VEGETATION OF DELHI STATE: MEHRAULI REGION

I. Analysis of Pattern

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Data on the distribution pattern of common trees and shrubs with special reference to the ridges in Mehrauli Region of the Delhi State have been discussed. Evidences have been provided for postulating that the factors controlling the distribution of *Prosopis spicigera* and *Rhus mysurensis* are different. It is suggested that variations in the soil factors, and not directly the moisture relations, are the important controlling factors.

Introduction

Delhi State stretches along the western bank of the Yamuna river between 28° 12′ and 28° 53′ North latitude and 76° 50′ and 77° 23′ East longitude. It is surrounded on the south-east by Thar desert, north-east by Indo-Gangetic Plain and in south by Aravallis. Due to this location of the State, which is 53·8 km (33 miles) in length and 48 km (30 miles) in width, the physiographic features as well as vegetation vary. Though sufficient information is available regarding the flora of the State (Maheshwari 1963; Parker 1918, 1920; Singh 1945; Stewart 1869), a connected account of the vegetation is lacking. The present studies, therefore, are an attempt to study the composition and variation in vegetation as it exists today. In order to facilitate the collection of data, the State has been divided into four regions. Mehrauli, which lies in the south-east of the State, is one of these four regions and the subject of the present investigations.

Mehrauli, situated among the outliers of the remnants of Aravallis, which like other portions (Mukherjee 1953) of the ridge is very uneven, undulated and trenched by ramifying ravines which are separated by lower ridges representing slightly harder beds. These ridges are flat-topped and dominated by symmetrically folded quartzites, and they are supposed to be formed during Tertiary times due to the uplifting of the strata as a result of peneplanation. Since these north-south running ridges were initiated along lines of structural weakness, i.e. along anticlinal axis, we now get a parallel system of flat-topped synclinal ridges intervened by anticlinal valleys which are covered by 'Bhangar aluvium' (Sen 1953).

In general, the vegetation is composed of stunted, medium-sized trees and shrubs which are more or less widely spaced and do not form a continuous canopy—a characteristic of semi-desert scrub. In accordance with the variation in the nature of the substratum and also as a result of recurring biotic factors such as grazing and felling coupled with the constant vagaries of the climate, prevalent in the State, the vegetation indicates variability in the distribution of its components. If the factors are the same throughout the region, the pattern of distribution of different trees and shrub species in the region should also be the same. In this communication, therefore, the data on the pattern shown by different shrubs and trees in several plant communities and habitat are presented as a contribution to the understanding of the interaction between plants and their environment. Further observations on the community composition, soil conditions and succession shall be presented later.

Methods

These data were collected with the help of transects and square units of 10 m as suggested by Greig-Smith and Chadwick (1965). Details like canopy, density and girth at breast height were noted for every tree and shrub in each unit. Soil characteristics such as *p*H, organic matter, total inorganic elements, etc., were recorded following the methods of Piper (1947). In some regions due to appreciable biotic influence, the girth does not give a clear correlation with the habitat and, therefore, the correlation is based on canopy of the plant species. The data on the pattern were analysed by analysis of variance as suggested by Greig-Smith (1961).

Observations

The area under study can be divided into three distinct physiographic regions: (*a*) ridges—including the upper and lower slopes, (*b*) valleys and (*c*) valley flats. The valleys are comparatively densely vegetated and the common constituents of this region are: *Anogeissus pendula, Diospyros cordifolia, Flacourtia indica, Jasminum multiflorum* and rarely *Zizyphus oenoplia,* etc. The valley flats usually covered with eluvial soil are mostly inhabited by *Balanites roxburghii, Capparis decidua, C. sepiaria, Carissa spinarum, Zizyphus nummularia,* etc. The vegetation on the ridges is peculiar, for the components change from north to south. In the extreme north the ridges are covered with dense *Prosopis spicigera* which stands accompanied by *Acacia leucophloea, A. modesta, A. senegal, Capparis decidua, Tephrosea villosa, Zizyphus nummularia,* etc., but the inner ridges (i.e. towards south) are dominated by *Rhus mysurensis.* The other associates of *R. mysurensis* are *Lycium europaeum, Melanthesa rhamnoidis* and *Securinega leucopyrus.* One may occasionally also get *Acacia leucophloca.*

The vegetational stand is open and the percentage densities of various trees and shrubs are as follows:

Acacia leucophloea (Roxb.) Willd. ..	6·4
Carissa spinarum Linn.	5·1
Prosopis spicigera Linn.	8·5
Rhus mysurensis Heyne ex Wt. & Arn. ..	7·0
Securinega leucopyrus (Willd.) Muell.-Arg. ..	8·3
Zizyphus nummularia (Burm. f.) Wt. & Arn.	38·0

From the above figures we get an over-all picture regarding the distribution of various plant species, yet no information is available about the relation of each with the habitat. Therefore, the pattern which reflects determination of the occurrence of plants and performance by one or two factors or groups of correlated factors has been analysed (Greig-Smith 1957, 1959).

These data are based on the study of 17 transects. Graphic representation of mean square/mean (density data) against block size is given in Fig. 1. The curves for *Acacia leucophloea, Carissa spinarum* and *Prosopis spicigera* show peaks at block size 8. For *Rhus mysurensis* and *Securinega leucopyrus*

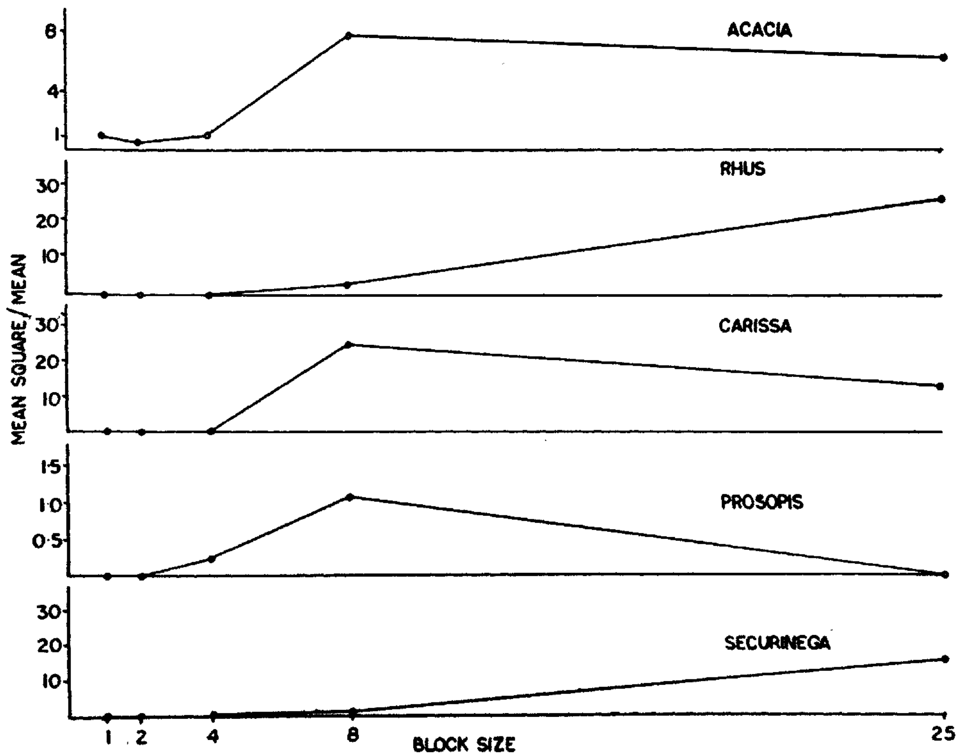

FIG. 1. Graph of mean square/mean (density data) against block size.

this block size is the starting point and the curve shows a gradual rise. The curves for canopy (Fig. 2) of different plant species are not highly significant but show a downward trend for *Acacia leucophloea*, *Carissa spinarum* and *Prosopis spicigera* and a slight upward trend for the other two with the increase in block size. The curve for *Prosopis spicigera* is very characteristic since there is an abrupt decrease in the canopy after block size 4. Thus, it can be deduced that these two groups of plant species are controlled by a different set of conditions.

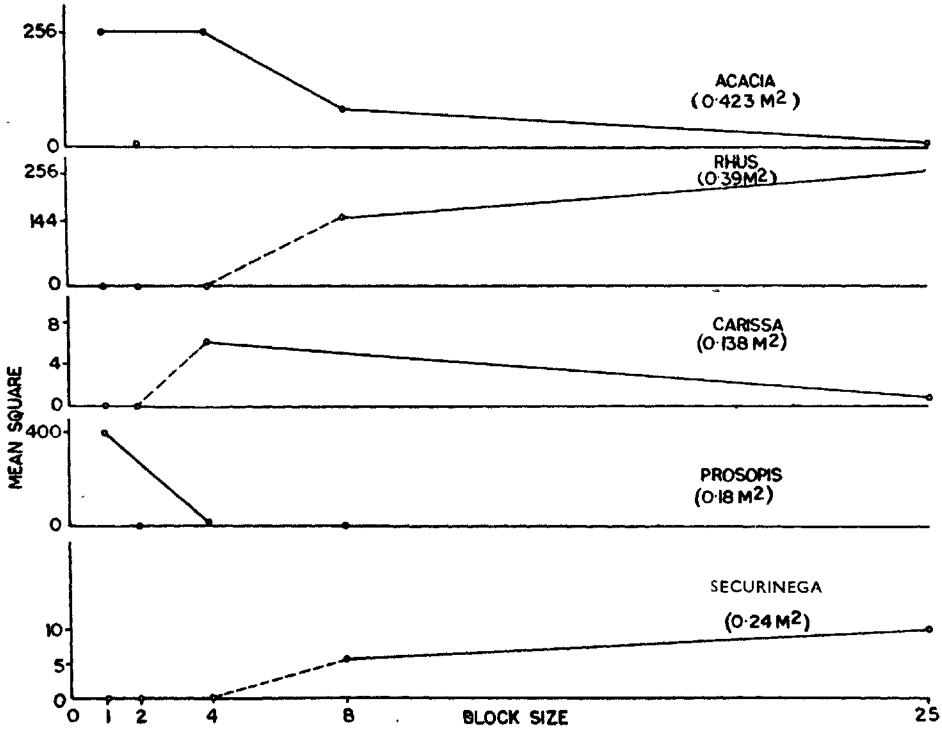

FIG. 2. Graph of mean square (canopy) against block size, figures in parentheses are mean values per unit 100 m^2.

The seedlings of *Prosopis spicigera* are aggregated around larger trees but those with a canopy of more than 6 cm^2 are random like the mature trees. This may indicate a habitat control in the seedling stage. On the other hand, seedlings of *Rhus mysurensis* are very rare showing poor regeneration and less control of habitat. This further supports the presumption that the two sets of plant species of which these are the representatives are controlled by different factors.

Correlation coefficient between *Prosopis spicigera* and *Rhus mysurensis* is $-1 \cdot 0$: providing no evidence of association between the two plant species.

In order to find out the correlation with the habitat factor, *p*H of soil of different units was studied and a graphical representation is given in Fig. 3. Although the curve is not very significant and cannot be discussed without considering other soil factors, yet the general trend of variation in *p*H is in conformity with the distributional pattern of the plant species under study.

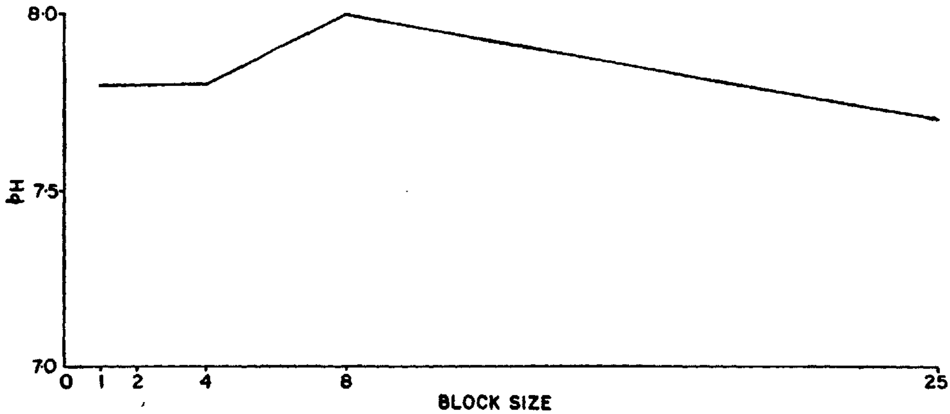

FIG. 3. Graph of *p*H against block size.

DISCUSSION

The distribution of plant species mentioned above is controlled by different factors as reflected by their distributional pattern. The Delhi State has a scanty rainfall (60 cm and most of it is received during July to September). This limited period of precipitation, coupled with the almost uniform depth of soil, is likely to create equal moisture status on different ridges. Hence, it may be deduced that the distribution of the large and mature two important plant species, *Prosopis spicigera* and *Rhus mysurensis*, is not controlled by this factor alone. On the other hand, as indicated by the abundance of seedlings round mature trees during and immediately after the rains does suggest that the moisture content of soil and relative humidity of atmosphere control the germination of seeds. But the percentage density of seedlings is higher (82·7) of *Acacia leucophloea* and *Prosopis spicigera* than of *Rhus mysurensis* which may indicate a variability in the moisture status of soil at the two places. The complete seasonal data of the moisture content of the soil are not available presently, but the behaviour of germination of these two species can be explained on the basis of morphology of the fruit of the three plant species cited above. In *Acacia leucophloea* and *Prosopis spicigera* the pod consists of a spongy mesocarp which can absorb and retain moisture for a considerable time and thus help the seeds to germinate. In *Rhus mysurensis*, on the other hand, the drupe is stony and without any means for the retention of water necessary for the germination of seed. This may be one of the reasons for the poor regeneration of *Rhus mysurensis*. Thus, it may be argued that like mature trees even the germination and aggregation of the seedlings near the mature trees are not controlled by the moisture-status of the substratum; it is very likely that the moisture status in the two cases is identical.

Therefore, in this instance, as also reported from semi-arid regions (Boaler and Hodge 1962, 1964; Glover *et al.* 1964; Macfadyen 1950; Slatyer 1961; Worrall 1959, 1960*a*, *b*), the obvious vegetational pattern can be interpreted in terms of soil variability. Such variations are well known, e.g. Muller (1887) described from Denmark the occurrence of distinctive mull humus profiles developed under oaks in the otherwise podsolic soils developed under heath. More recently, Zinke (1962) has studied the detailed pattern of soil properties such as *p*H, exchangeable bases and cation exchange capacity developed under individual trees in a stand of *Pinus contorta*. From the studies of Zinke (1962) and Anderson (1965) it is clear that 'considerable quantitative variation in chemical soil variables may be developed over quite short distances'. The present observations regarding the variation in vegetational cover may be explained in the light of such observations on soil variability. A *p*H curve (Fig. 3) in relation to block size provides some evidence to this hypothesis. This supports the concept of Anderson (1965) that at least part of the soil environment is important in controlling the distribution of at least some of the species growing together in this community, and that the scale of this control may be determined, at least in part, by the detailed distributional pattern of past vegetation of the area. Therefore, the data reported here emphasize the need for a critical investigation of soil variability, detailed vegetational composition and succession.

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REFERENCES

Anderson, D. J. (1965). Studies on structure in plant communities. I. An analysis of limestone grassland in Monks Dale, Derbyshire. *J. Ecol.*, **53**, 97–107.

Boaler, S. B., and Hodge, C. A. H. (1962). Vegetation strips in Somaliland. *J. Ecol.*, **50**, 465–474.

——— (1964). Observations on vegetation areas in the Northern Region, Somali Republic. *J. Ecol.*, **52**, 511–544.

Glover, P. E., Trump, E. C., and Wateridge, L. E. D. (1964). Termitaria and vegetation patterns on the Lotia Plains of Kenya. *J. Ecol.*, **52**, 367–377.

Greig-Smith, P. (1957). Quantitative Plant Ecology. London.

——— (1959). The use of pattern analysis in ecological investigations. *Proc. IX Int. bot. Congr. II A*, 13.

——— (1961). Data on pattern within plant communities. I. The analysis of pattern. *J. Ecol.*, **49**, 695–702.

Greig-Smith, P., and Chadwick, M. J. (1965). Data on pattern within plant communities. III. *Acacia-Capparis* semi-desert scrub in the Sudan. *J. Ecol.*, **53**, 465–474.

Macfadyen, W. A. (1950). Vegetation patterns in the semi-desert plains of British Somaliland. *Geogrl J.*, **116**, 199–211.

Maheshwari, J. K. (1963). The Flora of Delhi. C.S.I.R., New Delhi.

Mukherjee, S. K. (1953). Vegetation of Delhi 'Ridge'. *J. Bombay nat. Hist. Soc.*, **51**; 439–465.

* Muller, P. E. (1887). Studien über die natürlichen Humusformen und deren Einwirkungen auf Vegetation und Boden. Berlin.

Parker, R. N. (1918). A Forest Flora for the Punjab with Hazara and Delhi (ed. 2, 1924). Lahore.

——— (1920). Afforestation of the 'Ridge' at Delhi. *Indian Forester*, **46**, 21–28.

Piper, C. S. (1947). Soil and Plant Analysis. Adelaide.

Sen, N. (1953). Geomorphological evolution of Delhi Area. *Curr. Sci.*, **21**, 157–159.

Singh, H. (1945). Some useful wild plants of Delhi Province. *Indian J. agric. Sci.*, **15**, 297–308.

Slatyer, R. O. (1961). Methodology of water balance study conducted on desert wood-land (*Acacia aneura* F. Muell.) community in Central Australia. *Arid Zone Research*, 16, *Plant-water Relationships in Arid and Semi-Arid Conditions*, 15–26.

Stewart, J. L. (1869). Punjab Plants, comprising Botanical and Vernacular Names, and Uses of most of the Trees, Shrubs and Herbs of Economic Value, growing within the Province of Lahore.

Worrall, G. A. (1959). The Butana grass patterns. *J. Soil Sci.*, **10**, 34–55.

——— (1960*a*). Patchiness in vegetation in Northern Sudan. *J. Ecol.*, **48**, 107–115.

——— (1960*b*). Tree patterns in the Sudan. *J. Soil Sci.*, **11**, 63–67.

Zinke, P. J. (1962). The pattern of influence of individual forest trees on soil properties. *Ecology*, **43**, 130–133.

* Not seen in original.