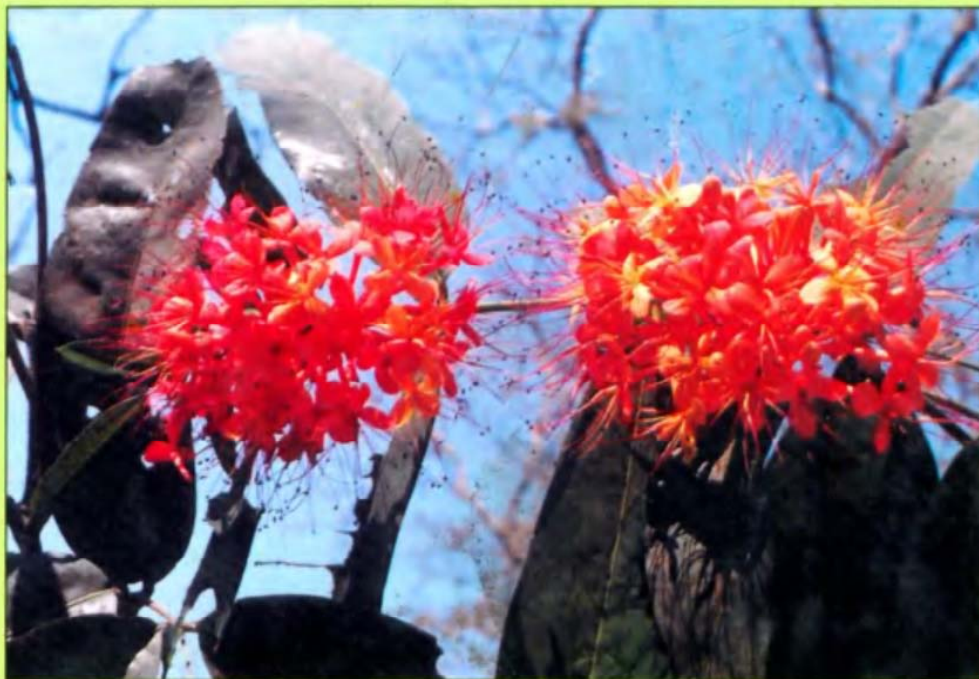


Flora of India
Series 2

FLORA OF MAHARASHTRA STATE
DICOTYLEDONES
VOLUME 1

Editors
N. P. Singh
&
S. Karthikeyan

With assistance from
P. Lakshminarasimhan
&
P. V. Prasanna



BOTANICAL SURVEY OF INDIA

FLORA OF MAHARASHTRA STATE

DICOTYLEDONES

VOLUME 1

(Ranunculaceae to Rhizophoraceae)

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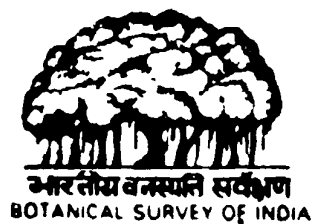
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BOTANICAL SURVEY OF INDIA

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Date of Publication : January 1, 2000

Price : Rs.

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Front Jacket : **Saraca asoca** (Roxb.) de Wilde

Back Jacket : **Erythrina stricta** Roxb.

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FOREWORD

There is a global concern for assessing the status of living organisms belonging to various kingdoms and conserving biodiversity. All life is based on the genetic code: all forms have life evolved by natural selection and all life is connected. There is no true estimate of the total number of species in the world, although the sum of recorded number exceeds 1.7 million. As plants are the main solar energy converters and providers of food, oxygen and a host of useful products, it is essential to estimate their occurrence and availability. As continued research is yielding plant compounds with newer uses, it is all the more essential to prepare comprehensive databases. The main requirements for an inventory are accurate identification, nomenclature, description and environmental status.

Since its re-organisation, the Botanical Survey of India (BSI) has been engaged in floristic survey of unexplored and incompletely studied areas of the country. From 1980, the BSI has started publishing the **Flora of India** under four series: (i) national flora comprising taxonomic revisions of families of flowering plants, tribes and genera of the entire country, (ii) floristic inventories of the various states / union territories, (iii) floras of phytogeographically interesting and floristically rich districts and (iv) special and miscellaneous publications. The number of recorded species of plants including lichens and fungi from India is around 47,000 of which 17,500 are angiosperms.

The present publication belongs to Series (ii) and covers the State of Maharashtra. This state is the third largest in the Indian Union and was carved out of the former Bombay Presidency, that included parts of Gujarat, Maharashtra, Goa, North Kanara and Sind (which is now in Pakistan). As now reconstituted Maharashtra has 34 districts and is bounded by the Arabian sea in the west, Goa and Karnataka in the south, Andhra Pradesh in the south-east, Madhya Pradesh in the north and Gujarat in the north-west.

Cooke's **Flora of the Presidency of Bombay** (1901-1908) continues till today as the most authoritative floristic account for the identification of species of this region. Nevertheless, this work has become obsolete owing to changes in the regional boundaries and modifications in the patterns of the flora caused by natural and anthropogenic activities. Through extensive collections in the past ninety years 1087 species, 21 sub-species, 51 varieties, one sub-variety and two formas have been added to Cooke's **Flora**. Importantly, taxonomists have introduced name changes for 1045 species, 4 sub-species and 18 varieties. Therefore, revising and rewriting this flora along modern lines have become absolutely essential.

The flora of Maharashtra is rich and extremely interesting. Internationally, the Western Ghats have been classified as one of the world's hotspots of biodiversity that are under threat. A major portion of northern Western Ghats the **Sahyadris** is spread over 11

districts. The **Sahyadris** are characterised by a high degree of diversity in floristic composition that is only next to the Indian Himalayan region. Moreover, 400 sacred groves are reported from Maharashtra at various conditions of preservation and floral composition. Konkan, Deccan, Khandesh, Marathwada and Vidarbha regions represent unique floristic features that differ from one another owing to differences in rainfall, temperature, elevation and edaphic features.

The BSI is bringing out floristic account of the Maharashtra State in **three volumes**. The volume containing the account of **Monocotyledones** has already appeared in 1996. The remaining two volumes deal with **Dicotyledones**. It is estimated, that presently the state of Maharashtra is represented by 187 families, 1081 genera, 3025 species, 21 sub-species, 145 varieties, one sub-variety and two forms that occur in the wild. Besides, 844 cultivated species have been recorded. 25 genera and 694 species which are endemic to India occur in Maharashtra. Some of the critically endangered plants from this flora include among others : *Abutilon ranadei*, *Aponogeton bruggenii*, *Bonnayodes limnophiloides*, *Ceropegia panchganiensis*, *Crinum brachynema*, *Dipcadi concanense*, *Frerea indica* and *Lepidagathis bandraensis*.

The highest amount of colchicine the polyploidizing agent has been reported from the seeds of *Iphigenia stellata*, endemic to Maharashtra.

This is the **second** of the three **volumes** covering 70 families, 314 genera, 856 species, 10 subspecies and 53 varieties in wild. In addition, there are 5 families which include only cultivated species. A total of 262 cultivated taxa have also been treated in this volume. The **Flora** provides an extended introductory chapter on several topics such as vegetation, mangroves, aquatics, weeds, economically important plants, medicinal plants, endemic and threatened plants, major threats to diversity, national parks and sanctuaries, ethnobotany, sacred groves, wasteland development and forest biota. Line drawings of 179 plants and 26 colour photographs have also been given.

It is hoped that the **Flora** will be useful to students of botany, professional taxonomists, teachers, plant geographers, wildlife biologists, foresters, and all those interested in learning about the flora, conservation and utilisation of the plant resources of the state. This is also an authentic source of reference to planners and decision makers.

I congratulate the scientists who have brought this volume by professional competence, dedication and labour.

H. Y. Mohan Ram
INSA Senior Scientist,
Formerly Professor of Botany
University of Delhi, Delhi

1 January, 2000

ACKNOWLEDGEMENTS

- Our thanks are due to the Director, Botanical Survey of India for providing all facilities and also for permitting to use 98 illustrations from various Botanical Survey of India Publications. Our sincere thanks are to the Deputy Director, Botanical Survey of India, Pune for constant encouragement during the course of this work. We thank Dr. H. Y. Mohan Ram, INSA Senior Scientist, formerly Professor of Botany, University of Delhi, Delhi for rendering the Foreword.

We wish to record our sincere gratitude and appreciation to :

- All Contributors for writing accounts of their allotted families.
- Sarva Sree R.R. Mohare, Senior Artist and S.D. Kadam, Junior Artist for preparing the maps and illustrations.
- Dr. V.P. Prasad, Scientific Assistant for drawing graphs and helping in index work.
- Shri K.V. Sasidharan, U.D.C. for typing introductory chapters and index.
- To the field staff of Western Circle, Pune for help and co-operation.
- Forest Department, Maharashtra State for help in the field studies.
- Authorities of Blatter Herbarium (BLAT), Mumbai for permitting consultation of their herbarium.
- The Deputy Director, Zoological Survey of India, Western Regional Station, Pune for permitting to consult their library for updating zoological names.
- Shri S.R. Gupta of M/s. Flamingo Business Systems, Pune for neat execution of computer typesetting and Photo offset printing.

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A view of semi-evergreen forest at Ambolighat, Sindhudurg district with ***Actinodaphne angustifolia***, ***Ancistrocladus heyneanus***, ***Atalantia racemosa***, ***Mangifera indica***, ***Memecylon umbellatum***, ***Nothapodytes nimmoniana***, ***Symplocos racemosa***, ***Syzygium hemisphericum***, etc.
(Courtesy, P. Tetali, N. G. C. P. R.)



Scree vegetation comprising ***Ensete superbum***, ***Eriophorum canosum***, ***Senecio bombayensis***, etc.



A view of moist deciduous forest at Sinhagad,
Pune district.



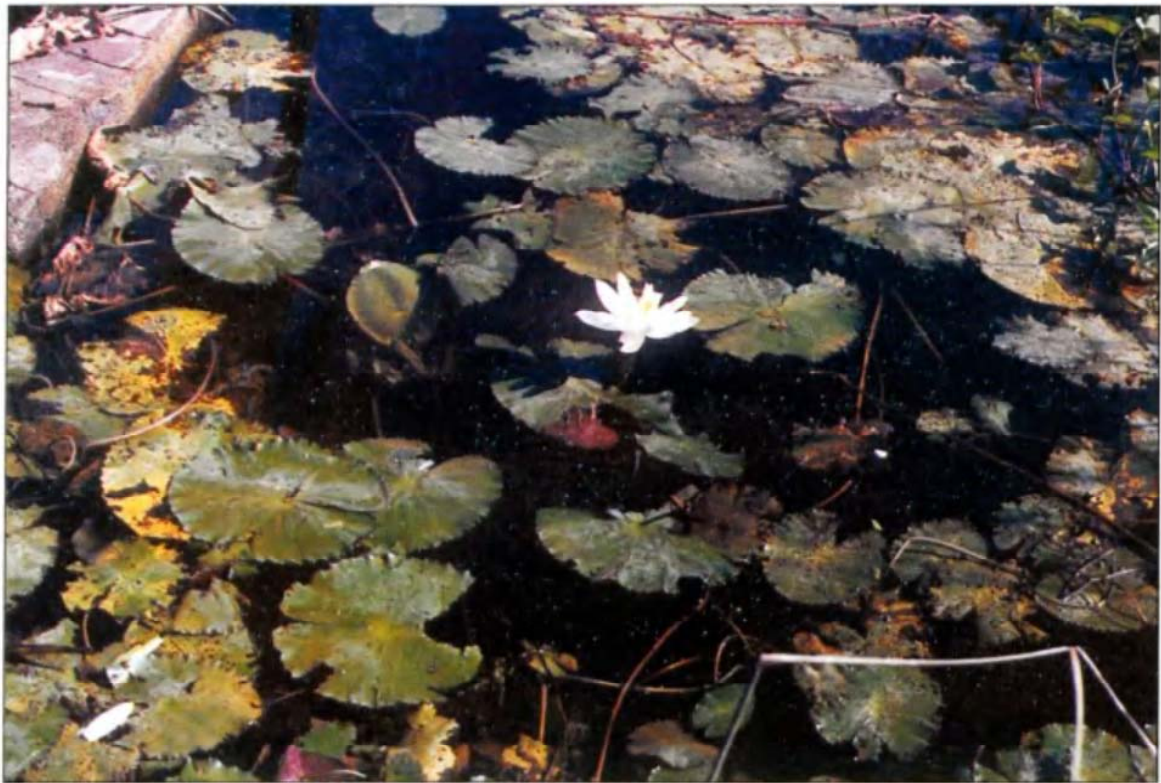
A view of moist deciduous forest on way to Vishalagad, Kolhapur district
comprising **Hymenodictyon orixense**, **Lanea coromandelica**,
Terminalia elliptica, **Trema orientalis**, etc.



A view of dry deciduous forest at Yavatmal comprising ***Madhuca longifolia*** var. ***latifolia***, ***Tectona grandis***, ***Terminalia cuneata***, etc.



Degraded scrub land at Panshet, Pune district.
(Courtesy, P. Tetali, N. G. C. P. R.)



***Nymphaea nouchali* Burm. f. - An aquatic plant.**



A view of mangrove vegetation.



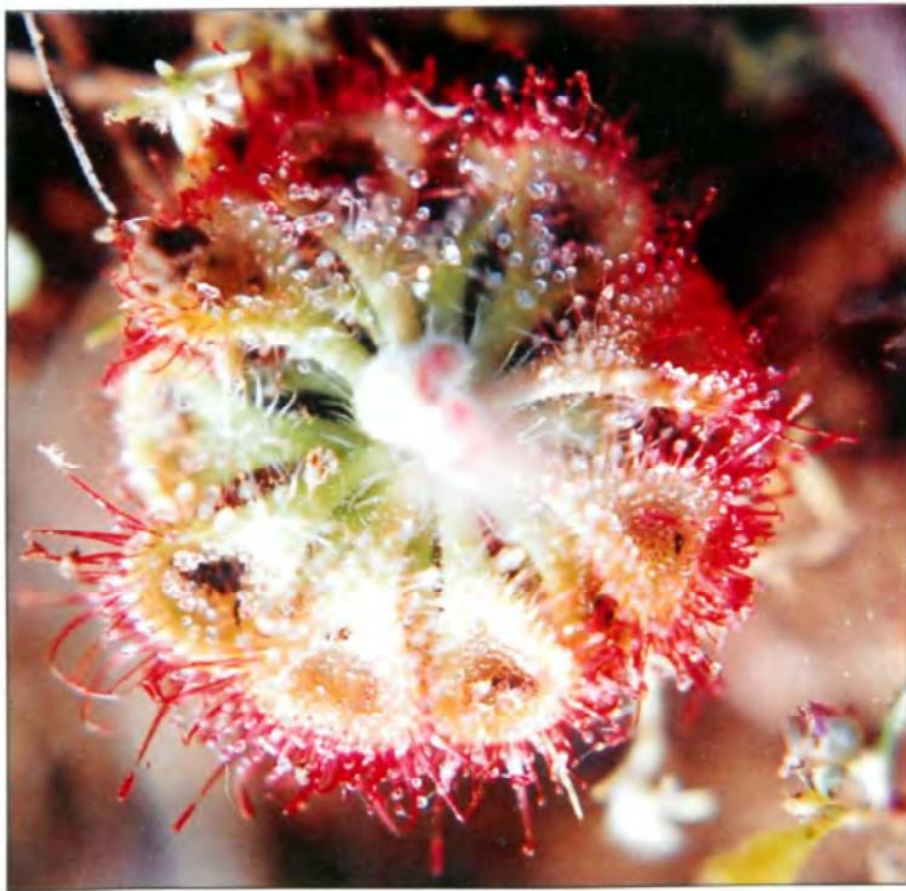
Viviparous germination in ***Bruguiera gymnorrhiza*** Lam.



Habit of ***Rhizophora mucronata*** Lam.



Nothapodytes nimmoniana Grah. - A source of anti carcinogenic drug.



Drosera burmannii Vahl - An insectivorous plant
(Courtesy : P. Tetali, N. G. C. P. R.)



Abutilon ranadei Woodr. &
Stapf - Endemic.
(Courtesy : P. Tetali, N. G. C. P. R.)



Crotalaria decasperma Naik - Endemic.



Eriolaena quinquelocularis (Wight & Arn.) Wight - Endemic.
(Courtesy : P. Tetali, N. G. C. P. R.)



Flemingia neilgheriensis (Baker) Wight ex T. Cooke - Endemic.



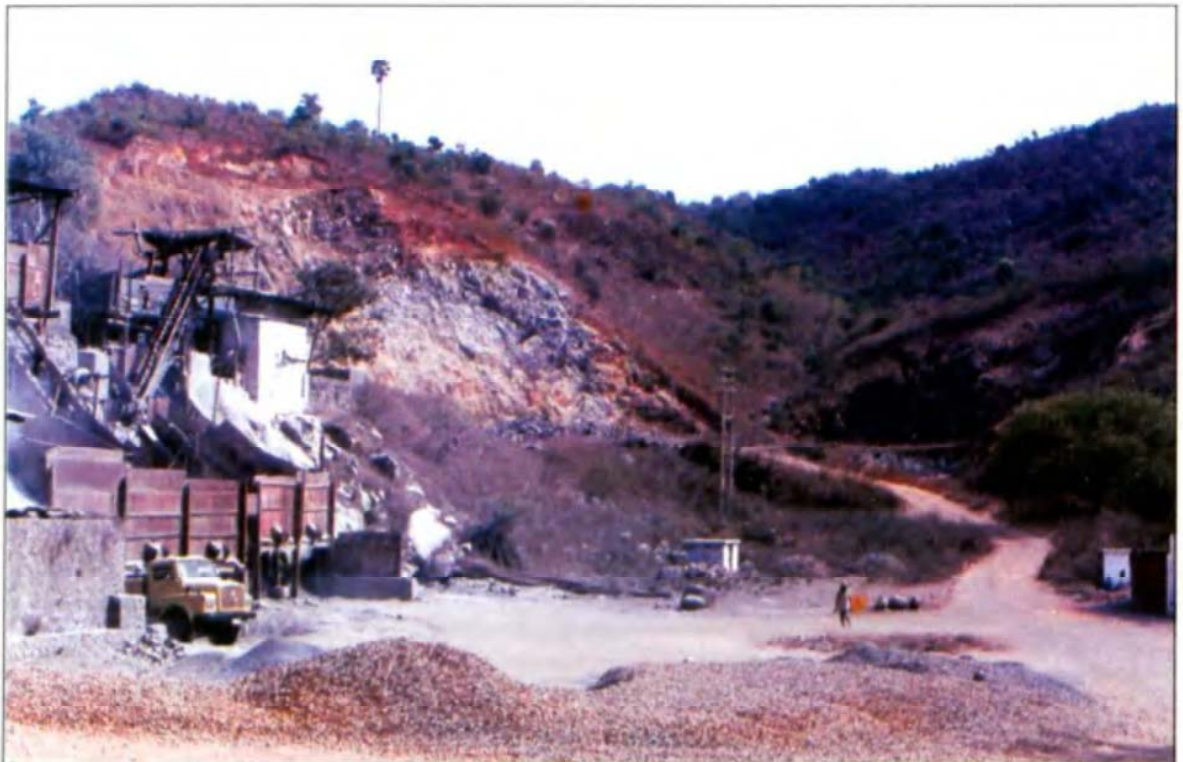
Moullava spicata (Dalz.) Nicols. -
Endemic.



Vigna khandalensis (Sant.)
Raghavan & Wadhwa - Endemic.
(Courtesy : P. Tetali, N. G. C. P. R.)



Sacred grove at Mangaon, Pune District.
(Courtesy : P. Tetali, N. G. C. P. R.)



Quarry mining operation affecting the vegetation.



Capparis divaricata Lam.



Celastrus paniculatus Willd.



Cleome speciosa Raf.



Memecylon umbellatum Burm. f.

INTRODUCTORY CHAPTERS FOR THE FLORA OF MAHARASHTRA STATE

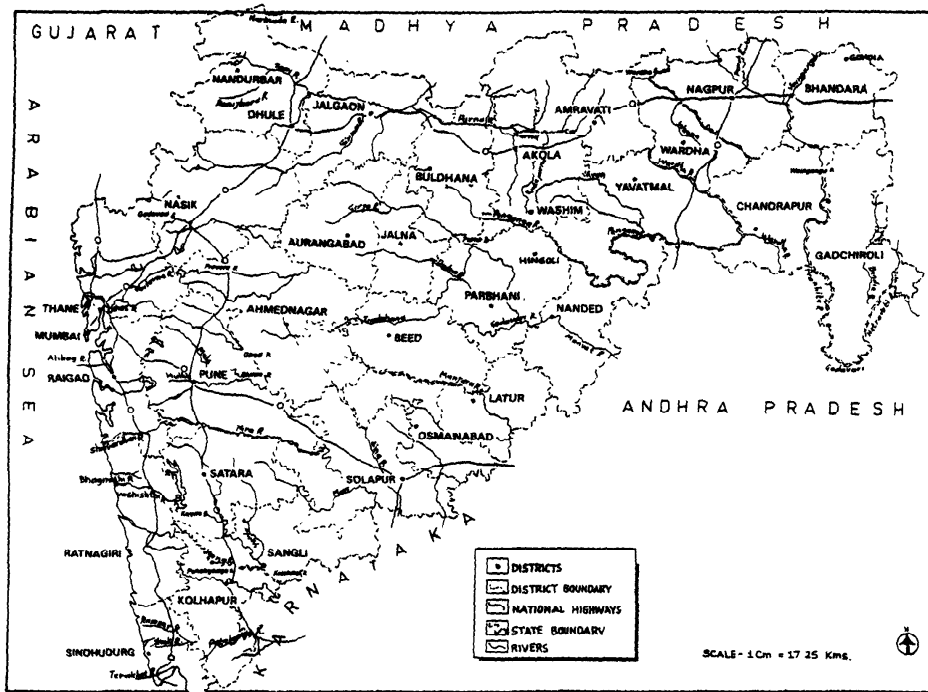
(*P. Lakshminarasimhan & N. P. Singh*)

GENERAL NOTE

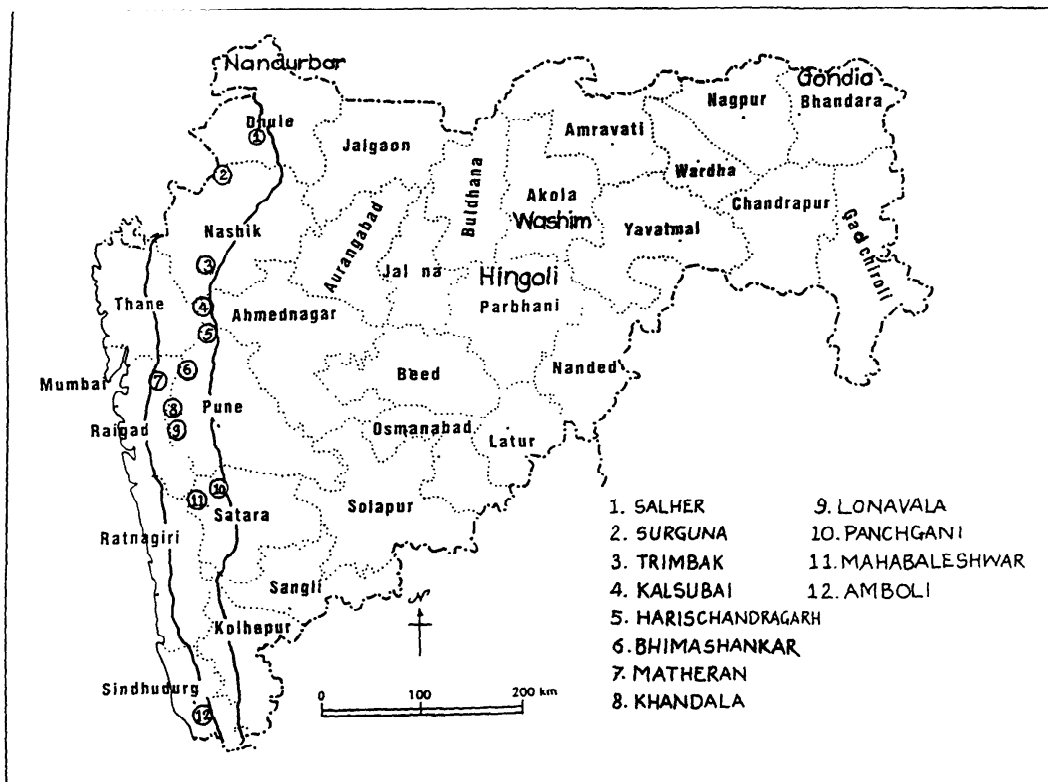
Maharashtra state was part of Bombay Presidency during the British rule, subsequently it formed part of Bombay State. The present state of Maharashtra was formed on 1st May, 1960. Its political boundary extends from Bombay to Gadchiroli and Dhule to Sindhudurg and Kolhapur districts. It is about 800 km east-west and 700 km north-south, lying between 22°1' to 16°4' N latitude and 72°6' to 80°9' E longitude, having an area of 3,07,690 sq km (The Hindu Survey of the Environment, 1998).

Its limits are Arabian Sea on the west whose coast line extends up to 720 km, Goa and Karnataka in the south, Andhra Pradesh in the south-east, Madhya Pradesh in the north and Gujarat in the north-west (MAP I). It is the third largest state of Indian union. The state has a population of 7,89,37,187 people according to the 1991 census. The language spoken is Marathi. The state has been divided into 34 districts.

The state is divided into high and low level tracts by Western Ghats which run parallel to the western coast. The area of Western Ghats of Maharashtra known as 'Sahyadris' (Map II) lies between 72°61' to 74°40' E and 15°60' to 20°75' N, covering an area of c 1500 m. The north-south run of Western Ghats is c 750 km and average breadth is 80 km. The ghat region traverse 11 districts viz., Thane, Raigad, Ratnagiri, Sindhudurg, Dhule, Nasik, Ahmednagar, Pune, Satara, Sangli and Kolhapur. The ghats receive high rainfall (250-440 cms) and are densely forested. They also constitute the main watershed of the Deccan, feeding the great east flowing rivers of Godavari, Krishna and their numerous tributaries, as well as smaller and shorter rivers flowing into the Arabian sea. The western face of the ghats is cut by deep ravines and canyons. Between the foot hills and the Arabian Sea lies a narrow strip (40 miles in width) of rugged land broken by numerous rapid flowing rivers and streams, creeks and isolated ranges of hills. The rainfall in this area ranges between 190-250 cms a year. The river Tapti flows through a valley between Satpura hills situated along the northern fringe of the State Ajanta hills which form the northern edge of the plateau. The valley is distinguished from the main plateau by its alluvial soils. Being a rain shadow area, the precipitation is as low as 63 cm in the western portion whereas the eastern portion of the valley receives up to 88 cm.



Map I : Maharashtra State-General



Map II : Maharashtra State-North Western Ghats (not to scale)

The Maharashtra plateau is a table-land, it accounts for major portion of State's area; it slopes gradually away from the eastern sides of the Ghats. It is made up of an impervious base of basaltic rocks overlaid with the Deccan lavas. The Mahabaleshwar-Panchgani plateau is ecologically a very important region in the North Sahyadri hill ranges. It forms watershed of 5 rivers viz., Krishna, Koyna, Venna, Gayatri and Savitri and for the three important reservoirs of Koyna, Dhom and Kanhar. The high wall of Sahyadris serves as a barrier for the migration of species on either side. The mountain passes locally called Ghat or Bari, are useful for traffic, trade and commerce. They are the routes for going from Desh to Konkan and vice versa. The river valley system in Desh are Narmada, - Tapti, - Purna, Wardha, Vainganga, Godavari, Bhima and Krishna. They run from west to east forming four compartments of the state. The Satmala range starts from Saptashringi hills and extends towards Daulatabad, Aurangabad and Manmad. The second range of mountain is Balaghat range which starts from Harishchandragad in Ahmednagar district and extends up to Gulbarga through Osmanabad and Bidar. The third mountain range is Shambu Mahadev mountains. They extend further into Karnataka.

The other major rivers in the state are Pravara, Pranahita, Ghatprabha, Damanganga, Tansa, Vaitarna and Ulhas. The principal smaller rivers are Amba, Kundalika, Savitri, Shastri, Vasishthi, Kajali, Muchkundi, Shuk, Gadnadi, Terekhol, etc.

The hill passes, known as ghats and the hill forts built along the line to Sahyadri on places that are not easily accessible are the two conspicuous features in Sahyadris. There are at least 20-30 major passes or ghats serving as highways or bye-ways between Konkan and Desh. These ghats are often quite narrow and lead from plains at lower altitude to higher mountain plateau and vice-versa. They are generally in the weak sectors of mountains where the lava flows have been brittle and get easily disintegrated and washed away, than in harder core of the Deccan traps. Quite often rivers, brooks, or small streams follow labyrinthous path by their side and open into a low altitude basin of a river in the valley. Such valleys are well protected by two mountain spurs running parallel and are fed by mountain streams. They provide unique climate and locations for plants to grow isolated. They are called 'Mavals' which are many. They are well protected uplands, well-drained valleys, well-watered by hill streams. Their environment and flora are different and resemble like the Sholas in the Nilgiris. Humidity in Maval valleys is conducive to the development of semi-evergreen forest types and to endemism.

The principal hill forts on the peaks and spurs of Sahyadris are Sinhgad, Raigad, Pratapgad, Purandhar, Panhala, Harishchandragad,

Shivneri, Daulatabad, Songa, Aguala, Fonda, etc. In their canyans and trenches, ledges and chinks often rare species have been preserved due to their inaccessibility. Many ferns, liverworts and mosses grow on fort walls. Another habitat of plants in Maharashtra are the sacred groves of trees dedicated to Gods, locally known as 'Dev Raies'. They constitute bits of select vegetation and are conservatories of past types.

The north-eastern portions of the state, comprising basins of Wardha and Vainganga rivers, are known as Nagpur plains. The Wardha basin has the characteristic black soil of the Deccan, but geologically it is in the transition zone. More minerals, especially coal are found in this region. The transition is complete in Vainganga basin, which presents marked contrast to the plateau. The rainfall is heavy (125 cms or more). The valley floors and its adjoining hills are thickly forested with bamboo; the soils are lateritic and the geological formation is quite different from those of plateaus. This region has the largest known concentration of the mineral deposit in the state. The early cultivation in India was associated with Maharashtra and cereals were first grown in the state. Maharashtra is not only industrially advanced and has in Bombay city, the commercial capital of India but is also one of the highly literate states of India. Agriculture continues to be the main occupation of the people. The net irrigated area is c 25.14 lakh hectares and the principal crops include rice, jowar, bajra, wheat, pulses, cotton, sugarcane, several oil seeds including groundnut, sunflower and soyabean, turmeric, onion and other vegetables (Bhatt, 1998). The state has large areas under fruit cultivation, of which mangoes, bananas, grapes and the Nagpur oranges are important. In Maharashtra, the average yield of cotton is 4 quintals per hectare. Maharashtra tops onion production in the country as follows :

	Area (in hectares)	Production (in lakh tonnes)
Kharif	11,000	1.5
Rabi	32,500	6.0

GEOLOGY

The rock formation in Maharashtra can be classified into the following divisions :

- I. A group of very ancient rocks partly crystalline and partly sedimentary. These includes a variety of granite and gneisses which occur in southern districts of Kolhapur and also in parts of Rewa and Panch Mahals.

- II. An immense accumulation of volcanic rocks, principally basaltic lavas, known as Deccan Trap. Ninety percent of Maharashtra's geology is made up of Deccan Traps. The word 'Trap' is applied to the step-like aspect of the weathered hills of basalt which is the most common feature in the state. In composition, the basalts are singularly uniform. Augite basalt of specific gravity 2.68 is the most common. The colour of the rock is greyish-green with lighter or deeper shades. The bulk of the rock is composed of fine-grained mixture or ground mass of feldspar or augite. Besides, abundant plagioclase (labradorite or anorthite) prisms, sometimes large tubular crystals of clear glossy orthoclase (sanidine or adularia) as phenocrysts in the ground mass are observed. Primary accessory minerals like abate are few but secondary minerals like calcite and quartz are plenty. Another important formation is the Gondwanas seen in Bhandara, Chandrapur, Wardha, Wardha-Godavari-Pranahita valley and in Konkan. Small areas in Konkan have the Archeans.

The state Geological and Mineral Ore Department has carried a survey of more than 1,464 sq km in the state and has been successful in unearthing large reserves of minerals in the region. Coal reserves to the tune of 60.97 million tonnes have been found in Nagpur, Chandrapur and Yavatmal districts while 4,200 sq mtrs of granite has been found in Sindhudurg district (Indian Express, 9.8.1997).

Recently two scientists of MIT, Pune have discovered large deposits of copper in the form of Malachite in dense forest area, 15 km north-east of Vaibhavwadi in Sindhudurg district. They have also detected another large site of copper ore (Chalcopyrite or copper sulphide) from a location 5 km east of Kankavali. Until now Konkan was only known for chromite deposits found in Kankavali, mica in Kadaval and iron in Redi. According to Dr. Avinash Phadke, well known geologist, volcanic ash deposits seen in plenty in and around the Kukdi river basin at Bori village are significant geologically since they provide new insight into the historical perspective of human life in Maharashtra (Indian Express, 9.12.1998). According to Prof. Somaya, the age of tephra (ash) deposit is seven lakh years. Similar deposits are also found near Morgaon (Pune district) and in Purna river bed (Akola district).

SOILS

Most of the soils in Maharashtra are formed from the Deccan Traps generally from the augite or amygdaloidal basalt. These soils are black, dark brown or reddish in colour and hence are called Black

cotton soils or 'Regur' soils meaning thereby red soils. Some soils in Nagpur, Bhandara and Chandrapur districts are derived from Vindhyan and Gondwana formations. They form small areas of sandy or loamy soils in Bhandara, Chandrapur and in small pockets in Ratnagiri district near Redi and Savantwadi.

The largest area is occupied by the black soils. The black cotton soils are heavy in texture and have high percentage of clay. They have adequate proportions of mineral nutrients and also micronutrients, hence they are considered good for plant nutrition. Sometimes they are slightly alkaline but they are poor in humus or nitrogen. The dark colour of the trap soils is due to clay fraction and is responsible for their sticky nature. The black cotton soils are one of the oldest group of soils since the Tertiary era. The temperature and rainfall where the black cotton soils occur support dry deciduous forests or a thorn savannah. They have 40-60 percent clay contents. The structure of these soils is usually cloddy or sometimes crumbly with aggregates having natural cleavages.

Padoley (1955) observed that (1) the detritus (material above 2 mm in diameter) in soil consists of disintegrated and weathered bits of parent rock, (2) the hygroscopic moisture content varies from 5-7%, (3) the pore space is 48 to 61%, the volume expansion ranges from 17 to 34% and (4) dispersion co-efficient ranges from 5 to 12 in surface soils.

Black soils, in general, are calcareous, neutral to mild alkaline in reaction (pH 7.2-8.5), high in clay contents. The most characteristic black soil cap the volcanic plateau of Deccan traps forming a mantle of rich residual soils of moderate depth. There are a few definite horizons, the lowest of which passes with easy gradations to the disintegrated lava (murrum) of red to brown colour. There are also alluvial black soils, the profiles of which are much deeper.

Black soils :

In general are very fertile except in the uplands where it shows low fertility. In the valleys the soils are darker, deeper and richer and are constantly enriched by washings from highlands. Calcium and magnesium carbonates and iron are found in appreciable proportions with variable proportions with variable quantities of potash. These soils are, however, poor in organic matter, nitrogen and phosphorus. The black cotton soils, if fed with sufficient water and nitrogen, are capable of high productivity, particularly of cash crops like sugarcane, chillis, groundnut, jowar, wheat, etc. Saline soils occur in the khar-land zone close to sea coast. The khar-lands lead to mangrove soils which are quite rich in salt content and also calcium. They form an important

belt of vegetation along the sea coast. The black cotton soils in scarcity zone of Ahmednagar, Solapur, Jalna, Beed and Aurangabad districts are saline and infertile. Due to high temperature and low rainfall, they become unproductive. But in some years when the rains are heavy they produce bumper crops. The most important soils of Maharashtra are as given below:

Deep black soils :

These are found along the courses of the river Tapti, Godavari, Bhima and Krishna and are observed on low lying or flat topography.

Medium black soils :

These are similar in properties described earlier, but are of medium depth up to about 1.2 to 1.5 m, comparatively less clayey and have higher calcium carbonate contents.

Shallow black soils :

These are residual soils derived from trap and are usually found on hill slopes and plateaus. They are lighter in colour and are well suited for perennial or seasonal irrigation and especially so when adequately manured.

Laterite soils :

The laterite belts are found in Ratnagiri district and western portions of Kolhapur and North Satara. It has concretionary clay loam soil at the surface. These areas stand good vegetative cover. These soils are poor in plant nutrients and organic matters. The pH ranges from 5.5 to 6.5.

Red and grey soils :

Red and grey soils are present in north of the laterite belt mainly in Thane and Raigad districts and also in the western portion of Pune district. On the hill slopes, coarse sandy soil and on the valleys clay loam soils are observed. These are complex group of soils varying in depth and texture. The soils of the hill slopes are reddish-brown or yellowish-red in colour varying in depth from 8-15 to 45 cm. They are sandy loams with gravel and iron concretions and have a pH slightly on the acidic side. They rest on Deccan trap which in places is columnar. Occasionally thin laterite capping are observed in the area.

The soil on the flat land and valleys are deeper. The colour ranges from dark-red to grey and depth from 60 cm onwards. They are generally loam having neutral to very slightly alkaline reactions.

Paddy is main kharif crop while in rabi season, small areas grow crops like tur, mung, etc.

Coastal alluvial :

These are deep sandy soils of very little clay content. In certain portion in this sandy belt there are saline soils, a condition brought about mainly by the ingress of sea water or by the low lying nature. The surface layers are clay loams, have cloddy structure, grey colour and extensive incrustation of salts. The lower layers are silty loams. The profile contains fair quantities of calcium carbonate.

CLIMATE

It is monsoonal. Rainfall and humidity in Konkan and hill tops in Sahyadris are equable and suitable for plant growth. There is no extreme of hot or cold. Generally from the last week of March to first week of May, it is very pleasant in Western Maharashtra. It is a little hotter in Vidarbha and quite hot in summer in Khandesh. A peculiar type of climate intermediate between that of hill tops and plains on Desh side prevails in Mavals. It provides very salubrious climate in cities like Pune, Nasik, Kolhapur and Satpura ranges. Because of the varied climate, temperature, rainfall, humidity and topography different types of plants and crops thrive in Maharashtra.

Rainfall

According to India Meteorological Department, the average annual rainfall in the peninsular India which accounts for 49.5 per cent of the country's total Geographical area during the period from 1901-1990 was 86.92 cm (The Hindu, 26.4.99). The rainfall is mostly due to SW monsoon. The total rainfall in different parts of Maharashtra is not uniform. The Konkan and the coastal regions get regularly about 2,540 mm per annum, though much of the water goes to the sea. In western Vidarbha, the rainfall is c 975 mm. In the eastern Vidarbha, the rainfall is between 1200-1400 mm. The highest rainfall recorded in Vidarbha is 1,736 mm at Dhanora in Chandrapur District. At Mahabaleshwar, the rainfall rises to 6226.3 mm. The lowest rainfall is in Solapur district at Akluj which is 448.8 mm. In Khandesh, rainfall is 900-1000 mm. The highest number of rainy days ranges from 120-140 and the lowest is 25-40. The high level plateaus such as Matheran, Mahabaleshwar, Lonavla, Trimbak have relatively high rainfall, but the vegetation does not look much different from that on the Desh side, as it gets dried up in summer months. Table I gives the rainfall at selected centres (See also graphs 1-4).

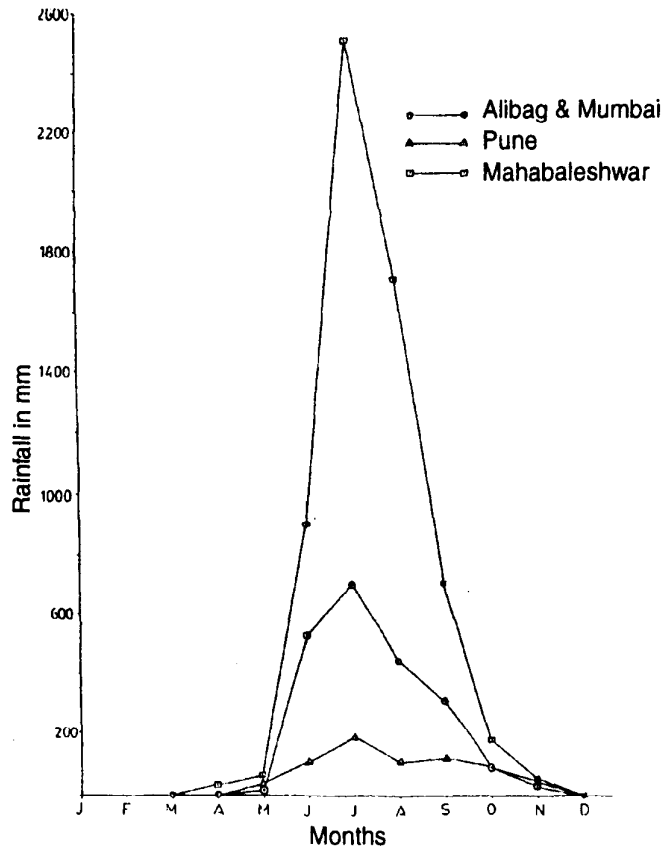
Table I : Rainfall at selected centres in Maharashtra (1931-1960)

Name of the Month	Bombay		Alibag		Jalgaon		Malegaon		Ahmednagar		Pune		Mahabaleshwar	
	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days
January	2.0	0.3	2.0	0.3	5.1	0.4	4.0	0.4	3.3	0.3	1.9	0.2	3.1	0.3
February	1.1	0.1	0.3	0.1	2.1	0.2	2.8	0.2	0.4	0.1	0.3	0.1	1.8	0.1
March	0.4	0.1	0.3	0	4.7	0.5	1.2	0.2	5.0	0.3	3.1	0.3	6.8	0.5
April	2.8	0.3	2.0	0.2	2.1	0.2	3.6	0.4	11.2	1.0	17.6	1.3	29.6	1.8
May	16.0	1.2	17.0	1.1	12.5	1.0	14.8	1.2	26.2	1.8	34.7	2.4	55.4	3.9
June	520.3	15.4	528.3	15.4	142.7	6.9	109.5	6.3	131.2	7.2	102.8	6.9	898.3	21.3
July	709.5	23.5	699.3	24.2	242.2	15.6	108.8	7.9	101.9	7.0	186.8	13.9	2521.3	30.9
August	439.3	19.1	447.7	21.0	194.0	11.6	94.9	5.7	98.3	5.5	106.4	9.0	1714.7	29.4
September	297.0	12.8	310.1	14.1	159.3	8.1	144.1	8.2	174.7	8.4	127.3	7.8	709.2	22.5
October	88.0	3.7	90.2	4.2	48.1	2.2	55.7	3.2	83.9	4.5	91.9	5.8	179.3	8.4
November	20.6	1.0	28.2	1.4	21.6	1.1	36.2	1.5	33.3	1.6	37.0	2.0	56.7	3.2
December	2.2	0.3	2.5	0.2	6.0	0.5	3.9	0.4	7.9	0.5	4.9	0.4	6.1	0.4
Annual Total	2099.2	77.8	2124.9	82.2	840.4	48.3	579.5	35.6	677.3	38.2	714.7	50.1	6182.3	122.7

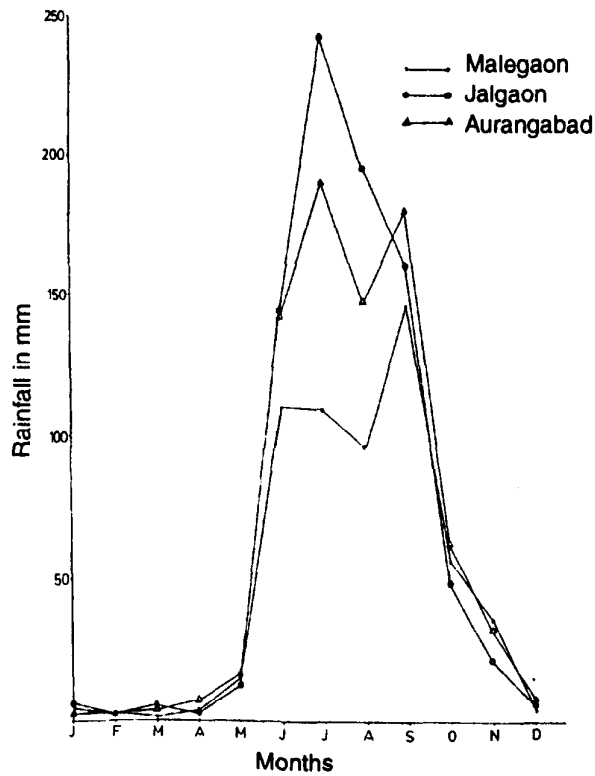
Name of the Month	Solapur		Miraj		Aurangabad		Amravati		Akola		Chandrapur	
	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days	Monthly total (mm)	No. of Rainy days
January	3.6	0.1	2.7	0.1	2.7	0.4	15.0	1.3	9.1	0.8	5.1	0.6
February	2.0	0.2	0.3	0	3.0	0.3	12.7	1.1	7.7	0.6	20.6	1.4
March	7.2	0.7	4.4	0.6	3.8	0.5	12.3	1.0	7.5	0.5	21.5	1.7
April	15.8	1.6	30.3	2.3	7.2	0.7	13.0	0.9	6.6	0.6	17.1	1.6
May	26.4	2.2	55.9	3.5	16.8	1.3	11.9	1.2	10.9	1.1	10.9	1.1
June	108.7	7.3	70.8	5.9	141.2	8.0	149.3	8.6	146.0	8.2	181.1	1.3
July	127.7	9.2	116.3	10.8	189.3	13.1	285.7	14.7	260.7	14.1	403.8	18.3
August	139.9	8.5	100.7	8.7	145.8	10.1	209.6	11.3	170.1	9.4	362.6	15.4
September	183.8	9.3	104.8	6.1	179.4	9.4	185.9	9.3	177.9	8.1	234.5	10.8
October	92.3	5.3	107.2	6.4	62.1	4.2	49.6	2.9	46.3	2.7	72.5	3.9
November	28.0	1.5	42.0	2.4	32.3	1.7	23.9	1.2	27.6	1.3	14.4	0.9
December	6.6	0.6	3.5	0.3	8.5	0.4	5.6	0.5	6.4	0.5	2.5	0.3
Annual Total	742.0	46.5	638.9	47.1	792.1	50.1	974.5	54.0	876.8	47.9	1346.6	65.3

Source : Climatological tables of observatories in India (IMD)

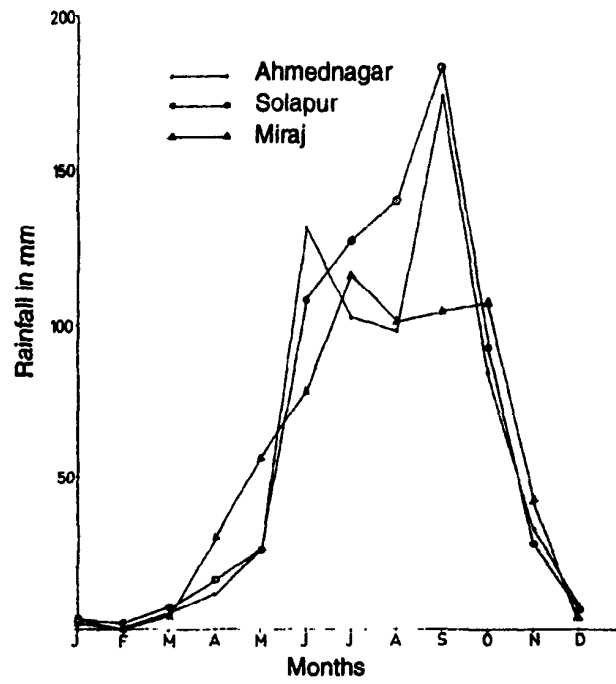
Graphs 1-4 : Rainfall at selected centres in Maharashtra (1931-1960)



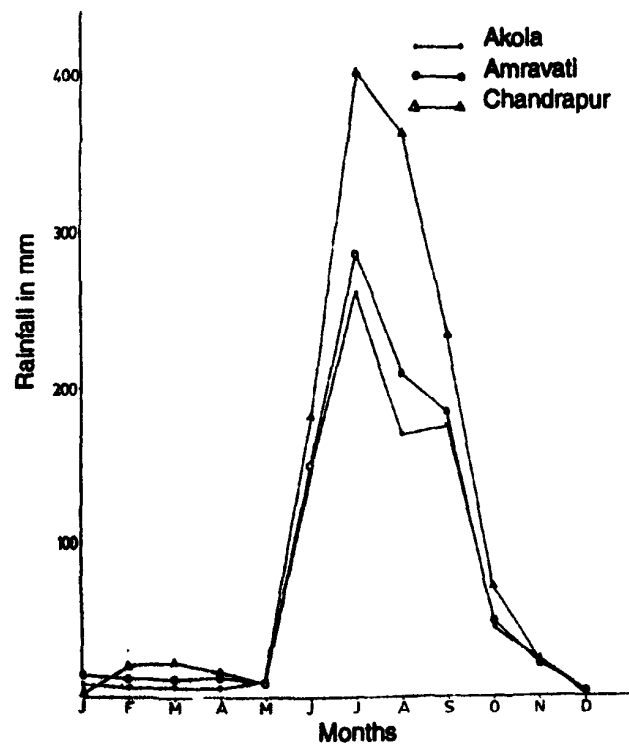
1. Alibag & Mumbai, Pune, Mahabaleshwar



2. Malegaon, Jalgaon, Aurangabad



3. Ahmednagar, Solapur, Miraj



4. Akola, Amravati, Chandrapur

Temperature

The temperature prevalent in Konkan is the lowest due to the nearness of Arabian sea. In highlands and hill tops in Sahyadris also, the temperature is low due to the altitude. The temperature in parts of Ahmednagar, Solapur and Osmanabad districts and Khandesh is high. The temperature in the whole state at different places normally vary from 10° to 42.7° C. Table II shows the maximum and minimum monthly temperature at selected centres in Maharashtra (See also graphs 5-8).

Humidity

All through Maharashtra, the humidity is low. Average mean humidity ranges between 56% to 74%. The humidity in Konkan never goes below 60% and plants look lush green. On the Desh side it is quite high for four months of the rainy season and low for eight months (October-May). The relative mean humidity is as high as 80% in July-August, but the lowest in March-April, as low as 25 to 30%. Table III shows relative humidity at selected centres, (See also Graph III).

Wind Movements

During the summer months and rainy season movement of wind is from sea to land and is from land to sea during winter. The Sahyadri ranges obstruct the water laden clouds as they ascend them. Naturally the rainfall on the top of the ghat regions and in the regions in the immediate vicinity of Sahyadris is high. There are no frosts except an occasional thundershower in winter months and early May. The trees on mountain top consequently grow low and stunted. There are pockets of evergreen vegetation and humid monsoon evergreen forests in the valley and in a few places in the Satpura range in Melghat and at Khandala in Sahyadris where the vegetation has optimum conditions for growth and the plants well protected. These pockets of evergreen vegetation in Konkan and in Maval region on Desh side look something like the Shola pockets at higher altitudes in Nilgiris.

On the eastern side of Maharashtra, the Desh presents a different picture. It lies in the 'Rain shadow' region which forms the major part of Western Maharashtra. There is a dry belt of Maharashtra (parts of Ahmednagar, Solapur and Osmanabad districts) where rainfall is poorest, humidity low, temperature and evaporation rate high. In Khandesh, south-west monsoon clouds escape through the valley of Tapi. The annual mean temperature is high, rainfall is moderate which is helpful for Rabi crops. In the region of western Vidarbha, the

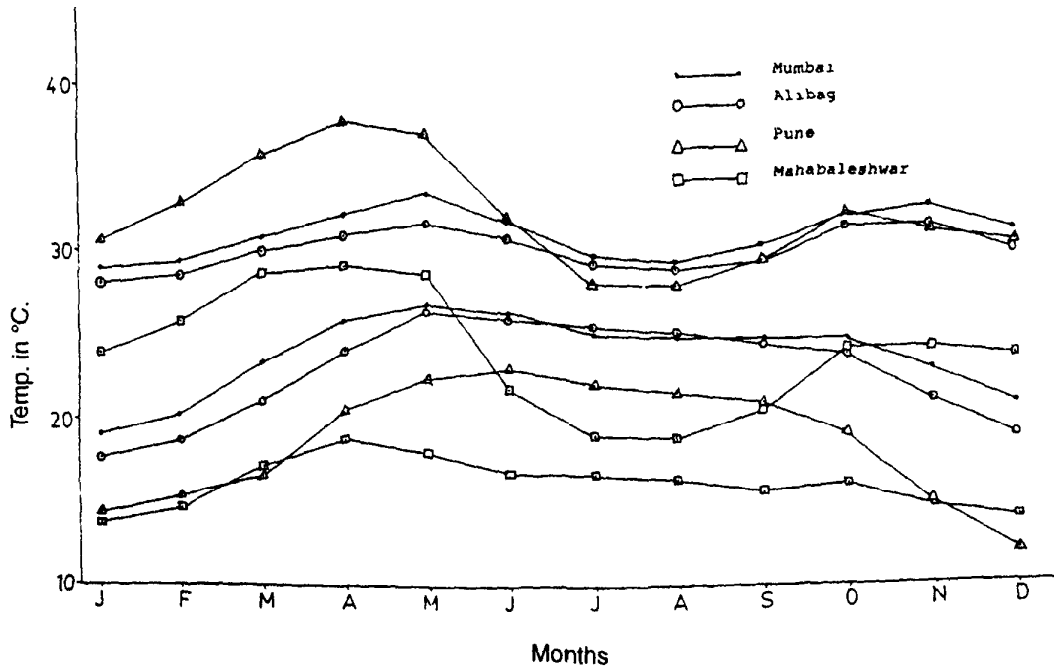
Table II : Maximum and minimum monthly Air temperatures of selected centres in Maharashtra (1931-1960) in °C.

Name of the month	Bombay		Alibag		Jalgaon		Malegaon		Ahmednagar		Pune		Mahabaleshwar	
	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.
January	29.1	19.4	28.2	17.7	30.6	12.7	30.1	11.5	29.5	12.5	30.7	12.0	24.6	13.8
February	29.5	20.3	28.6	18.4	33.2	14.3	32.6	12.8	32.0	14.1	32.9	13.3	26.1	14.9
March	31.0	22.7	30.1	21.2	32.6	18.7	36.5	17.0	35.6	18.0	36.1	16.8	28.8	17.4
April	32.3	25.1	31.1	24.2	41.1	24.1	39.4	21.8	38.0	21.8	37.9	20.6	29.3	18.8
May	33.3	26.9	31.8	26.4	42.6	27.2	40.7	24.3	39.1	23.1	37.2	22.6	28.8	18.2
June	31.9	26.3	30.8	26.0	38.1	26.0	36.1	24.2	33.7	22.5	31.9	23.0	21.9	16.9
July	29.8	25.1	29.2	25.3	32.1	24.0	31.1	23.0	29.5	21.7	27.8	22.0	19.0	16.7
August	29.5	24.8	28.8	24.9	31.2	23.4	30.7	22.3	29.4	20.9	27.7	21.5	18.9	16.3
September	30.1	24.7	29.2	24.4	31.8	22.9	31.1	21.3	29.9	20.3	29.2	20.8	20.3	15.7
October	31.9	24.6	31.2	23.6	34.1	19.2	32.7	18.8	31.2	19.1	31.8	19.3	24.0	16.1
November	32.3	22.8	31.3	20.9	32.0	14.5	31.0	14.3	29.7	15.1	30.8	15.0	24.0	14.9
December	30.9	20.8	29.7	18.7	30.3	12.0	29.9	11.7	28.9	12.3	30.1	12.0	23.5	13.9
Annual mean	31.0	23.6	30.0	22.6	34.6	19.9	33.5	18.6	32.2	18.5	32.0	18.2	24.1	16.1

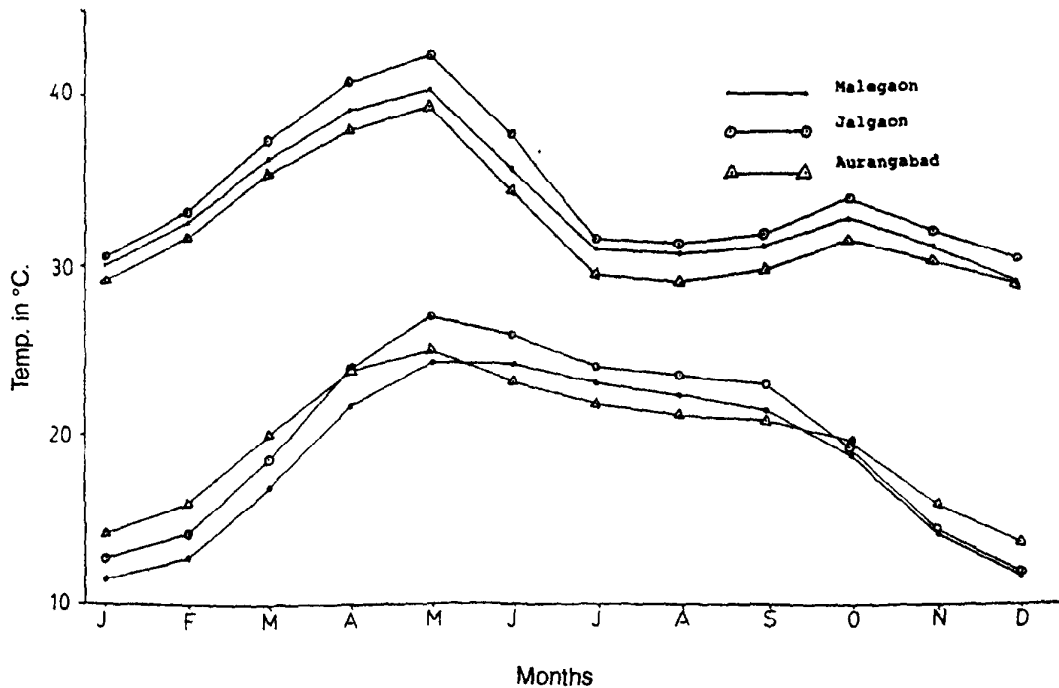
Name of the month	Miraj		Solapur		Aurangabad		Amravati		Akola		Chandrapur	
	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.	Daily max.	Daily min.
January	30.6	14.3	30.8	15.8	29.3	14.3	28.9	15.5	30.2	13.7	29.5	13.7
February	33.1	15.4	33.7	17.5	31.8	16.1	31.8	17.2	32.8	15.2	32.3	15.9
March	36.2	18.6	37.1	21.1	35.6	20.1	36.2	21.2	37.1	19.4	36.7	19.8
April	37.9	21.6	39.3	24.5	38.3	23.8	39.7	25.2	40.5	24.6	40.0	24.7
May	37.4	22.7	40.4	25.5	39.8	25.0	42.2	27.8	42.4	28.1	42.8	28.3
June	31.6	22.3	35.0	23.5	34.7	23.2	37.0	25.7	37.4	26.2	37.7	26.9
July	27.9	21.6	31.4	22.3	29.5	21.8	30.3	23.4	31.4	23.9	30.9	24.3
August	28.0	21.1	31.3	21.9	29.2	21.2	24.8	23.0	30.7	23.5	30.5	24.1
September	29.4	20.5	31.5	21.5	29.8	20.9	30.6	22.7	31.5	23.1	31.2	23.7
October	31.0	20.1	32.3	20.6	31.6	19.6	32.1	20.8	33.3	20.0	31.6	20.7
November	30.1	17.1	31.0	17.2	30.3	16.1	30.1	17.4	31.0	15.0	29.5	15.1
December	29.7	14.6	30.0	15.0	28.9	13.8	28.6	15.1	29.6	12.6	28.4	12.2
Annual mean	31.9	19.2	33.7	20.5	32.4	19.7	33.1	21.3	34.0	20.4	33.4	20.8

Source : Climatological tables of observatories in India (IMD)

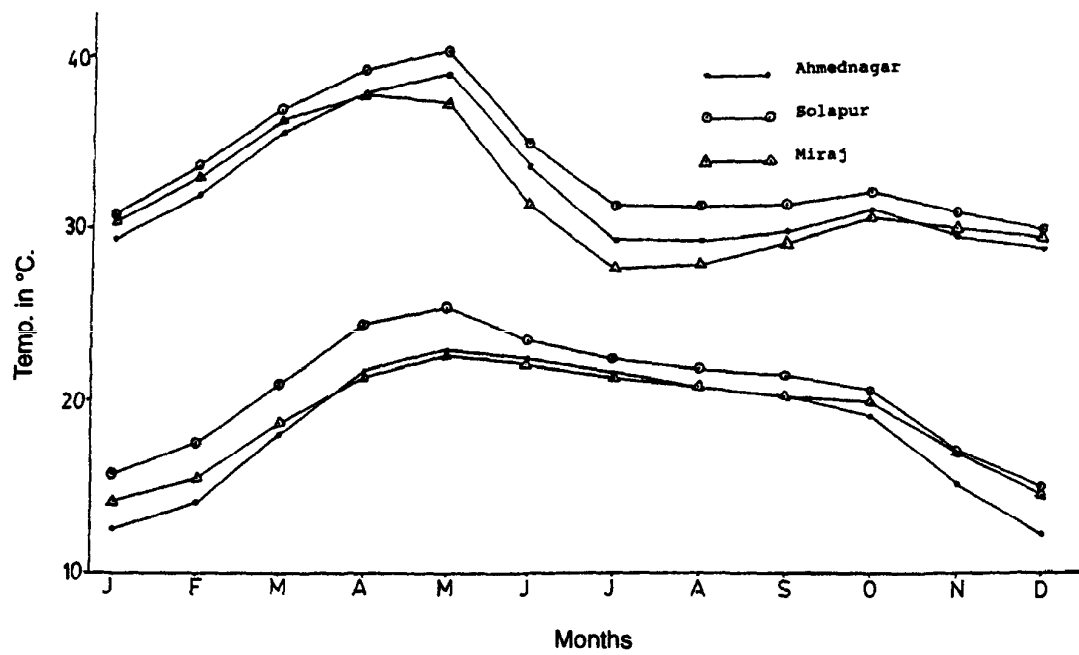
Graphs 5-8 : Maximum & Minimum Temperatures at selected centres in Maharashtra (1931-1960)



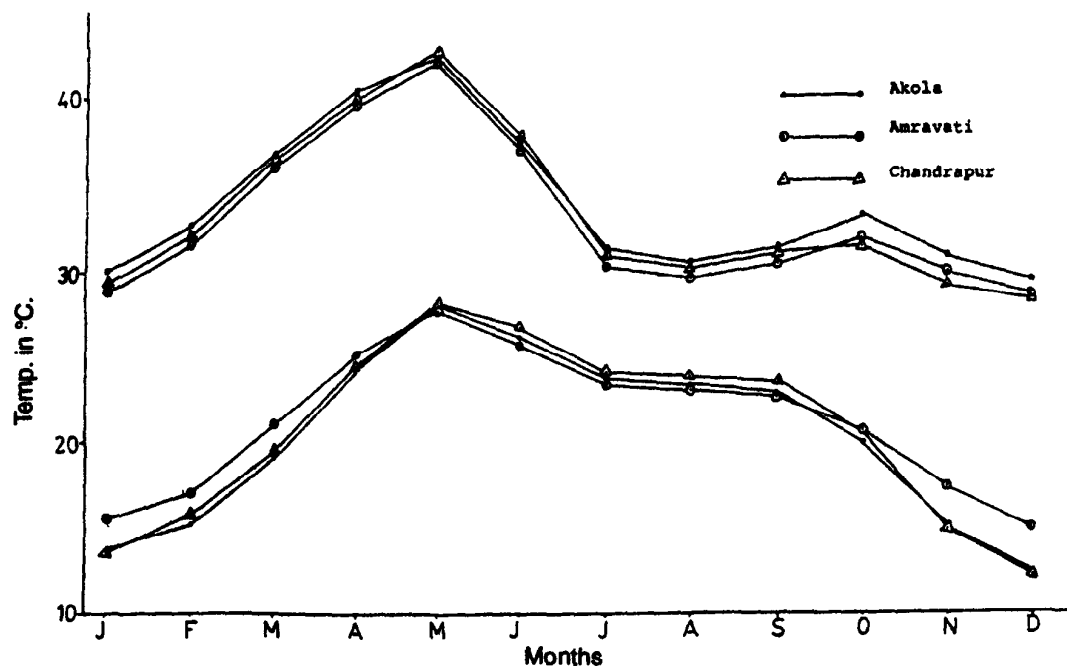
5. Mumbai, Alibag, Pune, Mahabaleshwar



6. Malegaon, Jalgaon, Aurangabad



7. Ahmednagar, Solapur, Miraj



8. Akola, Amravati, Chandrapur

temperatures are quite high, rainfall is moderate. The eastern part of Vidarbha (Chandrapur, Bhandara and Nagpur) gets substantial rains from the Bay of Bengal. The humidity becomes high and temperature is low. Rainfall is comparatively higher. The soils are sandy and or black cotton trap soils which support rich forest vegetation. Chandrapur and Bhandara have the best forests in Maharashtra. The thunderstorms are quite common. In mountainous regions and valleys fog is there in winter.

In Khandesh, frost is occasional at early morning hours in winter. The water evaporation due to transpiration from forest trees does not make much difference in the humidity on Desh side, as there are no thick forests and they are mostly deciduous.

Table III. : Relative Humidity of selected centres in Maharashtra in %

Name of the Month		Bombay	Alibag	Jalgaon	Malegaon	Ahmednagar	Pune	Mahabaleshwar
January	I	71	69	58	53	54	74	54
	II	63	-	27	27	29	30	49
February	I	72	70	45	43	44	64	43
	II	62	-	17	21	23	23	40
March	I	72	71	38	35	34	52	36
	II	63	-	13	18	17	20	43
April	I	73	74	39	33	34	50	39
	II	66	-	14	15	18	26	55
May	I	73	76	54	43	44	58	59
	II	68	-	18	23	22	36	67
June	I	80	84	72	67	72	74	95
	II	78	-	42	48	51	63	94
July	I	85	87	85	76	79	83	95
	II	85	-	65	66	64	78	100
August	I	85	87	87	77	80	85	99
	II	84	-	70	65	63	77	100
September	I	85	86	66	77	81	82	96
	II	80	-	60	63	62	71	98
October	I	80	79	70	65	68	79	75
	II	74	-	39	40	47	52	78
November	I	73	69	61	57	59	73	63
	II	67	-	30	34	40	40	62
December	I	70	68	63	56	57	75	56
	II	64	-	31	30	34	35	52
Mean	I	77	77	63	57	59	71	67
	II	71	-	325	37	39	46	70

Table III. : Continued

Name of the Month		Miraj	Solapur	Aurangabad	Amravati	Akola	Chandrapur
January	I	61	59	52	49	57	71
	II	34	29	30	30	29	43
February	I	56	39	41	40	46	61
	II	32	22	23	22	22	31
March	I	54	36	33	33	34	46
	II	25	19	18	25	18	24
April	I	64	41	34	30	30	41
	II	31	22	20	23	16	23
May	I	73	50	47	37	39	36
	II	41	24	24	21	19	21
June	I	81	72	76	65	66	64
	II	64	49	51	43	43	49
July	I	87	79	87	84	81	82
	II	76	61	72	69	68	75
August	I	87	79	87	83	82	83
	II	74	59	69	69	67	74
September	I	86	80	84	81	81	83
	II	68	58	64	66	64	74
October	I	76	68	64	60	66	76
	II	52	46	46	45	41	64
November	I	65	57	56	48	59	72
	II	42	36	38	33	55	53
December	I	65	54	55	50	60	75
	II	36	32	33	33	32	47
Mean	I	71	59	60	55	58	66
	II	48	38	41	40	38	48

Source : Climatological tables of observatories in India (1931-1960).

FLORISTIC STUDIES IN MAHARASHTRA

Some of the earliest explorers of Western India, particularly of Maharashtra, in the early 18th century include Law, Graham, Nimmo, Sykes, Jacquemont, Gibson and Dalzell followed by Birdwood, Nairne, Hallberg, Acland, Cooke, Woodrow, Gammie, Ryan, etc. around the turn of the century. Graham (1837) was the first to publish a 'Catalogue of Bombay Plants' which was followed by the 'Flora of Bombay' by Dalzell & Gibson (1861). Then came the 'Flowering Plants of Western India' by Nairne (1894). Many interesting papers on the Western India Flora were published by Woodrow (1897-1901). An enumeration of

plants of Matheran & Mahabaleshwar was published by Birdwood (1896, 1887, 1896, 1897) while a list of Bombay Grasses was published by Lisboa (1890-1898).

Cooke (1880-1896) and Woodrow (1880-1899) were the foremost in starting the Pune herbarium (BSI). Cooke's 'Flora of the Presidency of Bombay' (1901-1908) continues till today to be the most important floristic work for identification of the species that would be collected in the localities of the erstwhile Bombay Presidency viz., parts of Gujarat, Maharashtra, Goa, North Kanara and Sind which is now in Pakistan. This flora included 2513 species and 162 varieties under 999 genera belonging to 147 families to which Karthikeyan et al. (1981) added 5 genera, 715 species and 133 infraspecific taxa. Cooke was ably assisted by a number of Indian workers like Kanitkar (1891), Ranade (1898) and Bhide (1898), to mention a few. Gammie (1899-1902) also explored the Presidency and enriched the herbarium, who was followed by a number of workers like Patwardhan (1908), Paranjpye (1909), Shevade (1909), Burns (1916), Narayana (1922), Godbole (1929), Bhiva, Garade, etc. Talbot supplemented Cooke's work by publishing the 'Forest Flora of the Bombay Presidency and Sind' (1909 & 1911). Blatter & McCann (1926-1935) published a series of valuable papers enriching our knowledge of the Bombay Flora besides publishing a monograph on 'Bombay Grasses' (1935).

Santapau took over the Blatter Herbarium (BLAT) at St. Xavier's College, Bombay in 1940 and was largely responsible in reviving the interest in taxonomy and floristics and getting its due recognition in India. Some of his important works includes revisionary studies on Convolvulaceae (1947), Solanaceae (1948), Gesneriaceae (1949), Scrophulariaceae (1950 a), Lentibulariaceae (1950b), Acanthaceae (1952), Asclepiadaceae and Periplocaceae (with Irani, 1962), Orchidaceae (with Kapadia, 1966), etc. of Bombay besides 'The flora of Khandala' (1953, 1967) and 'The Flora of Purandhar' (1958). Bole (1970) has listed the numerous papers of Santapau (1944-1969) and his students which deal with varied aspects of taxonomy and floristics including history, herbarium techniques, bibliography, nomenclature and regional revision of some families and genera. This institute continues to serve the cause of taxonomy and floristics even today. Saldanha revised two genera viz., *Striga* and *Torenia* of Scrophulariaceae (1963, 1966). Bole and Almeida (1981-1985) have published materials for the Flora of Mahabaleshwar in a series of articles. S.M. Almeida (1983-1986) submitted a 'Report on the Flora of Ratnagiri district' which comprise c 1000 species and published the 'Flora of Savantwadi' (1990) which includes c 1600 species. G.L. Shah has also contributed many papers to the Flora of Bombay and its neighbouring Islands, the last being 1984. M.R. Almeida has recently

published 'Flora of Maharashtra Vol. 1' (1996) which includes families from Ranunculaceae to Connaraceae with 614 species.

Another school has been set up by Vartak at the Agharkar Research Institute, Pune. He has contributed to a better understanding to the Flora of Western Maharashtra, particularly of Pune, Satara, Raigad and Ahmednagar districts. His publications deal with varied topics like new and interesting records, medicinal, economic, horticultural and edible plants, ethnobotany and Flora of Sacred Groves besides families Cyperaceae (Vartak, 1966, Datar & Vartak, 1976, Vartak & Ghate, 1983), Podostemaceae (Vartak & Dhadbhade, 1973) and Vitaceae and Leaceae (Kumbhojkar & Vartak, 1983). Pune Agriculture College has contributed to the knowledge of a few grasses. Karnik (1961) and Mahabale & Karnik (1960) have published the Flora and vegetation of Satpura mountains (Dhule & Jalgaon district) besides the study of the flora of Ulhasnagar in Thane district (Dabhade, 1966), Mahabale (1987) has published the 'Botany and Flora of Maharashtra'. Pune University has also contributed some stray papers.

Naik from Marathwada University, Aurangabad has published a book on the 'Flora of Osmanabad district' (1980) and 'Flora of Marathwada' (1998) comprising 1718 taxa. He has described some new species of Fabaceae and Poaceae and some records as well. Mirashi and his team from Nagpur University have published many papers on Asteraceae, Cyperaceae (Dande, 1966), Tubiflorae and new records for Nagpur district as precursors to the Flora of Nagpur. Finally, Ugemuge (1986) has published a book on the 'Flora of Nagpur district' with 1163 species. B.D. & M.D. Deshpande (1963) have published the Flora of Chandmari hills in Wardha district. Mahajan and his co-workers from Shivaji University, Kolhapur have published some stray papers on the Flora of Kolhapur. Patel (1968) has worked out the 'Flora of Melghat'. Dhore & Joshi (1988) have published the 'Flora of Melghat Tiger Reserve' comprising 648 species. A contribution to the flora of Sholapur district has also been published. Bharucha and Shankarnarayan (1958) and Satyanarayan (1958, 1959, 1961) have studied the ecology of grasslands, coastline strand vegetation and evergreen forests of Maharashtra.

Soon after the re-organisation of the Botanical Survey of India, Western Circle, Pune, the explorations in Maharashtra were of general nature leading to a proper and rational planning of future exploration programmes to under explored and un-explored regions. In the early years (1956-1960), several papers were published on the ecology and vegetation of Pune district (Puri & Jain, 1959-1960; Puri & Patil, 1960), Konkan (Jain, 1959), Khandesh (Jain & Deshpande, 1964),

Mahabaleshwar (Puri & Mahajan, 1960), Mangrove vegetation of Western India (Patil, 1957; Puri & Jain, 1957) and few more miscellaneous publications. This preliminary survey led to the identification and future exploration of floristically and taxonomically rich areas besides the developmental project sites whose flora was threatened with a drastic and sudden change, in Sahyadri ranges, particularly so in Pune district. Janardhanan (1966) dealt with 838 species from Bhimashankar and surroundings. Reddi (1969, 1970) enumerated 850 species from Sakarpathar & Ambavane areas while Hemadri (1970) detailed 986 species from Junnar and surroundings, describing over a dozen new species besides several new and interesting records. Ansari (1960- onwards) undertook many short field trips to Sinhagad, Purandhar and other adjoining areas and again described quite many new species belonging to *Ceropegia* in particular. All these works of Pune district added to Santapau's Flora of Khandala and that of Purandhar total up to c 60% of the Flora of the complete Maharashtra State. Short field trips to Mahabaleshwar and Panchgani resulted in one new genus viz., *Seshagiria* and many new species while several described earlier by Hallberg, Blatter & McCann could not be recollected.

Subramanyam & Rao (1961) have made representative collections from Pravarasangam in Ahmednagar district whereas Harischandragarh was similarly explored by Billore & Hemadri (1969). Singh et al. (1972) published an account of the Flora of Kolhapur district based on earlier collections. Billore (1972) has dealt with 1096 species from Thane district describing over half a dozen new species besides many interesting records. Cherian & Pataskar (1969a, b) have published on Surgana-Harsul ranges; Saptashringi and adjoining hills in Nasik district. Karthikeyan et al. (1981) has published 'An Annotated Bibliography of Taxonomic Botany of Peninsular India 1959-1978'. Karthikeyan et al. (1982) has listed the aquatic angiosperms of Maharashtra. Karthikeyan & Sharma (1983) have discussed about species whose occurrence Cooke expressed doubt and have been subsequently collected.

Recently many district floras have been worked out by research workers of Pune in Botanical Survey of India, who have explored intensively and extensively. The following district floras have been published or is in press. 'Akola district' with 651 taxa (Kamble & Pradhan, 1988), 'Sindhudurg district' (Kulkarni, 1988) with 1123 taxa, 'Nasik district' (Lakshminarasimhan & Sharma, 1991) with 952 taxa, 'Mahabaleshwar & adjoining' (S.D. Deshpande et al. 1993 & 1995) with 1446 taxa, 'Raigad district' (Kothari & Moorthy, 1993) with 1248 taxa, 'Yavatmal district' (Karthikeyan & Anand Kumar, 1993) with 579 taxa, 'Ahmednagar district' (Pradhan & Singh ined.) with 1042 taxa,

'Buldhana district' (Diwakar & Sharma ined.) with 584 taxa, 'Kolhapur district' (Sharma et al. ined.) with 1255 taxa, 'Chandrapur district' (Malhotra & Moorthy ined.) with 1184 taxa and 'Bhandara district' (Malhotra & Rao ined.) with c 600 taxa. Besides Amravati district with special reference to Project Tiger area, Melghat with c 600 species has been explored by Ansari. Explorations in Dhule district (by Pataskar) has yielded 630 species and Jalgaon district (by Rao) has yielded 500 species. In addition some wild life sanctuaries and National Parks have been explored. Nagzira (174 species) and Nawegaon (301 species) in Bhandara district have been published by Malhotra & Rao, 1980, 1981), 'Taroba National Park' (Chandrapur Dt.) comprising 667 species by Malhotra & Moorthy has been published in 1992. Work on Sanjay Gandhi National Park (Borivli) comprising 1064 taxa by Sharma & Pradhan and have been completed and submitted for publication. 'Grasses of Maharashtra State' comprising c 400 species has been published by Deshpande & Singh (1986). Bison Sanctuary at Dajipur has been included in Kolhapur district Flora. Recently 'Flora of Maharashtra State : Monocotyledones' by Lakshminarasimhan in Sharma et al. 1996 has been published which included 34 families, 956 genera, 904 species, 2 subspecies, 39 varieties, 1 subvariety and 1 forma of wild plants. 'Flora of Maharashtra State : Dicotyledones' is being brought out by BSI in 2 volumes. Karthikeyan et al. in Mudgal & Hajra (1997) have discussed about the Floristic Diversity and conservation strategies in Maharashtra. Karthikeyan in Hajra et al. (1996) has published an account of the Northern Western ghats (3000 species) and Northern West coast (1550 species).

PHYTOGEOGRAPHY

The flora of Maharashtra is heterogeneous in composition. The Deccan traps continue into Madhya Pradesh and Gujarat through Khandesh. The flora of regions such as Nag region formed by Nagpur, Bhandara, Chandrapur and Gadchiroli districts, the plateau of Vidarbha composed by Wardha, Amravati, Yavatmal, Akola and Buldhana districts and the ten districts of Maharashtra such as Raigad, Ratnagiri, Sindhudurg, Thane, Ahmednagar, Kolhapur, Nasik, Pune, Sangli and Satara with some part of Sahyadris, and the long narrow coastal strip of Konkan running through the districts of Bombay, Thane, Raigad, Ratnagiri and Sindhudurg differ because their physiography, climate and soil conditions are different.

The flora akin to Malabar region is met with in coastal Konkan. The plants from the Vindhyan and Indo-Gangetic plains meet those in Khandesh and in Narmada basin. There is similarity between the plants of Maharashtra, Madhya Pradesh and South Gujarat.

The rainfall and humidity progressively increase towards south and west. As a result Sahyadri regions in Karnataka have rich vegetation of moist deciduous species and some evergreen species which do not occur in Maharashtra.

There is a strange resemblance between the flora of Assam and flora of Maharashtra as illustrated by grasses. One of the reasons for this is, because of soils and due to migration of species along Garo hills, Vindhya, Satpuras down to Malabar through Sahyadris. This forms a route for migration of species from Malaya-Burma-Assam-Garo-Vindhyan-Satpuras-Konkan-Malabar (Mahabale, 1987). This is evidenced by the occurrence of species like *Lilium nilgirensis*, which grow in E. Himalayas as well as Nilgiris. The Satpura Hypothesis explains the migration of species across the continent of India from East to West and from there to South through Satpuras. The Junagadh hill, Girnar Parvat and Barda-dongar have species akin to those in dry parts of Deccan of Maharashtra. The flora of Saurashtra resemble the flora in deciduous forests of Deccan and that in drier parts of Konkan like Deogad.

The flora of Khandesh is comparable of South Gujarat and Madhya Pradesh.

FOREST DIVISIONS AND RANGES IN MAHARASHTRA

The Forest area in the Maharashtra State is 63,798 sq km. There are eleven Forest circles, forty three divisions and five subdivisions. The undermentioned table gives forest circles, divisions and the forest area for facilitating the research workers and other interested parties in locating the Ranges and Divisions properly (Chief Forest Statistician Bulletin, 1992).

Name of the circle	Divisions/ S. Div.	No. of ranges	Forest area
Kolhapur	Kolhapur division	27	4,466 sq km
	Savantwadi division		
	Satara division		
	Sangli subdivision		
	Chiplun subdivision		
Pune	Pune division	18	2,386 sq km
	Junnar division		
	Solapur division		
	Bhor subdivision		

Thane	Thane division Dahanu division Shahapur division Alibagh division Roha division Sanjay Gandhi National Park	48	5,632 sq km
Nashik	East Nashik division West Nashik division Ahmednagar division	21	5,280 sq km
Dhule	West Dhule division North Dhule division Mewasi division Jalgaon division Yaval division	28	6,431 sq km
Aurangabad	Aurangabad division Parbhani division Nanded division Beed sub division Osmanabad subdivison	22	2,820 sq km
Amravati	Akot division Dharani division Amravati division Paratwada division Tiger project circle Paratwada (308.24 sq km)	20	3,575 sq km
Yavatmal	Wani division Yavatmal division Pusad division Akola division Buldhana division	33	6,139 sq km
Nagpur	Nagpur division Wardha division Bhandara division Gondia division	31	8,293 sq km
North Chandrapur	Brahmapuri division Wadsa division Chandrapur division Gadchiroli division	17	7,676 sq km

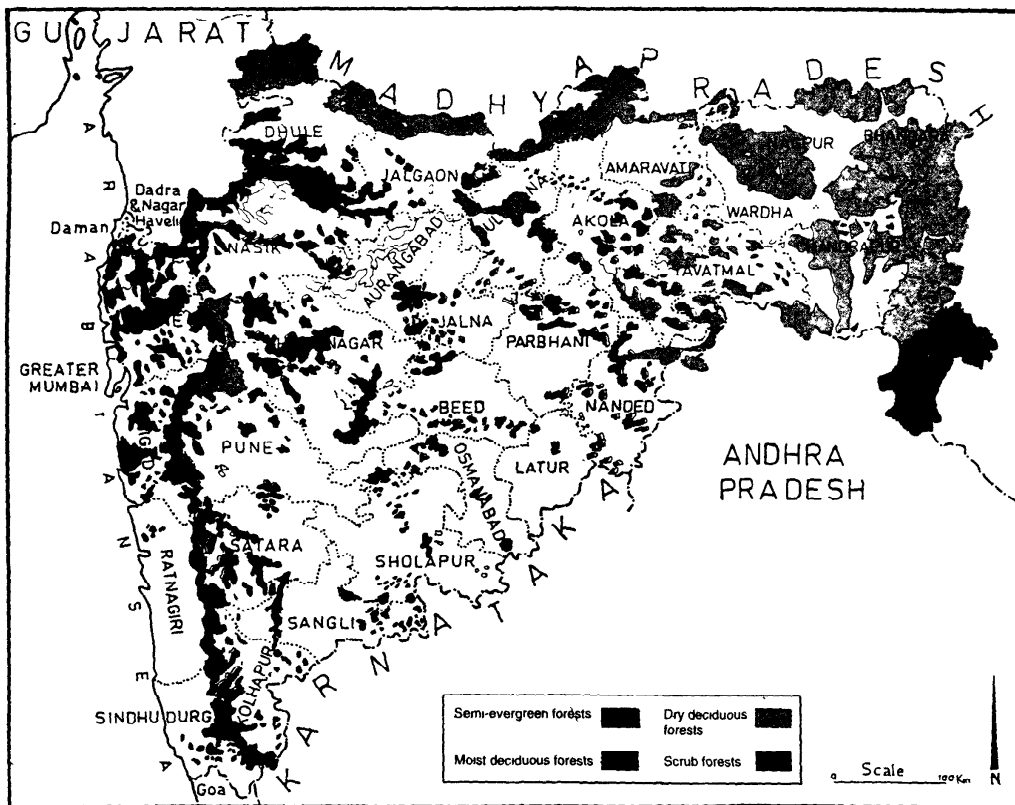
South Chandrapur Circle	Allapalli division Bhamragad division Sironcha division Central Chandrapur division	24	11,100 sq km
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The total geographical area of the state is 3,07,690 sq km, out of which, the forest area is 63,798 sq km which comes to 20.73%.

VEGETATION

The forest area recorded for Maharashtra state is 63,842 sq km which is c 20.75% of its geographical area (The Hindu, Survey of the Environment, 1998). The total forest cover is 46, 143 sq km which is 15% of area, out of which 23622 sq km is dense forest, 22,397 sq km is open forest and 124 sq km is mangrove forests. The vegetation of Maharashtra can be classified into the following zones (MAP III) : **Konkan strip adjacent to Arabian Sea, Sahyadris or N.W. Ghats; Desh forming a flat plain to east, with side off-shoots of ranges of Sahyadris, Khandesh at the north with low hills of Satpura and Vidarbha (Mahabale, 1987).** The vegetation of these zones differ due to factors like rainfall, temperature, humidity, type of soils and topography. The pattern of vegetation in these places is influenced by the vegetation of adjoining regions also, the plants from the Indo-Ganga plains reach as far as Khandesh, the Tapti and Narmada basins, and those from Gujarat enter at the North; those from Malabar at the South reach south Konkan. The forests of Andhra Pradesh and Madhya Pradesh adjoin the forests of Chandrapur and Gadchiroli districts and vegetation of Khandesh gets mixed with that of south Gujarat and Madhya Pradesh.

The vegetation of low lying valleys of Sahyadris differ from that of higher altitudes because of climatic and edaphic factors. The flora of Maharashtra is considered to have formed part of 'Dandakaranya' of ancient times. Major regions of Maharashtra belong to the 'Deccan' as proposed by Hooker & Thomson (1855). The Deccan Peninsula of which Maharashtra is a large part - is relatively a dry elevated table land and it is a part of the most ancient Indian continental land mass the Deccan peninsula. They have considered Konkan as part of Malabar.



Map III : Maharashtra State-Vegetation Types

The State of Maharashtra constitutes 34 districts which can be classified as follows (MAP IV):

1. Konkan Bombay, Raigad*, Ratnagiri*, Sindhudurg* and Thane*.
2. Desh or Deccan Ahmednagar*, Kolhapur*, Nasik*, Pune*, Sangli*, Satara* and Solapur.
3. Khandesh Dhule*, Jalgaon and Nandurbar.
4. Marathwada Aurangabad, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani.
5. Vidarbha Akola, Amravati, Bhandara, Buldhana, Chandrapur, Gadchiroli, Gondia, Nagpur, Wardha, Washim and Yavatmal.

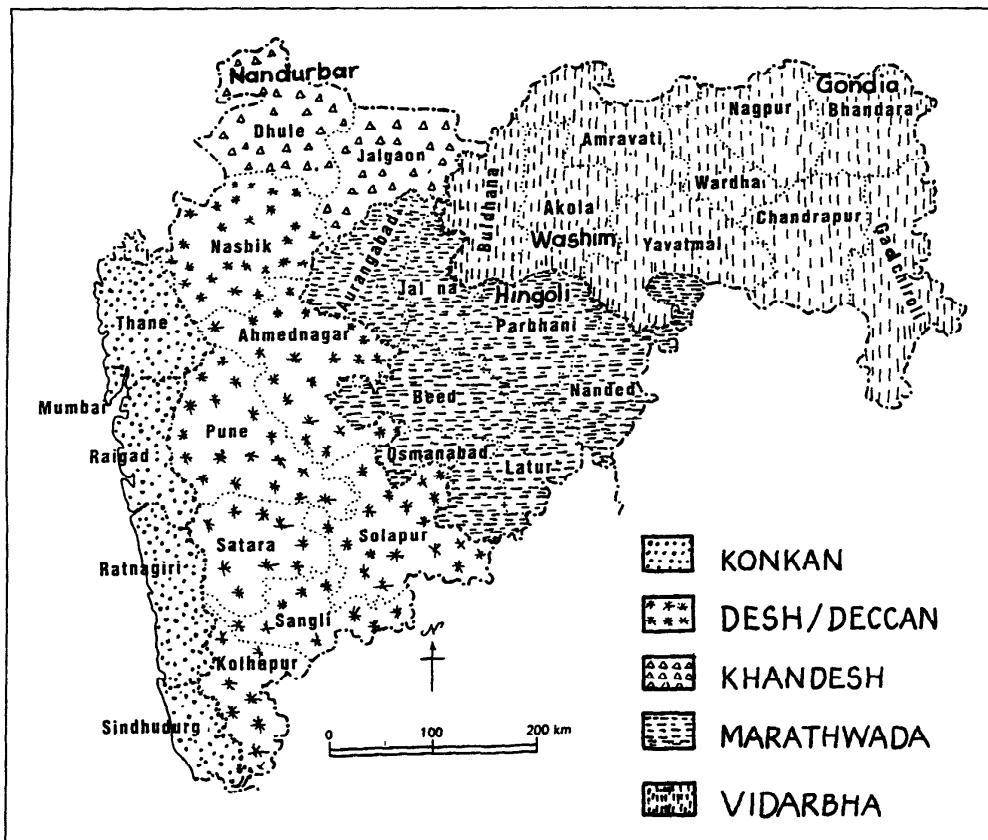
The greater part of Deccan table land is above 610 m above m.s.l.

* **Sahyadris** run through these districts starting from Dhule down to Sindhudurg.

FLORA OF KONKAN AND SAHYADRIS

Konkan is a narrow strip, 27 to 48 km broad and about 800 km long which starts from Tapti basin down to Goa. It is a botanical subunit of Malabar province of Hooker & Thomson. It is a maritime province, with high humidity throughout the year which is 60-70% at any time of the year. Throughout the year the vegetation is green, though the hills are barren. The average height of Konkan plains is 6-9 m above m.s.l. The higher peaks of adjoining Sahyadris - which rise to nearly 1220 m in Mahabaleshwar and Harischandragad serve as a wall to obstruct the clouds coming with S.W. monsoons and interrupt them in 'ghats' or passes from west to east. The rainfall at the foot of Sahyadris on the Konkan side on an average is c 2540 mm but it is less in the coastal region. The coastal strip of 15 to 17 km is a marshy saline bed due to the incoming of the Arabian sea. Only salt tolerant plants grow here. Konkan plains are full of cultivable lands where rice, ragi and other crops and vegetables are cultivated. Wherever rich alluvial deposits are found, coconut, areca-nut, mango, nut-meg, cashew, etc. are grown.

On the western side of Sahyadris, marshy conditions prevail only during monsoons. As soon as the rains are over, the soil becomes nearly dry because it is lateritic and the water flows away towards the sea.



Map IV : Maharashtra State—Major Regions

But on the eastern side, i.e. towards the Deccan side of the Sahyadris, the slope is gentle and ravines are deep. Small and large rivers bring rich detritus material from the traps to the valleys. Through the valleys the rain water flows enriching the river banks and valleys. Consequently, the lateral spurs of Sahyadris having high humidity and good drainage have developed 'Shola' like vegetation. These are known as 'Mavals'. The flora of Konkan has been studied by Hooker, Dalzell, Nairne, Cooke, Blatter, McCann, Santapau, Kulkarni, S. M. Almeida, etc.

The Flora of North Bombay is richer than that of S. Bombay. The flora of Sindhudurg has more humid species as in Goa, North Kanara and Malabar (Kulkarni, 1988). Dalgado (1896) has described the Flora of Savantwadi. The flora of Raigad (Kothari & Moorthy, 1993), Ratnagiri (S.M. Almeida, 1983-86 ined.), Thane (Billore, 1972 ined.) and Savantwadi (S.M. Almeida, 1990) have been thoroughly explored. The major rivers of Konkan region are Ulhas, Vashishthi, Kundalika, Shastri, Urali, Gad, Ter, etc. As they deposit rich alluvium on the banks and depressions, coconut, betelnut and mangoes grow well here. All along the coast line, there are tidal swamps and mud flats mostly covered by mangroves. *Avicennia marina*, *A. officinalis* and *Rhizophora mucronata* are the common mangrove species. The associate species are *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera cylindrica*, *B. gymnorrhiza*, *B. parviflora*, *Cerbera manghas*, *Ceriops tagal*, *Excoecaria agallocha*, *Kandelia candel*, *Lumnitzera racemosa*, *Rhizophora apiculata*, *Sonneratia apetala*, *S. caseolaris*, etc. Behind them sand binders and strand vegetation occurs. Wherever the soils are sandy and the coast is not muddy *Aeluropus lagopoides*, *Cressa cretica*, *Cyperus bulbosus*, *Pandanus tectorius*, *Pedaliium murex*, *Spinifex littoralis*, *Tribulus terrestris*, etc. occur.

There are semi-evergreen forest pockets interspersed with *Tectona grandis*. There are a few pockets of evergreen forests in Sindhudurg but they are not continuous.

The strand vegetation present behind the tidal swamps is in patches. Trees and shrubs such as *Caesalpinia bonduc*, *Calophyllum inophyllum*, *Clerodendrum inerme*, *Colubrina asiatica*, *Pandanus tectorius*, *Pongamia pinnata*, *Prema corymbosa*, *Thespesia populnea*, *Vitex trifolia*, etc. are common. The commonly found climbers in these patches are *Canavalia virosa*, *Derris trifoliata*, *Ipomoea pes-caprae*, etc. The herbs prevalent here are *Crotalaria verrucosa*, *Cyperus squarrosus*, *Launaea procumbens*, *Neanotis rheedii*, *Perotis indica*, *Tricholepis glaberrima*, *Vernonia cinerea*, *Zoysia matrella*, etc. Groves of *Cocos nucifera* fringe behind the coast line. The branched palm