

ECOLOGICAL OBSERVATIONS ALONG THE RIVER BANKS AT ALLAHABAD, U. P.

J. S. SINGH

Department of Botany, Banaras Hindu University, Varanasi-5

AND

KRISHNA MITRA (née GHOSH)

Botanical Survey of India, Central Botanical Laboratory, Calcutta

ABSTRACT

This paper embodies the ecological observations made along the exposed riverbeds and the immediate banks of the rivers Jamuna and Ganga at Allahabad during the months of April to June in 1962 and 1963.

The physical features, climate and soil of the area are discussed.

Botanical composition of the vegetation and the relative abundance, preference for habitat, types, and phenology of the important species are given.

The vegetation is characterised by the preponderance of annual plants and consists of the species of the wet meadow and dry meadow stages of Dudgeon (1920). The thorn scrub stage is represented by *Acacia arabica* and *Zizyphus jujuba*.

INTRODUCTION

Some ecological studies on the river banks in India are already on record. Misra (1944) has discussed in detail the ecology of Rajghat ravines at Varanasi and Maheshwari (1960) has described the vegetation of marshes, swamps and riverside in Khandawa district. Chauhan and Sinha (1961) and Chavan, Sabnis and Pathak (1961) have also reported their studies of the river banks in the form of abstracts. The present observations were made along the exposed river beds and the immediate banks of the rivers Jamuna and Ganga at Allahabad in 1962 and 1963 during the months of April to June, when the maximum area was exposed for observations due to the receding water level.

PHYSICAL FEATURES

Allahabad (25°26' N latitude : 81°52' E longitude) is situated at about 97 m above the sea level and forms a representative part of the upper Gangetic Plain (Dudgeon, 1920) which has been recognised as a distinct botanical region of India (Chatterjee, 1939). The old city of Allahabad is surrounded by the Jamuna river in the south and Ganga river in the north and east sides. The confluence of rivers Ganga and Jamuna takes place in the south-east direction near the Allahabad Fort.

A number of small ravines have been formed along the banks of both the rivers, especially Jamuna, on account of gully erosion and land slides. The formation of gullies and land slides are most frequent during the rainy season. Apart from the gullies, drainage nullahs cut across the banks at places and give to the sides an appearance of deep gorges.

The banks of the Jamuna river are mostly precipitous, while those of Ganga have gentle slopes.

CLIMATE

The climate of Allahabad is continental showing a large range of temperature between summer and winter seasons. Owing to the monsoon conditions, the area experiences three distinct seasons in a year, viz., summer, rainy and winter. The characteristics of these seasons have already been discussed in detail by Dudgeon (1920). According to Subrahmanyam (1956), Allahabad comes under the climatic type C₁ (Dry sub-humid).

SOIL

The soil is alluvial in nature and sandy clay in texture. The proportion of sand to clay is higher in the soil of Ganga bank as compared to that of Jamuna bank. At some places, where the banks have more or less flat topography, large amounts of sand are deposited on inundation during the later part of the rainy season. The deposition of sand is more frequent on the Ganga bank. Because of the clayey nature of soil the freshly exposed bed of the river Jamuna is often muddy. Soil along the drainage nullahs is also clayey. 'Kankar' (calcareous nodules) is frequently met with at higher reaches of the sides.

BIOTIC FACTORS

Plant cutting, grazing and cultivation are very common practices which have greatly modified and checked the development and succession of the vegetation. Moreover, the city of Allahabad has been a religious centre from ancient times and there is a continuous influx of pilgrims and tourists throughout the year. A number of bathing ghats have also been built on the banks of both the rivers. All these have disturbed the natural vegetation to a great extent.

VEGETATION

Ecological studies on the vegetation of Allahabad were first attempted by Dudgeon (1920). Later on

Srivastava (1944) reported his studies of the biological spectrum of the Allahabad flora, subsequent to his publication of the *Flora of Allahabad* in 1939 and Verma and Arora (1961) discussed some of the bio-climatological aspects of Allahabad in relation to the planting of trees. Recently Singh and Ghosh (1963) gave a preliminary account of the vegetation of Jamuna bank and Patil and Singh (1963) listed the species growing in association with *Phyla nodiflora* on the Ganga bank at Phaphamau.

In general, the vegetation of the river banks at Allahabad is thin and sparse exhibiting a preponderance of annual plants.

The important species occurring on the wet ground just adjacent to the flowing rivers are: *Ranunculus sceleratus*, *Potentilla supina*, *Phyla nodiflora*, *Polygonum plebejum*, *Rumex dentatus*, *Cyperus rotundus*, *Fimbristylis dichotoma*, *Juncellus pygmaeus* and *Scirpus maritimus*. In this habitat, at certain places (especially observed in the Sangam area and near the Curzon bridge) *Phyla nodiflora* forms a continuous cover over the ground. This cover extends in the wet ground to about 30 m further from the river. Associates of *Phyla nodiflora* in such habitat are already reported (Patil and Singh, 1963).

Higher up, on relatively dry ground the following main species are found: *Argemone mexicana*, *Portulaca* sp., *Alhagi camelorum*, *Mollugo hirta*, *Seseli-indicum*, *Dentella repens*, *Eclipta prostrata*, *Gnaphalium indicum*, *G. leuto-album*, *Grangea maderaspatana*, *Launaea nudicaulis*, *Pulicaria foliolosa*, *Xanthium strumarium*, *Solanum nigrum*, *Celsia coromandeliana*, *Scoparia dulcis*, *Phyla nodiflora*, *Boerhaavia diffusa*, *Alternanthera sessilis*, *Amarantus spinosus*, *Chrozophora rotleri*, *Euphorbia thymifolia*, *Cyperus rotundus*, *Juncellus pygmaeus*, *Cynodon dactylon*, *Digitaria adscendens*, *Echinochloa colonum*, *Eleusine indica*, *Eragrostis poaeoides*, *Polypogon monspeliensis*, *Setaria verticillata* and *Equisetum debile*. Plants of *Cassia occidentalis* and *C. tora* are also seen.

Chrozophora rotleri grows on silt and is abundant on the Jamuna bank, where at places especially near the Allahabad Fort and near the Jamuna bridge on the Naini side it often forms pure, dense colonies. In such colonies *Alhagi camelorum* and dried plants of *Argemone mexicana* are frequently encountered. *Alhagi camelorum* also shows a tendency to form pure or mixed colonies.

The upper reaches of the banks, where the ground is more or less gravelly, are mainly inhabited by *Xanthium strumarium*, *Calotropis procera*, *Datura innoxia*, *Solanum surattense*, *Croton bonplandianum* and *Euphorbia thymifolia*. *Lantana indica* grows well on the slopes laden with stones at the bottom of the Railway bund at Phaphamau.

Tamarix sp. is frequent on the sandy flats of the Ganga bank below the Curzon bridge. The wet

depressions in such sandy flats have the following species in addition to those reported for wet ground just adjacent to the flowing rivers: *Portulaca* sp., *Dentella repens*, *Eclipta prostrata*, *Launaea nudicaulis*, *Pulicaria foliolosa*, *Nicotiana plumbaginifolia* and *Eragrostis poaeoides*. At certain places in the Sangam area *Eichornia crassipes* forms a complete cover over the water-filled and wet depressions.

New sandy islands formed in the Ganga river are colonised by: *Ranunculus sceleratus*, *Potentilla supina*, *Polygonum plebejum*, *Gnaphalium leuto-album*, *Cyperus rotundus* and *Equisetum debile*. The vegetation of the fresh sandy deposits of Jamuna bank is similar to this.

Plant species which are frequently met with along the drainage nullahs falling in the river Jamuna are: *Ranunculus sceleratus*, *Argemone mexicana*, *Portulaca oleracea*, *Linum usitatissimum* (escape), *Eclipta prostrata*, *Pulicaria foliolosa*, *Xanthium strumarium*, *Solanum nigrum*, *Ocimum* sp., *Amarantus gangeticus* (escape), *A. spinosus*, *A. viridis*, *Chenopodium album*, *Croton bonplandianum*, *Fimbristylis dichotoma*, *Juncellus pygmaeus*, *Cynodon dactylon*, *Echinochloa colonum* and tomato (escape).

A list of the plants collected from the river banks (except very rare ones) with their relative abundance based on visual estimation (see Brown 1954) and their phenology is given in table I.

DISCUSSION

The preponderance of annuals, as observed along the river banks at Allahabad, is characteristic of "the regions with a dry summer, slightly humid winter and a long rainy season in between the two seasons" (Srivastava, 1944). The exposed riverbeds are mainly inhabited by annuals owing to the inundation during the rainy season and the first half of the winter season, which makes the establishment and survival of perennial species difficult. The botanical composition of the vegetal cover and the relative abundance of the individual species populations are influenced by factors like topography, moisture physical characteristics of the soil and biotic factors. Thus certain species are more frequent on the Jamuna bank than on the Ganga bank and vice versa. Likewise *Phyla nodiflora* forms extensive communities on the wet sandy flats of the Ganga bank and *Eichornia crassipes* covers the water filled and wet depressions in certain localities on the Ganga bank. On the other hand *Solanum surattense*, *Calotropis procera*, *Croton bonplandianum*, *Euphorbia thymifolia* and *Datura innoxia* are found on the upper dry reaches of the riversides having calcareous nodules.

For the most part, the present vegetation consists of plants of the wet meadow and dry meadow stages described by Dudgeon (1920). The thorn scrub stage is only represented by *Acacia arabica* and

Zizyphus jujuba. Trees of *Azadirachta indica*, *Ficus religiosa*, *F. bengalensis*, *Syzygium cumini* and *Moringa oleifera* are also found at places but these are planted. The absence of natural trees

and shrubs from the immediate banks of both the rivers is due probably to factors like biotic pressure, inundation during the spate of the rivers, sand deposition and erosion.

Abbreviations used : a = abundant, f=frequent, o=occasional, r=rare, v=prefix 'very' and l=prefix 'locally'. Families are arranged in accordance with the system followed by Duthie (1960, reprinted edition).

TABLE I
Relative abundance Phenology (3rd week of May)

Plant species	Relative abundance		Phenology (3rd week of May)
	Ganga bank	Jamuna bank	
1	2	3	4
Ranunculaceae			
1. <i>Ranunculus sceleratus</i> L.	a	a	Flowering
Papaveraceae			
2. <i>Argemone mexicana</i> L.	f	f	Late fruiting or dried plants
Portulacaceae			
3. <i>Portulaca oleracea</i> L.	f	f	Flowering
4. <i>Portulaca</i> sp.	o	f	"
Tamariscinae			
5. <i>Tamarix</i> sp.	lf	—	Vegetative phase
Lineae			
6. <i>Linum usitatissimum</i> L.	—	r	Flowering
Rhamnaceae			
7. <i>Zizyphus jujuba</i> Lamk	o	o	—
Leguminosae			
8. <i>Acacia arabica</i> Willd.	r	r	—
9. <i>Alhagi camelorum</i> Fisch.	f to la	f to la	Flowering
10. <i>Cassia occidentalis</i> L.	f	o	Fruiting
11. <i>C. tora</i> L.	—	r	Late fruiting
12. <i>Melilotus</i> sp.	r	—	Flowering
Rosaceae			
13. <i>Potentilla supina</i> L.	vf	f	Fruiting
Ficoideae			
14. <i>Mollugo hirta</i> Thunb.	f	f	Flowering
Umbelliferae			
15. <i>Peucedanum graveolens</i> Benth.	—	r	Flowering and fruiting
16. <i>Seseli indicum</i> W. & A.	f	—	Flowering
Rubiaceae			
17. <i>Dentella repens</i> Forst.	—	o	Flowering
Compositae			
18. <i>Eclipta prostrata</i> L.	f	o	Flowering
19. <i>Gnaphalium indicum</i> L.	σ	f	"
20. <i>G. leuto-album</i> L.	f	f	"
21. <i>Grangea maderaspatana</i> Poir	lf	lf	"
22. <i>Launaea nudicaulis</i> Less.	o	o	Fruiting
23. <i>L. pinnatifida</i> Cass.	r	—	"
24. <i>Pulicaria foliolosa</i> DC.	o	f	Flowering
25. <i>Vernonia cinera</i> Less.	r	r	"
26. <i>Xanthium strumarium</i> L.	f	f	Fruiting
Asclepiadaceae			
27. <i>Calotropis procera</i> Br.	f	f to lf	Flowering
Solanaceae			
28. <i>Datura innoxia</i> Mimm.	o	r	Flowering and fruiting
29. <i>Nicotiana plumbaginifolia</i> Viv.	f	o	"
30. <i>Solanum nigrum</i> L.	f	f	"
31. <i>S. suratense</i> Burm. f.	f	f	Fruiting
Scrophulariaceae			
32. <i>Celsia coromandeliana</i> Wall.	o	f	Fruiting
33. <i>Scoparia dulcis</i> L.	f	f	"

1	2	3	4
Verbenaceae			
34. <i>Lantana indica</i> Roxb.	la	—	Flowering
35. <i>Lippia geminata</i> H. B. & K.	r	—	"
36. <i>Phyla nodiflora</i> Greene	la	o	" mainly in bud
Labiatae			
37. <i>Ocimum</i> sp.	r	o	Flowering
38. <i>Salvia plebeja</i> Br.	—	r	Fruiting
Nyctaginaceae			
39. <i>Boerhaavia diffusa</i> L.	f	f	Flowering
Amarantaceae			
40. <i>Alternanthera sessilis</i> Br.	f	f	Flowering
41. <i>Amarantus gangeticus</i> L.	—	r	"
42. <i>A. spinosus</i> L.	o	f	"
43. <i>A. viridis</i> L.	o	f	Fruiting
Chenopodiaceae			
44. <i>Chenopodium album</i> L.	c	c	Flowering
Polygonaceae			
45. <i>Polygonum plebejum</i> Br.	vf	vf	Flowering
46. <i>P. tomentosum</i> Schr.	r	—	—
47. <i>Rumex dentatus</i> L.	a	a	Late fruiting
Euphorbiaceae			
48. <i>Chrozophora rotleri</i> Juss.	f	f to la	Occasional flowering
49. <i>Croton bonplandianum</i> Baill.	f	f to la	Flowering
50. <i>Euphorbia thymifolia</i> L.	f	f	—
Pontederiaceae			
51. <i>Eichornia crassipes</i> Solms.	la	—	Flowering
Cyperaceae			
52. <i>Cyperus rotundus</i> L.	f	f	Occasional flowering
53. <i>Fimbristylis dichotoma</i> Vahl	f	o	Flowering
54. <i>Juncellus pygmaeus</i> C.B.Cl.	f	f	—
55. <i>Scirpus maritimus</i> L.	f	f	—
Gramineae			
56. <i>Cynodon dactylon</i> Pers.	a	a	Vegetative phase
57. <i>Digitaria adscendens</i> (H. B. & K.) Henr.	r	r	Flowering
58. <i>Echinochloa colonum</i> (Linn.) Link	o	f	"
59. <i>Eleusine indica</i> Gaertn.	f	o	"
60. <i>Eragrostis minor</i> Host.	o	—	"
61. <i>Polypogon monspeliensis</i> Desf.	f	o	"
62. <i>Setaria verticillata</i> Beauv.	r	r	—
Equisetales			
63. <i>Equisetum debile</i> Roxb.	f	r	—

ACKNOWLEDGEMENTS

The authors are grateful to Prof. R. Misra, F.N.I. for critically going through the manuscript and offering many helpful suggestions. Thanks are also due to the Director, Botanical Survey of India and Dr. R. P. Patil, Botanist-in-charge, Central Botanical Laboratory for the facilities and encouragement.

LITERATURE CITED

- BROWN, D. *Methods of surveying and measuring vegetation*: Commonwealth Agric. Bureau, England 1954.
- CHATTERJEE, D. Studies on the endemic flora of India and Burma. *J. Roy. Asiat. Soc. Beng. Sci.* 5 : 19-67, 1939.
- CHAUHAN, R. K. S. AND S. SINHA. Preliminary investigation of soil factors and ravine topography in treated and untreated Jamuna ravines at Agra during June 1959. *Proc. 48th Indian Sc. Congr. Pt. III : Abstracts* : 370-371, 1961.
- CHAVAN, A. R., S. D. SARNIS AND C. H. PATHAK. Preliminary report of the observations on the longitudinal zonation of vegetation along the river Mahi. *Ibid.* : 372, 1961.
- DUDGEON, W. A contribution to the Ecology of the Upper Gangetic Plain. *J. Indian bot. Soc.* 1 : 296-321, 1920.
- DUTHIE, J. F. *Flora of the Upper Gangetic Plain and of the adjacent Siwalik and sub-Himalayan Tracts*. Botanical Survey of India, Calcutta. Reprinted 1960.
- MAHESHWARI, J. K. The vegetation of marshes, swamps and river side in Khandawa district (Madhya Pradesh), *J. Bombay nat. Hist. Soc.* 57 : 371-387, 1960.
- MISRA, R. The vegetation of Rajghat Ravines, *J. Indian bot. Soc.* 23 : 113-121, 1944.
- PATIL, R. P. AND J. S. SINGH. On the ecology and anatomy of *Phyla nodiflora* Greene at Allahabad, U. P. *Trop. Ecol.* 4 : 68-73, 1963.
- SINGH, J. S. AND KRISHNA GHOSH. Ecological observations along the Jamuna bank at Allahabad, U. P. *Ibid.* : 441-442, 1963.
- SRIJASTAVA, G. D. Flora of Allahabad Parts I and II, *University Studies, Allahabad* 1939.
- The biological spectrum of the Allahabad Flora. *J. Indian bot. Soc.* 23 : 1-7, 1944.
- SUBRAHMANYAM, V. P. Climatic types of India according to the rational classification of Thornthwaite, *Indian J. Meteor. and Geoph.* 7 : 1-12, 1956.
- VERMA, D. M. AND C. M. ARORA. Phytological bioclimatic studies at Allahabad. *Proc. 48th Indian Sci. Congr. Pt. III : Abstracts* : 361-362, 1961.