BOTANY
of some
TIGER HABITATS
in
INDIA

BOTANICAL SURVEY OF INDIA
DEPARTMENT OF ENVIRONMENT
GOVERNMENT OF INDIA

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OF SOME

TIGER HABITATS IN INDIA

Compiled by

S. K. JAIN and **A. R. K. SASTRY**

BOTANICAL SURVEY OF INDIA, DEPARTMENT OF ENVIRONMENT

Cover photo : A view of vegetation at Corbett National Park, Garhwal, Uttar Pradesh (Ph. BSI, Dehradun),

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About the Book

Conservation of wild flora, fauna and their habitats is now receiving attention all over the world. In India, the activities of the Indian Board for Wildlife, the National Man and Biosphere Committee, Central and State Forest Departments, the Botanical Survey of India, the Zoological Survey of India and several other official and non-official organisations are contributing to these efforts.

Certain endangered species, such as the tiger, and rhino among animals, and plants of horticultural and medicinal importance are receiving particular attention.

The 'PROJECT TIGER' was initiated in India, not only with a view to conserve and increase the tiger population, but along with it a number of other animal and plant species which form the constituents of the ecosystem of tiger habitats.

It cannot be overemphasized that no animal can be preserved without proper care and preservation of its habitat. The scientists of the Botanical Survey of India and some other institutions have been interested in the study of National Parks, Wildlife Sanctuaries and other habitats, important for preservation of Wildlife. The papers describing the vegetation and sometimes also the flora of tiger habitats have been appearing in a variety of journals.

It was considered that on the occasion of completion of a decade of Project Tiger in India, bringing together some information on the botany of the tiger habitats in India would be useful. Studies on the flora of various tiger habitats are at various stages of preparation. Enumeration of all plant species has, therefore, been mostly avoided in the present work. Emphasis has been laid on a brief description of location and climate, general physiognomy of vegetation, important constituents of the forests and other significant botanical aspects.

It is interesting to note that the tiger habitats in India are spread throughout the country; they are located from lower north-western Himalayas through the Indo-Gangetic plains to far east in Assam, Rajasthan in the West and southwards to Tirunelveli far south in peninsular India.

The account of vegetation of the different tiger habitats in India, therefore, gives in a way a glimpse of the vegetation of a good part of the country.

The question has often arisen about finding alternative habitats for certain animals and plants, or restoration of certain degraded habitats of wildlife. It is hoped that the present work will be useful in this regard also, and the botanical account of the various tiger habitats would assist not only in evaluation of the habitat requirements for tigers, but many other animals and plants, commonly found in association with the Tiger.

For convenience, the Tiger habitats have been broadly divided here into two categories viz., *Tiger Reserves* recognized by the Tiger Programme and other

Tiger Habitats. The Botanical accounts of the Tiger Reserves has been given first, followed by other Tiger Habitats. Effort has been made to illustrate some Tiger Habitats by a few photographs representative of different vegetation types.

The names of the plants have been taken as given by the various authors in original publications including names of authors of taxa. If author-names were not given in original papers, they have deliberately not been introduced, as the specimens were not available to us for scrutiny. Similarly, there are some inconsistencies in names of plants; for the same reason, no effort has been made to change the names. It was also felt that the main users of this work will be the persons interested in conservation, environment and wildlife and such minor inconsistencies would not materially effect the main objective of the work.

Publications on the Botany of tiger habitats have emanated from the scientists working in far off places. Material for the present work has been freely borrowed from published literature and sources have been indicated for each of the tiger habitats. In a few instances only, the material had to be written on the basis of our own observations or material scattered in reports, other documents and herbaria. Some readers might be interested in knowing more details about the floristic constituents or the forest vegetation of these areas. A selected bibliography has been appended.

We are grateful to the authors of all the publications indicated as source of information, to those individuals and institutions whose photographs have been used in the work, and to several colleagues in the BSI who have assisted in numerous ways. The information has been taken from the work and publications of such a large number of persons that it is not possible to acknowledge our gratitude to all of them individually by name.

We record our gratitude to Dr. T. N. Khoshoo, Secretary, Department of Environment, Government of India, for encouraging us to undertake this publication, to Shri Samar Singh, Director, Wildlife, Shri H. S. Panwar, Director and several other officials of the Project Tiger and Wildlife Department who have been continuously assisting the field parties of the BSI in their field work, not only in tiger habitats, but in all forest areas in the country.

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Contents

Bandipur National Park, Mysore, Karnataka

Approach : Rail –Mysore, 65 km. Air—Bangalore, 190 km.

Bandipur is situated at an altitude varying from 600-1400 m. between 11°20'-11°40' N and 76°20'-76°32' E. The area under study may be divided into four parts, the northern part includes a part of Gundlupet; the southern part begins with Kakanallha; the western part is limited to Gopalswamy hills and the eastern part is demarcated by the beginning of Moyar Reserve Forest. Bandipur is an important National Park and preserves rich flora and fauna.

The soil is usually a mixture of red laterites and black-cotton soil but the black-cotton soil does not show a higher percentage of salt concentration. In some places sand stones and semi-quartzites and shales are present.

The climate is warm and equable and the temperature fluctuates between 20° and 34° C. The annual rainfall is 48 cm, and the major portion comes down during September and October. The hottest part of the year is from April to June.

The vegetation at lower elevations is of the scrub jungle type (600-650 m), at slightly higher elevations (650-1000 m) the mixed deciduous type is met with in open areas, and at still higher elevations (1000-1400 m) the semi-evergreen type is seen.

Scrub jungle consists of *Bauhinia racemosa* Lamk., *Capparis grandiflora* Wall. ex Hk. & Th., *Dichrostachys cinerea* Wt. & Arn., *Dodonaea viscosa* Jacq., *Flacourtia indica* Merr., *Gmelina asiatica* Linn., *Grewia obtusa* Wall. and *Pterolobium hexapetalum* Sant. & Wagh. Climbers like *Aristolochia indica* Linn., *Ceropegia hirsuta* Wt. & Arn., *C. intermedia* Wt., *Cocculus hirsutus* Diels, *Cissus quadrangularis* Linn., *Ipomoea staphylina* R. & S. and *Pergularia daemia* Chiov. are of common occurrence in the scrub jungle. Succulents like *Caralluma umbellata* Haw. and *Euphorbia antiquorum* Linn. are intermixed with scrub elements. Trees like *Aegle marmelos* Corr., *Albizia amara* Boivin, *Chloroxylon swietenia* DC., *Diospyros montana* Roxb., *Pongamia pinnata* Pierre and *Sterblus asper* Linn. grow sparsely in the scrub. This type of vegetation is found in all the four areas.

The mixed deciduous type is characterised by the following species: Trees like *Anogeissus latifolia* Wall. ex Bedd., *Cassia fistula* Linn., *Dolichandrone arcuata* Clarke, *Emblica officinalis* Gaertn., *Hymenodictyon excelsum* Wall., *Mitragyna parvifolia* Korth., *Terminalia bellerica* Roxb. and *Vitex altissima* Linn. f. are common. The common shrubs are *Clerodendrum serratum* Moon, *Crotalaria verrucosa* Linn., *Eriolaena quinquelocularis* Wt. and *Sophora glauca* Lesch. Climbers like *Cryptolepis buchanani* R. & S., *Ipomoea muricata* Jacq., *Jasminum malabaricum* Wt. and *Thunbergia laevis* Nees are well represented. Among the herbs *Cleome monophylla* Linn., *Melochia corchorifolia* Linn. and *Sida acuta* Burm. f. are most

(Source : Naithani, 1966)

common. Good growth of grasses was found in bushy areas in open places. *Cymbopogon caesius* Stapf., *Eragrostis gangetica* Steud., *E. unioloides* Nees ex Steud. and *Themeda cymbaria* Hack. are the common ones.

Parasites like *Dendrophthoë falcata* (*Linn. f.*) Etting., *Viscum angulatum* Heyne ex DC. and *V. ramosissimum* Wall. are very common throughout the forest on deciduous trees.

The ponds and lakes inside the R. F. are populated with aquatics like *Lemna paucicostata* Hegelm., *Nymphaea nouchali* Burm. f. and *Pistia stratiotes* Linn. In marshy places *Hygrophila auriculata* (Schum.) Heyne, *Limnophyton obtusifolium* (*Linn.*) Miq. and *Typha angustata* Bory & Chaub. are the common species.

In the semi-evergreen type, trees like *Ficus glomerata* Roxb., *Glochidion ellipticum* Wt., *Ligustrum walkeri* Dene., *Olea dioica* Roxb., *Syzygium cumini* (Linn.) Skeels and *S. malabaricum* Gamb. are common. *Artemisia nilagirica* (Cl.) Pamp., *Pogostemon pubescens* Benth., *Xenacanthus pulneyensis* (Cl.) Brem. and *Rauvolfia densiflora* (Wall.) Benth. ex Hook. f. are some of the common shrubs, and intermixed with these, thick patches of *Bambusa arundinacea* (Retz.) Willd. and *Dendrocalamus strictus* Nees are encountered. Herbs like *Blumea membranacea* DC. var. *jacquemontii* (Hook. f.) Randeria, *Justicia nilgherrensis* Wall., *Launaea acaulis* (Roxb.) Babcock ex Craib and *Murdannia simplex* (Vahl) Brenan are seen growing abundantly.

It is interesting to note that at 1400 m epiphytes like *Aerides cylindricum* Lindl., *Cirrhopetalum fimbriatum* Lindl., *Coelogyne breviscapa* Lindl., *Dendrobium aqueum* Lindl. and *Liparis viridiflora* (Bl.) Lindl. grow abundantly. Pteridophytes like *Nephrolepis cordifolia* (Linn.) Presl., *Pteris quadriaurita* Retz. and *Pyrrosia acrostichoides* (Fost.) Ching are poorly represented in shady places. This type of vegetation occurs towards the Gopalswamy hills, situated at an altitudinal range of 1000-1400 m.

Buxa Tiger Reserve, Jalpaiguri, West Bengal

Approach : Rail Jalpaiguri, Air—Bagdogra

The Buxa Tiger Reserve in the district of Jalpaiguri lies in the hills south of Kalimpong division of Darjeeling district and the western part of Bhutan. The Buxa hills at the north eastern part occupy less than a hundredth part of a total area of 6,234.13 sq. km. These hills are the southern out-spurs of the hills of Bhutan and at Sinchula attain an elevation of 3,000 m. The hills on the north of the district usually rise abruptly from the plains while at some places the ground is slightly undulating at the foot of the hills.

The flat submontane country known as the Western Duars is made up of alluvium with deposits of coarse gravels near the hills, sandy clay and sand along the course of the rivers and fine sand consolidating into clay in the rest of the district. The beds of Buxa hills consist of variegated slates, quartzites and dolomites, and the low hills on the south belong to the upper tertiary strata.

The rainfall is rather heavy in this area (5323 mm). The monsoon current flows northwards and is deflected towards the west in northern Bengal so that the prevailing direction of the wind at Jalpaiguri during the rains is east or southeast.

The average rainfall of the district is 3925.1 mm (154.33").

The summer is rather hot excepting at Buxa Cantonment and the temperature is maximum in April.

A damp warm climate as is met with in the district of Jalpaiguri, usually favours the formation of a wet evergreen forest, but this is found only in small patches, while tropical semievergreen forests, moist Sal forests, reverine Khair Sisoo forests and the savannah forests are the different types of forests met with in that area.

Two broad types of savannahs occur in this area, the low-level and high-level savannahs. The low-level savannahs occupy low lying moist grounds containing a dense growth of tall grasses like *Phragmites karka* Trin., *Saccharum procerum* Roxb., *Erianthus elephantinus* Hk.f., *Anthistiria gigantea* Cav., *Saccharum spontaneum* Linn., etc. There are scattered trees on such savannahs and these are chiefly *Albizzia procera* Bth., *Salmalia malabarica* Scott. et Endl. *Bischopfia* Bl, *Syzygium cerasoides*. (Roxb.) Raizada and *Butea monosperma* O. Ktz. In the riverine alluvial savannahs *Dalbergia sissoo* Roxb. is dominant. The high level savannahs are situated on well drained soils where *Narenga porphyrocoma* (Hance) Bor is dominant. Other grasses in these tracts are *Saccharum arundinaceum* Retz., *Arundinella decempedalis* (O.K.) Janos, *Eulalia fastigiatus* Nees, *Cymbopogon nardus* (L.) Rendl. and *Imperata cylindrica* (L.) A. P. Beauv. These tracts favour growth of Sal, while the low-level savannahs are unsuitable in that respect.

(Source : Mukherjee, 1965)

Wherever silt deposit is formed on the riverbeds, tall grasses grow followed by a few herbaceous and shrubby plants and scattered trees covering the wasteland with a savannah type of vegetation. *Dalbergia sissoo* Roxb. and *Acacia catechu* Linn. gradually predominated and as associates of these two *Salmalia malabarica* Schott. & Endl., *Albizzia procera* Bth., *Randia dumetorum* Lamk. and *Albizzia odoratissima* Bth. established themselves. In such riverine forests, as the trees increased in number the grasses were killed out and other deciduous species of trees grew up, e.g., *Wrightia tomentosa* Roem. *Dillenia pentagyna* Roxb., *Sterculia villosa* Roxb., *Terminalia crenulata* Roth, with *Shorea robusta* Gaertn. But these savannahs fell prey repeatedly to fire which cleared the grounds for formation of fresh savannah. However fire-resistant species such as *Shorea robusta* Gaertn., *Careya arborea* Roxb., *Dillenia pentagyna* Roxb., *Syzygium cerasoideum* (Roxb.) Raizada, *Salmalia malabarica* Schott. & Endl. and a few others gradually invade the savannahs and slowly establish themselves killing out the grasses.

The most characteristic of the invasive trees are *Macaranga denticulata* Muell.-Arg., *Trema orientalis* Wall., and *Callicarpa arborea* Roxb., and *Alpinia allughas* Rosc.—a tall herb of the Zingiberaceae spreads very rapidly. Other deciduous trees such as *Sterculia villosa* Roxb., *Litsaea polyantha* Juss., *Terminalia bellirica* Roxb., *Gmelina arborea* Roxb., *Salmalia malabarica* Schott. & Endl., *Toona ciliata* Roem., *Lagerstroemia parviflora* Roxb., *Dillenia pentagyna* Roxb., *Careya arborea* Roxb. etc. soon occupy the place of the grass forming a mixed deciduous forest with *Shorea robusta* Gaertn.

Presence of sufficient moisture convert the deciduous forest to an evergreen by helping to establish such trees as *Amoora rohituka* W. & A., *A. spectabilis* Miq., *Meliosma simplicifolia* Walp., *M. pinnata* Maxim., *Turpinia pomifera* DC., *Phoebe lanceolata* Nees, *Litsaea sebifera* Pers., *L. citrata* Bl., *Cinnamomum obtusifolium* Nees, *C. cecicodaphne* Meisn., *Actinodaphne obovata* Bl., *A. angustifolia* Nees, *Cryptocarya amygdalina* Nees, *C. floribunda* Nees, *C. griffithiana* Wt., *Polyalthia simiarum* Bth. & Hk. f., *Saccopetalum longiflorum* Hk. f. & T., *Casearia kurzii* C. B. Cl., *Vatica lanceaefolia* Bl., *Walsura tubulata* Hiern, *Elaeocarpus varuna* Buch.-Ham., *E. rugosus* Roxb., *Dysoxylum procerum* Hiern., *D. hamiltoni* Roxb., *D. binectariferum* Hk.f., *Chisocheton paniculatus* Hiern., *Chukrasia tabularis* A. Juss., *Lophopetalum fimbriatum* Wt., *Kurrimia pulcherrima* Wall., *Pithecellobium angulatum* Bth., *Pygeum acuminatum* Colebr., *Tetrameles nudiflora* R. Br., *Symplocos spicata* Roxb., *S. caudata* Wall., *S. ramosissima* Wall., *Ehretia acuminata* R. Br., *Vitex heterophylla* Roxb., *Knema longifolia* Warb., and a few others. Shrubs like *Phlogacanthus thyrsiflorus* Nees, *Morinda angustifolia* Roxb., *Casearia vareca* Roxb., *Micromelum pubescens* Bl., *Coffea bengalensis* Roxb., different species of *Ixora*, *Clerodendrum* and *Bridelia* etc. with *Leea*, *Piper*, *Phyllanthus* and different species of Ferns form a dense undergrowth. Extensive climbers like *Spatholobus roxburghii* Bth., *Croton caudatus* Geisel., *Mucuna macrocarpa* Wall., *Milletia auriculata* Baker, *Mezoneurum cucullatum* W. & A., *Cissus*, *Smilax* and *Dioscorea* help to make the canopy more compact.

Corbett National Park, Garhwal, Uttar Pradesh

Approach : Rail—Ramnagar (Nainital), 50 km. Air —Phoolbagh (Nainital), 130 km.

Corbett National Park, earlier twice differently named, first as Hailey National Park, in 1935, and later as Ramganga National Park is situated in the foot hills of the Western Himalayas, along Delhi-Ranikhet National High-way between 29° 13'30"--29° 35'15" N and 78°46' 79°33' E. Originally comprising an area of about 324 sq km it now extends to 525 sq km. The park partly consists of the forest reserves of Ramnagar and Kalagarh division of Uttar Pradesh. The part in Kalagarh division includes the drainage area of the Ramganga river.

The natural forest of the park is confined to the Bhabar tract of Siwalik formation at altitudes 700-1500 m with varied topography of many temporary marshy depressions, ravines and plateau land (Patli Dun). The river Ramganga flows through the plateau in westward direction before it takes a southward turn at Doxar.

Geologically, the park belongs to Siwalik formation which is composed of conglomerates, sand rocks, and stones and boulders. The soil is alluvial, the river beds are composed of water borne debris of the granite core of the Himalaya, small rounded pebbles, scattered conglomerates, loose river gravel and sand.

The climate of the park area can be broadly distinguished as being cold from December-February with chilly and often frosty nights, at times with sufficient rains during this period, warm with sultry and high temperature from May-June, at times thunder showers with hail-stones not being unusual. Wet, warm and humid July-September with plenty of monsoon rains. During October-November with south-west monsoon retreating autumn prevails with clear days and moderate temperature. Spring is ushered in March-April, the period being quite pleasant with moderate warmth and fast growing vegetation all round.

The vegetation is a mixed one of deciduous tropical and subtropical species. Mention may be made of botanically interesting pockets in the park such as Dhulwa east, Dhikala, Dhanpadi nallah, Panoi nallah, Pater nallah (Paterpani block), Kanda, Domunda block. Riparian tract of Ramganga and the section Bijrani-Mailani.

The dominant tree species in the park is Sal *(Shorea robusta)*, forming pure stands. After crossing Gajar sot near the Sultan Forest Rest House, there is a particularly dense, pure population of these lofty trees. A frequent associate of Sal is *Adina cordifolia* with its buttressed base. *Holarrhena antidysenterica* also occurs scattered amidst the Sal. In open scrub land, one can easily spot *Bombax*

(Source : Pant, 1976)

Corbett National Park Pine Forest in Upper Reaches of Hills at Machan Tower (Ph- BSI, Dehradun)

ceiba the silk cotton tree. A few other easily noticeable trees in the park are *Anogeissus latifolia, Piliostigma malabarica, Bauhinia racemosa, Kydia calycina, Lagerstroemia parviflora, Cassia fistula*—the Indian Laburnum, *Semecarpus anacardium, Emblica officinalis* and *Ziziphus mauritiana.*

Some other miscellaneous deciduous species are *Holoptelea integrifolia,* or Indian Elm, *Careya arborea, Madhuca indica, Erythrina* sp. and *Butea* sp.

Among the evergreen trees along the dry nallahs and on exposed habitats occur *Wendlandia heynei, Mallotus philippensis, Syzygium cumini* or Black plum. The only indigenous conifer at Ghilmodya sot in the park boundary is *Pinus roxburghii.* Association of *Dalbergia sissoo—Acacia catechu,* along Ramganga river bordering Savannah at Dhikala is an interesting feature in the landscape of the park where a large area is covered with a dense growth of *Themeda arundinacea,* a tall wavy grass, bordered with *Thysanolena maxima* and *Vetiveria zizanioides.* Annually, after the burning of the dense dry grass of the savannah of Dhikala (Dhikala chaur) there spring up amidst the new culms many other herbaceous element. This temporary herbaceous growth constitutes the food of the herbivorous hog deer (Para) and spotted deer (Chital). Some of the easily noticeable herbaceous elements on Dhikala chaur are *Evolvulus alsinoides, Vicoa indica, Lactuca* sp., *Trichodesma indicum,* and species of *Ajuga, Polygala, Desmo-*

Corbett National Park : A view around Swamp (Ph- BSI, Dehradun)

dium, Crotalaria, Oldenlandia, members of Cyperaceae and terrestrial orchids such as grass like *Zeuxine* and tuberous *Eulophila* species with flowers in varying shades of pink-blue.

Apart from the savannah land of Dhikala, in quite a number of other spots also members of the Poaceae are widespread. Amongst these may be mentioned *Eulaliopsis binata, Apluda mutica, Oplismenus compositus* and *Eragrostis uniloides.* Of these, *Eulaliopsis binata*—the baib grass is of considerable commercial value being used in the paper industry.

At other places in the park amongst common shrubs mention may be made of *Clerodendrum viscosum.* This is a very close associate of Sal and densely gregarious. *Colebrookea oppositifolia, Pogostemon benghalense, Adhatoda vasica, Artemisia nilagirica, Spermadictyon suaveolens, Murrayya koenigii* (used in flavouring curries). *Rubus ellipticus, Ziziphus xylopyros, oenoplia. Glycosmis arborea* etc. form dense gregarious groups.

Still other shrubs of interest in the area are : *Helicteres isora, Moghania strobilifera, Sida cordifolia, Sida orientalis, Tephrosia candida, Carissa spinarum, Woodfordia fruticosa,* etc.

Among fleshy climbers, occasionally *Pothos* can be seen scrambling over the tall trunks of Sal trees. The lianoid climbers of common occurrence in the park area are *Milletia auriculata, Cryptolepis buchanani, Aspidopterys nutens, Vallaris solanacea,* etc. Forming a striking scene with its dense canopy of profuse flowers

covering small to tall trees, is another fairly common climber, *Porana paniculata*. Still another common climber is *Phanera vahlii*.

Parasitic plants, particularly the stem parasites, are easily noticeable due to their foliage, quite different from that of their host trees. These are *Dendrophthoe falcata* on *Shorea robusta*. *Scurrula pulverulenta* on *Boehmeria rugulosa* and *Shorea robusta*, *Scurrula cordifolia* on *Ougeinia oogeinensis*. *Cuscuta reflexa* covers many shrubs and low trees.

The epiphytic growth is scarce and consists of a few orchid species like *Vanda* and *Bulbophyllum*. There are numerous prostrate, selender herbs forming the ground cover. Of these the most noticeable, particularly in moist shady habitats is *Drymaria diandra* & other small spp.

Amongst some of the other familiar plants should be mentioned the bamboos. They occur frequently in several blocks of the park. There are practically no palms, excepting for the stemless *Phoenix acaulis* scattered at places along the park boundary and the quite rare palm *Wallichia densiflora* easily recognised by its large leaves, the leaflets dark green above and white beneath.

Mention should also be made of some of the non-flowering plants. In many cool, shady moist areas, often in gregarious patches, occur different species of ferns, all of them equally attractive due to their differently dissected leaves and the variously coiled young fronds. *Pteris* sp., *Adiantum* sp. etc. occur along running streams appearing almost like an arranged fernery. The snaketongued fern *Ophioglossum reticulatum* has been spotted below sal trees, and the horsetails or scouring rushes—*Equisetum* has been seen in clumps on sand banks along the river or stream margins.

The park with its falling trees, rotting trunks, and accumulating debris supports its due share of fleshy and other kinds of fungi and lichens. The liverworts and the mosses too are seen in their usual habitats, on moist trunks.

Indravati National Park, Bastar, Madhya Pradesh

Approach : Rail—Jagdalpur, 200 km. Air—Raipur, 490 km.

The Indravati area comes under Bastar district of Madhya Pradesh and lies south of Raipur between 19°0'-21°0' N and 81°0'-82°0' E and the altitude ranges from 400 to 1400 m. A major portion of this region forms the so-called Dandakaranya which is celebrated in the 'Ramayana' as the epic exile of Shri Rama; this region represents a broad stretch of land spread over three States—Andhra Pradesh, Madhya Pradesh and Orissa, reclaimed for rehabilitation purposes.

The common rocks are granites with granitoid gneiss, sandstones and laterites. Along the slopes of the hills in evergreen forests, the soil is fertile with rich black humus; in and around tanks and puddles, it is mainly clayey.

The amount of rainfall varies from east to west, from about 127 to 152 cm; the average daily maximum and minimum temperatures are 40°C in May and 11°C in December.

The vegetation at the foot and lower slopes of the hills is of the mixed deciduous type. Deciduous trees forming the chief components of these forests are: *Adina cordifolia, Anogeissus latifolia, Bombax ceiba, Boswellia glabra, Bridelia retusa, Buchanania lanzan, Cassia fistula, Cochlospermum religiosum, Gmelina arborea, Kydia calycina, Lannea coromandelica, Madhuca indica, Ougeinia oojeinensis, Semecarpus anacardium, Shorea robusta, Soymida febrifuga* and *Tectona grandis*. Some of the commoner climbers are: *Ampelocissus tomentosa, Combretum ovalifolium, C. roxburghii, Dalbergia volubilis, Gouania tiliaefolia, Hiptage benghalensis, Phanera vahlii, Ventilago calyculata and Zizyphus rugosa*. By about the middle of February, most of the trees, shrubs and climbers shed their leaves and the forests present a bare appearance. There are, however, a few evergreen trees like *Cipadessa baccifera, Linociera ramiflora* and *Mallotus philippensis* scattered all along the forests, but their distribution does not change the deciduous appearance of the forests.

The permanent undergrowth is rather sparse and consists of the following species: *Abutilon persicum, Andrographis paniculata, Azanza lampas, Blepharis maderaspatensis, Eranthemum purpurascens, Glycosmis mauritiana, Grewia hirsuta, G. rothii, Hemigraphis venosa, Lepidagathis incurva, Moghania paniculata, M. strieta, M. strobilifera, Peristrophe bicalyculata, Petalidium barlerioides, Phaulopsis dorsiflora, Triumfetta rhomboidea* and *Urena lobata*.

Evergreen forests occur in Kanger Valley, Dharba, Kutamsar and along the upper slopes of Bailadila. The vegetation here is dense, and trees like *Celtis cinnamomea, Callicarpa arborea, Eurya japonica, Symplocos laurina, Wendlandia*

(Source : Subramanyam & Henry, 1966)

heynei and *W. gamblei* are fairly well represented. The ground layer of these forests becomes dense immediately after monsoon and is made up of a number of herbs and cryptogams. The most common of these are *Aeginetia indica* (a complete root parasite with purple flowers), *Canscora decussata*, *C. diffusa*, *Celosia argentea*, *Commelina hasskarlii*, *Costus speciosus*, *Curcuma amada*, *Cyrtococcum oxyphyllum*, *Digitaria* spp., *Exacum bicolor*, *Floscopa scandens*, *Globba bulbifera*, *Lipocarpha argentea*, *L. triceps* and *Lygodium flexuosum*. Under the shade of trees and along the streams a number of ferns and fern allies, like *Adiantum philippense*, *Angiopteris evecta*, *Cyathea gigantea*, *C. latebrosa*, *Cyclosorus extensus*, *Schizoloma ensifolium*, *Ophioglossum reticulatum* and *O. polyphyllum* grow luxuriantly. Further, particularly amidst grasses where the soil is swampy, *Ophioglossum costatum* grows very well and some large-sized robust plants measuring up to 32 cm. were collected.

At Chapka and Jayathgiri water drains out continuously from natural springs and around them a compact closed swampy vegetation is seen. Populations of *Calamus rotang*, *Flagellaria indica*, *Pandanus tectorius* and *Smilax protifera* forming impenetrable bushes are met, amidst which are seen tall specimens of *Equisetum debile*, especially at Behatjeran near Jayathgiri. *Orthosiphon spiralis*, called commonly "Dr. Lim's diabetic tea" or "Java tea" also occurs along the outskirts of Jayathgiri. Near the Kutumsar caves, where the humus is rich and the humidity great, the rocks present a stratified appearance. On these rocks, where water drips constantly, populations of *Begonia picta*, *Epithema carnosum* and *Elatostema surculosum* are prominent.

Grasslands are on hill-tops particularly at Dharba and Narayanpur. The commoner grasses in almost pure formations are *Bothriochloa pertusa*, *Cymbopogon martinii*, *Eleusine indica*, *Eragrostis diarrhena*, *Heteropogon contortus*, *Pennisetum pedicellatum* and *Vetiveria zizanioides*. Other herbaceous plants found in these areas are *Acalypha ciliata*, *Alysicarpus bupleurifolius*, *Blechnum orientale*, *Coleus forskohlii*, *Crotalaria linifolia*, *Desmodium gyrans*, *Dicranopteris linearis*, *Exallage auricularia*, *Gonotheca ovatifolia*, *Pteridium aquilinum* and *Vernonia* spp. Amidst these, terrestrial orchids are present: *Habenaria decipiens*, *H. platyphylla*, *Liparis nervosa*, *Microstylis cardoni* and *Peristylus plantagineus*.

Since there are a number of tanks at the foot of these hills and in the plains which are wet and marshy during the rainy season, interesting aquatic and marshy plants are met with: *Nelumbo nucifera*, *Nymphaea nouchali*, *N. stellata*, *Nymphoides indicum*, *N. cristatum*, *Trapa natans* var. *bispinosa*, *Utricularia aurea* and *U. gibba* ssp. *exoleta*. Along the margin of the river Indiravathi near Chitrakut Falls *Cryptocoryne retrospiralis* was noticed in plenty. In a marshy rice field near Kondagaon a population of *Burmannia pusilla* with purple flowers was observed. Along the margins of a lake near Kanker a large population of *Isoetes coromandelina* was seen; and near the border of a tank in Kondagaon the tall erect sedge, *Elaeocharis acutangula* with triangular stems and terminal coneshaped spikes, was common; small, delicate herbs like *Microcarpaea muscosa*, *Mitrasacme alsinoides*, *Rotala densiflora*, *R. indica*, *R. rotundifolia* and *R. verticillaris* were also found in the same region.

Kanha National Park, Mandla & Balaghat, Madhya Pradesh

Approach : Rail-Air-Jabalpur, 170 km., Nagpur, 260 km.

The Park covers an area of 253 sq. km. of the forest of Mandla District. Two forest villages, *viz*., Kisli (512 m. above sea level) and Kanha (576 m. above sea level) are situated within the area of the Park. Apart from these, seven forest villages *viz*., Bamhni Daddar, Indri, Sonph, Silpura, Natigahen, Kisli-Bhilwani and Jhapal are situated along the boundry of the National Park. The Park is situated between 22° 13'-22° 22' N. and 89° 32'-89° 45' E. This area is essentially hilly and often very picturesque and rugged. There are also open maidans in the Park, near and around Kanha Rest House. The hills are typically flat-topped, the plateaux being locally known as "Daddara". They are characteristic of the district and occur at various elevations. In fact, the district extends over the highest plateaus of the Satpuras ranging from 457-762 m. above sea level. The successive elevations of valleys present a step-like formation from west to east. Further to the west, the valley of the Banjar river has a general height of *ca* 550 m. above sea level and that of the Sulkum *ca* 580 m. The principal river system in the Park is that of the Sulkum which is the chief feeder of Banjar river.

The average annual rainfall for the years 1870-1910 is 137 cm. for Mandla and 131 cm. for Dindori Tahsil. The maximum rainfall registered is 203 cm. for Dindori Tahsil in 1881 and minimum 59.7 cm. in 1886 in the same Tahsil. 5-8 cm. of rain may be expected during the spring and summer months, much of which falls in heavy showers between the middle of April and end of May. The average rainfall for the dry months is 13.8 cm. During the cold weather months of November to March, a very heavy dew falls and, in December and January there are occasional severe frosts, the temperature frequently falling as low as—5.6°C. The heat of the summer months is dry and healthy, and the nights are always pleasant. It appears that in the hottest days of the hot weather, the temperature never registers more than 40°C in shade, while in cold weather there are frequently one to ten degrees of frost in the open tracts.

The district is mainly covered by trap and its geology presents little variety. In the south, in immediate vicinity of the Banjar and eastwards as far as the Kawardha border, there is a narrow strip in which the crystalline formation is uppermost. East of the Banjar valley, granite, limestone and syanite also appear in some places on the edges of hills and nalas ; and occasionally, as for instance at Bamhni, Chiraidongri and Thawar, sandstone is uncovered.

The vegetation of the Park may be divided into four distinct types :

Sal Forest grows in rich profusion, unmixed with any other species and is practically evergreen. The best sal forest occurs on the porous, well-drained,

(Source : Maheshwari, 1983)

sandyloam soils derived from the disintegration of the mica schists and gneisses found in the greater part of the Banjar valley reserves.

Mixed Forest is most widely distributed among the forest types of Madhya Pradesh. It is found more particularly in the northern, central and western parts of Mandla district as well as in valleys and on the hill slopes of the Park. Here the growth of sal is poor and several other species characteristic of the district are found in this forest. The arboreal species most commonly found are :*Terminalia alata* Heyne ex Roth, *T. bellirica* Roxb., *T. arjuna* Wt. & Arn., *T. chebula* Retz., *Anogeissus latiolia* Wall., *Stereospermum suaveolens* DC. forma *suaveolens, Emblica officinalis* Gaertn., *Bridelia squamosa* Gehrm., *Mallotus philippensis* Muell.-Arg., *Bauhinia retusa* Buch.-Ham., *B. racemosa* Lamk., *Cassia fistula* Linn., *Piliostigma malabaricum* Benth., *Dugeinia oojeinensis* Hoch., *Pterocarpus marsupium* Roxb., *Dalbergia paniculata* Roxb., *Acacia catechu* Willd., *Albizzia odoratissima* Benth., *Sterculia urens* Roxb., *Boswellia serrata* Roxb. ex Colebr., *Syzygium cumini* Skeels, *S. fruticosum* DC., *Lannea coromandelica* Merr., *Buchanania lanzan* Spreng., *Semecarpus anacardium* Linn. f., *Ficus virens* Ait. var. *virens, F. glomerata* Roxb., *F. cunia* Buch.-Ham. ex Roxb., *F. gibbosa* var. *parasitica* King, *Mitragyna parvifolia* Korth., *Xeromphis uliginosa* Maheshwari, *Adina cordifolia* Hook. f., *Gardenia latifolia* Ait., *G. resinifera* Roth, *Garuga pinnata* Roxb., *Careya arborea* Roxb., *Bombax ceiba* Linn., *Madhuca indica* J. F. Gmel., *Lagerstroemia parviflora* Roxb., *Diospyros melanoxylon* Roxb., *Holarrhena antidysenterica* Wall., *Aegle marmelos* Corr., *Ziziphus xylopyra* Willd., *Z. rugosa* Lamk. and *Dendrocalamus strictus* Nees. The common shrubs and climbers in this forest are : *Woodfordia fruticosa* Kurz, *Carissa spinarum* Linn., *Nyctanthes arbor-tristis* Linn., *Flacourtia indica* Merr., *Helicteres isora* Linn., *Grewia subinaequalis* DC., *Ochna pumila* Buch.-Ham., *Olax scandens* Roxb., *Celastrus paniculata* Willd., *Indigofera pulchella* Roxb., *Securinega virosa* Pax & Hoffm., *Phoenix acaulis* Buch.-Ham. ex Roxb., *Combretum nanum* Buch.-Ham., *Xeromphis spinosa* Keay, *Mucuna prurita* Hook., *Bauhinia vahlii* Wt. & Arn., *Coccinia grandis* Voigt, *Diploclyclos palmatus* C. Jeffrey, *Cryptolepis buchanani* Roem. & Schult., *Hemidesmus indicus* Schult., *Ipomoea hederifolia* Linn., *I. maxima* Don ex Sweet, *I. pes-tigridis* Linn., *Dioscorea alata* Linn., *D. bulbifera* Linn., *Asparagus racemosus* Willd. and *Smilax zeylanica* Linn. Among herbaceous phanerogams may be noted : *Sida cordifolia* Linn., *Triumfetta rhomboidea* Jacq., *Crotalaria albida* Heyne ex Roth, *C. prostrata* Roxb., *C. medicaginea* var. *neglecta* Baker, *Desmodium gangeticum* DC., *D. heterocarpon* DC., *D. pulchellum* Benth., *Moghania bracteata* H. L. Li, *M. macrophylla* Kuntze, *M. nana* Mukerjee, *M. strobilifera* St. Hil. ex Jacks., *Osbeckia chinensis* Linn., *Peucedanum dhana* var. *dalzellii* Cl., *Pimpinella heyneana* Wall., *P. monoica* Dalz., *Oldenlandia gracilis* Hook. f., *Ageratum conyzoides* Linn., *Artemisia parviflora* Buch.-Ham., *Blumeopsis falcata* Merr., *Cyathocline purpurea* Kuntze, *Elephantopus scaber* Linn., *Emilia sonchifolia* DC., *Vernonia roxburghii* Less., *Vicoa indica* DC., *Lobelia heyneana* Roem. & Schult., *Campanula canescens* Wall. ex DC., *Wahlenbergia marginata* A. DC., *Evolvulus alsinoides* Linn., *Merremia gangetica* Cuf., *Nelsonia canescens* Spreng., *Micromeria capitellata* Benth., *Aerva sanguinolenta* Blume, *Rungia pectinata* Nees and *Orthosiphon rubicundus* Benth. The fern flora is represented by *Adiantum caudatum* Linn., *Cheilanthes farinosa* Kaulf., *Diplazium esculentum* Sw. and *Dryopteris prolifera* C. Chr.

Drosera burmanni Vahl and *Youngia acaulis* DC. grow frequently in open grasslands at Kanha and Kisli.

Rutea monosperma Taub. var. *monosperma* is common everywhere in the Park on cultivated and fallow lands. It springs up at once as a weed in black

soil areas of the Park. Besides, the common trees and shrubs in the open forest are : *Bombax ceiba* Linn., *Ziziphus mauritiana* Lamk., *Z. nummularia* Wt. & Arn., *Lagerstroemia parviflora* Roxb., *Madhuca indica* J. F. Gmel., *Calotropis procera* R. Br., *Cordia dichotoma* var. *wallichii* Maheshwari, *Ficus gibbosa* var. *parasitica* King and *Phoenix acaulis* Buch.-Ham. ex Roxb.

Grasslands are covered with luxuriant grasses, of which the common ones include : *Themeda quadrivalvis* Kuntze, *T. triandra* Forsk., *Iseilema prostratum* Anders., *Ischaemum indicum* Merr., *Dichanthium annulatum* Stapf, *Eragrostis unioloides* Nees ex Steud., *E. gangetica* Steud., *E. stenophylla* Hochst. ex Miq., *Cynodon dactylon* Pers., *Sacciolepis myosuroides* A. Camus, *Chloris dolichostachya* Lagasca, *Heteropogon contortus* Beauv. and *Eulalia trispicata* Henr. The line of demarcation, where the sal forests end and the grasslands begin, is always sharp and distinct, owing probably to frost or some unfavourable soil factors which are fatal to trees.

Bamboos grow in the Park along the banks of rivers and streams, in valleys and on hill slopes ; the only species met with in the forest is the Male Bamboo, *Dendrocalamus strictus* Nees.

The common habitats of the aquatic and marsh species in this area are a number of natural tanks and ponds (Shrawantalao, Deotalao), the rivers Kanhar, Banjar, Sulkum, Ganghar, Surwani, Surpan, Nila and their tributaries, irrigation channels and streams (Kanhanala, Salghatnala, Deshinala, Burburinala). The Banjar, Kanhar and Ganghar rivers flow in the western part of the Park and maintain a rich hydrophytic flora. The plants, to name the commoner ones, *Ammannia baccifera* Linn. ssp. *baccifera*, *Rotala rotundifolia* Blatt. & Hallb., *R. tenuis* Koehne, *Jussiaea suffruticosa* Linn., *Centella asiatica* Urban, *Hydrocotyle sibthorpioides* Lamk., *Ageratum conyzoides* Linn., *Caesulia axillaris* Roxb., *Xanthium strumarium* Linn., *Cyathocline purpurea* Kuntze, *Emilia sonchifolia* DC., *Sphaeranthus indicus* Linn., *Gnaphalium luteoalbum* ssp. *affine* Koster, *Canscora diffusa* R. Br., *Rotula aquatica* Lour., *Limnophila indica* Druce, *Lindernia anagallis* Pennell, *L. pyxidaria* All., *Mazus japonicus* Kuntze, *Mecardonia dianthera* Pennell, *Mimulus strictus* Benth., *Verbascum chinense* Sant., *Veronica anagallis-aquatica* Linn., *Salvia plebeia* R. Br., *Alternanthera sessilis* DC., *Polygonum barbatum* Linn., *P. plebeium* R. Br., *Mallotus philippensis* Muell.-Arg., *Juncus prismatocarpus* var. *leschenaultii* Buchenau, *Cyperus eleusinoides* Kunth, *C. pygmaeus* Rottb., *Fimbristylis dichotoma* Vahl, *Scirpus supinus* Linn., *Elytrophorus spicatus* A. Camus, *Imperata cylindrica* Beauv., *Saccharum spontaneum* Linn. and *Thysanolaena maxima* Kuntze, mainly constitute the vegetation of Banjar, Kanhar and Ganghar rivers, and their embankments.

In the neighbourhood of temporary ponds, puddles and ditches, a rich marsh flora is recognizable. The common species are : *Equisetum debile* Roxb., *Ceratopteris thalictroides* Brongn., *Marsilea quadrifolia* Linn., *Polycarpon prostratum* Aschers. & Schweinf., *Ammannia baccifera* Linn. ssp. *baccifera*, *Jussiaea suffruticosa* Linn., *Glinus oppositifolius* A. DC., *Centella asiatica* Urban, *Hydrocotyle sibthorpioides* Lamk., *Caesulia axillaris* Roxb., *Centipeda minima* A. Br. & Aschers., *Gnaphalium indicum* Linn., *Grangea maderaspatana* Poir., *Sphaeranthus indicus* Linn., *Canscora diffusa* R. Br., *Limnophila indica* Druce, *Mazus japonicus* Kuntze, *Mecardonia dianthera* Pennell, *Asteracantha longifolia* Nees, *Alternanthera sessilis* DC., *Rumex dentatus* Linn., *Polygonum barbatum* Linn., *P. plebeium* R. Br., *Eriocaulon quinquangulare* Linn., *Cyperus brevifolius* Hassk., *C. pygmaeus* Rottb. and *Fuirena ciliaris* Roxb. The vegetation of Shrawantalao

is mainly dominated by dense stands of *Polygonum limbatum* Meissn., *Nymphoides cristatum* Kuntze and *Aponogeton natans* Engl. & Krause.

The vegetation on the roads and pathways in the Park, along the sides of the road as well as in waste lands includes several weeds and weedy plants. All such man-made habitats are very susceptible to invasion of a weed flora which quickly occupies such areas unless they are properly cared for. Among the commoner roadside weeds, the following deserve mention : *Sida veronicifolia* Lamk., *Ziziphus nummularia* Wt. & Arn., *Cassia tora* Linn., *Blumea eriantha* DC., *B. fistulosa* Kurz, *B. lacera* DC., *B. mollis* Merr., *Launaea nudicaulis* Hook. f., *Tridax procumbens* Linn., *Vernonia cinerea* Less., *Evolvulus alsinoides* Linn., *Nelsonia canescens* Spreng., *Justicia diffusa* Willd., *Lepidagathis fasciculata* Nees, *L. hamiltoniana* Wall., *Boerhavia diffusa* Linn., *Amaranthus spinosus* Linn., *Euphorbia hirta* Linn., *Dichanthium annulatum* Stapf and *Eragrostis gangetica* Steud.

Among the foreign plants introduced and naturalized in the district, the following are noticeable : *Argemone mexicana* Linn., *Acanthospermum hispidum* DC., *Xanthium strumarium* Linn., *Gnaphalium purpureum* Linn., *Evolvulus nummularius* Linn., *Ipomoea hederifolia* Linn., *Mecardonia dianthera* Pannell, *Scoparia dulcis* Linn., and *Gomphrena celosioides* Mart.

Manas Tiger Reserve Sanctuary, Kamrup & Goalpara, Assam

Approach : Rail & Air—Gauhati

Manas Wild Life Sanctuary lies approximately between 26°30'-27° N and 91°-92° E. It is bounded in the north by the international bondary between India and Bhutan, in the south by the thickly populated regions of North Kamrup district of Assam; but in east and west, the different reserved forests of the sanctuary extend into other forests; at places they are separated by cultivated fields and gardens. Of the total area of 2837 sq. km. under the 'Tiger Project' in Assam, Manas has about 580 sq. km. It was established in 1928 and is named after the Goddess 'Manasa'.

The terrain is a flat land gently sloping to the south with a number of rivers draining from north to south. The main rivers are Manas, Mora-Manas (or Beki), Jongrong, Gyati, Chorphuli, Garuchara and Rabang. The climate is warm and humid. Maximum temperature goes upto about 37° C and the mean minimum temperature is about 11° C. The soil is deep alluvium.

The vegetation of Manas Wild Life Sanctuary can be broadly classified into three types:

(a) *Tropical semi-evergreen forests:*

Semi-evergreen patches occur chiefly along the northern part of the sanctuary, on the India-Bhutan international boundary. The common trees in these forests are *Aphanamixis polystachya, Anthocephalus chinensis, Syzygium cumini, S. formosum, S. oblatum, Bauhinia purpurea, Mallotus philippensis, Cinnamomum tamala, Actinodaphne obvata,* etc. These tree species occasionally form a dense canopy.

The undergrowth in these forests comprises mainly of *Leea aequata, Coffea bengalensis, Phlogacanthus thyrsiflorus, Adhatoda vasica, Clerodendrum viscosum, Holmskioldia sanguinea* and *Piper diffusum.*

(b) *Tropical moist and dry deciduous forests:*

This is the commonest vegetation type in the sanctuary. The common trees here are *Bombax ceiba, Sterculia villosa, Dillenia indica, D. pentagyna, Careya arborea, Lagerstroemia parviflora, L. speciosa, Terminalia bellirica, T. chebula, Trewia polycrapa, Gmelina arborea, Oroxylum indicum, Bridelia* spp. etc.

(*Source : Jain & Hajra, 1975*)

Manas Tiger Reserve : A Semi-evergreen Forest with Trees of Dillenia; Saccharum in foreground
(Ph- P. K. Hajra)

(c) *Alluvial grasslands:*

Extensive patches of grasslands are found in the western part of the sanctuary. They also occur in open areas at other spots. The common grass species are: *Apluda mutica, Brachiaria distachya, Capillipedium assimile, Chyrsopogon aciculatus, Cynodon dactylon, Cyrtococcum accrescens, Digitaria ciliaris, D. longiflora, Echinochloa colonum, Eleusine indica, Erianthus longisetosus, Hemarthria protensa, Imperata cylindrica, Neyraudia reynaudiana, Pogonatherum rufobarbatum, Polytoca digitata, Rottboellia exaltata, Saccharum procerum, S. spontaneum, Themeda villosa* and several species of the genera *Eragrostis, Panicum* and *Paspalum.* Several tree and shrub species grow scattered in the grasslands; these usually are *Dillenia pentagyna, Phyllanthus emblica, Bombax ceiba* and species of *Clerodendrum, Leea, Grewia, Premna* and *Mussaenda.*

There is considerable aquatic flora in the region. In addition to river banks and beds, there are numerous pools and puddles in the sanctuary, which have a variety of aquatic flora. The more common aquatic plants can be classified as below:

(a) Free-floating hydrophytes: e.g. *Azolla pinnata, Eichhornia crassipes.*

(b) Suspended submerged hydrophytes: *e.g. Ceratophyllum demersum.*

(c) Anchored submerged hydrophytes: *e.g. Limnophylla sessiliflora, Ottelia alismoides, Vallisneria spiralis, Cryptocoryne,* etc.

Manas Tiger Reserve : Trees of Bombax ceiba in a Saccharum Grassland (Ph—P. K. Hajra)

(d) Anchored hydrophytes with floating leaves: *e.g. Nymphaea nouchali, Nymphoides cristatum.*

(e) Anchored hydrophytes with floating shoots: *e.g. Limnophila heterophylla.*

(f) Emergent amphibious hydrophytes: *e.g. Polygonum posumbu, Typha elephantina, Monochoria hastata.*

(g) Wetland hydrophytes: *e.g. Cyperus brevifolius, Lasia spinosa* etc.

A special mention may also be made of the orchids and grasses in the flora; 15 species of orchids, 3 terrestrial and 12 epiphytic are known so far; 43 species of grasses belonging to 29 genera have been collected. Several exotic species have become almost completely naturalised in the area. Important among these are *Mikania micrantha, Eupatorium odoratum, Bidens biternata* and *Tridax procumbens* etc. *Mikania* is present in great abundance and is a very troublesome weed now. In adjacent forests, where silvicultural operations are necessary, the only way of containing it is mechanical, that is, cutting of stems above ground level.

The vegetation and flora of the Game Sanctuary has considerable utilitarian value. This Game Sanctuary is inhabited by such wild life as elephants, rhinoceros, deer, wild buffalo and Indian bison. Recently 'golden lengur' has also been reported from this sanctuary. These animals depend on the animals and plants of the sanctuary for their food. The information gathered from the staff of the

Manas Tiger Reserve : Dillenia indica
(Ph—P. K. Hajra)

wild life sanctuary and observations on animals actually eating some plants or sometimes observations on droppings suggest that the following plants are eaten by wild animals. The local names of plants are given against each species.

Alpinia allughas	'Tora'
Musa ornata	'Kal-Goss'
Saccharum procerum	'Kush-Bon' or 'Ikara'
S. spontaneum	'Kush-Bon'
Eichhornia crassipes	'Pani-Meteca'
Albizia odoratissima	'Sirish'
A. procera	'Koroi'
Bombax ceiba	'Simolu'
Dillenia indica	'Ou-Tenga'
Calamus floribundus	'Bet'
Ficus scandens	'Dimoru'
Lippia geminata	'Bon-Tulshi'
Alternanthera sessilis	'Mati Kaduri'
Oenanthe stolonifera	'Bon-Joni'
Hygroryza aristata etc.	'Dal-Ghah'

The flora of the sanctuary includes also some well-known medicinal and economic plants such as: *Phyllanthus emblica* L., *Terminalia bellirica* (Gaertn.) Roxb., *T. chebula* Retz., *Rauvolfia serpentina* (L.) Benth. ex Kurz, *Hodgsonia macrocarpa* (Bl.) Cogn., *Stephania hernandifolia* (Willd.) Walp., *Dillenia indica* L., *Gmelina arborea* L., *Toona ciliata* Roem, *Calamus floribundus* Griff., *Dioscorea bulbifera* L. and *D. pentaphylla* L.

Melghat Tiger Reserve Sanctuary, Amaravati, Maharashtra

Approach : Rail –Badnera 124 km., Air—Nagpur, 260 km.

The north-western compact block of forests extending over 3,075 sq. km. in the Amravati district of Maharashtra State is known as Melghat. Within Melghat, the Tiger reserve covers 1,489.95 sq. km. of area between the latitudes 21.15°N and 21.45°N and longitudes 76.57°E and 77.30°E. The reserve occupies portions of East and West Melghat Forest divisions of Amravati circle and forms a part of southern branch of Satpura range known as Gawilgarh hills. Dhakna-Kolkaa wild life sanctuary is included in the reserve. The area of *sanctum sanctorum* which falls in West Melghat division is 308.86 sq. km. The entire area of the Tiger reserve is extremely hilly and provides excellent habitat for wildlife. The highest point in the reserve is 992 m. above M.S.L.

The vegetation as such depends upon the climatic, edaphic and biotic factors. The annual rainfall occurs mostly during monsoon, and varies from 1000 mm. to 2250 mm. with the change in altitude and topography, so also the minimum and maximum temperatures which fluctuate considerably in the three different seasons. The soil types also vary, probably due to changing conditions of weathering and variations in rainfall. Bouldery soil mostly occurs on slopes, clayey soil in depressions and on level areas and lateritic loam on hill tops and plateaus. The biotic interferences are minimum and grazing is restricted. In this context, the Tiger reserve contains a suitable vegetation cover of dry and mixed deciduous forests which are fairly well described in the 'Forest Flora of Melghat' by R I. Patel (1968), at present the only consolidated account of the flora available for Melghat region in general. However, major portion of the reserve generally occurring between 300—900 m alt. contains forests of *Tectona grandis* L. which forms nearly 30—70% of the growing stock and in some pockets in valleys it is almost pure.

Alongwith the Teak in the forests, *Adina cordifolia, Anogeissus latifolia, Lagerstroemia parviflora, Mitragyna parvifolia, Terminalia tomentosa, T. bellirica, Dalbergia paniculata, Garuga pinnata, Pterocarpus marsupium, Schrebera swietenioides, Schleichera oleosa, Sterculia urens* etc. are some of the other associates met with. The understorey consists of *Lannea coromandelica, Diospyros melanoxylon, Wrightia tinctoria, Boswellia serrata, Kydia calycina, Cassia fistula, Ziziphus mauritiana, Z. xylopyra, Dendrocalamus strictus* and the likewise. The frequently met with shrubs are *Helicteres isora, Azanza lampas, Grewia abutilifolia, Casearia graveolens, Eriolaena quinqueloculoris, Colebrookia oppositifolia, Leea macrophylla, Woodfordia fruticosa* etc. The herbaceous cover varies with the density of the forest. In dense and shady areas, it is poor with some root

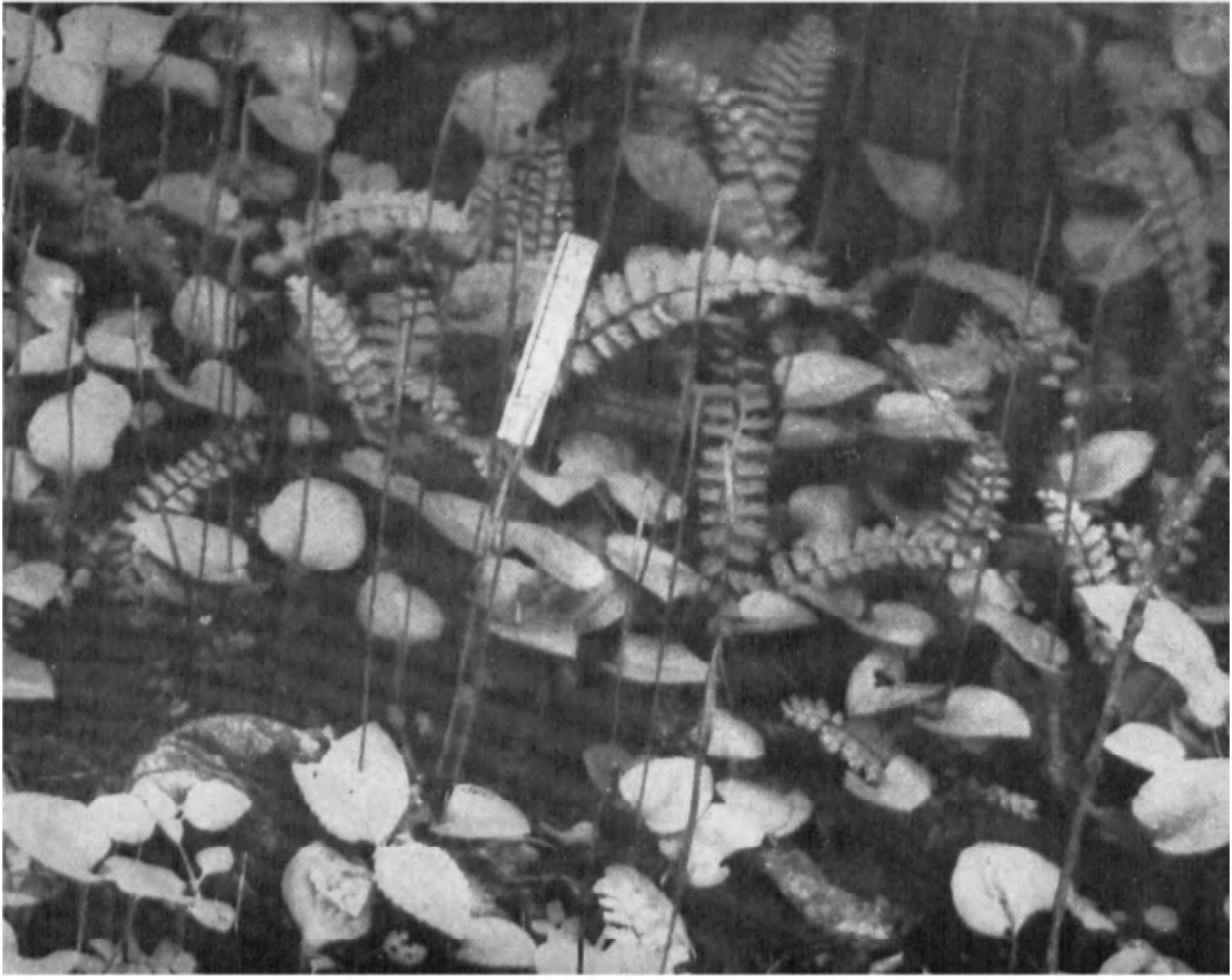
(Source : Ansari, 1983, tour report)

Melghat Tiger Reserve : Teak Forest with Anogeissus, Terminalia, Mitragyna etc.
(Ph- BSI, Pune)

parasites, terrestrial orchids, ferns and *Ophioglossum* sp. In open forests, quite a good growth of grasses and other herbs like the species of *Cleome, Polygala, Sida, Urena, Corchorus, Triumfetta, Impatiens, Biophytum, Alysicarpus, Crotalaria, Desmodium, Indigofera, Zornia, Cassia, Ageratum, Blumea, Exacum* sp. are observed. The frequently met with climbers are *Clematis triloba, Aspidopteris cordata, Mucuna prurita, Celastrus paniculata, Ventilago* sp., *Millettia auriculata, Phanera vahlii. Cryptolepis buchanani*, species of *Dioscorea* and *Acacia pennata*. Species of *Aerides, Rhynchostylis* and *Vanda* are common epihytic orchids. *Ceropegia odorata*, an interesting species, is extremely rare. Besides, there are forests of *Ougenia oojeinensis* on top of higher hills showing stunted growth of trees and forests of *Boswellia serrata* in some parts of Tarubanda range.

Melghat Tiger Reserve : Envete superba
(Ph- BSI. Pune)

Melghat Tiger Reserve : Population of Costus speciosus
(Ph-BSI. Pune)



Melghat Tiger Reserve : Undergrowth in Forest (Ph—BSI, Pune)

Nagarjuna Sagar Srisailam Sanctuary, Andhra Pradesh

Approach: Rail & Air—Hyderabad

The Nagarjunakonda valley, situated in the Nalconda district of the Krishna basin regions in Andhra Pradesh lies between 16°00′ and 17°01′ N. and 78°78′ and 80°00′ E. The valley has recently come into prominence owing to the massive dam across the river Krishna, as well as the archaeological excavations, made in the valley that depict the culture and civilization of the 2nd century A.D. The river Krishna flows through the valley in an eastward direction and the dam is constructed at a place called Vijayapuri.

The valley is surrounded by the Nallamalai hills on the southern and eastern side while the river Krishna, which flows in a south-west to north-east direction forms the boundary line on the other side. The altitude of the hills varies between 300 and 400 metres. The valley is more or less flat, while the slopes of the hills are well drained.

The Krishna basin lies entirely in the tropical zone with its typically hot and arid climate. The hottest months are from March to June, the temperature rising upto to 43°C. The annual rainfall varies between 59 and 76 cm. The rains are brought about by the south-west monsoon which prevails from June to October.

Geologically the rocks of the Nallamalai range belong to what is known as the Cuddapah system. They consist of quartzites and some sand-stones, overlaid with slaty formations which are soft and irregular in cleavage. The soil is of purana and archaean type, consisting of sandstones, quartzites and granite complex. It is red and loose and is devoid of humus.

The vegetation can broadly be classified into: 1. The vegetation of the plains, composed largely of herbs together with a few shrubs and rarely of trees, 2. Scrub-jungle at the foot of hills, 3. Thorn forests on the slopes of hills and 4. Dry deciduous forests at hill top.

The vegetation of the valley and plains consists for the major part of herbaceous plants together with a few shrubs, leaving little tree growth. Originally the valley too must have been a typical scrub-jungle which has now become denuded of its character due to human agency. This is evidenced by the presence of scrub-jungle all round the foot of the hills and to some extent interior in the plains.

Majority of the herbaceous plants in the valley are annuals and there is a distinct, seasonal succession of vegetation in the valley. Plants of the monsoon period are noted for their associations. Important associations of this type are *Cleome-Heliotropium*, *Tephrosia-Heliotropium* and *Cleome-Tribulus-Tephrosia*. *Cleome*

(*Source : Thothathri, 1964*)

viscosa is one of the most dominant plant, found everywhere in the valley. It grows in association with *Heliotropium zeylanicum* and *Tephrosia purpurea*, the former occurring in large populations and noted for its profuse blooming. *T. purpurea* is now rapidly spreading in the valley. *Tribulus terrestris*, a prostrate herb with yellow flowers is very common with other herbs such as *Evolvulus alsinoides* and *Boerhavia diffusa*. In the post-monsoon period, *Tephrosia hirta* and *Waltheria indica* are the most dominant plants in the valley. Associated with the above plants are *Indigofera cordifolia*, a wooly herb with pink flowers. *Crotalaria medicaginea*, *C. ramosissima*, *Corchorus trilocularis*, *C. aestuans* and a number of grasses. Among the other common plants in the valley, mention must be made of *Indigofera enneaphylla*, *Oldenlandia umbellata*, *Portulaca oleracea*. *Fusticia vahlii*, *F. diffusa*, *Dipteracanthus prostratus*, *Citrullus colocynthis*, *Polycarpaea corymbosa*, *Fimbristylis dichotoma*, *Borreria articularis*, *Cyperus rotundus* and *Blepharis maderaspatensis*. A few rare plants such as *Striga gesneroides*, *S. lutea*, *Trichodesma indicum*, *Dicoma tomentosa* and *Mollugo cerviana* grow interspersed with the above plants.

Members of the grass family flourish well in the valley, especially near the foot-hills where they form clear associations. Near Siddhartha hills, *Heteropogon contortus* and *Chrysopogon fulvus* from large associations while *Perotis indica*, *Aristida adscensionis* and *Eragrostiella bifaria* are the dominant grasses in other areas. The less common grasses are *Tetrapogon tenellus*, *Chloris barbata*, *Eragrostis tenella* var. *plumosa*, *Echinochloa colona*, *Dactyloctenium aegyptium*, *Aphida inutica*, *Bothriochloa pertusa*, *Eleusine indica* and *Cynodon dactylon*.

The plants that constitute the shrubby growth in the valley are *Cassia auriculata*, *Tephrosia hirta*, *Lepidagathis cristata*, *Securinega leucopyrus*, *Capparis stylosa*, *Helicteres isora*, *Ziziphus mauritiana* and *Vitex negundo*. *Waltheria indica*, a pubescent undershrub with yellow flowers occurs abundantly at foot-hills. Near Siddhartha hills *Melhania hamiltoniana* with its orange coloured flowers and *Solanum pubescens* are the dominant plants, the latter forming large populations. The valley is devoid of tree growth except a few like *Wrightia tinctoria* var. *rothii*, *Salvadora persica* and *Borassus flabellifer*. *Salvadora persica* is a small sized tree, growing to a height of 10 metres and is always found in moist, sandy soil.

A kind of marsh vegetation, composed mostly of sedges and a few herbs is noticeable near the river side. Important sedges are *Scirpus affinis*, *Fimbristylis dichotoma*, *F. ferruginea*, *Cyperus corymbosus* and *Pycreus globosus*. *Bacopa monnieri* grows in large numbers near the side of a streamlet. Its associates are *Ammania baccifera*, *Stemodia viscosa* and *Polygala erioptera*. *Acanthospermum hispidum* and *Xanthium strumarium* are the two principal plants, growing near the river side.

Foot-hill vegetation is composed of thorny shrubs and climbers which constitute a typical scrub-jungle, throughout the foot of the Nallamalai hills. *Acacia latronum*, *A. chundra* and *Dichrostachys cinerea* are the principal and dominant, thorny, xerophytic plants. *Grewia rotundifolia* is another shrubby tree, found all over the foot-hills, as well as on the slopes. This plant is noted for its abundance as well as edible fruits. The fruits are collected and eaten by the local tribes called 'Lambadi'. Another prominent shrub that grows with *Grewia rotundifolia* is *Premna latifolia* var. *mollissima*. Associated with *Acacias* and *Dichrostachys* are two, large, shrubby *Euphorbias*, namely, *Euphorbia antiquorum* and *E. nivulia*. A few undershrubs are not uncommon such as *Waltheria indica*, *Pavonia zeylanica* and *Indigofera hirsuta*. These shrubby plants are covered with a number of climbers such as *Cissus quadrangularis*, *Asparagus racemosus*, *Cardiospermum halicacabum*, *Abrus precatorius*, *Sarcostemma acidum*, *Blastania garcini*, and *Coccinia cordifolia*. Herbaceous undergrowth consists of *Dipteracanthus prostratus*, *Justicia glauca*, *Hibiscus micranthus*, *Eragrostiella bifaria*, *Aerva monsoniae* and *Glossocardia bosvallea*.

Thorn forests on hill-slopes of the Nallamalai hill range are well drained. Xerophytic plants grow well on the slopes. The floristic composition at lower elevations is more or less similar to that in foot-hills. *Grewia rotundifolia* is again the most dominant plant in this zone and its associates are *Euphorbia antiquorum*, *E. nivulia*, *Premna latifolia* var. *mollissima* and *Ziziphus oenoplia*. Of the climbers, *Cissus quadrangularis*, *Cardiospermum halicacabum*, *Sarcostemma acidum*, *Merremia aegyptica*, *Rivea hypocrateriformis*, *Ipomoea obscura*, *I. pilosa* and *Jacquemontia paniculata* are the important ones. Majority of the climbers belong to the family Convolvulaceae and possess showy flowers. *Grewia orientalis*, *Helicteres isora* and *Capparis sepiaria* constitute the less common shrubs. *Pavonia zeylanica* and *P. odorata* are the two, noteworthy undershrubs, found everywhere in the slopes. The ground cover is made up of herbs like *Cyanotis tuberosa*, *Hibiscus micranthus*, *Commelina longifolia*, *Cleome felina*, *Portulaca oleracea* and grasses like *Eragrostilella bifaria*, *Schima nervosum*, *Apluda mutica* and *Aristida hystrix*.

Dry deciduous forests at hill-top of the Nallamalai hill range is peculiarly flat enough for long distances and the vegetation is largely composed of dry, deciduous trees with a good undercover of shrubs. Grassland formation is a noteworthy feature. The tree growth are mainly *Bauhinia racemosa*, *Albizzia amara*, *Cassia fistula* and *Commiphora roxburghii*. Major portion of the forest growth is due to *Mundulea sericea*, a shrubby tree which occurs in large populations. *Niebuhria apetala*, *Ziziphus xylopyrus*, *Cissus vitiginea* and *Pterolobium indicum* are some of the rare plants in the hill-top. A few shrubs such as *Barleria acuminata*, *Carissa spinarum* and *Jasminum auriculatum* are not uncommon. The forest floor is covered with *Dipteracanthus prostratus*, *Aerva monsoniae*, *Justicia glauca*, *Merremia hastata*, *M. tridentata* and *Cymbopogon flexuosus*.

Namdapha Wild Life Sanctuary, Tirap, Arunachal Pradesh

Approach : Rail—Ledo, 90 km., Air-Chabua, 175 km.

(Salient features of the flora of proposed Namdapha biosphere reserve)

Namdhapa (means : mountain river) harbours the most extensive and wide range of natural primary vegetation types and extends over Lohit and Tirap districts in the south eastern part of Arunachal Pradesh. The topography is quite varied and hence congenial to harbour different ecosystems; the area is studded with a conglomeration of mountains of different altitudes in a very irregular pattern, ranging from 300 m to about 4,500 m. As a result a few minutes drive or trecking brings one of the vista of vast stretches of mountains and valleys concealed previously and also one can not escape noticing the change of directions of the sun from left to right or from back to the front thus affecting the duration and quantum of light and rainfall received by the different parts of the reserve and also the free flow of winds. Consequently there is an admixture of tropical, sub-tropical, temperate and even sub-alpine elements in the area. Some of the high mountains in the area are Champai Bum (2,950 m.), Dapha Bum (4,578 m.), Teng Bum (1,653 m.) and Nanon Bum (1,465 m.). There is no mountain within the reserve which excels the altitudinal limit of vegetation.

A preliminary analysis and critical study of collection have brought to light the presence of species hitherto known only from other parts of Himalayas, China, Burma, Thailand, Malesia, Malaya and other parts of India, especially S. India etc. It is interesting to record here the cardinal point that the area proposed for the Biosphere Reserve is least affected by human interference, since the tribal settlement is nil and the primary vegetation is intact without being affected by shifting cultivation. The area receives heavy rainfall both from N.E. monsoon and S.W. monsoon (3,000-4,000 mm.) practically throughout the year. The forests of the Namdapha are well watered not only by the incessant rains but also by many perennial rivers and numerous seasonal rivulets, traversing in all possible directions in tortuous course, like the circulatory system of the body and ultimately emptying their waters into the main river Noa-Dahing which inturn joins the mighty Brahmaputra as one of the tributaries. Some of the other rivers are Namdapha, Daban, Nampuk, Tilung, Korvaiwa, Longkar, Nshong Kha, Lali river, Namtiking river, Kumchai Kha and Legep Kha.

The vegetation of the Namdapha area is very luxiriant. The unique geographical position, varied topography, high annual precipitation spreading throughout the year coupled with varied photoperiodic effects, minimum devastation of the climax vegetation by natural calamities and human interference make it one

(Contributed by J. Joseph & A. S. Chauhan, Botanical Survey of India, Shillong)

of the largest and richest stores houses of Botanical treasure in the world. The genetic diversity met with both in the wild species and the cultivated ones of this region as a whole is enormous and fantastic and perhaps it may be one of the active speciation zones of the world.

Tropical and sub-tropical evergreen forests predominate in this area. It is interesting to observe that the forest type, though occupy, in general up to 100 m. altitude, still accomodate many typical sub-tropical and even temperate taxa betraying the latitude. Similarly, sub-tropical evergreen types of vegetation, though occupy between 1,000-2,000 m., there is a good admixture of taxa of typical tropical and temperate origin, although either the latitude or the altitude hardly permits their occurrence. Beyond the 2,000 m. altitude climax vegetation changes to temperate mixed forests of conifers—oaks Betulas and Rhododendron association. This is the case with climax vegetation of other North Eastern region also. The application of conventional criteria of the vegetational classification miserably fails in this part of India. It is unique in that the zonation of vegetation is either quite obscure or sets in quite imperceptibly.

The top canopy is formed of lofty trees of clear boles of 30-70 m. high and with canopy towards the apex only, looking very unproportionate to the tall boles. They are *Aquilaria agallocha, Dysoxylum binectariferum, D. humiltonii. Terminalia belerica, T. myriocarpa, T chebula, T. citrina, Elaeocarpus varunua, E. ganitrus, E. floribundus, Canarium resiniferum, Dipterocarpus turbinatus, D. macrocarpus, Anthocephalus chinensis, Acrocarpus fraxinifolius, Amoora wallichii, Cinnamomum obtusifolium, C. tamala, C. cecicodaphne, Toona ciliata. Bischofia javanica, Castanopsis* spp.. *Shorea assamica, Quercus dealbata, Pterospermum lanceaefolium, Mesua ferrea. Stereospermum chelonoides, Pterospermum acerifolium* and *Morus leavigata.* Some of the common large trees forming lower layers of the canopy are *Lagerstroemia flosreginea, Spondias mangifera, Myristica kingii, Beilschmiedia assamica, Talauma hodgsoni, Crateva nurvula, Syzygium praecox. Ailanthus grandis, Mangifera sylvatica, Cryptocarya amygdalina, Michelia champaca, Hydnocarpus* sp., *Gynocardia odorata, Artocarpus lakoocha. Ficus* spp., *Magnolia griffithii, Premna bengalensis, Gmelina arborea. Callicarpa arborea, Macaranga denticulata, Mallotus albus, Syzygium jambolana, Zizyphus* sp., *Echinocarpus assamicus, Michelia manii, Talauma phellocarpa, Albizia procera, Bridelia retusa, Beilschmiedia brandisii, Schima wallichii, Phoebe* sp., *Albizia lucida, Dillenia indica, Michelia montana, Trema orientalis, Michelia oblonga, Kydia calycina.*

Both types of forests –tropical evergreen and sub-tropical evergreen are dense with thick undergrowths of rhizomatous herbs, twining shrubs, climbers, bamboos and seedlings of various species of at different stages of development. Another feature of the forests is the lack of clear cut storey formation of the vegetations. Perhaps the vigorous as well as copious natural regeneration which is at work continuously throughout the year owing to the conducive climatic and edaphic conditions, probably obliterate the formation of different storeys of vegetation. Again spatial distinction between the top most canopy and the immediate lower one is quite obstruse although, horizontally the top canopy is well interrupted and discontinuous as the canopy spread of individual trees is very much limited and quite unproportionate to the very tall boles which support it. Very many different kinds of trees of all sizes grow together with broad and tall buttresses to anchor firmly from uprooting during stormy winds, supporting woody climbers, hosting multitude of epiphytic orchids, ferns, hepatics and lichens; and shrubs and herbs of different dimensions and habits to form an entangled carpet of luxuriant vegetation.

The following are the common tall perennial grasses among the wayside thickets: *Phragmatis karka*, *Saccharum spontaneum*, *Imperata arundinacea*, *I. cylindrica*, *Erianthus* sp., *Miscanthus* sp., etc. Besides, the common woody climbers are, *Heptapleurum venulosum*, *Entada scandens*, *Dircengia* sp., *Ficus* sp., *Smilax* sp., *Vitis* sp., *Combretum* sp., *Uncaria* sp. etc. *Gnetum gnemon*, the large climbing gymnosperm, could also be located in this region.

Orchids of different habits and habitats are prolific in this proposed Biosphere Reserve because of high humidity and of lofty evergreen trees which afford perch for numerous epiphytic ones. More than 100 species could be collected from this region. Some of the common terrestrial orchids of the humus covered forest floor are *Calanthe* sp., *Phaius* sp., *Habenaria* sp., *Goodyera procera* etc. But orchids of epiphytic habits out numbered the former group. Genera like *Bulbophyllum*, *Coelogyne*, *Eria*, *Pholidota*, *Orochilus*, *Dendrobium*, *Saccolabium*, *Liparis* etc. are well represented by different species. Since they are one main trunks of lofty trees, collection of them becomes a very difficult task. The study of the orchid flora of this large proposed Biosphere Reserve merits separate independent treatment after intensive collection and critical studies because of the richness, diversity of habits and habitats. Special equipments and arrangement of collection of them from lofty trees and also from different ecological nitches of the steep ravines are *sine qua non*. A thorough survey of this group would bring to light many orchids of ornamental value hitherto not known for commercial exploitation and for hybridisation programme; and also new ones unknown to the orchid world.

The forests abound in different species of *Calamus*, some of the common ones are *Calamus latifolius*, *C. tenuis*, *C. erectus*, *C. floribundus*, *C. flagellum*, *C. garuba* etc. and also bamboo like *Bambusa tulda*, *Dendrocalamus hamiltonii*, *Bambusa baloca* etc. The climbing bamboo *Teinistachym* sp. abounds in the sub-tropical forests. So also *Neohouseous* sp., the evergreen tufted bamboo which forms large impenetrable thickets in the forests. These two groups (Canes & Bamboos) too merit separate study based on intensive collection. The forest is also very rich in ferns and fern-allies, liverworts and lichens although Gymnosperms are quite conspicuous by their absence in the sub-tropical climax vegetation. About 300 species of ferns could be collected from this region. Our knowledge regarding liverworts and lichens is inadequate. Few morphologically distinct wild seed bearing *Musa* spp. could be located in many parts of the forests. In certain localities they form pure stands, but in other parts grow intermixed. The dwarf variety, *Musa rosea*, has been found flowering gregariously during the June-July. It is unique in that the short spadix is held erect at the apex with spreading bright brick-red spathes which open more or less simultaneously. Other variety of *Musa* is very tall with pendulous spadix and red spathes. A wild *Citrus* could be located in many places of the sub-tropical forests. Besides, palm like *Pinanga gracilis*, *Zalacca secunda*, *Wallichia densiflora*, *Livistona jenkinsiana* are found throughout the forest among other thickets. But *Phoenix rupicola*, a tall coconut tree-like palm is found only in restricted places on steep slopes of deep ravines in gregarious patches very inaccessible for collection. But *Caryota urens* is not commmon; although noticed in one or two places in the lower altitudes. On a previous exploration a new dwarf, reed-like palm could be discovered from the Dapha Bum foot hills of Lohit district (*Asraoa triandra* Joseph) which could also be located in this forest.

Rare and interesting large root parasite *Rhopalocnemis phalloides* (Balanophoraceae) could be collected in the sub-tropical evergreen forest near 40th mile Camp growing solitary or in cluster on the roots of Vitaceae host plant. The female inflorescence is very large and fleshy *ca* 25 cm. tall and 10-15 cm. in circumference, brown to rusty brown in colour, ovoid to oblong. *Sapria himalayana*,

another very large and rare root parasite belonging to the family Rafflesiaceae and *Aegenetia involucrata* (Orobanchaceae) could also be collected from this region.

The wild mango, *Mangifera sylvatica*, with its long pendulous bunches of beaked fruits could be located in many places in the forest around 40th mile Camp. Mature fruits are pinkish red with thick leathery edible skin and with very thin non-fibrous pulpy covering over nut.

Scarcity of perennial stagnant large water sources in this area is indeed a lacuna for the study of hydrophytes, although a few small lakes and 'Jheels' are located here and there. Some of which are silt lakes and other hot springs. The study of the vegetation in and around such hot springs and silt lakes might through some light on the plant indicator of the environment.

The selective felling of the *Aquilaria agallocha* from the Reserve forest surrounding Namdapha for "Agar" extraction on contract basis has been started which may perhaps be a potential threat to those trees of Biosphere Reserve which abounds with them, unless effective steps are taken in time. Another tree which is often wounded for its resin is *Canarium resiniferum* (Dhoop) is also found in abundance in this forest.

Thus it may be seen that the above proposed Namdapha Biosphere Reserve fulfils a number of criteria laid down by UNESCO in Biosphere selection viz. effectiveness of conservation, representativeness in terms of the flora of the region, in the richness of genetic diversity in respect of wild relatives and primitive cultivars of our crop plants.

Palamu Tiger Reserve, Daltongunj, Bihar

Approach : Rail—Chipadohar, 80 km. Air--Ranchi, 180 km.

The Palamau tiger reserve lies in the Western part of the Chotanagpur Plateau, Bihar state and covers an area of about 930 sq. km. of forests and lies approximately between 23°25′—23°55′ N and 83°50′ to 84°25′ E. Major portions of the Daltongunj South division, smaller part of the Garhwa South, Latehar and Ranchi West division are included in this Reserve.

The most remarkable topographic feature of the area is the prolongation of Neterhat Plateau with outlying spurs and slopes. The undulating hill tracts from the Ranchi South spread over between the Auranga and the North Koel rivers. The hill ranges are composed of granitic horneblend and calcarious gneisses. Bauxite, Coal, Dolomite, Iron-ore, Lime stone and mica also occur. Soils are of lateritic sandy loam type.

Climatically the area falls under dry to moderately dry tropical zone with heavy rainfall during the wet season. The summer temperature ranges from 19° to 45°C (March-June) and winter temperature ranges from 3° to 26°C (Dec.-Feb.). Average rainfall ranges from 600 to 1100 mm and sometimes it becomes much less causing severe drought condition. Drainage system of the reserve is by three main tributaries of the river North Koel namely Auranga, Burha and Pandra.

The undulating or gently sloping hill tracts in between the Auranga and the north Koel rivers of the Palamau Project Tiger area express the magnificent beauty of the eastern Peninsular forests dominated mainly by dry Peninsular 'Sal' moist Peninsular 'Sal' dry deciduous forests mixed with bamboo.

The vegetation chiefly comprises of moist deciduous and dry deciduous forests with *Shorea robusta* (Sal) as the dominant tree species. At places, large areas of 'bamboo brakes' of *Dendrocalamus strictus* are seen in the dry deciduous forests.

The other tree species which are typical associates of the dry peninsular Sal forests are : *Terminalia tomentosa, Ougeinia oojeinensis, Sacropetalum tomentosm, Bauhinia retusa, Diospyros melanoxylon* and *Anogeissus latifolia.*

In the moist sal type, the forests are composed of *Boswellia serrata, Dendrocalamus strictus, Bridelia retusa, Schleichera trijuga, Mitragyna parvifolia, Soymida febrifuga, Holarrhena antidysenterica, Gmelina arborea* and others.

(Source : Banerjee & Singh, Tour notes, 1983)

The dry mixed deciduous type are formed by *Acacia catechu*, *Mallotus philippensis*, *Lannea coromandelica*, *Kydia calycina*, *Aegle marmelos*, *Bombax ceiba*, *Hymenodictyon excelsum*, *Dendrocalamus strictus* and others.

The grassland formations on alluvial plains mainly consist grasses such as *Themeda quadrivalvis*, *Apluda mutica*, *Heteropogan contortus*, *Dichanthium annulatum* mixed with herbaceous legumes and other weeds.

The ground flora consisting of herbaceous species becomes conspicuous mostly during monsoon season.

Periyar National Park, Idukki, Kerala

Approach : Rail—Kottayam, 112 km. Air—Cochin, 200 km. Madurai—140 km.

Periyar Tiger Reserve is located in the western slopes of the southernmost part of the Western Ghats. The reserve has been the old hunting grounds of the erstwhile princely state of Travancore, and, presently covers an area of about 780 sq km. The terrain is chiefly hilly and forested and surrounds the much-branched Periyar Lake which covers an area of about 25 sq km. The lake forms one of the main attractions of the Reserve, which was created in a valley of the hills nearly a hundred years ago for irrigation-cum-hydel project. Most of the wildlife viewing is done from boats cruising in the Periyar Lake.

The surrounding hills of the lake are densely wooded and shelter a variety of wild animals.

The forests in this reserve are generally of tropical evergreen type with trees forming large canopy such as : *Artocarpus hirsutus* Lamk., *Dysoxylum malabaricum* Bedd., *Calophyllum elatum* Bedd., *Ficus travancorica* King, *Poeciloneuron indicum* Bedd., *Cullenia exarillata* Robyns, *Acrocarpus fraxinifolius* Wt., *Hopea parviflora* Bedd., *Antiaris toxicaria* Lesch., *Filicium decipiens* Thw., *Palaquium ellipticum* (Dalz.) Engl. and *Vateria indica* L. The evergreen forests composed of the above tree species occur at Kulamavu and Kanjiar.

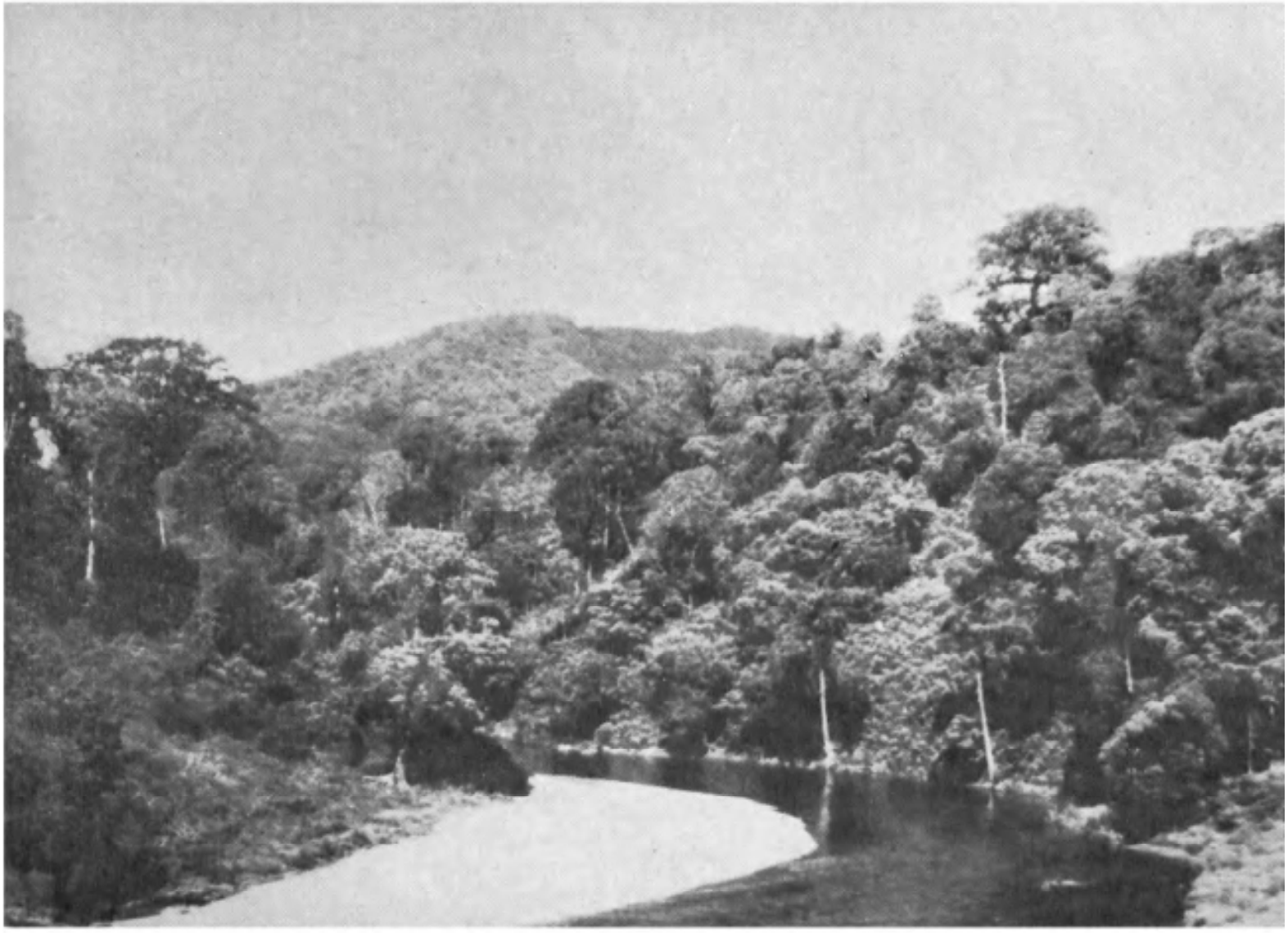
In certain disturbed and degraded areas of the reserve, semi-evergeen and moist deciduous forests consisting chiefly of tree species like *Careya arborea* Roxb., *Dillenia pentagyna* Roxb., *Actinodaphne malabarica* Balakr., *Elaeocarpus tuberculatus* Roxb. and *Terminalia paniculata* Roth, etc. are seen.

In relatively undisturbed areas in the vicinity of Panamkutty about 20 km downstream of the river Periyar, the vegetation is characteristically riparian with rheophytes and is dominated by *Cinnamomum riparium* Gamble, *Garcinia* sp., *Homonia riparia* Lour. and *Syzygium occidentale* (Bourd.) Gandhi.

The forests in the vicinity of Painavu and Meenmutty are subjected to heavy exploitation and the grasslands are being replaced by plantations of *Eucalyptus* sp. Similarly, pepper is being cultivated on a large scale towards Kattappana along the hill slopes. Crops of paddy, arecanut, banana, coconut and tapioca that are raised in the adjoining areas of Panamkutty also have claimed vast areas of natural forests in the reserve.

The natural forests in this reserve are still the home of several endemic and endangered species of flora; *Desmos lawii* (Hook. f. & Th.) Safford, *Meiogyne ramarowii* (Dunn.) Sinclair, *Orophea uniflora* Hook f. & Th., *Polyalthia coffeoides*

(Source : Reports on Idukki Project, B.S.I., Coimbatore)



Periyar National Park : Tropical Evergreen Forest (Ph—BSI, Coimbatore)

(Hook. f. & Th.) *Atuna travancorica* (Bedd.) Koster., *Didymocarpus fischeri* Gamble, *Kunstleria keralensis* C. N. Mohanan & N. C. Nair, and *Peucedanum anamallayense* C.B.Cl. serve as some of the best examples of these.

However, with the increased biotic factors in the reserve, several exotic and noxious weeds such as species of *Eupatorium*, *Lantana camara* L. var. *aculeata* (L.) Mold., *Mikania cordata* (Burm. f.) Robins., *Stachytarpheta indica* (L.) Vahl, and *Xanthium strumarium* L. are intruding into the forest openings and forest margins.

Ranthambore National Park, Sawaimadhopur, Rajasthan

Approach : Rail-Sawaimadhopur, 11 km., Air-Jaipur 132 km.

Ranthambore Tiger Reserve National Park is situated on Bombay-Delhi broad-gauge route and is accessible through Sawai Madhopur Railway Station (361 km. from Delhi); the latter is also approachable through road and a metre-gauge railway route from Jaipur (132 km.) The Park is spread over an area of 392.30 Sq. km. approx., in the *Anogeissus* and mixed miscellaneous forest vegetation on the Aravallis and Vindhyan ranges.

Like other forest ranges, these forests also have suffered biotically at the hands of man and his domesticated animals. However, some of the forests were saved in the past by the former rulers of the erstwhile princely States, who maintained them as game-reserves and these are maintained now by the forest departments of the State for the preservation of wild-life.

The locality comprises of hilly tracts, water bodies and narrow plains around the lakes and for the sake of convenience of study the vegetation is enumerated in different heads as under:

1. Plants of aquatic habitats.
2. Grasses.
3. Carpet vegetation on gravelly slopes.
4. Rainy season herbaceous flora in plains.
5. Annual climbers.
6. Perennial vegetation.

Plants of the aquatic habitats: *Phoenix sylvestris* usually occur near water-bodies. This is also true for *Ficus racemosa* in this area. Another species which grows in such habitats is the small tree, *Tamarix aphylla*. Hydrophytes, in reality, are not many in number.

Anchored species: *Vallisneria spiralis* and *Blyxa echinosperma* are the main submerged anchored species. However, occurrence of other submerged species is not ruled out.

Amongst the floating leaved anchored species, *Nymphaea nouchali*, *N. stellata* and *Nymphoides cristatum* are quite common.

Aeschynomene indica, *Bergia ammannioides*, *Dopatrium junceum*, *Hydrolea zeylanica*, *Limnophila indica*, *Pseudoraphis spinescens*, *Sesbania bispinosa*, *Vetiveria lawsonii* and *V. zizanioides* are the prominent emergent anchored species. Floating

(*Source: Sharma, 1983*)

shoot anchored species are represented by *Ipomoea aquatica*, *Ludwigia adscendens* and *Neptunia oleracea*.

Floating species: *Trapa natans* var. *bispinosa* are floating, but are anchored during the juvenile phase. Other floating species are *Pistia stratiotes* and *Spirodela polyrhiza*.

Suspended species: *Ceratophyllum demersum* are the sole suspended species noticed so far.

Some plants occur in marshes. At least in some phase of their life, preferably in the initial phase, they remain under water. Technically they are known as wetland hydrophytes. Some noteworthy species of this category are as follows:—

Amischophacelus axillaris, *Bacopa monnieri*, *Desmodium triflorum*, *Eclipta prostrata*, *Eriochloa procera*, *Hackelochloa granularis*, *Hemarthria compressa*, *Ludwigia perennis*, *Melochia corchorifolia*, *Murdannia vaginata*, *Oryza nivara*, *Paspalidium flavidum*, *Phyla nodiflora*, *Rottboellia exaltata* and *Xanthium indicum*.

Plants that grow in water, but come to live on dry soil as a result of evaporation or consumption of water from the water bodies, are classified as plants of dry phase; some such species from the area are: *Aerva sanguinolenta*, *Corchorus capsularis*, *Echinochloa colonum*, *Emilia sonchifolia*, *Glinus lotoides*, *Gnaphalium luteo-album* s. sp. *affine*, *G. luteo-album* var. *pallidum*, *Lindernia ciliata*, *L. multiflora*, *Oldenlandia corymbosa* and *Phyllanthus virgatus*.

Grasses: Thirty species of grasses have been recorded in the National Park, two of them being perennial. Following eight are valuable as fodder: *Chloris virgata*, *Dichanthium annulatum*, *Echinochloa colonum*, *Hemarthria compressa*, *Heteropogon contortus*, *Pennisetum pedicellatum* and *Themeda quadrivalvis*.

Vetiveria zizanioides, a common perennial on banks of ponds, carries little fodder value, but it is a source of extraction of 'khas', a scent. Its root are used for making screens for cooling the rooms. Other species of *Vetiveria*, *V. lawsonii* yield better scent, it is reported.

Carpet vegetation on gravelly slopes: Carpet vegetation consists of 22.6% grasses and 21.4% forage plants; annuals are dominant in this category.

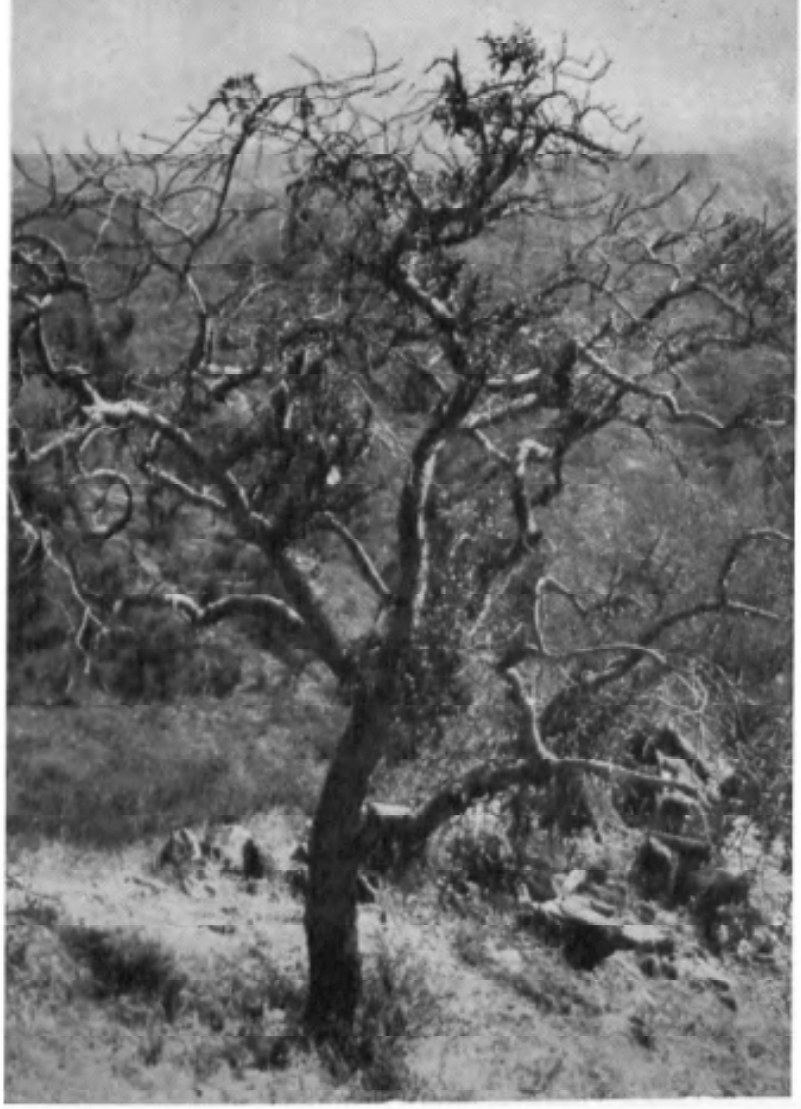
During the rainy season, *Cassia pumila*, *Euphorbia parviflora*, *Evolvulus alsinoides*, *Glossocardia bosvallea*, *Lepidagathis cristata*, *Tephrosia strigosa* and *Tridax procumbens* are the main prostrate herbs; *Cyanotis cristata* grow in between stones, where the soil is scanty; *Kickxia ramosissima* and *Lindenbergia muraria* occur as 'Calcicoles.'

Borreria stricta are seen as gregarious, tiny, erect herbs. Other erect herbs of the season, growing on gravel are: *Anisochilus carnosus*, *Bidens biternata*, *Cassia absus*, *Cleome viscosa*, *Desmodium repandum*, *Hibiscus lobatus*, *H. ovalifolius*, *H. vitifolius*, *Indigofera caerulea*, *Indoneesiella echioides*, *Lactuca remotiflora*, *Leucas cephalotes*, *Sclerocarpus africanus*, *Tephrosia villosa* and *Tirumfetta rhomboidea*.

Some of the grasses are also restricted to gravel, *viz.*, *Arthraxon prionodes*, *Chrysopogon polyphyllous*, *Melanocenchris jacquemontii* and *Pennisetum pedicellatum*.

Rainy season herbaceous flora in plains: Some note-worthy species are:

Acalypha ciliata, *A. indica*, *Alysicarpus buperifolius*, *A. vaginalis* var. *heterophyllus*, *Amaranthus tricolor*, *Blumea mollis*, *Cassia occidentalis*, *Corchorus aes-*



Ranthambore Tiger Reserve :
Boswellia serrata
Ph- BSI. Jodhpur

tuans, C. olitorius, C. trilocularis, Crotalaria medicaginea, C. triquetra, Indigofera astragallina, I. trita, Leucas aspera, Macrotyloma uniflorum, Martynia annua, Mollugo pentaphylla, Pedalium murex, Phyllanthus asperulatus, Physalis minima, Pupalia lappacea, Solanum nigrum, Vigna mungo, V. radiata, Waltheria indica and *Zornia gibbosa.*

Commonly occuring grasses are *Chloris dolichostachya, Eragrostis gangetica* and *Heteropogon contortus.*

Some species that grow equally well on gravel and sandy-clay are *Boerhavia diffusa, Cassia tora, Celosia argentea, Ocimum canum* and *Trichodesma amplexicaule.*

Annual climbers: Some annual species, since they are weak-stemmed, climb or twine around a support of other plants, usually. Some note-worthy of the latter category are:—

Atylosia scarabeoides, Ipomoea eriocarpa, Ipomoea nil, I. muricata, Macrotyloma uniflorum, Vigna mungo and *V. radiata.* Some have tendrils as organs for climbing viz., *Cardiospermum halicacabum, Ctenolepis cerasiformis, Cucumis setosus, Diplocyclos palmatus, Luffa acutangula, Momordica balsamina, M. charantia, M. dioica, Trichosanthes bracteolata* and *T. cucumerina.*

Cuscuta reflexa, *Striga angustifolia* and *S. lutea* parasitise various species during the rainy season.

Perennial vegetation: Perennial vegetation is represented by shrubs and trees. Most of the climbing shrubs are twiners except *Gloriosa superba* which climbs with the help of leaf-apices modified into tendrils. The noteworthy twiners are: *Abrus precatorius*, *Clitoria ternatea*, *Dioscorea bulbifera*, *Pergularia daemia*, *Gymnema sylvestres*, *Ichnocarpus frutescens*, *Mucuna pruriens*, *Rhynchosia capitata*, *R. minima*, *R. pulverulenta* and *Teloxma pallida*. A climber, *Oxystelma secamone* is seen in marshy areas, climbing upon *Typha* spp.

Erect shrubs on the gravel are *Barleria cristata*, *B. cuspidata*, *B. prionitis*, *Melhania futteyporensis*, and large shrubs like *Dyerophytum indicum*, *Grewia damine*, *G. flavescens* and *Plumbago zeylanica*. On relatively drier hills are the clumps of *Euphorbia neriifolia*, sometimes the only vegetation there. *Capparis sepiaria* var. *incanescens* often acquire a straggling habit.

Shrubs on sandy areas are *Crotalaria burhea*, *Mimosa rubicaulis*, *Securinega leucopyrus* and *Waltheria indica*.

Trees: Like other areas on Aravallis, *Anogeissus pendula* associated with co-dominent species *Acacia catechu* from the climax vegetation. Other commonly occurring tree species are *Diospyros montana*.

In open spaces, deciduous spiny trees dominate, viz. *Acacia leucophloea*, *A. senegal*, *Dichrostachys cinerea*, *Ziziphus trinervia* and *Z. xylopyra*.

Bambusa arundinacea is found scattered in moist shady gravel. Some trees have been planted e.g. *Bauhinea variegata*, *Eucalyptus* spp., *Melia azedarach*, *Pithecellobium dulce* and *Prosopis chilensis* etc.

Three hundred and five species, belonging to 217 genera and 70 families have been recorded from Ranthambhore Reserve National Park. The ratio between monocots and dicots comes to 1:5 at the species level, 1:4 at generic and 1:6 at the family level.

Seventy-three of the species are trees, besides 3 cultivated species; 13 are shrubs, 13 perennial climbers and 16 are annual climbers; 7 are undershrubs and rest are herbs. One species is a partial root-parasite, one is a total stem-parasite and 20 are adopted to an aquatic mode of life. There are 31 grasses, two of which are perennial.

One hundred and five species are of medicinal importance; eight of the grasses have good fodder-value. Fruits of *Ceratophyllum demersum* provide food for ducks, *Vallisneria spiralis* is grown in home aquaria and *Nymphaea* spp. are cultivated as ornamental plants. Fruits of *Diospyros montana* and the spongy petioles and peduncles of *Nymphaea pubescens* are edible. 'Khas' derived from *Vetiveria zizanioides* and *V. lawsonii* is used by man for cooling, and various other purposes *viz.*, as a scent, essence for syrups etc.

Similipal National Park, Mayurbhanj, Orissa

Approach : Rail—Baripada, 50 km. Air—Bhubaneshwar, 400 km.

Similipal National Park is located in the Mayurbhanj district of Orissa State and comprises an area of about 2,750 sq km (Lat. 21°30'-22°10' N and Long. 86°-87°E).

The area represents a compact block of hilly tracts ranging from 300-1250 m, the highest peak being the Meghasini. The high plateau consists of gneiss with laterite. The hills consists of shales, phyllites, haematite, iron schists with quartz veins, clay, slates and sand stones.

The area experiences monsoonic climate with an average rainfall ranging between 1500-2000 mm. The average maximum and minimum temperatures vary from 23°C to 10°C respectively. Burhabalanga, Palpala, Bandan, Khairi and Deo are the main rivers in this area.

The vegetation in the area is divisible into semi-evergreen forests, Moist Deciduous forests, Dry Deciduous Hill forests and Grasslands. However, Sal (*Shorea robusta*) forms the dominant species for a major part of these forests.

The semi-evergreen forests are usually met with in deep moist valleys and are formed of *Michelia champaca, Artocarpus lakoocha, Toona ciliata, Mangifera indica, Ailanthus excelsa, Mesua ferrea, Stereospermum suaveolens, Xylia xylocarpa,* and *Bridelia retusa.* Along stream beds in the moist and shady valleys *Salix tetrasperma, Trewia nudiflora, Macaranga peltata, Saraca indica, Pongamia pinnata, Diospyros peregrina, Syzygium cumini* are commonly noticeable. Along the higher damp hill slopes, the main forest trees are of *Bombax ceiba, Alstonia scholaris, Polyalthia cerasioides, Anthocephalus cadamba, Dillenia pentagyna* mixed with species of *Ficus, Litsea* and *Citrus.*

The moist deciduous forests are found all over the area except in the deep moist valleys and Sal forms the dominant species (50-80%) of the standing crop. The common associate species of Sal are species of *Terminalia, Pterocarpus marsupium, Anogeissus latifolia, Schleichera oleosa, Adina cordifolia.* Other species such as *Toona ciliata, Michelia champaca, Mangifera indica, Bombax ceiba, Careya arborea, Dillenia pentagyna, Gmelina arborea, Kydia calycina, Lagerstroemia parviflora* and such other moisture loving species also occur in certain areas.

The Dry Deciduous forests are usually seen with trees of *Anogeissus latifolia, Sterculia urens, Boswellia serrata, Dalbergia latifolia, Cleistanthus collinus, Eryth-*

(Source : Sastry, unpublished notes & tour reports)

rina suberosa and *Cochlospermum religiosum*. *Nyctanthes* and *Helecteres* are the common shrubby species.

The grasslands are found on hill tops and plateau areas that lie above 900 m altitude. These grasslands attain lush growth during the monsoon and are dominated by several species of *Dicanthium*, *Imperata*, *Arundinella*, *Bothriochloa*, *Cymbopogon*, *Heteropogon*, *Themada* and *Pseudanthistiria* and are associated with legumes and compositae weeds. In some places, poorly grown specimens of species of *Dillenia*, *Symplocos*, *Shorea* and *Emblica officinalis* are seen.

Imperata cylindrica, *Saccharum spontaneum*, *Eulaliopsis binata* and *Thysanolaena maxima* are the other grasses that grow along nalas.

The chief climbers are *Bauhinia vahlii*, *Milletia auriculata*. *Smilax macrophylla* and *Combretum decandrum*. *Gnetum* sp. occurs rarely in cool shady moist river gorges.

The herbaceous flora is rich and becomes conspicuous only during rainy reason.

Sundarban Tiger Reserve, 24-Parganas, West Bengal

Approach : Rail--Port Canning, 48 km. Air—Calcutta, 112 km.

The Sundarban Tiger Reserve is a part of the Ganga-Brahmaputra deltaic complex, which falls in two countries, viz., India and Bangladesh. The whole estuarine complex is approximately 9000 sq. km. and perhaps represents the world's largest stand of mangrove. Of this, about 2000 sq. km. of estuarine area falls in the Indian territory in the State of West Bengal. Much of this mangrove forest area has been lost in the recent years particularly due to reclamation for agricultural needs.

The entire mangrove forest in this estuarine complex is called Sundarban, owing to the dominance of the tree species, *Heritiera fomes*, which is locally called 'Sundari', because of its elegance. The area enjoys more or less tropical climate because of its situation at approx. lat. of 22°N. However, the temperature, rainfall and humidity are greatly influenced due to cyclonic storms that usually develop in the Bay of Bengal during the months from August to December.

The geomorphological and salinity conditions in this region also greatly vary from place to place, and have a great role to play in the formation of different types of vegetation and their composition.

The estuarine vegetation can be categorised under two distinct soil-vegetational types, viz., Euestuarine and Pro-estuarine, which are further classified into sub-types.

In the Gangetic Sundarban of West Bengal, the euestuarine type is composed of gregarious growth of *Nypa fruticans* Wurmb. and *Phoenix paludosa* Roxb. Of these, the latter occurs in pure formations along elevated fringes and drier border lands. *Aegialitis rotundifolia* Roxb. grows abundantly in inundated areas near the sea. *Porteresia coarctata* (Roxb.) Tateoka, is usually seen in the newly formed tidal flats. The tidal mangrove of the proestuarine complex type, which forms the main mangrove vegetation, usually occurs along the margins of creeks and other sheltered areas that lie slightly away from the mouths of the estuarine regions. This type of vegetation is best represented by dense and often gregariously growing tree and shrubby species such as *Aegiceras corniculatum* Blanco. *Avicennia* alba Bl., *Ceriops decandra* (Griff.) Ding Hou. *Kandelia candel* (L.) Druce, *Rhizophora mucronata* Lamk., and *Xylocarpus granatum* Koenig.

Behind this zone, salt tolerant freshwater plants such as *Amoora cucullata* Roxb., *Brownlowia tersa* (L.) Koster., *Bruguiera gymnorrhiza* (L.) Lamk..

(Source : Rao & Sastry, 1974 a, b; Blasco et al, 1974)

Sundarban Tiger Reserve. Heritiera fomes, showing buttresses and pneumatophores (Ph— L. K. Banerjee)

Clerodendrum inerme Gaertn., *Excoecaria agallocha* L., *Heritiera fomes* Buch.-Ham., *Lumnitzera racemosa* Willd., *Pongamia pinnata* (L.) Pierre, and *Sonneratia apetala* Buch.-Ham. grow densely. *Acanthus ilicifolius* L. grows gregariously along water margins of several creeks. The commonly noticeable prickly and woody climbers are *Caesalpinia bonduc* (L.) Roxb., *C. crista* L., *Dalbergia spinosa* Roxb., *D. candenatensis* Prain and *Derris trifoliata* Lour., which usually grow in slightly high elevated fringes.

In cleared froests, the so-called mangrove fern, *Acrostichum aureum* L., usually grows.

Sundarban Tiger Reserve: Rhizophora with stilt roots and pneumatophores (Ph— P. Sanyal)

The high hinterlands of the mangrove areas are usually degraded saline banks and support halophytic vegetation with species of *Suaeda, Salicornia* etc.

Several species of mangrove vegetation present very interesting biological features such as the xerophytic features of plants in having very thick leaves with waxy cuticles, puroduction of stilt roots, pneumatophores, knee-roots and viviparous germination. These are adaptative features of these species which enable them to survive in the extreme ecological conditions that prevail in these regions.

Sundarban Tiger Reserve Machanakhal · Pneumatophores seen (Ph—P. Sanyal)

Sundarban Tiger Reserve: Mangroves; Ceriops tagal, showing viviparv (Ph P. Sanyal)

Bori Wild Life Sanctuary, Hoshangabad, Madhya Pradesh

Approach : Rail- Itarsi, 104 km. Air -Bhopal, 200 km.

The area stretches between 77°45' to 78°30' E. Long. and 22°15' to 22°30' N. Lat. on the southern slopes of Satpura Range in the Hoshangabad District.

The altitude of the area under study ranges from 300 to 700 m., and in the Pachmarhi area altitude goes a little over 1000 m. There is hardly any perennial natural water source in the area, though there are many swiftly flowing temporary streams and rivulets traversing the forests at many places, besides ponds and puddles. The fairly big Towa river, near Bunglapura too gets dried up during dry months leaving few stagnant pools of water here and there along her course. A few hills like *SAKOTT* hill, *GOITU DEO* hill which are the outspurs of Satpura ranges protrude into the area. The altitudes of them hardly go above 700 m. The undulating forest floor mainly consists of fertile black-cotton soil, mixed with sandy loam. However, in the hills, soil is chiefly composed of sand stones and shales and basaltic rocks. The rain commences more or less in the middle of June, and the season protracts almost till the end of September. But it is during the months of July and August the area receives maximum record of rain, rendering the streams and rivers unpassable. The average rainfall of the area is 175 cm. The average maximum temperature is 40°C and 8°C is the average minimum in the winter.

The climax vegetation is typically of a dry deciduous type. The reclamation of land has led to the vanishing of virgin forests from a large area around Bunglapura. On the contrary around Churna, Dhain and Bori, vast areas of undisturbed forests are met with. As for the main components of the vegetation, there is hardly any change throughout the forest. The dominant tree species of the forests are *Anogeissus latifolia, Tectona grandis, Terminalia* spp., *Adina cordifolia, Aegle marmelos, Mitragyna parvifolia, Manilkara hexandra, Ficus* spp., *Lagerstroemia parviflora, Chloroxylum swietenia, Buchanania lanzan, Soymida febrifuga, Cassia fistula, Pongamia pinnata, Dalbergia sissoo, Diospyros melanoxylon, Syzygium cumini* and *Grewia tiliaefolia*. The best teak forest-tracts are met with nearer to Bori. It is interesting to observe that *Madhuca indica* a common and abundant tree around Churna is not met with in the forests around Bori. The undergrowth vegetation includes characteristic shrubs of *Helicteres isora, Grewia hirsuta, G. rothii, Celastrus paniculata, Ziziphus* spp., *Meghania sentialata, Mimosa himalayana, M. rubicaulis, Lawsonia inermis, Xeromphis spinosa, X. uliginosa, Carissa congesta, Petalidium barlerioides, Lantana camara* var. *aculeata, Baliospermum montanum, Securinega leucopyrus, Homonoia riparia* and *Boehmeria scabrella*. Near Dhain and Bori there are vast forests of *Dendrocalamus strictus*. In general

(Source : Joseph, 1963)

the ground cover is chiefly composed of different members of Gramineae, such as *Aplida mutica, Chloris dolichostachya, C. virgata, Dichanthium annulatum, Digitaria adscendens, Heteropogon contortus, Iseilema laxum, Manisuris forficulata, Melanocenchris jacquemontii, Panicum miliare, Pennisetum pedicellatum*, etc. as well as of Papilionaceae, such as *Alysicarpus hamosus, A. vaginadis, Crotolaria hirta, C. albida, C. linifolia, Desmodium diffusum, D. rotundifolium, Eleiotis sororia, Zornia diphylla, Teramnus labialis, Indigofera linnaei*, etc. Amidst the grasses in the open fields and also among the undershrubs the following herbaceous plants are commonly observed : *Cleome viscosa, Polygala chinensis, P. elongata, Polycarpon prostratum, Sida acuta, S. cordifolia, Urena lobata, Triumfetta rotundifolia, Mollugo pentaphylla, Borreria articularis, Acanthospermum hispidum, Eclipta prostrata, Elephantopus scaber, Tridax procumbens, Vernonia cinerea, Xanthium strumarium, Plumbago zeylanica, Canscora diffusa, Heliotropium scabrum, Trichodesma indicum, Leucas* spp., *Achyranthes aspera* var. *argentea, Aerva lanata, Alternanthera nodiflora* var. *dichotoma, Celosia argentea, Pupalia lappacea, Euphorbia hirta, E. parviflora, Costus speciosus* and *Curcuma amada*. Throughout the forests the undergrowth vegetation has been entangled by the numerous plants of climbing habit, such as *Ampelocissus latifolia, Cissampelos pareira, Passiflora foetida, Bryonopsis laciniosa, Momordica dioica, Clematis triloba, Lygodium flexuosum, Gymnema sylvestre, Hemidesmus indicus, Argyreia bracteata, A. involucrata, Ipomoea muricata, Dioscorea anguina, D. bulbifera, D. pentaphylla, Smilax zeylanica* and many members of the family Papilionaceae.

Epiphytic orchids like *Vanda tessellata* and *Aerides odoratum* and parasites such as *Dendrophthoe falcata, Scurrula philippensis* and *Viscum nepalense* are quite common on deciduous trees throughout the forests. Temporary ponds, puddles and water edges harbour plants like *Ammania baccifera, A. multiflora, Jussiaea suffruticosa, Caesulia axillaris, Rotula aquatica, Asteracantha longifolia, Cyperus* spp., *Eriocaulon, Sphaeranthus indicus* etc.

Darrah Wild Life Sanctuary, Kota, Rajasthan

Approach : Rail-Kota, 50 km., Air-Jaipur

The forest vegetation at Darrah comprises mainly of *Anogeissus pendula*. The common associates of *Anogeissus* are *Acacia chundra, Diospyros melanoxylon, Aegle marmelos, Dichrostachys cinerea, Bauhinia racemosa* and *Mitragyna parvifolia*. In comparatively protected spots, where soil is deeper, *Diospyros melanoxylon* is more common. *Aegle marmelos* is present in richer habitats at Sujalghat and Sundrapura-Ki-Pahari.

On lower slopes in plain areas and near valleys, a mixed vegetation of spinuous trees and shrubs is seen.

The other common tree and shrub species are *Butea monosperma, Cassia fistula, Schrebera swietenioides, Stereospermum personatum, Ziziphus mauritiana, Balanites aegyptiaca, Holarrhena antidysenterica* and species of *Flacourtia, Grewia, Helicteres, etc.* ; their relative frequency depends on variety of factors.

The other nearest area for which botanical account is available is Shahabad.

Shahabad is situated approximately at latitude 25.10°N and longitude 77.12°E.

The area generally receives about 500-600 mm rainfall. The watershed is towards north-east and the river Chambal and Kali and their tributaries which arise out in the eastern Aravallis run to north-east to finally join the Yamuna in U. P.

The solid geology is formed of the Vindhyan rocks precipitously cut at places.

Pindasar is a valley towards south of the Shahabad village. The soil is reddish clayey loam, sandy at some places near *Nalas*. The forest is closed. Some grazing is seen only in fringes. In the valley towards south of the Rest House, the forest is composed chiefly of *Butea monosperma* Taub., *Acacia catechu* Willd. and *Dichrostachys cinerea* W. & A. *Prosopis spicigera* L. is also common. *Grewia pilosa* Lam. is the most abundant dicot in the undergrowth. Grasses like *Heteropogon* and *Apluda* are common. *Gymnema sylvestre* Br. is a very common climber. *Ziziphus mauritiana* Lamk. shrubs grow sporadically but are frequent at some spots.

Due to proximity of road *Xanthium strumarium* L., *Cassia tora* L. and *Sida* spp. are common in several spots.

Elytraria acaulis Lindau, is a common herb in moister areas, covering the ground. A moist patch of soil in a dried ditch had *Caesulia axillaris* Roxb., *Sesbania aegyptiaca* Poir., *Ammannia* and *Nothosaerva brachiata* Wt.

(Source : Jain & Kotwal, 1960, and some unpublished notes of Jain in Ph. D Thesis, 1963)

Along the eastern slope of Patighati hill, right from the start of the slope up the hill, *Anogeissus pendula* Edgew. dominates the vegetation. *Acacia catechu* Willd. continues to be found mixed with it but is lesser. *Grewia pilosa* Lam. is here too present as undergrowth. *Barleria*, *Blepharis* and *Pupalia* species are commonest in the undergrowth in dense canopy patches. Trees of *Aegle marmelos* Corr., *Anogeissus latifolia* Wall. and *Wrightia tinctoria* Br. are met with in upper parts of the slope. Trees of *Mitragyna parvifolia* Korth. are seen only in upper part. Trees of *Lannea coromandelica* Merr., *Bauhina racemosa* Lam., *Ziziphus xylopyra* Willd., *Cassia fistula* L., *Schleichera oleosa* Oken. and *Diospyros* are few and grow sporadically only on the slope.

The vegetation at the top chiefly comprised of *Anogeissus latifolia* Wall., *Terminalia helerica* Roxb., *Boswellia serrata* Roxb., *Diospyros melanoxylon* Roxb., *Buchanania lanzan* Spreng., *Schleichera oleosa* Oken. and *Aegle marmelos* Corr. The undergrowth is of *Nyctanthes arbor-tristis* L., *Holarrhena antidysenterica* Wall. and abundant grasses chiefly in open patches. *Apluda* and *Heteropogon* are the commonest grass species.

The western slope is a precipitously cut rock and there is no real western slope. *Euphorbia nerilifolia* L., *Grewia pilosa* Lam. *Cayratia carnosa* Gagnep. were the main plants near the precipitous rock. *Eriophorum comosum* Wall. grows in crevices.

Plants of *Anogeissus pendula* Edgew., *Bambusa*, *Lannea coromandelica* Merr., *Ficus lacor* var. *lamberiana*, *Helicteres isora* L., and *Grewia tiliaefolia* Vahl. grow commonly on western slope. Due to cool, moist and shady situation, fern growth is abundant.

The western slope ends at the Mahatmaji garden, where a numbre of trees are also seen planted, *e.g. Citrus medica* L., *Putranjiva roxburghii* Wall., *Mangifera indica* L., *Syzygium cumini* Skeels., *Ficus religiosa* L. etc.

The soil at Ghirgavan forest is reddish, gravelly to clayey. It is sandy near the *nala* bed. Being nearer to town, cattle enter in the outskirts of the forest. Lopping is also evident. The vegetation in the valley is a scrub jungle of *Acacia catechu* Willd., *Dichrostachys cinerea* W. & A. and *Butea monosperma* Taub. Small and large bushes of *Ziziphus mauritiana* Lamk. are frequently met with. *Grewia pilosa* Lam. forms an undergrowth in the forest where canopy is denser. Trees of *Bridelia retusa* Spr., *Lannea coromandelica* Merr. and *Prosopis spicigera* L. occur scattered. *Anogeissus pendula* Edgew. is less common.

Gymnema sylvestre Br. and *Asparagus racemosus* Willd. are the climbers in the area. Shrubs of *Securinega* grow nearer to slope area.

Going up on the southern hill slope, trees of *Acacia catechu* Willd. become lesser in number. *Dichrostachys cinerea* W. & A. also is lesser. Trees of *Boswellia serrata* Roxb., *Lannea coromandelica* Merr., *Bauhinia*, *Wrightia tinctoria* Br. and *Anogeissus latifolia* Wall. increase in number. *Nyctanthes arbor-tristis* L. is the commonest plant on the slope usually as a shrub or a tree. Trees of *Ziziphus xylopyra* Willd., *Aegle marmelos* Corr., *Soymida febrifuga* Juss., *Euphorbia nerilifolia* L., *Diospyros* and *Sterculia* are less common. The grass, *Apluda mutica* var. *aristata* Pilger is most common specially in the opener spots. *Barleria* sp. is frequent as undergrowth. *Anogeissus pendula* Edgew., *Boswellia serrata* Roxb., *Wrightia tinctoria* Br. and *Aegle marmelos* Corr., are common in upper part of

the slope. *Nyctanthes arbortristis* L. shrubs are present chiefly in the upper slope, *Acacia catechu* Willd. and *Anogeissus pendula* Edgew. are commoner. *Grewia pilosa* Lam. is a common undergrowth.

Along the southern slope of Santora Block *Anogeissus pendula* Edgew. and *Acacia catechu* Willd. are the commonest species. *Acacia catechu* Willd. is present only on lower portions where there is rather more gradual slope. Trees of *Ziziphus mauritiana* Lamk., *Lannea coromandelica* Merr. and *Diospyros* occur scattered. Plants of *Boswellia serrata* Roxb. and *Wrightia tinctoria* Br. are more frequent towards the upper part of the slope. *Nyctanthes arbortristis* L. is frequent as undergrowth and assumes tree size nearer to top. The *Anogeissus* trees on this slope are healthy tall and with clear bole. Open patches in the forest are covered with tall grasses like *Apluda, Heteropogon* and *Themeda.*

The top of this hill has trees of *Boswellia serrata* Roxb., *Diospyros, Acacia catechu* Willd., *Buchanania lanzan* Spreng., *Terminalia belerica* Roxb., *Dalbergia latifolia* Roxb., *Soymida febrifuga* Juss., *Nyctanthes* is most abundant as under growth. *Apluda, Heteropogon* and *Themeda* are the commonest grasses on top as the area is open and sunny.

The south-western slope has *Acacia catechu* Willd., *Boswellia serrata* Roxb., *Soymida febrifuga* Juss., *Sterculia, Ziziphus xylopyra* Willd. and *Nyctanthes arbortristis* L. The canopy is dense and grasses are few. Trees of *Bauhinia, Wrightia, Diospyros* and *Lannea* also occur scattered.

The vegetation in the valley near Shahabad town is heavily grazed and so it is scrubby. *Butea* shrubs dominate the vegetation and *Ziziphus mauritiana* Lamk. is also mixed as subdominant species. The ground is covered with *Xanthium strumarium* L., *Achyranthes aspera* L., *Cassia tora* L. and *Pupalia lappacea* Miq., *Apluda, Heteropogon* and *Aristida* are the commonest grasses. Shrubs of *Dichrostachys cinerea* W. & A. and *Acacia catechu* Willd. occur scattered. This is the typical vegetation of the grazed areas in the valley.

Sitabari situated about 25 miles west of Shahabad on the Shahabad-Baran-Kota road is very interesting botanically and is, therefore included in the present account.

The average rainfall in the area is up 1250 mm. Tre soil is blackish, gravelly to clayey and moist. Moreover, a perennial water stream keeps the whole area moist all the year round and so in this area evergreen vegetation is seen. Due to religious sentiments for the Sitabari temple, trees are not cut, but some grazing and lopping is seen.

In the forest tall trees upto about 30 metres of *Terminalia arjuna* W. & A., *Mangifera indica* L., *Salmalia malabarica* Sch. & Endl., *Ficus lacor* var. *lambertiana, Syzygium* sp., *Manilkara hexandra* Dub., *Madhuca indica* Gmel. are seen. *Carissa* is abundant and is climbing high on all trees as a woody robust climber. The ground is covered with ferns, seedlings of bamboos, *Syzygium* and *Desmodium.*

In the open area on the outskirts of this forest are grasslands and tall grasses as *Apluda, Dichanthium* and *Ophiuros* grow profusely and are exploited for fodder and thatching.

Dudhwa National Park, Lakhimpur Kheri, Uttar Pradesh

Approach : Rail—Dudhwa, 4 km. Air—Lucknow, 250 km.

The Dudhwa National Park lies approximately between 28°18'-28°42' N and 80°28'-80°57' E. It is bounded in the north by international boundary of Nepal and remaining sides are contiguous with the Kheri district of Uttar Pradesh. The total area of the Park is about 490 sq km and adjoining area of 123 sq km is also under the administrative control of the Park, thus making it a complete block of 613 sq km. The Park area is a vast alluvial plain, traversed by a number of small rivers and rivulets and tals, the important among these being Mohan which more or less forms an international boundary between Nepal, and Suheli which forms southern boundary of the Park and Jauraha, Neora, Nagroles nalas and Kakarha, Nagra, Bhadi, Churela tals. The mean elevation above sea level ranges from 182 m in the extreme north to 150 m in the south-east.

There are distinctly 3 seasons, winter from mid-October to mid-March, summer from mid-March to mid-June and rainy season from mid-June to mid-October. Average rainfall is + 160 cm. About 90% of the total rainfall is between June and September. During rainy season the Park roads get water-logged and remain so till the end of November.

The vegetation of Dudhwa National Park is of Tropical moist deciduous type. It may be categorically stated that it is one of the best natural Sal forests, apparently a climatic climax in Uttar Pradesh. Champion & Seth have classified this Sal forest into Moist Bhabar Sal and Moist Plains Sal and further sub-types being Damar Sal forest and Western light alluvium plain Sal. These are found at Dudhwa, Bellraien, Bankati and several other places within the area. However, Sal gives the major coverage either natural or by plantation. Grasslands (phantas) are also seen within the area along with riparian fringe forest, Sal forest, mixed Sal and teak and semi-evergreen forests. The composition of these various forest types are as follows :

The various types of forests throughout the park are interrupted by wide stretches of mesophyllous grasslands locally called the 'phantas'. The common perennial grasses are *Themeda arundinacea* (Roxb.) Ridley, *Saccharum spontaneum* L., *S. bengalense* Retz., *Narenga porphyrocoma* (Hance) Bor, *Vetiveria zizanioides* (L.) Nash., *Cymbopogon flexuosus* (Nees) Wats., *Desmostachya bipinnata* (L.) Stapf, *Apluda mutica* L., *Dichanthium annulatum* (Forssk.) Stapf, *D. glabrum* (Roxb.) Jain et Deshpande, *Pseudosorghum fasciculare* (Roxb.) A. Camus, etc. *Hygroryza aristata* (Retz.) Nees is the common aquatic grass, and on the margins of ditches *Panicum paludosum* Roxb., *Echinochloa* spp. are frequent.

(Source : Hajra & Shukla, 1982)

Dudhwa National Park. Syzygium Forest, with grassland in foreground (Ph. BSI, Dehradun)

Occasionally scattered trees or shrubs of *Syzygium cumini* (L.) Skeels, *Lannea coromandelica* (Houtt.) Merr., *Mallotus philippensis* Muell.-Arg. with climbers like *Ventilago denticulata* Willd., *Dioscorea belophylla* Voigt, *D. bulbifera* L. and *Trichosanthes cucumeriana* L. are also seen.

Riparian forest is found on the bank of Suheli river near Dudhwa and elsewhere. *Acacia catechu* Willd. and *Dalbergia sissoo* Roxb. are found associated with *Trewia nudiflora* L., *Mallotus philippensis* Muell.-Arg. and occasionally with *Syzygium cumini* (L.) Skeels and *Barringtonia acutangula* Gaertn.

Thick Sal forests are met with in Dudhwa, Bankati, Bellraien and several other places and occupy a fairly large area in the National Park. The common associates of *Shorea robusta* Gaertn. f. are *Mallotus philippensis* Muell.-Arg., *Syzygium cumini* (L.) Skeels, *Ardisia solanacea* (Poir.) Roxb., *Callicarpa macrophylla* Vahl., *Murraya koenigii* (L.) Spreng., *Clerodendrum viscosum* Vent, *Mitragyna parvifolia* (Roxb.) Korth., *Flemingia macrophylla* (Willd.) Prain ex Merr., *Grewia elastica* Royle, *Ziziphus mauritiana* Lamk., *Z. oenoplia* (L.) Mill., *Z. xylocarpa* (Retz.) Willd., *Carissa spinarum* L., *Aegle marmelos* Corr. The common grass in undergrowth is *Desmostachya bipinnata* (L.) Stapf.

Mixed Sal and teak forests are found in Dudhwa, Bankati and elsewhere. The characteristic species in these forests are *Mitragyna parvifolia* (Roxb.) Korth., *Adina cordifolia* (Roxb.) Hook. f. ex Brandis, *Dalbergia sissoo* Roxb., *Aegle*

Dudhwa National Park: Sal Forest, undergrowth of Tiliocora (Ph—BSI, Dehradun)

marmelos (L.) Corr., *Kydia calycina* Roxb., *Emblica officinalis* Gaertn., *Ziziphus mauritiana* Lamk., *Ehretia laevis* Roxb., *Ficus semicordata* Buch.-Ham., *Desmodium triangulare* (Retz.) Merr., *D. pulchellum* (L.) Benth.

Semi-evergreen forest occupies a small portion of land in Gauriphanta, Bankati and Bellraien. The forest of these areas have no uniformity in composition of vegetation and with no apparent dominant species. The important constituents in this type are *Cassia fistula* L., *Kydia calycina* Roxb., *Mitragyna parvifolia* Korth., *Adina cordifolia* Benth., *Terminalia bellirica* Roxb., *Mallotus philippensis* Muell.-Arg., *Syzygium cumini* (L.) Skeels, *Acacia catechu* Willd., *Casearia elliptica* Willd., *Tectona grandis* L., *Emblica officinalis* Gaertn., *Phyllanthus reticulatus* Poir., *Holarrhena antidysenterica* (Roth) Wall. ex A. DC., *Milletia auriculata* Baker, *Helicteres isora* L. and *Xeromphis spinosa* (Thunb.) Keay.

The stragglers and climbers frequently met with are *Dioscorea belophylla* Voigt, *D. bulbifera* L., *Phanera vahlii* (W. & A.) Benth., *Porana paniculata* Roxb., *Ipomoea caririca* (L.) Sweet, *Cryptolepis buchanani* Roem. et Schult., *Ichnocarpus frutescens* (L.) R. Br., *Thunbergia grandiflora* Roxb., *Abrus precatorius* L., etc.

Occasional occurrence of *Naravelia zeylanica* (L.) DC., a climber, and *Olax nana* Wall. a short woody herb at Bellraien is interesting.

Dudhwa National Park: Tiger Tal with Syzygium forest in background (Ph BSI, Dehradun)

The herbaceous undergrowth often encountered in these forests has *Ajuga macrophylla* Wall. ex Benth., *Alternanthera sessilis* (L.) DC., *Borreria brachystema* (R. Br. ex Benth.) Valet, *Mazus pumilus* (Burm. f.) Steen., *Hemigraphis hirta* T. Anders., *Uraria picta* Desv. and sedges like *Cyperus rotundus* L.

There are a number of rivulets and temporary water pools and permanent tals in the Dudhwa National park which support a variety of aquatic plants; some are listed below :

Free-floating hydrophytes : *Trapa natans* L. var. *bispinosa* (Roxb.) Makino, *Utricularia flexuosa* Vahl, *Hygroryza aristata* (Retz.) Nees, *Lemna perpusilla* Torrey, *Spirodela polyrhiza* (L.) Schleid.

Suspended submerged hydrophytes : *Aponogeton crispum* Thunb., *Hydrilla verticillata* (L.f.) Royle, *Potamogeton pectinatus* L.

Anchored submerged hydrophytes : *Ottelia alismoides* (L.) Pers.

Anchored hydrophytes with floating leaves : *Nelumbo nucifera* Gaertn., *Nymphaea nouchali* Burm. f., *Nymphoides cristata* (Roxb.) Kuntze.

Anchored hydrophytes with floating shoots : *Monochoria vaginalis* (Burm. f.) Presl, *Sagittaria guayanensis* H.B.K. ssp. *lappula* (D. Don) Bogin.

Amphibious hydrophytes : *Echinochloa colonum* (L.) Link, *E. stagnina* (Retz.) P. Beauv., *Panicum paludosum* Roxb.

Wetland hydrophytes : These occur in low lying areas of the park and in marshy places near water pools, tals, rivers, drying up rice fields, etc. The common species are : *Ludwigia octovalvis* (Jacq.) Raven, *L. prostrata* Roxb., *Salvia plebeia* R. Br., *Alternanthera sessilis* (L.) DC., *Phyla nodiflora* (L.) Greene, *Mazus pumilus* (Burm. f.) Steen., *Amischophacelus axillaris* (L.) Rolla Rao et Kammathy, *Hydrolea zeylanica* Vahl, *Gnaphalium luteo-album* L., *Polygonum plebeium* R. Br., *P. barbatum* L., *Xanthium strumarium* L., *Cyanotis cristata* (L.) D. Don, *Commelina benghalensis* L., *Murdannia nudiflora* (L.) Brenan and sedges, e.g. *Cyperus iria* L., *Scirpus articulatus* L., *Scleria levis* Retz., *Eleocharis palustris* R. Br.

Kaziranga National Park, Sibsagar & Naogaon, Assam

Approach : Rail & Air—Gauhati, 217 km., Jorhat, 96 km.

The Kaziranga National Park lies approximately between 90°5'-93°40' E and 26°30'-26°45' N. The park is situated partly in the Nowgong district and partly in the Sibsagar district of Assam at the foot of the Mikir Hills (Karbi-Anglong) south of National Highway No. 37.

It is bounded in the north and west by the Brahmaputra river, in the south by Mora Diphlu river, Mikir Hills and a number of villages of Nowgong and Sibsagar districts and in the east and west by many villages and cultivated fields of Nowgong and Sibsagar Districts. The important small streams draining into the park from south to north are Borjuri, Dring, Kohora, Dihing, Bhalukjhuri, Deopani, etc. There are many 'Bils' inside the park.

The total area of the Kaziranga National Park is 429.96 sq. km. The terrain is a flat land.

There is heavy rainfall from July to October. The mild winter occurs from November to February and the summer is from March to May. The climate is tropical, hot and humid. Maximum temperature often approaches 35°C between March and September and minimum temperature rarely falls below 10°C during December and January.

Vegetation of Kaziranga National Park can be broadly classified into Alluvial inundated grasslands, Tropical wet evergreen forests and Tropical semi-evergreen forests.

Alluvial inundated grasslands: Almost two-third of the Park is covered by grasslands. Amidst grasses there are numerous herbaceous plants and scattered trees of *Bombax ceiba* L., *Dillenia indica* L., *Careya arborea* Roxb., *Emblica officinalis* Gaertn., etc. In the extensive grasslands the dominant grasses are *Saccharum procerum* Roxb., *S. spontaneum* L., *Vetiveria zizanioides* (L.) Nash, *Themeda villosa* (Poir.) A. Camus, *Apluda mutica* L., *Arundinella bengalensis* (Spreng.) Druce, *Digitaria setigera* Roth, *Hygroryza aristata* (Retz.) Nees, *Narenga porphyrocoma* (Hance) Bor, *Phragmites karka* (Retz.) Trin., *Sclerostachya fusca* (Roxb.) A. Camus, etc.

Tropical wet evergreen forests: Besides grasslands there are patches of evergreen forests near Kanchanjhuri, Panbari and Tamulipathar blocks. The common trees in these forests are *Aphanamixis polystachya* (Wall.) Parker. *Dillenia*

(Source : Hajra, 1980)

Kaziranga National Park : Rhino seen near a water-hole in grassland (Ph – P. K. Hajra)

indica L., *Syzygium tetragonum* (Wt.) Kurz, *S. cumini* (L.) Skeels, *Talauma hodgsonii* Hook. f. & Thoms., *Garcinia tinctoria* (DC.) Wight, *Ficus rumphii* Bl., *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, etc.

Tropical semi-evergreen forests: This type of forests occurs in the Baguri, Bimali and Haldibari surroundings. Here the common trees and shrubs are *Albizia procera* (Roxb.) Benth., *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Lagerstroemia speciosa* Pers., *Crateva unilocularis* Buch.-Ham., *Sterculia urens* Roxb., *Grewia serrulata* DC., *Mallotus philippensis* Muell.-Arg., *Bridelia retusa* Spreng., *Aphania rubra* (Roxb.) Radlk., *Leea indica* (Burm.) Merrill, *L. umbraculifera* Clarke, etc.

Mudumalai Wild Life Sanctuary, The Nilgiris, Tamilnadu

Approach : Rail—Ootacamund, 64 km. Air—Coimbatore, 160 km.

Mudumalai Wildlife Sanctuary lies between 11°32' and 11°43' N and 76°22' and 76°45' E and is situated along the eastern slopes of the Western Ghats. It forms the forest of the northern and north western side of the Nilgiri or Blue Mountains. The sanctuary is bounded on the north by the Bandipur National Park of Karnataka and on the west and south west by Kerala State.

The sanctuary consists of undulating hills with elevations varying from 350 to 1250 m. Many streams drain the sanctuary, the principal ones being (1) Moyar which flows along the borders of Tamil Nadu and Karnataka (2) Benne Hole draining the western part of the sanctuary and (3) Biden Halla which flows into the Moyar. Moyar is the most important source of water in the sanctuary, since most of the other streams dry up during the summer months.

The rocks are of typical archaean biotite and hornsblendic gneiss with intensive bands of charnokite and much younger biotite-granite, pegmatite and basic doleric dykes. Two kinds of soil, namely black sandy loam and red heavy loam may be recognised in the area. The red soil is confined to the southern part of the sanctuary.

The sanctuary is warmer than the rest of the area in the district. April, May and June are the hottest months and December and January are the coldest months. The rainfall varies greatly in different parts of the sanctuary. The western side receives more rainfall than the eastern part during the south-west monsoon period between June and September. In the eastern side most of the rainfall falls during the north-east monsoon period between October and December. The average annual rainfall is about 1420 m.

The vegetation varies in different parts of the sanctuary due to the variation in the extent of rainfall within the limits of the sanctuary and the period of its occurrence, and presents more luxuriance in October and November. Three main types of vegetation are met with: 1. Tropical moist deciduous, 2. Tropical dry deciduous and 3. Southern tropical thorn forest. In certain places mixed type of vegetation is noticed and demarcation between the first and second type and between the second and third type becomes difficult.

Tropical moist deciduous: In Benne block (western side of the sanctuary) this type of forest is encountered because of high rainfall when compared to the other blocks. *Bambusa arundinacea* is common and characteristic of this type. The forest is leafless during the dry season in March-April though there is a good covering of

(Source : Sharma, Shetty, Vivekanathan & Ruthakrishnan, 1977)

Mudumalai Wild Life Sanctuary: A view of Moist Deciduous Forest (Ph—BSI, Coimbatore)

evergreen species in the under-wood with shrubs such as *Toona ciliata, Euodia lunu-ankenda, Glochidion velutinum* and *Viburnum punctatum*. The prominent tree species which constitute the forest are: *Terminaia tomentosa, T. bellerica, Schleichera oleosa, Butea monosperma, Linociera malabarica, Scherbera swietenioides* and *Pterocarpus marsupium*. The undergrowth consists of *Antidesma diandrum, Clerodendrum serratum, C. viscosum, Desmodium pulchellum, Flemingia strobilifera, F. wightiana* and *Callicarpa tomentosa*.

Due to the heavy rainfall and inadequate drainage, swamps are of frequent occurrence in this region.

Tropical dry deciduous forest: This type of forest is confined to the eastern side of the sanctuary. It is composed of trees, practically all of which are deciduous during the dry season. It merges gradually into thorn forests, wherever the rainfall is inadequate. *Anogeissus latifolia* is the dominant species. Other common tree species are: *Buchanania lanzan, Tectona grandis, Diospyros montana, Semecarpus anacardium, Givotia rottleriformis, Lannea coromandeliana, Dalbergia latifolia, Bombax ceiba, Madhuca indica, Gmelina arborea, Mitragyna parvifolia* and *Wrightia tinctoria*. Some of the shrubs and climbers worthy of mention are *Carissa carandas, Maytenus emarginata, Scutia myrtina, Argyreia cuneata, Ventilago maderaspatana* and *Hiptage benghalensis*.

Grasses like *Heteropogon contortus* and *Themeda cymbaria* come up after the rains and give good grazing for wild animals. *Habenaria plantaginea*, a terrestrial orchid, is found in association with *Themeda cymbaria*. The forest fires begin in February and burn the grasses over extensive areas till the dry spell ends in April.

Southern tropical thorn forest: This type of forest also known as scrub jungle is dominated by *Acacia* spp. Sometimes elements of dry deciduous type are also mixed up in this forest and hence a clear demarcation cannot be made here. However, the predominance of thorny species together with plants of fleshy nature, both of which are xerophytic adaptations, are characteristics of this vegetation. Parts of Avarihalla, Moyar and Bokkapuram reserves constitute this type. The floristic constituents are: *Acacia chundra*, *A. leucophloea*, *Albizzia amara*, *Canthium parviflorum*, *Xeromphis spinosa*, *Zizyphus oenoplia*, *Capparis grandiflora*, *C. sepiaria*, *Barleria buxifolia*, *B. mysorensis* and *B. prionitis*.

Succulents like *Opuntia dillenii* and *Caralluma adscendens* are common in the open forests.

On the banks of Moyar and along the streams, narrow strips of riverine vegetation is noticed. The prominent species are *Linociera malabarica*, *Salix tetrasperma*, *Bischofia javanica*, *Terminalia arjuna*, *Vitex altissima*, *Diospyros peregrina*, *D. assimilis*, *Drypetes roxburghii*, *Memecylon edule* and *Mallotus muricatus*. *Homonoia riparia*, a rheophytic shrub, is well adapted to water currents in Moyar river.

Almost the entire sanctuary is exploited for forest produce. It supports a number of Teak plantations, particularly in the Benne Block and plantation of *Eucalyptus* is found in Masinagudi area. Bamboo plantation for rayon mills in Kerala has also gained importance during the last few years. The timber extraction includes both clear felling and selective cuttings.

The minor forest produce includes wild honey, bees wax, bark lichen, soapnut, tamarind, gallnut for medicinal use from *Terminalia chebula* and *T. bellerica*, antlers, etc.

Nagzira Wild Life Sanctuary, Bhandara, Maharashtra

Approach: Rail. -Gongle, 14 km, Air. - Nagpur, 160 km.

The Nagzira wildlife sanctuary lies in Tirora range of Bhandara Forest Division in Bhandara district. The area is approachable by the Sakoli-Nagzira forest road branching off from the Great Eastern Highway at Sakoli about 100 kms from Nagpur and the Murdoli-Nagzira forest road about 25 kms from Gondia. The forests of the area extend over 131.75 sq. km.

The climate of the area is quite pleasant during the greater part of the year. Only a little span of summer is very hot. The temperature varies between 6-5°C during January to 45°C during May. The average annual rainfall varies between 1,100 mm and 1,500 mm.

The vegetation of the area is of mixed deciduous type. *Anogeissus latifolia* (Roxb. ex DC.) Bedd., *Bauhinia racemosa* Lamk., *Bridelia retusa* (L.) Spreng, *Butea monosperma* (Lamk.) Taub., *Kydia calycina* Roxb., *Mallotus philippensis* (Lamk.) Muell-Arg., *Sterculia urens* Roxb., form the top canopy in the forests.

The second layer of the forest comprises a mixture of a number of small trees and shrubs like *Clerodendrum serratum* (L.) Moon., *Diospyros melanoxylon* Roxb., *Gardenia latifolia* Ait., *Holarrhena antidysenterica* (Roth) A. DC., *Lagerstroemia parviflora* Roxb., etc. The area usually comprises the lianas and climbers like *Acacia pennata* (L.) Willd., *Aspidopteris cordata* (Heyne) A. Juss., *Cocculus hirsutus* (L.) Diels, *Dioscorea bulbifera* L., *D. pentaphylla* L., *Hemidesmus indicus* (L.) R. Br., *Ichnocarpus frutescens* (L.) R. Br., *Smilax zeylanica* L., etc.

The ground flora is quite rich after the monsoon. The herbs, grasses, and a few under-shrubs like *Abutilon indicum* (L.) Sweet., *Achyranthes aspera* L., *Alternanthera sessilis* (L.) R. Br. ex DC., *Alysicarpus vaginalis* (L.) DC., *Amaranthus spinosus* L., *Ammannia baccifera* L., *Andrographis paniculata* (Burm.) Wall. ex Nees, *Buchnera hispida* Buch.-Ham., *Canscora diffusa* R. Br., *Cassia absus* L., *Commelina benghalensis* L., *Corchorus aestuans* L., *Crotalaria hirta* Willd.; *C. linifolia* L. f., *Cyanotis cristata* (L.) D. Don *Cyperus iria* L., *Dactyloctenium aegyptium* (L.,) P. Beauv., *Dichanthium annulatum* (Forsk.) Stapf., *Dipteracanthus prostratus* (Poir.) Nees, *Eclipta prostrata* (L.) L., *Elephantopus scaber* L., *Euphorbia hirta* L., *E. prostrata* L., *Heteropogon contortus* (L.) P. Beauv., *Hibiscus lampas* Cav., *Hybanthus enneaspermus* (L.) F. Muell., *Melochia corchorifolia* L., *Merremia emarginata* (Burm f.) Hall. f., *Peristrophe bicalyculata* (Retz.) Nees, *Plumbago zeylanica* L., *Sida acuta* Burm. f., *Scoparia dulcis* L., *Triumfetta rhomboidea* Jacq., *Vernonia cinerea* (L.) Less, etc. are frequently met with.

(*Source : Malhotra & Rao, 1981*)

The main trees and shrubs in the area are *Anogeissus latifolia* (Roxb. ex DC.) Bedd., *Acacia chundra* (Roxb.) Willd., *Bauhinia racemosa* Lamk., *Bridelia retusa* (L) Spreng, *Buchanania lanzan* Spreng, *Cassia fistula* L., *Cleistanthus collinus* Benth., *Diospyros melanoxylon* Roxb., *Emblica officinalis* Gaertn., *Eriolaena hookeriana* Wt. & Arn., *Grewia tiliaefolia* Vahl., *Gardenia latifolia* Ait., *Helicteres isora* L., *Holarrhena antidysenterica* (Roth) A. DC., *Kydia calycina* Roxb., *Lagerstroemia parviflora* Roxb., *Mallotus philippensis* (Lamk.) Muell.-Arg., *Mitragyna parvifolia* (Roxb.) Korth, *Semecarpus anacardium* L. f., *Sterculia urens* Roxb., *Stereospermum suaveolens* (Roxb.) DC., *Tectona grandis* L., *Terminalia tomentosa* Wt. & Arn., *Woodfordia fruticosa* (L.) Kurz., *Xeromphis uliginosa* (Retz.) Mahesh. etc.

Plants common in waste places and open areas are *Achyranthes aspera* L., *Alysicarpus vaginalis* (L.) DC., *Amaranthus spinosus* L., *Cassia absus* L., *Corchorus aestuans* L., *Crotalaria hirta* Willd., *C. linifolia* L. f., *Cyperus tenuispica* Steud., *Datura innoxia* Mill., *Desmodium triflorum* (L.) DC., *Elephantopus scaber* L., *Eragrostis unioloides* (Retz.) Nees, *Eriocaulon dianae* Fyson, *Heliotropium ovalifolium* Forsk., *Hemigraphis latebrosa* (Roth) Nees, *Heteropogon contortus* (L.) P. Muell., *Leonotis nepetifolia* (L.) R. Br., *Leucas biflora* R. Br., *Melochia corchorifolia* L., *Rhynchosia minima* DC., *Rungia pectinata* (L.) Nees, *Sida acuta* Burm. f., *Sida cordata* (Burm. f.) Boiss., *Tridax procumbens* L., *Triumfetta rhomboidea* Lamk., *T. rotundifolia* Lamk., *Uraria picta* (Jacq.) Desv. ex DC., *Urena lobata* L., *Vernonia cinerea* (L.) Less., *Vicoa indica* (Willd.) DC., etc.

Plant species recorded along the degraded forests and scrub jungle are *Abrus precatorius* L., *Abutilon indicum* (L.) Sweet, *Alternanthera sessilis* (L.) R. Br. ex DC., *Andrographis paniculata* (Burm.) Wall. ex DC., *Buchnera hispida* Buch. -Ham., *Canavalia ensiformis* DC., *Clerodendrum serratum* (L.) Moon, *Cocculus hirsutus* (L.) Diels, *Coldenia procumbens* L., *Corchorus aestuans* L., *Desmodium triflorum* (L.) DC., *Eclipta prostrata* (L.) L., *Eragrostis tenella* (L.) P. Beauv., *Grewia hirsuta* Vahl, *Hibiscus lampas* Cav., *Helicteres isora* L., *Paspalum scrobiculatum* L., *Phyllanthus urinaria* L., *Plumbago zeylanica* L., *Rhynchosia minima* DC., *Sida cordata* (Burm. f.) Boiss. *Urena lobata* L. etc.

Ammannia baccifera L., *A. multiflora* Roxb., *Commelina benghalensis* L., *Cyanotis cristata* (L.) D. Don, *Cyperus iria* L., *Dactyloctenium aegyptium* (L.) P. Beauv., *Echinochloa colonum* (L.) Link., *Eclipta prostrata* (L.) L., *Hygrophila auriculata* (Sch.) Heine, *Ipomoea aquatica* Forsk., *Limnophila indica* (L.) Druce, *Ludwigia octavalvis* (Jacq.) Raven, *Melochia corchorifolia* L., *Merremia emarginata* (Burm. f.) Hall. f., *Polygonum barbatum* L. var. *gracile* (Dans.) Steward, *P. glabrum* Willd., *P. plebeium* R. Br., *Utricularia stellaris* L. etc. are the common marsh plants.

Nawegaon National Park, Bhandara, Maharashtra

Approach : Rail—Devalgaon, 4 Km., Air-- Nagpur, 145 Km.

Nawegaon National Park is a popular forest resort with picturesque low lying hills fringing the lakes of Nawegaon, located towards south of Bhandara in Maharashtra. It covers an area of about 134 sq. km with several villages, all around.

Geologically, the area has varied rocks ranging from precambrian gneiss and granite to laterite and very recent alluvium. The Pratapgarh range is almost entirely Dharwars, with Quartzite prevailing in the hills, and extending north to the Nawegaon lake and Nishani hills to the north-east of the lake is of igneous rocks.

Weatherwise it is quite pleasant for the greater part of the year, with only a short span of hot weather. The temperature ranges from 5°C during January to 43° during May. The average rainfall varies from 11 to 16 mm with humidity being around 50%.

The vegetation of the area is of mixed deciduous type. In the forest areas of Pratapgarh, Nawegaon and Nishani the trees are close, rather tall, with spread out high canopy. The main species are *Albizia lebbeck* (L.) Benth. and *A. odoratissima* (L. f.) Benth., *Lannea coromandelica* (Houtt.) Merr, *Mitragyna parvifolia* (Roxb.) Korth. etc. Forming a second storey of small trees and often mixed with numerous shrubs, are species like *Bridelia retusa* (L.) Spreng, *Cleistanthus collinus* Benth., *Emblica officinalis* Gaertn., *Holarrhena antidysenterica* (Roth) A. DC. etc. Here and there, climbing over some of these trees and often forming thickets or bushes, are lianes and slender climbers like *Olax scandens* Roxb., *Ventilago denticulata* Willd., *Abrus precatorius* L. etc. Several trees are further marked by infestations of stem parasites like *Dendropthoe falcata* (L. f.) Etting., while on a few others orchids like *Vanda tessellata* (Roxb.) G. Don occur as epiphytes.

The ground flora is not particularly noticeable but briefly during the monsoon the forest floor becomes gay with grasses and sedges and scatterred Asteraceae herbs with pretty flower heads and an odd herbaceous climber here and there. *Bothriochloa pertusa* (L.) A. Camus, *Chrysopogon fulvus* (Spreng) Chiov., *Echinochloa colonum* (L.) Link., *Eragrostis tenella* (L.) Beauv. etc. are some of the prominent grass species which among the sedges can be spotted. *Cardiospermum halicacabum* L. is the lone herbaceous climber. Amongst other herbs that may be mentioned are *Cyperus cyperoides* (L.) O. Ktze of Cyperaceae, *Eriocaulon dianae* Fyson of Eriocaulaceae, *Euphorbia hirta* L. of Euphorbiaceae, *Sida corduta* (Burm. f.) Boiss. of Malvaceae, *Evolvulus alsinoides* L. of Convolvulaceae, the Amaranthaceae like *Gomphrena celosioides* Mart, the Asteraceae, *Eclipta prostrata* (L.) L., Acanthaceae, *Hygrophila auriculata* (Sch.)

(Source : Malhotra & Rao, 1980)

Heine, *Justicia diffusa* Willd., and still others of Labiatae like *Leucas cephalotes* Spreng. of Fabaceae like *Indigofera linifolia* Retz., & *Oldenlandia corymbosa* L. of Rubiaceae etc.

On the hillocks distinctive vegetation can be noticed along the base , on the slopes and at the top. Amongst the plants at the base of hillocks are trees like *Aegle marmelos* Corr., and *Butea monosperma* (Lamk.) Taub. and shrubs like *Cassia fistula* L., *Bauhinia purpurea* L., *Clerodendrum serratum* (L.) Moon. Amongst herbs *Cassia tora* L., *Hibiscus lobatus* (J. A. Murray) O. Ktze, *Sphaeranthes indicus* L. are common. Plants on the slopes of hillocks are *Anogeissus latifolia* (DC.) Wall ex Bedd., *Boswellia serrata* Roxb., *Mitragyna parvifolia* (Roxb.) Kunth, among trees, shrubs *Helicteres isora* L., *Woodfordia fruticosa* (L.) Kurz, *Ziziphus oenoplia* Mill,. herbs like *Andrographis paniculata* (Burm.) Wall. ex Nees, *Curculigo orchioides* Gaertn., *Desmodium velutinum* (Willd.) DC. The plants of the top of hillocks are trees like *Bombax ceiba* L., *Diospyros melanoxylon* Roxb., *Lannea coromandelica* (Houtt.) Merr., shrubs like *Gardenia latifolia* Ait., *Grewia hirsuta* Vahl and herbs like *Barleria prattensis* Sant., *Dipteracanthus prostratus* (Poir) Nees, *Waltheria indica* L.

There are also ponds and at places stagnant waters and ditches where there is a distinct aquatic vegetation. The species that occur here are *Bacopa monnieri* (L.) Pennell, *Coix lachryma-jobi* L., *Limnophila indicia* (L.) Druce, *Nymphoides cristatum* (Roxb.) O. Ktze, etc.

Along the roads, avenue trees include *Albizia lebbek* (L.) Benth., *Mangifera indica* L. and *Tectona grandis* L. etc.

There are a number of species which are used by the wild animals as a source of their food, varying with the animal and their food habits. Most of the animals prefer shorter grasses growing around the open areas. The tender shoots of the reeds coming out immediately after burning are also relished by the animals. But as the reeds grow taller shooting more than 6 metres or so they go out of the reach of the deer etc. Some of the plants generally relished by the wild animals in the area are *Bothriochloa pertusa* (L.) A. Camus, *Cynodon dactylon* (L.) Pers., *Ficus* spp., *Ipomoea aquatica* Forsk., *Tamarindus indica* L., *Terminalia bellirica* (Gaertn.) Roxb., *Themeda triandra* Forsk., *Ziziphus oenoplia* Mill. etc.

Most of the tree species in the area are being used by the animals and birds for their shelter purposes. Bison generally prefer a tree with thick canopy of branches over it while a deer can avail even the tall grasses as its source of shelter. Some of the other plants used as shelter are *Aegle marmelos* (L.) Corr., *Albizia odoratissima* (L.) Benth., *Bauhinia racemosa* Lamk., *Bridelia retusa* (L.) Spreng., *Diospyros melanoxylon* Roxb., *Ficus benghalensis* L., *Mangifera indica* L., *Tamarindus indica* L. etc.

Neyyar Wild Life Sanctuary, Trivandrum, Kerala

Approach : Rail & air—Trivandrum, 40 km.

The focal point of the sanctuary is the Neyyar reservoir, formed by the impounding water within the Neyyar Dam constructed by the Public Works Department for the purposes of irrigation of Neyyatinkara and Vilavankode taluks of Kerala and Tamil Nadu, respectively. The reservoir has an extent of about 1433 hectares. About 810 hectares of the reservoir has occupied areas like Kanipet lands, registered holdings and hillmen settlement along the reservoir banks, whereas the rest of the area, having an area of about 607.5 hectares along the course of the Neyyar river has a lovely forest canopy all round.

The sanctuary area is not accessible by roads beyond the Kottur Dry stock Farm site and Amboori located in the Kanipet lands. The only means of access to the interior areas of the sanctuary is by boats.

The soil is almost wholly loam. On the slopes of hills and on elevated grounds, there is a large proportion of laterite gravel and broken pieces of other rocks in different stages of disintegration. Good depth of alluvial deposit is found along the lower courses of the rivers.

The climate in the locality is moderately hot and humid with a low range of variation of temperature. The high hills are cooler and drier as compared to the foot hills. The months of March and April are the hottest period of the year. The average rainfall is 2684 mm. Maximum precipitation is from the South-west monsoon during May, June and July. The rains from the North East monsoon during October-November is also considerable.

The vegetation of Neyyar Wild Life Sanctuary and vicinity can be broadly divided into tropical evergreen type and moist deciduous type. The major portion of the forests falls under the category of moist deciduous type, which is the result of a retrogression of an originally evergreen type due to annual fires and other human interference. Even though *Terminalia alata* Heyne ex Roth, *T. bellirica* (Gaertn.) Roxb., *T. paniculata* Roth, *Pterocarpus marsupium* Roxb., etc., form the major tree species typical of the moist deciduous type, Teak is significantly absent. There are large patches of reed brakes in the higher slopes and patches of semi-evergreen forests along river banks and in the upper reaches. In areas above 1000 metres, vegetation is of a tropical evergreen type but due to exposure to dessicating winds and poor condition of the soil, the trees are stunted and are confined to protected hollows and valleys between ridges. In the high hills around Agastiyar peak, there are large patches of grasslands. There are no old

(Source : Joseph & Chandrasekaran, 1982)

forest plantations within the sanctuary limits. Since 1963 onwards, the islands within the Neyyar Reservoir which were barren, have been planted up with *Eucalyptus*.

Common trees forming the top canopy of Kottur Reserve Forest and also other forests where the altitude varies from 150 m to 225 m are *Artocarpus hirsutus* Lamk., *Careya arborea* Roxb., *Cleistanthus travancorensis* Jablonszky, *Dillenia pentagyna* Roxb., *Elaeocarpus serratus* Linn., *Ficus hispida* Linn. f., *Holigarna arnottiana* Hook. f., *Hydnocarpus laurifolia* (Densst.) Sleumer, *Lophopetalum wightianum* Arn., *Mastixia arborea* (Wt.) Bedd. subsp. *meziana* (Wangerin) Matthew. *Semecarpus anacardium* Linn. f., *Terminalia paniculata* Roth, *Vitex altissima* Linn. f and *V. pinnata* Linn. The shrubby vegetation of this forest is not at all dense due to human interference and is composed of *Grewia microcos* Linn., *Hedyotis pruinosa* Wt. & Arn., *Helicteres isora* Linn., *Ixora brachiata* Roxb., *I. lanceolaria* Colebr., *I. nigricans* R. Br. ex Wt. & Arn., *Melastoma malabathricum* Linn., *Mussaenda laxa* (Hook. f.) Hutch. ex Gamble, *Premna gluberrima* Wt. and *Psychotria curviflora* Wall. *Butea parviflora* Roxb. and *Gnetum ula* Brongn. are the conspicuous lianas of Kottur Reserve Forest. But, the common climbers are *Calycopteris floribunda* (Roxb.) Poir., *Derris thyrsiflora* Benth. var. *eualata* (Bedd.) Thoth., *Holostemma annulare* (Roxb.) K. Schum., *Jasminum rottlerianum* Wall. ex DC., *Rourea minor* (Gaertn.) Alston, *Salacia malabarica* Gamble, *Sarcostigma kleinii* Wt. & Arn. and *Strychnos cinnamomifolia* Thw. var. *wightii* Hill. Ground flora consists of the herbs such as *Adenosma bilabiatum* (Roxb.) Merr., *A. subrepens* Benth. ex Hook. f., *Anisochilus verticillatus* Hook. f., *Cyanotis cristata* (Linn.) D. Don, *Lindernia antipoda* (Linn.) Alston, *L. ciliata* (Colsm.) Pennell., *L. hyssopoides* (Linn.) Haines, *L. pusilla* (Willd) Boldingh, *Melochia corchorifolia* Linn. *Mitrasacme pygmaea* R. Br. var. *malaccensis* (Wt.) Hara, *Oldenlandia herbacea* (Linn.) Roxb., *Polygala glomerata* Lour., *Pycnospora lutescens* (Poir.) Schindl., *Spermacoce latifolia* Aubl., *Torenia travancorica* Gamble, *Utricularia caerulea* Linn. and *U. striatula* J. E. Sm. Sedges and grasses like *Cyperus castaneous* Willd., *Diplacrum caricinum* R. Br., *Fimbristylis cinnamometorum* (Vahl) Kunth, *F. narayanii* Fischer, *Lipocarpha chinensis* (Osbeck) Kern, *Mariscus squarrosus (Linn.)* C. B. Cl., *Pycreus puncticulatus* (Vahl) Nees, *Rhynchospora corymbosa* (Linn.) Britton, *Eragrostis uniloides* (Retz.) Nees ex Steud., *Ochlandra wightii* C. E. C. Fischer, *Paspalum scrobiculatum* Linn., *Pennisetum polystachyon* (Linn.) Schult., and *Sacciolepis myosuroides* (R. Br.) A. Camus are common in this area. Many plants of *Acrotrema arnottianum* Wt. could be seen along the slopes of the road sides within the forest area. Some of the common ferns met within this area are *Blechnum orientale* Linn., *Cheilanthes tenuifolia* (Burm.) Sw., *Cyathea gigantea* (Wall.) Holtt., *Hemionitis arifolia* (Burm.) Moore, *Lindsaea ensifolia* Sw., *Lygodium flexuosum* (Linn.) Sw., and *Thelypteris ciliata* (Wall. ex Benth.) Ching.

In Klamala R. F., which forms the South and South-east forest of Neyyar Wild Life Sanctuary, the trees such as *Abarema bigemina* (Linn.) Kosterm., *Actinodaphne malabarica* Balakrishnan, *Albizia odoratissima* (Linn. f.) Benth., *Cinnamomum iners* Reinw., *Dimocarpus longan* Lour., *Ficus dalhousiae* Miq., *Knema attenuata* (Hook. f. & Thoms.) Warb., *Lagerstroemia speciosa* (Linn.) Pers., *Litsea coriacea* (Heyne ex Meissn.) Hook. f., *Mitragyna tubulosa* (Arn.) Hav. and *Terminalia bellirica* (Gaertn.) Roxb. are common. The herbs such as *Ageratum conyzoides* Linn., *Cleome viscosa* Linn., *Ludwigia hyssopifolia* (G. Don) Excell., *Mollugo pentaphylla* Linn., *Polygala javana* DC., *Portulaca oleracea* Linn., *Sebastiania chamaelea* (Linn.) Muell. and *Synedrella nodiflora* (Linn.) Gaertn. form the common components of the ground flora.

The forests around Bonaccord Estate and those in the vicinity on the Western slope of Agastyamalai are more rich and dense and common trees are : *Acronychia pedunculata* (Linn.) Miq., *Aglaia bourdillonii* Gamble, *Antidesma menasu* Miq. ex. Tul., *Arenga wightii* Griff., *Baccaurea courtallensis* (Wt.) Muell.-Arg., *Bentinckia condapanna* Berry, *Buchanania lanzan* Spr., *Byrsophyllum tetrandrum* (Bedd.) Hook. f., *Emblica officinallis* Gaertn., *Ficus arnottiana* (Miq.) Miq., *F. tsjahela* Burm. f., *Garcinia morella* (Gaertn.) Dear., *Gordonia obtusa* Wall. ex Wt. & Arn., *Gyrinops walla* Gaertn., *Ligustrum travancoricum* Gamble, *Linociera courtallensis* Bourd., *Litsea bourdillonii* Gamble, *Mallotus resinosus* (Blanco) Merrill, *Pinanga dicksonii* (Roxb.) Scheffer, *Pterocarpus marsupium* Roxb., *Symplocos macrocarpa* Wt. ex Clarke, *Syzygium laetum* (Ham.) Gandhi, *Trichilia connaroides* (Wt. & Arn.) Bentvelzen, *Vernonia comorinensis* W. W. Smith and *Vitex altissima* Linn. f. The shrubby vegetation of this area is composed of *Crotalaria scabra* Gamble, *Diotacanthus grandis* (Bedd.) ex Clarke, *Glyptopetalum zeylanicum* Thw., *Hedyotis purpurascens* Hook. f., *Lasianthus cinereus* Gamble, *L. oblongifolius* Bedd., *Lepisanthes erecta* (Thw.) Leenh., *Litsea venulosa* (Meissn.) Hook. f., *Memecylon gracile* Bedd., *M. heyneanum* Benth., *Pandanus thwaitesii* Mart., *Psychotria macrocarpa* Hook. f., *P. nigra* (Gaertn.) Alston, *P. nudiflora* Wt. & Arn., *Sarcandra grandifora* (Miq.) Sub. & Henry, *Tabernaemontana gamblei* Subr. & Henry and *Vernonia salvifolia* Wt. Climbers like *Adenia hondala* (Gaertn.) de Wilde, *Cayratia tenuifolia* (Wt. & Arn.) Gagnep., *Cissus trilobata* Lamk., *Millettia rubiginosa* Wt. & Arn. and *Myxopyrum serratulum* A. W. Hill are common in this area. *Aneilema ovalifolium* (Wt.) Hook. f., *Asystasia dalzelliana* Sant., *Chlorophytum laxum* R. Br., *Didymocarpus ovalifolia* Wt., *D. repens* Bedd., *Emilia ramulosa* Gamble, *Eriocaulon ensiforme* Fischer, *Exacum courtallense* Arn. var. *laxiflorum* Gamble, *E. travancoricum* Bedd., *Geissaspis cristata* Wt. & Arn., *Globba ophioglossa* Wt., *Gomphostemma eriocarpon* Benth., *Impatiens travancorica* Bedd., *I. umbellata* Heyne, *Knoxia heyneana* DC., *Micrococa beddomei* (Hook. f.) Prain, *Murdannia glauca* (Thw. ex Clarke) Brueck., *Neanotis nummularia* (Arn.) W. H. Lewis, *Neurocalyx calycinus* (R. Br. ex Benn.) Robinson, *Osbeckia virgata* D. Don ex Wt. & Arn., *Pellionia heyneana* Wedd., *Pilea melastomoides* (Poir.) Wedd., *Plectranthus coleoides* Benth., *Pogostemon heyneanus* Benth. *Pouzolzia wightii* Benn. var. *lawsoniana* C. E. C. Fischer, *Reidia gageana* Gamble, *Senecio ludens* Clarke, *Sonerila rheedii* Wt. & Arn., *S. tinnevelliensis* C. E. C. Fischer and *Trichopus zeylanicus* Gaertn. sub sp. *travancoricus* (Bedd.) Burkill are some of the herbs and undershrubs found in this area. *Utricularia roseopurpurea* Stapf ex Gamble, *U. smithiana* Wt. and *U. uliginosa* Vahl are found in marshy and wet places. The common parasites of this area are *Aeginetia pedunculata* Wall., *Christisonia tubulosa* (Wt.) Benth. ex Hook. f., *Dendrophthoe falcata* (Linn. f.) Ettingsh and *Striga asiatica* (Linn.) Kuntze.

The orchid flora of this region consists mainly of *Brachycorythis splendida* Summerhayes, *Calanthe masuca* (D. Don) Lindl., *Coelogyne nervosa* A. Rich, *Dendrobium wightii* A. D. Hawkes & A. H. Heller, *Habenaria crinifera* Lindl., *Pecteilis susannae* (Linn.) Rafin., *Peristylus aristatus* Lindl., *P. goodyeroides* (D. Don) Lindl. *Saccolabium jerdonianum* Reichb. f., *Satyrium nepalense* D. Don and *Sirhookera latifolia* (Wt.) I. Kuntze. Sedges and grasses like *Bulbostylis capillaris* Kunth var. *trifida* C. B. Cl., *Fimbristylis aggregata* Fischer, *Arundinella leptochloa* (Ness ex steud.) Hook. f., *Eragrostis gangetica* (Roxb.) Steud., *Isachne setosa* C. E. C. Fischer, *Lophatherum gracile* Brongn., *Setaria barbata* (Lamk.) Kunth, *Tripsacum laxum* Nash and *Zenkeria sebastinei* Henry & Chandr. are common in this area. The vegetation of this region consists of a rich growth of ferns. The most common ones are *Arachniodes conifolia* (Moore) Ching,

Asplenium ensiforme Wall. ex Hook. & Grev., *A. serricula* Fee, *A. formosum* Willd., *Diplazium sylvaticum* (Bory) Sw., *Elaphoglossum beddomei* Sledge, *E. marginatum* (Wall. ex Fee) Moore, *Ophioglossum lusitanicum* Linn., *Paralepto-chilus decurrens* (Bl.) Copel., *Phymatodes nigrescens* (Bl.) J. Sm. and *Ctenitopis fuscipes* (Wall.) C. Chr. ex Tard.

Many interesting species have been collected from the region during the field trips. One of them is *Capparis fusifera* Dunn, a rare plant collected by Barber from Anamalai in 1903 and described by Dunn in 1914. *Phaius luridus* Thw., a terrestrial orchid previously reported from Ceylon could be located in this area for the first time for India. A new variety of Orchid *Eria muscicola* (Lindl.) Lindl. var. *brevilinguis* Joseph et Chandrasekaran has been described from this area. Another interesting new find is an undershrub with long moniliform tuberous roots, with spreading branches and milky latex and the leaves having the shape of *Ficus religiosa* Linn. belonging to Periplocaceae. This belongs to a new genus and is named after Dr. E. K. Janaki Ammal—*Janakia arayalpathra* Joseph et Chndrasekaran.

Pakhal Wild Life Sanctuary, Warangal & Godavari, Andhra Pradesh

Approach : Rail—Kazipet, 60 km. Air—Hyderabad, 200 km.

Pakhal Reserve Forest and surrounding regions situated in Narasampet Taluk, Warangal District, Andhra Pradesh lie between 17° & 18° N and 79° & 80° E. The whole tract which is about 32 km broad encloses the Pakhal lake. The altitude is about 280 to 300 m.

The maximum temperature attained during the month of May is 45.5°C and the minimum temperature for the year attained during the month of February is 15.1°C. The annual average rainfall is 122.5 cm.

The forests surrounding the lake are of mixed deciduous type. By the end of February or the beginning of March, most of the trees and shrubs shed their leaves. There are, however, a few evergreen trees like *Aegle marmelos* Corr. and *Mallotus philippensis* (Lamk.) Muell.-Arg. scattered all along the forests, but their distribution is not sufficient to change the deciduous appearance of the forests. The deciduous trees, forming the chief components of these forests are *Adina cordifolia* Hk. f. ex Brandis, *Bombax ceiba* Linn., *Bridelia retusa* (Linn.) Spreng., *Cleistanthus collinus* (Roxb.) Benth., *Cochlospermum religiosum* (Linn.) Alston, *Emblica officinalis* Gaertn., *Dalbergia latifolia* Roxb., *Flacourtia indica* (Burm. f.) Merrill, *Garuga pinnata* Roxb., *Gmelina arborea* Roxb., *Gyrocarpus jacquini* Gaertn., *Lannea coromandelica* (Houtt.) Merrill, *Madhuca indica* Gmel., *Sterculia urens* Roxb., *Tectona grandis* Linn. f., *Terminalia tomentosa* Wt. & Arn. and *Xylia xylocarpa* (Roxb.) Taub. Another dominant tree near about the lake is *Barringtonia acutangula* (Linn.) Gaertn. with its conspicuous long pedant racemes of pink flowers, followed by angular fruits. *Xeromphis uliginosa* (Retz.) Maheshwari is also rarely met with.

Growing all over these forests, and at times going over the high trees are some climbers of which only the following are common : *Ampelocissus latifolia* (Roxb.) Planch., *A. tomentosa* (Heyne) Planch., *Butea superba* Roxb., *Canavalia gladiata* (Jacq.) DC., *Combretum roxburghii* Spreng., *C. ovalifolium* Roxb., *Jacquemonia paniculata* (Burm. f.) Hall. f., *Mucuna hirsuta* Wt. & Arn., *Operculina turpethum* (Linn.) Silva Manso and *Passiflora foetida* Linn.

The permanent undergrowth vegetation of these forests is rather sparse and is made up of woody herbs and shrubs like *Andrographis paniculata* (Burm. f.) Ness, *Barleria prionitis* Linn., *Blepharis maderaspatensis* (Linn.) Roth, *Blumea eriantha* DC., *Eranthemum purpurascens* Ness, *Grewia hirsuta* Vahl, *Hemigraphis latebrosa* Ness var. *heyneana* Brem., *H. venosa* C. B. Cl., *Hibiscus lobatus* (Murr.) O. Kte., *H. vitifolius* Linn., *Moghania strobilifera* (Linn.) St. Hill. ex Jacks.,

(Source : Sebastine & Henry, 1966)

Pavonia odorata Willd., *Securinega virosa* (Roxb. ex Willd.) Pax & Hoffm., *Solanum indicum* Linn., *Uraria picta* Desv. and *Urena lobata* Linn.

The dominant monsoon plants which form the temporary undergrowth vegetation of these forests are *Curcuma amada* Roxb. which was in full bloom during August and *Costus speciosus* (Koenig ex Retz.) Smith with spirally twisted stems and white flowers with red bracts. The other common associates of this undergrowth vegetation are : *Acalypha ciliata* Forsk., *Boorreria articularis* (Linn. f.) N. Will.,*Catharanthus pusillus* (Murr.) G. Don, *Celosia argentea* Linn., *Euphorbia geniculata* Orteg., *Evolvulus alsinoides* (Linn.) Linn., *Habenaria platyphylla* Spr., *Mollugo pentaphylla* Linn., *Oldenlandia biflora* Linn., *Phyllanthus simplex* Retz., *Sesamum indicum* Linn. and *Vicoa indica* (Willd.) DC.

There are also extensive grassy plains near about the lake. These grasslands are mainly composed of *Apluda mutica* Linn., *Echinochloa colonum* (Linn.) Link, *Eragrostis pilosa* (Linn.) Beauv., *E. tenella* (Linn.) Beauv. ex Roem. & Schult., *Hackelochloa granularis* (Linn.) O. Ktze. and *Heteropogon contortus* (Linn.) Beauv. *Vetiveria zizanioides* (Linn.) Nash also occurs abundantly and can form a source of revenue for the Forest Department.

In the Pakhal lake and along its margin an interesting and luxuriant aquatic and marshy vegetation is met with. The vegetation is mainly characterised by populations of *Blyxa octandra* (Roxb.) Planch. ex Thw., *Ceratophyllum demersum* Linn., *Glossostigma spathulatum* Arn., *Hydrilla verticillata* (Linn. f.) Royle, *Ipomoea aquatica* Forsk., *Nechamandra alternifolia* (Roxb.) O. Ktze., *N. indicum* (Linn.) O. Ktze., *Scirpus supinus* Linn., *Tenagocharis latifolia* (D. Don) Buchen., *Utricularia inflexa* Forsk. var. *stellaris* (Linn. f.) P. Taylor and *Vallisneria spiralis* Linn. Moreover, it is interesting to observe along the margin of the lake, the mixed populations of *Isoetes coromandelina* Linn. and *I. panchananii* Pant & Srivastava.

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