Pak. J. Bot., 15 (2): 99–108, 1983.

PHYTOSOCIOLOGY OF THE MUSLIM GRAVEYARDS OF KOHAT DIVISION, NWFP, PAKISTAN

S. M. CHAGHTAI, NOOR AHMAD RANA* AND HABIBUR RAHMAN KHATTAK

Department of Botany
Islamia College, University of Peshawar, Pakistan.

Abstract

The plant communities of the Muslim graveyards of Kohat Division were studied. The number of species in a stand was controlled by the sand and $CaCO_3$ proportions of the soil. The developmental status of the vegetation was also determined.

Introduction

In fact the dearth of fully protected areas is so pronounced, not only in Pakistan but the world over, that a stage has now reached where one ought to feel contended with studying comparatively less disturbed areas in order to get an insight into the natural vegetation. Muslim graveyards were believed to be the most protected places by Stewart (1955) and Champion *et al.* (1965) and thus were regarded ideal for the study of the natural vegetation of the area. As a mark of respect to the dead ones, the people in the olden days used to refrain from cutting and chopping the trees and bushes, and did not let their cattle graze in the graveyards. But the ever increasing demand of organic fuel around has made the people draw their fuel requirements from the graveyards and this led to a considerable disturbance of the ecosystem, the extent of which will go on increasing with the passage of time. Despite this, the Muslim graveyards still offer an opportunity to study comparatively less disturbed vegetation of the area. The vegetaion of the graveyards of some parts NWFP has already been studied (Niazi, 1975, Chaghtai *et al.*, 1978); but Kohat Division remained still unexplored in this regard.

A representative sample comprising 10 graveyards was drawn from all over the division of Kohat. An effort has been made to draw the samples from a large variety of places differing in climate and topography. However, easy accessibility and the extent of protection were two other considerations kept in mind for the selection of the study sites.

**Present Address:* Cadet College, Kohat.

Location, Geology and Climate

Kohat Division spans between 32° 45' and 33° 45' north latitude and 70° 30' and 72° 15' east longitude. Physiographically it comprises Kohat Basin and Kohat Hills (Dichter & Popkin, 1967). The series of 915-1220 m east-west trending limestone-sandstone hills of Tertiary age which comprise the great portion of Kohat Division forms a distinct barrier between the large Peshawar and Bannu Basins which lie to the northeast and south, respectively.

Kohat Division shows the most extreme variations in seasonal temperatures (Dichter & Popkin, 1967). Winters are extremely cool in some parts and they receive heavy snowfall. January and February are the coldest months and the temperature sinks down the freezing point. The hottest month is June and the mercury shoots up above 40° C. The climate is semi-arid with most of the precipitation coming in summer months. The rainfall is so capricious in nature that the particular strike of a hill can mean one valley getting an excellent shower while the next does not receive a drop. The mean annual rainfall ranges from 25 cm to 76 cm (Table 1).

Materials and Methods

The vegetation was sampled in 0.5 x 0.5 m quadrats laid systematically. Daubenmire's method was used for gathering information on coverage (Daubenmire,

Table 1. Mean maximum and mean minimum temperature and normal precipitation recorded at Kohat City for a period of 10 years (1961-70) (courtesy Meteorological Department, Lahore).

Months	Temperature (°C)		Precipitation (cm)
	Max	Min	
January	20.1	5.8	3.22
February	23.9	17.2	4.14
March	23.9	17.5	6.83
April	28.9	22.6	5.35
May	35.2	27.1	3.32
June	40.3	27.1	2.54
July	38.0	27.1	8.76
August	36.5	26.2	7.77
September	35.4	24.0	5.25
October	31.0	18.8	3.17
November	24.8	12.1	1.75
December	17.7	6.9	3.50
		Total	55.60

1959). The number of plants in each quadrat was also recorded. The density, canopy-coverage, frequency and their relative values and the importance values of the species were calculated according to Cox (1967). The maturity index of the vegetation was determined by Pichi-Sermolli's method (1948).

The samples of soil from top 40 cm of the graveyards were collected and the techniques employed for determining the texture and $CaCO_3$ content of the soil were those of the American Society for Testing Materials (1964) and Jackson (1962) respectively.

The nomenclature followed is that of Stewart (1972). The data were collected in the summer of 1977.

Results and Discussion

Community

On the basis of climatological physiographic and topographic conditions, the stands can be grouped into three habitat types and the distribution of vegetation almost follows the same pattern.

Guruzai, Karak City, Latamber and Kiri Shaikhan stands sheer dry and hot climate; the elevations are between 323 m and 396 m and the soil is predominantly sandy. On the whole, xeric conditions prevail here. These stands support comparatively lesser number of both the arborescent and the understorey species.

Belitang, Toghbala and Kohat City stands are mesic; the elevation ranges from 457 m to 518 m and the sand proportion in the soil is low (Table 2). These stands have more understorey species (Table 3).

Ibrahimzai, Togh Sarai and Hangu City stands enjoy comparatively cooler climate; the elevations of these places are round about 915 m. They support higher number of woody and understorey plants.

Of the ten stands studied, one is dominated by *Cenchrus ciliaris,* two by *Brachiaria reptans* and seven by *Cynodon dactylon* (Table 3). In two stands arborescent species happen to be co-dominants with *C. dactylon.* The leading dominant in all the stands is always a grass and it seems to be in strict conformance with the previous findings of Chaghtai *et al.* (1978).

Number of species in a stand is controlled by soil texture and the calcareousness of the soil (Table 2). Stands with slightly calcareous soils having greater proportions of

Table 2. Stands characteristics (edaphic and floristic).

S. No.	Stands	Elevation (m)	Sand (%)	Silt (%)	Clay (%)	Soil Type	$CaCO_3$ (%)	Number of species	Dominants
1.	Guruzai	497	56.8	21.0	22.2	Sandy-clay loam	13.2	8	*Cenchrus*
2.	Karak City	396	66.8	14.0	19.2	Sandy loam	6.6	11	*Cynodon*
3.	Latamber	429	61.2	17.0	21.8	Sandy-clay loam	11.7	10	*Brachiaria*
4.	Kiri Shaikhan	323	48.8	22.0	29.2	Sandy-clay loam	9.7	9	*Cynodon*
5.	Ibrahimzai	914	24.8	46.0	29.2	Clay Loam	23.0	14	*Cynodon*
6.	Togh Sarai	914	8.4	55.0	36.6	Silty-clay loam	17.0	15	*Brachiaria*
7.	Hangu City	914	14.8	53.6	31.6	Silty-caly loam	25.5	13	*Cynodon & Ziziphus*
8.	Belitang	485	8.2	41.0	50.8	Silty caly	24.5	22	*Cynodon, Capparis & Salvadora*
9.	Toghbala	485	3.4	60.0	36.6	Silty-clay loam	22.5	23	*Cynodon*
10.	Kohat City	539	12.0	52.0	36.0	Silty-clay loam	26.5	18	*Cynodon*

sand support lesser number of species. In these stands, the importance values of the community dominants are higher than the other stands in which the number of constituent species is high (Tables 2 & 3). In stands with sand-dominated soils, the number of woody species is low. These stands are considerably open and this has led to a greater competition among the understorey species of exposed habitats for dominance. *Cenchrus ciliaris, Brachiaria reptans* and *Cynodon dactylon,* the plants of exposed and sandy habitats, have outcompeted other plants under the conditions prevailing in these stands. The shade casted by the trees has provided more niches in other stands and it is because of this that these stands support more species. In general, greater competition has resulted in low importance values of the dominants. In Belitang and Kohat City stands, the importance values of *C. dactylon,* the leading dominant, are considerably low and this is probably because of its tense competition with other species in general and the sedges in particular (Table 3). These stands are very much protected and it may be regarded as one of the many reasons for these stands supporting maximum number of woody species. In case these stands remain protected for some more years, *Salvadora oleoides* and *Capparis decidua* would dominate comparatively drier sites and would probably form climaxes Chaghtal & Yusaf, 1976). *Acacia modesta,* a common plant of the landscape of Kohat Division, has been recorded in all the stands except one which seems to be extremely disturbed by grazing (Table 3). *Prosopis glandulosa,* one of the leading dominants of the plant communities of the graveyards of the district of Peshawar was found missing here(Chaghtai& Yusaf, 1976).*P. glandulosa* grows successfully in arid conditions (Troup, 1921) and since Kohat Division receives more precipitation than Peshawar district, hence the absence of mesquite from the research sites in Kohat Division may be explained on the basis of its inability to compete other native species under increasingly mesic conditions.

In stands with low proportions of $CaCO_3$, (Table 2) *C. dactylon* is dominant because of its superb capability of competition in open and dry places; but in stands with highly calcareous soils, the dominance is largely because of greater tolerance this species possesses for these conditions (Woodhouse, 1968; Anon., 1958; Burton, 1944; Ramakrishana & Singh, 1966). In Belitang stand, although shade has considerably affected *C. dactylon* and has reduced its importance value to a minimum in comparision with other stands yet this species managed to out compete other herbs and shrubs (Table 3). This is one of the most protected stands and the arborescent species are doing well in the absence of human axe. The dominant arborescent species are not perpetuating well in any of the stands.

Maturity Status of the Stands.

The development of vegetation on these sites seems to fit into three patterns. On comparatively xeric sites, grass alone seems to dominate the scene. In this group, Guruzai stand with a maturity index of 38 seems to represent the highly developed vegetation

(Table 4). The complete absence of sporadic species, smaller number of species inhabiting this stand and the outright dominance of a single species *(Cenchrus ciliaris)* hint at higher developmental status of this stand (Pichi-Sermolli, 1948).

Mesic sites support more both understorey and woody species. *C. dactylon* is dominant on these sites but its lead on other inhabitants is just marginal (Table 3). The competition is very severe and *C. dactylon* has failed to outclass other herbaceous plants

Table 3. Importance values.

Species	Stands									
	1	2	3	4	5	6	7	8	9	10
Cynodon dactylon	–	99	–	128	100	44	80	35	83	31
Cenchrus ciliaris	185	–	–	–	–	–	–	3	–	–
Fagonia bruguieri	8	7	11	13	–	–	–	8	–	–
Acacia modesta	24	47	47	42	47	–	–	5	18	10
Capparis decidua	–	–	–	–	–	–	–	27	25	29
Salvadora oleoides	–	–	–	42	29	–	–	27	7	21
Tamarix aphylla	–	–	–	–	–	–	–	–	7	–
Ziziphus nummularia	–	–	–	–	19	–	73	18	18	28
Portulaca quadrifida	14	–	–	–	–	–	–	–	–	–
Solanum surattense	14	–	–	–	–	–	–	6	8	–
Rhazya stricta	26	11	–	–	–	–	–	–	–	–
Withania coagulans	13	–	–	17	16	11	–	17	7	10
W. somnifera	–	–	–	–	–	–	–	7	–	–
Amaranthus virdis	16	–	37	28	7	–	6	–	11	9
Boerhaavia coccinea	–	27	–	–	–	–	21	–	–	3
Suaeda fruticosa	–	10	–	–	–	–	–	12	–	18
Euphorbia clarkeana	–	–	16	–	–	18	–	–	–	19
E. prostrata	–	29	–	–	–	–	–	–	–	–
Cyperus rotundus	–	16	–	16	–	–	–	26	10	10
Peganum harmala	–	21	–	–	12	15	–	10	6	–
Chenopodium murale	–	2	–	9	16	16	21	24	8	21
Tribulus terrestris	–	30	1	–	5	11	14	–	–	–
Brachiaria reptans	–	–	144	–	30	88	20	–	–	–
Herniaria cinerea	–	–	19	–	–	–	–	–	–	–
Dalbergia sissoo	–	–	7	–	–	–	–	–	–	–
Calotropis procera	–	–	12	–	–	3	–	–	–	–
Cassia sp.	–	–	4	–	–	–	–	–	–	–
Gymnosporia royleana		–	–	–	3	3	–	–	–	–
Oligomeris linifolia	–	–	–	–	5	–	–	–	–	8
Salvia moorcroftiana	–	–	–	–	5	11	–	–	–	–
Carthamus oxyacantha	–	–	–	–	4	–	–	–	6	–
Centaurea iberica	–	–	–	–	–	9	15	–	7	–

Table 3. (continued)

Species	Stands									
	1	2	3	4	5	6	7	8	9	10
Eryngium bieberstein-ianum	–	–	–	–	–	8	–	–	–	–
Cynoglossum glochi-diatum	–	–	–	–	–	7	–	–	–	–
Verbena officinalis	–	–	–	–	–	4	–	–	–	–
Oxalis corniculata	–	–	–	–	–	–	7	–	14	–
Dicliptera roxburghiana	–	–	–	–	–	–	17	–	–	11
Malvastrum cormande-lianum	–	–	–	–	–	–	6	–	11	–
Adhatoda vasica	–	–	–	–	–	–	13	7	–	–
Polygonum plebejum	–	–	–	–	–	–	7	–	–	–
Ephedra ciliata	–	–	–	–	–	–	–	8	–	–
Rhynchosia minima	–	–	–	–	–	–	–	5	4	–
Convza bonariensis	–	–	–	–	–	–	–	26	8	–
Pluchea lanceolata	–	–	–	–	–	–	–	11	–	11
Pupalia lappacea	–	–	–	–	–	–	–	5	–	–
Eragrostia sp.	–	–	–	–	–	–	–	5	–	–
Atriplex crassifolia	–	–	–	–	–	–	–	5	9	–
Achyranthes aspera	–	–	–	–	–	–	–	–	5	–
Kochia indica	–	–	–	–	–	–	–	–	13	28
Asparagus gracilis	–	–	–	–	–	–	–	–	2	–
Haloxylon salicorn-icum	–	–	–	–	–	–	–	–	11	–
Desmostachya bipi-nnata	–	–	–	–	–	–	–	–	–	29
Alhagi maurorum	–	–	–	–	–	–	–	–	–	2

primarily because of greater shade cast by woody plants. Among mesic sites, Kohat City stand seems to attain highest level of development with a maturity index of 44. Belitang stand has been pushed to a lowest position on the maturity scale (Table 4). This stand supports large number of species of which few succeeded to achieve some importance but not so much as to dominate and to eliminate many other species which appear sporadically and are less adapted to the ecological conditions. This community is heterogenous, incoherent and liable to important changes sooner or later.

Among cool and comparatively wet sites, Hangu City stand has attained a highest degree of stability and maturity which is manifested by the total absence of sporadics

Table 4. Maturity index and its components. (Sporadics, species with frequencies 10%; Frequents, frequencies 50-79%; and Dominants, frequencies 80-100%).

S. No	Stands	Points	Number of species	Maturity Index	Sporadics (%)	Frequents (%)	Dominants (%)
1.	Guruzai	303	8	38	Nil	12	12
2.	Karak City	394	11	36	9	18	9
3.	Latamber	310	10	31	30	10	10
4.	Kiri Shaikhan	323	9	36	11	11	11
5.	Ibrahimzai	449	14	32	7	14	7
6.	Togh Sarai	571	15	38	13	20	7
7.	Hangu City	577	13	44	Nil	31	8
8.	Belitang	642	22	29	14	23	Nil
9.	Toghbala	852	23	37	4	22	4
10.	Kohat City	800	18	44	5	33	5

coupled with the outright dominance of two species – one grass and the other a woody plant (Tables 3 & 4). This stand is made up of few species, all well established, which occupied all the free spaces, eliminating the sporadic species completely. This community is more homogenous, close and less liable to infiltration by new species and thus more stable.

Based upon observations it seems probable that the climax vegetation of the area, provided the area remains undisturbed, would be a woodland in which the constituent species will be *A. modesta, S. oleoides, C. decidua* and *Ziziphus nummularia* with *A. modesta* as a leading dominant mostly on mesic sites and with *S. oleoides* replacing it on more xeric sites. The understorey vegetation will be dominated by one or more grasses of which *C. dactylon* will be far ahead of other species on sandy and exposed habitats. The number of species reported in a study of the native vegetation of Kohat is far lower than that found here (Chaghtai & Yusaf, 1976). The obvious reason of this discrepancy seems to be the time of study. The present study is based on the observations made in summer, whereas the study referred above is based on winter flora.

References

Anonymous, 1958. Introduced grasses and legumes. Section 5; Series Pasture and landplants. Phillips petroleum Co., U.S.A., 25 pp.

Anonymous, 1964. Book of ASTM Standards. Part II. Bituminous materials for highway construction, waterproofing, and roofing; Soil, Philadelphia.

Burton, G. W. 1944. Seed production of several southern grasses as influenced by burning and fertilization. *Amer. Soc. Agron. J.*, 36:523–529.

Chaghtai, S. M., H. Shah and M. A. Akhtar. 1978. Phytosociological study of the graveyards of Peshawar District, NWFP, Pakistan. *Pak. J. Bot.*, 10: 17–30.

Chaghtai, S. M. and M. Yusaf. 1976. The ecology of the native vegetation of Kohat, NWFP, Pakistan. *Pak. J. Bot.*, 8: 27–36.

Champion, H. G., S.K. Seth and G. M. Khattak. 1965. *Forest types of Pakistan.* Pakistan Forest Institute, Peshawar. 238 pp.

Cox, G. W. 1967. *Laboratory Manual of General Ecology.* Wm. C. Brown Co. Publishers, Iowa. 165 pp.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. *Northwest Sci., 33: 43–66.*

Dichter, D and N. S. Popkin. 1967. The North-West Frontier of West Pakistan – *A study in regional geography.* Clarendon Press, Oxford, U. K. 231 pp.

Jackson, M. L. 1962. *Soil Chemical Analysis.* Constable & Co. Ltd., London. 498 pp.

Niazi, D. M. K. 1975. Graveyard flora of Bannu and its outskirts. M. Sc. Thesis. Botany Department, Govt. Post-graduate College, Bannu.

Pichi-Sermolli, R. E. 1948. An index for establishing the degree of maturity in plant communities. *J. Ecol., 36:85-90.*

Ramakrishanan, P. S. and V.K. Singh. 1966. Differential response of the edaphic ecotypes in *Cynodon dactylon* (L.) Pers. to soil calcium. *New Phytol., 65: 100-108.*

Stewart, R. R. 1958. *The flora of Rawalpindi District.* Frontier Exchange Press Ltd., Rawalpindi.

Stewart, R. R. 1972. An annotated catalogue of the vascular plants of West Pakistan and Kashmir. (ed). Nasir, E. and S. I. Ali. *Flora of West Pakistan,* University of Karachi, Pakistan. 1029 pp.

Troup, R. S. 1921. *The Silviculture of Indian Trees.* Vol. II. Leguminosae (Caesalpinaceae) to Verbenaceae. Clarendon Press, Oxford, U. K. 399 pp.

Woodhouse Jr. , W. W. 1968. Long-term fertility requirements of coastal bermudagrass *(Cynodon dactylon):* I. Potassium. *Agron.* J., 60: 508–512..