ECOSYSTEM STUDIES AND MANAGEMENT IN COASTAL UTTARA KANNADA

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PREFACE

This report, the result of an exploratory survey of one year's duration, mainly deals with the producer component of the forest ecosystems. The extensive data collected is being processed and it is hoped to bring out in the due course a more detailed second part as a corollary to this. Due to the shortages of time and manpower the study is mainly of qualitative nature and no quantifications have been attempted to except by counting. It is hoped that one will bear with the many inadequacies of this study caused by the limitations and constrains under which the work was carried out and also its pioneering nature as far as this region is concerned. The positive contributions, whatever it be, if adapted suitably for the forest management in Uttara Kannada, could salvage the last remains of evergreen ghat forests and save the region from impending ecological and economical catastrophes.

The tropical evergreen forests, the planets' most productive, diverse and oldest land ecosystems still persist in their primeval glory on the ghats of Uttara Kannada. Not far away, along the more populated lowlands of the west, is a desolate and desertified tract where a sparse growth of stunted and poinsonous trees and thorny bushes survive clinging to a desiccated and rocky terrain.

Between these two extremes of highest and lowest are all intergrading forms of vegetation. This study attempts to prove that the desertification of large areas along the coastal Uttara Kannada is due to ruthless exploitation of evergreen forests in the past.

As the pressures on the forests continue unabated, logging has commenced in the hitherto unexploited interior high forests along the Uttara Kannada ghats. The flourish of economic activities based on the last reserves of evergreen forests could be short-lived, losses permanent and consequences catastrophic. The wiser thing to do today seems to be to use the remaining evergreen forests of the Uttara Kannada ghats as a source of enrichment for the other degraded forest ecosystems thereby increasing their carrying capacity and protecting the ecological balance of the region.

Along with the few recommendations given at the end of the text the idea of creation of an arboretum in Uttara Kannada for mainly growing the trees of the Western Ghats also needs to be seriously considered. Such a tree garden while conserving the germplasm from deplotion will be of much educative value for the foresters and common man, scientists and students and also act as a great draw for tourists.

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M.D. SUBASH CHANDRAN

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SECTION - A

ECOSYSTEM STUDIES AND MANAGEMENT IN COASTAL UTTARA KANNADA

I. LOCATION AND PHYSIOGRAPHY

The district of Uttara Kannada is situated along the west coast of South India between Lat.13°55'N. and 15°31'N. and Long. 74°9'E. and 75°4' E. and covers an area of 10,276 sq. kms. The hill chain of the Western Ghats, which runs parallel to the West Coast, from the river Tapi in the north to the Kanyakumari in the south, passes through this district and divides it into two zones viz. the narrow coastal strip and the wider upland country along the ghats at a general elevation of 675 meters (approx.). The length of the Uttara Kannada coastal line is around 144 kms. The coastal Uttara Kannada consists of five taluks namely Karwar, Ankola, Kumta, Honavar and Bhatkal from north to the south and has a total area of 3,300 sq.kms. The Western Ghats which are to the east of the coastal plain come close to the Arabian sea at Karwar and almost plunge into it with many peaks jutting out of the water as small wooded islands. Four main rivers - the Kali, Gangavali (Bedti), Aghanashini and Sharavati which

originate in the Western Ghats traverse through the district and join the Arabian Sea. The jurisdiction of the coastal taluks generally extends to the crest of the ghats.

II. GEOLOGY AND ROCKS

Geologically the Peninsular India formed part of an ancient gigantic land mass called the Gondwanaland which stood out of the primeval oceans ever since the close of the Proterozoic Era 1,500 million years ago. At the close of the Crestaceous Period, 120 million years ago, the Gondwanaland split up into four different blocks, Australia, Africa, South America and Peninsular India. No wonder some of the oldest forests of the planet are present in parts of these lands.

At the end of the Cretaceous due to extensive volcanic activity most of the northern Peninsular India was buried in lava, hundreds of meters in thickness, forming what is called the Deccan Trap. But the part of India southwards of present Kalinadi remained unchanged. Uttara Kannada begins here, where the younger and relatively more fragile basaltic rocks of the Deccan Trap give place to the most ancient rocks of the Archaean Complex. This complex consists of granites, gneisses and schists. Quartzites and limestones are also associated with these.

The Soil: The weathering of the rocks created soil. The tropical soils are at least 60 million years old. The extensive superficial deposits of laterite on the rugged landscape of the Kanara coast is of recent origin. Many of the high hills are also laterite topped. High temperature, moisture and CO_2 production favour a far reaching destruction of silicate rocks and leaching of bases and silicic acid. The remaining substances are mostly Al_2O_3 and Fe_2O_3. This process is called laterisation (Walter 1971). Except extremely precipitious slopes, where the underlying rock is exposed, the entire western slopes of the ghats have fairly deep soil. This soil bears the luxuriant evergreen forests and the forests in turn conserve and build the soil. The depth of the weathering is very high in many places of this extremely ancient tract. The road cuttings through the Uttara Kannada ghats testify to the depth of the soil capital built up and stabilised by the plant roots. This soil which is loose and soft and covering the most ancient rocks, even on precipitous slopes, is very vulnerable to massive erosion if the plant cover suffers and the loss could be irreparable.

The soil of the coastal ghats is red loam, sandy loam and greyish clayey loam mixed with various degrees

of humus (Shanmukhappa 1979). The litter cover in the evergreen ghat forests is not very thick except during the dry weather. The dampness of the forest floor and its humid interior atmosphere favour the decomposition of litter by a variety of soil micro-organisms, fungi of varied sorts like Polyporus, Geaster, Xylaria, Clavaria, Fusarium, and other bracket fungi, molds, earthworms and termites. Fallen leaves and twigs decompose very fast whereas fallen trunks and standing dead trees take longer time and crumble into a soft mass on slightest pressure. The elements locked up in countless biological compounds are returned to the nature for recycling. The freed mineral nutrients are immediately taken up by the plant roots and therefore there is no nutrient accumulation in the soils of the tropical evergreen forests. The soil profiles show the decomposing amorphous humus only on the very surface. Therefore it is said that the nutrient capital of the tropical evergreen or rain forest is in the plant cover itself and not in the soil.

The soils of areas clear felled in the past, abandoned fields and the teak plantations along the windward side of the Western Ghats where the soils are exposed to the strongest rains, the organic matter and mineral nutrients are leached away and thus such soils

have a bleached appearence. If the clearings are small the vegetation re-establishes through the light demanding pioneer species. If the clearings are large the sheltering effect of the tropical forest ceases. Not only the nutrients but the soil itself is lost exposing the highly weathered underlying rocks with scanty scope for regeneration of soil for centuries to come even under protection. Such highly eroded and rocky landscape is the most striking aspect of the Uttara Kannada coast. This degraded land supports only a sparse growth of hardy retrograde plant communities. Walter (1971), an authority on tropical rain forests, considers the destruction of such forests as probably permanent because logging and burning of slash cause a sudden mineralisation of the entire nutrient capital and it is leached by the rains. Such loss of fertility necessitated the people to practice shifting cultivation in the past so much so Buchanan (1801) stated that the tract from Bhatkal to Bailur (near Karwar) was the barest he had ever seen.

Aitchison (1911), who prepared the 'First Working Plan for Ankola-Kumta' states, 'where laterite occurs the soil is rich, provided it is covered with forest vegetation, but if left exposed for any length of time .....it becomes hot and bare and unsuited for production of trees or indeed any other growth.'

In the valleys the soil consists of gravelly loam redeposited from elsewhere and of lateritic and granitic composition rich in humus (Mavinkurve 1955). The sandy belt nearer to the sea is considered to be due to local submergence and marine erosion and deposit during the recent times. Alluvial deposits mostly consisting of sand, silt and mud cover the lowlands on the banks of the rivers.

III. CLIMATE

The tract lies in the passage of the summer monsoon winds which bring a rather heavy rainfall. The normal annual rainfall for the coastal stations are (in mm): Bhatkal 3850, Honavar 3500, Kumta 3730, Ankola 3930 and Karwar 3010. The south-west monsoon (June-September) accounts for most of the annual rainfall on the coast. The rainfall sharply declines by the end of September but the region may continue to receive some rains upto the end of November. There may be occasional premonsoon showers in May especially in the ghat areas. No data, however, is available about the actual rainfall and its seasonal distribution in the evergreen interior high forests. The district average for the dry months in (in mm): Dec. 9.1, Jan.1.6, Feb.1.5, Mar.4.3, Apr.26.2 and May 78.2. As far as the evergreen forests are concerned

the off-season rainfall, however little it may be, is helpful in the upkeep of its dampness and microclimate, very essential for the evergreen species. But for the more desiccated and open moist deciduous and the rocky and xeric scrub not much purpose will be served by this insignificant rainfall.

Rainfall and Vegetation: Over the Malabar on the west coast and in the north eastern regions, the annual rainfall is high and good rainfall is received for nine months in a year (e.g. Alleppy and Shillong). The natural vegetation of these regions would be the tropical evergreen forests. Honavar on the coastal Uttara Kannada has about the same annual rainfall as Alleppy but it is restricted to seven months with significant rainfall only in four summer months - June-September. Therefore the vegetation is of semi-evergreen type.

The temperature remains moderate in the coastal Uttara Kannada ranging between 18-34°C. The air is very humid except during the winter months. The forest interior has its own microclimate with difference in light, temperature, humidity and wind from the regions macroclimate. Alterations in the vegetation through human interference change the microclimate and composition of the vegetation itself.

SECTION - B

VEGETATIONAL STUDIES IN KUMTA TALUK

I..INTRODUCTION

Kumta Taluk is situated in the middle of the coastal Uttara Kannada and could be considered as a representative type for the region as: 1. The physiography is typical of other coastal taluks. The densely wooded Western Ghats rising upto 500 metres form the back drop for the taluk. The landscape is very undulating due to a chain of low hills which finally merge with the Western Ghats. The sandy beaches of the Arabian sea on the west are lined with Calophyllum, Casuarina, coconut and screw-pine. Precipitous rocky hills cut the continuity of these beaches and a variety of seaweeds and other algae grow in the intertidal zone and below it attached to these rocky hills. The animal life is also rich in this zone. 2. The river is the life-line of the agricultural economy of the taluk. The rising tides travel many kilometers, almost reaching upto the base of the Western Ghats and flooding the low lying lands en route. These estuarine lands or 'kharlands' form a characteristic feature of coastal Uttara Kannada. 3. There is no significant variation in the rainfall or general climate. 4. The land use pattern is similar and the biotic influences on the flora also are identical. 5. The vegetational types are very similar in species composition.

II. THE OBJECTIVES : A REVIEW

1. The green plants are the producers of any ecosystem. The human and animal life and welfare primarily depend on the quality and quantity of the plants of the ecosystem. A knowledge of the plant species and their association to form the vegetational types of the region is essential basic knowledge for a. management of ecosystems for optimization of biomass production and b. to understand the role of plant formations in conserving the general ecology of the region.

2. This study, though exploratory in nature, in general, reflects on the quality of ecosystem management in the region.

3. The changing trends in the floristic composition of the plant formations have been broadly detected and their implications are analyzed.

4. The species list appended herewith may be used as a check list though it needs to be elaborated further.

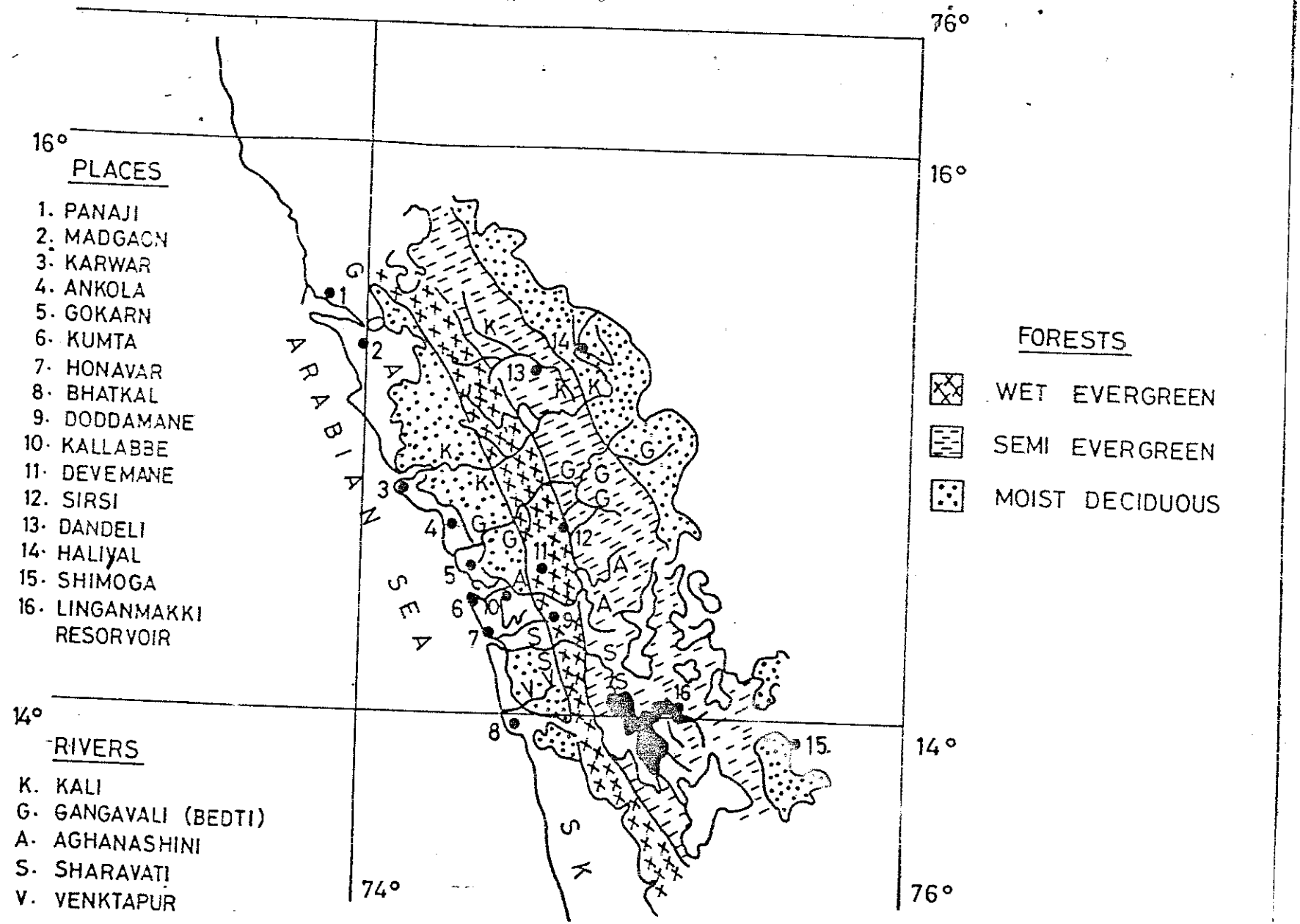
5. Though different ecosystems of the region have been studied, due to practical limitations, this report concentrates only on the forests, which form the back-bone of the economy and ecology of the Uttara Kannada

district. A note on management of forests prepared on the basis of species composition and other observations is also presented.

III. CONCLUSIONS IN A NUTSHELL

West Coast Tropical Evergreen Forests are considered as the most ideal forest formation of the coastal Uttara Kannada. Considering the diversity of plant species inhabiting them, the panorama of animal life depending on them and utilization of their potential for solving problems ranging from poverty to pollution through exploring, hitherito untapped or undertapped, plants of nutritional and fodder value, animal proteins, wild relatives of cultivated plants and animals as breeding materials, original parent stock for replacing the over-exploited and genetically unsound tree forms of the degraded forests, medicinal plants, ornamental orchids for the world market, rare majestic trees for parks and gardens etc., the remaining ghat forests should be preserved and restored in all marginal areas through massive inter-disciplinary and multi-agency efforts.

Due to single objective or few objectives-forestry, as is being practised now, and wanton and ruthless



FOREST MAP OF UTTARA KANNADA

exploitation of forest resources by the inhabitants of this tract through past centuries, who even joined hands with plunderers, who marauded this land, in setting fire to the very roots of their existence, the climax tropical forests, one of the highest productive ecosystems in the world, have almost degraded into a desert scrub along the denuded and rocky coastal hills and plateaus. In between the highest and lowest there are all intergrading forms and the forces of degradation are at large everywhere

As logging has commenced in the so far unexploited interior high forests, with hordes of men moving and loaded trucks plying on the newly made mud roads through the soft and porous mountain soil, which was stabilised on the Archaean rocks of the precipitous slopes, by virtue of the plant roots, the last refuge of Uttara Kannada's virgin evergreen forests, the planet's one of the oldest land ecosystems is facing degradation, desiccation and even extinction of species. Notwithstanding the fact that the new working plan for the interior high forests of Karwar and Honavar Divisions (Shanmukhappa, 1979) aims at sustainable utilisation and selective felling, by the very nature of the precipitous terrain and the vulnerability of the ecosystem where it is being executed, the consequences could be catastrophic and the losses irrepairable.

This report therefore recommends an immediate stoppage of logging operations in the interior high forests until its impact on the ecosystem and full implications on human life and welfare in the region are studied by an inter-disciplinary team of foresters, scientists and economists. This report also makes certain suggestions for the betterment of afforestation programmes in the coastal Uttara Kannada.

SECTION - C

THE FORESTS

Past studies on the flora of Uttara Kannada were carried out by many persons. Buchanan (1801), the British traveller gives a brief general account of the plants he encountered in the course of his journey through this district. Our present knowledge of most of the botany of Uttara Kannada ghats is mainly due to Talbot (1909). Santapau (1955) has given an account of his botanical excursion to some of the forests in the uplands of Uttara Kannada. A good deal of information on coastal, inland and interior high forests is available from the forest working plans (Aitchison 1911; Mavinkurve 1955; Shanmukhappa 1979). Puri (1960) has also given a general account of the forests of Uttara Kannada. Dhareshwar (1941) gives a graphic picture of the denudation of Kanara coast. Arora (1961, 62, 63) has made significant ecological studies on the forests of Uttara Kannada.

This investigator, after a detailed survey of the various forests, mainly of Kumta Taluk attempts to link forest composition with management of the forest ecosystem and makes certain recommendations for more sustainable utilisation of forest resources and betterment of the degraded forest ecosystem.

I. FOREST TYPES

A look at the forest map of Uttara Kannada shows that the tropical evergreen forests exist as a narrow belt along the Western Ghats. This type is distributed in the high rainfall areas in the central and western parts of the district. Though this type mostly occurs between elevation of 525-925 M, and above, along the west coast it predominates from 125 to 150 M (Arora 1963). This evergreen forest changes into semi-evergreen-moist deciduous types towards the lower hills and inland coastal plateau. These categories are ill defined and often one merges into the other and some times degrade into a scrub in the climatically and topographically homogeneous areas without any other apparent reason than degrees of biotic interference. This mosaic pattern of forest distribution is found all along the Uttara Kannada coast. It is not uncommon to find many evergreen species in a small patch of woods, amidst most degraded scrub, due to some degree of protection enjoyed by the former. Therefore it is hard to find any clear cut zonation into semi-evergreen and deciduous forms.

The scrub type is very common along the 'Minor Forest' tract which runs as a belt of around 8 to 16 kms. width along the coast.

The study by this investigator was mainly within the confines of Kumta taluk and along its fringes in Siddapur, Sirsi and Ankola taluks in the ghat areas.

II. METHODOLOGY

Primary survey on a wider area was conducted before the suitable sample sites were selected. Nature of observations is mostly qualitative. Enumeration of trees, species-wise, was carried out in 40 quadrats, each about 1000 M^2 (50 x 20 M). These 40 quadrats are spread over the entire study area covering top, middle and base of ghats, inland coastal forests and scrubs. Shrubs were enumerated in two sub quadrats, within the main quadrat, each of 10 x 5 M size. As the appearance of herbs is very seasonal no simultaneous visits could be carried out in the different quadrats for enumeration of herbs. Moreover the interior of the evergreen ghat forests are unapproachable during the rainy period due to leeches and the general precipitous nature of the terrain. Therefore herbs were enumerated only within few quadrats. However a general study of the herb flora of the entire region was carried out. Enumeration of the lianes and climbers being most difficult, and prone to errors, only a general account of their occurance in each quadrat is given.

The 50 x 20 M size of the quadrat is selected more as a matter of convenience for the difficult ghat areas and adopted as the uniform standard for other habitats. Any erect woody plant with its main stem 15 cm. or more in girth at b.h. is categorised as a tree; any plant less than 90 cm. in height constitute the ground layer or herb layer and the in between category is grouped in the shrub layer.

III. THE EVERGREEN GHAT FORESTS

These forests were studied at Doddamane Ghat, Santgal, Devimane Ghat and Wodegar Ghat their general elevation not exceeding 500 M. Some parts of the Wodegar Ghat top have laterite outcrops with semi-evergreen plant community. Rest of the areas have typical evergreen forests. However biotic interference from the adjoining villages seems to be on the increase at the top of the ghats. The lower slopes at Santgal and all other ghats are also much disturbed. This disturbance is perceptible upto 150 M.

Classification: The ghat forests mostly conform to the standards of the Tropical Wet Evergreen Forests or Rain Forests (Champion 1936). Some of the drier hills with shallow soil and lower slopes have semi-evergreen forests. Champion considered both as climax formations.

According to him these evergreens come under the category of West Coast Tropical Evergreen Forests. Gupta (1981) considers the forests of Devimane Ghat as good representative of the West Coast Evergreen type. Arora (1963) and Puri (1960) also give evergreen status to these ghat forests.

III. 1. PLANT DIVERSITY OF THE EVERGREEN FORESTS

1. A. Altitudinal zonation: Within the ghat forests no striking altitudinal variations are noticed since the coastal ghats do not rise beyond 500 M. However certain plants were found to occur only in the comparatively cooler and relatively more humid zone over 400 M. They are 1. Garcinia talboti, 2. Memecylon talbotianum, 3. Apodytes dimidiata and 4. Walsura trifolia among trees. Epiphytic flora is richer in the cooler higher elevations. Plants like Lasiosiphon, Atylotia lineata and Rubia cordifolia were collected only over 400 M.

1. B. Vertical stratification: In general 5 layers of plants are present in the well developed evergreen forests of the gentle slopes and valleys. Very tall trees are rare on more sloping terrain and the layering was not very pronounced. The top strata has lofty trees often exceeding 30 M. and consists of Syzygium gardneri,

Calophyllum tomentosum, Bischofia javanica, Alstonia scholaris, Sterculia alata (only at Yan), Antiaris toxicaria, Diospyros microphylla, Lophopetalum wightianum, Machillus micrantha, Grewia tiliaefolia, Artocarpus hirsuta, Hopea wightiana, Vitex altissima and Dysoxylum malabaricum. The tall trees of the first layer do not form a closed canopy among themselves. Their imposing crowns emerge out of the green sea of foliage of the second storey trees.

The trees of the second storey are of medium height and are in majority. Whereas the first storey trees are isolated the trees of the second storey grow close together. Their straight slender stems are unbranched for considerable heights. These are mostly evergreen trees and their dense crowns of dark broad leaves fit together forming a canopy which cuts off most of the light from reaching the forest floor. The common species of this strata are Garcinia cambogea, Garcinia morella, Knema attenuata, Myristica malabarica, Myristica beddomei, Diospyros Paniculata, Diospyros candolleana, Actinodaphne spp., Cinnamomum spp., Alseodaphne semicarpifolia, Dimocarpus longan, Dysoxylum binectarifolium and some other Meliaceae, Mimusops elengi, Chrysophyllum roxburghii, Polyalthia fragrans, Olea dioica, Syzygium spp., Holigarna arnottiana, Pterospermum spp., Litsea spp., Caryota urens etc. Their cylindrical stems appear like numerous pillars supporting a green roof.

There is a third strata of trees less than ten meters in height. They are Nothopegia colebrookiana, Syzygium laetum, Symplocos spp., Elaeocarpus serratus, Diospyros nigrescens, Bocagea dalzelli, Ehretia canarensis, Isonandra stocksii, Acronychia laurifolia, Murraya paniculata, Aporosa lindleyana, Walsura trifolia, Neolitsea scorbiculata, Litsea floribunda etc. A striking palm with short stem and large feathery leaves, Arenga wightii may be taken as a member of this layer.

Adapted to live in the dim light conditions nearer to the ground are some shrubs or very small trees. They form a fourth strata of plants. The common constituents of this layer are Memecylon talbotianum, M.wightii, M.malabaricum, Canthium angustifolium, Saprosma glomerata, Psychotria flavida, P.dalzelli, Gardenia lucida, Ixora nigricans, I. polyantha, Tarenna asiatica, Pavetta indica, Syzygium macrosepala, Chailletia gelonoides, Mallotus Iawii, Capparis heyneana, Leea spp., Boehmeria platyphylla, Nilgirianthus spp., Dracaena ternifolia, Pandanus spp., etc. The gregarious occurence of Memecylon terminale, an attractive slender shrub with blue flowers is found in the undisturbed areas. On the other hand the dense undergrowth of Rubiaceae shrubs like Psychotria spp., Saprosma spp., and Acanthaceae members like Nilgirianthus etc.,

and Boehmeria platyphylla indicate disturbances and openings in the canopy. The weed Eupatorium spp., was not noticed as occuring in the diffuse light of the interior of evergreen forests. Some members of Zingiberaceae with long leafy stems are also characteristic of the forest interior.

The harsh flora which forms a fifth layer is very poorly represented unlike more open habitats of the moist deciduous and scrub forests. Whereas the herbs in the open habitats desiccate and dry up soon after the wet weather, in the dampness and higher humidity of the evergreen forest even tender herbs with delicate leaves like balsams and Begonia and delicate pteridophytes like Selaginella, and Hymenophyllum last longer. Pteris is the most common fern of the herb layer. Ophiorrhiza harrisiana and Chasalia Ophioxyloides are some of the important Dicots of the forest floor. There is more variety among the monocots. Many ground orchids and Zingiberaceae members like Bosenbergia pulcherrima and Curcuma spp., wild arrowroot etc. are common. A lily with grass like linear leaves, Ophiopogon intermedius, is common at the top of Doddamane Ghat. Grasses and sedges are completely absent inside the evergreen forests.

The moss layer is most common in the higher elevations. The mosses grow attached to stems and even leaves of higher plants and on rocks.

1.C. Lianes, climbers and other scandent plants:

A large number of lianes or woody climbers are characteristic of the evergreen ghat forests. However they are prolifically developed and form impeneterable tangled masses only in disturbed areas, edges of forests and along the streams. These woody perennials are sometimes considered as climbing trees, their peculiar habit necessiated in the course of evolution of the tropical evergreen forest where there is a race between trees for sunlight which makes them grow taller and taller by shedding the lower branches. In the diversity of species the lianes reach their zenith in the evergreen forests. The massive stems of some lianes creep on the forest floor, sometimes get buried in the soil and then emerge and form large spirals in the air and rest on the top of trees. Like cables and ropes they extend from tree to tree. It is difficult to make a count of them. Trees crashing under the oppressive weight and other restraints imposed by these univited guests are not infrequent. Such openings in the canopy provide a chance for the younger trees to fill the lacuna. Members of Apocynaceae,

Asclepiadaceae, Celastraceae, Convolvulaceae, Annonaceae, Leguminosae and Vitaceae have large number of species as lianes.

Gnetum ula, a gymnospermous liana, is frequent in degraded forests. Lianes and other climbers have various devices for climbing upon the support. Tendrils are most common for Vitaceae, Cucurbitaceae, Smilax spp., Clematis spp., Naravelia zeylanica, Gouania microcarpa, Entada pursaetha and Adenia hondala. Artabotrys zeylanica and Ancistrocladus heyneanus are hook climbers, the latter having chains of hooks. Piper spp., and Pothos scandens have climbing roots. Chonemorpha fragrans has warty stem. Others with no special climbing organs like Beaumontia jerdoniana, Jasminum spp., Randia rugulosa, Sarcostigma Kleinii, Hippocrates spp., Ventilago spp., Mucuna monosperma, Schefflera venulosa, Derris spp., Spatholobus spp., Ipomoea spp., and Argyreia spp., wind over the support. Erycibe paniculata and Elaeagnus conferta are subscandent forms.

Tangles of canes with their whorls of sharp spines and very long, spiny and whip like flagella criss - crossing the forest interior impede one's movement which otherwise is not that difficult. Such a rich variety of climbers whose list could be prolonged further pays a tribute to the evergreen character of the ghat forests.

1.D. Epiphytes: Though the epiphytic flora is well developed the trees are not loaded with epiphytes unlike the more wet southern evergreen forests. The forests over 400 M. elevation have more epiphytes. Epiphytic flora of Uttara Kannada requires more detailed studies. Rhynchostylis retusa, Vanda spp., Acampespp., Oberonia large and small types (just 2 cm. length), Dendrobium macrostachyum, D. crepidatum and other spp., Porpax reticulata, Bulbophyllum neilgherrense, Cymbidium aloifolium, Sarcanthus pauciflorus etc., are some of the epiphytic orchids. Remusatia vivipara is an epiphytic aroid. Drynaria and Pleopeltis are epiphytic ferns. Even the degraded forests have many epiphytes. A beautiful fern with its fronds dropping to a length of over one metre was noticed in the evergreen bushes at Divgi. Two species of Hoya are also frequent.

Such a variety of epiphytes is due to the heavy rainfall and higher humidity. Asplenium nidus, a remarkable fern with dark green ribbon like succulent leaves, was found in the damp interior of Doddamane Ghat. But when brought and fixed to a tree at Kumta it started steadily desiccating in spite of frequent watering. This shows how the forest interior is a hatchery for a great variety of plants as its microclimate is much different from the general climate of the region.

The hemiepiphytes are transitional between lianes and epiphytes. The strangler fig very common in the evergreen forests, starts its life as an epiphyte, sends down a number of aerial roots which anastamose around the host plant, grow down and reach the soil. Therefore the root network becomes large and woody and the victim often dies and the strangler becomes an independent tree. Fragraea obovata of Loganiaceae is another woody hemiepiphyte. Even the palm Caryota urens was found growing as an hemiepiphyte - from the pouch of a tree at Yan.

1.E. The edges of the evergreen forest: There is a profusion of herbs and shrubs, ferns and Bryophytes thriving in the partial shade on the edges of the evergreen forests. Such habitats include banks of streams, road cuttings, edges of villages and other clearences. Most of them do not thrive in dim light of the forest floor. Their number is really high and includes even exotic weeds and other non-endemic plants. This variety vanishes towards the desiccated edges of teak plantations and in the fully exposed areas. A number of medicinal plants like Amomum spp., Costus speciosus Zingiber spp., Maranta spp., Apama siliquosa, Asparagus racemosus etc. are found here. Others include Desmodium congestum,

Crotalaria retusa, Tephrosia pulcherrima, Shuteria vestita, Desmodium pulchellum, Amorphophallus bulbifer, Globba spp., Melothria spp., g Grewia disperma, Leucas spp., Gymnostachyum latifolium, Nilgirianthus spp., Canscora spp., Many grasses like Arundinella spp., Isachne globosa, Cyrtococcum oxyphyllum and some sedges grow here.

Ferns like Atherium, Gleichenia, Lygodium, Lycopodium, Petrogama coromandalinus. Tectoria microdonta, Davallia spp., are abundant here. Angiopteris grows more hidden among bushes.

1.F. River banks: Calophyllum wightianum, Vitex leucoxylon, Diospyros embryopteris, Pterospermum reticulatum, Madhuca neerifolia, Diospyros nigrescens, Garcinia indica, Saraca indica etc., are characteristic trees along the river banks. Shrubs or small trees like Syzygium heyneanum and Homonoia riparia are found right in the rocky river-beds. Palms like Arenga wightii with their spectacular leaves line up the banks of shaded mountain streams. Canes and creepers form tangled masses. A small herb with striking rose coloured flowers, Impatiens acaulis grows clinging to the shaded rocks of streams. Members of Podostemonaceae with thalloid plant body grow firmly fixed to the smooth rocks bathed in the sparkling and cool water of Aghanashini.

2. Tree diversity: An analysis of trees in four samples, each 50 x 20 M^2 is given in Table 1. Location: Doddamane Ghat

TABLE - 1

Sl. No.	Name of trees	QI	QII	QIII	QIV
1.	Vitex altissima	1	2	2	X
2.	Hopea Wightiana	13	2	2	1
3.	Garcinia morella	8	7	1	1
4.	G.Cambogea	2	X	X	1
5.	Calophyllum tomentosum	1	2	1	X
6.	Olea dioica	11	31	X	X
7.	Holigarna grahami	3	1	5	5
8.	Nothopegia colebrookiana	3	3	4	X
9.	Apodytes dimidiata	4	X	X	X
10.	Knema attenuata	11	6	1	12
11.	Terminalia bellerica	1	1	X	X
12.	Minusops elengi	2	2	1	2
13.	Dimocarpus longan	5	X	6	9
14.	Memecylon malabaricum	1	1	X	X
15.	Ixora brachiata	2	1	1	1
16.	Symplocos spp.	7	X	X	X
17.	Artocarpus hirsuta	1	2	1	3
18.	Walsura trifolia	1	2	X	X
19.	Meliaceae x	5	X	7	11

Table - 1 (contd.)

20.	Diospyros nigrescens	3	4	X	X
21.	Caryota urens	1	X	5	1
22.	Litsea spp.	1	1	1	X
23.	Lauraceae G	1	X	X	X
24.	D Q-D	1	2	X	X
25.	D Q-H	1	X	X	X
26.	Holigarna arnottiana	X	2	X	X
27.	Terminalia paniculata	X	2	X	X
28.	Cinnamomum spp.	X	2	1	1
29.	Dysoxylum malabaricum	X	1	X	1
30.	Garcinia talboti	X	1	X	X
31.	Aporosa lindleyana	X	1	X	X
32.	Flacourtia indica	X	1	X	X
33.	F. montana	X	1	X	X
34.	Acronychia pedunculata	X	1	X	X
35.	D Q-1	X	1	X	X
36.	Other unknown	X	2	X	X
37.	Chrysophyllum roxburghii	X	X	1	X
38.	Syzygium gardneri	X	X	4	7
39.	Bischofia javanica	X	X	2	X
40.	Neolitsea zeylanica	X	X	1	X
41.	Pterospermum spp.	X	X	1	X
42.	Macaranga peltata	X	X	1	X

Table - 1 (Contd.)

43.	Alstonia scholaris	X	X	2	X
44.	Stereospermum personatum	X	X	1	X
45.	Arenga wightii	X	X	2	X
46.	Myristica malabarica	X	X	6	7
47.	Diospyros spp.	X	X	4	1
48.	Other unknown	X	X	5	X
49.	Ochrocarpus longifolius	X	X	X	1
50.	Bocagea dalzelli	X	X	X	4
51.	Dipterocarpus spp.(?)	X	X	X	1
52.	Lophopetalum wightianum	X	X	X	1
53.	Polyalthia fragrans	X	X	X	1
54.	Artocarpus gomezianus	X	X	X	1
55.	'Havagai'	X	X	X	1
	TOTAL	90	85	69	75

The four quadrats are within a distance of 1.5 kms. and between altitudes 250 and 450 M. The Q I and Q II are at the top with elevation around 450 M. No rock outcrop was noticed and in the dampness of depressions herbs of varied sorts were growing. Q III and Q IV are on more or less steep slopes and between elevations 250 to 275 M. Soil cover is thick as is evident from the road

cuttings but severe erosion was noticed where the tree cover was disturbed. However both the quadrats were free from disturbances.

The high number of Hopea (13) in Q I and Olea in QI(11) and Q II(31) may be due to more biotic interference since these two are near a village, Udolli, in Siddapur Taluk.

A feature of tropical evergreen or rain forest is large number of tree species. According to Wilson (1971) the tree species are commonly 40 per hectare. The ghat forests of coastal Uttara Kannada easily fit into this category having perhaps 50 to 60 species of trees per hectare. Here Q I with an area of 0.10 hectare has 25 sps. If Q II is added the species number rises to 36. Q III raises it to 49 and Q IV to 55. More quadrats could go on adding a small increase to the total species. Arora (1960) states there are 405 recorded species of trees from Uttara Kannada.

3. Plank buttresses and stilt roots: Buttresses are moderately developed and more well developed in the valley parts, but not as much as in the more wet southern forests. Their formation seems to be in response to alternate inundation and exposure to air (Oosting H.J. 1956). The

trees of the perpetually wet Yan valley have well developed buttereses.

Stilt roots are normally associated with plants of bogs and marshes and other wet places. They give additional grip to the plants in an uncertain terrain. Myristicaceae with buttresses and stilt roots is associated with swamps of evergreen forests of Kerala (champion and Seth 1969; Krishnamoorthy 1969). The common occurence of Myristica malabarica and Madhuca neerifolia, another plant with stilt roots and associated with river banks, in the evergreen ghat forests even on steep slopes, is perhaps an indication of the wetness and sponginess of the soil.

4. Thin Bark: The bark is thin and smooth in majority of trees. As the forest interior is very humid there is only minimum loss of water through the bark and hence the evergreen trees have mostly thin bark. The bark is thicker in trees like Hopea wightiana, Olea dioica etc. which are very common evergreens in semi-evergreen forests. Openings in the evergreen forests of this region which depend on seasonal heavy rainfall would result in increased water loss from the soft wooded thin barked evergreens.

5. Cauliflory: Production of flowers from the older stems and from parts below the leaves is found in many

plants like members of Menispermaceae, Artabotrys zeylanica, Polyalthia fragrans, Bocagea dalzelli., Garcinia cambogea, G. talboti, Ochrocarpus Longifolius, Sarcostigma kleinii, Gnetum ula, Memecylon spp., Diospyros paniculata, Homonoia riparia etc., Ficus spp., Artocarpus heterophyllus and Saraca indica are classical examples of cauliflory.

6. Thorniness: Evergreen forests have very few species with thorns, spines or prickles. Many climbers and canes which possess such organs mostly use them for holding on to the support than for protection. Flacourtia spp. are common exceptions. But as one comes down to the moist deciduous and scrub forests he could notice an increase in thorniness which could be in response to the excessive biotic pressure.

IV. THE SEMI-EVERGREEN AND MOIST DECIDUOUS FORESTS

These two forest types occur towards the lower slopes, foot hills and along the interior coastal plains. They occur in discontinuous patches separated by villages, teak plantations, cashew groves etc. A clear cut zonation into semi-evergreen and evergreen types based on topography or climate do not applicable here. The degrees of biotic disturbances and the state of soil which alter the habitat seems to be the deciding factors. These forests

are subjected to logging, lopping for green manure, cattle grazing etc. Often one merges into the other imperceptibly. For instance as one descends the Devimane Ghat he enters into the ill defined patches of deciduous - semi-evergreen forests and re-enters typical semi-evergreen forests at Katgal and soon into deciduous forests at Androlli from where the forest degrades into a lateritic scrub towards the populated coast. All these changes occur within a distance of 15 kms. Every patch of forest is in a disturbed state.

1. The semi-evergreen forest: This type was studied at Katgal, foot-hills of Devimane Ghat, foothills of Doddamane Ghat, Nagoor, Kallabbe and at Kadekodi - Dhareshwar, very close to the Arabian sea. Here most of the forest is evergreen, but it also contains a varying percentage of deciduous trees which usually top the evergreen growth and form a conspicuous feature of the mixture. There are more openings in the canopy. Their main characteristics are as follows:

1. a. Decline in tree species: The number of tree species are only 12 to 17 per quadrat. Similarities are more between different quadrats as the species repeat. Trees like Holigarna grahamii, Garcinia cambogea, G.morella,

G.talboti, Calophyllum tomentosum, Myristica beddomei, M. Malabarica, Chrysophyllum roxburghii, Diospyros nigrescens, Bischofia javanica, Syzygium gardneri etc., and the palms Arenga wightii and Corypha umbraculifera are conspicuous by their absence or rare presence. The common evergreen species here are Hopea wightiana, Olea dioica, Pterospermum spp., Diospyros microphylla, Mangifera indica, Hydnocarpus wightiana, Elaeocarpus serratus, Aporosa lindleyana, Ixora brachiata, Carallia integerrima, Flacourtia montana, Bocagea dalzelli, Syzygium spp., Cinnamomum spp., Knema attenuata, Mimusops elengi, Ochrocarpus longifolius, Lophopetalum wightianum etc. Some of these evergreen even increase in number in these habitats.

The deciduous species include Careya arborea, Dillenia pentagyna, Terminalia spp., Schleichera oleosa, Adina cordifolia, Eryatamia heyneana, Lagerstroemia spp., Grewia tiliaefolia etc.

1. b. Ground vegetation: The different species of Nilgirianthus are very conspicuous. They have gregarious growth and mass flowering once in six or seven years. Psychotria flavida is another gregarious undershrub. Leea sambucina, and Ixora migricans are also common. The seasonal herbs include Bosenbergia pulcherrima,

Curcuma spp., Impatiens spp., Begonia spp., Geophila spp., Zingiber spp., etc. Many ferns are found growing here in moist shaded stream banks and road cuttings. There are plenty of climbers and lianes.

An analysis of trees in the Katgal forest is presented in Table 2.

TABLE - 2

Sl. No.	Name of trees	QI	QII	QIII
1.	Knema attenuata	20	14	X
2.	Cinnamomum spp.	1	X	X
3.	Actinodaphne spp.	3	X	X
4.	Dysoxylum malabaricum	4	4	X
5.	Dioxpyros candolleana	4	2	X
6.	Diospyros microphylla	2	X	X
7.	Mangifera indica	1	2	X
8.	Holigarna arnottiana	1	X	3
9.	Madhuca neerifolia	2	7	X
10.	Olea dioica	3	X	7
11.	Ixora brachiata	1	1	1
12.	Pterospermum reticulatum	1	2	X
13.	Artocarpus hirsutus	1	1	X
14.	Lophopetalum wightianum	1	1	X
15.	Hopea wightiana	3	4	3

Table - 2 (Contd.)

16.	Nothopegia colebrookiana	X	3	X
17.	Dimocarpus longan	X	1	X
18.	Vitex altissima	X	1	1
19.	Syzygium gardneri	X	1	X
20.	S.cumini	X	1	1
21.	Ficus spp.	X	1	X
22.	Schleischera oleosa	X	X	10
23.	Lannea coromandelica	X	X	1
24.	Lagerstroemia microcarpa	X	X	2
25.	Elaeocarpus serratus	X	X	2
26.	Careya arborea	X	X	1
27.	Carallia integerrima	X	X	1
28.	Flacourtia montana	X	X	1
29.	Terminalia paniculata	X	X	1
30.	Dillenia pentagyana	X	X	1
31.	Aporosa lindleyana	X	X	1
32.	Machillus micrantha	X	X	1
	TOTAL	48	46	38

All these three quadrets in Table 2 were laid in one unbroken stretch of forests within 1 sq.km.area. Q I and Q II are towards interior and Q III very near the main road. The topography is uniform but Q III appeared to be a more exploited area. The quadrat III is very much deprived of soil exposing the underlying laterite. Q III is almost deciduous compared to Q I and Q II and the reasons seems to be more human interference.

Such a mosaic of evergreen and moist deciduous is the common feature within the confines of one forest having uniform topography. Aitchison (1911) mentions small evergreen forest areas found scattered within the limits of the deciduous forests in Ankola-Kumta area. A sample analysis of Murdeshwar (Table) village forest proximity the classical case of degradation of evergreen into the scrub through intermediate stages. This forest is of more than 1000 hectares area and is situated along the low hills and plains by the side of Aghanashini. Patches of forests away from human habitation and roads, even on hill tops are evergreen though degrading fast. Other areas have moist deciduous and even Sapium - Strychnos - Memecylon dominated scrub. The forest floor in evergreen - semievergreen patches have more soil. Moist deciduous and scrub zones are under degrees of laterisation. Last of the evergreens were

succumbing to axe as the investigation was going on. Though their number is small per quadret it is an important evidence about the prevalence of evergreen forests on the Uttara Kannada coast. Deciduous species and Eupatorium clumps ha ve already established in newly cleared areas. See Table - 3 for tree analysis.

TABLE - 3

Sl. No.	Name of the trees	QI	QII	QIII	QIV
1.	Knema attenuata	8	3	X	X
2.	Myristica malabarica	4	10	X	X
3.	Garcinia cambogea	1	X	X	X
4.	Ficus nervosa	4	X	X	X
5.	Polyalthia fragrans	1	X	X	X
6.	Holigarna arnottiana	7	3	7	4
7.	Nothopegia colebrookiana	2	1	X	X
8.	Madhuca neerifolia	1	X	X	X
9.	Olea dioica	1	X	19	6
10.	Dysoxylum malabaricum	1	X	X	X
11.	Hopea wightiana	1	1	X	X
12.	Sterculia foetida	1	X	X	X
13.	Other species	1	X	X	X

Table - 3 (Contd.)

14. Garcinia indica	X	1	13	6
15. Mimusops elengi	X	1	X	X
16. Artocarpus hirsuta	X	2	X	X
17. Diospyros microphylla	X	5	X	X
18. Terminalia paniculata	X	X	3	6
19. T.bellerica	X	X	4	1
20. T.tomentosa	X	X	4	15
21. Vitex altissima	X	X	1	X
22. Xylia xylocarpa	X	X	3	1
23. Aporosa lindleyana	X	X	4	2
24. Ixora brachiata	X	X	5	4
25. Careya arborea	X	X	1	X
26. Strychnos nuxvomica	X	X	1	1
27. Memicylon umbellatum	X	X	1	X
28. Ervatamia heyneana	X	X	1	1
29. Schleischera oleosa	X	X	X	27
30. Randia dumetorum	X	X	X	1
31. Pajanelia longifolia	X	X	X	1
32. Mangifera indica	X	X	X	1
TOTAL	33	27	67	77

In these four sites Q I and Q II are fast departing from their evergreen nature due to openings in the canopy. Their regeneration is at stake and in a matter of years the deciduous species of Q III and Q IV types will invade the area thus wiping out the evidences for evergreen origin of semi-evergreen moist-deciduous forests. However it should be possible to reconvert the transitional forms into original evergreen type under careful management before massive soil erosion sets in causing irreversible laterisiation and retrogression into moist deciduous - scrub disclimax.

1.c. Nonsustainable utilisation of forests:

'Logging has only a minor and temporary impact on tropical rain-forests - if the harvesting is strictly managed' - that is the conclusion of a study by the Queensland Department of Forestry, based on 80 years of research in the rainforests of northern Australia (Catherine Caufield 1983). The study adds, 'the heavily logged plot had the guts ripped out of it and that would have affected the environment of the forest, the nutrient levels, the microclimate, the soil water balance, so as to inhibit its recovery'.

A study was made of the current year's (1983-84) logging in one of the coupes in the already much exploited reserve forests of moist deciduous type in the plains along the Chandawar-Badal tract. Freshly cut stumps numbering to about 75 per hectare were counted. Trucks were plying in every nook and corner to transport the stacked wood further loosening the fully exposed soil and the forest is facing massive soil erosion during the next rainy season. An analysis of two quadrats in the logged area in comparison with two unlogged quadrats is presented in Table - 4.

TABLE - 4

Sl. No.	Name of trees	Unlogged		Logged	
		QI	QII	QIII	QIV
1.	Aporosa lindleyana	5	8	7	X
2.	Dillenia pentagyna	3	2	X	2
3.	Schleischera oleosa	5	1	X	1
4.	Terminalia paniculata	1	1	X	2
5.	Randia dumetorum	1	1	X	1
6.	Lagerstroemia microcarpa	1	2	X	X
7.	Heterophragma roxburghii	1	X	X	X
8.	Strychnos nuxvomica	1	X	X	X

Table - 4 (Contd.)

9.	Terminalia bellerica	X	1	1	X
10.	Careya arborea	X	1	1	X
11.	Sterculia foetida	X	1	X	X
12.	Lannea coromandelica	X	1	1	X
13.	Ervatamia heyneana	X	1	X	1
14.	Olea dioica	X	1	X	X
15.	Alstonia scholaris	X	1	X	X
16.	Vitax altissima	X	X	1	X
17.	Hopea wightiana	X	X	1	X
18.	Syzygium caryophyllata	X	X	1	X
19.	Terminalia tomentosa	X	X	X	2
	TOTAL	18	22	13	9

Number of current years stumps in Q III - 13

-do- in Q IV - 5

The number and types of species in all the four quadrats show that the forest was much logged in the past and the current logging testifies that the pressure on forests continues unabated.

The ground vegetation consists of bamboo and saplings of Aporosa, Ervatamia, Zanthoxylum rhetsa, Holigarna arnottiana, Flacourtia spp., Leea spp. and

Lagerstroemia microcarpa. The climbers are Calycopteris floribunda, Embelia spp., Dalbergia sympathetica and Derris spp.

V. THE SCRUB VEGETATION

The scrub is the characteristic vegetation of the denuded landscape of coastal Uttara Kannada. The habitat is very lateritic, mostly bereft of soil and highly unproductive. The most characteristic tree of this desolate habitat is Sapium insigne, a stunted plant which remains leafless throughout the dry season. The plant multiplied and colonised the dry rocky hills in large numbers as people and cattle carefully avoided it due to its poisonous and blister causing latex. Of late the people have started cutting this species in large numbers due to the severe fuel problem.

Memecylon umbellatum, Syzygium jambolana and Syzygium caryophyllata are some hardy evergreen species suited for the lateritic habit. Islands of woods sometimes surprisingly evergreen are found to survive in the midst of extensive lands in the grip of desertification.

A narrow belt of forest about 100 meters in width and having an area of less than 10 hectares exist along the western slope of a low lateritic plateau in the Kadekodi

village. The top of the plateau is completely denuded and so too rest of the unprotected slopes. During the months of June-July broad sheets of clear water from the plateau rush down the wooded slope carrying away what little soil it is left with. This forest is classified as 'Betta' and is meant for leaf collection by the farmers. Three samples were studied here: QI-well protected, QII and QIII were more degraded. (See Table 5 for details)

TABLE - 5

Sl. No.	Name of trees	QI	QII	QIII
1.	Diospyros embryopteris	28	2	1
2.	D. candolleana	1	X	X
3.	Aporosa lindleyana	16	26	X
4.	Ixora brachiata	4	1	3
5.	Mimusops elengi	8	2	1
6.	Plectronia wightii	1	X	X
7.	Holigarna arnottiana	1	8	10
8.	Nothopegia colebrookiana	3	X	X
9.	Ochrocarpus longifolius	5	2	X
10.	Alscodaphne semicarpifolia	1	X	X
11.	Ficus arnottiana	10	3	1
12.	Unknown	4	X	X

Table - 5 (Contd.)

13. Olea dioica	X	2	X
14. Memecylon umbellata	X	3	X
15. Mangifera indica	X	2	2
16. Aglaia roxburghiana	X	1	X
17. Salmalia malabarica	X	1	X
18. Macaranga tomentosa	X	X	2
19. Caryota urens	X	X	13
20. Hopea wightiana	X	X	1
TOTAL	82	53	34

The composition of this community easily brings to the mind a picture of a relict evergreen community clinging to a precarious habitat. Gymnosperm Gnetum, wild banana, canes and epiphytes like Remusatia vivipara and Fragraea obovata are other members of this community.

The scrub community just outside this partially protected zone consists of hardly any trees barring the stunted Sapium indicum. The other members are Euphorbia antiquorum, E.acaulis, Canthium parviflorum, Zizyphus jujuba, Z. rugosa, Solanum xanthocarpum, lopped clumps of Memecylon unbellatum, Aglaia roxburghiana, Ervatamia heyneana, Carissa carandans, Ixora coccinea etc.

The study of these green islands in the midst of extensive rocky areas point out to the bio-edaphic nature of the scrub vegetation of coastal Uttara Kannada.

SECTION - D

A NOTE ON ECOSYSTEM MANAGEMENT IN COASTAL, UTTARA KANNADA

INTRODUCTION

'Two features characterize our time. The first is the almost limitless capacity of human beings for building and creation, matched by equally great powers of destruction and annihilation. The escalating needs of soaring numbers have often driven people to take a short-sighted approach when exploiting natural resources. The toll of this approach has become glaringly apparent: a long list of hazards and disasters, including soil erosion, desertification, loss of cropland, pollution, deforestation, ecosystem degradation and destruction, and extinction of species and varieties. This situation underlines the need for conservation, comprising the ecologically sound management of productive systems and the maintenance of their viability and versatility (World Conservation Strategy 1980).

The scope of this report is limited to the management of basically the most important ecosystem of the region - the forests.

I. THE FORESTS AND THEIR MANAGEMENT

A. TROPICAL RAIN FORESTS - HIGHEST PRODUCTIVE ECOSYSTEMS ON THE EARTH

The most favourable environments for biological activity occur in humid tropical regions of the earth. The rain forest ecosystems constitute the tallest closed canopy vegetation with highest rates of primary production, highest standing biomass and the greatest diversity of species anywhere on the earth (Gadgil 1978). The highest known gross production rates of around 120 mt/ha/yr were obtained in tropical rain forests of Thailand. Compared to the temperate forests the tropical rain forests are more productive by a factor of 1.7 to 2.

B. THE STATUS OF THE GHAT FORESTS OF NORTH KANARA

According to champion (1936) the forest between 300 and 1500 M elevation and receiving 2000 - 5000 mm rainfall on the Western Ghats form the West Coast Tropical Evergreen Forest which comes under the major group Tropical Wet Evergreen Forest (rain forests). Puri (1960) also recognises it as belonging to the broad group of Tropical Wet Evergreen Forests. He brings Uttara Kannada Ghat forests under Western Tropical evergreen forests.

Gupta (1961) considers Devimane forest of Kumta as a good representative of West coast tropical evergreen forests. Arora (1963) states about the occurence of evergreen forests to the lowest elevations of 125 to 150 M on the Western side of the ghats.

This investigator, after a study of the ghat forests of Kumta, parts of Sirsi (top of Devimane Ghat), and parts of Siddapur (top of Doddaman Ghat) also came to the conclusion that these forests conform to the standard of the tropical wet evergreen or rain forests. A detailed description of the ghat forests is made in Section C. Therefore the evergreen ghat forests of Uttara Kannada fit into the category of the oldest (60 million years approx.), highest productive and most diverse land ecosystem of the planet namely the Tropical Wet Evergreen Forest. In the world largest and densest such forests exist in Amazon basin, the second largest in South East Asia and a smaller one in West Africa. In India it occurs mainly along the Western Ghats, and in the North East. The evergreen forest attains its highest development in the south of Western Ghats as in Kerala which has a more wet climate.

C. THE FOREST TYPES OF UTTARA KANNADA LOWLANDS

As was discussed in the Section - C the Uttara Kannada lowlands have varied sorts of vegetation ranging from small islands of degraded evergreen forests to semi-evergreen moist deciduous forests. Extensive areas on the Uttara Kannada coast have rocky hills and plateaus with sparse scrubby vegetation consisting mostly of thorny bushes and poisonous plants. During the rainy weather a carpet of grasses and various tiny annual herbs sprout on this harsh terrain and provide some foraging material for the thousands of famished cattle which wander all along this desertified tract posing a serious threat to the regeneration of trees.

C.1. Origin of semi-evergreen - deciduous forests and scrub on the Uttara Kannada Coast:

Champion (1937) considers semi-evergreen and moist deciduous forests as separate climax types. Chandrasekharan (1961) considers moist deciduous forests probably as a climax community in areas where rainfall is 127 to 203 cm. He treats the moist deciduous forests of Kerala, which has a higher rainfall, as a pseudo-climax caused by constant biotic interference. At the same time Karian Shola with just 1770 mm of rainfall as an advanced stage of evergreen forests. He holds the view that, 'Owing to

the sensitiveness of the evergreens to exposure, fire and probably to soil changes which have taken place, the return of the evergreen is usually a slow process and the deciduous type appears very stable'.

Arora (1967) follows Chandrasekharan in treating the deciduous and semi-evergreen forests of Dakshina Kannada as secondary seral rather than climax stages. He considers evergreen as the climax vegetation for Dakshina Kannada which has more or less has similiar physiographic and climatic conditions of Uttara Kannada.

The present study points out to the evergreen degrading into the scrub through varied stages under degrees of biotic interference. The mosaic pattern of evergreen-semi-evergreen - moist deciduous-scrub vegetation on the climatically homogeneous coastal Uttara Kannada, which has a rainfall exceeding 3000 mm in most places point out to the biotic origin of forest types other than evergreen. Moreover surprisingly well preserved evergreen patches of vegetation occur amidst the most degraded rocky scrub due to some amount of protection. Many species of trees, canes and epiphytes found only in the evergreen ghat forests are present in these isolated relict patches. Even the precipitous slopes on the Western Ghats have enough spongy soil to support

luxuriant evergreen forests. There may not be any other reason than misuse of forest wealth for the present denuded and rocky condition of the Uttara Kannada coast.

C.2. History of denudation of the Kanara coast:

Dhareshwar (1941) gives a graphic picture of the past history of deforestation and denudation of the Kanara coast. Widespread practice of shifting cultivation in the past and acts of vandalism and ruthless exploitation of forest resources created the desertification of what is called as the 'Minor Forest' belt of Uttara Kannada.

When Buchanan visited coastal Uttara Kannada in 1801 it was already in a denuded state so much so he stated this was the barest tract he had ever seen. He mentions about the widespread practice of hill cultivation in this region after clearing the forests.

Walter (1971) considers the destruction of rain forests as permanent because logging and burning of slash causes a sudden mineralisation of the entire nutrient capital. Since such burned areas are denuded of plants that could absorb the suddenly released nutrient capital, it is leached instead by rain. Therefore, cleared rain forests are infertile. This forces the people to practice shifting cultivation.

Gadgil and Malhotra (1981) trace the desertification of the Ratnagiri hills along the coastal Maharashtra to shifting cultivation and overgrazing.

C.3. Consequences of denudation: The nutrients are leached away by torrential rains. Soil itself is eroded and underlying rocks are exposed. As much of the tropical rocks are ancient and highly weathered and land becomes useless for agriculture (Harrison 1979).

Aitchison (1911) considers laterite soil as rich provided it is covered with forest vegetation, but if left exposed for longer time it becomes hot and bare and unsuited for the production of trees or any other growth.

D. THE NEW THREAT TO THE EVERGREEN GHAT FORESTS

D.1. Background: In India the tropical evergreen forests occur in a narrow strip along the Western Ghats and also in the Assam Region. The inhabitants of Uttara Kannada are singlurly lucky in having such unique, most diverse, highest productive and the most ancient land ecosystem of this planet to cater to their needs. A vegetational analysis reveals that in the coastal Uttara Kannada the evergreen forests are confined to mostly the less disturbed ghat areas. Such forests cover only 500 sq.kms.

roughly. It is rich in plant and animal diversity. The ecological stability of the region is largely dependent on these forests - Logging for timber has started in these hitherito unworked forests under the new working plan (Shanmukhappa 1979).

D.2. AN APPRAISAL OF THE DRAFT WORKING PLAN FOR THE UNORGANIZED FORESTS OF KARWAR AND HONAVAR DIVISIONS 1979

2.A. FEATURES

1. This working plant covers an area of 538.43 sq.kms. of ghat forests from Karwar to Bhatkal.

2. The plan recognises that the forest has reached its climatic climax stage and the absence of human interference seems to be the cause for it.

3. The plan considers it very difficult if not impossible to re-establish an evergreen forest after clearing it once.

4. The entire area is highly rugged and rocky with precipitous slopes along the courses of the rivers and their tributaries.

5. The General Objects of Management:

a. To exploit as far as practicable the mature and overmature crop and utilise the same according to market requirement on sustainable yield basis.

b. To raise the potential value and productive capacity with the funds availa ble by introduction of teak and other fast growing species, important and economically viable, suitable to the locality and thus improving the growing stock.

c. To open up the area by judicious arrangement of exploitable coupes with a view to establish roads and communications to make the forests easily approachable and accessible. Every opportunity will be taken to bring to the market as many new species as possible from these hitherito unworked areas.

6. Selection cum improvement felling will be the system adopted. In addition to this there will be an over-lapping working circle for extraction of plywood species.

7. The whole of the forests is divided into 34 blocks. The period of the plan will be 20 years after which it will have to be revised.

8. The working plan prescribes various regulations on cutting of specified economically important trees. It states, 'Besides, the other interior species are in abundance, there is no need to fix any limit for their extraction'.

2.B. THE APPRAISAL

a. Single objective forestry: The plan is a single objective market oriented one, aiming at timber extraction only and pays scanty attention to the maintenance of ecology of the evergreen forests. Not only that the plan advocates the introduction of teak and other fast growing species suitable to the locality.

b. Aitchison (1911) on teak: Commenting on the prospects of growing teak in the Ankola-Kumta forests, Aitchison states, 'There is not much object in doing this as teak does not grow well in these forests'.

c. Davis (1940) warning on teak: Davis states teak is most suitable for the moist river alluvium. He cautions against planting it on the well drained hills of the west coast as the exposed soil creates laterisation. Teak sheds its leaves during the dry weather unlike the natural evergreen forest. This promotes, according to Davis, oxidation of humus and washing of silicate gels

which otherwise prevents laterite formation. Most of the teak plantations observed in the Kumta taluk have bleached, highly eroded and rocky soil. In many plantations the litter is set on fire along with the weeds during the dry weather. This creates immediate mineralisation of nutrients. As the torrential rains arrive in June this ash is washed away. Thus teak returns nothing to the ecosystem. Davis found the state of teak on such 'petrified' earth in pathetic state. Teak in coastal Uttara Kannada was planted indiscriminately even in the recent past and most of it on hill slopes, sometimes not so gentle. These plantations in general, with their highly eroded and rocky soil and totally leafless state in the dry season are ecological misfits among evergreen forests. Degradation of evergreen forest was noticed around the teak plantations. The reasons might be increased evapo-transpiration from the evergreen community due to the desiccation created by teak plantations and entry of weeds from the plantation which might affect the regeneration of evergreens.

d. Degradation of evergreen forests: Due to biotic pressure from the villages evergreen forests around them have degraded into semi-evergreen - moist deciduous types.

This is due to partial opening of the canopy which promotes the growth of light loving deciduous species. There is every likelihood for retrogression of the evergreen forest into inferior forms under the new working plan.

e. Soil erosion: The working plan covers rugged and precipitous terrain where the soil and vegetation have been co-evolving on the world's most ancient rocks for tens of million years. One of the spelt out objectives of the working plan is to open up the area by establishing roads and communications to make the forests easily approachable. The logging and the road making and movement of men and loaded trucks through the soft forest soil would result in landslides and massive soil erosion, the signs of which were already observed at Yan after the plywood rounds, where the more intense 'selection cum improvement' programme is yet to begin.

f. Flash floods and droughts: The evergreen forests form the important watershed forests for the coastal Uttara Kannada. Therefore Aitchison (1911) excluded such forests from the first working plan for coastal North Kanara called the 'Ankola-Kumta Coast Working Plan'. He states, '....These evergreen forests play a very important part in the welfare of the deciduous forests on the slopes, and of the cultivated land in the valley below, and should consequently be conserved with as much care'.

Soil erosion will be followed by increased run off, swelling of streams and flash floods on the Uttara Kannada coast thereby rendering life on the river banks more unsafe.

g. Unregulated logging: The logging of trees carried out during the study period was sampled at Yan, in the interior high forest. At Yan the survey was made after the first round of felling during 1983 for plywood. The main purpose was to know its impact on a rare stand of magnificant Sterculia alata trees - very rare in India and in Uttara Kannada found in sizable number only in the calcium rich soil of Yan valley. Eight large trees were found to be cut in just half an hectare area.

At Chandawar - Badal tract the current year's logging intensity was studied in the already much worked coastal plain forests. In the sampled area 75 freshly cut stumps per hectare were counted. Working of the ghat forests if it goes unregulated would turn out to be detrimental and the damages irrepairable.

h. Forest replanting: The saplings raised in the five forest nurseries of Honavar Division during the study period had very little to do with the composition of the natural forests. The details available from two of the

nurseries were of 82-83 and the others of 83-84. The break up of the consolidated data is as follows:

1. Exotic xerophytes	-	02 spp
2. Exotic avenue trees, fruit trees and miscellaneous	-	13 spp
3. Evergreens from India	-	13 spp
4. Deciduous from India	-	15 spp
Total	-	43 spp

The working plan aims at bringing to the market more and more new species and including very rare Sterculia alata trees have been cut. The five forest nurseries together raised just 13 species of evergreen grees. This is another evidence to substantiate the biotic origin of the moist deciduous forests of the Kanara coast.

i. Outbreak of zoonotic diseases: These diseases are of animal origin and associated with certain ecosystems (Bhat 1981). Bhat states man's interference into these ecosystems results in modification of the natural cycle of the disease, which sometimes results in epidemic outbreaks like Kyasanur Forest Disease (Monkey fever). This killer disease has taken a great toll of human lives in the South and North Kanara and still rages unabated.

Bhat considers 90 percent of ticks in forests with high human interference as belonging to Haemaphysalis spinigera the one responsible for KFD.

A district consequence of forest clearence is the prolific growth of weeds like Eupatorium which harbour plenty of ticks. Eupatorium was found to spread in the interior forests after the canopy opening.

j. Increase in agricultural pests: Harrison (1979) warns that the increased insolation after forest clearing in tropics could trigger of mutations and create new species of resistant agricultural pests.

k. Effect on forest microclimate: The evergreen forest, where trees of varied heights form a multi-storeyed canopy creating altogether a different climate in its interior, highly essential for the regeneration of their own progeny, and sheltering myriads of other plants and animals all of which blend harmoniously to form one system which ticks in tune with the physical environment, is being vivisected in a major way perhaps never to recover again.

l. Desiccation of the ecosystem: Already under great stress from the desertification of large tracts in

coastal Uttara Kannada, retrogression of its much exploited forests into deciduous nature, large-scale creation of teak and Eucalyptus plantations, often at their very expense, the evergreen ghat forests of coastal Uttara Kannada are not likely to cope up with the new onslaught unleashed on them as the hydrological cycle would be further upset paving the way for the arrival of drought resistant and deciduous species.

m. Decline in wild-life: Wild-life flourished in this region during the historical past (Varthema 1503; Barbosa 1514; Fryer 1675). Today the habitat of the wild fauna is largely depleted. What remain are confined to the ghat forests. Champion (1969) considers production of fleshy fruits as the important character of many evergreen plants. The various species of Garcinia, Myristica, Syzygium, Flacourtia, Artocarpus, Elaeocarpus, Chrysophyllum, Mimusops etc. and many members of Anacardiaceae and Meliaceae produce fleshy edible furits. Many others produce edible seeds specialised to survive on such a wide array of foods are a variety of animals and birds. On the other hand the dominant deciduous species like Terminalia spp., Schleischera, Adina, Lagerstroemia spp., Albizzia spp., Dalbergia spp., etc. and pioneer evergreens like Macaranga and Trema produce dry pods and dry seeds. Decline in wild life removes an important source of protein for the many rural communities.

E. ISLAND BIOGEOGRAPHY AND BIOSPHERE RESERVES

The exploitation of interior high forests is also coupled with the good idea of creation of biosphere reserves for protection of representative natural ecosystems. The Theory of Island Biogeography was proposed by Robert McArthur and Edward Wilson in 1960's and developed since then by many other researchers. Norman Myers (1979), a world consultant on environment sums up this theory: If 90 percent of an original habitat becomes grossly disrupted, and if the remaining 10 percent is protected, we can expect to save no more than half of the species in that 10 percent. The extinction process starts soon after the establishment of the preserve. To save double the number of species ten times more of habitat should be preserved. Arithmetic loss of space appears to lead to geometric decline in the value of the remaining space.

According to this theory any preserve in the moist forests should be not less than 2500 sq.kms. Area of some of the biosphere reserves in Amazon is as follows:

Country	Reserve	Area in sq.kms.
Peru	Manu Park	15,000
-do-	Pacaya Samiria	14,000
Venezeula	Canaima	30,000

Venezeula has 4 more new parks. Even Surinam, a small country has large part under biosphere reserve.

Biosphere reserves of such magnitudes are not there in the Western Ghats where man's activities are ever on the increase with great decline in natural wealth. In the coastal Uttara Kannada the last of the 500 sq.kms. of unexploited ghat forests, already having numerous villages in it and four major highways and many other roads passing through it with degradation of the flora in their periphery, are being exploited. There is no meaning in creation of one or two small biosphere reserves in it hoping to protect its plant and animal species.

F. RECOMMENDATIONS

This report recommends:

1. Stoppage of all forestry operations in the interior high forests as recommended by Shyamsunder et al (1981).

2. Upgradation of the degraded forests through massive efforts, appropriate selection of species and greater protection.

3. Massive reforestation of the denuded coastal hills and plateaus with fast growing evergreen species which provide a canopy to shade the exposed habitat and litter to build the soil. A combination of *Acacia auriculiformis*, *Casuarina*, *Mimusops elengi*, *Dalbergia*, *Cordia*,

Syzygium cumini, Memecylon umbellatum, Mangifera etc., all of which can survive on a laterittic habitat, may be included in such projects.

4. Intensive fuel plantations of Casuarina, and Calophyllum inophyllum may be raised on the beach sands. Combined with Pandanus these could form a formidable natural wall guarding the beaches against sea erosion for preventing which millions of rupees are being spent on erection of stone walls along the Kanara coast which not only disfigure the beaches but also give no returns.

5. Lastly this rep ort recommends an ecological regionalism. Every place should develop the renewable resources necessary for its varied demands. If forests of North Kanara are to cater to the paper, plywood, timber requirements of the entire India it could lead to the desertification of this region cutting at the very roots of the productive systems and making human existence here miserable.

REFERENCES - GENERAL AND CITED

1. Aitchison P.E. The Ankola - Kumta Coast Working Plan; 1911.

2. Arora R.K. The flora of North Kanara (Statistico-biological notes). Ind. For. Vol. 86, No.10; 1960.

3. Arora R.K. The forests of North Kanara District. Journ. Ind. Bot. Soc. Vol. 40, 41, 42; 1961,62,63.

4. Arora R.K. The vegetation of South Kanara District. Ibid. Vol. 45, Nos. 1-2; 1966.

5. Barbosa, Fryer, Vartheme, Accounts of North Kanara, 1514, 1675, 1503. Kanara Gazetteer.

6. Bhat H.R. Recent changes in the ecology of Malnad and their implications. Major Dams a Second Look; 1981.

7. Buchanan F. Journey through the Northern Parts of Kanara ; 1801.

8. Champion, H.G. A preliminary survey of the forest types of India and Burma. Ind. For. Rec. 1(1): 1-286; 1938.

9. Champion H.G. and Seth S.K. Southern Forest Types of India:, 1969 Ed.

10. Chandrasekharan C. Forest types of Kerala State. Ind. For. 88 : 660 - 74 ; 1962.

11. Caufield C. Rainforests can cope up with careful logging. New Scientist 1 Sept. 83.

12. Cooks T. Flora of Bombay Presidency, Vol.I-III ; 1901 - 3.

13. Davis P.W. Preliminary note on Nilambur soils with special reference to their suitability for teak. Ind. For. Nov. 1940.

14. Dhareshwar S.S. The denuded condition of the minor forest in Kanara coastal tract. Ind. For. 67 : 68-81 ; 1941.

15. Gadgil Madhav. Lecture Notes of the Special Training Programme in Wild Life Biology (Bandipur Tiger Reserve) : 1978.

16. Gadgil Madhav and Malhotra Kailesh. What price is development? Science Today Vol. 16, No.2; 1981.

17. Gupta A.C. Preservation plot in Karnataka. National Seminar on Forests and Environment ; 2-3. Dec. 1981 ; Bangalore.

18. Harrison P. The curse of the tropics. Now Scientist Vol. 84. No.1182; 1979.

19. Kadambi Krishnamurthy. The evergreen ghat rain forest; Agumbe - Kilandur zone. Ind. For. Vol.67, 184-203; 1941.

20. Krishnamoorthy, K. Myristica swamps in the evergreen Forests of Travancore. Ind. For. Vol.86, No.5; 1960.

21. Mavinkurve G.R. Working Plan for Inland Coastal Forests of Kanara Western Division; 1955.

22. Myers Norman. Islands of conservation. New scientist Vol. 83, No.1169 ; 1979.

23. Odum E.P. Ecology ; 1963.

24. Oosting H.J. The Study of Plant Communities; 1948.

25. Patil, R.H. Forests of North Kanara and biological diversity. Major Dams - a Second Look ; 1981.

26. Puri G.S. Indian Forest Ecology Vol. I and II ; 1960.

27. Saldanha C.J. Flora of Hassan District ; 1976.

28. Santapau H. Indian Botanical Society Excursion Journ. Ind. Bot. Soc. 30 : 181 - 191.

29. Shanmukhappa. Draft Working Plan for the Unorganised Forests of Karwar and Honnavar Divisions ; 1979.

30. Shyamsunder S., D.K. Deshmukh R.M. Palanna and A.N. Yellappa Reddy 1981. Evergreen forests should these be worked? Proceedings of the National Seminar on Forests and Environment. Bangalore 2-3 December 1981. Section IV. 113-116.

31. Talbot W.A. Forest Flora of the Bombay Presidency and Sind. 2 Vol., Poona.

32. Walter Heinrich. Ecology of Tropical and Subtropical Vegetation. Oliver and Boyd. Edinburgh.

33. Weaver and Clements. Plant Ecology 1931.

34. World Conservation Strategy. 1980. IUCN, UNEP and WWF.