: 212-234.

Fogg, D.N. and N.T. Wilkinson. 1958. The colorimetric determination of phosphorus. *Analyst*, London, 83: 406-414.

Shah, S.M.I. 1977. *Stratigraphy of Pakistan.* Vol. 12. Printing Cooperation of Pakistan, Islamabad.

Jackson, M.L. 1958. *Soil chemical analysis.* Prentice Hall Inc., Englaewood Cliffs. N.J.

Keen, B.A. 1931. *The physical properties of soil.* Longman Green and Co., New York.

Mueller-Dombois, D. and H. Ellenberg. 1974. *Aims and methods of vegetation ecology.* John Wiley and Sons. Inc., New York.

Peech, M. and L. English. 1944. Rapid micro-chemical soil test. *Soil Science*, 57: 167-195.

Peech, M., L.T. Alexander; L.A. Dean and J.F. Reed. 1947. Methods of soil analysis for soil fertility investigations. U.S.D.A. Cir 75-25 pp.

Qadir, S.A; S.Z. Qureshi and M.A. Ahmed. 1966. A phytosociological survey of Karachi University campus. Vegetation, 20: 339-362.

Qadir, S.A. 1968. Bio-climatic plant formations of W. Pakistan. Abst. Biol. Sci. Proc. Pak. Sci. Conf.

Runkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford Clarendon Press. 632 pp.

Shaukat, S.S., Khairi A. and Ahmed R. 1976. A phytosociological study of Gadap area, Southern Sind, Pakistan. *Pak. J. Bot.*, 8: 133-149.

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