FLORA
OF INDIA
SERIES 3

FLORA OF BILASPUR DISTRICT M.P.

VOLUME I
(RANUNCULACEAE TO CONVOLVULACEAE)

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BOTANICAL SURVEY OF INDIA

FLORA OF BILASPUR

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FOREWORD

The Botanical Survey of India has taken up publication of the new flora of India under four series : Series 1 on the national flora comprising taxonomic revisions of families, tribes and large genera for the whole country; Series 2 on the floristic inventories of different states or large regions; Series 3 on the district floras and Series 4 to include special publications and monographs on Indian flora.

Madhya Pradesh, the largest state in the country with its dense forests forms a meeting ground of floristic elements characteristic to north-eastern, western and south-western India. The state has not been fully explored for its plant wealth and no flora for the state as such has been written. With the opening of the Central Circle of the Botanical Survey of India at Allahabad in July, 1962, several botanical explorations in floristically diverse areas and hill ranges in the state have been undertaken with a view to prepare a much needed state Flora of Madhya Pradesh. It is in this context areas and districts like Pachmarhi, Raipur, Durg and Rajnandgaon were botanically explored and their floras published by the Botanical Survey of India.

The present work on the flora of Bilaspur district is the outcome of extensive and intensive botanical explorations in the district and a critical evaluation of the flora carried out by Dr. G. Panigrahi and Dr. S. Krishna Murti of the Botanical Survey of India.

In the introduction, the authors have given interesting details on the physical and climatic features, different types of vegetation and their floristic composition, economic plants and phytogeographical considerations of the district. The families Ranunculaceae to Convolvulaceae have been dealt in this volume.

The flora provides a comprehensive coverage of the floristics of the Bilaspur district. I trust this work will be of immense help to students and teachers of botany, foresters, environmentalists, conservationists and persons concerned with raw plant materials for industry alike and will also richly contribute for writing up of the Flora of Madhya Pradesh.

1st March, 1989.
Botanical Survey of India
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M. P. NAYAR
Director

PREFACE

Flora of Bilaspur district, Madhya Pradesh, India—its publication is indeed a 'Dream comes true' It was conceived way back in 1970, when both the authors were posted at the Central Circle, Botanical Survey of India, Allahabad. It was submitted as a Thesis to the Calcutta University in June 1985, and the Ph.D. Degree was awarded to the Jr. author (S. K. Murti) by the University in July 1988. And, the release of Volume I, with a Foreword by Dr. M. P. Nayar, the present Director, in early 1989, is indeed the much-awaited and most important milestone in our endeavour to make available to the readers, at large, a District Flora, should one say, in a semi-revisionary format.

The Flora of Bilaspur District is a thoroughly revised version of the original Thesis, re-set, edited and proof-read, solely by the senior author. It is designed to provide much more information than a District Flora usually does : (i) references to protologue literature and citation of type genus/type species, respectively, for 125 families and some 500 genera of Indian angiosperms, would aid those investigators in fundamental taxonomic research, who do not have easy access to Farr *et al.* (1979), *Index Nominum Genericorum (Plantarum)*, to Stafleu and Cowan (1976-1987), *Taxonomic Literature*—2 and to the *International Code of Botanical Nomenclature* (Berlin Code), 1988; (ii) a mine of information on the economic/medicinal uses of plants, both as a separate section and appended as notes against many species dealt with and citation of Sanskrit/Local names for most species would act as : (a) an aid for development of plant-based rural and cottage industries, (b) a guide to the practitioners of Ayurvedic/Unani medicines, and (c) a Handbook for environmentalists to focus attention on conservation of indigenous germplasm of economic plants and of rare/threatened/endangered taxa in all-India context.

Nomenclature of several taxa has been up-dated, with critical comments, as and when called for, citing references to publications, upto 1988.

The authors are indeed grateful to Dr. V. S. Agarwal, former Editor of publications, to Sri S. K. Pal, Publication Assistant and to the authorities of the Pooran Press, Calcutta who have shown exemplary patience and extended cooperaton for incorporating much additional new information from time to time. Despite such efforts, if any serious lacunae are noticed, the responsibility is entirely of the senior author.

We hope, Botanical Survey of India will follow up the release of Volume I, with publication of Volume 2, comprising the remaining families, from the Solanaceae to the Poaceae, *Literature cited* and an *Index to botanical names*, both for Volume I and Volume 2 and a *synopsis* of Cronquist's (1981) system of classification, following which the families recognished in the 'Flora' have been, by and large, delineated.

Calcutta
16th March, 1989

G. Panigrahi
Sri Krishna Murti

INTRODUCTION

For a proper utilization of the vegetable raw materials in a developing country like India, the need for surveying the plant-resources—indigenous, naturalized and introduced, for developing rural, as well as urban economy, is often emphasized; and for this, factual data, involving the vegetation, flora and economic plants of the area, are essential for planning development programmes. Such assessment of the floristic components and the resulting inventory of the vegetable raw materials of potentially economic value would not only help plant-based industries of a developing country, but also would stimulate rural people to utilize the minor forest produce available locally or in the neighbourhood for cottage industries. For drawing up rational social foresty schemes, such assessments of floristic wealth of a region is essential.

It should be realized that a 'Flora' will be able to offer critical knowledge of numerous forest products, plants containing vegetable oils, fats and resins, timber, gums, fruits, insecticides, fibres, dyes and medicines, or species which may serve for afforestation, for ornamental use, as new green manures, fodder plants, or possibly, of species withstanding drought or being resistant to fire or inundation, suitable for combating erosion and other economic aspects (van Steenis, Fl. Males. Ser. I. 4 : x. 1948).

Further, there is a severe threat to natural vegetation owing to increasing urbanization. Listing of the endangered, threatened and extinct species of a flora and drawing attention to the occurrence of such species in different forest-types of India would aid in creating an awareness amongst the people as a whole to protect such species from extinction and to take necessary measures for conservation of our seriously disturbed ecosystem and the environment. 'Flora' is an inventory for such purposes and hence a necessity.

Madhya Pradesh, the largest state of the Indian Union is in the centre of India. The state was formed in 1948, from the former Central Provinces and Berar. Subsequently, in 1956, Berar was transferred to Maharashtra, and Madhya Bharat (the former Central Indian Agency or Central India and at one time, a part of Rajputana) and Vindhya Pradesh (formerly a part of Central India, known as Bundelkhand) were merged with Madhya Pradesh to form the present state. Jashpur, Surguja and Bastar, belonging to the Eastern State Agency, were also merged into Madhya Pradesh.

Madhya Pradesh forms a compact and distinct phytogeographical unit and is floristically one of the most interesting sectors of the country. Phytogeographically, the area comes under the Deccan sub-region of India (Chatterjee, 1940). From a botanical point of view this region is of high interest, as it forms the meeting ground of some forms of flora, which appear to be characteristic of north-eastern, western and south-western India. And yet, no 'Flora' exists for the state. The systematic study of the flora of Madhya Pradesh has been very much neglected. Hawetson (1951) has done well to draw attention of botanists to this lacuna. Sengupta (1979) has summarized the efforts at botanisation of Madhya Pradesh over the last one hundred years or more. This lacuna becomes more apparent in view of regional Floras of neighbouring states *viz.*, Prain's (1903) 'Bengal Plants', Haines' (1921-25) 'Botany of Bihar and Orissa', Mooney's (1950) 'Supplement to the Botany of Bihar and Orissa', Gamble & Fischer's (1915-36) 'Flora of Madras Presidency' and Duthie's (1903-23) 'Flora of Upper Gangetic Plain and of the adjacent Siwalik and sub-himalayan tracts'. All these were inspired by the monumental work—'Flora of British India' (Hooker *et al.*, 1872-97).

Although Duthie's (1903-23) 'Flora of Upper Gangetic Plain and of the adjacent Siwalik and sub-himalayan tracts' and Haines' (1921-25) 'Botany of Bihar and Orissa' and Mooney's (1950) 'Supplement to the Botany of Bihar and Orissa' could be utilized as probable indicators of the floristic elements of Bilaspur district, there is hardly any publication on the flora of eastern Madhya Pradesh, of which Bilaspur district forms an integral part. It is noticed that with the exception of Watt, who made sporadic collections of economic plants in 1894 and of Haines, who surveyed from time to time the Vindhyan range, Kaimur hills and plains (also touching a part of Bilaspur district), no other botanist appears to have made any collection of flora of Bilaspur before the reorganization of the Botanical Survey of India in 1954.

In consideration of these facts and circumstances, a comprehensive survey of the Bilaspur district (about 45% of whose total area is under forest and about 60% of these forest-areas represent high rugged hills and valleys, supporting rich tropical and sub-tropical flora) for preparation of a 'Flora', was undertaken. The botanical interest in the flora of Bilaspur district was heightened further from the three following major considerations *viz.*, the district

(i) forms almost north-eastern limit of the Deccan sub-region conceived as one of the eight phyto-geographical units proposed by Chatterjee (1940, 1962);

(ii) falls within the range of the 'Indian Region', one of the 37 floristic divisions recognised by Good (1947) for the world;

(iii) is an integral part of an endemic centre located at the junction of Bihar, Orissa and Madhya Pradesh (Clayton and Panigrahi, 1975).

This 'Flora' should, therefore, be a step towards better understanding of the flora of the state in general.

MATERIALS

More than 17,000 plant-specimens belonging to about 2500 field numbers and collected in different seasons in 12 collection trips involving about 200 collection-days between the years 1962 and 1973, form the basis of the present work. The herbarium materials have been deposited in the herbaria of Botanical Survey of India at Allahabad (BSA) and Howrah (CAL). The details of field numbers and months of collection with names of collectors are given in the following table :

TABLE I : Collection trips undertaken in Bilaspur District

Sl. No.	Field Numbers From	To	Month of Collection	Name of Collector
1	2		3	4
1.	3701	3965	April—May	C. M. Arora
2.	3966	4000	December	G. Panigrahi
3.	7101	7384	December—January	G. Panigrahi
4.	8501	9000	April	S. K. Murti
5.	12701	13100	October—November	S. K. Murti
6.	13201	13214	November	S. K. Murti
7.	13215	13400	February	S. K. Murti
8.	15201	15500	February	S. K. Murti
9.	16701	16760	February	S. K. Murti
10.	16761	16860	February	S. K. Murti
11.	19001	19400	July	S. K. Murti
12.	19401	19600	August	S. K. Murti

STYLE OF PRESENTATION OF THE FLORA

The Flora of Bilaspur district is presented in two volumes. Volume I is divided into two parts. Part one deals with the general considerations of the Flora, which include introduction, materials, abbreviations and general account dealing with area, topography, geology and soil, climate,

vegetation, biotic influences over vegetation and faunal composition. A few photographs, depicting different vegetation-types of the district, are included.

This is followed by general discussion, comments of nomenclatural interest, a statistical analysis of the flora and treatment of the rare and endangered elements, aliens, wild plants of ornamental importance and plants of economic value, including medicinal plants and their uses, etc.

The second part deals with the systematic account of families of angiosperms. Two lists of families are given in the Appendix—one indicates the families as delimited by Cronquist (1968) and adopted in the present work and the other shows the sequence of families followed in the systematic part. The families are arranged according to the sequence outlined in the system of Bentham and Hooker (1862-1883), with some modifications based on the recent knowledge as in Cronquist (1968). According to his terminology the Dicotyledons are called Magnoliatae and the Monocotyledons, the Liliatae; the family delimitations are altered in several cases, *e.g.* the Nymphaeaceae segregated from the Nelumbonaceae, the Amaryllidaceae merged in the Liliaceae, the Smilacaceae and the Agavaceae segregated from the Liliaceae, etc. A key to the four groups of families recognised and keys to the families in each of these respective groups precede the systematic part.

In the systematic part the genera and species are alphabetically arranged within the family/genus as the case may be, keys to the genera and species are given. Full author citations for families, genera and species are provided. For correct names of genera adopted, reference to the validating original literature is given and the type/lectotype species of the genus are cited on the authority of the Index Nominum Genericorum Plantarum (Farr *et al.*, 1979).

Description of only the species with data on flowering and fruiting time is given. Nomenclature has been brought up-to-date in accordance with I. C. B. N. (1983), as far as practicable. In several cases reference to types/lectotypes/syntypes or type localities, as available, are cited after the description of the taxon. The field numbers of the collector (s) are provided after the locality. For the names of collector(s), Table 1 may be referred to. Interesting notes on nomenclature, habit, habitat, economic aspects or any other point of interest, are given. Illustrations showing the habit and diagnostic characters of some selected species are provided.

Volume II deals with the systematics of the remaining families and ends with a comprehensive bibliography.

The systematic accounts of the 120 families are suitably split up in the two volumes.

ABBREVIATIONS

For economy of space, the following abbreviations have been used in reference citations of species, descriptions of taxa and at other places. These are explained below :

Art.	= Articles of I.C.B.N. 1983
BSA	= Herbarium of Botanical Survey of India at Allahabad, U. P., India
Bor, Grasses	= The Grasses of Burma, Ceylon, India and Pakistan (excluding Bambuseae) by N. L. Bor (1960)
CAL	= Herbarium of Botanical Survey of India at Howrah, W. B., India (Central National Herbarium—CNH)
cm	= *Centimetrum* : centimetre
comb. nov.	= *Combinatio nova* : new combination of name and epithet
etc.	= *et cetera* : and other
et al.	= *et alia* : and others
excl.	= *exclusus* : excluded
F.B.I.	= Flora of British India by J. D. Hooker *et al.* (1872-97)
Fl.	= Flowering time
Fl. Hassan	= Flora of Hassan district, Karnataka, India by C. J. Saldanha and D. H. Nicolson (ed.) (1976)
Frt.	= Fruiting time
Haines, Botany	= Botany of Bihar and Orissa by H. H. Haines (1921-25 ; BSI repr. ed. 1961)
Hara *et al.* Enum.	= Enumeration of flowering plants of Nepal by H. Hara *et al.* Vols. 1-3 (1978, 1979, 1982)
ibid.	= *ibidem* : the same, in the same place
I.C.B.N.	= International Code of Botanical Nomenclature
incl.	= *inclusus* : included
I.U.C.N.	= International Union for Conservation of Nature and Natural Resources

LT.	= *Lectotypus* : Lectotype
l.c.	= *loco citato* : at the place cited
m	= *meter* : metre
nom.	= *nomen* : name
nom. alt.	= *nomen alternativum* : alternative name
nom. confus.	= *nomen confusum* : confused name
nom. cons.	= *nomen conservandum* : conserved name vide International Code of Botanical Nomenclature, App. III. 1983
nom. cons. prop.	= *nomen conservandum propositum* : name proposed for conservation
nom. illeg.	= *nomen illegitimum* : illegitimate name
nom. nov.	= *nomen novum* : new name
nom. nud.	= *nomen nudum* : name unaccompanied by a description or reference to a published description
op. cit.	= *opere citato* : in the work cited
p.p.	= *pro parte* : partly
pro syn.	= *pro synonymia* : as far as synonym(s) is concerned
q.e.	= *quod est* : which is
quoad descrip. et spec.	= *quod descriptio et specimen* : as far as the description and specimen(s) are concerned
quoad spec.	= *quod specimen* : as far as specimens are concerned
quoad syn.	= *quod synonymon* : as far as synonym(s) is concerned
sens. lat.	= *sensu lato* : in a wide sense
sens. strict.	= *sensu stricto* : in a narrow sense
s.n.	= *sine numero* : without the collector's number, unnumbered
sphalm.	= *sphalmate* : by mistake
stat. nov.	= *status novus* : new rank
ssp.	= *subspecies* : subspecies
Typ.	= *typus* : type
typ. cons.	= *typo conservandum* : type conserved
typ. excl.	= *typo excluso* : type excluded
var.	= *varietas* : variety

GENERAL ACCOUNT

AREA

Bilaspur district (Map) belongs to the Mahakosal region (Chhattisgarh basin) of Madhya Pradesh, which also includes the districts of Raigarh, Raipur and Durg. The district lies between 21°37′ & 23°78′N and 81°12′ & 83°40′E and the area of the district is roughly 19,755 sq. km. The greatest length from Pandaria on the west, through Bilaspur town to Padampur on the east, is about 322 km and the greatest width from north to south is about 128 km. The district is bounded on the east by Raigarh district, on the west by the districts of Mandla and Shahdol, on the north by the Ambikapur district and on the south by the districts of Durg, Raipur and southern part of Raigarh district.

Bilaspur district is divided into two forest divisions *viz*., North Bilaspur Forest Division and Bilaspur Forest Division for administrative purposes. The former lies in the north and for the most part is hilly, while the latter lies in south and consists mainly of plain or undulating ground with a few scattered hills.

TOPOGRAPHY

(i) General:

The district is bounded by ranges of hills in the north, west and east, while the southern part is generally open and is delimited for the greater part of its length by the course of Mahanadi and Shaonath rivers. The Maikal range represents the eastern extension of the Satpuras and runs from south-west to north-east along the north-western border. Starting off from Saletekri hills of the Balaghat district, it culminates in the peak of Amarkantak in the Shahdol district. The range slopes gradually in the north and north-west to form the fertile narrow valley of the Narbada but the slope is rather abrupt on the southern side. The eastern-most portion of the district, lying between Siang and Kudmura sector is generally flat. On the eastern border the Sakti hills lead almost down to the course of the Mahanadi river, completing almost semi-circular chain by which the wide plain country of the Bilaspur Forest Division is surrounded.

The northern hills run along the whole face of the plain, sometimes thrusting forth an arm, or throwing out an isolated peak and advancing boldly in the level country or receeding into deep hollows and bays. These are usually covered with luxuriant vegetation and are included

within the ambits of the North Bilaspur Forest Division. In this Forest Division, Pandra lies on a plateau (600 m) between the Maikal range and the eastern hill ranges. It presents varied aspects of hills and dales, consisting partly of dense forests and partly of open areas cleared by tribals* for settlements. Matin and Uprora comprise the most rugged country of the eastern hill ranges, covered with dense forests.

In Bilaspur Forest Division a cluster of forests, comprising the Baloda range and forming a part of the plains lies scattered in the centre and on the east of the district, where terrain is flat or undulating. There are also a few isolated hills in this sector *e.g.*, Sonthi hills on the Khondra plateau. Madanpur-Kanteli and Champa lie embedded in the open country and there are large reserve forests of Lormi and Pandaria. Kanda, Lapha, Chhuri and Korba, which, while consisting of some hilly tracts, also have, with exception of Lapha, fair stretches of open country. Korba is situated to the east of Hasdo river.

(ii) **Elevations :**

In the Bilaspur Forest Division the important peaks are Gargaj Pahar (900 m) and Dalha (800 m), both on the Sonthi hills in the Baloda range. The level of the plain country decreases from about 300 m in the west in Mungeli to 200 m at the south-eastern extremity of the district, Bilaspur city itself standing at an elevation of about 250 m. In Mungeli sector, the Kathar hills, about 9 km north-east of Lormi, is the highest point (710 m).

In the north Bilaspur Forest Division, in contrast, there are a large number of peaks varying between 900 and 1200m, *viz.*, Bijora hills (1100 m), Mahadeo hills (1050 m), Manguru hills (1000 m), all in Uprora sector; Karela (1090 m), Simbidi (1025 m), both in the Korba sector; Godhaora (940 m), Mukua (900 m), Matin (750 m), all in Matin sector; Palma (1150 m), Dhitori (1000 m) in Lapha sector and Lilawani (1200 m) and Barabahar (950 m) in Pendra sector. The elevation varies from 300 to 500 m on the slopes of the hills in Lormi and Kota ranges, rising to 950 m on the hills abutting on the main Maikal range in the vicinity of Lamni.

(iii) **Drainage system :**

The northern hills provide an important water-shed, in as much as the two great rivers, the Narbada and the Son take their rise in them and flow

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*The tribal or aboriginal population of the district consists of Baiga, Dhanwar, Gond, Kanwar, Korwa and Pando.

west and north, and have practically no influence on the drainage system of Bilaspur.

The most important tributary of the Mahanadi river is Hasdo river. It rises in the upland of Ambikapur district and after a wild and picturesque course through the rocky gorges of Matin and Uprora, traverses Chhuri and Korba and debouches itself into the plain and passes through Champa, before joining the Mahanadi, about 12 km east of Seorinarayan. Its best known tributaries are the Jatashankari or Ahiran, Tan, Gel and Chornai.

The important tributaries of the Sheonath river, from west to east are Hanp, Maniari, Agar, Arpa, Kharung and Lilagar, each of which is fed by a number of streams and rivulets and which criss-cross the south-western sector of the district.

The drainage system which does influence the vegetation and flora of the district as a whole is represented, thus, by these tributaries of the rivers, Mahanadi and Sheonath.

Two dams erected on the rivers Maniari at Khuria and Kharung at Khootaghat (marked '1' and '2' in the map), have created two water reservoirs with vast expanses of water inside the forest tracts.

GEOLOGY AND SOIL

(i) Geology :

The southern flat area is occupied by horizontal or gently dipping purple shales and limestones belonging to the Rajpur series, a member of the Cuddapah system. These rocks are mostly concealed by alluvial and lateritic deposits and constitute a portion of the extensive flat expanse known as the Chhattisgarh basin. This basin is said to have originated as a sedimentary plain by the filling up of a sea during the pre-Cambrian times. These flats-to-gently-dipping sedimentary beds cover, unconformably, the Archaean granites and gneisses. It is only along a narrow discontinuous belt bordering their outcrop that the Chandanpur sandstones *i.e.*, the basal members underlying the Raipur series, become visible, forming a raised rim round the Chhattisgarh basin. The Chandanpur sandstones are restricted to a narrow zone extending from about 16 km east of Bilaspur up to the easternmost boundary of the district. Elsewhere, the Raipur series rest directly upon older rocks without the intervention of basal sandstones.

The northern hilly part of the district includes a varied assemblage of rocks, some of which are older, the others newer than the Cuddapah rocks of the southern belt. The rocks older than the Cuddapah system include gneisses, granites and schists of Archaean age and slates belonging to the Dharwar system, locally known as the Chilpighat series. Granites are mainly composed of quartz and felspar. Gneisses are divided into granite gneiss, granite-ferous gneiss and fine-grained biotite gneiss. Schists are mainly of two types *i.e.* mica-schists and quartz-mica-schists. The rocks newer than the Cuddapah system belong to the Gondwana system and include several sub-divisions *viz.* the Talchirs and the Barakars (coal-measures), belonging to the Lower Gondwana of Permian age and the Kamthi rocks belonging to the Middle Gondwana of Triassic age Of all these rocks the older ones prevail in the north-western half, which is occupied almost entirely by crystalline formations of the Archaean gneisses, while the Gondwanas occupy the north-eastern portion.

While the basal beds of Talchirs include greenish sandstones and shales, through which are scattered large boulders regarded as of glacial origin, the Barakars include white or grey sandstones interbedded with shales and coal seams. There are two patches of these rocks along the Mand and Hasdo valleys, constituting the Mand and Korba coal fields, separated from one another by a lofty hill-mass constituted by the massive sandstone of the Middle Gondwana or Kamthi. Rocks of Barakar formations are exposed between Korba, Kendai, Madanpur and Pali, being most predominant around Korba. The rocks are also predominant round about Kartala in the south to Siang in the north running in a narrow strip along the eastern boundary of North Bilaspur Forest Division. Intrusive dykes and sills, some of which are of very large size, consisting of basalt and dolerite of the age of the Deccan Trap (Upper Cretaceous), often intersect the Gondwana rocks.

Palma Pahar and hills a round Lapha are composed of the trap occurring on the hill tops and are flanked successively by the Lametas, Barakars and Talchirs along foot of the hills. Laterite occurs capping the trap hills. The laterite occurring on top of ridge and plateau are primary in origin and belong to lower Vindhyan group. Secondary laterites also occur in the area, but they are confined to the valleys and slopes and they are devoid of bauxite concentration. The most common variety of bauxite is either grey or pink.

(ii) **Soil :**

The soils vary in composition and texture from place to place depending

upon the underlying rocks and topography. The soil is of good depth along the river banks, of fair depth on gentle slopes, but is generally shallow and gravelly on the higher and steeper slopes.

According to the broad classification of soil types in India (Roychowdhury, 1962) the soils met within the Bilaspur district are included in Classes 12-18, *viz.*, mixed red and black soil, red loam soil, red gravelly soil, red and yellow soil, all supporting mixed deciduous forests, in which 'sal' is the predominant crop and laterite soil, laterite and lateritic soil and brown soil, supporting stands of deciduous forests.

The parent rocks consist of limestone, shales and sandstones in the southern part and granites and gneisses in the northern part. The south-western part of the district is mainly a black soil tract, the soil being formed from disintegrated trap rocks. It is suggested that in the centre and east of the district the red soil has been formed from the Vindhyan sandstones or the Gondwana rocks. Soils derived from the Gondwana rocks are generally immature soils and may be described as pale thin, sandy and calcarious soil, low in humus with no marked salinity or alkalinity. The Barakar-soils are generally in flat areas with deep sandy loam soil and mostly bear some of the very good sal forests of Kudmura, Korba and Kendai ranges. Soils derived from schists and slates are clayey. Gneiss and granite soils are generally reddish to dark brown in colour due to the diffusion of iron and of varying depth. In acidic area they support excellent growth of 'sal', whereas in the basic tracts the crop changes to mixed forests. These rocks give rise to either clayey or sandy soil depending on location. Soils derived from shales are pinkish to brownish and support mixed forests, where *Cleistanthus collinus* (Karra) forms almost pure crops.

The deciduous forests, in Bilaspur Forest Division, generally make a poor contribution of humus to soil. In contrast, the soil in the North Bilaspur Forest Division, which harbours mainly moist deciduous or semi-evergreen forest, is rich in humus content.

CLIMATE

The type of vegetation met within an area depends on the climate, the soil and the biotic factors. And, the climate, in its turn, is governed by the temperature, the rainfall and the relative humidity. Champion and Seth (1968) define tropical climate as "very hot and winterless" and

subtropical climate as "hot with cool winter". The following tabular representation of their data on mean annual temperature, mean January temperature and winter is of significance :

Zone	Mean annual temperature	Mean January temperature	Winter
1. Tropical	Over 24°C	Over 18°C	None, no frost
2. Sub-tropical	17° to 24°C	10° to 18°C	Definite but not severe ; frost rare

From the data provided in Table 2 below, it may be seen that Bilaspur district, as a whole, enjoys tropical climate, on the basis of mean annual temperature, but in the winter season, it experiences subtropical climate.

TABLE 2 : Average seasonal variations

Season	Period	Rainfall in cm	Rainy days (nos.)	Average temp. °C	Max. temp. °C	Min. temp. °C	Relative humidity %
Summer	Mar.—June	5.72	5.3	29.4	42.5	16.9	29.5
Rainy	June—Oct.	119.38	60.0	27.2	39.5	17.8	74.1
Winter	Nov.—Feb.	6.98	4.8	19.3	29.5	9.8	55.2

The factors which affect directly the seasonal temperature, as above, are altitude of the place. It is stated that for every rise of 270m in altitude, temperature falls by 1°C (up to about 1500 m). The altitudinal range of the Bilaspur district, varying between 300 to 1200 m may then account for a depression of about 3 to 4°C, compared to places near the sea level, thus transforming the expected tropical climate of the area to a subtropical one, in the winter months. Puri (1954) found that the soil temperature at all depths under the 'sal' forests was higher in the cold weather months than under deciduous forests or in the open.

While the total rainfall for an area is an important factor in determining the nature of vegetation, its seasonal distribution exerts an equally far-reaching influence. The maximum rainfall for the district is recorded from the middle of June to middle of October, the wettest month being July and August. It is derived mainly from the south-west monsoon, while the winter showers during November-January owe their origin to the north-east monsoon, the latter more severe in the northern part of the district. The average annual rainfall recorded for the district is about 132 cm. Champion and Seth (1968) notice no marked variations

Plate 1 *Shorea robusta* Gaertn forest (almost a pure formation), with dense undergrowths.

Plate 2 Moist mixed forest with lianes and climbers, such as *Bauhinia vahlii*.

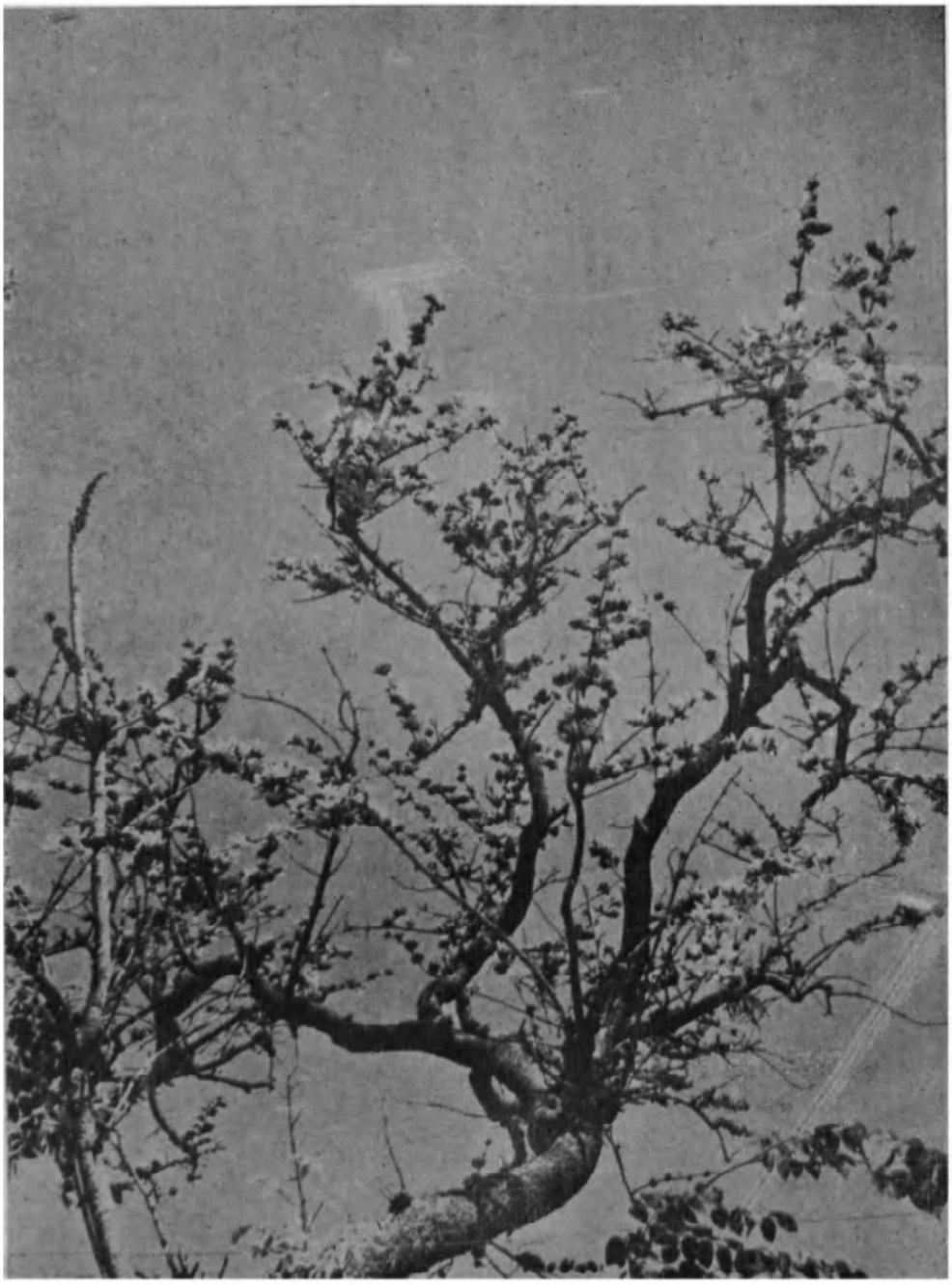

Plate : 3. *Butea monosperma* (Flame of the Forest) in bloom.

Plate : 4. Mixed Sal forest with *Shorea robusta, Anogeissus latifolia, etc.* and scanty undergrowth.

Plate 5 Dry mixed deciduous forest.

Plate 6. *Dendrocalamus strictus* (Bamboo) formation—an edaphic climax.

in rainfall due to the altitude. Yet, the mountain masses largely generate their own climate. Mountainous country with its steep gradients greatly emphasize the climatic effects of aspect, such as, differences in incident radiation, including light and moisture relations, particularly in the soil and exposure to wind, all in addition to the effects of altitude on temperature. Therefore, the climates on the hill-tops of the North Bilaspur Forest Division is generally moister than in the low-lying Bilaspur Forest Division.

While, thus, temperature and rainfall each plays vital role in determining the vegetation type, Champion and Seth (1968) admit that, when both the factors are seen together, it is not possible to analyse the complex factors responsible to explain the development of any given type of vegetation in an area.

Generally, frosts are common in the 'sal' area *e.g.*, Matinara nala and Maniari river areas in the Lamni and Lormi ranges. Amadob and Amanala valleys in Keonchi block also experience frequent frosts. The severity of frost is reduced by the occasional winter rains.

VEGETATION

General :

Champion and Seth (1968) discuss the climatic climax vis-a-vis the polyclimax theory. While the climatic climax theory of Clements (1916) holds that a single climatic climax develops in a given type of climate, the polyclimax theory considers that each pronounced variation in site conditions within a given type of climate will tend to have its own recognisable climax. They prefer to classify the forest types of India as various climatic climaxes depending on sites and soils of medium depth and fertility and define 'edaphic climaxes' as those types which appear to be the expression of markedly different conditions of soil.

Steenis (in the Mountain Flora of Java, Leiden : 17-18, 1972), in his adopted thermal ecological concept, classifies the plants occurring in the subtropical (as also, in the warm temperate) climatic conditions as Mesotherm plants and those restricted to tropical zones, as Megatherm plants. He equates the megatherm plants of the equatorial belt with the tropical montane forests (such as those found in Bilaspur at 1,200 m) and assigns the families Anacardiaceae, Burseraceae, Capparaceae, Combretaceae, Dilleniaceae, Dipterocarpaceae, Flacourtiaceae etc. as representing the Megatherm plant families characteristic of true tropical lowlands. He defines the climax vegetation as the original plant cover for each locality in agreement with the climate and soil. Climax vegetation may be inferred if the autecology of

each of the component species is adapted to perform its full life cycle in the climax and is capable to perpetuate as long as habitat factors remain constant. It follows that, of each individual species, plants of different ages will be present, from the germling to full-grown stages. He concludes from this that the germination of seeds of species in a climatic climax forest must be shade-tolerant, a most important point.

However, a broader correlation seems to exist between the forest types and the soil types supporting it. The red and the black soils/red and yellow soils derived from the disintegration of the underlying trap rocks and the Barakar soils in flat areas with deep sandy loam soil support mixed deciduous forests, in which 'SAL' is predominant; the laterite and the brown soils derived from the Vindhyan sandstones or the Gondwana rocks or schists and shales support stands of deciduous forests in which 'SAL' is somewhat tolerant and *Cleistanthus collinus* is predominant. While the 'acidic' soils support rich growth of 'sal', in the 'basic' soils, the crop changes to mixed forests, the underlying geological formations playing thus only an indirect role in determining the natural vegetational/ floristic cover.

As per classification of forest types by Champion and Seth (1968), the forests of the Bilaspur district can be classified as follows :

I. Moist Tropical Forest

Group 3—Tropical moist deciduous forest

Sub-group 3—North Indian moist deciduous forest

C_2—Moist 'sal'-bearing forest

e—Moist Peninsular 'sal' forest

C_3—Moist mixed deciduous forest (without 'sal')

II. Dry Tropical Forest

Group 5—Tropical dry deciduous forest

Sub-group 5B—Northern tropical dry deciduous forest

C_1—Dry 'sal'-bearing forest

c—Dry Peninsular 'sal' forest

C_2—Northern dry mixed deciduous forest

III. Montane Sub-tropical Forest

For general purposes the forests of Bilaspur district can be broadly classified into 'sal' forests (moist and dry) ; mixed deciduous forests (moist

and dry); bamboo forests representing edaphic climaxes and montane subtropical forests.

I. Group 3—Sub-group 3—C_2

e—*Moist Peninsular 'sal' forest:* (Plate 1)

The 'sal' (*Shorea robusta*) forests represent a stable climatic climax. 'Sal' is generally more aggressive than any of its associates in relation to the natural gregarious habit, coppicing power, resistance to burning, regeneration, adaptability to soil and site conditions and longivity. The 'sal' typically forms high forest, in which it constitutes 60 to 90% of the top canopy and attains 25-40 m in height. An important feature of 'sal' is its semi-evergreen habit throughout the year interspersed by a deciduous period of only 5-15 days at the beginning of the hot weather. The shade from the new foliage keeps the sal forests cool, in striking contrast to the fully deciduous forests. A dense shrubby undergrowth is usual, the shrubs being mostly semi-evergreen, but in some places almost pure sal forests with practically no undergrowth or very less undergrowth also occur.

The 'sal' grows best on well-drained flat plains, low hills, gentle slopes and valleys. Conditions required for the best growth appears to be well-drained deep loamy soils on the Kota, Lamni and Lormi ranges. Gondwana sandstones, Kamthi and Barakar series carry extensive areas of Sal as in Dhajag, Paturia, Lampahar of Kendai range, Semarkona. Sarsedewa, Thengrimar, Madanpur blocks of Kudmura range and Dondru, Kesla and Gorma blocks of Korba range. Ghatbahera, Bagru, Puta, Basti, Ramgarh, Umarkhoi, Sadhwan, Jilda, part of Kherdi, Jamdikhurd and Keonchi of Pendra range also have good sal forests. Sal usually degenerates in growth as it ascends hill slopes and ultimately gives place to mixed forests.

Sal grows best on acidic rock formation and its quality and quantity deteriorates as acidic condition retrogresses and is ultimately replaced by mixed crop on basic rock formation *e.g.*, Dhawalpur, Amlikunda, Senha-Lainga and parts of Matin and Ringania blocks. Sal occurs on cooler aspects, only where soil moisture content is higher. The northern slopes have sal forest, whereas mixed forests occur on southern slopes.

The chief associates of moist sal forests in the first storey are ***Terminalia alata, T. chebula, Anogeissus latifolius, Adina cordifolia, Mitragyna parvifolia, Stereospermum chelonoides, Lagerstroemia parviflora, Diospyros melanoxylon, Miliusa tomentosa, Pterocarpus marsupium, Schleichera oleosa, Albizia procera, Bridelia airyshawii, Gmelina arborea, Syzygium cumini*** and ***Madhuca longifolia*** var. ***latifolia.***

The second storey consists of *Ougeinia oojeinensis, Kydia calycina, Bauhinia malabarica, B. semla, Wendlandia exserta, Buchanania lanzan, Phyllanthus emblica, Semecarpus anacardium, Careya arborea, Grewia tiliaefolia, Mallotus philippensis* etc.

The third storey consists of *Flemingia macrophylla, F. nana, F. strobilifera, Phoenix humilis, Antidesma acidum, Indigofera cassioides, Helicteres isora, Colebrookea oppositifolia, Vernonia divergens, V. pyramidale, Embelia basaal* and *Grewia hirsuta.*

The herbaceous undergrowth consists of *Hybanthus enneaspermus, Drymaria cordata, Geranium mascatense, Biophytum reinwardtii, B. sensitivum, Leea alata, L. aspera, Desmodium dichotomum, D. gangeticum, Indigofera linifolia, Begonia picta. Rubia wallichiana, Blumea bifoliata, B. membranacea, Laggera alata, Mazus pumilus, Andrographis paniculata, Dipteracanthus prostratus, Aerva lanata, Euphorbia heterophylla, E. aracunculoides, E. thymifolia, Phyllanthus debilis, P. maderaspatensis, Chlorophytum arundinaceum, Commelina suffruticosa, Kyllinga tenuifolia, Alloteropsis cimicina, Brachiaria distachya, Eragrostis* spp., *Heteropogon contortus, Imperata cylindrica, Themeda quadrivalvis, Thysanolaena maxima, Vetiveria zizanoides* etc.

The important climbers include *Smilax zeylanica, Bauhinia vahlii, Millettia extensa, Ventilago denticulata, Celastrus paniculatus, Asparagus racemosus, Dioscorea bulbifera, D. hispida, D. oppositifolia* and *D. pentaphylla.*

The undergrowth (*see* Plate 1) is very dense in shady and cool localities. At places *Vernonia pyramidale* covers up the area completely, making it difficult for the 'sal' seedlings to come up. In the areas of Lormi and Lamni, *Colebrookea oppositifolia* grows densely, particularly along nala and river-banks. *Dendrocalamus strictus* creeps into these forests only at the fringes, where sal is overwhelmingly mixed with miscellaneous species. *Bambusa arundinacea* is restricted to special damp sites. Where 'sal' is almost pure, bamboo is scrupulously absent.

Group 3—Sub-group 3

C_3 *Moist mixed deciduous forest:* (Plate 2)

This is a fairly closed high forest, commonly 20-30 m or more in height, as the preceding Moist 'Sal' Forest, but the dominant species are mostly deciduous, though often only for brief periods. Although intimate mixture of species is the rule, a relatively smaller number of species form more or less pure associations in the top canopy. However, the evergreen

habit is more developed in the lower storey, giving the forest, as a whole, a more or less evergreen appearance over most of the year. A bamboo undergrowth is characteristic, although it may be locally absent on some sites. Climbers are abundant. The chief feature of the Moist Deciduous Forest is a leafless period in the dry season, which may or may not begin with the cold weather, but is met with typically during March-April, when the upper canopy is almost entirely leafless. Quite a number of species flower, while more or less leafless *e.g., Bombax ceiba, Cassia fistula, Sterculia urens, Erythrina suberosa, Lannea coromandelica,* or as the species start forming new foliage, *e.g., Dalbergia sissoo.*

This forest-type is found usually in patches in the midst of the 'sal' forest and over large areas in the relatively flatter plains *e.g.,* in Lormi, Kota and Baloda ranges of the Bilaspur Forest Division and Katghora, Pasan, Kudmura and Kendai ranges of the North Bilaspur Forest Division. The mixed deciduous forests are also met with on the upper slopes and dadar (flat hill-tops) and the southern aspects of hills.

Occasionally, moderately moist mixed deciduous forests, in which 'sal' is scarce or absent, is seen, but such forests appear to be only seral in status. Once the progression of this forest has reached a point at which 'sal' can obtain a footing, *Shorea robusta,* relatively quickly, establishes its dominance and characterises the climax formation. In more mesophytic habitats, however, such a progression may be arrested because of special site conditions and are considered as edaphic variations on the climax community.

The chief associates of these forests in the first storey are *Terminalia alata, T. bellirica, T. chebula, Anogeissus latifolius, Diospyros melanoxylon, Lagerstroemia parviflora, Madhuca longifolia* var. *latifolia, Pterocarpus marsupium, Bridelia airyshawii, Syzygium cumini, Dalbergia paniculata, Garuga pinnata, Adina cordifolia, Schleichera oleosa, Lannea coromandelica, Soymida febrifuga, Bombax ceiba, Chloroxylon swietenia, Semicarpus anacardium, Phyllanthus emblica, Aegle marmelos, Buchanania lanzan, Kydia calycina, Ougeinia oojeinensis. Butea monosperma,* (Plate 3), *Bauhinia malabarica, B. purpurea, B. variegata, B. semla, Hymenodictyon orixense, Sterculia urens* and *Dendrocalamus strictus.*

The second storey consists of *Mallotus philippensis, Xeromphis spinosa, X. uliginosa, Hollarrhena pubescens, Litsea glutinosa, L. monopetala, Nyctanthes arbor-tristis, Flacourtia indica, Cassia fistula, Ziziphus mauritiana, Carissa spinarum, Cleistanthus collinus, Casearia graveolens, Gardenia resinifera, G. turgida, G. gummifera, G. latifolia, Wendlandia exserta, Grewia tiliaefolia, G. hirsuta* etc.

The third storey consists of *Colebrookea oppositifolia, Helicteres isora, Eriolaena hookeriana, Pogostemon benghalense, Embelia basaal, Petalidium barlerioides, Woodfordia fruticosa, Phoenix humilis* etc.

The fourth storey consists of *Desmodium dichotomum, D. gangeticum, Indigofera linifolia, I. tinctoria, Cayratia trifolia, Begonia picta, Rubia wallichiana, Blumea bifoliata, B. fistulosa, Elephantopus scaber, Plumbago zeylanica, Bacopa monnieri, Mazus pumilus Blepharis maderaspatensis, Dicliptera verticillata, Dipteracanthus prostratus Boerhavia diffusa, Achyranthes aspera, Aerva lanata, Alternanthera sessilis, Celosia argentea, Acalypha ciliata, Euphorbia heterophylla, E. dracunculoides, E. thymifolia, E. hypericifolia, Phyllanthus debilis, P. maderaspatensis, P. virgatus, Chlorophytum arundinaceum, Amischophacelus axillaris, Commelina suffruticosa, C. paludosa, C. hasskarlii, Amorphophallus bulbifer, Alloteropsis cimicina, Arthaxon lancifolius, Brachiaria distachya, Heteropogon contortus, Eragrostis tenella, Imperata cylindrica* etc.

Some important climbers met within these forests are *Smilax zeylanica, Milletia extensa, Cryptolepis buchananii, Ampelocissus latifolius, Ventilago denticulata, Celastrus paniculatus, Dioscorea bulbifera, D. hispida* and *Bauhinia vahlii* Bamboos (*see* Plate 2) are common on the slopes.

II Group 5—Sub-group 5B—C_1

c—Dry Peninsular 'Sal' Forest: **(Plate 4)**

Shorea robusta of low quality and height predominates, the height not exceeding 10-15 m and regeneration is slow and difficult. It is mixed with other species in greater number than in the Moist Deciduous Forests and is often broken up into characteristically pure groups or mixed patches of varying extent between which its associates predominate. Most of the species also occur in the Moist Deciduous Forest. Though they form part of the main canopy in Dry Deciduous 'Sal'-bearing Forests, in the Moist Deciduous Forests, they may be in the second storey. Practically, all the trees are deciduous during the dry season, usually for several months and during monsoon season the forest takes on an almost luxuriant appearance from the growth of an ephimeral herbaceous vegetation. The lower canopy is likewise almost entirely deciduous or wherever evergreen or semi-evergreen species are present, they are inconspicuous and mainly confined to the moister and more-sheltered spots. An undergrowth of shrubs is usually present. Bamboos are often present but not luxuriant. Climbers are comparatively few. Epiphytes and ferns are quite inconspicuous.

These forests are met with on shallow loose sandy and friable soil on plains and undulating country which is cut up into ravines by numerous streams. Karela, Paunakhar, Rapta, Manguru Pahar, Ajagarbahar, Aratara, Ringania, Matin and Pasan are some of the important areas having this type of forest. Main rock formations consist of granite and schist. Parts of Semardari; Rumga, Dugra, Jogisar, Jamdikhurd, Khodri and Darnoli of Pendra range have this type of forests. Sandstones of Kamthi series also carries dry sal forests at Nonbira, Bundeli, Shreemar and Rampur. Parts of Kota and Baloda ranges also have such forests.

The chief associates of dry deciduous sal-bearing forests in the first storey are *Boswellia serrata, Adina cordifolia, Lannea coromandelica, Soymida febrifuga, Terminalia alata, Anogeissus latifolius, Lagerstroemia parviflora, Madhuca longifolia* var. *latifolia, Pterocarpus marsupium, Diaspyros melanoxylon* etc.

The second storey consists of *Buchanania lanzan, Phyllanthus emblica, Semicarpus anacardium, Flacourtia indica, Bauhinia semla, Ougeinia oojeinensis, Ziziphus xylopyrus, Gardenia latifolia, Cleistanthus collinus, Cassia fistula, Nyctanthes arbor-tristis* etc. *Dendrocalamus strictus* is occasionally met with in this storey.

The third storey consists of *Indigofera cassioides, Embelia basaal, Woodfordia fruticosa, Helicteres isora* and *Grewia hirsuta.*

The fourth storey consists of *Cayratia trifolia, Tephrosia purpurea, Uraria alopecuroides, Cassia obtusifolia, Blumea fistulosa, Andrographis paniculata, Dicliptera verticillata, Justica betonica, Achyranthes aspera, Euphorbia heterophylla, E. hypericifolia, Phyllanthus debilis, Carex cruciata, Cyperus* spp, *Aristida adscensionis, Brachiaria distachya, Themeda quadrivalvis, T. laxa, Thysanolaena maxima, Iseilema laxum* etc. The important climbers are *Bauhinia vahlii* and *Smilax zeylanica.*

II. Group 5—Sub-group 5B

C_2 *Northern dry mixed deciduous forest:* (Plate 5)

The upper canopy is thin but fairly complete in this type. Most trees have low-spreading crowns. Trees are deciduous during the dry season. *Boswellia serrata* and *Cleistanthus collinus* are characteristic of such forests. At the foot of the hills miscellaneous species are found associated with *Boswellia serrata* ('Salai'), but as the slope is ascended, the proportion of 'Salai' increases until it forms pure crop on hill tops. Bamboos are found scattered throughout.

These forests are found in vast stretches in Dhawalpur, Chindipani, parts of Amlikunda, Jatga, Senha-Lainga, Ringania and Matin of Pasan range, parts of Pendra and Katghora ranges, Mukia, Latgarh, Naktikar and Batali blocks of Korba range and southernmost part of Kudmura range. Sandstone and mica-schists are common rock formations. Soil is coarse sandy and shallow.

The main components of first storey are *Pterocarpus marsupium, Anogeissus latifolius, Acacia catechu, Diospyros melanoxylon, Butea monosperma, Phyllanthus emblica, Lannea coromandelica, Chloroxylon swietenia, Dalbergia paniculata, Lagerstroemia parviflora, Terminalia alata* etc.

The second storey consists of *Cleistanthus collinus, Ougeinia oojeinensis, Aegle marmelos, Careya arborea, Bridelia airyshawii, Buchanania lanzan, Gardenia resinifera, Bauhinia racemosa, Carissa spinarum, Ziziphus xylopyrus, Flacourtia indica, Nyctanthes arbor-tristis, Calotropis procera, Adhatoda zeylanica* etc.

The third storey consists of *Woodfordia fruticosa, Indigofera cassioides, Grewia hirsuta, Barleria prionites, Cassia tora, Peristrophe bicalyculata, Phoenix humilis* etc.

The undergrowth consists of *Tephrosia purpurea, Uraria alopecuroides, U. picta, Boerhavia diffusa, Achyranthes aspera, Aerva lanata, Alternanthera sessilis, Chrozophora prostrata, Euphorbia thymifolia, E. hypericifolia, Carex cruciata, Kyllinga tenuifolia, Aristida adscensionis, A. setacea, Imperata cylindrica, Heteropogon contortus, Thysanolaena maxima, Vetiveria zizanioides, Themeda quadrivalvis, T. triandra, Sehima nervosum* etc. Climbers area few and include *Asparagus racemosus, Smilax zeylanica, Celastrus paniculatus* etc.

Cleistanthus collinus grows, at places, in abundance and forms pure crop *e.g.*, parts of Ringania, Tanakhar, Latgarh, parts of Katghora range, parts of Senha, Dhawalpur, Amlikunda of Pasan range and Rampahar, Naktikhar, Betati and Bundeli of Korba range. Sandstone and gneiss with intrusive of trap are the main rock formations. Soil is sandy, loose and dry.

Common associates of these forests in the first storey are *Boswellia serrata, Terminalia alata, Anogeissus latifolius, Lagerstroemia parviflora* and *Lannea coromandelica*. The underwood consists of *Buchanania lanzan, Phyllanthus emblica, Bauhinia malabarica* and *Ougeinia oojeinensis*. The undergrowth consists mainly of *Gardenia resinifera, Woodfordia fruticosa* and *Phoenix humilis*. Grasses are a few. Climbers are rare.

Acacia catechu occurs on deteriorated soils and areas subjected to erosion *e.g.*, Manikpur and Mukua blocks of Pasan range.

Edaphic type : Bamboo forest : (Plate 6)

While Lamni, Lormi ranges and the Khondra block of Baloda range support some of the very good bamboo forests, some areas in Achanakmar and hills of Pandaria also have pure thick growth of bamboos; Jatga, Lendia, Pantha, parts of Matin, Ringania, Dhawalpur and Mukua also have moderately good bamboo forests. Bamboo grows best in localities where the soil is deep and loamy in texture, without excessive amount of clay and humus. *Dendrocalamus strictus* is the main species, but *Bambusa arundinacea* also occurs along the banks of rivulets.

III. Montane sub-tropical forest :

Typical Montane Subtropical Forest does not occur in the Bilaspur district, but in some pockets on higher hilly tracts in North Bilaspur Forest Division, components of such a forest type are met within cool, sheltered and moister places. These areas are usually above 1000 m *e.g.*, Kabirchabutra, Lamni, Bijora hills, Mahadeo hills, Karela Pahar, Palma etc.

The chief components of this type in the first storey are *Canthium dicoccum, Syzygium cuminii, S. nervosum, Litsaea glutinosa, L. monopetala, Ficus semicordata, Manilkara hexandra, Miliusa tomentosa* etc.

The second storey consists of *Grewia tiliaefolia, Glochidion multiloculare, G. zeylanicum, Mallotus philippensis, Symplocos laurinus, S. racemosus, Alangium salvifolium* subsp. *salvifolium* etc.

The third storey consists of *Colebrookea oppositifolia, Pogostemon benghalensis, Ixora arborea, Melastoma malabathrica, Jasminum auriculatum, Ochna obtusata* ssp. *obtusata, Thalictrum foliolosum, Rhamnus purpureus, Indigofera cassioides* etc.

The fourth storey consists of *Reinwardtia indica, Vernonia cinerea, V. divergens, V. pyramidale, Blumea membranacea, B. laciniata, B. mollis, B. bifoliata, Laggera alata, Leea indica, L. alata, Geranium mascatense, Wendlandia exserta, Ardisia solanacea, Celosia argentea, Begonia picta, Exacum tetragonum, Bacopa monnieri, Mazus pumilus, Dipteracanthus prostratus, Euphorbia heterophylla, E. dracunculoides, Chlorophytum arundinaceum, Commelina suffruticosa, C. paludosa, Amorphophallus bulbifer, Hypericum japonicum, Campanula benthamii, Lobelia alsinoides, Micromeria biflora,* ferns

and epiphytic herbs. The important climbers are *Clematis smilacifolia, Bauhinia vahlii, Ventilago denticulata, Ampelocissus latifolius, Smilax zeylanica* etc.

HYDROPHYTIC VEGETATION

General:

Weaver & Clements (1938) define the herbaceous vascular hydrophytes as "plants that grow in water, in soil covered with water or in soil that is usually saturated with water". Muenschar (1944) considered aquatic plants as "those species which normally start in water and must grow for at least a part of their life-cycle in water, either completely submerged or emerged". He includes some 'border-line' species of bogs and marshes among the aquatic plants. Reid (1961) expressed the same view when he defined water-plants as "those whose seeds germinate either in the water-phase or in the substrate of a body of water, and which must spend part of their life-cycle in water". According to Daubenmire (1956), "hydrophytes include aquatics which normally grow in water and swamps and bog-plants which inhabit soil containing a quantity of water that would prove supra-optimal for the average plant".

It is, however, difficult to draw line between a 'border-line' and a 'terrestrial' species growing on the shores of lakes, ponds or rivers which are periodically inundated or imersed and thus, grow in water for a brief period. Sculthorpe (1967) describes aquatic vascular plants as vascular hydrophytes and states, "it is difficult to suggest a definition of vascular hydrophytes, because aquatic habitats cannot be sharply distinguished from terrestrial ones. In most climates there is a seasonal fluctuation of the water-table. Habitats with standing water for most of the year may dry out completely in the summer, whilst normally terrestrial soils may be flooded during the rainy season. At no time there is an abrupt change from land to water, but rather a gradual transition from dry, through water-logged, to submerged soils. The reversion of vascular plants to aquatic life has involved colonisation of these transitional habitats and some of the marginal sites that are periodically flooded, have come to possess their own distinctive plant associations". Raunkiaer (1934) considered hydrophytes as plants which have vegetative parts submerged or floating at the water surface but not emerging up the air and which survive unfavourable seasons as submerged buds attached to the parent plant or lying free on the substrate. The concept would exclude: (a) *Phragmites, Typha* etc. which have submerged lower parts, but essentially aerial leaves; (b) also annuals, such as *Najas* and *Trapa*, which survive as seeds; (c) some species of *Potamogeton* and *Nymphaea* which produce

reduced land-forms as hemicryptophytes, if the habitat dries out; (d) the geophytes or species that pass the dry season as subterranean tubers or rhizomes, such as the sedges. Saxton (1924) refers to the adaptability of a hydrophyte to different seasonal and environmental factors during its life-cycle and enunciates the concept of "mixed formation in time".

Aquatic habitats:

The common habitats of hydrophytes in the Bilaspur district are a number of lakes, tanks, water- reservoirs, rivers, streams, deserted wells and the canal-systems from the Khuria and Khootaghat reservoirs. Seasonal puddles and ditches are scattered throughout the area. They get filled up with water during the monsoon period, Some dry in a short period, while, in others, water may persist for a long period. Some of the streams are permanent, while the others are temporary and seasonal. Paddy-fields also support hydrophytic vegetation. There are a few tanks which are considerably big in size *viz.*, one at Ratanpur, two at Pali, one on the way to Pali from Ratanpur and one each at Kota and Passan.

Classification:

Arber (1920) classified the hydrophytic plants into two groups—plants not rooted in soil (non-anchored hydrophytes) and plants rooted in soil (anchored hydrophytes) Weaver & Clements (1938) divided the hydrophytes into three groups *viz.*, floating, submerged and amphibious hydrophytes. Daubenmire (1956) recognized four groups within the hydrophytes—floating, suspended, submerged-anchored and emergent-anchored types. In the present work, the hydrophytes are classified, following Arber (*l.c.*), into two main groups, with one or more subgroups.

I. Non-anchored hydrophytes
- Free-floating hydrophytes
- Submerged hydrophytes

II. Anchored hydrophytes
- Floating hydrophytes
- Submerged hydrophytes
- Emergent hydrophytes
- Marshy-amphibious hydrophytes
- Wetland hydrophytes

Free-floating hydrophytes: These occur in stagnant water-bodies or slow-flowing waters and have contact with water and air only. Examples: species of *Azolla, Lemna, Wolffia, Spirodela, Trapa, Nymphoides, Pistia* etc.

Floating hydrophytes (anchored): These plants are in contact with soil, water and air, *e.g., Nymphaea pubescens, Nelumbo nucifera.*

Submerged hydrophytes (non-anchored): They generally occur submerged in stagnant water, *e.g., Ceratophyllum demersum, Najas* spp., *Potamogeton pectinatus* etc.

Submerged hydrophytes (anchored): These plants are in contact with soil and water, but usually the flowering parts are raised above the water level : *Hydrilla verticillata, Ottelia alismoides, Vallisneria natans, Najas graminea, Potamogeton nodosus* etc.

Emergent hydrophytes: They occur on exposed or submerged soil and are usually rhizomatous or cormous perennials. The roots, lower part of the stems and the lower leaves are submerged, but the upper part of the stem and flowering parts emerge out of water-level and are in contact with air, *e.g., Aeschynomene indica, Caesulia axillaris. Limnophila indica, Hygrophila auriculata, Sagittaria guayanensis* subsp. *lappula, Butomopsis latifolia, Phragmites karka, Monochoria vaginalis, Oryza rufipogon* etc. *Monochoria vaginalis* is perennial in permanently aquatic habitats but behaves as annual when growing in paddy-fields which are inundated for only 3-4 months and then dry up.

Marshy-amphibious hydrophytes: They occur on soft wet mud or root in shallow water. Many of these species thrive well even after the substratum is considerably dried up : *e.g., Ipomoea aquatica, Ludwigia adscendens, L. octovalvis, L. perennis, L. prostrata, Phyla nodiflora, Hoppea dichotoma, Bacopa monnieri, Limnophila aromatica, L. chinensis, Eclipta prostrata, Veronica anagalis-aquatica, Polygonum barbatum, P. glabrum, P. hydropiper* etc.

Wetland hydrophytes: These are so-called 'border-line' species. A few woody trees/shrubs *e.g., Terminalia arjuna, Vitex negundo, Homonoia riparia, Salix tetrasperma, Tamarix dioica* are usually found near streams, rivers and on the lake margins. Herbaceous elements like *Gnaphalium polycaulon, Ageratum conyzoides, Portulaca pilosa, Sphaeranthus indicus, Canscora diffusa, C. decussata, Exacum tetragonum, Ammannia baccifera, A. multiflora, Rotala indica, R. rotundifolia* etc. also grow in marshy or wetland habitats.

It is difficult to distinguish the zone of submerged hydrophytes from the zone of floating hydrophytes, the zones overlapping with each other. Floating hydrophytes like *Pistia, Eichhornia* etc. may also grow as emergent forms or some border-line plants send out long floating shoots on the surface of water *e.g., Ipomoea aquatica.* In the zone of emergent hydrophytes, occasional puddles, which are deep enough, support submerged hydrophytes. Some floating species with extensive root system may become anchored in shallow water, several species may produce land-forms when stranded on marginal wet soil, *Ipomoea carnea* subsp. *fistulosa,* a species naturalized in India, exhibits quite different phenotypes in water, on wet muddy soil and on drier habitats.

Hydrophytic plant-communities :

The following hydrophytic plant-communities are conspicuous in the district :

Azolla-Lemna community.

Eichhornia-Pistia community.

Ludwigia-Polygonum community.

Hygrophila auriculata-Caesulia axillaris community.

Nelumbo nucifera-Nymphaea pubescens-Nymphoides community.

Rostellularia-Caesulia-Alternanthera community.

General composition of hydrophytic vegetation :

Ipomoea aquatica forms floating mats during rainy season. *Cleome chelidonii* grows luxuriantly in the ditches and puddles at Khuria. *Lemna* and *Wolffia* form dense cover on the surface of many stagnant water-bodies. The tanks at Pali and Ratanpur are full of *Nelumbo nucifera* and species of *Nymphoides. Trapa bispinosa* is commonly cultivated in the ponds. *Hygrophila auriculata* is very common in ditches. The irrigation canals near Khuria and Khootaghat reservoirs contain species of *Potamogeton, Vallisneria, Hydrilla, Sagittaria, Najas* etc. On canal-banks grow *Mazus pumilus, Echinochloa colona,* and species of *Commelina, Ammannia, Rumex, Lindernia* and sedges. *Rotula aquatica* is most common in sandy-rocky river beds. During monsoon the paddy fields support the growth of large number of marshy species *viz., Utricularia aurea, U. caerulia, U. exoleta, Juncus leschenaultii, Drosera burmanni, D. indica, Eriocaulon cinereum, E. polycephalum, E. quinquangulare, Pogostemon stellatus,* sedges etc. In the marshy depressions and swampy areas inside the forests we generally find *Limnophila rugosa, Bacopa monnieri, Monochoria vaginalis, Centella asiatica, Lindernia crustacea* etc.

A rich carpet-vegetation consisting of *Phyla nodiflora, Polygonum plebium, Veronica anagallis-aquatica, Bergia ammannioides, Mollugo pentaphylla, Caesulia axillaris, Eclipta prostrata, Cyatholine purpurea, Lobelia alsinoides, Anagalis arvensis, Hydrolea zeylanica, Allmania nodiflora, Burmannia coelestis, Xyris pauciflora, Amischophacelus axillaris, Cyanotis fasciculata, Floscopa scandens, Polycarpaea aurea, P. corymbosa, Ammannia baccifera, A. multiflora, Rotala indica, R. rosea, R. rotundifolia, R. serpyllifolia, Glinus lotoides, G. oppositifolius, Oldenlandia corymbosa, O. diffusa, Merremia emarginata, M. tridentata, Limnophila aromatica, L. chinensis, L. rugosa, Eriocaulon cinereum, E. polycephalum* and many species of sedges etc. occur around the tanks in Pasan, Ratanpur, Pali, around water reservoirs at Khuria and Khootaghat and other aquatic habitats.

Very few members of the largest and most advanced monocot families *viz.* Poaceae and Orchidaceae venture into the water and there is equally conspicuous paucity of hydrophytes among the gamopetalous dicots. This led Arber (1920) to postulate that the highly evolved angiosperms probably lack the plasticity of their early aquatic pioneers derived from the more primitive stocks.

Adventive spread of certain aquatic vascular plants:

The geographical distributions of many vascular hydrophytes are intriguing and anomalous. About 40% of hydrophytes display smaller ranges confined within the limits of a single continent or major land-mass. In common with the more extensive types, many of them exhibit marked latitudinal penetration. Such latitudinal extension, not so conspicuous amongst terrestrial herbs, is attributable primarily to the less violent variations of temperature and edaphic factors in the aquatic environments and perhaps also to the dissemination of seeds and vegetative propagules by migrant birds.

Yet, it is surprising to note that about 25 to 30% of hydrophytes in an area are endemic, related probably to the edaphic limitation of hydrophytes. Most endemic hydrophytes are to be found in the tropics *viz.* numerous ecologically restricted members of the Podostemaceae. Yet, as a result of dispersal and colonisation, on the one hand, and the changing climate, physical and edaphic factors of the environment, on the other, great migrations of species continue to occur, as they have occurred during the geological and historical times and floras everywhere; consequently the aquatic, no less than the terrestrial, are always in a state of flux. The adventive spread and naturalisation of certain hydrophytes and

the extension and post-glacial restriction of others, illustrate these dynamic aspects of plant geography.

(a) Temperate European species introduced to India :
Veronica anagallis-aquatca, Anagallis arvensis, Oxalis corniculata, Polygonum hydropiper, Potamogeton crispus.

(b) Neotropical or neo-temperate species introduced to palaeotropics :
Ageratum conyzoides, Eclipta prostrata, Eichhornia crassipes, Ipomoea carnea subsp. *fistulosa.*

(c) Tropical and sub-tropical species of the Old World introduced to Europe etc. :
Azolla pinnata, Najas graminea, Nelumbo nucifera, Ottelia alismoides, Trapa bispinosa, Vallisneria natans.

Riverain vegetation :

The vegetation along the course of rivers, rivulets, streams and in the sandy-rocky river beds are quite characteristic. The stream beds appear as an arid stretch of sand and boulders.

Terminalia arjuna, Bombax ceiba, Aegle marmelos, Dalbergia sissoo, Ficus benjamina subsp. *comosa, F. hispida, F. microcarpa, F. racemosa, Mitragyna parvifolia* etc. are some of the common trees and shrubs along the streams and river courses. The shrubby vegetation is represented by *Woodfordia fruticosa, Adhatoda zeylanica, Calotropis procera, C. gigantea, Vitex negundo, Lantana camara, Tragia involucrata, Ludwigia octovalvis* etc. *Ipomoea carnea* subsp. *fistulosa* forms a continuous straggling mass along streams and rivers. *Homonoia riparia* and *Rotula aquatica* are always found in the boulder-strewn river beds.

The herbaceous flora is represnted by *Indigofera linifolia, Alysicarpus vaginalis, Solanum surattense, Phyla nodiflora, Rumex dentatus* subsp. *klotzschianus, Heliotropium strigosum, H. indicum, Boerhavia diffusa, Cassia occidentalis, C. pumila, C. tora, Cyperus alulatus, C. iria, C. distans, C. niveus, C. rotundus, Fimbristylis bisumbellata, F. complanata, F. miliacea, Bulbostylis barbata, Gomphrena celosioides, Allmania nodiflora, Dactyloctenium aegyptium, Imperata cylindrica, Saccharum spontaneum, Equisetum diffusum* etc. Weeds of exotic origin, such as *Ageratum conyzoides, Argemone mexicana, A. ochroleuca* sometimes form pure patches in the sandy river beds. *Polygonum barbatum, P. hydropiper* and *P. stagninum* are found in streams with sluggish water. Several of cultivated species belonging to Brassicaceae, Malvaceae, Fabaceae Cucurbitaceae, Apiaceae, Asteraceae, Solanaceae etc. find their way in these river beds as escapes.

PTERIDOPHYTIC FLORA

The vegetation of Bilaspur district in quite rich in ferns and fern-allies. These are found mainly in sheltered localities, in shady and cool places under moist conditions. They are one of the chief constituents of moist deciduous forests. The following list includes 33 species under 21 genera belonging to 13 families.

Selaginellaceae

Selaginella bryopteris (L.) Bak., *S. ciliaris* (Retz.) Spring, *S. kurzii* Bak. and *S. repanda* (Desv. ex Poir.) Spring

Isoetaceae

Isoetes cormandelina L. f., *I. bilaspurensis* Panigrahi

Equiestaceae

Equisetum diffusum D. Don

Ophioglossaceae

Ophioglossum reticulatum L.

Lygodiaceae

Lygodium flexuosum (L.) Sw.

Gleicheniaceae

Dicranopteris linearis (Burm. f.) Underwood

Adiantaceae

Adiantum incissum Forssk., *A. lunulatum* Burm. f.

Sinopteridaceae

Aleuritopteris anceps (Blanf.) Panigrahi, *A. farinosa* (Forssk.) Fée, *A. grisea* (Blanf.) Panigrahi, *Cheilanthes tenuifolia* (Burm. f.) Sw.

Pteridaceae

Pteris quadriaurita Retz. complex, *P. vittata* L.

Lindsaeaceae

Sphenomeris chinensis (L.) Maxon

Parkeriaceae

Ceratopteris thalictroides (L.) Brongn.

Thelypteridaceae

Ampelopteris prolifera (Retz.) Copel., *Pronephrium lakhimpurense* (Rosenst.) Holtt., *P. nudatum* (Roxb. ex Griffith) Holttum. *Thelypteris arida* (D. Don) Morton, *T. dentata* (Forssk.) E. St. John

Athyriaceae

Athyrium falcatum Bedd., *A. hohenackerianum* (Kze.) Moore

Dryopteridaceae

Dryopteris cochleata (D. Don) C. Chr.

Tectariaceae

Tectaria macrodonta (Fée) C. Chr.

Polypodiaceae

Leptochilus axillaris (Cav.) Kaulf., *L. decurrens* Bl.

Marsiliaceae

Marsilia minuta L.

Azollaceae

Azolla pinnata R. Br.

BIOTIC INFLUENCES OVER THE VEGETATION

General:

Man and the domestic animals have always played a vital role in changing the vegetation pattern of any place. The same is true also for the Bilaspur district. The vegetation has been degraded into scrub jungles in some localities and to grassland, in other places.

Population pressure:

Due to mounting population pressure, some of the forest areas have been converted into agricultural lands. Due to destruction of the original forests several obnoxious exotic plants have invaded the area *viz.*, *Lantana camara, Malvastrum coromandelianum, Bidens pilosa, Acanthospermum hispidum, Tridax procumbens, Ageratum conyzoides, Argemone mexicana, Cassia occidentalis, Ipomoea carnea* subsp. *fistulosa, Xanthium strumarium, Urena lobata* etc. The formation of bare ravines due to soil erosion is a result of forest clearing. The exposed soil surface, either due to clearing of forest for agricultural purposes or for habitation, faces direct action of wind and rain.

Cattle-grazing :

Due to grazing and browsing by domesticated animals, some of the forest areas have changed into grasslands. Domesticated cattle, goat etc. freely graze in the forests and on the slopes, thus transforming these forests into grasslands. Further, trampling of the forest floor by the cattle has adverse affects on seedlings, obstructing the successional stages of recovery. Lopping of forest trees and shrubs has also affected the vegetation. The regeneration is poor and even absent in some localities. Selective fellings and hacking are common in the forests close to human habitation, leading on to forests devoid of valuable tree-growth, leaving only the malformed ones.

Fire hazards :

Fire for hunting, for pleasure, for pestering neighbours or neighbouring village, for clearing land, for making land passable, for converting forest into pasture land, has played havoc with the forest and affected the vegetation to a great extent (Steenis in Fl. Males. Bull. 22 : 1562-1567, 1967). All gradations can be observed from the 'Sal' forests to the grasslands studded with a few crooked shrubs and stunted trees in the district. Occasionally, fire is used for clearing the undergrowth of 'Sal' forests. Fire also causes the change of the normal habit-form of certain species *e.g., Premna herbacea,* an undershrub transformed into a dwarf, stemless herb of 5-15 cm high. A few plants *viz., Desmodium pulchellum, D. triflorum, Uraria rufescens* etc. are fire-indicator species. The recurrence of fire depletes the plant cover. With rainfall, water washes away the surface soil, exposing the hard rock.

Shifting cultivation (BEWAR or PODDU or JHUMING) :

The practice of shifting cultivation (bewar) has resulted in extensive hill slopes being cleared of vegetation, as in Aurapani in the Lormi range. The Baigas of Amanala, Amadob, Khairdabre etc. largely depend for their livelihood on bewar cultivation. In such cases, 'Sal' forest has changed to mixed forest with poor regeneration and malformed tree-habit.

Soil erosion :

It is seen mostly in the areas with mixed forests where recurrence of fires deplete the plant cover, or to 'Sal' areas, where felling has been done. With heavy rainfall water washes away the surface soil, exposing the hard rock. These conditions are noticeable in the old 'bewar' areas of Aurapani in the Lormi range to the north and west of the villages. Areas subject to gully erosion due to fellings and heavy grazing are seen

along the hill slopes to the north-west of Sonthi in the Baloda range and to the west of Sheotarai in the Kota range. Sheet erosion is commonly noticed in areas where grazing pressure is high *e.g.*, Bhimpuri in Lormi range, north of Beltukri, north and south of Karli in Baloda range and in areas north of Tingipur in Kota range. The effect of soil erosion can also be seen in Kesla, Dordro, Barpali, Gorma, Chhindipani, Ringania, Pantha, Sakti and on the steep hill slopes of Bhojagarh, Latgarh, Led, Lampahar and Ajgarbahar, all in North Bilaspur Forest Division.

Industrial activities :

Industrial activities at Korba and other places and mining activities at places, where alluminium ore (Bauxite) and coal are being extracted on a massive scale, have also adversely affected the vegetation.

FAUNAL COMPOSITION

The district does not have any sanctuary or national park. Although during 1942-43, two sanctuaries, one around Khurita and another around Katra were created, soon after, these were abolished. Wild animals used to be abundant in the recent past, but are gradually decreasing in number. The remoter areas, particularly Lormi, Lamni, Kota, Pasan, Pandra, Mafin, Uprora, Kendai etc. were once rich in games.

The animals commonly met with are tiger, panther, hyeana, jackal, wolf, fox, bear, spotted deer, barking deer, chamois, antilope, gazelle, bison, hare, monkey, a wild pig, flying-squirrel, 'Neelgai' and jungle fowl, pea powl, partridge, peacock, green pigeon, quail, sand gorouse, snipes and egrets, among birds.

Tiger is mostly seen around Aurapani, Lomni, Chaparwa, Rajak, Khondra and Sarasdol. Panthers are seen around Achanakmar, Lormi and Lamni. Bison is found around Khondra and Seotarai. Bear can be seen around Samardhasan and Chaparwa and in such areas, where *Ziziphus xylopyrus, Diospyros melanoxylon, Buchanania, lanzan, Madhuca longifolia* var. *latifolia* grow in abundance, because they consume fruits of these species. Chamois is found in Mukua, Amlikunda, Jatga, Rapta, Madanpur etc. Spotted deer, bison and Neelgai, prefer bamboo forests and can be seen in Jatga, Lendia, Pantha, parts of Matin, Ringania, Dhawalpur and Mukum. Ape enjoys fruits of *Bauhinia semla, Buchanania lanzan, Phyllan-*

thus emblica, Ficus benghalensis, Shorea robusta, leaves of *Bridelia airyshawii, Cleistanthus collinus* and flowers of *Diospyros melanoxylon* and *Shorea robusta.* Monkeys are found throughout the district.

ANALYSIS OF THE FLORA

Of the 852 species in 507 genera under 120 families, the class Magnoliatae (Dicotyledons) comprise 96 families, 377 genera and 604 species and the class Liliatae (Monocotyledons) comprise 24 families, 130 genera and 248 species. Out of 120 families, the dicotyledons represent 80% and monocotyledons represent 20%. Out of 507 genera, the dicotyledonous genera represent 74.35% and monocotyledonous genera represent 25.65%. Out of 852 species the dicotyledons represent 70.90% and monocotyledons represent 29.10%. There are 109 species of trees, 102 species of shrubs, 565 species of herbs, 60 species of climbers, 6 species of epiphytes, 5 species of parasites and 5 species of insectivorous plants. Out of 565 herbaceous species, about 185 species are hydrophytic.

Table 3 indicates the break up of the 852 species with respect to the dicotyledons and monocotyledons and the former, in the three broad groups as recognised by Bentham and Hooker (1862-1883). Table 4 shows the number of genera and species in respect of the 10 dominant families represented in collections from Bilaspur district.

TABLE 3

Group	Families		Genera		Species	
	No.	% of total	No.	% of total	No.	% of total
I. Dicotyledons						
1. Polypetalae	54	45	157	30.95	264	31.00
2. Gamopetalae	32	25	177	34.90	260	30 50
3. Monochlamydeae	12	10	43	8.50	80	9.40
II. Monocotyledons	24	20	130	25.65	248	29.10
Total :	120	100	507	100	852	100

TABLE 4

Sl. no.	Name of family	Number of Genera	Species
1.	Poaceae	64	116
2.	Fabaceae	43	98
3.	Cyperaceae	13	52
4.	Asteraceae	37	49
5.	Euphorbiaceae	17	35
6	Acanthaceae	18	32
7.	Rubiaceae	18	26
8.	Scrophulariaceae	13	22
9.	Lamiaceae	16	21
10.	Malvaceae	9	19

The ten dominant families comprise 470 species *i.e.* about 55.15% of the total species dealt with, remaining 110 families with a total of 382 species constitute 44.85%. The families represented by a single genus with a single species are Dilleniaceae, Nymphaeaceae, Nelumbonaceae, Violaceae, Portulacaceae, Elatinaceae, Hypericaceae, Dipterocarpaceae, Bombacaceae, Geraniaceae, Olacaceae, Celastraceae, Crassulaceae, Lecythidaceae, Trapaceae, Passifloraceae, Begoniaceae, Cactaceae, Alangiaceae, Stylidiaceae, Plumbaginaceae, Hydrophyllaceae, Orobanchaceae, Plantaginaceae, Chenopodiaceae, Salicaceae, Ceratophyllaceae, Burmanniaceae, Costaceae, Taccaceae, Pontederiaceae, Xyridaceae, Juncaceae, Arecaceae, Butomaceae, Najadaceae and Aponogetonacae. Some of the dominant genera with maximum number of species are *Cyperus* (16), *Fimbristylis* (13), *Eragrostis* (10), *Ficus* (10), *Ipomoea* (9), *Desmodium* (8), *Cassia* (8), and *Blumea* (8).

Although *Shorea robusta* constitutes the dominant vegetation of the district with millions of trees of timber value, neither the genus, nor the family Dipterocarpaceae come up as amongst those which are considered composing the 'dominant' families/genera in the area, when judged by the number of taxa, as distinct from the biotypes.

Some of the genera, which are represented in India by single species/varieties (some of them aliens), also occur in the district: *Cissampelos, Nelumbo, Drymaria. Waltheria, Aegle, Limonia* (monotypic), *Dodonaea, Lablab* (monotypic), *Lawsonia* (monotypic), *Woodfordia,*

Diplocyclos, Centella, Anthocephalus, Amberboa, Blainvillea, Butmopsis (monotypic), *Centipeda, Chrysanthellum, Crassocephalum, Eclipta, Grangea, Lagascea, Siegesbeckia, Tridax, Holarrhena, Dregea, Hemidesmus* (monotypic), *Oxystelma, Hydrolea, Coldenia, Rotula, Nicandra* (*monotypic*), *Sutera, Martynia* (monotypic), *Nelsonia* (monotypic), *Petalidium, Duranta, Phyla, Tectona, Allmania* (monotypic), *Ricinus* (monotypic), *Sebastiania, Hydrilla* (monotypic), *Nechamandra, Ottelia, Costus, Gloriosa, Floscopa, Pistia* (monotypic), *Limnophyton* (monotypic), *Acrachne* (monotypic), *Apluda Desmostachya* (monotypic), *Diectomis* (monotypic), *Elytrophorus, Pseudosorghum* (monotypic), *Thysanolaena* (monotypic).

An analysis of the 852 species shows that it shares as many as 795 species with Bihar and Orissa (*vide* Haines, 1922-1925), 728 species with the Upper Gangetic Plain (*vide* Duthie, 1903, 1922), 757 species with Madras Presidency (*vide* Gamble and Fischer, 1915-1935) and Karnataka (*vide* Saldanha and Nicolson, 1976) and 619 species with Nepal Himalayas (*vide* Hara *et al.*, 1978, 1979, 1982). It is evident, then, that Bilaspur district provides a cradle, a meeting ground, of many of the indigenous taxa met with in the eastern, northern, western and southern India.

It is of further interest to record that 26 monotypic genera, of which 8 are endemic in India, have also been collected from the district. Again, 35 species reported as endemic to India and which include some monotypic genera, such as, *Soymida, Chloroxylon, Schleichera, Spermadictyon* etc. have also turned up here. *Cucumis setosus* known to be endemic to Maharashtra and Rajasthan and *Euphorbia perbracteata* endemic to Maharashtra, extend their range to Bilaspur district. *Limnophila chinensis* var. *clarkei* (Haines) S. K. Murti, earlier known from Chotanagpur in Bihar, also occurs here.

All the same, presence, in Bilaspur flora, of as many as 46 species not recorded by Haines, 11 species not recorded by Hooer *et al.*, 99 species not recorded by Duthie, 88 species not recorded by Gamble & Fischer, Saldanha & Nicolson and as many as 220 species not recorded by Hara *et al.* from Nepal, may suggest that Bilaspur district harbours a number of species (although not endemic) not yet known to have been recorded from the adjoining areas of the Indian region.

The following 10 species are new records for Madhya Pradesh (Murti, 1972, 1976, 1979) : *Althaea ludwigi* L., *Arundinella setosa* Trin. var. *lanifera* C.E.C. Fischer, *Cymbidium macrorhizon* Lindl., *Desmodium benthamii* Balak., *Pogostemon stellatus* (Lour.) Kuntze, *Lepidagathis purpuricaulis* Wall. ex Nees, *Ludwigia prostrata* Roxb., *Plantago exigua* Juss. ex Murray, *Stylidium kunthii* Wall. ex DC. and *Syzygium nervosum* DC.

Another lot of 64 species have turned up as new records for Bilaspur district (some of them are species of special interest), such as: *Aeginetia indica* L., (root parasite), *Androsace umbellata* (Lour.) Merr. (the lone member of the Primulaceae, a family restricted to the temperate Himalayas), *Eleiotis monophylla* (Burm. f.) DC. (Fabaceae). *Radermachera xylocarpa* (Roxb.) K. Schum. (Bignoniaceae—an antidote for snake-bite; *cf.* Panigrahi 1963), *Clematis smilacifolia* Wall., *Tacca leontopetaloides* (L.) Kuntze and *Thalictrum foliolosum* DC. (species of higher latitudes/altitudes) and a number of species of orchids, [both terrestrial and epiphytic, *e.g.*, *Aerides multiflorus* Roxb., *Eulophia flava* (Lindl.) Hook. f., *E. nuda* Lindl., *Geodorum densiflorum* (Lam.) Schlecht., *Habenaria dentata* subsp. *ecalcarata* (King and Pantling), *H. digitata* Lindl., *Peristylus constrictus* (Lindl.) Lindl., *P. goodyeroides* (D Don) Lindl., *P. lawii* Wight and *Pelatantheria insectifer* (Reichb. f.) Ridley].

Three species, *viz.*, *Desmodium benthamii* Balak., *Arundinella setosa* Trin. var. *lanifera* C.E.S. Fischer and *Cymbidium macrorhizon* Lindl. collected from the district, extend the known range of distribution from South India/ the Eastern Himalayas.

Plants of higher elevations, such as *Argostemma sarmentosum*, *Begonia picta*, *Clematis smilacifolia*, *Conyza stricta*, *Cymbidium macrorhizon*, *Hypericum japonicum*, *Lepidagathis purpuricaulis*, *Laggera alata*, *Rorippa indica*, *Rhamnus purpureus*, *Swertia angustifolia* and *Thalictrum foliolosum* etc. and some temperate genera, such as *Sonchus*, *Dumasia*, *Pimpinella*, *Geranium*, *Swertia* and *Gerardinia* etc. descend down to the tropical latitudes and find shelter in the higher altitudes in the North Bilaspur Forest Division.

RARE, ENDANGERED AND ENDEMIC PLANTS

Some of the rare elements of the flora are: *Clematis smilacifolia*, *Thalictrum foliolosum*, *Althea ludwigii*, *Geranium mascatense*, *Psoralea corylifolia*, *Drosera burmanni*, *D. indica*, *Bigonia picta*, *Argostemma sarmentosum*, *Canthium dicoccum*, *Crassocephalum crepidioides*, *Dichrocephala integrifolia*, *Stylidium kunthii*, *Androsace umbellata*, *Diospyros malabarica*, *Marsdenia tenacissima*, *Oxystelma esculentum*, *Exacum petiolare*, *Swertia angustifolia*, *Rhamnus purpureus*, *Cassytha filiformis*, *Elatostema cuneatum*, *Ficus benjamina* subsp. *comosa*, *Typhonium trilobatum*, *Brachiaria deflexa* and *Spodiopogon rhizophorus*.

The orchids, so widely distributed in India, are scarce in the district and are becoming scarcer day by day due to destruction of habitat and

over exploitation, despite the fact that orchids are listed as 'threatened' and included in the Red Data Book by I.U.C.N. From Bilaspur district 15 species of orchids have been collected, of which 6 are epiphytic: *Aerides multiflora, Oberonia falconeri, Rhynchostylis retusa, Pecteiltes insectifer, Vanda testacea* and *V. tassellata* and 9 are terrestrial: *Cymbidium macrorhizon, Eulophia flava, E. nuda, Geodorum densiflorum, Habenaria dentata* subsp. *ecalcarata, H. digitata, Peristylus constrictus, P. goodyeroides* and *P. lawii. Cymbidium macrorhizon* is credited with a distributional range from N.W. Himalaya, Sikkim, Meghalaya to Nagaland. The present collection from Sonmuda extends its range to Madhya Pradesh.

None of the species collected from the district is endemic to Madhya Pradesh, but about 41 species,, restricted to India, occur as rare elements in the Bilaspur district.

Aliens Naturalized in the Flora:

About 65 exotic species of flowering plants, naturalized in the district have been collected. For an account of these species, indicating their country of origin, probable year of introduction to India, and the localities where they occur, one may refer to Murti, (1979). These naturalized elements in the Indian flora have been grouped into 4 categories *viz.* Neo-tropical, North temperate, North-African and Austro-Asian

NOTES ON NOMENCLATURE

Some intricate problems of nomenclature unravelled during this study are:

Thevetia L. (1758) is conserved against *Ahouai* P. Miller (1754); with *T. ahouai* (L.) DC. (1844), (*Cerbera ahouai* L.) (*typ. cons.*) and *Thevetia* Adans. (1763) is a later homonym.

Volvulopsis Roberty (Candollea 14 : 28. 1953), typified by *Evolvulus nummularia* (L.) L. is *nom. superfl. illeg.* for *Evolvulus* L. (1762). lectotypified by *E. nummularius* (L.) L. (*Convolvulus nummularius* L.) (*vide* Britton and Brown, Ill. Fl. N.U.S. ed. 2, 3 : 42. 1913).

Medicus (1790), in establishing *Adhatoda zeylanica* Medic. (*Justicia adhatoda* L.) made it explicit that *J. adhatoda* L. (1753) is the type species of *Adhatoda* Miller (1754). In view of this, N. L. Britton's (Fl. Bormuda : 354. 1918) subsequent lectotypification of *Justicia* L. by the type species of *Adhatoda* P. Miller, (*vide* Farr. *et al.* 1979) must be set aside. Hitchcock and Green (Int. Bot. Cong. Cambridge, 1930) have, in the circumstances, justifiably selected *J. hyssipifolia* L. as the lectotype species of *Justicia* L. (1763), when it is treated generically distinct from *Adhatoda* Mill.

El-Gazzer and Watson (Taxon 16 : 136-189. 1967) transferred four species of *Dysophylla* Bl., including the type species, *D. auricularia* Bl., to *Pogostemon* Desf. Panigrahi (1976, 1984 a, b), Keng (1978) and Press (1982) transfer the verticillate-leaved species of *Dysophylla* Bl. sect. *Verticillatae* Benth. to *Pogostemon* Desf. sect. *Verticillati* (Benth.) Panigr., and following Kuntze (1891), the species of this section now stand transferred to *Pogostemon* Desf. (1815). [*cf.* Panigrahi 1984 a, b]

Loranthus Jacq. (1762) (T. : *L. europaeus* Jacq.) is *nom. cons.* against *Loranthus* L. (1753) and *Scurrula* L., the latter typified by *S. parasitica* L. In 1762, Linnaeus merged *Scurrula* L. in *Loranthus* L., but was in error in naming the species *L. scurrula* L. in stead of renaming it as *L. parasitica* (L.) L.

Author citations for *Anisochilus* and *A. carnosus* are established as Walt. ex Benth. (1830) and (L. f.) Wall., respectively (Panigrahi and Murti, 1981).

Volutarella Cass. (1826), typified by *V. lippii* (L.) Cass. is conserved against *Amberboi* Adans. (1763) *nom. rej vs Amberboa* (Pers.) Less. (1832), *nom. cons.* Therefore, *Amberboa ramosa* (Roxb.) Jafri is established as the correct name for *V. ramosa* (Roxb.) Santapau.

Following Cronquist (1968), Saldanha and Nicolson (1976) and Robson (1972) include *Hypericum* L., the type genus of the Hypericaceae Juss. (1789), in the Clusiaceae Lindl. (1836). If the two families are to be united, although both are listed as family conserved (*vide* App. II, ICBN 1983) and Guttiferae Juss. (1789) is an alternate name for the Clusiaceae Lindl., it is a moot point whether Art. 57.1, would apply in accepting the Clusiaceae Lindl. (1836) (Alt. Gutifferae Juss.) to be the correct name for the Hypericaceae Juss. (1789).

Alpinia L. (1753) based on *A. racemosa* L. is *nom. rejic.* in favour of *Alpinia* Roxb. (1810) *nom. cons.* with *A. galanga* (L.) Willd. (1797) (*Maranta galanga* L.) (*typ. cons.*) ; similarly, *Curcuma* L. (1753) is *nom. rejic.* in favour of *Curcuma* Roxb. (1810) with *C. longa* L. '*typ. cons.*' (*cf.* Taxon 33. 705-707. 1984).

Borreria G.F.W. Mey. (1818), *nom. cons.* is not conserved against *Spermacoce* L. (1753) and the only difference between the two genera rests on one character : whether the fruits dehisce or not. Verdcourt (1975), in agreement with Hook. f. (1881) and Bremekamp (1934), treats them as congeneric, reducing the former as a section. *viz.*, *Spermacoce* L., sect. *Borreria* (Mey.) Verdc. (Kew Bull. 30 : 366. 1975).

Leea aspera Wall. in Roxb., Fl. Ind. 2 : 468. 1824, *adnota*, is *nom. nud.* (Art. 34.1,c) but was validated by G. Don (1831) and again independently by Edgeworth (1846). Therefore, *L. edgeworthii* Santapau proposed as a *nom. nov.* for *L. aspera* Wall. ex Edgew., non G. Don (1831) is to be rejected as nom. superfl. illeg. for *L. aspera* Wall. ex G. Don (1831), the latter reduced as a taxonomic synonym of *L. crispa* D. van Royen ex L. (1767) (*cf.* Panigrahi, 1978). However, the correct name of the taxon is now established as *Leea asiatica* (L.) Risdale.

The correct names for black mustard (kala sarson) and yellow mustard (pila sarson) are established as *Brassica rapa* L. subsp. *campestris* (L.) Clapham var. *campestris* and *B. rapa* L. subsp. *campestris* var. *glauca* (Roxb.) Watt.

Lipocarpha R. Br. (1818) is *nom. cons.* with *L. senegalensis* (Lam.) T. & H. Durand (*Scirpus senegalensis* Lam.). But *S. senegalensis* Lam. is also one of the syntype species of *Hypolytrum* L. C. Rich. (1805) and of *Hypaelyptum* Vahl (1806), *nom. rejic.* To maintain the status quo and the current usage of *Lipocarpha* R. Br. and *Hypolytrum* L. C. Rich. as two distinct genera, Panigrahi [Taxon 34 (3) : 510-512. 1985] has selected *Hypolytrum lalifolium* Rich. and *Hypaelyptum filiformis* Vahl, as lectotype species of *Hypolytrum* Rich. and *Hypaelyptum* Vahl, respectively.

Farr *et al.* (1979) treat *Kydia calycina* Roxb. as the type species of *Kydia* Roxb. Since Roxburgh (Pl. Corom. 3 : 11. 1811) described two species, *viz. K. calycina* (t. 215) and *K. fraterna* (t. 216), without naming any one of them as the type, *K. calycina* Roxb. is to be treated as the lectotype species.

Malvastrum A. Gray was proposed to be conserved with *M. coromandelianum* (L.) Garcke as the lectotype species (Borssum in Taxon 9 : 212-213, 1960). Since A. Gray did not include *M. coromandelianum* within the scope of her genus, Borssum (Blumea 14 : 151. 1966) again proposed *M. spicatum* (L.) A. Gray as the lectotype. However, *Malvastrum* A. Gray *nom. cons.*, is finally lectotypified with *M. wrightii* A. Gray (*typ. cons.*).

R. Brown (Tuck. Narr. Exp. Congo : 484. 1818) was the first to combine *Waltheria indica* L. (1753) and *W. americana* L. (1753), accepting *W. indica* L. as the name for the combined taxon. Although *W. americana* L. was selected as the lectotype species at a later date by N. L. Britton, (Fl. Bermuda : 242. 1918), R. Brown's choice has to be followed (Art. 57.2, Ex. 3).

Although Arnott in Wight et Arnott, Prodr. : 226 1834 combined *Hedysarum dichotomum* Willd. and *H. diffusum* Willd. under *Desmodium diffusum* (Willd.) DC. (Nov. 1825), the latter is a later homonym of *D. diffusum* Roxb ex DC. (Jan. 1825). *D. dichotomum* (Willd.) DC. (Nov. 1825) is, therefore, the correct name for the later homonym.

Emblica J. Gaertn. [LT. *E. officinalis* J. Gaertn. based on *Mirobalanus emblica* Rumph. 1756, nom. invalid,] and *Kirganelia* Juss. are treated as congeneric synonyms of *Phyllanthus* L. (1753); *Cyperus* L., *Kyllinga* Rottb., *Mariscus* Vahl, *nom. cons. Pycreus* P. Beauv., as also *Rikliella* Raynal (1973), *Schoenoplectus* Palla, *nom. cons.* and *Scripus* L. *sens. strict.* are treated as generically distinct (S. Hooper, 1976; Koyama 1977, 1978); *Bothriochloa* Kuntze (1891), *Capillipedium* Stapf (1917) and *Dichanthium* Willem. (1796) are treated as generically distinct, although some treat them as congeneric : *Pseudobrachiaria* E. Launert (1970), with *P. deflexa* (Schumach.) E. Launert as its type, is reduced as congeneric with *Brachiaria* (Trin.) Griseb. (1853) (Cope, 1982).

Butomopsis Kunth (May, 1841) and *Tenagocharis* Hochst (June 1841), when treated as congeneric, the former is the correct name.

Attention may be drawn to the fact that in respect of 404 species as dealt with in *Flora of British India* (1872-1896), of 61 species as in the *Herbaceous Flora of Dehra Dun* (1977), of 34 species as in the *Flora of the Hassan District, Karnataka State* (1976) and of 47 species as in *Enumeration of the Flowering plants of Nepal* (1978, 1979, 1982), name changes have been effected after due scrutiny of published literature to conform with the I.C.B.N. (1983). Citation of original literature and type/lectotype in respect of 507 genera (from amongst an estimated total of 2,200 genera of angiosperms for India) in consultation with Farr *et al.* (1979), is a unique feature of the FLORA OF BILASPUR DISTRICT. All these, together with reference to the types/syntypes/lectotypes/type localities of a number of species, as available, are aimed at setting a new trend in floristic research in this country and is designed to have wider impact and to stimulate research over a wider area beyond the borders of the district/state. It must be emphasised that 852 species in the systematic treatment do not include any of the exotic species, maintained purely in cultivation/plantation/gardens, although references to some of them are made here and there in some other context.

It is our hope and belief that the present Flora of Bilaspur district would not only enable one to know about the vegetation and flora of the area in a most modern context, but would give an integrated view of the physical, ecological and biotic factors that condition the composition of the vegetation. Of late, the natural ecosystems are being drastically altered by human

interference in the form of deforestation, industrialisation, urbanization, extension of agriculture, construction of huge dams over rivers etc. For achieving balanced ecosystem, conducive to better life of the people of the region, such rapid inroads of modern civilisation should be checked/moderated.

Since we in India are familiar with Bentham and Hooker's (1862-1883) system of classification and all Indian herbaria are arranged (even current regional Floras are being published) according to this system, the sequence of presentation of the 120 families to which the 507 genera from Bilaspur are assigned, is presented after this system for convenience of reference and study. Yet, in view of the fact that Cronquist's (1968) classification of the Magnoliophyta (Angiosperms) is accepted currently as a phylogenetic one. 507 genera are assigned to 120 families, as delimited by Cronquist, with minor exceptions (*e.g.* Hypericaceae Juss. segregated from the Clussiaceae Lindley). The position of these families are shown in a hierarchical system which recognises CLASSES, SUBCLASSES and ORDERS (Appendix I) and in which the subclass Magnolidae are considered more primitive than the subclass Hamameliidae, the subclass Caryophyllidae representing an evolutionary blind end. But according to some others (*see* Panigrahi, Jour. Orissa Bot. Soc. 7 : 1-14. 1984 for a review), the Hamameliidae are more primitive than the Magnoliidae.

ECONOMIC PLANTS

Man's dependence on Plants needs no exaggaration. An attempt has been made to enumerate plants of economic importance and of medicinal value with notes on their local names, parts of plants and for the purpose for which they are used. It is hoped that planned cultivation of some of these plant species on a larger scale may be of considerable help to young enterpreuners interested in starting small-scale industries. For example, *Hyptis suaveolens* yields an aromatic oil which is mosquito-repellant. This can be profitably exploited. *Eichhornia crassipes* may be a substitute for cow-dung in operating "Gobar-Gas Plants", for which there is popular demand throughout the country. *E. crassipes* may also be grown *in vivo* for purifying industrial affluents of hard metals, such as cobalt and magnesium, which prove health-hazards.

It is also hoped that the Flora would stimulate chemotaxonomic and phytochemical studies, comparatively recent areas of investigations. A phytochemical study of the hitherto uninvestigated taxa of medicinal importance may unravel new compounds and potential drugs of great therapeutic value, and in the years ahead, may bring to market newer drugs of enormous utility in alleviating human suffering. Discovery of the alkaloid reserpine in the roots of *Rauvolfia serpentina*, as late as 1956, and of