

## BIOLOGICAL SPECTRUM OF THE FLORA OF GUJARAT STATE

G. L. SHAH, S. S. YADAV AND A. R. MENON

*Sardar Patel University, Vallabh Vidyanagar*

## INTRODUCTION

The description of the vegetation of an area, based on visual observations, is found in research papers dealing with the floristics. However, a simpler but meaningful system of vegetation description on a physiognomic basis is the life form system first proposed by Humboldt (1805) and subsequently by a number of workers (Grisebach, 1884; Kraus, 1891; Drude, 1897; Pound and Clements, 1898; Warming, 1909 etc.). Raunkiaer's (1934) system is based on the principle of protection of buds during unfavourable season(s). It is most compact, consistent and widely used as such or with a few modifications (Braun-Blanquet, 1932; Cain, 1950; Danserau, 1951, 1957; Phillips, 1956; Kershaw, 1973; Muller-Dombois & Ellenberg, 1974). Raunkiaer (1934) worked out the life form spectrum or biological spectrum of the entire phanerogamic flora of the world which is known as the normal spectrum. According to him, the plant climate of a region is characterised by the life form(s) which in the biological spectrum of the region exceed the percentage of the same life form(s) in the normal spectrum.

Biological spectra have been worked out for the flora of restricted localities in India by Ferriera (1940), Bharucha & Ferriera (1941 a, 1941 b), Bharucha & Dave (1944) Das & Sarup (1951), Sarup (1952), Lakshmanan (1962),

Meher-Homji (1962, 1964), Trivedi & Sharma (1965), Rao (1968) and Agarwal (1975). For Gujarat, Borgesen (1929) studied the vegetation of Dwarka in Saurashtra with reference to Raunkiaer's life forms. This work is followed by an account of the biological spectrum of the vegetation of Bhavnagar also in Saurashtra (Murthy, 1957) and Dangs (Shah & Yadav, 1979). But this information is meagre because no data of this type are available for many forest divisions of Gujarat and the State of Gujarat as a whole. An attempt is now made to present a comparative account on the biological spectra of different forest divisions as well as the whole State of Gujarat as an adjunct to the FLORA OF GUJARAT (Shah, 1978). The biological spectrum of Gujarat is also compared with the biological spectra of Madhya Pradesh, Rajasthan, Mount Abu, Bombay and Mahabaleshwar.

The biological spectra, where data are not available, are carefully worked out from the published literature on floristics for Madhya Pradesh (Misra, 1956; Maheshwari, 1960; Rao & Sastry, 1964; Panigrahi *et al.*, 1965, 1966a, 1966b, 1967; Ramlal & Panigrahi, 1967; Sankaran, 1967a, 1967b; Shukla & Panigrahi, 1967; Agarkar, 1969; Kaushik, 1969; Saxena, 1970; Saxena & Shukla, 1970), for Rajasthan (Jain & Kotwal, 1960; Puri *et al.*, 1964; Verma *et al.*, 1935; Dhillon & Bajwa, 1969) and Sal-

sette Island (Malad-Madh area), Bombay (Shah, 1961). A detailed account of the edaphic and climatic conditions of Gujarat is given by Shah (1978) and hence omitted here.

### OBSERVATIONS

A comparison of the biological spectra of different forest divisions of Gujarat reveals that of all the life forms, therophytes constitute the highest percentage which in turn is relatively much higher than their percentage in the normal spectrum. Among the forest divisions, Northern Gujarat has the highest percentage followed by that in Pavagadh. In other forest divisions their percentage are 30.2-39.2.

The phanerophytes (meso-, micro-, and nano-) become next abundant life form in Panchmahals, Chhotaudepur, Pavagadh, Rajpipla, Dangs, Bulsar and Dharampur (23.1-29.77%), the highest and the lowest percentage in Dangs and Pavagadh making up 29.77% and 17% respectively against 43% in the normal spectrum.

The mesophanerophytes are relatively more than the microphanerophytes except in Saurashtra, North Gujarat and Panchmahals where the converse is true. The nanophanerophytes are almost equal or slightly more than the mesophanerophytes in Rajpipla, Dangs, Bulsar and Dharampur.

On the other hand the chamaephytes become the next abundant life form in Saurashtra and North Gujarat. The phanerophytes are relatively less in these divisions because of unfavourable climatic conditions like longer periods of dry months, relatively less annual rainfall and therefore, less humidity and also,

in general, absence of dense forests over most of these divisions.

As compared to the normal spectrum, the hydrophytes are better represented in all forest divisions. Their occurrence in variable proportion depends on the abundance of puddles, ditches, ponds and river beds. Their lowest percentage (0.41%) in Pavagadh seems to be due to lack of puddles and ditches and only 3 to 4 ponds.

The geophytes are fairly represented in the areas studied except Saurashtra, North Gujarat, Pavagadh and Chhotaudepur. The higher percentage of geophytes at Bulsar (6.43%) as against the normal spectrum (4%) may be due to slightly more humid and warm conditions as compared to other regions and also due to loose, fertile upper soil horizon which favours the development of the rhizome geophytes, while considerable shading of leaves hinders the growth of therophytes as in hilly regions (Braun-Blanquet, 1932).

The epiphytes, succulents and parasites are poorly represented in all divisions and even their aggregate percentage is lower than that in the normal spectrum. However, the lianas are more than ten percent in all regions except North Gujarat, the highest percentage being at Rajpipla.

The hemicryptophytes are much less in all forest divisions than those in normal spectrum but among the forest divisions of Gujarat the highest percentage is in Panchmahals followed by Rajpipla.

Thus the phytoclimate is chamae-therophytic in Saurashtra and North Gujarat, mesophanero-chamae-therophytic in Panchmahals, Pavagadh, Rajpipla and Bulsar and mesopha-

nero-therophytic in Chhotaudepur, Dangs and Dharampur.

Gujarat State has on the whole a chamae-therophytic plant climate. A comparison of this biological spectrum with those of the adjacent States, shows that Rajasthan and Madhya Pradesh also have similar plant climate, but it is variable for some parts in Maharashtra State, chamaetherophytes in Salsette-Island (Malad-Madh area)—Bombay and phanerophytic-therophytic in Vihar lake—Bombay but only phanerophytic in Mahabaleshwar.

#### DISCUSSION

From the above data it is evident that the dominant life form is therophytes indicating a warm dry climate (Danserau, 1951, 1957). According to Pandeya (1961, 1964) and Pandeya *et al.* (1968) their higher percentage indicates a pronounced biotic or anthropogenic influence which maintains the vegetation open for further invasion of annuals with a result that a good phanerophytic flora may be very much reduced in course of time. Beadle (1951) and Agarwal (1975) concluded that in such affected areas the phytoclimate is not likely to give a correct indication of the vegetation. A similar conclusion is also drawn by Meher-Homji & Misra (1973) while discussing the biological spectra of Mount Abu, Bombay (Vihar lake), Allahabad and Karamnasa (Varanasi District). One of us (Shah, 1961) who has studied the flora and vegetation of Salsette Island—Bombay has also made similar observations.

In the eastern and south-eastern forest divisions of Gujarat, though the indiscriminate cutting of trees, overgrazing of herbaceous vegetation and seedlings of tree and shrub species, fair season or permanent road cons-

tructions and shifting cultivation have affected the vegetation, the phanerophytes are next abundant life forms. This may suggest that the biotic interference is not too intense and the favourable climate especially the rainfall accompanied by relatively more humidity and less temperatures during summer months prevails as yet (*see also* Meher-Homji & Misra, 1973).

Meher-Homji & Misra (1973), have traced the gradual evolution of the biological spectrum from therophytic of the desert with extreme aridity to the phanerophytic of the humid tropics. Our data also indicate a change in phytoclimate from chamae-therophytes in semi-arid regions of Saurashtra and North Gujarat to the mesophanero-therophytic of humid regions of Dharampur and Dangs with mesophanero-chamae-therophytic as an intermediate phytoclimate in Panchmahals, Pavadh and Rajpipla forest divisions.

An uniform type of phytoclimate in Rajasthan, Gujarat and Madhya Pradesh indicates the dominant semi-arid conditions in these States. In Maharashtra a similar climate does prevail in drier parts (*e.g.* Pune) but in hilly regions which are more humid, it is phanerophytic. There seems to be a change from mesophanero-therophytic phytoclimate in southern hilly parts of Gujarat to phanero-therophytic and phanerophytic phytoclimate in hilly parts of Maharashtra (*e.g.* Mahabaleshwar, Vihar). But there exists a gap in the information about the phytoclimate in the regions between the southern most limits of Gujarat and Bombay in Maharashtra. This lacuna can be bridged up by the floristic studies of the unexplored areas,

## REFERENCES

- AGARKAR, D. S. Enumeration of the plants of lower Chambal Valley Ravines, Madhya Pradesh. *Bull. bot. Surv. India* 11 : 398-402. 1969.
- AGARWAL, S. K. Biological spectrum of the flora of Western Rajasthan. *Journ. Biol. Sci.* 18 : 43-44. 1975.
- BEADLE, N. C. The misuse of climate as an indicator of vegetation and soil. *Ecology* 32 : 343-345. 1951.
- BHARUCHA, F. R. AND R. N. DAVE. The biological spectrum of a grassland association. *Journ. Univ. Bombay* 12 : 15-25. 1944.
- AND D. B. FERREIRA. The biological spectra of the Matheran and Mahableshwar flora. *Journ. Indian bot. Soc.* 20 : 195-211. 1941 a.
- AND — The biological spectrum of the Madras flora. *Journ. Univ. Bombay* 9 : 93-100. 1941 b.
- BISWAS, K. AND R. S. RAO. Rajputana desert vegetation. *Proc. Indian nat. Inst. Sci.* 19B : 411-421. 1953.
- BORGESSEN, F. Notes on the vegetation at Dwarka on the West Coast of India with reference to Raunkiaer's "Life-forms" and statistical methods. *Journ. Indian bot. Soc.* 8 : 1-18. 1929.
- BRAUN-BLANQUET, J. Plant Sociology (Translation). New York. 1932.
- CAIN, S. A. Life-forms and phytoclimate. *Bot. Rev.* 16 : 1-32. 1950.
- DANSERAU, P. Description and recording of vegetation upon a structural basis. *Ecology* 32 : 172-229. 1951.
- Biogeography—An Ecological Perspective. New York. 1957.
- DAS, R. B. AND S. SARUP. The biological spectrum—Indian desert flora. *Univ. Rajasthan Stud.* 36-42. 1951.
- DHILLON, K. B. S. AND B. S. BAJWA. A contribution to the botany of Ganganagar district in North Rajasthan. *Bull. bot. Surv. India* 11 : 234-244. 1969.
- DRUDE, O. Manuel de Geographic Botanique. Paris. 1897.
- GRISBACH, A. Die vegetation der Erde. Bd. I and II. Leipzig. 1884.
- HUMBOLDT, A. Essai sur la Geographic des Plants. Paris. 1805.
- JAIN, S. K. AND N. N. KOTWAL. On the vegetation of Shahbad in Rajasthan. *Indian Forester* 86 : 602-608. 1960.
- KAUSHIK, J. P. A contribution to the flora of Shivpuri. Madhya Pradesh. *Bull. bot. Surv. India* 11 : 51-69. 1969.
- KERSHAW, K. A. Quantitative and Dynamic Plant Ecology. E. L. B. S. 1973.
- KRAUS, E. H. L. Die eintheilung der Pflanzen nach inner Dauer. *Ber. d. dt. bot. Ges.* 9 : 223-237. 1891.
- LAKSHMANAN, N. K. The application of Raunkiaer's life-forms. *Journ. Indian bot. Soc.* 41(4) : 585-589. 1962.
- MAHESHWARI, J. K. The vegetation of marshes, swamps and river sides in Khandwa District (Madhya Pradesh). *Gazetteer of Gwalior State (Hindi Edn.)*, Allahabad. 57 : 371-387. 1960.
- MEHER-HOMJI, V. M. The bioclimates of India in relation to the vegetational criteria. *Bull. bot. Surv. India* 4 : 105-112. 1962.
- Life forms and biological spectra as epharmonic criteria of aridity and humidity in the tropics. *Journ. Indian bot. Soc.* 43(3) : 424-430. 1964.
- AND K. C. MISRA. Phytogeography of the Indian Sub-continent. *Progress of Plant Ecology* (edited by R. Misra et al.) 1 : 67-71. 1973.
- MISRA, R. The vegetation of Amarkantak. *Bull. bot. Soc. Univ. Saugar* 8 : 1-2. 1956.
- MUELLER-DOMBOIS, D. AND H. ELLENBERG. *Aims and Methods of Vegetation Ecology*. N. Y. 1974.
- MURTHY, M. H. S. The vegetation of Bhavnagar and its biological spectrum. *Vidya* 1 : 42-46. 1957.
- NAIR, N. C. AND K. C. KANODIA. A sketch of the vegetation of Ajit Sagar Bundh. Rajasthan. *Journ. Bombay nat. Hist. Soc.* 56(3) : 524-557. 1959.
- PANDEYA, S. C. Ecology of grasslands of Sagar, Madhya Pradesh-I, Grassland map of the area on physiognomic basis. *Journ. Indian bot. Soc.* 40 : 592-600. 1961.
- Ecology of grasslands of Sagar, Madhya Pradesh -II, A—Composition of the fenced grassland association. II B—Composition of the associations

- open to grazing or occupying special habitat. *Ibid.* 43 : 577-605 ; 606-639. 1964.
- PANDEYA, S. C., G. S. PURI AND J. S. SINGH. *Research Methods in Plant Ecology*. 1968.
- PANIGRAHI, G. AND R. PRASAD. Contribution to the botany of Madhya Pradesh-IV (The families Euphorbiaceae and Urticaceae). *Ibid.* 36 : 553-564. 1966a.
- AND A. N. SINGH. Contribution to the botany of Madhya Pradesh-V. The family Leguminosae. *Proc. nat. Acad. Sci. India* 37 : 77-104. 1967.
- AND D. M. VERMA. Contribution to the botany of Madhya Pradesh-III. (The families Ebenaceae to Convolvulaceae). *Ibid.* 35 : 99-109. 1965.
- , C. M. ARORA, D. M. VERMA AND V. N. SINGH. Contribution to the botany of Madhya Pradesh—I (Dilleniaceae to Moringaceae). *Bull. bot. Surv. India* 8 : 117-125. 1966b.
- POUND, R. AND F. E. CLEMENTS. *The Phytogeography of Nebraska*. Lincoln. 1898.
- PURI, G. S., S. K. JAIN, S. K. MUKHERJEE, S. SARUP AND N. N. KOTWAL. Flora of Rajasthan. *Rec. bot. Surv. India* 19 : 1-159. 1964.
- RAMLAL AND G. PANIGRAHI. Contribution to the botany of Madhya Pradesh VI (Compositae to Sapotaceae). *Bull. bot. Surv. India* 9 : 262-267. 1967.
- RAO, A. S. AND A. R. K. SASTRY. An account of the flowering plants of Indore District in Madhya Pradesh. *Ibid.* 6 : 267-286. 1964.
- RAO, C. C. Biological spectrum of Karamnasa watershed flora (Varanasi District). (Abstract). *Proc. Symp. Recent. Adv. Trop. Ecol.* (Eds. R. Misra and B. Gopal) : 458-465. 1968.
- RAUNKIAER, C. *The Life-forms of Plants and Statistical Plant Geography*. London. 1934.
- SANKARAN, K. Studies on the vegetation of ponds, swamps and river banks in Raipur, Madhya Pradesh. *Journ. Bombay nat. Hist. Soc.* 64 : 95-102. 1967a.
- Compositae of Raipur and its surroundings (M. P.). *Journ. Bombay nat. Hist. Soc.* 64 : 333-338. 1967b.
- SARUP, S. The biological spectrum of the flora of Mount Abu. *Univ. Rajasthan Stud. (Biol. Sci. Med.)*, Jaipur. 1952.
- SAXENA, H. O. The flora of Amarkantak (Madhya Pradesh). *Bull. bot. Surv. India* 12 : 37-66. 1970.
- AND S. G. SHUKLA. On a collection of plants from Patakot (M. P.) *Ibid.* 12 : 188-202. 1970.
- SHAH, G. L. *The Flora of Gujarat State*. Vallabh Vidyanagar. 1978.
- AND S. S. YADAV. A contribution to the flora of Dangs forest in Gujarat. Floristics, floristic composition and biological spectrum. *Indian Journ. Forestry* 2 : 13-19. 1979.
- SHUKLA, U. AND G. PANIGRAHI. Contribution to the botany of Madhya Pradesh—VII, (Graminae excluding Bambusae). *Bull. bot. Surv. India* 9 : 268-276. 1967.
- SRIVASTAVA, G. D. The biological spectrum of the Allahabad flora. *Journ. Indian bot. Soc.* 23(1) : 1-7. 1944.
- TIWARI, S. D. N. AND J. K. MAHESHWARI. The Cyperaceae of Madhya Pradesh-I. *Indian Forester* 90 : 147-159. 1964 a.
- AND — The Cyperaceae of Madhya Pradesh-II. *Ibid.* 90 : 616-629. 1964 b.
- TRIVEDI, B. S. AND P. G. SHARMA. Biological spectrum of Lucknow flora. *Proc. nat. Acad. Sci. India* 35 : 15-20. 1965.
- VERMA, D. M., B. M. WADHWA AND O. P. MISRA. Some additions to the flora of Rajasthan. *Ibid.* 35 : 163-170. 1965.
- WARMING, E. *Oecology of Plants. An Introduction to the Study of Plant Communities*. London. 1909