

A CONTRIBUTION TO THE FLORA OF DANGS FOREST IN GUJARAT: FLORISTIC COMPOSITION, FLORISTIC ELEMENTS AND BIOLOGICAL SPECTRUM

By

SHAH, G.L. AND YADAV, S.S.

Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar-388120, Gujarat

Introduction

Dangs forest is botanically the richest forest of Gujarat and has attracted botanists for plant exploration as early as the middle of the 19th century as can be judged by the collections of Dalzell (see Kuruvilla, 1967), followed by the collections of Bhiva, Woodrow, Saxton, Dastur etc. in the 1st quarter of the 20th century. In the last quarter of the century or so, the information about the flora of Dangs is considerably increased through the extensive works of Santapau (1954-1955), Santapau & Shah (1965), Santapau & Kapadia (1966), Chavan & Oza (1966), Chavan & Sabnis (1967) and Shah & Suryanarayana (1967a, 1967b, 1968, 1969a, 1969b). A critical study of the literature indicates a lacuna in our knowledge about the floristics of some areas like Kalibel, Bheskatri, Galkund and Borkhal, the floristic elements, and biological spectrum of the Dangs forest. The present paper is, therefore, prepared with a view to incorporate our data on these points.

Materials and Methods

Botanical explorations were conducted in different areas of Dangs forest to study primarily the phytosociology of the permanent vegetation, but pertinent attention was paid to the flora of unexplored areas. All plants, collected during outings, were carefully processed, identified, labelled and deposited in the herbarium of Sardar Patel University, Vallabh Vidyanagar.

The data on life forms (biological spectrum) are prepared following the works of Raunkiaer (1934) and Dansereau (1957) whereas details of the floristic elements have been worked out as a phylogeographic note for the area (see Meher Homji & Misra, 1973).

Geography, Topography, Soil and Climate

Dangs district in the Western Ghats is situated at 20° 34' to 21° 5' N and 73° 15' to 74° E, about 250 km south of Ahmedabad in Gujarat State. The total area of the forests is about 1945 sq. km. The entire district is undulating consisting of numerous hills, valleys and rivulets. The entire hilly region forms a part of the outer edges of Sayadris, with hills ranging in elevation from 500 m to 1024 m. The valleys in the district are formed by the Gira and Purna in north, Khaphri and Ambica in south. Their tributaries are seasonal and dry during summer months.

The underlying rocks are Deccan trap. The soil in plains is generally alluvial with two distinct types, "regur" and "morang" and is sufficiently fertile to support large tree growth.

Dangs experiences solubrious monsoonic climate with an average rainfall of 1825 mm. Winters are never too cold and the summer never too hot. The mean maximum and minimum temperatures are 41.2° C and 14° C respectively.

Observations

(a) *Synoptic data*—The total number of wild species so far recorded from Dangs is 765, belonging to 463 genera, spread over 114 families. This makes up nearly 46.4% of the species listed for Gujarat State (Shah, 1978). The dicotyledon-monocotyledon ratios with reference to species, genera and families are 3.5 : 1, 4.4 : 1 and 5 : 1 respectively.

A comparison of ten dominant families (with number of species in parenthesis) in Dangs with those in Gujarat State (Shah & Menon, 1977) is given below. The prefixed numbers in parenthesis show the order of dominance.

Dangs	Gujarat State
(1) Papilionaceae, Caesalpinaceae & Mimosaceae (134)	(1) Papilionaceae, Caesalpinaceae and Mimosaceae (258)
(2) Gramineae (86)	(2) Gramineae (229)
(3) Compositae (52)	(4) Compositae (89)
(4) Acanthaceae (39)	(5) Acanthaceae (68)
(5) Euphorbiaceae (32)	(6) Euphorbiaceae (63)
(6) Cyperaceae (28)	(3) Cyperaceae (112)
(7) Malvaceae (24)	(7) Malvaceae (53)
(8) Scrophulariaceae (22)	(10) Scrophulariaceae (37)
(9) Convolvulaceae (22)	(8) Convolvulaceae (53)
(10) Rubiaceae (20)	(12) Rubiaceae (30)

These data clearly show that most of the dominant families in Dangs and Gujarat State are same but the order of dominance differs. Papilionaceae-Caesalpinaceae-Mimosaceae (together) and Gramineae occupy the 1st and 2nd positions.

A critical analysis of the floristic composition shows that monotypic families constitute a larger portion (36.85%) of the total number of families in Dangs, but the families with one genus make up the highest percentage (50%), followed by those families with two (16.66%),

three (11.40%), five (7.0%), six (5.26%) and four genera (3.50%) respectively. Those with 7-9 genera are very rare but the number of families with 10 or more than 10 genera is proportionately higher (9.64%) occupying a position next to that of the families with three genera (Fig. 1). Similarly, out of 463 genera, the genera with one species (67.82%) are much more in number than those with two (16.4%) and three (5.61%) species. The genera with four or more species are relatively less ranging from 0.42% to 3.02% (Fig. 2).

(b) *Additions to the flora of Dangs*—14 species, not recorded earlier from Dangs, are *Aerva lanata* (L.) Juss., *Alysicarpus monilifer* (L.) DC., *Cleome brachycarpa* Vahl, *Cochlospermum religiosum* (L.) Alst., *Coldenia procumbens* L., *Cordia domestica* Roth, *Desmodium alysicarpoides* Kraap van Mecuvan, *D. motorarium* (Houtt.) Merr., *Ficus rumphii* Bl., *Lindernia parviflora* (Bth.) Huines, *Pergularia daemia* (Forsk.) Choisy., *Radermachera xylocarpa* (Roxb.) K. Schum., *Ruellia tuberosa* L. and *Stereospermum personatum* (Hassk.) Chatt.

(c) *Comparison of Dangs flora with that of Khandala*—Since Khandala (Santapan, 1967) (with its highest spot Bhoma hill 848 m) and Dangs (with its highest spot Gira hill 1024 m) are hilly regions in Western Ghats, a comparison of the flora of two regions will be worthwhile because some rare species restricted to Dangs in Gujarat are also found in Khandala; further, most of such species have been found only in the Malegaon-Saputara range which is the highest hilly region of Dangs. Dangs, of course, is not as wet as Khandala and therefore, variations in the floristic composition such as absence of Ancistrocladaceae, Balanophoraceae, Gnetaceae, Lauraceae, Melastomaceae, Smilacaceae etc. in Dangs can be attributed to climatic and topographic conditions. The list of species is *Acacia polyacantha* Willd., *Anagallis punila* Sw., *Ari-*

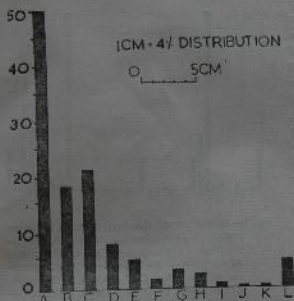


FIG. 1

Fig. 1.—Histogram showing the number of monotypic families and families with one genus, two genera etc. A—total number of families in Dang forest. B—monotypic families. C—families with one genus. D—families with two genera. E—families with three genera. F—families with four genera. G—families with five genera. H—families with six genera. I—families with seven genera. J—families with eight genera. K—families with nine genera. L—families with ten or more than ten genera.

saema tortuosum Schott, *Aspidopteris cordata* A. Juss., *Barleria gibsoni* Dalz., *B. lowii* T. Anders., *Boehmeria scabrella* Gaud., *Centranthera indica* (L.) Gamble, *Clematis gouriana* Roxb., *Clerodendrum serration* Moon, *Colebrookea oppositifolia* Sm., *Cynoglossum meeholdii* Brand., *Cyperus cyperoides* var. *subcompositus* Kuk., *Cyperus malabaricus* Cl., *Dendrobium barbatulum* Lindl., *D. microbulbon* A. Rich., *D. ovaatum* Kranz, *Diospyros montana* Roxb., *Embelia Tsjerian-cotton* DC., *Gelasspis cristata* W. & A., *Habenaria grandifloriformis* Blatt. & McC., *H. longi-*

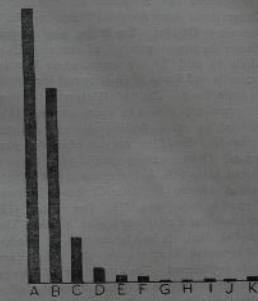


FIG. 2

Fig. 2.—Histogram showing the number of genera with one or more species. A—total number of genera in Dang forest. B—genera with one species. C—genera with two species. D—genera with three species. E—genera with four species. F—genera with five species. G—genera with six species. H—genera with seven species. I—genera with eight species. J—genera with nine species. K—genera with ten or more than ten species.

corniculata Grah., *Ischaeman santapauli* Bor., *I. timorensis* Kueth, *Justicia betonica* L., *Neuracanthus trinervius* Wt., *Nicandra physalodes* Gaertn., *Pavetta crassicaulis* Bremek., *Peristylus stockii* Kranz, *Peucedanum grande* Cl., *Platanthera susanna* Lindl., *Plectranthus mollis* Spr., *Pseudosorghum faxelcalare* A. Camus, *Sapium insigne* var. *malabaricum* Hk. f., *Vernonia divergens* Edgew., *Vigna khandalensis* Bole & Shah, *Wahlenbergia marginata* A. DC., *Wenlandia heynei* Sant. & Mer. and *Zingiber cernuum* Dalz.

Floristic elements—A statistical study of the flora of Gujarat State (Shah & Menon,

1977) shows that 91 species are restricted to Dangs forest but no one of these species is endemic to Gujarat. The Indian element constitutes the largest number of species (145) of which 48 and 25 are restricted to Western Peninsula and States of Gujarat and Maharashtra respectively. The Indo-Malaysian element also constitutes almost an equal number (143), followed by other floristic elements of other regions in order of the number of species, pantropical (109), paleotropical (57), tropical African-Asian (45), Indo-Ceylonese (44), Indotropical African (33), Indo-Ceylonese-Burmese (27) and Indo-Burmese (26). The exotics (33) also constitute a relatively higher number. The Indo-Pakistani, Indo-Afghanistani or Indo-Mediterranean elements on the whole are poorly represented. Thus the flora of Dangs shows the dominance of Indian element, Indo-Malaysian element and pantropical element (Fig. 3).

Biological spectrum—In Table I the biological spectrum of the flora of Dangs forest is given along with the biological spectra of Poona, Vihar lake, Mt. Abu, Mahabaleshwar and the normal spectrum for comparison. The Dangs spectrum reveals that the therophytes (42.48%) are slightly more than three times those of the normal spectrum (13%). This is natural since the annuals are best adapted to tide over the unfavourable period which they do in the form of seeds. They germinate after the first rains, grow very rapidly and produce flower and seeds within a short span of two to four months. By the end of the rainy season or a little later, they complete their life-cycle and disappear leaving behind their seeds in the soil. The preponderance of therophytes is indicative of a warm-dry climate in conformity with the bioclimate diagram of Dansereau (1951).

The phanerophytes (meso-mega-, micro- and nano-) become next abundant life form making

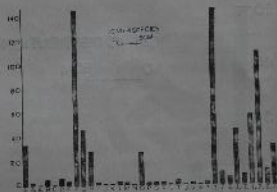


Fig. 3.—Histogram of the floral elements in Dangs forest. A—India-Tropical Africa. A₁—India-Tropical Africa-Ceylon. A₂—India-Tropical Africa-Burma. B—India-Persia-Egypt, extending to Australia. C—India-Arabia. D—India-Afghanistan. E—India-Pakistan. F—India (including W.P. and Gujarat-Maharashtra). G—India-Ceylon. H—India-Ceylon-Burma. I—India-Ceylon-Burma-Malaya (extending to Philippines). J—India-Ceylon-Burma-Malaya (extending to north Australia). K—India-Ceylon-Burma-Malaya (extending to north Philippines). L—India-Ceylon-Burma-Java. M—India-Ceylon-Java. N—India-Ceylon-Malaya. O—India-Burma. P—India-Burma-Java. Q—India-Burma-Indochina. R—India-Burma-South-east Asia. S—India Burma-Afghanistan. T—India-Burma-China. U—India-Burma-Pakistan. V—India-Java. W—India-Java-China. X—India-south-east Asia. Y—India-Malaysia. Z—Tropical south-east Asia. Z₁—Tropical Asia. Z₂—Tropical Asia and Africa. Z₃—Tropical Asia and Australia. Z₄—Paleotropical. Z₅—Pantropical. Z₆—Tropics and temperate regions of old world. Z₇—Exotics.

NB Upper arrow in F shows number of species in Western Peninsula while the lower arrow shows number of species in Gujarat-Maharashtra State.

up about 27.44% of the total as against 43% in the normal spectrum, but the percentage of meso-megaphytes (9.45%) is more than that in the normal spectrum (6%). These data

Table 1: Biological spectra and climatic features of some regions

Regions	Rainfall (mm)	Number of dry month	Tempera- ture (°C)	Number of species	The percentage distribution of the species among life forms											Plant-climate
					L	E&S	P	MM	M	N	Ch	H	G	IH	Th	
Normal spectrum (Raunkiaer, 1934)	—	—	—	400	—	4	—	6	17	20	9	27	3	1	13	
Poona (Ferreira, 1940)	790	7	20.5	—	7	—	—	—	22	16	20	4	—	—	26	Nanophan- erophytic- Chamac- phytic
Vihar lake forest (Bombay) (Lukshmanan, 1962)	1800	7	23.8	—	16.2	2.3	2.3	—	41.8	7	—	2.3	—	—	27.9	Phane- rophytic- Therophytic
Mount Abu (Sarup, 1952)	1560	8	14.6	245	8.5	—	1	5.3	17.9	17.4	2.4	2.4	—	—	46.71	Thero- phytic
Mahableshwar (Bharucha & Ferreira, 1941)	6977	7	19.7	469	—	1.0	—	—	28.6	19.6	3.4	3.4	3.2	0.6	13.2	Phane- rophytic
Dangs	1825	8	26.8	765	10.31	1.44	1.70	9.45	9.07	9.42	3.0	3.27	3.14	6.66	42.48	Therophytic

MM—Mega-Meso-phanerophytes, M—Micro-phanerophytes, N—Nano-phanerophytes, Ch—Chamaephytes, H—Hemicryptophytes, G—Geophytes, IH—Helophytes and hydrophytes, Th—Therophytes, S—Stem succulent, E—Epiphytes, P—Parasites.

indicate that the trees in Dangs are in good condition and their dormant buds are well protected against the relatively less dry condition because the environmental conditions like higher annual precipitation accompanied by relatively high humidity and less temperatures during summer months and high organic matter content in the soil are favourable. The relatively higher percentage of lianas (10.7%) indicates denseness of the forest.

The biological spectrum of Dangs can be compared with Mt. Abu because of the topography and preponderance of therophytes and

with Vihar lake and Mahableshwar because of climatic and topographic resemblances, they being parts of the same hilly region, Western Ghats.

The biological spectrum of Dangs is to some extent similar to that of Mt. Abu, even though the annual rainfall is less. The therophytic climate of Mt. Abu has also phanerophytes as a whole second abundant life-form but the meso-megaphytes, are less in number than those in Dangs. The hydrophytes and helophytes (6.66%) and geophytes (3.14%) in Dangs are not represented in the spectrum of Mt. Abu.

Further lower percentage of lianas (8.5%) indicates to some extent that the forests of Mt. Abu are open.

A comparison with the life forms at Vihar lake where the annual rainfall, average annual temperatures and the number of dry months are almost equal to those of Dangs shows microphanerophytic-therophytic plant-climate and higher percentage of lianas suggest more dense forests at Vihar lake.

Mahableshwar shows phanerophytic climate and the percentage of phanerophytes far exceeds that in the spectrum of Dangs. This can naturally be attributed to a more wet, humid climate than the climate in Dangs. The other life forms like epiphytes, succulents, chamaephytes, homocryptophytes, geophytes, hydrophytes and helophytes have almost equal percentage in the two areas under consideration.

Discussion

The vegetation of Dangs is of the "Tropical-moist deciduous forests" with *Tectona-Terminalia-Butea-Wrightia-Holarrhena* as the dominant community. Because of the richness of the flora, the results of botanical explorations of several workers have been published. Yet it is possible to add 14 more species as new additions to Dangs.

Again a study of the geographical distribution of various species in Dangs revealed that some species are restricted to certain localities only and that some species recorded for Khandala are found only in the Mulegaon-Saputara region of Dangs which is the highest hilly region. As a result, it was also thought reasonable to compare the floras of Dangs and Khandala. The list comprised 40 species common to Dangs and Khandala but rare and restricted in Dangs in Gujarat.

Raunkiaer (1934) worked out life form system with the definite purpose of using the flora of a given tract of a country as an exact indi-

cator of its climate for he firmly believed that the plant climate is characterised by the statistics of life forms, i.e. the life-forms best adapted to certain climate will form a higher percentage of flora than others. This concept of biological spectrum has aroused considerable interest among ecologists as can be judged by a number of papers published (see Ferreira, 1940; Bharucha & Ferreira, 1941a, 1941b; Srivastava, 1944; Das & Sarup, 1951; Sarup, 1952; Lakshmanan, 1962; Mcher-Hornji, 1964; Trivedi & Sharma, 1965; Rao, 1968; Agarwal, 1974). Some work of this nature is published for Gujarat (Borgesen, 1929 and Murthy, 1957). Murthy (1957) has reported a very dry climate with preponderance of therophytes and poor representation of phanerophytes at Bhavnagar. He also reported Hydro + Helophytes and Geophytes constituting 6.6% and 3.1% respectively, which is almost equal to their percentages in spectrum of Dangs. Since Gujarat has diversity of the flora, it is, therefore, now felt that such biological spectra be prepared for other regions in the State to note the changes in plant-climates, associated with changes in annual precipitation.

Summary

In this paper additional information about the flora of Dangs is recorded. (i) 14 species are added to existing data. (ii) The number of wild species in Dangs makes up nearly 46.4% of the flora of Gujarat State and from the number of species ten dominant families have been worked. (iii) Information about monotypic families, families with one genus, two genera and so on and a similar information for genera with reference to the number of species is given. (iv) The flora of Dangs and Khandala show similarity to some extent. (v) The dominant floristic elements are Indian and Indo-Malaysian. (vi) The biological spectrum shows therophytic plant climate.

BIBLIOGRAPHY

- Agarwal, S.K. (1974). The biological spectrum of the flora of Gogunda and Prasad (Udaipur-Rajasthan) *J. Ind. Sci.* 17: 67-71.
- Bharucha, F.R. and Ferreira, D.B. (1941a). The biological spectra of Matheran and Mahabaleswar. *J. Indian bot. Soc.* 20: 195-211.
- Bharucha, F.R. and Ferreira, D.B. (1941b). The biological spectrum of the Madras Flora. *J. Univ. Bombay* 9: 95-100.
- Borgeen, F. (1925). Notes on the vegetation at Dwarka on the West Coast of India, with reference to Kaulniker's "Life-form" and statistical methods. *J. Indian Bot. Soc.* 1: 1-18.
- Chavva, A.R. and Oza, G.M. (1966). Contribution to the flora of Dang forest. *Indian For.* 92 (8): 533-535.
- Chavva A.R. and Sabelis, S.D. (1967). Cyperaceae of Dang Forest. *Ibid* 93 (3): 190-193.
- Dansereau P. (1951). Description and recording of vegetation upon a structural basis. *Ecology* 32: 172-229.
- Dansereau, P. (1957). *Bibliography—An ecological perspective*. New York.
- Das, R.B. and Sarup, S. (1951). The biological spectrum of the Indian desert. *Univ. Rajasthan stud. Ind. Sci.* 1: 36-42.
- Ferreira, D.B. (1940). The vegetable life-forms of Central and Southern Deccan in Peninsular India. M.Sc. Thesis, Bombay University.
- Karivilla, K. (1967). Ecology of Dang forest (Gujarat)—I. Phytosociology of the forests in Alwa "Block". *Indian For.* 93 (10): 720-733.
- Lakshmanan, N. (1962). The application of Raunkiaer's life forms. *J. Indian Bot. Soc.* 41: 585-589.
- Meher-Homji, M. (1964). Life-forms and biological spectra as epharmonic criteria of aridity and humidity in the tropics. *Ibid.* 43: 424-430.
- Meher-Homji, M. and Misra, K.C. (1973). *Progress of plant ecology in India* (edited by R. Misra, B. Gopal, K.P. Singh and J.S. Singh). Today and Tomorrow's publication. 1: 26-48.
- Murthy, M.H.S. (1957). The vegetation of Bhavnagar and its biological spectrum. *Vidya* 1: 42-46.
- Rao, C.C. (1968). Biological spectrum of Karmata, waterbed flora (Varanasi, India). *Proc. Symp. Recent Adv. Trop. Ecol.* 458-465.
- Raunkiaer, C. (1934). *The life-forms of plants and statistical plant geography*. London.
- Santapan, H. (1954-1955). Contribution to the botany of Dang forest in Gujarat. *J. Guj. Res. Soc.* 16: 204-320; 1934 and 17: 1-59, 1955.
- Santapan, H. (1967). The flora of Khandala on the Western Ghats. *Rec. bot. Surv. India* 16 (1) (ed. 3): 1-372.
- Santapan, H. and Kapadia, Z. (1966). *The Orchids of Bombay*. Government of India Publication, Calcutta.
- Santapan, H. and Shah, G.L. (1965). Further contribution to the botany of Dang forest. *J. Bombay Nat. Hist. Soc.* 62 (2): 201-210.
- Sarup, S. (1952). The biological spectrum of the flora of Mt. Abu. *Univ. Rajasthan Stud. Biol. Sci.* 1.
- Shah, G.L. (1978). The Flora of Gujarat State. Sardar Patel University Publication, Vallabh Vidyanagar.
- Shah, G.L. and Menon, A.R. (1977). The vegetation of Gujarat. Floristic studies in India: Present status and future strategies. An All India Symposium. Abst. p. 11.
- Shah, G.L. and Suryanarayana (1967a). Additions to the flora of Dang. *J. Bombay Nat. Hist. Soc.* 63: 278.
- Shah, G.L. and Suryanarayana (1967b). Additions to the flora of Dang. *Ibid.* 64: 136-138.
- Shah, G.L. and Suryanarayana (1968). On the occurrence of *Eriolaena stockii*. *Indian For.* 94: 894-896.
- Shah, G.L. and Suryanarayana (1969a). New plant records for Bombay collected from Dang forest, Gujarat. *J. Bombay Nat. Hist. Soc.* 66: 412-414.
- Shah, G.L. and Suryanarayana (1969b). Further contribution to the flora of Dang Forest in Gujarat. *Bull. bot. Surv. India* 11: 290-300.
- Srivastava, G.I. (1944). The biological spectrum of the Allahabad flora. *J. Indian bot. Soc.* 23: 1-7.
- Trivedi, R.S. and Sharma, P.C. (1965). Biological spectrum of Lucknow flora. *Proc. Nat. Acad. Sci. India* 35: 15-20.