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VOLUME XII.—NO. I.

THE FORESTS OF KALIMPONG

AN ECOLOGICAL ACCOUNT

BY

J. M. COWAN, M.A., D.Sc.

GOVERNMENT OF INDIA
PUBLICATION BRANCH
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INTRODUCTION.

THE FORESTS OF KALIMPONG.

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J. M. COWAN, D.Sc.

INTRODUCTION.

ALTHOUGH the vegetation of Sikkim is as well known as that of any part of India, comparatively little attention has been paid to the area now known as the Kalimpong Sub-Division of the Darjeeling District.

The territory, though originally part of the Sikkim State, was annexed by the Bhutanese in 1706 and until 1865 it remained in their hands. Under the Senchula Treaty of 1865 it became part of British India and was added to the Darjeeling District being known for a time as British Bhutan. Although Sir JOSEPH HOOKER explored the greater part of Sikkim in 1848-49 and GRIFFITH passed through part of Kalimpong Sub-Division when accompanying Major Pemberton's expedition to the Bhutanese Government in 1837-38, little attention was paid to the flora of this area.

The most complete account of the vegetation of Kalimpong hitherto written was published by the late Mr. J. S. GAMBLE in the Indian Forester in 1875, in an article entitled "Darjeeling Forests," and yet in this article Mr. GAMBLE described the area east of the Tista, which is the Kalimpong Sub-Division, as "practically unexplored." Before leaving the District finally in 1882 Mr. GAMBLE had visited a considerable part of this area and noted the prevalence of certain plants in various localities. These he recorded in his "List of the Trees, Shrubs and Climbers of the Darjeeling District."

Of subsequent publications relating to Darjeeling or Sikkim the most important have dealt with the Alpine Flora of the higher levels in Sikkim proper or with plants of a particular family only. Nothing more than notes of cursory tours in this region have appeared.

The District is included in the Flora of British India but not in Prain's Bengal Plants, and for many years GAMBLE'S List has been the only convenient Forest Flora of the District. It has now been revised under the title "The Trees of Northern Bengal."

Altogether three Forest Working Plans for the Kalimpong Forest Division have been published. The Third Working Plan was published by myself in 1924. The data given in the present work were collected mainly from 1922 to 1924 during the preparation of the Third Forest Working Plan, and have now been supplemented by further observations made in 1926. Although the Forest Climax Communities are fairly well known much work still remains to be done before the same can be said of the herbaceous communities. It would be dangerous to attempt to do more than to tentatively outline the Seral Communities at present. The study of the cryptogamic plants has only just been begun.

PART I.

THE REGION DESCRIBED.

1. *Situation.*

Kalimpong is a Sub-Division of the Darjeeling District, situated in Northern Bengal, between 26° 5′ and 27° 12′ North Longitude and between 88° 28′ and 88° 56′ East Latitude. It is bounded on the North by Sikkim and Bhutan ; on the East by the Jaldhaka River, which is also the western boundary of Bhutan ; on the South by the Jalpaiguri District and on the West by the Tista River, which separates the tract from Sikkim proper and from the rest of the Darjeeling District.

The Forests form a nearly continuous belt round the sub-division, enclosing a large area of cultivated land in the centre. This is partially intersected by the forests of the Lulygaon ridge, a spur which runs south-east from the main forest area on the Rechi La. The width of the belt varies considerably, being about half a mile to one mile broad on the west, where the forests occupy the land at elevations between 1,000 and 3,000 feet, and about 10 miles broad on the east, where the forests reach from the plains to an altitude of over 10,000 feet. The township of Kalimpong, the head-quarters of the sub-division, is situated some five miles from the western boundary (10 miles by road) and at an elevation of 4,000 feet. The distances from Kalimpong to the boundaries of the sub-division vary from 10 to over 60 miles.

2. *Area.*

The area of the Kalimpong sub-division is 412 square miles, of which 206 square miles are Government Reserved Forests constituting the Kalimpong Forest Division. The whole forest area has been divided into five Ranges. These are again divided into 52 blocks, distributed as follows :—

Range.	No. of Blocks.	Area in Acres.	Area in Sq. Miles.
Tista	12	16,595	26·2
Chel	7	31,302	49·0
Neora	5	16,631	26·3
Jaldhaka	6	26,025	40·7
Pankasari	22	40,807	63·8
TOTAL	52	131,360	206·0

It will be shown that outside the reserves, there is practically no forest land, except in a small area on the Western boundary where the population is very sparse.

3. *Maps.*

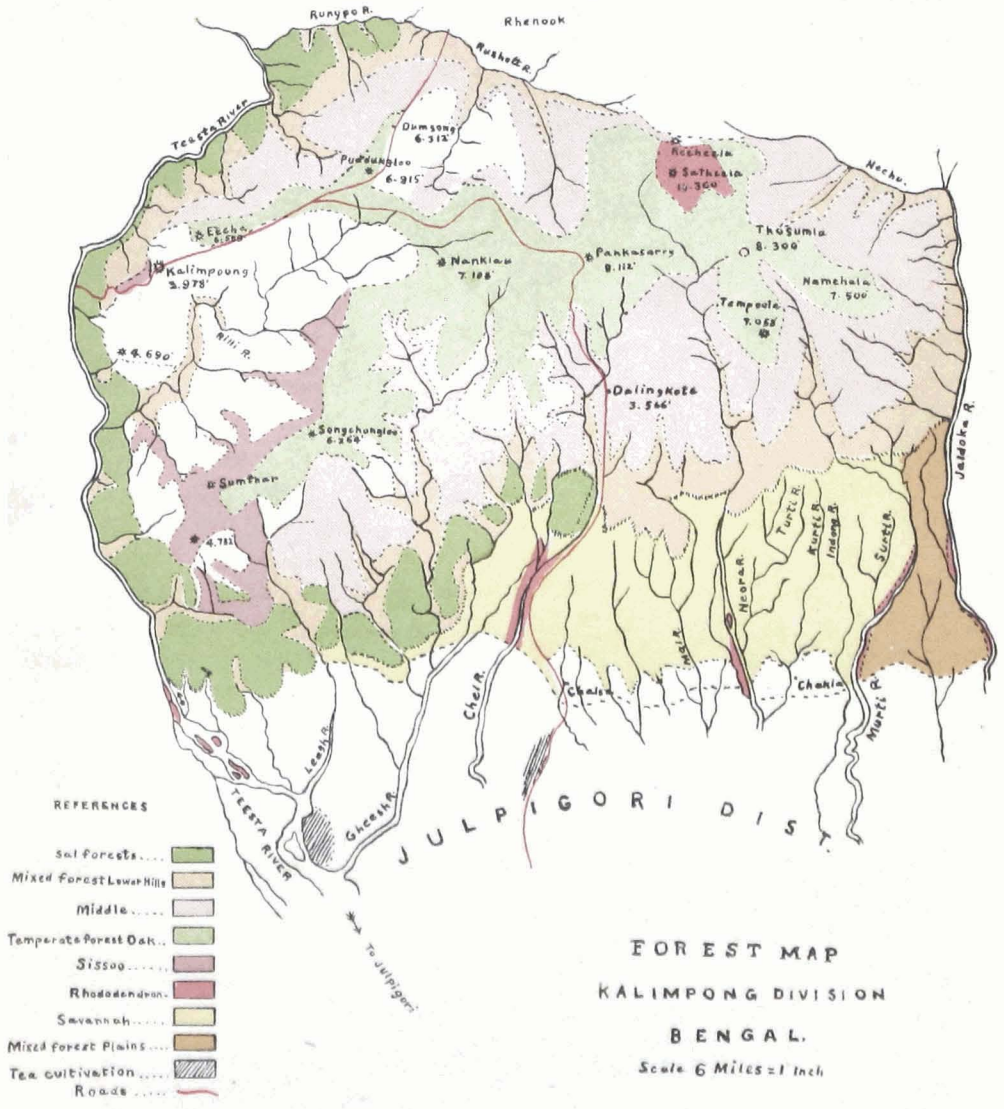
Maps of the area on a scale of four inches to a mile were made by the Forest Branch of the Survey of India in 1902 and published in 1904-05. These show boundaries, interior details and contours at twenty-five feet intervals. Using these as a basis an atlas on the same scale was prepared by the writer, showing the distribution of different types of forests and this has been reduced to a convenient size for ready reference. At the same time the Forest Survey Maps were brought up to date.

4. *History.*

When the Kalimpong Sub-division was annexed by the British under the Senchula Treaty (1865), the greater portion of the area, at elevations between 3,000 and 6,000 feet was even then under cultivation, but in the hot damp valley of the Tista there was magnificent Sal (*Shorea robusta*) forest. This, together with part of the Lulygaon ridge, was declared by the Government to be Reserved Forest in 1879. In 1881, the remainder of the belt surrounding the cultivated land and an area of some 60 square miles in the remote eastern side of the sub-division were also reserved.

Following the policy which had already been adopted in the Darjeeling District, Government left the land between 3,000 and 6,000 feet for cultivation, except in the less accessible parts of the District where there would have been little demand for it. A map, now of considerable interest, was published by the late Mr. J. S. GAMBLE to illustrate his article in the Indian Forester of 1875. This map, part of which is reproduced on the opposite page, shows that West of the Tista large areas between these elevations were already under tea cultivation. East of the Tista, as shown in the map, tea planting had been begun only in two localities both of which are in the Jalpaiguri District, some ten or twenty miles south of the Kalimpong Division. Mr. GAMBLE records that a great part of this tract immediately at the foot of the hills, bore 'creeper jungle' and that there were scattered Mech villages in clearings, where the principal crop grown was cotton of poor staple. The Mechis have quite disappeared and within the last fifty years practically the whole of this tract has been brought under tea cultivation.

The effect on the Kalimpong Forests has been considerable, as, with the rise of the tea industry, there arose an enormous demand both for timber and firewood. In the hills of the Kalimpong Sub-division the



FOREST MAP

KALIMPONG DIVISION

BENGAL.

Scale 6 Miles = 1 Inch

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Heliozincographed at the Survey of India Offices, Calcutta

land actually given for the cultivation of tea was greatly restricted by Government and there are even now only three tea gardens, all of small extent, within the area. Land between 3,000 and 6,000 feet was, however, made freely available for general cultivation, and is now practically all under crops, the principal of which are rice and maize. The population has steadily increased, emigrants from Nepal having settled in great numbers and large areas formerly under Forest are now under cultivation (*cf.* maps of 1875 and 1924). In fact, there is practically no forest outside the Forest Reserves. The land is either under cultivation or is waste land where cultivation has been tried and abandoned.

Regarding the past history of the Forests themselves a certain amount of information is available. The Sal Forests on the southern boundary had already been worked by 1870 and it is recorded in the First Working Plan that full-sized Sal trees were left only in places difficult of access. The extraction of Sal in the Tista Valley on a large scale started about 1886. Prior to 1896, the felling of timber was quite unregulated and apparently a good deal of damage had been done to the forests by ruthless felling. The First Forest Working Plan, written in 1896, regulated the felling of Sal and a second plan, written in 1906, after the Sal had been enumerated, defined the areas from which it was to be cut and further prescribed a girth limit (6′ 4″ at breast height) under which no tree should be felled.

The demand for species other than Sal was at first comparatively small and no prescriptions regarding them were made, except that in the second Plan, a girth limit was enforced under which no trees of certain species could be felled.

The demand created by the rise of the tea garden industry in the Jalpaiguri District for firewood, tea-box planking and building timber for some forty tea gardens, situated along or near the boundary of the Kalimpong Division, has resulted in a scarcity of species which were at one time common in the Lower Hills. At the same time species formerly neglected came into use so that in 1924 it was recognised that the felling of all species had to be regulated. Accordingly, when preparing the Third Working Plan, in addition to enumerating all the Sal a count of all the trees, of whatever species, on about 10 per cent. of the more accessible areas was made. In order that the survey might be complete from the botanical point of view, enumerations were made in the less accessible areas, to the extent of about 2 per cent.

PART II.

METHODS OF INVESTIGATION.

Accurate maps on a scale of four inches to the mile, contoured to every twenty-five feet, were fortunately available and greatly facilitated investigation and description; in fact, without these, accurate detailed investigations would not have been possible nor could the attached map have been prepared.

After a preliminary reconnaissance, occupying about two months during which the maps were brought up to date, the area was divided into Blocks and these were sub-divided into Compartments, averaging about 200 acres.

It was decided that all the Sal over 1′ in diameter and over about 10 per cent. of the accessible area, every tree, of whatever species above this diameter should be counted.

The method of selecting the areas on which all the trees were to be enumerated was considered. The writer had considerable experience of the belt transcept method, having enumerated the trees on belts one chain wide and altogether over 1,200 miles long in Chittagong District. This method was rejected as being difficult to control owing to the irregular configuration of the country. It was decided that sample plots averaging 50 acres should be taken dotted over the area.

A staff of thirty specially selected enumerators, well acquainted with the local plants and each with 4 coolies, was recruited and a week was spent on instruction. This staff was divided into three sections, each under an Assistant or Extra Assistant Conservator of Forests. Each party of five was supplied with note books, callipers and scribers. Enumeration was carried out within the sample plots in strips along the contours. Each enumerator, as well as entering the trees, was required to keep notes on the soil, undergrowth etc. Ten per cent. of the area enumerated was checked, and only in one case had the enumerator's figures to be rejected. The average error was under 5 per cent. Every evening the staff wrote up notes taken during the day.

A vegetation map was prepared, partly by actual survey on the ground and partly by survey from a distance, the one method being used to check and supplement the other. The contoured maps greatly facilitated this. Certain plants show up clearly from a distance so that an accurate survey of parts of the area could often be made from an adjoining ridge. Examples of plants which are visible at a distance when in flower are *Shorea robusta* Gaertn., *Terminalia myriocarpa* Heurck. and Muell. Arg. and *Castanopsis indica* A. DC. Some are easy to distinguish from a distance when the leaves are shed, *e.g.*, *Sterculia villosa* Roxb. and *Tetrameles nudiflora* R. Br.; some by their form,

e.g., *Alnus nepalensis* D. Don., *Betula cylindrostachys*, Wall., Conifers, Rhododendrons and Bamboos; some by their darker or shining leaves, *e.g.*, *Bucklandia populnea* R. Br. and *Macaranga* spp. With a plane table, telescope and an aneroid barometer accurate work could therefore be done much more quickly than in flat country, where long vistas are not obtainable. The vegetation stock map was prepared on a scale of 4″ to a mile, but this in itself forms a very large volume and is not suitable for publication. The attached map is produced from a reduced copy of the original.

The survey occupied one cold season, but without previous experience it would have taken much longer. Compilation of the results took about 4 months.

The total area in which all species were enumerated was 6,296 acres. While enumeration was in progress, detailed notes were made in each block and from these this account has been prepared.

In utilizing the enumeration results for an exact ecological census of the plants a difficulty arises from the fact that, in enumerating, the Nepalese names had to be used. To ensure accuracy they were carefully checked in the field and in doubtful cases specimens were collected and subsequently named. In several cases, however, where the Nepalese name includes several species or where the distinction between two species is minute it has been impossible to determine the percentage of each species separately, the names are shown in brackets or, if the Nepalese name is generic, the genus only is given. In the great majority of cases the species have been accurately determined.

PART III.

ECOLOGICAL FACTORS.

1. Climatic.

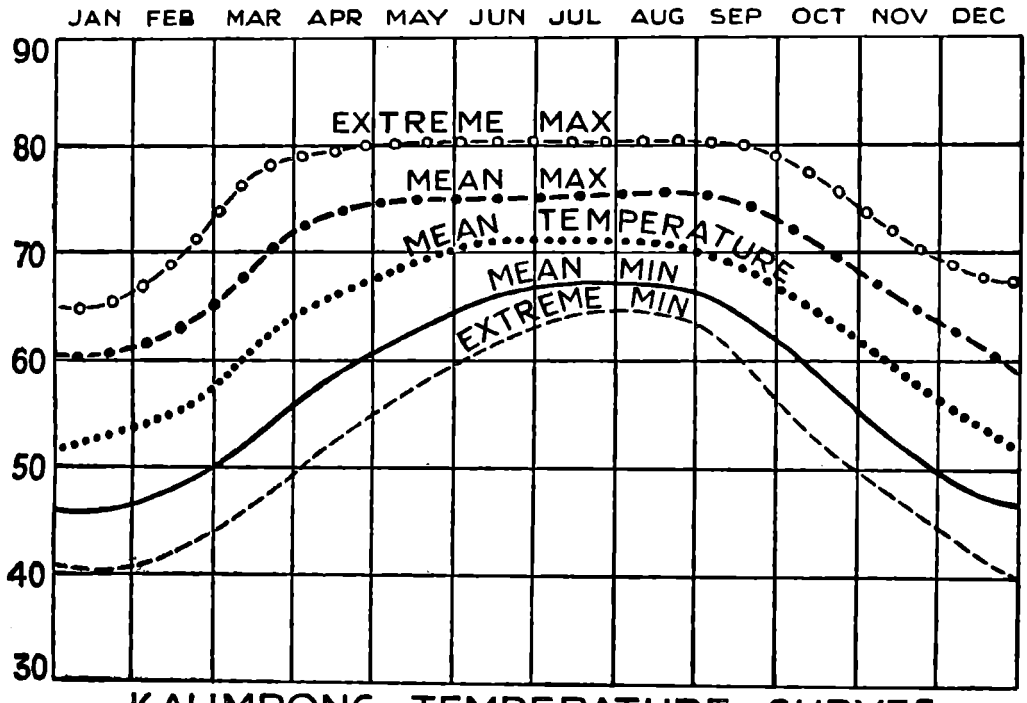
Climatic conditions are dependent largely upon the south-west monsoon, and there are three seasons. The rainy season lasts from June to October, the cold season from November to March and the hottest months are April and May. In different parts of the district the climate is mainly dependent upon the altitude. Tropical conditions prevail at the lower levels, while at elevations above 6,000 feet the climate is temperate. During most of the cold season, from November to March, the sky is cloudless and, even at the lower levels it is distinctly chilly in the early mornings and in the evenings. The temperature reaches freezing point at elevations over 6,000 feet or even lower. On the Rechi La snow sometimes falls to a depth of three or four feet. It seldom however lies on the ground for more than a few days at a time. The monsoon breaks in June, its arrival being frequently heralded by violent storms. From June to October the upper levels are, for the most part, shrouded in mist. Severe storms may be expected in March. Occasionally they are accompanied by hail, with hailstones of enormous size, and consequently crops are sometimes much damaged.

The configuration of the ground is an important factor modifying the rainfall. The full force of the monsoon strikes the outer hills so that the outer slopes have the highest rainfall, while the inner ranges, which are partially protected, enjoy a lower rainfall. The difference in the rainfall of different localities throughout the district amounts to as much as 120 inches per annum.

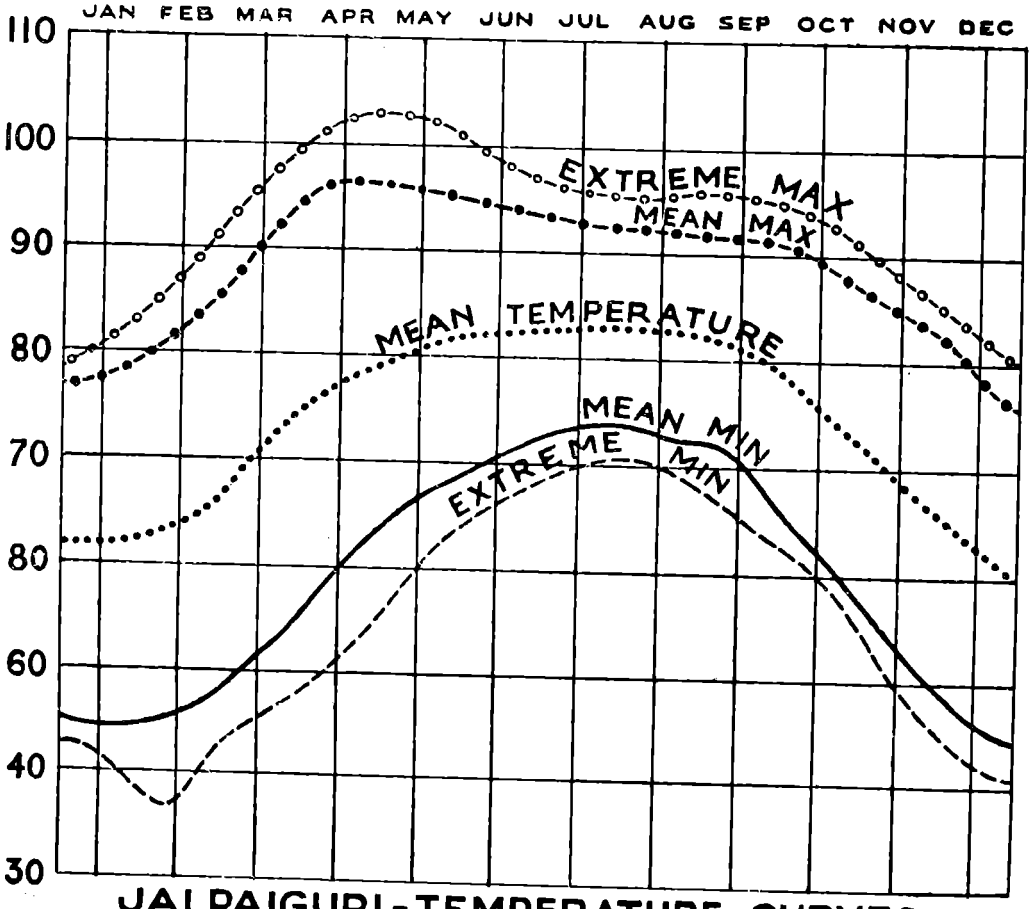
Kalimpong itself enjoys an equable climate, being neither too hot in summer nor too cold in winter. It enjoys, too, a moderate rainfall, the force of the monsoon having been intercepted by the outer ranges of hills.

Temperature.—Climatic conditions, especially as regards temperature, are necessarily varied, as the district consists of hill ranges and valleys, with a variation in altitude of over 10,000 feet.

The average, mean maximum, mean minimum and extreme temperatures for Jalpaiguri, which very closely resembles conditions in the plains, and for Kalimpong are given in the graphs on the next page. Both



KALIMPONG TEMPERATURE CURVES



JALPAIGURI-TEMPERATURE CURVES.

graphs are prepared from official figures, the former from records extending over thirty-seven years, the latter being the averages of the past five years.

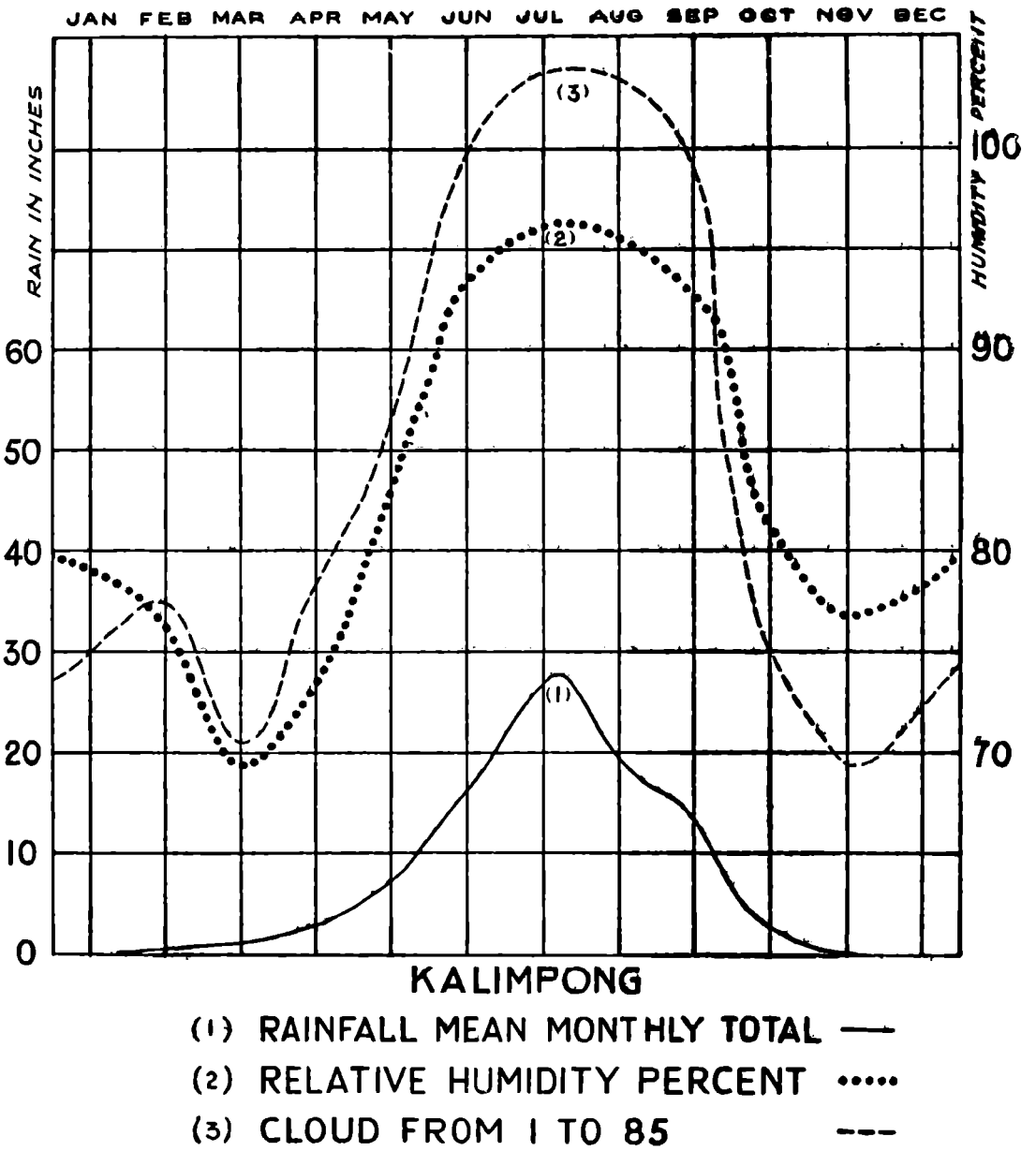
Darjeeling, at an elevation of 7,000 feet, has a mean temperature of about 42° from December to February. A rapid increase of temperature takes place during March and April, owing to the warmer air which penetrates through from the plains. From May to November the average temperature is about 60°. The lowest average minimum for a month is 35° in January and the highest mean maximum 66° in July and August.

Rainfall.—It has already been stated that most of the rain fall between June and October. During the rest of the year there is little rain, although there may be a shower or two about Christmas and some rain may normally be expected in May. The south-west monsoon, which is accountable for the greater part of the rainfall, beats up from the Bay of Bengal against the Assam Hills and there its course is deflected so that it strikes the district from the south-east. The slopes of the outer ridges, facing the monsoon, have accordingly a rainfall of 200 inches, while the north-west slopes have only about 120 inches, as the clouds, on striking the first line of hills lose the greater part of their moisture. Along the foot hills, where the monsoon has met little or no obstruction to mitigate its force, the rainfall varies from 200 inches near the Jaldhaka to 140 inches near the Tista decreasing from east to west. Passing inwards from Sivoke, where the Tista emerges from the hills, the rainfall gradually decreases along the Valley, from 140 inches to 100 inches at Rungpo.

Kalimpong itself has the lowest rainfall in the district, averaging about 80 inches per annum.

The variation of rainfall is of considerable economic importance determining the limits within which certain plants will grow. At the lower elevations, when the rainfall exceeds 180 inches, evergreen species predominate, but where the rainfall is less than 160 inches, most of the trees are deciduous, shedding their leaves during the hot season, before the rains. The cold season is the period of physiological drought. At elevations above 4,000 feet where the temperature is equable, the greater number of the trees are evergreen.

Exact meteorological data for the district do not exist. Observations recorded at the recently established station in Kalimpong indicate the range of rainfall. Figures for Jalpaiguri, some twenty miles south of the district, indicate the conditions at the foot of the hills and are given for comparison. The curves on pages 11 and 12 show cloud, rainfall and humidity per cent.


JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
RAIN IN INCHES
HUMIDITY PERCENT
0
10
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30
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60
70
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90
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(1)
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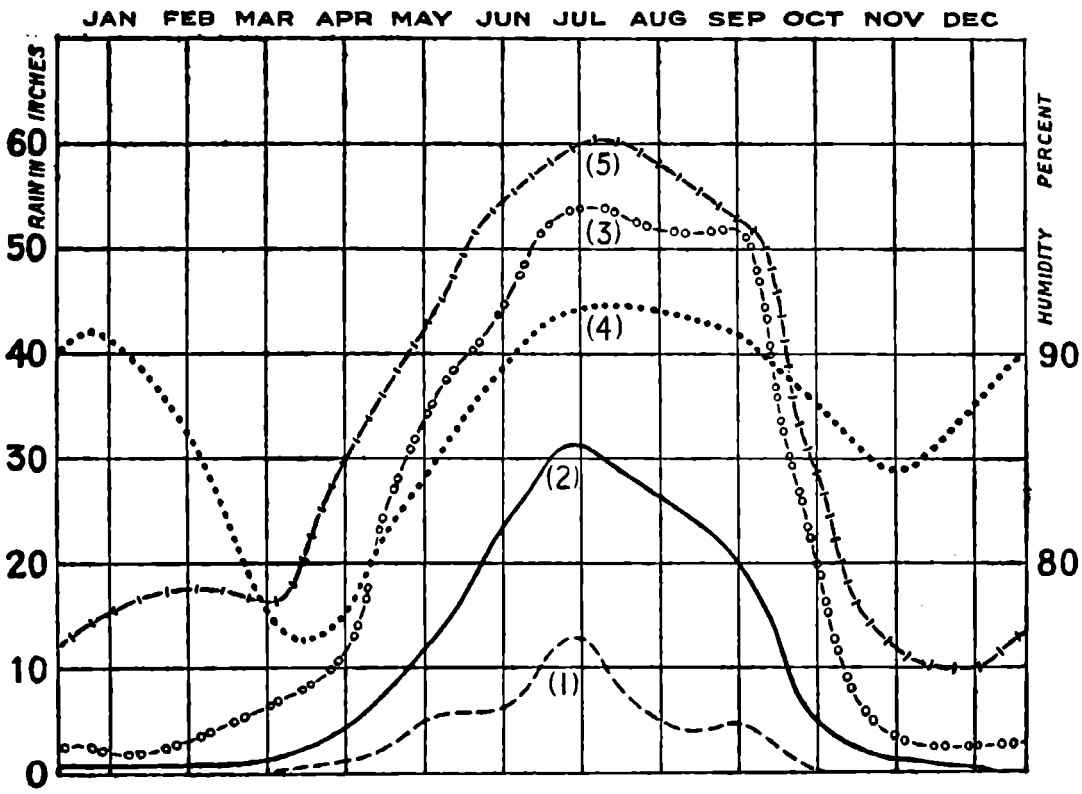
KALIMPONG
(1) RAINFALL MEAN MONTHLY TOTAL
(2) RELATIVE HUMIDITY PERCENT
(3) CLOUD FROM 1 TO 85



JALPAIGURI

(1) RAINFALL TOTAL IN DRIEST MONTH---

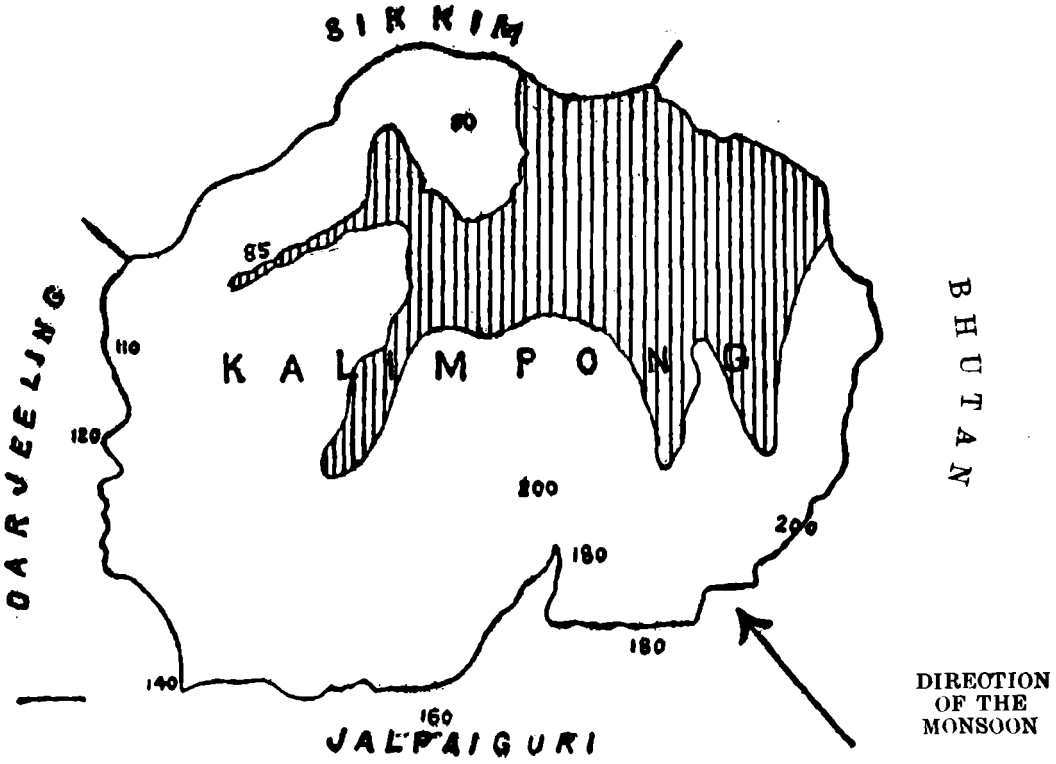
(2) MEAN MONTHLY TOTAL ——

(3) TOTAL IN RAINIEST MONTH -oo-oo-

(4) RELATIVE HUMIDITY PERCENT ••••••

(5) CLOUD FROM 1 TO 6 -|-|-|-

The approximate total annual rainfall in various parts of the district is shown in the sketch map below :—



Land at an elevation of over 5,000 feet has been shaded, so that the effect of the configuration in modifying the rainfall may at once be seen.

2. *Physiographic*.

The country is entirely mountainous, the only flat land in the district being small areas in the river beds near the plains. The elevation, where the sub-division meets the plains of the Jalpaiguri District on the southern boundary, varies from 300 to 900 feet and, from these levels the hills rise, till they reach a maximum of 10,400 feet on the Rechi La, near the Sikkim and Bhutan boundaries. The slopes vary considerably. They are seldom gentle, more usually moderate, but often steep and precipitous.

The main trend of the rivers is from north to south. The Tista River on the western boundary is the largest and has numerous tributaries.

Its principal tributary is the Rilli which flows through the division, in a wide valley, with a winding course but mainly easterly trend, to join the Tista opposite Riyang. Other rivers, the Lish, the Gish, the Ramthi, the Chel and the Murti, rise within the district and flow rapidly southwards to the plains. Where they emerge from the confines of the valleys to the expanse of the open plains, their course is never constant from year to year and very wide stony river beds are formed. The Jaldhaka River which rises in Thibet forms the eastern boundary of the District, separating it from Bhutan.

3. *Edaphic.*

Geology.—The chronological sequence of the geological series occurring in the area is as follows, in descending order :—

Name.	Age.	Lithological characters.
Alluvium . .	Recent . .	....
Bhabar . .	Glacial . .	Enormous boulder deposits which merge into the ordinary alluvium of the plains. (This occurs in the area east of the Chel.)
Nahan .	Lower Tertiary	Soft massive sandstones and clunchy beds. The sandstone is usually a soft, highly felspathic and slightly micaceous white rock of medium fineness with black specks. Wellrounded pebbles, mostly of white quartz, are commonly scattered through the sandstone.
Sikkim Gneiss .	Lower Tertiary Eocene.	Well foliated gneiss, often with wavy layers composed of quartz, white felspar and dark brown mica. The rock, though usually a true gneiss, sometimes passes into mica schist or intermediate forms, so that it is often difficult to distinguish this series from the contiguous Dalings.
Damuda, (Lower Gondwana).	Carboniferous .	Sandstones (often felspathic and sometimes calcareous), grey shales and coal seams. Owing to the intense crushing to which they have been subjected during the building up of the Himalayas, they have been locally changed to quartzites slates and carbonaceous schists. The sandstones are never pebbly as in the Nahans. Small deposits of coal are found.
Baxa Series .	Algonkian .	Very brittle siliceous flags with pink calcareous layers interspersed with red shale.
Daling Series .	Archæan .	Green and grey slates, quartzites and occasionally hornblende schist. They pass insensibly into ordinary clay slates. Copper and iron deposits occur.

The distribution of these series is shown in the map on page 16.

It is interesting to note that the Daling and the Baxa series always appear to overlie the Damuda and the latter to overlie the Nahans, owing to a series of reversed faults.

Besides the iron, copper and coal deposits already mentioned, deposits of lime, in the form of calcareous tufa, occur in all the formations, except the gneiss. Specially good deposits are found in Lish block.

Orography.—The gneiss and the slates are both considerably harder than the Nahans. They form high mountain ridges, sending long spurs down to well-defined valleys, while the Nahans form a belt of much broken country, of comparatively low hills, seldom rising above 2,000 feet in elevation. Bordering the plains, between the Che and the Jaldhaka, where the Nahans are absent, continuous ranges rise from a series of plateaux to a high altitude.

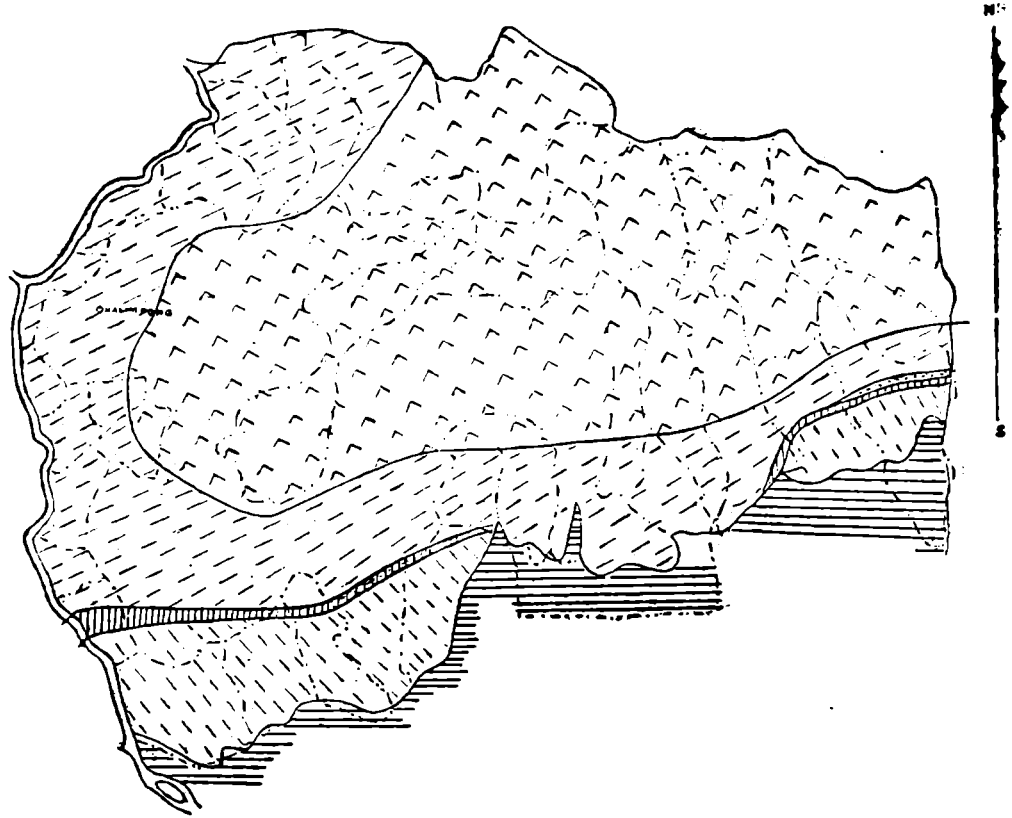
Soil.—The soil resulting from the decomposition of the gneiss is usually a light brown clay, well adapted, when mixed with humus, to the growth of certain types of forest but somewhat too plastic for Sal. The Dalings weather to a sandy loam of great fertility and eminently suited to Sal. The Nahan sandstones yield a dry sandy soil which is best suited for the growth of deciduous species.

4. *Biotic Factors.*

Human agency.—Of biotic factors by far the most important is human agency. Before the land was annexed by the British, shifting cultivation had been practised and a good deal of the land in Chel Range has at one time been 'jhumed.' By this system of cultivation a household fells a few acres of forest, sets fire to it and cultivates the land for one season, moving the following year to a new area. The fire frequently spreads to adjoining areas and in this way a good deal of forest must have been destroyed. Recently in Bengal this system has been turned to good purpose by insisting upon the cultivators sowing the seed of trees in lines, at the same time as they sow their crops. This method is now being generally adopted as the most economical and successful means of reafforestation. In the early days, however, no reafforestation was attempted and *Dendrocalamus Hamiltonii* Nees. the 'Tama Bans,' common enough in the lower storey of the deciduous forests and fire resisting on account of its underground rootstocks, has invaded large areas where shifting cultivation was practised.

It has already been shown that man has been responsible for the disappearance of the greater part of the forests at elevations between 3,000 and 6,000 feet, over an area of about 188 square miles. It is

GEOLOGICAL MAP
OF
KALIMPONG
Scale 1"-6 Miles.



PREPARED FOR AND PUBLISHED IN THE THIRD WORKING PLAN OF THE KALIMPONG FOREST DIVISION.

estimated that, when the land was annexed from Bhutan, there was a population of 3,530. By 1901 it had increased to 41,511 and the present population is, according to a recent census, 50,093 persons. The rapid expansion is due entirely to the immigration of agriculturalists, the great majority of whom are Nepalese.

The development of the Tea industry has also been mentioned. This and the growing population are largely responsible for the low density of the forests in easily accessible areas, and also for the scarcity of certain species which are prized for timber. Among the most striking examples of this scarcity *Duabanga sonneratioides* Ham. may be cited. This species was formerly common enough to be very conspicuous in the tract forming Tista and Chel Ranges. The only locality where it is at all frequent now is Ponbu block which is exceedingly difficult of access and has scarcely been worked for species other than Sal. The prevalence of *Terminalia myriocarpa* Heurck. and Muell. Arg. in Paren Block and its comparative scarcity elsewhere is attributable to the same cause. In the Hills *Castanopsis tribuloides* A. DC. is exceedingly common, except on the areas nearest Kalimpong where scarcely a tree is left.

On the other hand man has been responsible for encouraging certain species. Forest management has favoured the species which are of greater economic importance. " Improvement fellings," creeper cutting and felling rules account for the slight increase of Sal during the past 20 years.

Cattle.—Indirectly, by grazing cattle, man is responsible for alteration in the vegetation. Areas which are continually grazed in the Middle and Upper Hills have a characteristic flora. Cattle, too, have helped to cause the frequent landslips, which are also invaded by a definite flora.

Fire.—Fire, caused by human agency, is another important factor. The evergreen forests are too damp to burn, but in the dry deciduous forest areas, fires overran large tracts, until fire protection was introduced. To this may be attributed the prevalence of bamboos in certain areas. At the highest elevations fire causes considerable havoc. Rhododendrons and other trees are killed and, as at the lower elevations, the resistant bamboo quickly grows again and occupies the land. In this manner, considerable tracts have been covered by Arundinarias to the exclusion of other species.

Other factors.—Wild animals, insects, creepers and fungi also play a minor part which is most evident when an attempt to make plantations is made.

PART IV.

THE NATURE OF THE VEGETATION.

1. General Considerations.

The mountains of the Eastern Himalayas may be divided into two regions—the Snow Range—and the Outer or Lower Himalayas, mountains of inferior though still of considerable altitude.

The Outer or Lower Himalayas lie to the south of the snows and are subject to the influence of the south-west monsoon. The main valleys run from north to south but there are many subsidiary valleys running east and west. The rainfall, which has a considerable influence on the vegetation, increases from north to south or outwards, while at the same time it is very much higher on southern than on northern slopes. The mountain range ends abruptly in an east to west line giving place to plateaux which are said to be of glacial origin. These plateaux gradually slope to the plains, sometimes terminating in a steep bank. The main rivers cut through the plateaux which are otherwise waterless, as the smaller streams are dry during part of the cold season. They disappear underground and reappear further south as pools of running water. The breadth of the dry belt varies from 8 to 10 miles. South of this belt the streams are perennial and vary little in volume at different seasons.

The Climax Vegetation both of the plateaux and mountain ranges is Forest to an altitude of about 12,000 feet. The last trees to survive are Conifers and Rhododendrons. Above 12,000 feet the vegetation is alpine in character, the upper limit of plant life being reached at about 18,000 feet.

Kalimpong Division stretches from the higher plateaux to an elevation of 10,400 feet or nearly to the limit of the forests.

The principal climatic, physiographic, edaphic and biotic factors which have influenced the forest vegetation have already been described. Placing these factors in the probable order of their importance, we find that the vegetation has been influenced by elevation, configuration of the ground, geological formation, soil and rainfall.

Certain species have a very wide distribution with regard to elevation. *Andromeda ovalifolia* Wall. is one of the most universally distributed trees in the district with a range of 9,000 feet. *Artemisia vulgaris* Linn. has a range of about 8,000 feet; *Schima Wallichii* Choisy. of 6,000 feet. The majority of species have a range of only 2,000 to 3,000 feet and hence the vegetation varies in different altitudinal zones.

The configuration of the ground is important, first as it determine the local rainfall, secondly by influencing the amount of direct sunlight

in a given locality. In the Lower Hills evergreen species, especially in the undergrowth, tend to be more frequent on northern aspects and in the valleys.

The influence of the geological formation is somewhat masked by the other factors and yet is strikingly exemplified by the absence of Sal in a portion of the Lower Hills. What is said to be the only gap in the line of Tertiary Formation along the Himalaya foot-hills occurs east of the Chel River and beyond this point Sal is absent.

The influence of the rainfall has been described.

It is clear that any one of these factors can by itself alter the vegetation. As all the factors are combined the possibility of variation is very great, and this makes classification difficult as the change from one type to another is very seldom abrupt.

2. *Classification.*

The difficulty in classifying vegetation in the tropics has been experienced by many. It has been said that existing systems of nomenclature may not be suitable when applied to tropical vegetation* and it has been maintained that the " great need at present is for straightforward description of the vegetation unhampered by conceptions and terminology which may not fit the facts."† There is a great deal of truth in the above statements, but they represent only part of the truth. Some uniformity in investigation and description is desirable and a uniform system of nomenclature would have its advantages.

It may be definitely stated in the first place that the nomenclature —I refer particularly to that of Clements‡—is suitable for the intensive study of any particular area in the tropics. That there are difficulties in its application cannot be denied, but it should be recognised that the difficulties are not inherent in the system of nomenclature itself, they arise because :—

(1) There is so little exact information on the vegetation of many regions in the tropics. Most of the surveys so far undertaken are reconnaissances rather than intensive ecological studies. These reconnaissances are undoubtedly of the greatest value and will have to be continued until our knowledge of the vegetation in India is very much further advanced than it is at present. They in no way obstruct the intensive study of smaller areas, but when hundreds of square miles have to be surveyed the term intensive study

* L. Dudley Stamp in " Aims and Methods in the Study of Vegetation, " by A. G. Tansley and T. F. Chipp, p. 258, see also " The Ecology of part of the Riverain Tract of Burma " by the same author, in the Journal of Ecology, Vol. IX, No. 2. pp. 158-9.

† Quoted in the " Aims and Methods in the Study of Vegetation," page viii.

‡" Plant Succession " by F. E. Clements, 1916, pp. 118-140.

must bear a different meaning than when applied to an area which can be measured in hundreds of acres or less. Terms are needed in the tropics as elsewhere to describe the distinguishing features in the vegetation whether these are broad or minute.

(2) Ignorance of facts prevents the full application of the system. The surveyor of large tracts must often be content to apply only the skeleton of any system. It is for this reason that in many cases only Zones or Formations have been described without any attempt to distinguish the Associations and minor units. Succession has scarcely been studied at all and seral communities, with one or two exceptions, have never been described. The long residence in a district that may be necessary to determine the series in a succession and to classify correctly the seral units, is usually impossible, as members of the Services and others are frequently transferred.

Clements describes an Association as follows :—

"Associations are marked primarily by differences of species, less often by differences of genera. At the same time their organic relation to each other in the climax unit or formation rests upon floristic identity to the extent of one or more dominants, as well as upon the fundamental development and the life forms."*

I believe that, if the investigator in the tropics takes the ASSOCIATION as his primary unit, his difficulty in applying this system of nomenclature will largely disappear. Even if he cannot determine the seral communities with accuracy and if the area is too large or his time too short to undertake the intensive study of minor groups such as, Societies and Clans he lays a solid foundation for more intensive work later and brings his own work in line with that of recent investigators. In the present instance, starting with the Association or Hylium, the Climax vegetation has been classified according to the floristic composition as determined by the dominant species. Consociations, which are units of the Association, are marked by a single dominant and so easily recognised. The Societies or communities characterised by groups of sub-dominant species or species dominant over portions of an area already marked by the dominance of an Association have been described but minor units have not been included as no complete account could be prepared. There is inevitably a certain overlapping or mixing where two communities meet and this presents perhaps the greatest difficulty to the investigator in the tropics. Such Ecotones sometimes cover a considerable area and, as Clements points out, their relations are often

*Clements l. c. page 128.

puzzling and their real nature is only to be ascertained by a study of the adjacent communities.

It is admitted that this system of classification has the disadvantage of obscuring certain obvious differences in the vegetation, which would have been more readily apparent if such terms as, 'Evergreen Forests,' 'Creeper Jungle,' 'Sal Forest,' 'Mixed Dry Forest' and 'Middle Hill Forest' had been used. The desirability for some common basis of classification however, is so apparent in these terms themselves that no further argument in favour of a system of nomenclature seems necessary.

That these and similar terms are constantly used, does show however, that there is a need for some standardised method of combining Associations into groups and sub-groups. For this purpose the term 'Formation' is usually employed whether the distinction be broad, as between Forest and Grassland or narrower as between Deciduous Forests and Evergreen Forests and without modification whether the grouping be dependent upon physiognomy, habitat or development.

The application of the term 'Formation' to every sort of Association group is certainly open to objection. Clements points out that such uses are "makeshifts against the time when development studies have become general." Nevertheless it would be advantageous however, for the immediate survey of the varied vegetation of the tropics, to adopt a few terms for the various groupings and sub-groupings of Associations. Until, however, the subject has been more fully discussed and there is more general agreement as to the classification of ecological units it would be inadvisable to attempt to introduce new standard terms. In the present instance the difficulty can be overcome, as the change in altitude is a potent factor in determining the nature of the vegetation. I therefore have grouped Associations according to altitudinal zones and, in the absence of sufficient data regarding Succession, avoid the term 'Formation.'

Taking altitude, as the most prominent factor in determining the range of distribution of the various species, Associations may be grouped under three main Zones, the Tropical or Lower Hill Zone, the Subtropical or Middle Hill Zone and the Temperate or Upper Hill Zone. These Zones correspond fairly well with the range of the various Associations but there is no hard-and-fast line of demarcation and certain Associations overlap into two zones. Gamble, classifying the forests according to these altitudinal zones, described them as Lower Hill Forest, Middle Hill Forest and Upper Hill Forest, adding Conifers and Rhododendrons at the upper limit. The Alpine Zone which begins at about 12,000 feet is not represented in the Kalimpong District.

The most important of the Seral Communities are described, but much further investigation is necessary before our knowledge of them

can be regarded as at all complete and they cannot be classified without further investigation. Where there is little doubt as to the rank of the seral community, it has been shown as an Asocies or Hylis corresponding to an association of a climax community. Consocies designated by the suffix ies, the seral equivalent of a consociation and, Socies, corresponding to the Consociation and Societies of the Climax vegetation. The term Mictium, which has been tentatively used, refers to what is probably a mixture of two stages in development.

PART V.

CLIMAX COMMUNITIES.

In this section the principal Climax Communities are summarized and the diagram on page 24 illustrates the distribution of Associations according to Altitudinal Zones. As both Consociations and Societies are sometimes units of more than one Association, but are usually constant in a single Zone, they are grouped together under each Zone. Where the Communities are described, Consociations and Societies are referred to the Associations to which they belong.

The following list gives the principal Climax Communities in the Kalimpong District.

1. The Tropical Zone.

ASSOCIATIONS.

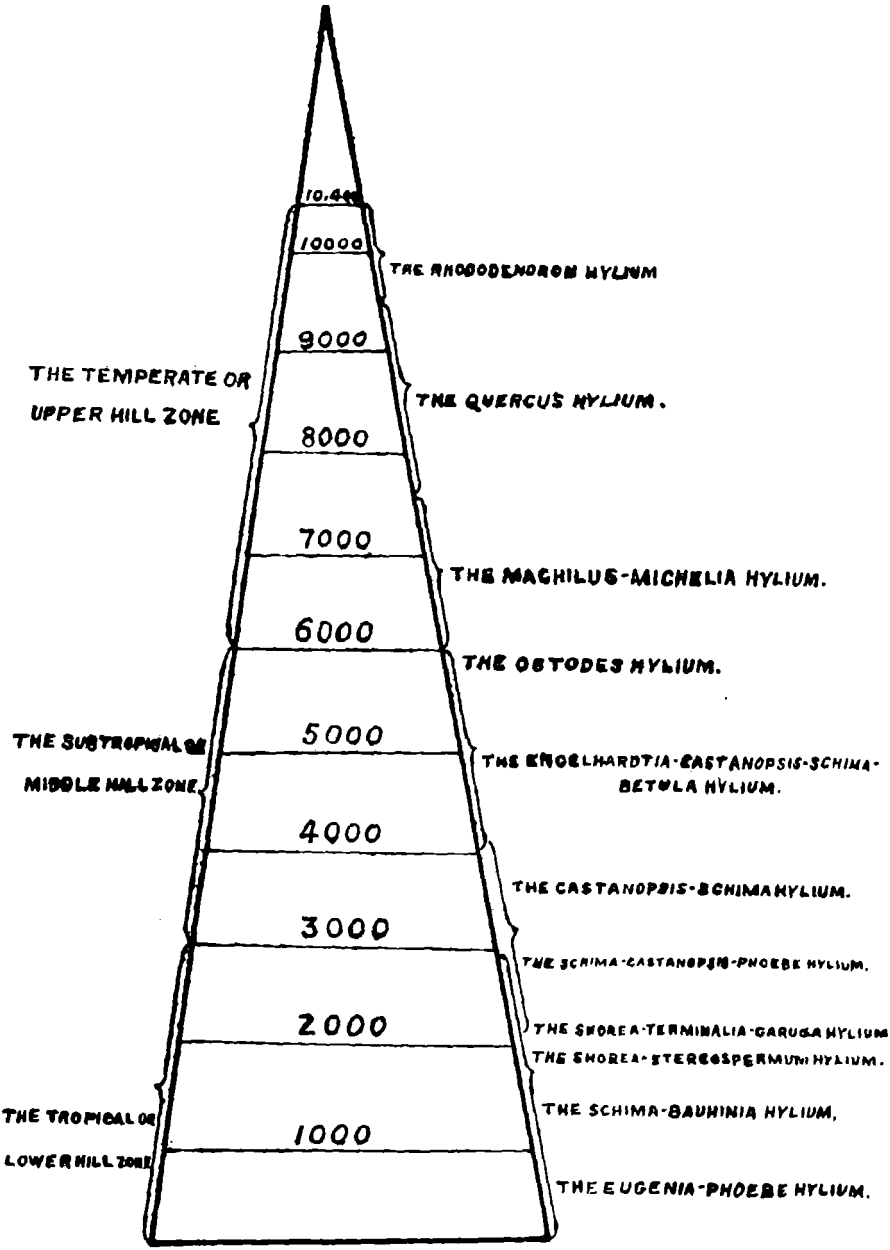
(1) THE SHOREA-TERMINALIA-GARUGA HYLIUM, (2) THE SHOREA-STEREOSPERMUM HYLIUM, (3) THE SCHIMA-BAUHINIA HYLIUM AND (4) THE EUGENIA-PHŒBE HYLIUM.

CONSOCIATIONS.

Acrocarpus fraxinifolius W. and A.
Albizzia marginata Merr.
Dillenia pentagyna Roxb.
Duabanga sonneratioides Ham.
Firmiana colorata R. Br.
Jambosa ramosissima Cowan.
Phœbe attenuata Nees.
Schima Wallichii Choisy.
Shorea robusta Gaertn.
Sterculia villosa Roxb.
Terminalia crenulata Roth.
T. myriocarpa Heurck. & Muell. Arg.

SOCIETIES.

Andropogon assimilis Steud.
Calamus acanthospathus Griff.
C. erectus Roxb.
C. leptospadix Griff.
Camellia drupifera Lour.
Casearia Vareca Roxb.
Crotalaria tetragona Roxb.
Daemonorops Jenkinsianus Mart.
Dendrocalamus Hamiltonii Nees.
Desmodium dioicum DC.
D. latifolium DC.
D. pulchellum Benth.
Dillenia indica Linn.
Endospermum chinense Benth.
Flemingia bracteata Wight.
F. congesta Roxb.
F. stricta Roxb.
Gleichenia linearis Burm.
Homonoia riparia Lour.
Imperata arundinacea Cyrill.
Indigofera pulchella Roxb.
Inula eupatrioides DC.



The distribution of the Associations in the various Zones.

SOCIETIES—*contd.*

Jambosa præcox Cowan.
Leea crispa Willd.
L. robusta Roxb.
Licuala peltata Roxb.
Mesua ferrea Linn.
Micromelum pubescens Bl.
Phlogacanthus thyrsiflorus Nees.
Pinanga gracilis Bl.
Pseudostachyum polymorphum Munro.
Saurauia Roxburghii Wall.
Woodfordia floribunda Salisb.

2. *The Sub-tropical Zone.*

ASSOCIATIONS.

(1) THE CASTANOPSIS-SCHIMA HYLIUM, (2) THE SCHIMA-CASTANOPSIS-PHŒBE HYLIUM, (3) THE ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA HYLIUM AND (4) THE OSTODES HYLIUM.

CONSOCIATIONS.

Alnus nepalensis D. Don. *Betula cylindrostachys* Wall.

SOCIETIES.

Aechmanthera tomentosa Nees.
Dichroa febrifuga Lour.
Dendrocalamus sikkimensis Gamble.
Eurya japonica Thunb.
Helicia erratica Hk. f.
Lastrea dissecta Forst.
Mœsa Chisia Don.
Neillia thyrsiflora D. Don.
Plectocomia himalayana Griff.
Reinwardtia trigyna Planch.
Rhus semialata Murr.

3. *The Temperate Zone.*

ASSOCIATIONS.

(1) THE MACHILUS-MICHELIA HYLIUM, (2) THE QUERCUS HYLIUM, (3) THE RHODODENDRON HYLIUM AND (4) THE TSUGA-ABIES HYLIUM.

CONSOCIATIONS.

Michelia Cathcartii Hk. f. and T.
Quercus lamellosa Smith.
Quercus pachyphylla Kurz.
Rhododendron arboreum Smith.
R. barbatum Wight.
R. campanulatum Don.
R. grande Wight.
Tsuga Brunoniana Carr.

SOCIETIES.

Actinodaphne sikkimensis Meissn.
Ardisia macrocarpa Wall.
Arundinaria aristata Gamble.
A. Griffithiana Gamble.
A. Pantlingi Gamble.
A. Hookeriana Munro.
A. Maling Gamble.
A. racemosa Munro.
Berberis aristata DC.
B. insignis Hk. f. and T.
Bœhmeria polystachya Wedd.
Buchlandia populnea R. Br.
Cephalostachyum capitatum Munro.
Croton Tiglium Linn.
Dichroa febrifuga Lour.
Edgeworthia Gardneri Meissn.
Eurya japonica Thunb.
Girardinia palmata Gaud.
Indigofera hebepetala Benth.
Laurocerasus acuminata Roem.
Leucosceptrum canum Smith.
Leycesteria formosa Wall.
L. stipulata Fritsch.
Macaranga pustulata King.
Maesa Chisia Don.
Pilea smilacifolia Wedd.
Piptanthus nepalensis D. Don.
Pittosporum nepalensis Rehd. & Wils.
Polygonum molle Don.
Populus Gamblei Dode.
Rubus Andersoni Hk. f.
Rubus rosæfolius Smith.
Rubus Thomsoni Focke.
Rhus semialata Murr.
Strobilanthes spp.
Symplocos theifolia D. Don.
S. ramosissima Wall.

PART VI.

THE TROPICAL OR LOWER HILL ZONE.

The Lower Hill Zone stretches from the plains to an elevation of 3,000 feet above sea level, occupying altogether an area of about 95 square miles. There are small areas of waste land, but the greater part of the Zone bears forest which is the climax vegetation.

It has been shown that within the Zone there are considerable differences of temperature, soil and rainfall; innumerable spurs run from the main ridges to the valleys or to the plains. Classification of the vegetation is somewhat difficult as there is a gradual alteration from a ridge to a valley, from a northern to a southern slope, from the mica schists of the Tista to the sandstones and the more broken country of the Nahan formation and again to the alluvial flats and plateaux towards the Jaldhaka.

The forests, over the greater part of the area, are mainly deciduous and would come under Schimper's Monsoon Forest type, if as Professor Troup suggests,* Schimper's limit of rainfall (180 cms. or about 70 ins.) is not adhered to. The minimum rainfall in the Lower Hill Zone is about 90 ins. and the change from mainly deciduous species to mainly evergreen occurs in the Zone when the rainfall reaches 160 inches. Where the rainfall increases to about 200 inches the forests are practically entirely evergreen and they approach Schimper's Tropical Rain Forest in character.

Taking the other important ecological factors separately, where there is a change of geological formation within the deciduous forest belt, there is at the same time a considerable change in floristic composition. *Shorea robusta* Gaertn. forms 34 per cent. of the crop on the Dalings in the Tista valley, but only 13 per cent. in the Nahans and is absent on the alluvial plateaux east of the Chel River. Again Terminalias, Albizzias, *Lagerstramia parviflora* Roxb., *Bombax malabaricum* DC. and *Cedrela Toona* Roxb. are exceedingly prominent on the Dalings; *Stereospermum tetragonum* DC., *Dillenia pentagyna* Roxb. and *Sterculia villosa* Roxb. are prominent on the more xerophilous Nahans.

The configuration accounts for modifications between the valleys and the ridges, particularly in the second storey, which is usually evergreen even where the dominant species are deciduous. There is a distinct tendency also to a greater proportion of evergreens in the valleys the following species being common. *Meliosma simplicifolia* Walp., *Mangifera sylvatica* Roxb., *Glochidion lanceolarium* Walz., *Albizzia lucida* Benth., and *Garcinia stipulata* T. And

* "Aims and Methods in the Study of Vegetation" page 292.

The aspect also introduces modifications. A northern aspect tends to a greater frequency of trees either of higher levels or of areas of greater rainfall. For example in Mungpong Block on the northern slopes of the inner valleys, Eugenias and Laurels, associated with *Michelia champaca* Linn. and *Schima Wallichii* Choisy., predominate, although they are more typical of areas of higher rainfall further east.

The lateral range of the principal species is of interest. Starting from Rungpo and proceeding down the Tista valley to Mungpong and then eastward to Khumani, *Shorea robusta* extends s far as L·thi. *Garuga* species are frequent only in the Tista Valley; *Terminalia crenulata* Roth. follows Sal. *Stereospermum tetragonum* is most frequent from Mungpong to Noam, or between the Tista and Chel rivers. *Bauhinia purpurea* Linn. is exceedingly common from Fagu to East Nar, *Phœbe attenuata* Nees. from West Nar to near Khumani and *Jambosa formosa* Walp. in the wetter parts of Khumani Block. *Schima Wallichii*, which is the commonest tree at 4,000 feet is very widely distributed within the zone, reaching its maximum frequency within the zone in East and West Nar Blocks where the rainfall is about 180 inches.

A characteristic of all these forests is the large number of epiphytes, Figs, Aroids, Hoyas and Orchids. There are many huge climbers, the largest and most abundant being *Aspidocarya uvifera* Hk. f., *Bauhinia Vahlii* W. and A., *Beaumontia grandiflora*. Wall., *Buettneria pilosa* Roxb., many species of *Combretum*, *Cissampelos Pareira* Linn., *Desmos chinensis* Lour., *Entada scandens* Benth., *Hiptage Madablota* Gaertn., *Millettia pachycarpa* Benth., and *Tinospora cordifolia*, Miers.

A type of forest described by Gamble as "Creeper Jungle" or "Savanah" is found between the Chel and Neora rivers, principally in Mal Block and is referred to later. It is characterised by the sparseness of trees, under which are a mass of creepers, chiefly Convolvulaceæ and Argyreias, Ipomæas and Poranas. There are also *Smilax*, spp. and several scandent Acacias.

Associations.

(1) THE SHOREA-TERMINALIA-GARUGA HYLIUM.

The *Shorea robusta*—*Terminalia belerica*—*Garuga pinnata* Association occupies the greater part of the forest belt on the western boundary of the District. It is a characteristic of the lower slopes of the Tista valley and covers an area of about 10,000 acres between Rungpo, where the Tista river first touches the District and Mungpong where it emerges on the plains. The main ridge above the Tista rises to 6,000 feet above sea level at Dumsong, the elevation diminishing towards the plains; from this ridge numerous spurs run down towards the river and it is on

their lower slopes, to an average elevation of 3,000 feet, that this Association is found. It occasionally rises higher on southerly aspects and sometimes only reaches considerably lower elevations on northerly aspects and in the subsidiary valleys. The slopes of the main valley are steep to precipitous, the underlying rock is mica schist and slates and the soil for the most part is a fertile sandy loam sometimes stony with either a thin or a moderate covering of humus. The Association is characterised by a very high percentage of *Shorea robusta* and by a large number of species mainly deciduous. The average density of the trees is about 40 per acre.

The actual percentage composition of the Association is as follows :—

(1) Species over 1 per cent.—

Shorea robusta Gærtn. 34·4, (*Garuga pinnata* Roxb. also *G. Gamblei* King) 7·1, *Terminalia belerica* Roxb. 5·0, *Terminalia crenulata* Roth. 4·8, *Schima Wallichii* Choisy. 2·8, *Lagerstræmia parviflora* Roxb. 2·7, *Tetrameles nudiflora* R. Br. 2·6, *Sterculia villosa* Roxb. 2·6, *Stereospermum tetragonum* DC. 2·1, (*Cedrela Toona* Roxb. also *C. microcarpa* C. DC. and *C. Kingii.* C. DC.) 2·1, *Bauhinia purpurea* Linn. 2·0, *Premna* species chiefly *P. mucronata* Roxb. 1·8, *Duabanga sonneratioides* Ham. 1·7, *Gmelina arborea* Linn. 1·7, *Dysoxylum* spp. 1·5, *Bombax malabaricum* DC. 1·4, *Bauhinia variegata* Linn. 1·3, *Callicarpa arborea* Roxb. 1·2, *Litsæa polyantha* Juss. 1·1, *Semecarpus Anacardium* Linn. 1·0, *Mallotus phillipinensis* Muell. Arg. 1·0.

(2) Species under 1 per cent. and over. ·1 per cent., in order of frequency—

Spondias mangifera Willd., *Grewia vestita* Wall., *Castanopsis indica* A. DC., *Anthocephalus indicus* A. Rich., *Albizzia odoratissima* Benth., *Cordia obliqua* Willd., *Talauma Hodgsoni* Hk. f. and T., *Ailanthus grandis* Prain., (*Kydia calycina* Roxb. and *K. jujubifolia* Griff.), *Dillenia pentagyna* Roxb., *Engelhardtia spicata* Bl., *Albizzia marginata* Merr., *Ficus Cunia* Ham., *Morus lævigata* Wall., *Chickrassia tabularis* A. Juss., *Alstonia scholaris* R. Br., *Terminalia myriocarpa* Heurck. and Muell. Arg., *Mallotus* spp., *Oroxylum indicum* Vent., *Vitex heterophylla* Roxb., *Albizzia procera* Benth., *Garcinia stipulata* T. And., *Terminalia Chebula* Retz., *Sapindus detergens* Wall., *Ficus nemoralis* Wall., (*Beilschmiedia Roxburghiana* Nees. and *B. sikkimensis* King.), *Bœhmeria rugulosa* Wedd., *Litsæa* spp., *Symplocos spicata* Roxb., *Helicia erratica* Hk. f., *Antidesma diandrum* Roth., (*Cinnamomum caudatum* Nees. and others), *Gynocardia odorata* R. Br., *Bischofia javanica* Bl., *Styrax* spp., *Machilus* spp., *Ficus glomerata* Roxb.,

Amoora Wallichii King., *Pterospermum acerifolium* Willd., *Odina Wodier* Roxb., *Mangifera indica* Linn., *Ficus bengalensis* Linn., and *Ficus Benjamina* Roxb.

The above figures represent the average occurrence of the species throughout the area covered by the Association. The actual frequency per acre naturally varies somewhat in different localities.

To illustrate the modifications which may be found, the density per acre of each species which occurs more than once in two acres, as well as the density of all species, is recorded below for several blocks.

(i) Sangser Block—

Density per acre—All species—38.

Shorea robusta 7·74, (*Garuga pinnata* and *G. Gamblei*) 3·15, *Terminalia belerica* 1·9, *Callicarpa arborea* 1·8, *Chickrassia tabularis* 1·27, *Albizzia* spp. 1·27, *Schima Wallichii* 1·18, *Bombax malabaricum* 1·17, *Terminalia crenulata* 1·15, *Amoora Rohituka* 1·1, *Premna* spp. 1·0, *Bauhinia purpurea* 1·0, *Duabanga sonneratioides* 94, *Tetrameles nudiflora* ·9, *Gmelina arborea* ·51, and *Engelhardtia spicata* ·5.

(ii) Rinkingpong.

Density per acre—All species—33·5.

Shorea robusta 13·38, *Castanopsis indica* 2·42, *Terminalia crenulata* 1·71, (*Garuga pinnata* and *G. Gamblei*) 1·55, *Terminalia belerica* 1·43, *Schima Wallichii* 1·33, (*Cedrela Toona* and *C. microcarpa*) 1 17, *Gmelina arborea* ·98, *Lagerstræmia parviflora* ·90, *Sterculia villosa* ·81, *Bauhinia purpurea* ·74, *Albizzia* spp. ·59, *Duabanga sonneratioides* ·56, *Semecarpus Anacardium* ·54, and *Bridelia* spp. ·5.

(iii) Tunang.

Density per acre—All species—41·3.

Shorea robusta 6·01, *Terminalia crenulata* 2·62, *Schima Wallichii* 2·62, *Bauhinia purpurea* 1·76, (*Garuga pinnata* and *G. Gamblei*) 1·71, *Styrax* spp. 1·69, *Duabanga sonneratioides* 1·69, *Terminalia belerica* 1·55, (*Cedrela Toona* and *C. microcarpa*) 1·40, *Bombax malabaricum* 1·28, *Stereospermum tetragonum* 1·28, *Tetrameles nudiflora* 1·21, *Albizzia procera* ·79, *Gmelina arborea* ·76, *Castanopsis indica* ·64, *Spondias mangifera* ·64, *Bischofia javanica* ·64, *Dysoxylum* spp. ·62 and *Fraxinus floribunda* ·52.

(iv) Guling.

Density per acre—All species—37·1.

Shorea robusta 5·28, *Meliosma simplicifolia* 2·80, (*Garuga pinnata* and *G. Gamblei*) 2·56, *Tetrameles nudiflora* 2·01, *Sterculia*,

villosa 1·79, *Terminalia crenulata* 1·59, *Schima Wallichii* 1·22, *Stereospermum tetragonum* 1·21, *Grewia vestita* 1·11, *Terminalia belerica* 1·0, *Cedrela Toona* ·82, *Litsæa polyantha* ·82, *Bœhmeria rugulosa* ·79, *Duabanga sonneratioides* ·71 *Castanopsis tribuloides* ·74, *Engelhardtia spicata* ·60, and *Gmelina arborea* ·55.

In Rungpo, Tashiding and Kamesi Blocks there is little difference in the vegetation from the average given for the Association but the density in each of these blocks is above the normal, being as much as 52·2 per acre in Kamesi. The same remark as regards floristic composition applies to Nazeok block but the density there is only 12·4 trees per acre.

The effect of the configuration upon the vegetation is well exemplified by the composition in Mangbar Block, where the aspect is mainly north. Species typical of the crests and spurs are not common but those of the lower slopes of the subsidiary valleys are frequent, while certain species more common at higher elevations are well represented. Although there is no real change in the floristic composition, the frequency per acre differs from the average. The majority of the Association dominants occur locally less frequently than once in two acres.

The density of all species is, in this case, 34·5 per acre and of individual species as follows :—

Bauhinia purpurea 2·62, *Betula cylindrostachys* 2·54, *Albizzia procera* 1·67, *Engelhardtia spicata* 1·54, *Cedrela Toona* 1·28, *Chikrassia tabularis* 1·17, *Litsæa polyantha* 1·14, *Pterospermum acerifolium*, 1·12, *Castanopsis indica* 1·09, *Gmelina arborea* 1·07, *Schima Wallichii* 1·03, (*Cinnamomum caudatum* and others) ·94, *Callicarpa arborea* ·91, *Tetrameles nudiflora* ·89, *Firmiana colorata* ·86, *Daubanga sonneratioides* ·86, *Ficus Cunia* ·81, *Bombax malabaricum* ·81, *Stereospermum tetragonum* ·72, (*Garuga pinnata* and *G. Gamblei*) ·68, *Litsæa* spp. ·67, and *Styrax* spp. ·5.

The vegetation in Ponbu Block might be regarded as a transition area or Ecotone between this Association and the next, as it shows features of both Associations. It is not distinctive enough to be regarded as a separate Association and I prefer to include it under the SHOREA-TERMINALIA-GARUGA HYLIUM, as there is here again a merely local alteration in frequency rather than of floristic composition. The soil is a pebbly loam of moderate depth. The comparatively high frequency of *Duabanga sonneratioides* is chiefly due to the fact that this area is very different of access.

The frequency per acre is as follows :—

Duabanga sonneratioides ·95, *Erythrina stricta* ·80, *Pterospermum acerifolium* ·72, (*Cephalanthus naucleoides* and others) ·71, *Oroxylum indicum* ·68, *Stereospermum tetragonum* ·65, *Tetrameles nudiflora* ·64, *Gmelina arborea* ·63, *Talauma Hodgsoni* ·61, *Semecarpus Anacardium* ·57, and *Terminalia belerica* ·55.

(2). THE SHOREA-STEREOSPERMUM HYLIUM.

This Association is characterised by the dominance of the two species *Shorea robusta* Gærtn. and *Stereospermum tetragonum* DC. It differs from the SHOREA-TERMINALIA-GARUGA ASSOCIATION by the very much smaller percentage of *Shorea, viz.*, 13 per cent. and the very much higher percentage and much greater prevalence of *Stereospermum. Terminalia crenulata* Roth. is more frequent in this Association ; *Terminalia belerica* Roxb. and *Garuga pinnata* Roxb. are much less frequent. It differs also by the much lower density of trees per acre and much greater prevalence of the bamboo, *Dendrocalamus Hamiltonii* Nees.

Although many species are common to both Associations, the dominating species differ and, in appearance, both Associations are quite distinct, the SHOREA-STEREOSPERMUM HYLIUM being decidedly the more xerophilous.

This Association is found on the Nahan geological formation on the Lower Hills facing the plains, over an area of about 20,000 acres The country is much more broken than in the Tista Valley ; the ridges and spurs are shorter and more numerous and the trend of the main ridges is mainly North to South. Although the rainfall is higher than in the Tista Valley, being 140 to 160 inches, the soil is more porous and consequently drier. The underlying rock is sandstone and the soil a light sandy loam. The slopes are for the most part steep to precipitous.

The percentage of the principal species, which again are numerous, is as follows :—

(1) Species over 1 per cent.—

Shorea robusta Gærtn. 13·3, *Stereospermum tetragonum* DC. 9·7, *Terminalia crenulata* Roth. 9·1, *Schima Wallichii* Choisy. 4·3, *Bauhinia purpurea* Linn. 3·5, *Gmelina arborea* Linn. 3·3, *Dillenia pentagyna* Roxb. 3·2, *Sterculia villosa* Roxb. 2·5, *Talauma Hodgsoni* Hk. f. and T. 2·3, *Garuga pinnata* Roxb. 2·2, *Albizzia* spp. 2·1, *Michelia champaca* Linn. 2·0, *Amoora Wallichii* King. 2·0, *Duabanga sonneratioides* Ham. 1·8, *Terminalia belerica* Roxb. 1·6, *Chickrassia tabularis*

A. Juss. 1·5, *Jambosa ramosissima* Cowan. 1·3, *Lagerstræmia parviflora* Roxb. 1·3, (*Beilschmiedia Roxburghiana* Nees. and *B. sikkimensis* King.) 1·2, *Meliosma simplicifolia* Walp. 1·1, *Gynocardia odorata* R. Br. 1·1, *Machilus* spp. 1·0, *Grewia vestita* Wall. 1·0, *Syzygium* spp. 1·0 and *Elæocarpus aristatus* Roxb. 1·0.

(2) Species under 1 per cent. and over ·1 per cent. in order of frequency—

Terminalia Chebula Retz., *Jambosa formosa* Walp., *Ficus infectoria* Roxb., *Ficus Cunia* Ham., *Dillenia indica* Linn., *Terminalia myriocarpa* Heurck. and Muell. Arg., *Bridelia* spp., (*Cedrela Toona* Roxb. and *C. microcarpa* C. DC.), *Trewia nudiflora* Linn., *Dysoxylum* spp., *Terminalia belerica* Roxb., (*Cephalanthus occidentalis* Linn. and others), *Ailanthus grandis* Prain., *Tetrameles nudiflora* R. Br., (*Macaranga* and *Mallotus* spp.) *Vitex heterophylla* Roxb., *Oroxylum indicum* Vent., *Styrax* spp., *Engelhardtia spicata* Bl., *Bombax malabaricum* DC., *Zanthoxylum* spp., *Mangifera indica* Linn., *Cinnamomum obtusifolium* Nees., *Meliosma simplicifolia* Walp., (*Melia composita* Willd. and *Spondias axillaris* Roxb.), *Castanopsis tribuloides* A. DC., *Sapindus detergens* Wall., *Pterospermum acerifolium* Willd., *Actinodaphne obovota* Bl., (*Knema linifolia* Warb. and *K. angustifolia* Warb.), *Quercus spicata* Sm., *Anthocephalus indicus* A. Rich., *Spondias mangifera* Willd., *Litsæa* spp., *Ficus nemoralis* Wall., *Castanopsis indica* A. DC., *Helicia erratica* Hk. f., *Elæocarpus* spp., *Garcinia stipulata* T. And., and *Alstonia scholaris* R. Br.

When the density of the forest is considered the difference between this and the SHOREA-TERMINALIA-GARUGA ASSOCIATION is very striking.

In Ramthi Block, the density per acre of all species is 5·4 ; *Shorea robusta* being 1·25, and *Stereospermum tetragonum*, ·76. There are no other trees occurring oftener than once in two acres. This may be regarded as the typical composition of the Association. Radiating from Ramthi as a centre, variation in the frequency of the principal species and Ecotones between this and adjoining Associations are encountered.

In Lish the only species occurring oftener than once in two acres are as follows :—

Terminalia crenulata ·96, *Stereospermum tetragonum* ·93, and *Schima Wallichii* ·51.

and in Churonthi —

Stereospermum tetragonum 1·57, *Terminalia crenulata* ·96, *Schima Wallichii* ·92, *Shorea robusta* ·92, *Dillenia pentagyna* ·66, and *Gmelina arborea* 59.

(3) THE SCHIMA-BAUHINIA HYLIUM.

This Association marks the transition from the mainly deciduous to the mainly evergreen forest. *Schima Wallichii* Choisy. is the dominating species. It is one of the most widely distributed species in the district, both laterally and vertically. Its dominance at the comparatively low levels where this Association is found is due to the heavy rainfall which varies from 160 to nearly 200 inches.

Shorea robusta does not occur in this Association and the Terminalias of the former Associations are inconspicuous constituents of the forest. *Stereospermum* only occurs sporadically. Many more of the secondary species are evergreen.

The Association covers an area of about 9,000 acres, from the plains' level which is about 800 feet to an elevation of 2,500 or 3,000 feet. At elevations above and below these limits most of the land is under cultivation, the extent of the Association being reduced on that account.

It extends from the Chel to some distance beyond the Neora River, but does not extend to the alluvial flats near Khumani.

The underlying rock is micaceous schist and the soil for the most part deep loam. The slopes are on the whole more moderate than further west. The percentage composition of the principal species in the Association is as follows :—

(1) Species over 1 per cent.—

Schima Wallichii Choisy. 18·6, *Bauhinia purpurea* Linn. 9·7, *Phœbe lanceolata* Nees. 4·2, (*Cedrela Toona* Roxb. and *C. microcarpa* C. DC.) 2·9, *Stereospermum tetragonum* DC. 2·6, *Castanopsis indica* A. DC. 2·2, *Ailanthus grandis* Prain. 2·0, *Duabanga sonneratioides* Ham. 1·9, *Jambosa formosa* Walp. 1·9, *Turpinia pomifera* DC. 1·8, *Garcinia stipulata* T. And. 1·8, *Jambosa ramosissima* Cowan. 1·7, *Sterculia villosa* Roxb. 1·6, *Meliosma simplicifolia* Walp. 1·5, *Dysoxylum* spp. 1·5, *Terminalia myriocarpa* Heurck. and Muell. Arg. 1·4, *Actinodaphne obovata* Bl. 1·4, *Michelia champaca* Linn. 1·3, *Tetrameles nudiflora* R. Br. 1·2, *Litsœa* spp. 1·1, (*Macaranga* and *Mallotus* spp.) 1·0, *Gmelina arborea* Linn. 1·0, *Gynocardia odorata* R. Br. 1·0.

(2) Species under 1 per cent. and over ·1 per cent., in order of frequency—

Syzygium spp., (*Cephalanthus occidentalis* Linn. and others), (*Garuga pinnata* Roxb. and *G. Gamblei* King), *Castanopsis tribuloides* A. DC., *Beilschmiedia* spp., *Erythrina stricta* Roxb., *Talauma Hodgsoni* Hk. f. and T., *Eurya accuminata* DC., *Pterospermum acerifolium* Willd., *Premna* spp., *Quercus spicata* Sm., *Brassaiopsis* spp., *Elæocarpus* spp., *Betula cylindros-*

tachys Wall., *Bombax malabaricum* DC., *Albizzia* spp.' *Zanthoxylum* spp., *Amoora Wallichii* King., *Hovenia dulcis* Thunb., *Cordia obliqua* Willd., *Ficus Cunia* Ham., *Helicia erratica* Hk. f., *Odina Wodier* Roxb., *Ostodes paniculatus* Bl., *Cinnamomum Cecicodaphne* Meissn., *Alstonia scholaris* R. Br., *Terminalia belerica* Roxb., *Morus lævigata* Wall., *Engelhardtia spicata* Bl., *Styrax* spp., *Aporosa dioica* Muell. Arg., *Spondias mangifera* Willd., *Anthocephalus indicus* A. Rich., *Vitex heterophylla* Roxb., *Cratæva unilocularis* Ham., *Mallotus phillipinesis* Muell. Arg., *Acrocarpus fraxinifolius* W. and A., *Bauhinia purpurea* Linn., *Terminalia crenulata* Roth., *Cinnamomum obtusifolium* Nees., *Litsæa polyantha* Juss. and *Trema* spp.

It will be noticed that *Beilschmedia Roxburghiana* and species of *Eugenia* which are the dominating trees in the region of heavier rainfall, are becoming more plentiful.

The gradual increase in the number of evergreens and in the density of the forest from west to east is illustrated by the following examples showing the frequency per acre of the species in various blocks.

(i) Lethi block. Density per acre, all species, 1 ·1—

Schima Wallichii 3·63, *Bauhinia purpurea* ·87, *Stereospermum tetragonum* ·82, *Terminalia crenulata* ·73, *Sterculia villosa* ·72, *Michelia champaca* ·60, *Jambosa ramosissima* ·57, and *Castanopsis tribuloides* ·5.

(ii) In Sakkam Block which is some 5 miles further east, *Terminalia crenulata* disappears and evergreens are rather more frequent. The figures are as follows :—

Density per acre, all species, 22·3—

Schima Wallichii 4·79, *Bauhinia purpurea* 2·55, *Stereospermum tetragonum* 2·02, *Phœbe lanceolata* 1·3, (*Phœbe Hainesiana* and *P. attenuata*) 1·12, *Sterculia villosa* ·78, *Duabanga sonneratioides* ·85, *Castanopsis indica* ·69, *Ailanthus grandis* ·60, and *Cedrela* spp. ·55.

This block is about the centre of the area covered by this Association.

(iii) The figures for West-Nar show a still greater prevalence of evergreens and a higher frequency of the species in the next Association and are as follows :—

Density per acre all species, 25·5—

Schima Wallichii 2·34, *Bauhinia purpurea* 2·0, *Jambosa ramosissima* 1·07, (*Phœbe Hainesiana* and *P. attenuata*) ·98, *Cedrela* spp. ·82, *Garcinia stipulata* ·73, *Stereospermum tetragonum* ·73, *Duabanga sonneratioides* ·68, *Terminalia myriocarpa* ·60, *Meliosma simplicifolia* ·60, *Ailanathus grandis* ·56 and *Turpinia pomifera* ·50.

(4) THE EUGENIA-PHŒBE HYLIUM.

The Eugenia-Phœbe Association is found principally in the east of the District where the rainfall is heavy approaching or reaching 200 inches per annum. It is occasionally found further west on northern aspects. The great majority of the trees are evergreen. In this Association species elsewhere uncommon in the Lower Hill Zone are to be found in abundance. The extent of the area covered by the Association is however small.

The principal species in the Association occur in the following percentages :—

(1) Species over 1 per cent.—

Jambosa formosa Walp. 24·1, (*Phœbe Hainesiana* R. Br. and *P. attenuata* Nees.) 20·0, (*Beilschmiedia Roxburghiana* Nees. and *B. sikkimensis* King.) 6·8, *Dysoxylum* spp. 5·9, *Polyalthia simiarum* Benth. and Hk. f. 4·0, *Jambosa ramosissima* Cowan. 4·0, *Meliosma simplicifolia* Walp. 3·0, *Castanopsis indica* A. DC. 2·8, *Litsœa* spp. 2·3, *Terminalia myriocarpa* Heurck. and Muell. Arg. 1·8, *Michelia champaca* Linn. 1·7, *Stereospermum tetragonum* D.C. 1·7, *Cinnamomum obtusifolium* Nees. 1·6, *Bauhinia purpurea* Linn. 1·5, *Syzygium* spp. 1·2, *Elæocarpus* spp. 1·0.

(2) Species under 1 per cent. but over ·1 per cent., in order, of frequency—

Alstonia scholaris R. Br., *Premna* spp., *Amoora Wallichii* King *Gynocardia odorata* R. Br., (*Garcinia stipulata* T. And. and *Sarcosperma arboreum* Benth.), *Duabanga sonnertioides* Ham., *Tetrameles nudiflora* R. Br., *Turpinia pomifera* DC., *Castanopsis tribuloides* A. DC., *Ficus infectoria* Roxb., *Ailanthus grandis* Prain., *Styrax* spp., *Holarrhena antidysenterica* Wall., *Endospermum chinense* Benth., *Actinodaphne obovata* Bl., *Phœbe lanceolata* Nees., *Cordia obliqua* Willd., *Schima Wallichii* Choisy., *Talauma Hodgsoni* Hk. f. and T., *Garuga* spp., *Cinnamomum Cecicodaphne* Meissn., *Machilus* spp., *Mangifera indica* Linn., *Firmiana colorata* R. Br., *Kydia calycina* Roxb., *Canarium sikkimensis* King., *Chickrassia tabularis* A. Juss., *Cedrela* spp., *Sterculia villosa* Roxb., *Sapindus detergens* Wall., *Semecarpus Anacardium* Linn., *Glochidion* spp., *Bischofia javanica* Bl., and *Acrocarpus fraxinifolius* W. and A.

Surrounding the region characterised by the EUGENIA-PHŒBE HYLIUM there are considerable areas to the east, west and north in which the dominants of this Association mingle with both those of the

SCHIMA-BAUHINIA HYLIUM and those of the SCHIMA-CASTANOPSIS-PHŒBE HYLIUM of the subtropical zone.

Examples of these Ecotones are found both in East Nar to the west of the area where the EUGENIA-PHŒBE HYLIUM is found, and to the east of it in Paren Block.

The dominating species, expressed in terms of density per acre, are given below.

(i) East Nar—

Schima Wallichii 9·26, *Cinnamomum obtusifolium* 2·4, *Talauma Hodgsoni* 2·31, *Jambosa ramosissima* 2·16, (*Phœbe Hainesiana* and *P. attenuata*) 1·70, *Machilus* spp. 1·55, (*Beilschmiedia Roxburghiana* and *B. sikkimensis*) 1·44, *Terminalia myriocarpa* 1·19, *Meliosma simplicifolia* 1·15, *Garcinia stipulata* ·86, *Quercus spicata* ·77, *Michelia champaca* ·68, *Jambosa formosa* ·68, *Phœbe lanceolata* ·63, *Turpina pomifera* ·56, *Castanopsis indica* ·55, *Castanopsis tribuloides* ·54, *Dysoxylum* spp. ·5.

(ii) Paren Block—

Density per acre all species 43·0—

Schima Wallichii 9·26, *Terminalia myriocarpa* 2·24, *Syzygium* spp. 1·75, *Castanopsis indica* 1·68, *Cinnamomum Cecicodaphne* 1·61, *Beilschmiedia* spp. 1·58, *Litsœa lanceolata* 1·42, *Cordia obliqua* 1·28, *Betula cylindrostachys* 1·28, *Bauhinia purpurea* 1·26, *Stereospermum tetragonum* 1·1, *Dysoxylum* spp. ·84, *Gynocardia odorata* ·82, *Talauma Hodgsoni* ·79, *Duabanga sonneratioides* ·63, *Erythrina stricta* ·61, *Jambosa ramosissima* ·58, *Turpinia pomifera* ·54, *Michelia champaca* ·51 and *Meliosma simplicifolia* ·51.

A similar floristic composition occurs in a locality isolated from the main area dominated by the SCHIMA-EUGENIA ecotone, namely in the upper parts of Mungpong Block. The occurrence of these species in this locality, where the rainfall is much lower, is dependent upon the aspect which is north. The frequency in this part of Mungpong is as follows :—

Density per acre, all species, 38·2—

Syzygium spp. 2·35, *Schima Wallichii* 1·94, *Jambosa formosa* 1·66, *Mangifera indica* 1·50, *Michelia champaca* 1·48, *Machilus* spp. 1·22, *Cinnamomum Tamala* 1·11, *Talauma Hodgsoni* ·84, *Dysoxylum* spp. ·80, *Stereospermum tetragonum* ·78, *Myrsine semiserrata* ·74, *Symplocos* spp. ·70, *Dillenia-pentagyna* ·59 and *Duabanga sonneratioides* ·53.

Consociations.

Acrocarpus fraxinifolius W. and A. A few pure groups of this species are found in the EUGENIA-PHŒBE ASSOCIATION some two miles north of Khumani. Although this is not one of the principal species of the Association, it is the dominant species over small areas and not sub-dominant. It must, therefore, be regarded as forming Consociations and not Societies, which according to Clements* are groups of sub-dominant species—" In forest only beneath the primary layer of trees." It is interesting to note that the seed of this species appears to germinate very readily on land cleared for plantations. For example, in the Forest Department plantations in Mal Block, there is a profuse growth of young *Acrocarpus* poles within a distance of four to five hundred yards of the Gorubathan road along which a number of these trees have been planted.

Albizzia marginata Merr. Consociations of this species are found in the SHOREA-TERMINALIA-GARUGA HYLIUM and are confined to the land within a few hundred yards of the Tista River. The Consociations along the upper reaches of the river are the largest within the District and are typically found where the land at the foot of the valley is fairly flat. Although the Consociations are of small extent this tree is fairly common in the forests to an elevation of 5,000 feet.

Dillenia pentagyna Roxb. This is a medium-sized tree, very common on the plateaux and drier ridges of the Lower Hill Zone and also typical of the Savannah forest in the plains. In the hills it frequently grows to a large size and is often buttressed at the roots. The leaves, which are very large, appear after the flowers, in May. In both the SHOREA-STEREOSPERMUM and SHOREA-TERMINALIA-GARUGA ASSOCIATIONS, it is common, but is usually mixed with other species and when found with *Shorea robusta* it seems to indicate poor soil. It does, however, form Consociations, especially in the former Association. These Consociations are open and the trees are usually scattered with *Dendrocalamus Hamiltonii* Nees. in the lower storey.

Duabanga sonneratioides Ham. In the SHOREA-TERMINALIA-GARUGA HYLIUM the dominant species near the banks of streams is sometimes *Duabanga sonneratioides*. The Consociations are however always of small extent. The long pendent branches, large opposite leaves and terminal flowers make this tree very conspicuous wherever it occurs. It was undoubtedly formerly much commoner in the forests than it is to-day and its comparative scarceness is due to its popularity as a box-planking timber. It is noteworthy that it may be found more frequently than elsewhere in Ponbu Block, which is the most inaccessible part of

* Clements l.c. page 130.

Tista Range. It is also typical on land-slips in the Lower Hills and will be mentioned in this connection under Serai Communities.

Firmiana colorata R. Br. This species is rather rare but small Consociations of it are found locally in the SHOREA-STEREOSPERMUM HYLIUM, especially near the top of Lish Block and in Noam and Fagu Blocks. Like *Dillenia pentagyna* this tree is leafless during the hot season.

Jambosa ramosissima Cowan. This is an evergreen tree of medium size very common on the slopes between the Tista and Jaldhaka rivers. It grows in rather damp or shaded localities. Consociations of it are found in the SCHIMA-BAUHINIA HYLIUM and in the SCHIMA-EUGENIA ECOTONE, both in Mungpong Block, on the northern slopes of the inner valleys and, in the eastern portion of the Lower Hill Zone.

Phœbe attenuata Nees. This is a very common tree of the areas of higher rainfall in the Lower Hills. In appearance it very closely resembles *Machilus edulis* King. and is the *Aule Lapche Kawla* of the Nepalese. It forms Consociations in both the SCHIMA-BAUHINIA and EUGENE-PHŒBE ASSOCIATIONS.

Schima Wallichii Choisy. This is a large tree and one of the most widely distributed. It is the commonest species at about 4,000 feet but extends to the plains and up to 6,000 feet. In the Lower Hill Zone it is commonest at the upper levels, except in the east where, with a higher rainfall. it is common at all elevations. Consociations are found principally in the SCHIMA-BAUHINIA HYLIUM.

In the Tista valley at elevations of 2,500 to 3,000 it is sometimes mixed with *Shorea robusta* forming an Ecotone between the SHOREA-TERMINALIA-GARUGA HYLIUM and the CASTANOPSIS-SCHIMA HYLIUM of the Middle Hill Zone. At an elevation of 1,-2,000 feet, it commonly forms an Ecotone with *Stereospermum* between the SHOREA-STEREOSPERUM and SCHIMA-BAUHINIA ASSOCIATIONS in Fagu, Noam and Sakkam Blocks. In the Lower Hill Zone its optimum rainfall is from 160 to 180 inches ; on areas of lower rainfall it usually avoids dry exposed slopes.

Shorea robusta Gærtn. Sal, which is very widely distributed both in the Lower Hill Zone of the Himalayas and on well drained land in the Terai, extends also far into the Hills along the valleys of the main rivers. Consociations of this species are one of the principal features of both the SHOREA-TERMINALIA-GARUGA and the SHOREA-STEREOSPERMUM ASSOCIATIONS. *Shorea robusta*, one of the commonest and most valuable trees on the Lower Hills, grows gregariously on the ridges and extends for a considerable distance down southern and south-westerly slopes. The number of species associated with it increases with the distance from the ridge and *Shorea robusta* is seldom found in the small valleys.

In the area dominated by the SHOREA-TERMINALIA-GARUGA HYLIUM, large compact masses of Sal are found in Rungpo, Sangser, and Bhalukop Blocks. Consociations are small and few in Mangbar but are again large in Tashiding, Kamesi and Rinkingpong Blocks Southwards from the Rilli the extent of the Consociations gradually decreases till in Ponbu Block most of the Sal is scattered, there being only a few small groups. Scattered trees also decrease in numbers downwards along the Tista Valley. It is interesting to note also that from north to south as the rainfall increases, the elevation to which Sal goes decreases from about 3,500 feet in Rungpo to 1,500 feet in Ponbu.

In the SHOREA-STEREOSPERMUM HYLIUM the Consociations of Sal are smaller, partly because the soil is poorer, but chiefly because the ridges are narrower and often discontinuous and *Shorea robusta* is found principally on the crests of the ridges. A characteristic of *Shorea* Consociations in this locality is the absence of tall savanah grasses, very common as Societies in certain types of Sal forest in the Terai. The principal undergrowth in the Sal forest of the Tista Valley is bamboo-like grasses,—*Pogonantherum saccharoideum* Beauv. and *P. crinitum* Trin.

There is a very striking absence of Sal in the Kalimpong Division between the Chel and Jaldhaka rivers. In Lethi block, the easternmost block of Chel Range, it is more plentiful than elsewhere between the Tista and Chel Rivers. At the Lethi River it suddenly stops and is not found east of this area within the division, except for one or two trees at Khumani near the eastern boundary. This curious break in the distribution of this species, which is common along the whole of the foot-hills of the Himalayas, is chiefly accounted for by the geological formation. The absence of Sal coincides with what is said to be the only gap in the Tertiary Series along the whole front of the mountain range. The Nahan series ends abruptly at the Chel River and the Dalings abut on to the alluvial plateaux, which here reach an elevation of nearly 2,000 feet. At the same time the hills at this point recede some five miles further north. Another factor which plays some part in checking the spread of Sal beyond the Lethi is the rainfall. It increases eastwards from the Tista and in the vicinity of the Lethi is about 160 inches, making suitable conditions for heavy evergreen forest, which in any case, in this area, tends to encroach on Sal forest when the latter is not periodically burnt. The few Sal trees near Khumani cannot be regarded an strays from the Lethi area some 20 miles away, but mark the northern limits of *Shorea robusta* in the Jalpaiguri District. This is fairly conclusive for proceeding south from Khumani, Sal gradually becomes more frequent and at some five miles' distance it may be found in considerable quantities.

Mr. Gamble's map opposite page 4 shows a very much larger area dominated by Sal than is at present found. Although the map is undoubtedly not very accurate and exaggerates the extent of the Sal

forests in 1875, it is probable that Sal was decreasing until about 1895 when restrictions on felling were introduced. During the past 20 years there has been a slight increase in the total number of trees. This is borne out by the figures of the recent and previous Forest Working Plans and the increase is certainly due to measures of conservancy enforced by the Forest Department.

Sterculia villosa Roxb. This is fairly large deciduous tree very typical of the dry mixed forests in the plains and on the plateaux near the foot of the hills. It forms Consociations in the SHOREA-TERMINALIA-GARUGA and SHOREA-STEREOSPERMUM ASSOCIATIONS on dry exposed slopes. It is often associated with *Dillenia pentagyna*, *Stereospermum tetragonum*, *Terminalia belerica* and *Bauhinia purpurea*. Open Consociations are found principally in Bhalukop, Tashiding, Kamesi, Ringkingpong and Lethi Blocks.

Terminalia crenulata Roth. This is one of the commonest species in the SHOREA-STEREOSPERMUM HYLIUM and is not uncommon in the SHOREA-TERMINALIA-GARUGA HYLIUM. It is a large deciduous tree and forms Consociations on dry slopes but is not confined principally to the ridges as is the case with *Shorea robusta*. Consociations of *Terminalia crenulata* are smaller than those of *Shorea robusta*, but still of fairly large extent, particularly in the Rilli valley, namely in Ringkingpong, Kamesi and Tunang Blocks. In the SHOREA-STEREOSPERMUM HYLIUM Consociations are very frequently found, especially in Mungpong, Lethi and Churonthi Blocks. This species although an excellent timber tree, has largely escaped felling on account of the extreme hardness of its wood.

Terminalia myriocarpa Heurck. and Muell. Arg. This is a large deciduous tree growing throughout the Lower Hill Zone in rather damp localities and particularly in the valleys. It is the *pani* (water) saj of the Paharias in contradistinction to *Terminalia crenulata*, *Pakha saj* or the *Saj* of the slopes. Consociations are very noticeable when the tree is in flower, the largest being found in Paren and Rungo Blocks. This locality, having a heavy rainfall, is well suited to this species, but its prevalence is probably attributable more to the fact that both these blocks are remote and have practically never been worked for timber. In the Tista Valley the largest Consociations are to be found in Mangchu Block. Elsewhere the tree must have been formerly much more common. It is one of the most popular timber trees and a very large number must have been felled and extracted during the past fifty years.

Societies.

Andropogon assimilis Steud. A gregarious grass common in the Lower Hills.

Calamus acanthospathus Griff. This cane is not very common, but it forms small Societies in the CASTANOPSIS-SCHIMA ASSOCIATION, east of the Tista, in the upper parts of Chel Range. Its scarcity is partly due to the fact that it is the stoutest and strongest species in the district.

Calamus erectus Roxb. var. **schizospaths.** A densely tufted rattan very common in both the SHOREA-TERMINALIA and SHOREA-STEREOSPERMUM ASSOCIATIONS, especially on drier slopes.

Calamus leptospadix Griff. Societies are common in the valleys, especially in very damp places where the cane forms dense thickets.

Camellia drupifera Lour. A shrub closely resembling the Tea plant and forming societies in the SHOREA-STEREOSPERMUM HYLIUM especially in Mungpong Block.

Casearia Vareca Roxb. A small shrub forming Societies along the banks of streams on the plateaux and in the valleys.

Crotalaria tetragona Roxb. A common shrub 6-8 feet high, on the drier slopes, in both the SHOREA-TERMINALIA-GARUGA and SHOREA-STEREOSPERMUM ASSOCIATIONS.

Dæmonorops Jenkinsianus Mart. Societies are common locally, especially in the valleys and damper parts of the Lower Hill Zone.

Dendrocalamus Hamiltonii Nees. This is the commonest bamboo in the Lower Hills, where it covers large tracts, to the exclusion of most other species. It forms very extensive Societies in the SHOREA-TERMINALIA-GARUGA ASSOCIATION, especially in the neighbourhood of the Tista river. In the SHOREA-STEREOSPERMUM ASSOCIATION, some 6,000 acres are covered with this bamboo, with tall trees often scattered at wide intervals. In the *Shorea* Consociations it grows under shade, does considerable damage to the Sal and effectually prevents the natural regeneration of this species. It is also exceedingly common in the SCHIMA-BAUHINIA ASSOCIATION.

Desmodium dioicum DC. A small shrub, commonly forming Societies in the SHOREA-TERMINALIA-GARUGA HYLIUM in the Tista Valley, especially in *Shorea* Consociations.

Desmodium heterocarpum DC. Societies of this plant occur everywhere from plains, level up to 4,000 feet.

Desmodium latifolium DC. Societies are found in *Shorea* Consociations.

Desmodium pulchellum Benth. This species also forms Societies in the *Shorea* Consociations in the Tista Valley, at altitudes not exceeding 2,000 feet.

Dillenia indica Linn. Small Societies are common in the valleys and in the plains in damp localities, especially near streams.

Endospermum chinense Benth. This species was only recently found at Rajabhatkhawa by Mr. Shebbeare and myself. There only two isolated trees were found. Several small Societies have, however,

been found more recently in the EUGENIA-PHŒBE HYLIUM near Khumani.

Flemingia bracteata Wight. An erect shrub, 5-10 feet high, forming Societies on the drier slopes in the Lower Hill Zone.

Flemingia congesta Roxb. Societies of this species are found especially in *Shorea* Consociations, although it is also fairly common elsewhere on the drier slopes of the Lower Hills.

Flemingia stricta Roxb. A small shrub characteristic of *Shorea* Consociations.

Gleichenia linearis Burm. A very common straggling gregarious fern in all Associations in the lower hills.

Homonoia riparis Lour. Small Societies are very common in the Tista river bed.

Imperata arundinacea Cyrill. A common thatching grass which forms Societies, especially in *Shorea* Consociations of the SHOREA-STEREOSPERMUM ASSOCIATION.

Indigofera pulchella Roxb. A handsome under-shrub common in Shorea Consociations.

Inula eupatorioides DC. A common Society in dry localities especially in the SHOREA-TERMINALIA-GARUGA ASSOCIATION, most frequently on the ridges in *Shorea* Consociations.

Jambosa praecox Cowan. A medium sized tree forming Societies, especially near streams in the EUGUNIA-PHŒBE HYLIUM.

Leea crispa Simm. A gregarious shrub common in the drier parts of the lower hills, very frequent in *Shorea* Consociations.

Leea robusta Roxb. Societies of this species are characteristic of the ridges, especially in *Shorea* Consociations.

Licuala peltata Roxb. This palm is not common, but is gregarious forming small Societies. It ascends to 6,000 feet.

Mesua ferrea Linn. This tree is only found in two localities, namely in Khumani Block and in Mal forest. Where it occurs it is gregarious over a fairly large area.

Micromelum pubescens Bl. A very strongly scented shrub, commonly forming Societies in the valleys.

Phlogacanthus thyrsiflorus Nees. Societies are common on the damper slopes, near the foot of the valleys in the SHOREA-TERMINALIA-GARUGA Association. It is an evergreen shrub with handsome flowers, occurring in large groups.

Pinanga gracilis Bl. A palm, frequently gregarious, forming small Societies in damper localities, especially in the valleys of the Lower Hill Zone.

Pseudostachyum polymorphum Munro. A common bamboo in the valleys of the lower hills, especially in the SCHIMA-BAUHINIA and EUGENIA-PHŒBE ASSOCIATIONS.

Saurauia Roxburghii Wall. A small tree, forming Societies on the banks of streams and in the valleys of the Lower Hills.

Woodfordia floribunda King. A straggling shrub fairly common in the SHOREA-TERMINALIA-GARUGA ASSOCIATION, but more so in the SHOREA-STEREOSPERMUM ASSOCIATION, *e.g.*, at the top of Lish Block. Societies are usually found in open places in the forest.

PART VII.

THE SUB-TROPICAL OR MIDDLE HILL ZONE.

Mr. Gamble in his account of the Darjeeling Forests* uses the term "Middle Hill Forests" in referring to elevations between 3,000 and 6,000 feet. He notes that "when the Forests of Darjeeling were gazetted between 1865 and 1866 all Government Forest lands above an altitude of 6,000 feet and below that of 3,000 feet were reserved and the land (between 3,000 and 6,000 feet) was held fit to be given up to cultivation."

The same policy was followed when the Reserved Forests in the Kalimpong sub-division were gazetted, with the result that it is only in the remoter Eastern portion of the area that extensive Forests occur between these elevations. In this Zone the Forests occupy an area of less than 30 square miles, there being only about 1 square mile in the Tista Valley, 4 square miles between the Chel and the Neora Rivers, about 6 square miles on Lulygaon spur and the remainder in the east of the District.

A perusal of the map accompanying Gamble's article in the Indian Forester of 1875 reproduced opposite page 4 shows that the extent of these forests, particularly in the south-west, was far larger fifty years ago than it is at present. Much the greater part of the land between elevations of 3,000 and 6,000 feet is now under cultivation. It may be said that there is now no normal forest between these elevations, other than that within the Forest Reserves. There are considerable areas where the trees have been felled for cultivation and the land has been abandoned or where most of the trees have been felled and the area is used as grazing grounds for the cattle of the neighbouring villages. The vegetation on such areas will be described.

Mr. Gamble notes that "The finest and largest specimens of Toon timber occur just in the belt we are noticing"; and speaks of "the walnut, *Juglans regia*, whose favourite habitat appears to be the lower slopes of the valley at about 5,000 feet altitude", but both these trees are now exceedingly scarce in this Zone.

The great majority of the trees are evergreen. The commonest species are *Castanopsis indica* A. DC., *Schima Wallichii* Choisy., and *Engelhardtia spicata* Bl. The first is the most frequent species between 2,500 and 3,500 feet, the second reaches its maximum frequency about 4,000 feet and the third between 5,000 and 5,500 feet.

The first two Associations to be described do not lie entirely within the zone, as they are found at elevations between 2,000 and 4,000 feet. The principal Association is the ENGELHARDTIA-CASTA-

* Gamble in the Indian Forester, Vol. I, 1875.

NOPSIS-SCHIMA-BETULA HYLIUM. There is less differentiation within this zone than in the Tropical Zone, a feature partly dependent upon the fact that there is no change in the geological formation, the whole area being on Sikkim gneiss.

Epiphytes are not nearly so common as in the Tropical Zone and mostly belong to the family Vacciniaceæ. Numerous species also of the parasitic genus *Loranthus* are found on both *Castanopsis* and *Schima*. Large climbers, too, are much less common, although there are a number of them belonging principally to the Apocynaceæ. The largest climber of the Middle Hill Zone is *Mucuna macrocarpa* Wall.

A further quotation may be given from Mr. Gamble's account.

"The European character of this Middle Hill Forest is sometimes very remarkable; in one small forest near Kalimpong the following European trees were found, though of course the species were different:— Oak, chestnut, cherry, maple, birch, alder, all of them fine large trees.

"A noticeable feature in many of these forests is the prevalence of tree ferns, Alsophilas, with tall graceful stems and feather foliage, making them at once the most conspicuous and the most beautiful of forest plants; the dense thickets of hill cane *Plectocomia Himalayana*, especially found wherever the rocks are too steep for big trees, and the multitude of large-leaved Aralias whose leaves are often much used for feeding cattle."

Associations.

(1) THE CASTANOPSIS-SCHIMA-HYLIUM.

This Association and the next are found at elevations intermediate between the Lower and Middle Hill Zones, from 2,000 to 4,000 feet, varying according to aspect. In the CASTANOPSIS-SCHIMA-ASSOCIATION *Castanopsis tribuloides* A. DC. greatly predominates, being 37 per cent. of the total number of trees on the area. *C. indica A. DC.* and *Schima Wallichii* Choisy. follow and are almost equally common, each being 13 per cent. of the total. The percentage of evergreens in this Association is much smaller than in the next, and the Association is characteristic of the slopes of the Tista Valley, wherever the forest rises above 3,000 feet, especially above the Rilli in Kamesi and Tunang Blocks. The Association is also found in the valleys of the higher parts of Chel Range, especially in Churonthi, Noam and Fagu Blocks. Graduations between this and both the SHOREA-TERMINALIA-GARUGA and SHOREA-STEREOSPERMUM ASSOCIATIONS are found, *Shorea* and *Schima* being the predominating species over small areas. The Association is found on clayey loam over-lying Sikkim gneiss and

extends to about 650 acres in the Tista Valley and 2,500 acres in Chel Range.

The percentage of the different species is as follows :—

(1) Species over 1 per cent.—

Castanopsis tribuloides A. DC. 37·2, *Castanopsis indica* A. DC. 13·4, *Schima Wallichii* Choisy. 13·0, *Bœhmeria rugulosa* Wedd. 3·8, *Ficus Cunia* Ham. 3·1, *Terminalia belerica* Roxb. 2·6, *Syzygium* spp. 2·4, *Terminalia crenulata* Roth. 1·9, *Albizzia procera* Benth. 1·9, *Callicarpa arborea* Roxb. 1·4, *Bombax malabaricum* DC. 1·4, and *Sterculia villosa* Roxb. 1·4.

(2) Species under 1 per cent. but above ·1 per cent., in order of frequency—

Machilus spp., *Bauhinia purpurea* Linn., *Heynea trijuga* Roxb., *Quercus spicata* Sm., *Bischofia javanica* Bl., *Grewia vestita* Wall., *Semecarpus Anacardium* Linn., *Cinnamomum Cecicodaphne* Meissn. (*Cedrela Toona* Roxb. and *C. microcarpa* A. DC.), *Stereospermum tetragonum* DC., *Litsœa polyantha* Juss., *Terminalia Chebula* Retz., *Erythrina stricta* Roxb., (*Kydia calycina* Roxb. and *K. jujubifolia* Griff.), *Terminalia belerica* Roxb., *Gmelina arborea* Linn., (*Garuga pinnata* Roxb. and *G. Gamblei* King), *Albizzia marginata* Merr., *Terminalia myriocarpa* Heurck. and Muell. Arg., *Firmiana colorata* R.Br., *Prunus cerasoides* Don., *Spondias mangifera* Willd., *Ficus religiosa* Linn., *Albizzia odoratissima* Benth., *Elæocarpus* spp., *Mallotus phillipinensis* Muell. Arg., *Meliosma simplicifolia* Walp., *Oroxylum indicum* Vent., *Eurya* spp., (*Phœbe Hainesiana* Br. and *P. attenuata* Nees.), *Bridelia* spp., and *Duabanga sonneratioides* Ham.

(2) THE SCHIMA-CASTANOPSIS-PHŒBE HYLIUM.

Although this Association and the former are closely allied, two of the principal species being the same, there is a considerable difference in the subordinate species, there being a very much higher percentage of evergreens in the Association now described. At the same time the frequency of the dominant species is different. *Schima Wallichii* Choisy. is the commonest, forming 26 per cent. of the crop, *Castanopsis indica* A. DC. remains second in frequency, but *Phœbe Hainesiana* Br. and *P. attenuata* Nees. come third and *Castanopsis tribuloides* A. DC. only fourth at 4·5 per cent., instead of first at 37 per cent. The additional number of evergreen species gives the Association a distinct appearance from the former. It occurs at the same altitudes but in regions of higher rainfall, *viz.*, above 160 inches per annum. The Association is found

principally in Dalingkot, Ambiok, Rungo and Paren Blocks, occupying altogether about 4,000 acres.

The percentage composition is as follows :—

(1) Species over 1 per cent.—

Schima Wallichii Choisy. 25·9, *Castanopsis indica* A. DC. 8·7, (*Phœbe attenuata* Nees. and *P. Hainesiana* Br.) 4·7, *Castanopsis tribuloides* A. DC. 4·5, *Bauhinia purpurea* Linn. 4·1, *Stercospermum tetragonum* DC. 3·1, *Phœbe lanceolata* Nees. 2·6, *Michelia champaca* Linn. 2·5, (*Cedrela Toona* Roxb. and *C. microcarpa* A. DC.) 2·1, *Erythrina stricta* Roxb. 2·0, *Duabanga sonneratioides* Ham. 1·8, *Eurya* spp. 1·7, *Macaranga* spp. 1·5, *Turpinia pomifera* DC. 1·4, *Machilus* spp. 1·4, *Beilschmiedia* spp. 1·4, *Ailanthus grandis* Prain. 1·4, *Callicarpa arborea* Roxb. 1·2, *Helicia erratica* Hk. f. 1·2, *Meliosma simplicifolia* Walp. 1·2, *Quercus spicata* Sm. 1·1, *Terminalia myriocarpa* Heurck. and Muell. Arg. 1·0 and *Jambosa ramosissima* Cowan. 1·0.

(2) Species under 1 per cent. but over ·1 per cent., in order of frequency—

Anthocephalus indicus A. Rich., *Gynocardia odorata* R. Br., *Dysoxylum* spp., *Cordia obliqua* Willd., *Cinnamomum Cecicodaphne* Nees., *Bauhinia purpurea* Linn., *Albizzia odoratissima* Benth., *Engelhardtia spicata* Bl., *Elæocarpus* spp., (*Kydia calycina* Roxb. and *K. jujubifolia* Griff.), *Betula cylindrostachys* Wall., *Alstonia scholaris* R. Br., *Syzygium* spp., *Actinodaphne obovata* Bl., *Garcinia stipulata* T. And., *Vitex heterophylla* Roxb., *Talauma Hodgsoni* Hk. f. and *T., Mallotus phillipinensis* Muell. Arg., (*Myrsine capitellata* Mez. and *M. semiserrata* Wall.), *Hovenia dulcis* Thunb., *Gmelina arborea* Linn., *Styrax* spp., (*Drypetes lancifolia* Pax. and *Premna* spp.), (*Aporosa dioica* Muell. Arg. and *Casearia glomerata* Roxb.), *Litsæa* spp., (*Macropanax* and *Brassaiopsis* spp.), *Laurocerasus acuminata* Roem., *Ostodes paniculata* Bl., *Wendlandia tinctoria* DC., *Litsæa polyantha* Juss., *Albizzia marginata* Merr., *Aesculus punduana* Hiern., *Albizzia procera* Benth., *Ficus glomerata* Roxb., *Ficus nemoralis* Wall., (*Garuga pinnata* Roxb. and *G. Gamblei* King.), *Glochidion* spp., *Morus lævigata* Wall., *Michelia champaca* Linn., *Holarrhena antidysentrica* Wall., *Ficus Benjamina* Roxb., *Terminalia crenulata* Roth., *Sterculia villosa* Roxb., *Cephalanthes occidentalis* Linn., *Polyalthia simiarum* Benth. and Hk. f., *Jambosa formosa* Walp., *Mangifera indica* Linn. and *Acrocarpus fraxinifolius* W. and A.

(3) THE ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA HYLIUM.

The ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA HYLIUM is characteristic of the greater part of the Sub-tropical Zone, and, except where the rainfall is exceedingly heavy, it is the only Association found at elevations between 4,000 and 6,000 feet. This Association is characterised by the high percentage of *Engelhardtia spicata* Bl., *Castanopsis tribuloides* A. DC., *Schima Wallichii* Choisy. and *Betula cylindostachys* Wall. The frequency of these four species depends chiefly upon elevation. *Engelhardtia* usually takes premier place at elevations above 5,000 feet, and below this elevation *Castanopsis tribuloides* followed by *Schima*.

As has already been pointed out the greater part of the land between these elevations is under cultivation, so that at one time this Association would have occupied a very much larger area than it does at present. It is found chiefly on Lulygaon spur and in the east of the area, covering, altogether about 15,000 acres, the underlying rock being Sikkim gneiss and the soil a fertile clayey loam with a moderately deep layer of humus. Two series of percentage figures are given, showing the changes in the relative frequency of the dominants below and above 5,000 feet.

(*a*) Below 5,000 feet.

(1) Species over 1 per cent.—

Castanopsis tribuloides A. DC. 16·2, *Engelhardtia spicata* Bl. 15·0, *Betula cylindrostachys* Wall. 11·0, *Schima Wallichii* Choisy. 8·6, *Alnus nepalensis* D. Don. 7·7, (*Macropanax* and *Brassaiopsis* spp.) 3·4, *Talauma Hodgsoni* Hk. f. and T. 2·4, *Reevesia pubescens* Mast. 2·2, (*Cinnamomum caudatum* Nees. and others) 2·0, (*Macaranga* and *Mallotus* spp.) 2·0, *Hovenia dulcis* Thunb. 1·8, *Acer Thomsoni* Miq. 1·5, (*Cedrela Toona* Roxb. and *C. microcarpa* DC.) 1·5, *Cinnamomum Cecicodaphne* Nees. 1·2, *Sarcosperma arboreum* Ham. 1·2, *Evodia fraxinifolia* Hk. f. 1·1, *Melia composita* 1·1, *Beilschmiedia* spp. 1·1, *Castanopsis indica* DC. 1·0.

(2) Species under 1 per cent. but over ·1 per cent., in order of frequency—

Ficus Roxburghii Wall., *Elæocarpus* spp., *Nyssa javanica* Wangerin., *Alstonia scholaris* R. Br., *Dysoxylum* spp., *Cinnamomum obtusifolium* Nees., *Litsæa* spp., *Acrocarpus fraxinifolius* W. and A., *Ficus elastica* Roxb., *Gynocardia odorata* R. Br., *Terminalia Chebula* Retz., (*Phœbe Hainesiana* R. Br. and *P. attenuata* Nees.), *Semecarpus Anacardium* Linn., *Turpinia pomifera* DC., *Jambosa Kurzii* Cowan., *Machilus edulis*

King., *Quercus lanceæfolia* Roxb., *Callicarpa arborea* Roxb., *Ostodes paniculata* Bl., *Morus lævigata* Wall., *Meliosma simplicifolia* Walp., *Eurya* spp., *Syzygium claviflorum* Wall., *Ficus Cunia* Ham., *Albizzia marginata* Merr., *Acer Campbellii* Hk. f. and T., *Quercus spicata* Sm., *Brassaiopsis* spp., *Styrax* spp., *Ficus Benjamina* Linn., *Odina Wodier*, *Prunus nepaulensis* C. K. Schn., *Cordia obliqua* Willd., *Ailanthus grandis* Prain., *Grewia vestita* Wall., *Albizzia procera* Benth., *Machilus* spp., *Helicia erratica* Hk. f., *Aporosa dioica* Muell. Arg. and *Vitex heterophylla* Roxb.

(*b*) Above 5,000 feet.

(1) Species over 1 per cent.—

Engelhardtia spicata Bl. 19·1, *Castanopsis tribuloides* A. DC. 13·3 *Schima Wallichii* Choisy. 7·8, *Machilus* spp. 4·4, (*Betula alnoides* Ham. and *B. cylindrostachys* Wall.) 4·0, *Eurya* spp. 4·0, *Cinnamomum obtusifolium* Nees. 3·8, *Michelia Cathcartii* Hk. f. and T. 3·7, *Machilus edulis* King. 3·1, *Nyssa javanica* Wangerin. 2·8, (*Macaranga* and *Mallotus* spp.) 2·5, *Reevesia pubescens* Mast. 2·5, *Elæocarpus lanceæfolius* Roxb. 2·4, *Ehretia Wallichiana* Hk. f. and T. 1·9, *Beilschmiedia* spp. 1·8, *Symplocos* spp. 1·7, (*Brassaiopsis* spp. and other Aralias.) 1·3, *Acer lævigatum* Wall. 1·1, *Pyrularia edulis* A. DC. 1·0.

(2) Species under 1 per cent. but over ·1 per cent., in order of frequency—

Prunus nepaulensis C. K. Sch., *Alnus nepalensis* D. Don., *Magnolia Campbellii* Hk. f. and T., *Litsæa* spp., *Bucklandia populnea* R. Br., *Evodia fraxinifolia* Hk. f., *Glochidion* spp., *Wendlandia puberula* DC., *Morus lævigata* Wall., *Saurauia napaulensis* DC., (*Eriobotrya petiolata* Hk. f., *E. dubia* and *E. bengalensis* Hk. f.), *Cedrela febrifuga* Bl., *Quercus lineata* Bl., *Ficus nemoralis* Wall., *Acer Thomsoni* Miq., *Machilus odoratissima* Nees., *Andromeda ovalifolia* Wall., *Drypetes lancifolia* Pax and K. Hoffm., *Jambosa Kurzii* Cowan., *Hovenia dulcis* Thunb., *Croton Tiglium* Linn., *Erythrina arborescens* Roxb., *Turpinia nepalensis* Wall., *Echinocarpus dasycarpus* Benth., *Helicia erratica* Hk. f., *Meliosma Thomsoni* King., *Vitex heterophylla* Roxb. and *Heynea trijuga* Roxb.

The density per acre is usually high. The local variation in frequency of the different species in different areas is shown by the following examples.

(i) Damsong.

Density per acre 79·7—

Castanopsis tribuloides, 10·2, *Michelia Cathcartii*, 8·78, *Engelhardtia spicata* 7·53, *Quercus fenestrata* 5·56, *Litsæa* spp. 3·96, (*Macaranga* and *Mallotus* spp.) 3·61, *Schima Wallichii* 2·86, *Betula* spp. 2·58, *Magnolia Campbellii* 1·78, *Symplocos* spp. 1·45, *Prunus nepalensis* 1·43, *Machilus edulis* 1·41, *Nyssa javanica* 1·40, *Elæocarpus lanceæfolius* 1·36, *Eurya* spp. 1·35, *Beilschmiedia* spp. 1·35, *Acer lævigatum* 1·12, *Reevesia pubescens* 1·03, *Cinnamomum obtusifolium* ·89, *Meliosma Thomsoni* ·68, *Casearia glomerata* ·65, *Brassaiopsis* spp. ·63, *Quercus lineata* ·61, *Turpinia nepalensis* ·54, and *Castanopsis indica* ·5.

(ii) Saihur.

Density per acre 60·4—

Castanopsis indica 9·7, *Alnus nepalensis* 9·7, *Betula* spp. 8·32, *Engelhardtia spicata* 4·84, *Schima Wallichii* 3·62, *Reevesia pubescens* 3·20, (*Macaranga* and *Mallotus* spp.) 2·86, *Cedrela febrifuga* 1·60, *Brassaiopsis* spp. 1·26, *Litsæa* spp. 1·15, *Nyssa javanica* 1·11, *Machilus edulis* 1·11, *Cinnamomum obtusifolium* 1·11, *Evodia fraxinifolia* 1·06, *Talauma Hodgsoni* 1 04, and *Acer Thomsoni* ·62.

(iii) Bokhim.

Density per acre 74·8—

Engelhardtia spicata 15·82, *Castanopsis tribuloides* 13·60, *Schima Wallichii* 7·60, *Betula* spp. 4·42, *Machilus* spp. 3·04, *Cinnamomum obtusifolium* 2·52, *Eurya* spp. 2·16, *Nyssa javanica* 2·12, *Alnus nepalensis* 1·89, (*Macaranga* and *Mallotus* spp.) 1·76, *Machilus edulis* 1·58, *Beilschmiedia* spp. 1·41, *Brassaiopsis* spp. 1·38, *Reevesia pubescens* 1·19, *Elæocarpus lanceæfolius* ·91, *Evodia fraxinifolia* ·88, *Symplocos* spp. ·82, *Michelia Cathcartii* ·79, *Pyrularia edulis* ·71, *Prunus nepalensis* ·57, *Bucklandia populnea* ·56, and *Acer lævigatum* ·51.

(iv) Kafir.

Density per acre 76·2—

Betula spp. 8·3, *Engelhardtia spicata* 7·85, *Castanopsis tribuloides* 5·15, *Schima Wallichii* 4·64, *Alnus nepalensis* 4·2, *Brassaiopsis* spp. 3·92, *Talauma Hodgsoni* 2·6 (*Cinnamomum caudatum* and others) 2·57, *Nyssa javanica* 2·52, *Macaranga* spp. 2·17, *Reevesia pubescens* 1·79, *Hovenia dulcis* 1·76, *Acer Thomsoni* 1·75, *Machilus edulis* 1·69, *Sarcosperma arboreum* 1·53, *Cinnamomum Cecicodaphne* 1·32, *Melia composita* 1·25, *Cedrela febrifuga* 1·11, *Mangifera sylvatica* ·93, *Beilschmiedia*

spp. ·88, *Castanopsis indica* ·83, *Evodia fraxinifolia* ·79, *Acrocarpus fraxinifolius* ·77, *Gynocardia odorata* ·74, *Casearia glomerata* ·74, *Fraxinus floribunda* ·73, *Andromeda ovalifolia* ·68, *Rhus* spp. ·68, *Cinnamomum obtusifolium* ·63, *Dysoxylum* spp. ·63, *Echinocarpus dasycarpus* ·57, and *Litsæa* spp. ·5.

(4) THE OSTODES HYLIUM.

At elevations between 4,000 and 6,000 feet, in localities exposed to the full force of the monsoon and consequently having a heavy rainfall, the OSTODES HYLIUM may be found. The extent of this Association is small. It is found in parts of Mo Block, and on the south-east slopes of Lulygaon ridge, especially in Bokhim Block.

The percentage composition is as follows :—

(1) Species over 1 per cent.—

Ostodes paniculata Bl. 11·5, *Machilus* spp. 8·1, *Beilschmiedia* spp. 5·8, *Andromeda ovalifolia* Wall. 5·2, *Schima Wallichii* Choisy. 4·6, *Engelhardtia spicata* Bl. 4·6, *Terminalia Chebula* Retz. 4·3, (*Macaranga* and *Mallotus* spp.) 3·7, *Aglaia perviridis* Hiern. 3·7, *Meliosma simplicifolia* Walp. 3·6, *Cedrela febrifuga* Bl. 3·4, *Betula* spp. 3·3, *Jambosa Kurzii* Cowan. 3·3, *Ehretia Wallichiana* Hk. f. and T. 2·5, *Elæocarpus lanceæfolius* Roxb. 2·5, *Turpinia nepalensis* Wall. 2·4, (*Brassaiopsis* and *Schefflera* spp.) 2·1, *Sterculia lancæfolia* Roxb. 2·0, *Syzygium claviflorum* Wall. 2·0, *Litsæa* spp. 1·8, *Talauma Hodgsoni* T. And. 1·7, *Gynocardia odorata* R. Br. 1·6, *Nyssa javanica* Wangerin. 1·6, *Casearia glomerata* Roxb. 1·5, *Machilus edulis* King. 1·4, *Castanopsis tribuloides* A. DC. 1·2 and *Rhus* spp. 1·1.

(2) Species under 1 per cent. but over ·1 per cent., in order of frequency—

Castanopsis indica A. DC., *Sarcosperma arboreum* Hk. f., *Acer Campbellii* Hk. f. and T., *Quercus spicata* Sm., *Laurocerasus acuminata* Roem., *Quercus lanceæfolia* Roxb., *Quercus lineata* Bl., *Michelia Cathcartii* Hk. f. and T., *Glochidion* spp., *Ficus Roxburghii* Wall., *Cinnamomum obtusifolium* Nees., *Eurya* spp., *Terminalia myriocarpa* Heurck. and Muell. Arg., *Wendlandia puberula* DC., *Bridelia* spp., *Ailanthus grandis* Prain., *Helicia erratica* Lk. f., *Ficus Cunia* Ham., *Elæocarpus* spp., *Hovenia dulcis* Thunb. and *Morus lævigata* Wall.

Consociations.

Alnus nepalensis D. Don. This tree, which is very characteristic of secondary growth forest, is the dominating species over certain areas. Consociations of it, in Climax Communities, are typically found near streams. It grows rapidly and is commonest in the ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA HYLIUM.

Betula cylindrostachys Wall. This species sometimes attains a large size and usually grows gregariously, forming Consociations which are sometimes of considerable extent. Consociations occur most commonly in the ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA ASSOCIATION but they frequently extend downwards to 3,000 feet or even lower and may be found in the other Associations of the Middle Hill Zone. At the lower elevations, however, the Consociations are less extensive. Occasional trees are found even on the plains. The Consociations are usually found on the ridges and can be easily recognised from a distance when the tree is leafless. The largest Consociations are in West Nar Block; others are found in Ambiok, Dalingkot and Fagu Blocks. They are not uncommon on parts of Lulygaon ridge, and are occasionally observed in the Tista Valley, principally in Bhalukop and Tunang, in the CASTANOPSIS-SCHIMA HYLIUM.

Societies.

Æchmanthera tomentosa Nees. A small gregarious shrub of the CASTANOPSIS-SCHIMA ASSOCIATION, which flowers at irregular intervals.

Dichroa febrifuga Lour. A shrub, with conspicuous blue flowers, exceedingly common, most frequently growing gregariously. Societies are found in the ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA ASSOCIATION, and it forms the chief undergrowth in open places in the forest below 6,000 feet.

Dendrocalamus sikkimensis Gamble. This bamboo is not nearly so common as *D. Hamiltonii* is in the Lower Hill Zone but Societies are not infrequent in the forests of the Middle Hills.

Eurya japonica Thunb. Open Societies of this small tree are very common in the ENGELHARDTIA CASTANOPSIS-SCHIMA-BETULA ASSOCIATION and, mixed with *Schima Wallichii*, this species is one of the commonest on abandoned cultivation at these elevations.

Helicia erratica Hk. f. This species, a medium-sized tree, is found at elevations between 2,000 and 6,000 feet, forming Societies in the CASTANOPSIS-SCHIMA HYLIUM. There is an extensive open Society in Rinkingpong under Durbin Dara. It is common also in open ground.

Lastrea dissecta Forst. A very large fern with fronds up to 9 feet long. Very common at elevations between 4,000 and 7,000 feet.

Maesa Chisia Don. This species is a straggling shrub which grows gregariously and is extremely common between 3,000 and 6,000 feet, although it extends at least 1,000 feet above and below these elevations. Societies are frequent, especially in the ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA ASSOCIATION and then frequently on sites which have been occupied by graziers' *bathans*. On abandoned cultivation, Societies are extensive and very characteristic, where the shrub is almost always gregarious, growing in dense masses.

Neillia thyrsiflora D. Don. A common shrub in open dry places.

Plectocomia himalayana Griff. A scandent rattan very common from 4,000 to 7,000 feet.

Reinwardtia trigyna Planch. This shrub is fairly common in the CASTANOPSIS-SCHIMA ASSOCIATION and forms Societies, particularly on southern aspects.

Rhus semialata Murr. This is a small tree commonly forming Societies near the forest boundaries but especially in open ground or abandoned cultivation.

PART VIII.

THE TEMPERATE OR UPPER HILL ZONE.

The Temperate Zone ranges from an elevation of 6,000 to 12,000 feet. The forests of this Zone within the District extend to an area of 78 square miles, and reach an elevation of 10,400 feet on Rechi La, the highest point in the District and one of the passes to Bhutan. An elevation of about 7,000 feet marks the limit of cultivation. Even above 6,000 feet the area cultivated is small, the vegetation being almost entirely forest. The geological formation is again Sikkim gneiss throughout and the soil a rich clayey loam.

During the rainy season the humidity is greater and more constant than in the lower zones and for three to four months the hills at this level are enveloped in mist. Owing to the great humidity the trees in this Zone are covered with mosses and Lichens which give them a shaggy appearance. This shagginess of the trees is a very striking characteristic of the Zone.

The chief differentiation in the vegetation is according to altitude. From 6,000 to 7,000 feet *Machilus edulis* King. and *Michelia Cathcartii* Hk. f. and T. are the commonest trees. The undershrubs are often gregarious forming extensive Societies. Above 7,000 feet there are Oak forests. *Quercus lamellosa* Smith. covers most of the ridges, with Laurels, *Acer Campbellii* Hk. f. and T., *Echinocarpus dasycarpus* Benth. and Magnolias on the slopes.

From 8,000 to 9,000 feet *Quercus pachyphylla* Kurz. is the principal species. The trees are of enormous size and frequently hollow. At this elevation the undergrowth is principally bamboo, several species of the genus *Arundinaria* being common.

Scattered Rhododendrons are found from an altitude of about 8,000 to 9,000 feet. From 9,000 feet upwards they grow gregariously with *Arundinaria* as undergrowth or sometimes, when the area has been burnt. Arundinarias are the only species with no Rhododendrons above them. The area of Rhododendron forest on the Rechi La is very small compared with the areas on Tonglu and in Sikkim, for it is only the lower limits of the Rhododendron belt that are reached. The stunted Rhododendrons so typical of the upper ranges in Sikkim are entirely absent.

Conifers, too, which are typical of the higher levels on the Tonglu-Sundakphu ridge and more so at similar elevations in Sikkim are practically absent in the Kalimpong Division, being represented only by a few isolated groups.

Associations.

(1) THE MACHILUS-MICHELIA HYLIUM.

This Association occurs almost universally at elevations between 6,000 and 7,000 feet. It may extend down to 5,000 feet. The area covered by the Association is almost 17,000 acres, 6,000 acres being on Lulygaon spur, 6,000 on the Rissum, Khampong and Pankasari hills and 5,000 acres in the upper parts of Chichu, Mo, and in East and West Nar Blocks. *Michelia Cathcartii* Hk. f. and T. and *Machilus edulis* King. are the commonest trees ; in some areas the first predominates, in others the second.

Under the dominants there are many smaller trees in the second storey. *Eurya acuminata* DC., *Symplocos theæfolia* Ham., *S. ramossisima* Wall. many Aralias, several species of *Ilex, Acer Thomsoni* Miq., *Turpinia nepalensis* Wall., *Hydrangea anomala* Don., *Mahonia sikkimensis* Takeda. and *M. acanthifolia* G. Don. being most often found. Under these again are herbaceous undershrubs which are frequently gregarious. Many species of *Strobilanthes*, Balsams, Begonias, Nettles, Thunbergias and Selaginellas are the commonest. Sometimes the lower storey consists entirely of small bamboos, particularly Arundinarias.

The percentage composition, where *Machilus edulis* is commonest is as follows :—

(1) Species over 1 per cent.—

Machilus edulis King. 12·3, *Michelia Cathcartii* Hk. f. and T. 8·1, *Engelhardtia spicata* Bl. 7·2, *Schima Wallichii* Choisy. 4·6, *Beilschmiedia* spp. 4·6, *Ehretia Wallichiana* Hk. f. and T. 3·0, *Eurya* spp. 3·0, *Castanopsis tribuloides* A. DC. 2·7, *Prunus nepalensis* C. K. Sch. 2·7, (*Brassaiopsis* and *Macropanax* spp.) 2·6, *Mallotus nepalensis* Muell. Arg. 2·5, *Betula alnoides* Ham. 2·5, *Symplocos* spp. 2·4, *Acer Thomsoni* Miq. 2·3, *Magnolia Campbellii* Hk. f. and T. 2·0, *Cinnamomum obtusifolium* Nees. 1·7, *Quercus spicata* Sm. 1·7, *Casearia glomerata* Roxb. 1·7, *Litsæa* spp. 1·5, *Machilus* spp. 1·5, *Vitex heterophylla* Roxb. 1·5, *Nyssa javanica* Wangerin. 1·4, *Acer lævigatum* Wall. 1·3, *Cedrela febrifuga* C. DC. 1·3, *Saurauia napalensis* DC. 1·3, *Acer Campbellii* Hk. f. and T. 1·3, *Reevesia pubescens* Mast. 1·2, *Alnus nepalensis* Don. 1·2.

(2) Species under 1 per cent. but above ·1 per cent., in order of frequency :—

Glochidion spp., *Juglans regia* Linn., *Croton Tiglium* Linn., *Meliosma Thomsoni* King., *Quercus lanceæfolia* Roxb., *Elæocarpus lanceæfolius* Roxb., *Macaranga pustulata* King., *Echinocarpus dasycarpus* Benth., *Acrocarpus fraxinifolius*

W. and. A., *Turpinia nepalensis* Wall., *Leucosceptrum canum* Sm., *Bucklandia populnea* R. Br., *Actinodaphne sikkimensis* Meissn., *Michelia excelsa* Bl., *Heynea trijuga* Roxb., *Andromeda ovalifolia* Wall., *Symplocos spicata* Roxb., *Quercus lineata* Bl., *Evodia fraxinifolia* Hk. f., *Ficus nemoralis* Wall., *Castanopsis indica* A. DC. and *Rhus* spp.

Where *Michelia Cathcartii* is commonest the percentages are—

(1) Species over 1 per cent.—

Michelia Cathcartii Hk. f. and T. 16·6, *Machilus edulis* King. 7·6, *Litsœa* spp. 7·4, *Quercus fenestrata* Roxb. 7·1, *Castanopsis tribuloides* A. DC. 6·0, (*Brassaiopsis* and *Macropanax* spp.) 3·8, *Symplocos* spp. 3·8, *Prunus nepalensis* C. K. Sch. 3·6, *Acer Campbellii* Hk. f. and T. 2·6, *Beilschmiedia* spp. 2·6, *Schima Wallichii* Choisy. 2·6, *Nyssa javanica* Wangerin. 2·5, *Machilus* spp. 2·5, *Ehretia Wallichiana* Hk. f. and T. 2·5, *Betula alnoides* Ham. 2·2, *Meliosma Thomsoni* King. 2·0, *Magnolia Campbellii* Hk. f. and T. 1·8, *Acer lœvigatum* Wall. 1·7, *Echinocarpus dasycarpus* Benth. 1·6, *Cinnamomum obtusifolium* Nees. 1·3, *Castanopsis indica* A. DC. 1·2, *Eurya* spp. 1·2, and *Magnolia Campbellii* Hk. f. and T. 1·2.

(2) Species under 1 per cent. but above ·1 per cent., in order of frequency :—

Casearia glomerata Roxb., *Quercus lineata* Bl., *Glochidion* spp., *Turpinia nepalensis* Wall., *Cinnamomum obtusifolium* Nees., *Michelia excelsa* Bl., *Croton Tiglium* Linn., *Saurauia nepalensis* Don., (*Macaranga* and *Mallotus* spp.), *Prunus acuminata* Wall., *Andromeda ovalifolia* Wall., *Engelhardtia spicata* Bl., *Cedrela febrifuga* C. DC., *Reevesia pubescens* Mast., *Cinnamomum Cecicodaphne* Meissn., *Machilus* spp., *Mangifera sylvatica* Roxb., *Lindera pulcherrima* Benth., *Vitex heterophylla* Roxb., *Ficus nemoralis* Wall., *Erythrina arborescens* Roxb., *Acer Thomsoni* Miq., *Castanopsis* spp., *Alnus nepalensis* Don., *Symplocos spicata* Roxb., *Rhus insignis* Hk. f., *Evodia fraxinifolia* Hk. f., *Pyrularia edulis* A. DC., *Eriobotrya* spp. and *Sterculia lanceœfolia* Roxb.

The following figures illustrate the frequency of the species in various blocks where this association is found :—

(i) Paengaon.

Density per acre 41·88—

Cinnamomum obtusifolium 6·25, *Michelia Cathcartii* 4·97, *Machilus edulis* 3·54, *Litsœa* spp. 3·48, *Nyssa javanica* 3·35, *Quercus fenestrata* 2·50, *Engelhardtia spicata* 2·03, *Castanopsis tribuloides* 2·0, *Ehretia Wallichiana* 1·57, *Machilus* spp. 1·34,

Schefflera spp. 1·26, *Meliosma simplicifolia* 1·25, *Acer Campbellii* 1·22, *Beilschmiedia* spp. 1·18, *Eurya* spp. 1·01, *Macaranga* spp. ·94, *Elæocarpus* spp. ·54, *Echinocarpus dasycarpus* ·53, *Acer lævigatum* ·5 and *Michelia lanuginosa* ·5.

(ii) Merong.

Density per acre 75·2—

Machilus edulis 8·3, *Michelia Cathcartii* 6·66, *Engelhardtia spicata* 6·52, *Beilschmiedia* spp. 3·72, *Ehretia Wallichiana* 3·59, *Prunus nepalensis* 3·18, *Litsœa* spp. 3·12, *Acer Thomsoni* 2·84, *Castanopsis tribuloides* 2·44, *Schima Wallichii* 2·41, *Betula alnoides* 2·34, *Symplocos* spp. 2·33, *Schefflera* spp. 1·61, *Reevesia pubescens* 1·56, *Casearia glomerata* 1·48, *Vitex heterophylla* 1·43, *Cinnamomum obtusifolium* 1·39, *Alnus nepalensis* 1·35, *Cedrela febrifuga* 1·29, *Machilus* spp. 1·27, *Quercus fenestrata* 1·21, *Acer lævigatum* 1·14, *Eurya* spp. 1·07, *Juglans regia* 1·0, *Macaranga* spp. 1·0, *Croton Tiglium* ·92, *Quercus lanceæfolia* ·77, *Nyssa javanica* ·72, *Mallotus nepalensis* ·67, *Glochidion acuminatum* ·56, *Echinocarpus dasycarpus* ·65, and *Meliosma Thomsoni* ·55.

(iii) Paktham.

Density per acre 43·5—

Michelia Cathcartii 6·48, *Litsœa* spp. 4·56, *Machilus edulis* 3·72, *Symplocos* spp. 3·22, *Schima Wallichii* 2·86, *Prunus nepalensis* 2·55, *Schefflera* spp. 2·46, *Machilus* spp. 2·19, *Beilschmiedia* spp. 2·03, *Echinocarpus dasycarpus* 1·90, *Acer Campbellii* 1·44, *Quercus fenestrata* 1·28, *Ehretia Wallichii* 1·17, *Glochidion acuminatum* ·85, *Acer lævigatum* ·69 and *Castanopsis indica* ·62.

(2) THE QUERCUS HYLIUM.

Between 7,000 and 9,000 feet the dominating species are *Quercus lamellosa* Smith and *Quercus pachyphylla* Kurz. The former is the commoner at the lower level, the latter at the higher and both form Consociations of considerable extent. This Association covers about 6,000 acres in Pankassari, Rashet, Rhenok, Rechi La and Ruka Blocks.

The number of species in this Association is very much less than in those of lower levels and the number of dominating species is also small. Next in frequency to the Oaks, in the upper storey come *Acer Campbellii* Hk. f. and T., *Michelia excelsa* Bl., *Echinocarpus dasycarpus* Benth. and *Michelia Cathcartii* Hk. f. and T. The second storey contains many Laurels, principally *Machilus* and *Litsœa* spp. and other trees enumerated

below. The undergrowth is bamboo. *Arundinaria Maling* Gamble., *A. Griffithiana* Munro. and *A. Pantlingii* Gamble. are all common, the first especially at lower, the others especially at higher elevations. The bamboos grow close together. As the old culms die and fall in all directions, it is exceedingly difficult to penetrate through them. There is one path 17 miles long from Pankasari to Tode Tangta. For the whole of this distance this bamboo thicket has to be traversed and except when a vista is cut the view is entirely obscured. Elephant tracks afford a means of moving more quickly, but, even on these, continuous cutting is necessary. No enumerations were made at elevations above 8,000 feet, as the cost would have been exhorbitant owing to the remoteness of the area and the length of time which would have been necessary to penetrate through the dense bamboo undergrowth.

The frequency of species between 7,000 and 8,000 feet is as follows :—

(1) Species over 1 per cent.—

Machilus spp. 21·5, *Litsœa* spp. 16·3, *Quercus lamellosa*, Smith. 12·6, *Acer Campbellii* Hk. f. and T. 5·5, *Symplocos* spp. 5·4, *Michelia excelsa* Bl. 4·3, *Ficus nemoralis* Wall. 4·1, *Eriobotrya petiolata* Hk. f. 4·0, *Meliosma Thomsoni* King. 2·9, *Castanopsis tribuloides* A. DC. 2·8, *Prunus acuminata* Wall. 2·7, *Turpinia nepalensis* Wall. 2·6, *Brassaiopsis* spp. 2·2, *Machilus edulis* King. 1·9, *Elœocarpus lanceœfolius* Roxb. 1·3, *Michelia Cathcartii* Hk. f. and T. 1·3, *Evodia fraxinifolia* Hk. f. 1·3, *Echinocarpus dasycarpus* Benth. 1·1, *Quercus lanceœfolia* Roxb. 1·1.

(2) Species under 1 per cent. but above ·1 per cent. in order of frequency—

Beilschmiedia spp., *Lindera pulcherrima* Benth., *Prunus nepalensis* Wall., *Cinnamomum obtusifolium* Nees., *Eurya* spp., *Nyssa javanica* Wangerin., *Acer lœvigatum* Wall., *Ilex insignis* Hk. f., *Saurauia napalensis* C. K. Sch., *Castanopsis indica*, A. DC.

As the identification of the Lauraceæ is still very far from satisfactory and the first two figures include several species, it is probable that *Quercus lamellosa* is actually the commonest species. There is certainly no doubt that *Q. lamellosa* and *Q. pachyphylla* together are the most frequent of the dominants at these levels.

(3) THE RHODODENDRON HYLIUM.

The principal species in this Association are *Rhododendron arboreum* Smith. and *R. campanulatum* Don., *R. grande* Wight. forms smaller Consociations on the ridges. *Sorbus cuspidata* Hedlund. and *Andromeda*

villosa Wall. are occasionally found and *Viburnum cordifolium* Wall. is not uncommon among them in open places.

The Association is found on the slopes of the ridges leading to the Rechi La, in Ruka, Rechi La, Thosum and Rhenock Blocks, occupying altogether an area of about 3,000 acres.

The forests are very similar to those on the Tonglu-Sundakphu ridge, which have been frequently described, differing only in extent. At one time another 1,000 acres was probably covered with Rhododendron Forest but this has subsequently been destroyed by fire and bamboos (*Arundinaria* spp.) now entirely occupy this area. Part of Rhenock Block below the Rechi La is exceedingly precipitous and this, too, is covered principally with bamboos. Near the summit there is only one species, *Arundinaria racemosa* Munro.

(4) THE TSUGA-ABIES HYLIUM.

The Conifers in Kalimpong scarcely deserve the rank of an Association, as only one or two small patches are found. The total area amounts only to a few acres. They have been given Association rank, however, as considerable areas of Conifer Forest are found on Tonglu in the Darjeeling Division while in Sikkim they cover considerable areas. The only species which form small Consociations within the Kalimpong area are *Tsuga Brunoniana* Carr. and *Abies densa* Griff. In Ruka Block there are two groups of the former one on the northern slope of Thosum La, about three quarters of a mile from the summit of Rechi La, the other at the junction of Thosum La with Chumang Danda.

Consociations.

Michelia Cathcartii Hk. f. and T. Although this species seldom forms pure forest small Consociations may occasionally be found especially near Labha.

Quercus lamellosa Smith. Consociations of this species are confined to the Quercus Hylium. They occupy considerable areas at elevations between 6,000 and 9,000 feet in Kolbong, Khampong, Pankasari, Rashet, Rhenok, Paren, Mo and East and West Nar Blocks, totaling altogether about 5,500 acres. Consociations are particularly characteristic of the forests at elevations from 7,000 to 8,000 feet and are mainly on the ridges, being easily distinguished from a distance by the dark shining leaves of the trees.

Quercus pachyphylla Kurz. Consociations of this species occur also in the Quercus Hylium at elevations between 6,000 and 9,000 feet, but principally above 8,000 feet. They cover altogether an area of

about 5,000 acres, in Pankasari, Rashet, Thosum, Rechi La, and Rukha Blocks. These, too, are readily recognised from a distance by the shape and immense size of the trees, the majority of which are of great age.

Rhododendron arboreum Smith. This is the principal species in the RHODODENDRON HYLIUM and forms large Consociations which have already been described.

Rhododendron barbatum Wall. Consociations of this species are also not uncommon at the upper levels.

Rhododendron campanulatum Don. This species, which closely resembles the former, also forms Consociations at high elevations.

Rhododendron grande Wight. Small Consociations are commonly found on the ridges and may be seen in the QUERCUS HYLUM on the Damsong hills, as well as in the RHODODENDRON HYLIUM.

Tsuga Brunoniana Carr. The Consociations of this species are mentioned under the TSUGA-ABIES HYLIUM.

Societies.

Actinodaphne sikkimensis Meissn. A small tree usually much branched from the base, common in the MACHILUS-MICHELIA ASSOCIATION. Societies are very common near Algarah and on Khampong.

Ardisia macrocarpa Wall. A low, single-stemmed shrub, with brilliant red berries, very common as the undergrowth in the forests of the Lulygaon ridge and also on Damsong.

Arundinaria aristata Gamble. A small gregarious bamboo with culms 8-12 feet high and tufted stems, very common near the summit of Rechi La.

Arundinaria Griffithiana Gamble. and **Arundinaria Pantlingii** Gamble. Both species are found in Societies on the slopes below the Rechi La from an elevation of about 8,000 feet, upwards. They do not reach the summit.

Arundinaria Hookeriana Munro. This species is not so common as most of the others but occurs locally in patches. It is found below the Mo-Chichu ridge, at Pankasari and Pashiting, on the south-west slopes of Pemling and in Merong and Rashet Blocks. It is very common in Khampong and Kolbong Blocks. It completely holds the ground along the banks of streams, but elsewhere in these blocks it grows only in patches.

Arundinaria Maling Gamble. This is the commonest of the hill bamboos and over large areas between 5,000 and 9,000 feet it forms the undergrowth almost everywhere in the forest.

Arundinaria racemosa Munro. A small bamboo up to four feet high, found at elevations above 7,000 feet, where it forms extensive Societies

Berberis aristata DC. and **Berberis insignis** Hk. f. and T. These species grow gregariously and form typical Societies of open ground at elevation between 9,000 and 10,000 feet. In Kalimpong there is not much open ground in the forest at these elevations and the Societies are much smaller and much less frequent than on Tonglu where both species grow profusely.

Boehmeria polystachya Wedd. Small Societies are not infrequent near the edge of the forest and are quite common at Munsong.

Bucklandia populnea R. Br. Gamble describes this tree as perhaps the most ornamental of the Upper Hills. Small groups of these trees are not infrequently found locally, for example, on the Lulygaon ridge and on several of the spurs running down from the main Kolbong ridge.

Cephalostachyum capitatum Munro. A large common straggling bamboo, exceedingly common on the Lulygaon ridge, where it forms very extensive Societies. There are less extensive Societies in Merong and in Mo Blocks.

Croton Tiglium Linn. This species grows under the best conditions to quite a large sized tree and one or two Societies may be found in Saibur and Bokhim Blocks on the Lulygaon spur. In the open it usually only attains a height of about twenty feet and Societies occur locally on waste ground especially in the Cinchona plantations at Munsong.

Dichroa febrifuga Lour. This has already been described. In the MACHILUS-MICHELIA ASSOCIATION, Societies are very common from Algarah to Pashiting and on the Lulygaon ridge.

Edgeworthia Gardneri Meissn. A shrub often found near the edge of the forest and on open ground. It occasionally forms small open Societies. The largest I have seen is in the abandoned *Digitalis* clearings above Sureil.

Eurya japonica Thunb. Societies of this species which have already been mentioned as occurring in the Middle Hill Zone are equally common in the MACHILUS-MICHELIA ASSOCIATION.

Girardinia palmata Gaud. This is the largest of the nettles. Both this and smaller nettles, species of *Urtica* and *Laportea*, commonly form Societies in the MACHILUS-MICHELIA HYLIUM, especially in hollows.

Gleichenia glauca Hk. A very common straggling fern growing in patches and forming small Societies.

Indigofera hebepetala Benth. A common shrub forming Societies about Dumsong.

Laurocerasu acuminata Roem. A small tree which very commonly forms open Societies in the MACHILUS-MICHELIA ASSOCIATION.

Leucosceptrum canum Smith. Within the forest, Societies of this species usually indicate localities where graziers have had their resting places. Societies are frequently found in the MACHILUS-MICHELIA ASSOCIATION, but are never of any great extent.

Leycesteria formosa Wall. and **Leycesteria stipulata** Fritsch. The former species is not nearly so common as the latter, but Societies of both are found locally, usually on places which have been cleared or on open ground in the forest in the MICHELIA-MACHILUS ASSOCIATION.

Macaranga pustulata King. A small tree which forms Societies in the MACHILUS-MICHELIA ASSOCIATION.

Mæsa Chisia Don. See page 48.

Pilea smilacifolia Wedd. This is perhaps the commonest of the numerous Pileas found in these forests, many of which are gregarious and form Societies in the MACHILUS-MICHELIA ASSOCIATION.

Piptanthus nepalensis D. Don. A small shrub found with *Berberis insignis* at elevations of 9,000 to 10,000 feet in open places. It frequently grows gregariously especially after forest fires.

Pittosporum nepalensis Rehd. and Wils. A shrub very common in the undergrowth about Dumsong.

Polygonum molle Don. A large trailing shrub which frequently forms Societies more especially on freshly denuded land, on the steep banks of the 'jhoras' and on road embankments. It is common in Rissum and Khampong, and very common in Chumang, on the Lulygaon ridge.

Populus Gamblei Dode. A small or medium sized tree growing gregariously and found chiefly in the forests near Algarah.

PART IX.

SERAL COMMUNITIES.

When this survey of the Kalimpong Forests was made, attention was directed principally to the forest climax vegetation. Time was not available for a detailed investigation of the Seral Communities, which would require several years of close study before anything like complete information could be obtained. A detailed classification is therefore not attempted, but the most important are described under the following heads :—

1. SERAL COMMUNITIES IN RIVER BEDS.

When the rivers, which become roaring torrents during the rainy season, emerge from the hills to the level ground of the plateaux, they are no longer confined by the limits of a narrow valley. Consequently they often take a different course each year and considerable havoc is done to the surrounding country. Some of these rivers have, soon after leaving the hills, a bed a mile broad and this, during the cold season, is a waste of stones. Here and there in these rivers beds deposits of silt are formed and vegetation begins to appear. Such areas are first occupied by grasses, *Saccharum arundinaceum* Retz. being the commonest, and then with Associes (Seral or developmental Associations) of *Dalbergia Sisoo* Roxb. and *Acacia catechuoides* Benth. or of *Albizzia odoratissima* Benth. and *Albizzia procera* Benth. In both Associes, which may perhaps be described as the DALBERGIA-ACACIA HYLIS and the ALBIZZIA HYLIS, a shruby and herbaceous undergrowth appears, when the trees have reached a considerable height. Through this undergrowth a number of trees gradually push their way and later open deciduous forest may be formed.

So far the succession agrees with that described for the river beds of the sub-Himalayan tract by Prof. Troup.* Speaking generally, he says, that the next stage may be Sal forest which again may give place to evergreen or semi-evergreen forests, if the former is protected from fire. On the area described, Sal forest is never an intermediate stage, but there is a tendency, in fire-protected areas for deciduous forest to give place to evergreen or semi-evergreen species.

The two Associes mentioned occupy only a very small area within the Kalimpong Division in the beds of the principal rivers, the Tista, the Lish and the Chel. The whole of Mal Block, an area of over 6,000 acres, is however old river bed and it is probable that the type of forest found in this block represents a later stage in the normal succession from the ALBIZZIA and DALBERGIA-ACACIA HYLIS.

*Troup l.c. pages 307 to 309.

Gamble described the forest in Mal Block as " creeper jungle "and for want of a better term, I have called it a CONVOLVULUS MICTIUM.

This CONVOLVULUS MICTIUM is not entirely confined to Mal Block although it is there that by far the largest area is found. It appears to have arisen on river bed on which the first trees were probably *Dalbergia Sisoo* and *Acacia catechuoides*. There are still a number of trees of the former species near the edge of the area towards the Chel river. Instead of the DALBERGIA-ACACIA HYLIS directly passing to deciduous forest the process has been greatly delayed by the invasion of an enormous number of climbers the majority of which are herbaceous. The undergrowth consists principally of sprawling shrubs, *Croton caudatus* Geisel. being apparently the commonest. There are also, however, several scandent Acacias, various species of *Capparis*, especially *C. multiflora* Hk. f. and T. and *C. olacifolia* Hk. f. and T., *Derris* spp., *Dalbergia stipulacea* Roxb., *Homskioldea sanguinea* Retz., *Zizyphus apetala* Hk. f., *Munronia Wallichii* Wight. and several species of *Glochidion*. These are bound together with herbaceous or semi-herbaceous creepers. Convolvulaceæ— Argyreias and Poranas, with Puerarias, especially *P. sikkimensis* Prain., Asclepiads, *Smilax* and Mucunas. The result is an absolutely impenetrable thicket through which even an elephant can only with difficulty force a way. A number of trees with light seeds grow simultaneously with the shrubs and later over-top them. These are *Premna mucronata* Roxb., *Trema orientalis* Wall., *Bridelia* spp., *Callicarpa arborea* Roxb. and *Anthocephalus indicus* A. Rich. Most of these are shortlived and gradually a few more permanent trees manage to push their way through the entanglement. A typical CONVOLVULUS MICTIUM has large trees scattered at wide distances with the entanglement of creepers beneath. The principal of the more permanent trees which first force their way through are *Amoora Wallichii* King., *Duabanga sonnertioides* Ham., *Michelia champaca* Linn. and *Acrocarpus fraxinfolius* W. and A. on loamy clay, and *Sterculia villosa* Roxb., *Tetrameles nudiflora* R. Br. and groups of *Duabanga sonnertioides* Ham. on stony ground.

The CONVOLVULUS MICTIUM seems, however, to have sometimes arisen on land either burnt or felled for cultivation, in places where bamboos are not too frequent. Following herbaceous species the shrubs already mentioned invade such land and the sequence from this point onwards is the same. The apparent stability of the CONVOLVULUS MICTIUM is probably due more to the aggressiveness of the climbers than to favourable edaphic or climatic conditions. Although it persists on an area for a very considerable time, there is evidence to show that it eventually gives place to evergreen forest, at least where the rainfall is heavy. Gamble's map of the forests in 1875 shows that at that time " savannah " or " creeper jungle " extended approximately from the Chel to the Murti river. Even allowing that the map may not be very accurate

it is scarcely possible that so large an area would have been shown if the extent of the "creeper jungle" were the same as it is at present. The greater part of this area was probably either "creeper jungle" or "savannah" and evergreen forest has gradually been encroaching upon it particularly from the east. The CONVOLVULUS MICTIUM now scarcely extends beyond the Neora River and an examination of the areas between the CONVOLVULUS MICTIUM and the evergreen climax forest shows that evergreen trees gradually push their way through the creeper entanglement in increasing numbers and eventually become dense enough to form an upper storey with a closed canopy under which the majority of the original shrubs and climbers fail to survive. This process may be partially aided by fire protection. There is little doubt that on such areas evergreen forest is the climax community.

2. SERAL COMMUNITIES OF BURNT AREAS.

A regular system of fire protection was organised soon after the forests were reserved and this has undoubtedly had a considerable effect upon the vegetation. Fire protection in the Duars of the Jalpaiguri District is responsible for the change in the vegetation from savannah to evergreen forest over large areas and this has attracted the attention of Forest Officers, as it has been accompanied by the disappearance of young Sal forest. The process has been described by Troup and others* and need not be recorded here. Prior to 1880 the greater part of the forests in Chel Range in the Kalimpong Division must have been burnt almost annually. A considerable part of the area has in the past been "jhumed." Fires from the "jhumed" areas must have spread over many times the area of the "jhums" themselves. *Dendrocalamus Hamiltonii* Nees. is the undergrowth over large areas in these forests. As the culms of the bamboo die they become exceedingly dry in the hot weather in March or April so that if a fire is started it spreads with great rapidity. With fire protection fires are now usually only ground fires; but formerly, when fires used to spread over large areas almost annually, many of the trees, especially the smaller ones, must have been killed. These fires left the ground bare and where this happens, *Careya herbacea* Roxb., *Olax nana* Wall., *Premna herbacea* Roxb., and *Grewia sapida* Roxb. are among the first species to invade such areas. All these grow gregariously forming considerable Socies and have perennial root stocks which enable them to survive frequent fires. Where *Dendrocalamus Hamiltonii* forms the undergrowth its underground rhizomes enable it to survive a fire and new culms appear the following season. They shoot up very quickly and soon the area becomes covered with bamboos

* Troup l.c. pages 307 to 309.
Greive and Shebbeare. Indian Forester, Vol. XI. No. 4, 1904.
Glasson. Indian Forester, Vol. LIII, No. 2, 1927.

practically to the exclusion of other species. A few scattered trees may have survived or there may be none at all. *Dendrocalamus Hamiltonii* may therefore be found either as undergrowth with a fairly close canopy of trees above or it may occupy the ground to the exclusion of trees. When there are no trees the area has invariably been subjected to severe fires and has often been "jhumed" as well. Such bamboo areas may be described as DENDROCALAMIES, and this stage seems fairly stable. In open spaces, however, between the bamboo clumps, trees gradually push their way through and this process is helped by man through fire protection and the cutting of bamboos. On the other hand the succession to forest is hindered by the aggressiveness of herbaceous and semi-herbaceous creepers which often climb to the tops of the highest bamboos and in many places between the bamboo clumps form an impenetrable tangled mass similar to that of the CONVOLVULUS MICTIUM.

The evergreen forests of the Lower Hill Zone are naturally much less liable to fire than the dry deciduous forests. Fires seldom occur in the former, are never extensive and have little or no effect on the vegetation. The same remark applies to the forests of the Middle Hill Zone.

At the higher levels of the Upper Hill Zone however, where Arundinarias form a dense undergrowth in Rhododendron Forest, the dead culms of the bamboos become very inflamable in the dry season. When forest is felled for cultivation the debris is invariably cleared by burning; such fires are very liable to spread and are scarcely ever controlled. Before the forests were reserved and fire protection was introduced, considerable areas both on the Rechi La in Kalimpong and on the Tonglu ridge in Darjeeling were burnt by fires spreading from Sikkim and Nepal. The Rhododendrons which are not fire resistant were killed. The bamboos however by virtue of their underground rhizomes were again able to survive. In this way considerable areas have become covered with a dense growth of bamboos, *Arundinaria racemosa* Munro, and *A. Maling* Gamble. These grow so closely together that trees or other species, even if their seed germinates, have little or no chance of pushing their way through. The aggressiveness of the bamboo is responsible for the stability of the ARUNDINARIES.

3. SERAL COMMUNITIES OF WASTE LANDS.

When forest has been felled and the land cultivated and then abandoned a number of very typical communities are to be found. First of all herbaceous species, mostly Compositæ, grow as weeds in the crops. Then semi-herbaceous shrubs appear during the first rains and are accompanied or followed closely by larger woody species, and often by herbaceous creepers.

(*a*) *The Lower Hill Zone.*

In the Lower Hill Zone species of *Blumea* are among the first comers on such areas. Occasionally, however, *Lantana aculeata* Linn. is the only species to establish itself and large Consocies are to found on land which has been cleared and hoed for tea cultivation, in the east of the area towards Khumani. Having obtained a foot hold on fresh soil, the *Lantana* quickly spreads and has become a troublesome weed in forest plantations in this locality. It is quickly killed by shade, however, and only reaches the borders of the forest.

Large Consocies of *Calamintha umbrosa* Benth. may also be seen and this species grows so rapidly and densely that others cannot compete. *Plumbago zeylanica* Linn. and *Blumea balsamifera* DC. also invade fresh land and often form extensive Socies. Among the first shrubs to appear are those mentioned as occurring in the CONVOLVULUS MICTIUM. Large Consocies of *Croton caudatus* Geisel. are characteristic.

When cultivation is abandoned the land is usually heavily grazed and the growth of short grasses is encouraged by cleaning and burning. The Succession, which may be through CONVOLVULUS MICTIUM or direct to Forest, is therefore often checked and a number of species which are seldom found in the forest, except on abandoned village sites, become common. *Callicarpa vestita* Wall. is the most characteristic tree of waste land, but *Callicarpa arborea* Roxb., *Bombax malabaricum* DC., *Trewia nudiflora* Linn. and *Trema orientalis* Wall. are also found, the latter sometimes occurring in small Socies. The largest shrub is *Zizyphus jujuba* Linn. which grows either in solitary slumps or in dense thickets forming Consocies. *Callicarpa macrophylla* Vahl. and *Buddleia asiatica* Lour. are common.

In addition to those mentioned the following species form typical Socies on waste land in the Lower Hills. *Acacia cæsia* Willd., *Acacia concinna* DC. and *Acacia Gageana* Craib, all forming tangled thickets very difficult to penetrate on account of their thorns. *Cassia Sophera* Linn. and *Cassia Tora* Linn. both form small or sometimes fairly large Socies on waste land, particularly along road sides. *Clerodendron infortunatum* Gærtn. is a small shrub almost always gregarious and is common in waste places and on old village sites in the Terai, and in the Lower Hills. *Crotallaria striata* DC. grows gregariously in extensive Socies and is very common in the Lower Hills. *Desmodium floribundum* DC. is a very common shrub especially on abandoned cultivation. *Grewia disperma* Roxb. is found in dry places in the Lower Hills and a few small Socies of this shrub are found in waste places near the foot of the hills. *Grewia serrulata* DC. is found in Socies especially near streams. It is also very common along roadsides. *Mimosa pudica* Linn. is not uncommon in small Socies in waste places, especially on roadsides. *Osbeckia nutans* Wall. is another common species often

growing in Socies on cleared land in the Lower Hills. *Pueraria sikkimensis* Prain. is one of the commonest creepers, sprawling over shrubs on open land. *Sida cordifolia* Linn. and *Sida veronicæfolia* Linn. both occasionally form small Socies. *Solanum indicum* Linn. and *Solanum Torvum* Swartz. are common, both forming open Socies on abandoned cultivation especially on the actual sites of old villages. *Urena lobata* Linn. is a small shrub usually found in small Socies on rather poor stony soil. It is frequently found on abandoned cultivation and on roadsides.

(*b*) *The Middle Hill Zone.*

The greater part of the Waste Land Vegetation of the Middle Hills might be described as an ARTEMISIA HYLIS.

Artemesia vulgaris Linn. covers large areas where the land has been cleared. This is probably the commonest plant in the whole of the District. In the open it is usually 2 to 3 feet high but may grow much taller and its stems sometimes attain a girth of 6 to 8 inches. In places *Artemisia* grows so closely that other species cannot survive beneath, but it is usually scattered at irregular intervals with short grasses, chiefly *Eragrostis* and *Panicum* spp. forming the ground carpet. Frequently woody shrubs are found either mixed freely with the *Artemisia* or more commonly in clumps with *Artemisia* at the edges and in the intervening spaces. These shrubs usually represent a somewhat later stage in the Succession.

Large Consocies of *Mæsa macrophylla* Wall., a shrub 3 to 4 feet high, are common about 4,000 feet, especially near Kalimpong itself and cover a considerable part of the slopes of Deolo. *Mæsa Chisia* Don., which is much less local in occurrence than the former grows gregariously ousting the *Artemisia*, especially near the forest boundaries. Areas dominated by *Mæsa Chisia* are very numerous and although not as a rule extensive must amount in total to a very considerable area.

Socies of *Croton caudatus* Geisil. are not uncommon, though not nearly so extensive as in the Lower Hills. Smaller Socies are formed by *Rubus elipticus* Smith., by *Inula Cappa* DC., by *Osbeckia crinata* Benth. and by *Clerodendron bracteatum* Wall. at elevations up to 4,000 feet. *Dichroa febrifuga* Lour. very commonly forms Socies at the higher levels. Over certain areas *Pteridium aquilinum*. Linn. is the commonest species usually growing with *Artemisia*. The beginning of the Succession to forest is marked by the presence of a number of trees, *Schima Wallichii* Choisy. and *Eurya japonica* Thun. being the commonest, the latter forming open Socies. *Ehretia Wallichii* Hk. f. and T. and *Evodia fraxinifolia* Hk. f. also are frequently found, especially the latter, which grows gregariously. *Litsæa oblonga* Wall., *Saurauia nepalensis* DC., *Helicia erratica* Hk. f., *Ficus hispida* Linn. and *Ficus Roxburghii* Wall. are also common, scattered over the area.

(c) *The Upper Hill Zone.*

In the Temperate Zone, excluding open spaces in the forest of which the principal Societies have already been mentioned, there is very little waste land within the Kalimpong Division, and it is practically all at levels below 8,000 feet. *Artemisia* persists up to this level as the commonest species on waste land and most of the Socies, already mentioned as occurring in the Middle Hill Zone, are to be found in the Upper Hill Zone also. In forest plantations at about 6,000 feet, where the land is cleared and burnt and the soil is turned over, *Ageratum conyzoides* Linn. usually appears first and completely covers the ground. The most typical shrub of waste land at elevations between 6,000 and 10,000 feet is *Viburnum erubescens* Wall. which is common everywhere and usually occurs in open Socies. *Schima Wallichii* scarcely goes above 6,000 feet, but *Eurya japonica* and *Evodia fraxinifolia* maintain their frequency up to about 7,000 feet. From this level upwards the commonest tree in waste land is *Rhus semialata* Merr. which ranges from 6,000 to 10,000 feet. *Priotropis cytisoides* W. and A. is a much branched shrub, very common about Damsong. Socies of *Leycesteria stipulata* Fritsch. are common from 7,000 to 8,000 feet. *Broussonetia papyrifera* Vent., which is spreading rapidly, is found in Socies on areas cleared in connection with Cinchona cultivation, at elevations of about 6,000 feet. *Hypericum patulum* Thunb. forms Socies in open land round Labah.

4. SERAL COMMUNITIES IN FOREST COUPES.

When virgin forest is felled and left to grow up again, the secondary growth may consist of a thicket of coppice shoots of the original species or may be totally different in floristic composition from the original forest. Very often such areas are invaded by *Macaranga denticulata* Muell. Arg. in the plains or by *Macaranga indica* Wight. at the foot of the hills. Both form extensive Consocies and reach a height of 20 to 30 feet in two or three seasons and, as their crowns form a closed canopy, the ground below is usually bare.

In other places there are numerous coppice shoots of the original species together with *Alangium begonœfolium* Bail. and *Kydia jujubifolia* Griff. and extensive Socies of *Adenanthera pavonina* Linn. or occasionally of *Acrocarpus fraxinifolius* W. and A. if seed bearers are present.

In the Middle Hills *Prunus cerasioides* Don. is one of the commonest species in secondary growth forest with Consocies of *Evodia fraxinifolia* Hk. f., *Alnus nepalensis* D. Don. and *Saurauia nepalensis* DC. Socies of *Clerodendron Colebrookianum* Walp. are common in clearings below 6,000 feet.

In the Upper Hills Consocies of *Mallotus nepalensis* Muell. Arg. are very characteristic of secondary growth forest, with *Betula alnoides* Ham. either scattered or in smaller Consocies. *Alnus nepalensis* D. Don. is also found in secondary growth forest, sometimes with *Mallotus* sometimes in pure patches.

An area of secondary growth forest on Lulygaon ridge, which had been in existence for a very long time, was enumerated and the frequency of the species occurring in the area was found to be as follows :—

1. Species over 1 per cent.—

Mallotus nepalensis Muell. Arg. 22·3, *Betula alnoides* 13·7, Aralias 8·9, *Castanopsis tribuloides* A. DC. 7·4, *Saurauia nepalensis* 6·2, *Quercus fenestrata* Roxb. 5·3, *Michelia Cathcartii* Hk. f. and T. 5·3, *Machilus* spp. 2·5, *Machilus edulis* King. 2·4, *Schima Wallichii* Choisy. 2·1, *Ehretia Wallichii* Hk. f. and T. 1·7, *Ficus Roxburghii* Wall. 1·6, *Andromeda ovalifolia* Wall. 1·4, *Bucklandia populnea* R. Br. 1·3, *Elæocarpus lanceæfolius* Roxb. 1·2, *Ficus nemoralis* Wall. 1·2, and *Magnolia Campbellii* Hk. f. and T. 1·0.

2. Species under 1 per cent. but over ·1 per cent. in order of frequency—

Prunus acuminata Wall., *Turpinia nepalensis* Wall., *Reevesia pubescens* Mast., *Glochidion acuminatum* Muell. Arg., *Cedrela febrifuga* DC., *Engelhardtia spicata* Bl., *Litsæa chartacea* Wall., *Meliosma* spp., *Alnus nepalensis* D. Don., *Echinocarpus dasycarpus* Benth., *Michelia excelsa* Bl., *Nyssa javanica* Wangerin., *Symplocos* spp., *Cinnamomum obtusifolium* Nees, and *Eurya japonica* Thunb.

5. SERAL COMMUNITIES ON LANDSLIPS.

Two Seral Communities require to be mentioned as occurring on landslips. In the Lower Hills Consocies of *Duabanga sonneratioides* Ham. are invariably to be found in such places, an occasional *Anthocephalus indicus* A. Rich. may be present and sometimes *Woodfordia fruiticosa* Kurz. forms the undergrowth when the Consocies is open.

In the Middle and Upper Hills to about 6,000 feet fresh land is frequently invaded by Socies of *Polygonum* especially *Polygonum molle* Don. The typical tree of landslips is *Alnus nepalensis* D. Don., Consocies being of considerable extent when a large area has been exposed.

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MGIPC—M—IV-3-(7)—14-6-29—400

THE KALIMPONG FORESTS

SCALE 1" = 1 MILE

FURLONGS 3 6 9 2 3 MILES

SIKKIM

BHUTAN

RANG CHU

RANGPO

MANGCHO

GOVT. CINCHONA PLANTATION

KASHYEM

LINGSA

LADAM

LINGSIKHA

KAGYA

MARIA BASTI

SAKYONG

DAMSONG

ICHE

PAIENGAON

SANGSER

BHALUKOP

SANGSER

PAIYUNG

PARTHAM

MERONG

RISSUM

RHENOCK

CHAK

RUKA

RASHET

RECHILA

THOSUM

TODE TANGTA

PATEN GOTAK

CHICHU

KOLBONG

KHAMPONG

DOLEPCHAN

MANGBAR

DUNGRA

ICHE

SINDEBONG

LABHA

RANKASARI

SAIHUR

CHUMANG

KALIMPONG

PUDANG

LOLE

PALA

GITDABLING

GITBYONG

SAMABYONG

PANKASARI

MC

PAREN

RILLI R.

YOKPRINGTAM

KANKIBONG

PAGAG

AMBIOK

SIYOKBHIR

TASHIDING

KAMESI

KYAFIR BOKHIM

EASTNAR

SAMSING

KUMAI

RONGO

WESTNAR

RINKIN PONG

TUNANG

SAMALBONG

SINJI

LULAGAON

PEMLING

AMBIOK T.E.

NIAZEOK

SURUK

SAMTHAR

SAMTHAR

DILINGKOT

SAKAM

FAGU

NOIAM

FAGU T.E.

SAMSING T.E.

KUMAI T.E.

KHUMANI

CHILAUNI T.E.

YONGTONG T.E.

NIMBONG

PABRINGTAR

GORUBATHAN

ENGO T.E.

MURTI N.

JALDHAKA R.

GUHING

PONBU

NOBONG

YONGMAKUM

LETHI

PUTHARJHORA T.E.

MAL

NEGRA R.

ZURANTEE T.E.

RAMTHI

CHURONTHI

MINGLASS T.E.

NAKHATI T.E.

MAL N.

NIDEEM T.E.

MALNADI T.E.

SYLI T.E.

GURJONG T.E.

CHEL R.

RANICHERA T.E.

LISH R.

BAGRAKOTE R.S.

MANABARI T.E.

MANGPONG

WASHABARI T.E.

BAGRAKOTE T.E.

GISH R.

UDLABARI R.S.

MAL R.S.

TISTA R.

ELLENBARI T.E.

DAM-DIM R.S.

PHULBARI T.E.

JALPAIGURI

DARJEELING

REFERENCES

BOUNDARY, PROVINCE

" DISTRICT

" BLOCK

SHOREA-TERMINALIA-GARUGA HYLIUM

SHOREA-STEREOSPERMUM HYLIUM

SCHIMA-BAUHINIA HYLIUM

EUGENIA-PHOEBE HYLIUM

CASTANOPSIS-SCHIMA HYLIUM

SCHIMA-CASTANOPSIS-PHOEBE HYLIUM

ENGELHARDTIA-CASTANOPSIS-SCHIMA-BETULA HYLIUM

OSTODES HYLIUM

MACHILUS-MICHELIA HYLIUM

QUERCUS HYLIUM

RHODODENDRON HYLIUM

DALBERGIA-ACACIA HYLIS

CONVOLVULUS-MICTIUM

DENDROCALAMIES

ARUNDINARIES

SHOREA CONSOCIATIONS

LANDSLIPS BLANKS CULTIVATION

STROBILANTHES SPP... V ARDISIA MACROCARPA... o

DICHROA FEBRIFUGA.. x POLYGONUM MOLLE... A

MALLOTUS & MACARANGA SPP mm DENDROCALAMUS HAMILTONII

CEPHALOSTACHYIUM CAPITATUM /// ARUNDINARIA HOOKERIANA

PSEUDOSTACHYUM POLYMORPHUM... ###

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