INTRODUCTION

The humid tropics generally correspond to areas which under the effect of heavy precipitation, high temperature and humidity have developed 'Tropical Rain Forest' as the climax form of vegetation. Immensely rich and varied in its variety of plant wealth, this formation type is distributed along a somewhat interrupted and irregular belt 20 to 40° wide around the earth on either sides of the equator in areas where generally:

a) the mean annual rainfall is usually above 200 cms,

b) the dry period if present is very short,

c) the annual temperature is usually above 75°F, never less than 64°F for the coolest month, and

d) winter is lacking, the regions remain constantly warm.

This forest formation which occupies one third of the world's land surface (vide Trumble, 1958) until recent times existed in a sort of stable equilibrium with the environmental complex. But, over the last few decades, the spread of population and the efforts put forth to meet its increasing needs in the humid tropics areas, have brought about considerable changes. The practice of shifting cultivation, burning and grazing, and the clearing of forest lands for cultivation of *Areca, Anacardium, Cacao, Coconut, Coffee, Rubber, Tea* and other plants; have over a short span of time reduced the rain forest vegetation at most of the places to scrubby savannahs or other biotic/bioedaphic types. Thus, over the world the area where rain forest occurs as a natural climax has considerably diminished.

The growing need for more food is to be met somehow;
the rain forest wealth is got to be preserved, and the spread of savannahs to be checked. These, and many other related problems of deforestation, erosion and land use which confront the workers engaged in humid tropics studies remain thus, yet to be solved.

It were considerations of this sort which prompted the proposal that UNESCO should develop a programme to assist research in the humid tropics regions. The problem was approved at the 8th session of the general conference of UNESCO held at Montevideo in November 1954. In accordance with this resolution, a meeting of specialists in humid tropics research was held at Kandy (March 22nd - 24th 1956). Problems relating to the humid tropics ecology were discussed at the Symposium on 'The study of Tropical Vegetation', which was attended by delegates from Brazil, Ceylon, France, Holland, India, Pakistan, Philippines, United Kingdom, U.S.A.; and the world organisations like F.A.O. and W.H.O. This Symposium resolved that,

"... for many practical purposes in forestry, agriculture, land-surveys, etc. it is of utmost importance that the taxonomic studies on all Tropical floras should be encouraged. We recognize the value of the flora of Africa and Malaysia now in preparation and urge that modern floras should be prepared more especially of Burma, Ceylon, India and Pakistan, ......... Resolution No.3, p.221, Kandy Sym. 1956".

The Symposium also revealed that there still exists a considerable disparity of thought on the rain forest sociology, and studies on this field should be encouraged.

Following this Symposium, two more Symposia have been held lately. At the Bogor Symposium (1958) on the vegetation of
the humid tropics similar problems were discussed while at Ivory Coast (1959), more emphasis was laid on the role of soil features in relation to vegetation in the wet tropics.

The present work owes its initiation through recommendations made at such symposia (Kandy, 1956; Bogor, 1958; Ivory Coast, 1959) by the able body of specialists on humid tropics studies. The line of work pursued was suggested by Dr. G. S. Puri, Director, Central Botanical Laboratory, Botanical Survey of India, who was also one of the participants to all these meetings.

REVIEW OF LITERATURE

A thorough perusal of literature on the humid tropics points out that this subject has been studied only to a meagre detail. Contributions in this field have been of varied nature, dealing either with the development, structure and classification of the forest types, i.e., Bews (1914, 1916), McLean (1920), Chipp (1931), Davis & Richards (1933), Champion (1936), Bartlett Davy (1938), Richards (1939), Eggeling (1941, 47), Beard (1944, 45, 46), or with the compilation of the regional floras. Amongst these the monumental achievements of Richard's 'Tropical Rain Forest' and Van Steenis's 'The flora malaysiana' deserve a noteworthy mention.

Over the wet tropics, three formation types have been recognised (Richards, 1952);

The American rain forest
The African rain forest
The Indo-Malayan rain forest
and the work carried on these, may now be discussed in brief.
The American rain forest formation which is distributed in parts of central and south America contains some of the best tropical American types. Much of the work in this belt has been carried on by Bailey (1898), Richards (1936, 39, 58), Beard (1944, 46), Wadworth (1954), Loveless & Aprey (1957), and others. As such, there has been considerable addition to our knowledge on:

1) the forest types of America, and
2) the rain forest sociology of American types, pertaining to the tropical vegetation.

The African rain forest extends from the Congo basin westwards to French equatorial Africa, Gabon, the Cameroons, the French Guinea and eastwards into the region of great lakes. Southwards these forests stretch on to Rhodesia.

A review of work on the vegetation of Tropical Africa points out that this formation type has been more thoroughly explored than the American forests. Contributions of Bews (1914, 16), Chipp (1927, 31), Morean (1935), Lavauden (1937), Burtt Davy (1938), Evans (1939), Richards (1939, 56), Thomas (1941, 43, 45, 46), Burtt (1942), Fuggie (1947), Keay (1953), Jones (1955), Mangenot (1956) amongst others may be recorded. In most of these works emphasis has been laid on the tropical forests of Nigeria, British Guinea, Cameroons and Gold Coast. Tropical vegetation types for Africa have been discussed to a great detail and the succession of different plant associations worked out.

The Indo-Malayan rain forest has its chief distribution in Malaysia, adjoining parts of S.E. Asia, Australia, and the Pacific islands. This type stretches from Ceylon and Western
India to Indo-China, and the Philippines, through the Malay Archipelago to New Guinea. It has its best development in Borneo and adjacent parts. Much of the work in the Indo-Malayan formation has been done on the pacific isles (Van Steenis 1938, 53, 56, 58) and in Ceylon (Rosaryo, 1943, 50, 54, 58). Amongst other contributions, the works of Beccari (1904), Whitford (1911), Gibbs (1914), Brown & Fisher (1918), Stamp (1925), Watson (1929), Blanford (1929), Champion (1936), Richards (1936), Baker (1938), Coffey (1940), Holmes (1945, 48, 57, 58), Wyatt Smith (1949, 50), Pursglove (1950), Koelmeyer (1951, 58), Cousens (1951), Ghani (1954); Landan (1954), Calixto (1954), Anderson (1954), Dilmey and Kostermans (1954), Haley (1954), Szechowyer (1954, 57), Abeywickrema (1955), Posberg (1956), Bedard (1950), Webb (1956), Kostermans (1956), Browne (1956), Wood (1956), Ashton (1958), may be mentioned. The centre of interest here seems to have been focussed especially on the forests of Borneo, Ceylon and India including Burma. For the pacific isles and Ceylon, an illustrative account has been given by Van Steenis, Rosaryo, Richards and others, and a thorough information on the forest types, their structure, composition and succession has been traced out. But for India and Burma lot of work remains yet to be done, especially on:

1) forest-type classification, and
2) the successional trends of tropical communities.

HUMID TROPICS OF INDIA

In India, the area of the rain forests is not large and it is found locally in the western and eastern ghats. More extensively, these forests are met with in the high rainfall
tracts of Assam in the north-east, and in the southern peninsula along the western ghats in parts of Madras, Mysore, Kerala, and Bombay states. They are also locally common at Andamans. Thus three humid tropics zones may be described for India:

1) The Andamans.
2) The eastern ghats and Assam including N.E.F.A.
3) the western ghats.

THE ANDAMANS:—The Andaman islands are located on the southeast of the bay of Bengal (Lat. 15° 41' & 10° 30' N and Long. 92° 11' & 93° 7'E) with an area of 2,500 sq. miles. With a warm and equable climate, they offer an interesting type of vegetation which has been studied in detail by Changappa (1934, 44), Deans (1936), Banerji (1954), Bhargave (1958) and Varmah (1960). The formation of different types of vegetation is purely edaphic and follows the soil types worked out for the area. Mangrove forests, beach forests, low evergreen forests, hill evergreen forests, deciduous and semi-deciduous forests are met with. The climax form of vegetation is an evergreen wet forest with trees like:

Artocarpus chaplasha, A. gomeziana, Calophyllum spectabile, Canarium euphylumn, Cryptocarya and other Lauraceae, Dipterocarpus alatus, D. pilosus, Endospermum malaccense, Hopea odorata, Mesua ferrea, Myristica andamanica, M. glauca and other Myristicaceae, Sterculia campanulata and other spp; and Xanthochymus andamanicum.

There is no appreciable difference in the physiognomy of these types with those predominant over the western ghats, except for the floristic composition which again here too, has a considerable number of endemic or narrowly distributed species.
THE EASTERN ZONE:— The tropical vegetation of eastern ghat, Bengal, Assam & K.E.F.A has been chiefly studied by Campbell (1936), Rowbatham (1929), Bor (1931, 33, 39, 42), Champion (1934), Purkayastha (1926), Sengupta (1937), Das (1939), Biswas (1941), Rowntree (1954), Srinivasan (1955), Chatterjee (1956), Islam (1959), Deb (1959), Rao (1959), Panigrahi (1960), Rajkhowa (1960) and others.

Rowntree established three major formations, besides a few proclimax types, grasslands, scrubs, and riverain forests i.e., Cinnamomum - Amoora - Michelia formation, Tetrameles - Stereospermum - Calotropis formation, and Shorea - Billonia - Ficusformic formation. Recently, Rajkhowa (loc. cit) described two main climatic formations i.e. (a) Evergreen including semievergreen, and (b) deciduous including semideciduous. He classified the evergreen formation into:—

Bhimastan - Dinterocarp type, Kayea assamica type and the Assam valley semievergreen formation, with a good number of biotic variants. The general physiognomy of the climax types in this zone of the humid tropics of India does not differ appreciably, from the western ghat types. The chief associates met with are:

Artocarpus chaplasha, Amoora vallichii, Altingia excelsa, Alseodaphne cordifolia, Cinnamomum obtusifolium, Caesalpinia spp., Dinterocarpus macrocarpus, Diaphora somerothyris, Echinocarpus assamicus, Kayea assamica, Kayea floribunda, Nemastoma ferrea, Michelia montana, Nephelium lontana, Phoebe spp., Palauquium polyanthum, Ptergosota alata, Schima vallichii, Shorea assamica, Sterculia spp., Symplacos spp.,

with other like, Cinnamomum clausdiferum, Cinnamomum eocido-
damne, Cedrela spp., Cryptocarya amylidae, Cryptomeria
paniculata, Celtis spp., Cyclostenon sp., Diospyros spp.,
Dysoxylum spp., Endospermum chinense, Eugenia spp., Fagel-
hardia spicata, Elaeocarpus sp., Litsea sp., Haemietia
insignis, Myristica spp., Pterospermum spp., Sanium baccatum,
Stroespermum spp., Terminalia spp., Tetranocas nudiflora,
Vatica lanceaefolia, Vitex spp.,

THE WESTERN GHATS: - The humid tropics of the western ghats extends from Bombay southwards up to the state of Kerala.
The tropical rainforests here are extensively met with in the high rainfall areas of Mysore and Malabar, and have been studied by Beddome (1376), Pyson (1922), Callophyllum (1939), Aiyer (1933), Champion (1935, 36), Bor (1938), Kadambe (1939, 41, 45, 50, 54), Krishnaswamy (1952), Nair (1953, 57), Banerjaa (1954), Puri (1957) 53 and by the author during exploration tours to different localities (1957-60).

The principal vegetation types met with are:

Tropical evergreen, including the tropical semi-
evergreen type.
Tropical moist deciduous.

TROPICAL EVERGREEN TYPE: - This type is recognised by the dense-
ness of the forest canopy, huge tall trees with long clean boles, numerous epiphytes and climbers, good growth of canes and rich pteridophytic growth. Plank buttresses, clustering of leaves and cauliflory are the common peculiar features.
The forests are generally 4 - 5 storeyed, with the top canopy, attaining a height of over 150'. The more common trees in the top storey are: *Acrocarpus fraxinifolius*, *Artocarpus hirsuta*, *Balanocarpus utilis*, *Calophyllum elatum*, *C. decipiens*, *Cinnamomum zeylanicum*, *Diospyros microphylla*, *Dipterocarpus indicus*, *Donella roxburghii*, *Dysoxylum malabaricum*, *Elaeocarpus tuberculatus*, *Holigarna grahamii*, *Hopea parviflora*, *H. wightiana*, *Lepisanthes tetraphylla*, *Lophopetalum wightianum*, *Litsea stocksii*, *Knema attenuata*, *Machilus macrantha*, *Mesua ferrea*, *Myristica beddomei*, *Palaquium ellipticum*, *Poeclioneuron indicum*, *Polvalthia fragrans*, *Pithecolobium bigeminum*.

The second storey has a good number of top storey species like *Cinnamomum zeylanicum*, *Diospyros microphylla*, *Knema attenuata*, *Polvalthia fragrans* with others like *Actinodaphne hookeri*, *Alstonia scholaris*, *Aporosa lindlevana*, *Varyota urens*, *Diospyros sp.*, *Elaeocarpus serratus*, *Flacourtia montana*, *Garcinia sp.*, *Holigarna arnottiana*, *Hydnocarpus laurifolia*, *Linociera malabarica*, *Olea dioica*, *Strchnos nux-vomica*, *Smplocas sp.*, *Terminalia sp.*, *Syzygium* and others.

The third storey usually never exceeds 25'. The species present are *Callicarpa tomentosa*, *Canthium dicoccum*, *Buonynus sp.*, *Flacourtia montana*, *Ixora bractiata*, *I. nigricans*, *Leea indica*, *Maesa indica*, *Nothapodytes foetida*, *Olea dicoa*, *Randia brandisii*, *Smplocas sp.*, *Syzygium* and others.

Shrubs, herbaceous and woody climbers, grow in abundance and make these forests impenetrable. The following species are generally noted:-

Climbers - *Allophyllus serratus*, *Asparagus racemosus*, *Calycoperis floribunda*, *Clematis sp.*, *Cissus sp.*, *Cyclea peltata*, *Entada pha-
saoloides, Gnetum ula, Hemidesmus indicus, Schefflera venulosa, Jasminum rotterianum, Naravela zeylanica, Piper nigrum, Pothos scandens, Toddalia aculeata.

Shrubs - Chasalia curviflora, Clerodendrum spp., Ixora sp., Murraya koenigii, Psychotria sp., Leca indica, Melanthesa turbinata; Bamboos, canes and other palms; Calamus pseudotenuis, and other spp.; Arenga wightii, Ochlandra sp., Pinanga dicksonii and others.

The ground flora is rich in the tree seedlings of the evergreen species of the top or second storey. Herbs are few and generally of Zingiberaceae and allied families are prominent with ferns like Pteris spp., Angiopteris erecta, Gymnopteris sp., and Stenochlena chinensis.

Amongst the epiphytes species like, Pholidota imbricata, Oberonia sp., Aerides sp., Bulbophyllum sp., Dendrobium sp., are common.

A thick layer of humus is always present underneath. This type generally develops in regions which get a high rainfall upto 800 cms. and have a short annual dry season of about 3 months. Mean annual temperature roughly varies between 70°F - 95°F and the soil is red.

TROPICAL SEMI-EVERGREEN: - This type occurs in the western ghats as a narrow strip between the wet evergreen and moist deciduous types. The forests have composition of an intermediate type, having been composed of a number of species common to both the types, some being evergreen preferents, others moist deciduous. The trees are of large size and attain a height of 100' or more. There is a tendency to gregarousness and the frequency of domi-
nants is quite high. Trees occasionally have buttressed stems. The canopy, however, is less dense than in the evergreen type. The undergrowth is rich and climbers are dense and numerous.

The common tree components are Alseodaphne semecarp-pifolia, Aporosa lindleyana, Actinodaphne sp., Artocarpus hirs-suta, Celtis cinnamomea, Cinnamomum zeylanicum, Flacourtia montana, Hevea trifluga, Macaranga peltata, Syzygium sp., Tabernaemontana heveana, Terminalia paniculata, Terminalia tomentosa.

The climbers like Cissus sp., Ceylea sp., Derris sp., Dioscorea sp., Diploclisia glaucescens, are seen. Gnetum gla is occasionally noted while Calycopeperis floribunda is chiefly observed along edges and forest openings.

The shrubs present are Clerodendron infortunatum, Holarrhena antidysenterica, Leea indica, Notapodytes, Psychotria sp., Zizyphus sp.

The undergrowth has herbs like Costus speciosus, Cur-culigo sp., Curcuma sp., Cyanotis sp., Elephantopus scaber, with ferns like Adiantum sp., Pteris sp., Seedlings of evergreen species of Cinnamomum, Holigarna, Olea, Litsea, and others are often observed.

This type has a moderate rainfall (above 200 cms.) and has a comparatively short annual dry season. This type is generally developed on red soil derived from Granite/gneiss or on laterite. It also occurs on deep mature soil which gets a brownish dark colour.

TROPICAL MOIST DECIDUOUS TYPE:- These forests are widely distri-
buted in India, and are met with along the western ghats in North Kanara, South Kanara, west portion of Mysore, Manglore, Coorg and Travancore-Cochin.

The type attains a height of 80' or so, in which the dominant trees are mostly leafless during the dry season. Evergreen species are absent or else may be met with in the understorey. Teak and/or Bamboo forests are prominent.

The main tree species met with are: Adina cordifolia, Albizzia sp., Bauhinia sp., Dalbergia latifolia, Dillenia pentagyna, Diospyros montana, Emblica officinalis, Ficus sp., Gmelina arborea, Kydia calycina, Lagerstroemia lanceolata, Lannea coromandelica, Eugenia oleinensis, Pterocarpus marsupium, Miliusa tomentosa, Spondias sp., Sterculia sp., Tectona grandis, Terminalia sp., Xyia xylocarpa, Zanthoxyllum rhetsa.

Small trees are of species like Bauhinia malabarica, Callicarpa tomentosa, Careya arborea, Holarrhena antidysenterica, Leea indica, Nothapodytes foetida, Meyna laxiflora, Randia brandisii.

Shrub layer consists of Carissa congesta, Carvia callosa, Colebrookia oppositaefolia, Lantana, Leea indica, Murraya koenigii, Solanum sp., Zizyphus oenoplia, Z. rugosa, Z. xylopyra.

Amongst the climbers, Acacia concinna, Asparagus racemosus, Calycopteris floribunda, Cissus sp., Cryptolepis buchanani, Diplolclisia glaucescens, Smilax, Entada with Wagatea spicata may be mentioned.

The undergrowth consists of herbs like Crotalaria sp., Desmodium triquetrum, Mimosa pudica, Flemingia sp., Sida sp.,
Triumfetta sp., Urena lobata; with grasses like Asloda aristata, Erasrostis sp., Opilismenus sp., Themeda sp., and others.

The forests contain a number of bamboos. The following four types are generally observed; Bambusa bambos, Dendrocalamus strictus, Ochlandra talboti, Oxytenthera monostigma.

The type is developed on river bank alluvium, the soil usually being black and rich in humus. Rainfall generally ranges from 100-200 cms. The annual dry season may last for 4-6 months. The maximum temperature is 100°F and the minimum drops to 55°F.

TROPICAL RAINY CLIMATES

The tropical rainy climates also pertain to the humid tropics regions. Restricting this subject to the western ghats in the areas surveyed (North Kanara southwards to Kerala) two climate types based on rainfall contrasts are identified, i.e.

Af........ The constantly wet type, and
Aw........ The tropical wet and dry type.

The Af type (Koppen, 1936) is characterised by the absence of a dry season or quite often as is the case along the western ghats, by the presence of a short dry period, i.e., sub-type Am, called as the monsoon rain forest climate. The well spread biotic/bioedaphic types of tropical forests in the dry belt along the western ghats, where the rainfall is low, and the temperature shows more extremes, may be classified under the Aw type 'Tropical Savannah Climate'.

Following Thornthwaites (1948) moisture provinces, on the basis of Precipitation effectiveness (P.E. index) and Temperature efficiency (T.E. index), the majority of the areas
studied may be classified under AA'r type, the tropical wet type (A — 128+wet — PE index; A' — 128+Tropical, and r gives the significance of an adequate supply of rainfall throughout the year). The change from Per-humid — Humid types is correlated with a change from an evergreen — low-evergreen — semi-evergreen types of forests.

In general it has been observed that the short dry period in the Am types hardly brings any change. The heavy rainfall compensates to nullify the effect of the dry period, and so the vegetation developed here is a dense evergreen forest. Thus no appreciable difference in the forest types is seen in the areas of study, so far as the constantly wet types (Af) or the monsoon wet types (Am) are concerned.

Average monthly temperature, and precipitation amounts for certain areas from the western ghats have been plotted. All these patterns, seem to fit in the Am sub-type 'The Monsoon rain forest climate' (Thewartha, 1954).

PRESENT APPROACH

After a general survey of the vegetation and forest types of the western ghats, it was thought necessary that for a detailed work, the interest should be located over a small area, all the same, keeping in mind that the area selected should give a representative account for this whole belt of the humid tropics.

Accordingly, North Kanara district (Lat. 13°55'N & 15°31'N and Long. 79°9'E & 75°10'E) was chosen for detailed botanical and ecological studies. The exploration tours having been further extended to the Malabar hilly tracts and with a
better known of the tropical plant life, another work on the
'Botany of Coorg forests' was also undertaken later on (1958).

The areas being considerably large and with problems
too many, it could not have been possible to study each and
every aspect of rain-forest-sociology. Nor could the humid
tropics wealth, be explored to a greater extent over a span
of 3-4 years. It being rather impossible for a single hand to
tackle all the aspects of this untrodden field, the work has
been shaped to the best, in the following way.

PART I.

THE BOTANY AND ECOLOGY OF NORTH KANARA
DISTRICT

1. The structure and floristic composition of the
   principal forest types has been dealt.
2. The succession of the plant communities recognised
   under each forest type; and the general trend of
   the development of vegetation and its correlation
   with the main types of forests, is brought out.
3. The total floristic wealth for the area has been
   worked out.
4. Statistico-biological analysis of the flora has
   been given.
5. Salient features of plant distribution with empha-
   sis on the 'humid tropics element' has been dealt,
   and the main types of plant - distribution patterns
   worked out.
6. The biological spectra for the lowlands and uplands
   types is presented.
PART 2

THE BOTANY OF COORG FORESTS

1. The structure and floristic composition of the principal forest-types has been given.

2. The plant wealth collected during 1957-60, is enumerated here in the form of a short forest flora.

PART 3

SOIL STUDIES IN THE HUMID TROPICS

The soil-types for the North Kanara district, their composition, distribution and correlation with the vegetation types has been discussed. The data is presented on the basis of soil-profile studies, for profiles under different vegetation types.

Above all, the main contribution of the work presented lies, in presenting a lucid picture of the successional trends of forest communities for the humid tropics of the western ghats. Nevertheless the subject of forest-types and their classification for the tropical communities has been discussed and the views of Champions (1936) and others, modified.