THE FORESTS OF KALIMPONG.

An Ecological Account.

BY


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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. Although both Sikkim and Bhutan were explored by Dr. Griffith and Sir Joseph Hooker early in the nineteenth century, little attention was paid to this area.

The most complete account of the vegetation of Kalimpong which has hitherto been written was published by the late Mr. J.S. Gamble in the Indian Forrester in 1875, in an article entitled "Darjeeling Forests", and yet in this article Mr. Gamble describes 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 area 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. This List was revised by myself and my wife in 1925 and is now being published 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 and is the only plan which contains a detailed description of the forests. The data given in the present work were collected mainly from 1922-1924 during the preparation of the Third Forest Working Plan and part of the material has already been published in a different form in the Plan itself. It has now been supplemented by further observations made in 1926 and it is believed that the account of the forest climax communities is fairly complete although much work still remains to be done before our knowledge of the herbaceous communities reaches the same standard. The study of the cryptogamic plants has only just been begun.
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Map.
Chapter 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 ft. The township of Kalimpong, the head-quarters of the division, is situated some five miles from the western boundary (10 miles by road) and at an elevation of 4,000 ft. 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 sq. miles, of which 206 sq. miles are Government Reserved Forests. The whole forest area has been divided into five Ranges. These are again divided into 52 blocks, distributed as follows:

<table>
<thead>
<tr>
<th>Range</th>
<th>No. of Blocks</th>
<th>Area in Acres</th>
<th>Area in Sq. Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tista</td>
<td>12</td>
<td>16,595</td>
<td>26,2</td>
</tr>
<tr>
<td>Chel</td>
<td>7</td>
<td>31,302</td>
<td>49,0</td>
</tr>
<tr>
<td>Neora</td>
<td>5</td>
<td>16,631</td>
<td>26,3</td>
</tr>
<tr>
<td>Jaldhaka</td>
<td>6</td>
<td>26,025</td>
<td>40,7</td>
</tr>
<tr>
<td>Pankasari</td>
<td>22</td>
<td>40,807</td>
<td>63,8</td>
</tr>
</tbody>
</table>

52 | 131,360 | 206,0 |

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


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 1903 and published in 1904-5. These show boundaries, interior details and contours at 25 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.
REFERENCES

FOREST MAP
KALIMPONG DIVISION
BENGAL.
Scale 4 Miles 1 Inch
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, and 6,000 ft., 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 western 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, 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 Forrester of 1875; This map, part of which is reproduced on the previous 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 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 as 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 inaccessible places. 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. The writer, accordingly, when preparing the Third Working Plan, in addition to enumerating all the Sal made a complete count of all the trees on about 10% of the accessible areas. In order that the survey might be complete from the botanical point of view, enumerations were made in the non-accessible areas, to the extent of about 2%. 
Accurate maps on a scale of four inches to the mile, contoured to every fifty 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 2 months, during which the maps were brought up to date, the area was divided into Blocks and these were subdivided into compartments, averaging about 200 acres.

It was decided that all the Sal (Shorea robusta) over 1' in diameter and over about 10% of the accessible area, every tree 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 1200 miles long in Chittagong. 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 5 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 by myself and assistants, and only in one case had the enumerators' figures to be rejected. The average error was 3.5%. Every evening the staff wrote up notes taken during the day.

A stock 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, Terminalia myriocarpa and Castanopsis indica. Some are easy to distinguish from a distance when the leaves are shed, e.g. Sterculia villosa, Tetrameles nudiflora; some by their form, e.g. Alnus nepalensis, Betula cylindrostachys, Conifers, Rhododendrons and Bamboos; some by their darker or shining leaves, e.g. Bucklandia populnea 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 stock map was prepared on a scale of 4" to a mile, but this is not available for submission. The attached map is produced from a reduced copy of the original, modified and redrawn.
During enumeration opportunity was taken to make botanical collections. These were utilized in the revision of Gamble's List.

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, the writer, while checking enumerations, made detailed notes 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.
Chapter 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 6000' 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 6000 ft., or even lower. On the Reichi 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 facing south-west have the highest rainfall. 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. In the accompanying sketch map land at an elevation of over 5000 feet has been shaded. Figures in red indicate the approximate average annual rainfall, and the effect of the configuration in modifying the rainfall may at once be seen. (vide. pg. 12.)

Kalimpong itself enjoys an equitable 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.

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 following page, Both graphs are prepared from official figures, the former from records extending over thirty seven years, the latter being the average of the past five years.

Darjeeling, at an elevation of 7000 ft., 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 the month is 35° in January and the highest 56° in July.

It has already been stated that most of the rain falls 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 be expected in May. The south-west slopes of the outer ridges have a rainfall of 200 inches, while the north-east slopes have only about 120 inches, as the clouds, on striking the ridge, 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 140 inches near the Tista to 200 inches near the Jaldhaka, increasing from east to west. The rainfall at Rungpo is 100 inches, and it gradually increases along the Tista Valley to 140 inches at Sivoke, where the Tista emerges from the hills.

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. 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 4000 ft., 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 the next page show cloud, rainfall and humidity per cent. The approximate total annual rainfall in various parts of the district is shown in the sketch map below:

The portion shaded in red is over 5,000 feet above sea level.
KALIMPONG

1. RAINFALL MEAN MONTHLY TOTAL
2. RELATIVE HUMIDITY PERCENT
3. CLOUD FROM 1 TO 8.5

JALPAIGURI

1. RAINFALL TOTAL IN DRIEST MONTH
2. MEAN MONTHLY TOTAL
3. TOTAL IN RAINIEST MONTH
4. RELATIVE HUMIDITY PERCENT
5. CLOUD FROM 1 TO 6.
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 this level the hills rise, till they reach the 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 eastern 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 western boundary of the District, separating it from Bhutan.

A useful bird's eye view of the configuration of the land is given by the accompanying photograph. A relief map, on a horizontal scale of 2" to 1 mile was made by the writer with the help of Mr. J. Lloyd, Geography Master at St. Andrews Homes, Kalimpong, and the map was then photographed.
ACTUAL SCALE 1" = 5 MILES.
3. Edaphic.

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Lithological characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent</td>
<td></td>
<td>Alluvium</td>
</tr>
<tr>
<td>Bhabar</td>
<td>Glacial</td>
<td>Enormous boulder deposits which merge into the ordinary alluvium of plains (This occurs in the area east of the Chel).</td>
</tr>
<tr>
<td>Nahan</td>
<td>Lower tertiary</td>
<td>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. Well rounded pebbles, mostly of white quartz, are commonly scattered through the sandstone.</td>
</tr>
<tr>
<td>Sikkim</td>
<td>Lower tertiary</td>
<td>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.</td>
</tr>
<tr>
<td>Gneiss</td>
<td>Eocene</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>Lithological characters</td>
</tr>
<tr>
<td>------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Damuda,</td>
<td>Carboniferous</td>
<td>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.</td>
</tr>
<tr>
<td>(Lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gondwana)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baxa series</td>
<td>Algonkian</td>
<td>Very brittle siliceous flags with pink calcareous layers inter-spersed with red shale.</td>
</tr>
<tr>
<td>Daling</td>
<td>Archaean</td>
<td>Green and grey slates, quartzites and occasionally hornblende schist. They pass insensibly into ordinary clay slates. Copper and iron deposits occur.</td>
</tr>
<tr>
<td>series</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The distribution of these series is shown in the accompanying map, on the next page.

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
Prepared for and published in The Third Working Plan of the Kalimpong Forest Division.
tufa, occur in all the formations, except the gneiss. Specially good deposits are found in Lish block.

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, where the Nahans are absent, between the Chel and the Jaldhaka, continuous ranges rise from a series of plateaux to a high altitude.

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 Nahans sandstones yield a dry sandy soil which is best suited for the growth of deciduous species.


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 falls 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 with
their crops. It 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*, 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 186 sq. miles. It is estimated that, when the land was annexed from Bhutan, there was a population of 3,530 souls, by 1901 it had increased to 41,511 and the present population is estimated at 50,093. The rapid extension is due entirely to the immigration of agriculturalists, the great bulk 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 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* 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 inaccessible and has scarcely been worked for species other
than Sal. The prevalence of *Terminalia myriocarpa* in
Paren Block and its comparative scarcity elsewhere is
attributable to the same cause. In the hills *Casta
gopsis tribuloides* 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.

Indirectly, by grazing cattle, man is responsible
for alteration in the vegetation. Areas which are con-
tinually 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, 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 consid-
erable 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 Arun-
dinarias to the exclusion of other species. Wild animals,
insects, creepers and fungi also play a minor part which
is most evident when an attempt to make plantations is
made.
Chapter IV.

THE NATURE OF 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 lower plateau to an elevation of 10,400 feet or nearly to the limit of the forests.

The principal climatic, phisiographic, edaphic and biotic factors which have influenced the forest vegetation have already been described. Placing these factors in the 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 elliptica* is one of the most universally distributed trees in the District with a range of 9,000 feet. *Artemisia vulgaris* has a range of about 8,000 feet. *Schima Wallichii* of 6,000 ft. The majority of species have a range of only 2,000 to 3,000 ft. and hence the vegetation varies in different altitudinal zones.

The configuration of the ground is important, first as it determines 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 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 unhindered 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. 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 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 must bear a different meaning than when applied to an area which can be measured in hundreds of acres or less.

(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 the system. It is for this reason that in many cases only zones or formations have been described without any attempt to

distinguish the associations or minor units. 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 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. He may still be faced with this difficulty that he has described a large number of associations which he finds can be grouped in various ways. For example groups of forest associations may be classified as forest formation in contradistinction

Clements l.c. page 128
to grassland formation, etc, or certain groups may be classed as 'deciduous' and others as 'evergreen' or certain associations may be confined to a definite geological formation, while others are constant on a different formation.

Each of these methods of grouping associations has been used by various writers and there are many other possible methods, so that the term 'formation' has been used by ecologists with various significations, depending upon habitat, physiognomy or development.

Clements points out that such classifications are "makeshifts against the time when development studies have become general".

It may be advisable for the immediate survey of the varied vegetation of the tropics to adopt terms for the various groupings and sub-groupings of associations. The application of the term 'formation' to every sort of association group, for the sake of straightforward description, is open to objection. 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 group associations according to altitudinal zones and in the absence of sufficient data regarding succession, I 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 Sub-tropical or Middle Hill Zone and 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 ft. is not represented in the Kalimpong District.

The most important of the serai communities are described in a separate chapter 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. The following diagram illustrates the distribution of the associations according to the altitudinal zones.
The Temperate or Upper Hill Zone:
- The Rhododendron Hylium

The Subtropical or Middle Hill Zone:
- The Quercus Hylium
- The Machilus-Michelia Hylium
- The Ostodes Hylium
- The Engelhardtia-Castanopsis-Schima-Betula Hylium
- The Castanopsis-Schima Hylium

The Tropical or Lower Hill Zone:
- The Shorea-Terminalia-Careya Hylium
- The Shorea-Stereospermum Hylium
- The Schima-Bauhinia Hylium
- The Eugenia-Phoebe Hylium
Chapter V.

CLIMAX COMMUNITIES.

In this chapter the principal Climax Communities are summarized. 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. In the chapters which follow, in which the Communities are described, Consociations and Societies are referred to the Associations to which they belong.

The following is a summary of the principal Climax Communities in the Kalimpong District.

The Tropical Zone.

Associations.

The Shorea-Terminalia-Garuga Hylium.
The Shorea-Stereospermum Hylium.
The Schima-Bauhinia Hylium.
The Eugenia-Phoebe Hylium.

Consociations.

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

Andropogon assimilis Steud.
Calamus acanthospathus Griff.
Calamus erectus Roxb.
Calamus leptospadix Griff.
Camellia drupifera Lour.
Casearia Vareca Roxb.
Crotalaria tetragona Roxb.
Daemonorops Jenkinsianus Mart.
Dendrocalamus Hamiltonii Nees.
Desmodium diocum DC.
Desmodium latifolium DC.
Desmodium pulchellum Benth.
Dillenia indica Linn.
Endospermum chinense Benth.
Flemingia bracteata Wight.
Flemingia congesta Roxb.
Flemingia stricta Roxb.
Gleichenia linearis Burm.
Heteroeca riparia Lour.
Imperata arundinacea Cyrill.
Indigophora pulchella Roxb.
Inula eupatrioides DC.
Jambosa praecox Cowan.
Leea crispa Simm.
Leea robusta Roxb.
Liculia peltata Roxb.
Mesua ferrea Linn.
Micromelum pubescens Bl.
Phlogacanthus thyrsiflorus Nees.
Pinanga gracilis Bl.
Pseudostachyum polymorphum Munro.
Saurauja Roxburghii Wall.
Woodfordia floribunda King.

The Sub-tropical Zone.

Associations.
The Castanopsis-Schima Hylium.
The Schima-Castanopsis-Phoebe Hylium.
The Anglehardtia-Castanopsis-Schima-
Betula Hylium.
The Ostodes Hylium.

Consociations.
Alnus nepalensis D.Don.
Betula cylindrostachys Wall.
Societies.

Aechmanthera tomentosa Nees.
Dichroa febrifuga Lour.
Dendrocalamus sikkimensis Gamble.
Hura japonica Thunb.
Helicia erratica Hk.f.

Lastrea dissecta Forst.
Maesa Chisia Don.
Neillia thyrsiflora D.Don.
Plectocormia himalayana Griff.
Reinwardtia trigyna Planch.
Rhus semialata Murr.

The Temperate Zone.

Associations.

The Machilus-Michelia Hylium.
The Quercus Hylium.
The Rhododendron Hylium.
The Tsuga-Abies Hylium.

Consociations.

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

Societies.

Berberis aristata DC.
Berberis insignis Hk.f. and T.
Boehmeria polystachya Weed.
Buchlandia populnea R.Br.
Cephalostachyum capitatum Munro.
Croton Tiglium Linn.
Dichroa febrifuga Lour.
Edgeworthia Gardneri Meissn.

Actinodaphne sikkimensis Meissn.
Aristida macrocarpa Wall.
Bordelia aristata Gamble.
Bordelia Griffithiana Gamble.
Bordelia Panthlingii Gamble.
Bordelia Hookeriana Munro.
Bordelia Maling Gamble.
Bordelia racemosa Munro.
Societies (contd.)

Jocopia japonica Thunb.
Rhipidocarpa palmata Gaud.
Idigofera hebepepetala Benth.
Idigofera acuminata Roem.
Pterospermum canum Smith.
Idigofera formosa Wall.
Idigofera stipulata Fritsch.
Stenocarpus pustulata King.
Chesia Chisia Don.
Silia smilacifolia Wedd.

Piptanthus nepalensis D.Don.
Pittosporum nepalensis Mehd. & Wils.
Polygonum molle Don.
Populus Gamblei Dode.
Rubus Andersoni Hk.f.
Rubus rosaeolius Smith.
Rubus Thomsoni Focke.
Rhus semialata Murr.
Strobilanthes spp.
Symplocos theifolia D.Don.

Symplocos ramosissima Wall.
Chapter 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 are mainly deciduous over the greater part of the area 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 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 reaches 200 ins. the forests are practically entirely evergreen and they approach Schimper's Tropical Rain Forest in character.

Taking the other important geological 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* forms 34% of the crop on the Dalings in the Tista valley, but only 13% in the Nahans and is absent on the alluvial plateaux east of the Chel River. Again *Terminalia*, *Albizia*, *Lagerstroemia parviflora*, *Bombax malabaricum* and *Cedrela Toona* are exceedingly prominent on the Dalings; *Stereospermum tetragonum*, *Dellinia pentagyna* and *Sterculia villosa* are prominent on the more xerophylic 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*, *Mangifera sylvestris*, *Glochidion lanceolarium*, *Albizia lucida* and *Garcinia stipulata*.

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 Mangpong Block on the northern slopes of the inner valleys, *Eugenia* and Laurels associated with *Michelia excelsa* and *Schima Wallichii* 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 Rangpu and proceeding down the
Tista valley to Mungpong and then eastward to Khumani. *Shorea robusta* extends as far as Lethi. *Garuga* species are frequent only in the Tista Valley. *Terminalia crenulata* follows Sal. *Stereospermum tetragonum* is frequent from Mungpong to Sakam, or between the Tista and Chel rivers. *Bauhinia purpurea* is exceedingly common from Fagu to East Nar, *Rhoeas attenuata* from west Nar to near Khumani and *Jambosa formosa* 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 160 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 *Aspidocarva uvifera* Hk.f., *Bauhinia Valhii* W. & A., *Beaumontia grandiflora* Wall.*Buettneria pilosa* Roxb., many species of *Combretum*, *Cissampelos Pareira Linn.*, *Desmos chinensis* Lour., *Entada scandens* Benth., *Hiptage Madabiotae* Gaertn., *Milletia pachycarpa* Benth., *Tinospora cordifolia* Miers.

A type of forest described by Gamble as "Creeper Jungle or "Savannah" 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 Convolvulaceae *Argyreias*, *Ipomaeas*, *Porana*, and frequently *Pueraria sikkimensis*. There are also *Smilax* spp. and several scandent *Acacias*. 
Associations.

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 Rungpu, where the Tista river first touches the District and Mungpong where it emerges on the plains. The main ridge above the Tista reaches 6,000 ft. 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 the 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 precipitious, 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:

Species over 1 per cent:

*Shorea robusta* Gaertn. 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, Lagerstroemia parviflora Roxb. 2.7, Tetrameles nudiflora R. Br. 2.6, Sterculia villosa Roxb. 2.6, Stereospernum tetrazonum DC. 2.1, (Cedrela Toona Roxb. also C. microcarpa C. DC. and C. Kingii. C. DC.) 2.1, Bauhinia purpurea Linn. 2.0, Prema species chiefly P. mucronata Roxb. 1.8, D. bananca 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, Litsaea polyantha Juss. 1.1, Semecarpus Anacardium Linn. 1.0, Mallotus philippinensis Muell. Arg. 1.0.

Species under 1 per cent and over 1 per cent in order of frequency:


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 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.

**Sangser Block.**

Density per acre -- All species -- 38.

<table>
<thead>
<tr>
<th>Species</th>
<th>Density per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorea robusta</td>
<td>7.74</td>
</tr>
<tr>
<td>(Garuga pinnata and G. Gamblei)</td>
<td>3.15</td>
</tr>
<tr>
<td>Terminalia belerica</td>
<td>1.9</td>
</tr>
<tr>
<td>Callicarpa arborea</td>
<td>1.8</td>
</tr>
<tr>
<td>Chickrasia tabularis</td>
<td>1.27</td>
</tr>
<tr>
<td>Albizzia spp.</td>
<td>1.27</td>
</tr>
<tr>
<td>Schima Wallichii</td>
<td>1.18</td>
</tr>
<tr>
<td>Bombax malabaricum</td>
<td>1.17</td>
</tr>
<tr>
<td>Terminalia crenulata</td>
<td>1.15</td>
</tr>
<tr>
<td>Amoora Rohituka</td>
<td>1.1</td>
</tr>
<tr>
<td>Premna spp.</td>
<td>1.0</td>
</tr>
<tr>
<td>Bauhinia purpurea</td>
<td>1.0</td>
</tr>
<tr>
<td>Duabanga sonneratioides</td>
<td>0.94</td>
</tr>
<tr>
<td>Gmelina arborea</td>
<td>0.51</td>
</tr>
<tr>
<td>Engelhardtia spicata</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Rinkingpong.**

Density per acre -- All species -- 33.5.

<table>
<thead>
<tr>
<th>Species</th>
<th>Density per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorea robusta</td>
<td>13.38</td>
</tr>
<tr>
<td>Castanopsis indica</td>
<td>2.42</td>
</tr>
<tr>
<td>Terminalia crenulata</td>
<td>1.71</td>
</tr>
<tr>
<td>(Garuga pinnata and G. Gamblei)</td>
<td>1.55</td>
</tr>
<tr>
<td>Terminalia belerica</td>
<td>1.43</td>
</tr>
<tr>
<td>Schima Wallichii</td>
<td>1.33</td>
</tr>
<tr>
<td>(Cedrela Toona and C. microcarpa)</td>
<td>1.17</td>
</tr>
<tr>
<td>Gmelina arborea</td>
<td>0.98</td>
</tr>
<tr>
<td>Lagerstroemia parviflora</td>
<td>0.90</td>
</tr>
<tr>
<td>Sterculia viliosa</td>
<td>0.81</td>
</tr>
<tr>
<td>Bauhinia purpurea</td>
<td>0.74</td>
</tr>
<tr>
<td>Albizzia spp.</td>
<td>0.59</td>
</tr>
<tr>
<td>Duabanga sonneratioides</td>
<td>0.56</td>
</tr>
<tr>
<td>Gmelina arborea</td>
<td>0.51</td>
</tr>
<tr>
<td>Engelhardtia spicata</td>
<td>0.5</td>
</tr>
<tr>
<td>Ámeticarpus Anacardium</td>
<td>0.54</td>
</tr>
<tr>
<td>Briedilia spp.</td>
<td>0.5</td>
</tr>
</tbody>
</table>
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.

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, Litsea polyantha .82, Boehmeria rugulosa .79, Duabanga sonneratioides .71, Castanopsis tribuloides .74, Engelhardtia spicata .60, and Gmelina arborea .55.

In Xungpu, 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 over per acre, being 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 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. 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 apicata 1.54, Cedrela Toona 1.28, Chukrasia tabularis 1.17, Litsaea polyantha 1.14, Pterospermum acerifolium 1.12, Castanopsis indica 1.09, Gmelina arborea 1.07, Schima Wallichii 1.03, (Cinnamomum caudatum and others) 0.94, Callicarpa arborea 0.91, Tetrameles nudiflora 0.89, Firmiana colorata 0.86, Duabanga sonneratioides 0.86, Ficus Cunia 0.81, Bombax malabaricum 0.81, Stereospermum tetragonum 0.72, (Garuga pinnata and G. Gamblei) 0.68, Litsaea spp. 0.67, and Styrax spp. 0.5.

The vegetation in Ponbu block might be regarded as an 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 this is again a merely local alteration in frequency rather than of floristic composition. The soil here 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 inaccessible. The frequency per acre is as follows:—

Duabanga sommeraticoides 95, Erythrina stricta 80, Pterospermum acerifolium 72, (Cephalanthus nucleides and others) 71, Croxylum indicum 68, Stereospermum tetragonum 65, Tetrameles nudiflora 64, Smeliana arborea 63, Talauma Hodgsoni 61, Semecarpus Anacardium 57, and Terminalia belerica 55.

The Shorea-Stereospermum Hylium.

This Association is characterised by the dominance of the two species Shorea robusta Gaertn and Stereospermum tetragonum DC. It differs from the Shorea-Terminalia-Garuga association by the very much smaller percentage of Shorea, viz. 13%, and the very much higher percentage and much greater prevalence of Stereospermum. Terminalia crenulata is more frequent in this Association; Terminalia belerica and Garuga pininata 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.

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 xerophilus.

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 Gaertn. 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. & T 2.3, Garuga pinnata Roxb. 2.2, Albizzia spp. 2.1, Michelia champaca Linn. 2.0, Amoora Wallichii King. 2.0, Duabanga sonneratiioides Ham. 1.8, Terminalia belerica Roxb. 1.6, Chakravatia tabularia A.Juss. 1.5, Jamboa ramosissima Cowan. 1.3, Lagerstroemia 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 Elaeocarpus aristatus Roxb. 1.0.

2. Species under 1 per cent and over 1 per cent in order of frequency:

Terminalia Chebula Retz., Jamboa 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 Grands Prain., Tetrameles nudi-

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 Stereoesperum 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.

The Schima-Pauhinia 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 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 much of the land is under cultivation, the extent of the Association being reduced on that account.

It extends from the Chel as far as the Jaldhaka River, and is found on the alluvial flats near Khumani, as well as on the lower hills.

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, Pheoebe 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, Melicoma simplicifolia Walp. 1.5, Dysoxylum spp. 1.5, Terminalia myricarpa Heurck. and Muell. Arg. 1.4, Actinodaphne obovata Bl. 1.4, Michelia Champaca Linn. 1.3, Tetrameles nudiflora R. Br. 1.2, Litsaea app. 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 0.1 per cent in order of frequency —

nalia belerica Roxb., Morus laevigata Wall., Engel-
hardtia spicata Bl., Styrax spp., Aporosa dioica Muell.
Arg., Spondias mangifera Wild., Anthocephalus indica
A. Rich., Vitex heterophylla Roxb., Crataeva unilocularis
Ham., Mallatua philippinensis Muell. Arg., Acrocarpus
fraxinifolius W. and A., Bauhinia purpurea Linn.,
Terminalia crenulata Roth., Cinnamomum obtusifolium
Nees., Litsea polyantha Juss. and Trema spp.

It will be noticed that Beilschmedia Roxb. hiana
and species of Eugenia which are the dominating trees
in the region of heavier rainfall, are on the increase.

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

**Lethi.**

Density per acre all species 4.1.

Schima Wallichii 3.63, Bauhinia purpurea .87, Stereos-
permum tetrarongum .82, Terminalia crenulata .73, Ster-
culia villosa .72, Michelia champaca .60, Jambosa ramos-
sissima .57, and *Castanopsis* tribuloides .5.

In Sakkara 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, Stereos-
permum tetrarongum 2.02, Phoebe lanceolata 1.3, (Phoebe
Hainesiana and P. attenuata.) 1.12, Sterculia villosa .78
Duabanga sonneratioides .85, Castanopsis indica .69,
Ailanthus grandis .60, and *Gedrela* spp. .55.
This block is about the centre of the area covered by this association.

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:--

(a) Density per acre all species :- 25.5.

Schima Wallichii 2.34, Bauhinia purpurea 2.0, Jambosa ramosissima 1.07, (Phoebe Hainesiana and P. attenuata). 98, Cedrela spp. 82, Garcinia stipulata 73, Stereospermum tetragonum 73, Duabanga sonneratioides 68, Terminalia myriocarpa 60, Meliosma simplicifolia 60, Ailanthus grandis 56, and Turpinia pomifera 50.

The Eugenia-Phoebe Hylium.

The Eugenia-Phoebe 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 as follows:--

1. Species over 1 per cent.

Jambosa formosa Walp. 24.1, (Phoebe Hainesiana R.Br. and P. attenuata Nees.) 20.0, (Beilschmiedia Roxburghiana Nees. and B. sikkimensis King.) 6.8, Dysoxylum spp. 5.9, Polyaltha simiarum Benth. and Hk.f. 4.0, Jambosa
Francoissima Cowan.4·0, Melicope simplicifolia Walp.3·0, Castanopsis indica A. DC. 2·8, Litsea spp.2·3, Terminalia urticarpa Heurck and Muell.Arg.1·8, Michelia Champaca Linn.1·7, Stereospermum tetragonum 1·7, Cinnamomum obtusifolium Nees.1·6, Bauhinia purpurea Linn.1·5, Strychnos spp.1·2, Treacarpus spp. 1·0.

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

Alstonia scholaris R.Br., Prumua spp., Amoora


Surrounding the region characterised by the Eugenia-Phoebe Hylum 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 Hylum and those of the Schima-Castanopsis-Phoebe Hylum of the subtropical zone.
Examples of the Schima-Eugenia ecotone are found both in East Nar to the west of the area where the Eugenia-Phoebe 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.

**East Nar:**

- Schima Wallichii 9.26
- Cinnamomum obtusifolium 2.4
- Talauma Hodgsoni 2.31
- Jambosa ramosissima 2.16
- (Phoebe 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 0.86
- Quercus spicata 0.77
- Michelia Champaca 0.68
- Jambosa formosa 0.68
- Phoebe lanceolata 0.63
- Turpinia ponifera 0.56
- Castanopsis indica 0.55
- Castanopsis tribuloides 0.54
- Dysoxylum spp. 0.54

**Paren Block:**

- Density per acre all species 43.00.
- Schima Wallichii 9.26
- Terminalia myriocarpa 2.24
- Syzygium spp. 1.75
- Castanopsis indica 1.68
- Cinnamomum Cecicodaphne 1.61
- Beilschmiedia spp. 1.58
- Litsaea lanceolata 1.42
- Cordia obliqua 1.28
- Betula cylindrostachys 1.28
- Bauhinia purpurea 1.26
- Stereospermum tetragonum 1.1
- Dysoxylum spp. 0.84
- Gynocardia odorata 0.82
- Talauma Hodgsoni 0.79
- Duabanga sonneratioides 0.63
- Erythrina stricta 0.61
- Jambosa ramosissima 0.58
- Turpinia ponifera 0.54
- Michelia Champaca 0.51

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:

(b) 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 1.46, Macnilius spp. 1.22, Cinnamomum Tamala 1.11, Talauma Hodgsoni 0.84, Dysoxylum spp. 0.80, Stereospernum tetragonum 0.78, Myrsine semiserrata 0.74, Symplocos spp. 0.70, Dillenia pentagyna 0.59 and Duabanga sonneratioides 0.53.
Acrocarpus fraxinifolius W. and A. A few pure groups of this species are found in the Eugenia-Phoebe 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 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.

Lbizzia 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 within the District are the largest 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.

Illeia 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.

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1 Clements l.c. page 130.
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 in the lower storey.

Duabanga sonneraticoides Ham. In the Shorea-Terminalia-Garuga Hylium the dominant species near the banks of streams is sometimes Duabanga sonneraticoides. 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 scarcity 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 Tista Range. It is also typical on landslips 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 Naam 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 Jalchaka 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 western portion of the Lower Hill Zone.

Phoebe 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 Eugenia-Phoebe 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 1,000-2,000 feet between the Shorea-Stereospermum and Schima-Bauhinia Associations, it commonly forms an Ecotone with Stereospermum in Fagu, Noam and Sakkam blocks. In the Lower Hill Zone its optimum rainfall is from 160-180 inches; on areas of lower rainfall it usually avoids dry exposed slopes.
Shorea robusta Gaertn. 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 3500 ft. in Rungpo to 1500 ft. in Ponbu.

In the Shorea-Stereospermum Hylium the Consociations of Sal are smaller, partly because the soil is poorer, and partly 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
savannah 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 plentiful than elsewhere between the Tista and Chel Rivers. At the Lethi River it suddenly stops and is not found west of this area within the division, except for one or two trees at Khumani near the western boundary. This curious break in the distribution of this species, which is common along the whole of the foothills 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 formation 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 2000 ft. 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 here 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 as 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 on page 3 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 a 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 and 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 Hilli valley, namely in Ringkimgpong, Kamesi and Tunang blocks. In the Shorea-Stereospermum Hylium Consociations are very frequently found, especially in Mongpong, 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' - 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 acanthophatus 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. Schizospadix. 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 resembling closely 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 on the valleys.

Crotalaria tetragona Roxb. A common shrub 6-8 ft. high, on the drier slopes, in both the Shorea-Terminalia-Garuga and Shorea-Stereospermum Associations.

Daemonorops 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 Association, especially in the neighbourhood of the Tista river. In the Stereospermum-Terminalia Association, some 6000 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 4000 ft.

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 2000 ft.

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 were, however, found by me more recently in the *Eugenia-Phoebe Hylium* near Khumani.

**Flemingia bracteata** Wight. An erect shrub, 5-10 ft. 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 riparia** Lour. Small societies are very common in the Tista River bed.

**Imperata arundinacea** Cyrill. Forms Societies, especially in *Shorea* Consociations of the *Shorea-Stereospermum* Association.

**Indigophera 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.

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 6000'.

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-Phoebe Associations.
Saurauja Roxburghii Wall. A small tree, forming Societies on the banks of streams and in the valleys of the lower hills.

Woodfordia fruticosa Kurz. A straggling shrub fairly common in the Shorea-Terminalia 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.
Chapter 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 ft. He notes that "When the Forests of Darjeeling were gazetted between 1665 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 these altitudes 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 East of the area that extensive Forests occur between these elevations. In this Zone Forest Associations occupy an area of less than 30 square miles, there being only about 1 sq. mile in the Tista Valley, 4 sq. miles between the Chel and the Neora, about 6 square miles on Lulygaon spur and the remainder in the west of the District.

A perusal of the map accompanying Gamble's article in the Indian Forester of 1875 reproduced on page 3 shows that the extent of these forests, particularly in the South-west has been reduced in the past 50 years and much the greater part of the land between elevations of 3, 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 ground 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 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-Castanopsis-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 are mostly Vacciniaceae. 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 Apocynaceae. 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, *Alsophila*, 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."
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 Association Castanopsis tribuloides greatly predominates, being 37% of the trees on the area. C. indica and Schima Wallichii are almost equally common, each being 13% 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, where 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 overlying 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, Boehmeria rugulosa Wedd. 3.8, Ficus Cunia Ham. 3.1, Terminalia belerica Roxb. 2.6, Syzygium spp. 2.4, Terminalia crenulata Roth. 1.9, Albizia 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 --


The Schima-Castanopsis-Phoebe 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, Castanopsis indica A. DC. remains second in frequency, but Phoebe Hainesiana Br. and P. attenuata Nees. come third and Castanopsis tribuloides A. DC. only fourth
at 4.5 %, instead of first at 37%. 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 blicks, occupying altogether about 4,000 acres. The percentage composition is as follows:

Species over 1 per cent.

Schima Wallichii Choisy. 25.9, Castanopsis indica A.D.C. 8.7, (Phoebe attenuata Nees and P. Hainesiana Br.) 4.7, Castanopsis tribuloides A.D.C. 4.5, Bauhinia purpurea Linn. 4.1, Stereospernum tetragonum DC. 3.1, Phoebe lanceolata Nees. 2.6, Michelia Champaca Linn. 2.5, (Cedrela Toona Roxb. and G. microcarpa A.D.C. 2.4, Erythrina stricta Roxb. 2.0, Duabanga sonneratioides Ham. 1.8, Eryta spp. 1.7, Macaranga spp. 1.5, Turpinia pumifera 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 myricarpa Heurck and Muell. Arg and Jambo sa ramosissima Cowan 1.0.

Species under 1 per cent but over .1 per cent in order of frequency --


The Engelharditia-Castanopsis-Schima-Betula-Hylium.

The Engelharditia-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 Engelharditia spicata Bl., Castanopsis tribuloides A.DC., Schima Wallichii Choisy. and Betula cylindrostachys Wall.

The frequency of these four species depends chiefly upon elevation. Engelharditia usually takes premier place at elevations above 5,000 ft., 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 to the north-west of that 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 composition below and above 5,000 ft.

Below 5,000 ft.
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 Brassaipsis spp. 3.4, Talauma Hodgsoni Hk.fil. and T. 2.4, Reeyesia pubescens Mast. 2.2, (Cinnamomum caudatum Nees and others) 2.0, (Macaranga and Mallotus spp.) 2.0, Hovenia dulcis Thunb. 1.8, Acer Thompsoni Mig. 1.5, (Cedrela Toona Roxb. and C. microcarpa DC.) 1.5, Cinnamomum cecidodaphne Nees. 1.2, Sarcocperma arbo- reum Ham. 1.2, Evodia fraxinifolia Hk.f. 1.1, Melia com- posita 1.1, Beischmiedia spp. 1.1, Castanopsis indica DC. 1.0.

Species under 1 per cent but over .1 per cent in order of frequency --

Ficus Roxburghii Wall., Blaescarpus spp., Nyssa javanica Wangerin., Alstonia scholaris R.Br., Dysoxylum
app., Cinnamomum obtusifolium Nees., Litsaea spp., Acer-
carpus fraxinifolius W. & A., Ficus elastica Roxb.,
Gynocardia odorata R.Br., Terminalia Chebula Retz. (Phoebe
Hainesiana R.Br. and P. attenuata Nees.), Semecarpus anacardium
Linn., Turpinia pomifera DC., Jambosa Kurzii Cowan., Machilus
edulis King., Quercus lanceolata Roxb., Callicarpa arborea
Roxb., Oostodes paniculata Bl., Morus laevigata Wall., Meliome
simplicifolia Walp., Eurya spp., Syzygium claviflorum Wall.,
Ficus Cunia Ham., Albizzia marginata Merr., Acer Campbellii
Hk.fil. & T., Quercus spicata Sm., Brassaioipsis spp., Styplay
app., Ficus Benjamina Linn., Cina Wodier, Prunus nepaulensis
C.K.Schn., Cordia obliqua Willd., Ailanthus grandis Prain.,
Grewia vestita Wall., Albizzia procera Benth., Machilus
app., Helicia erratica Hk.f., Aporose dioica Muell. Arg. and
Vitex heterophylla Roxb.

Above 5,000 feet.

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. cylindrostachya Wall.} 4·0, Eurya
app. 4·0, Cinnamomum obtusifolium Nees. 3·8, Michelia Cath-
cartii Hk.f & T. 3·7, Machilus edulis King. 3·1, Nyssa javanica
Wangerin. 2·9, Macaranga and Mallotus spp.) 2·5, Reevesia
pubescens Mast. 2·5, Eleocarpus lanceaeolatus Roxb. 2·4,
Ehretia Wallichiana Hk.f. & T. 1·9, Heilschmiedia spp. 1·6,
Sympl iOS. spp. 1·7, (Brassaioipsis spp. and other Araliaceae)
1·3, Acer laeigatatum Wall. 1·1, Pyrularia edulis A.DC.1·0.

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

Prunus nepaulensis C.K.Sch., Alnus nepaulensis D.Don.,
Magnolia Campbellii Hk.fil. & T., Litsaea spp., Bucklandia
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.

Damsong.

Density per acre :-- 79.7.

Castanopsis tribuloides 10.2, Michelia Cathcartii 8.78, Engelhardtia spicata 7.53, Quercus fenestrata 5.56, Litsaea spp. 3.96, (Caracanga and Mallotus), 3.61, Schima Wallichii 2.86, Betula spp. 2.58, Magnolia Campbellii 1.76, Symphococos spp. 1.45, Prunus nepalensis 1.45, Machilus edulis 1.41, Nyssa javanica 1.40, Elaeocarpus lanceaeafolius 1.36, Surya spp. 1.32, Beilschmiedia spp. 1.35, Acer laevigatum 1.12, Nevesia pubescens 1.03, Cinnamomum obtusifolium 0.89, Meliosma Thomsoni 0.68, Casearia glomerata 0.65, Brassaiopsis spp. 0.63, Quercus lineata 0.61, Turpinia nepalensis 0.54, and Castanopsis indica 0.5.
(b) 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, Litsaea 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 0.62.

(b) 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 1.69, Macaranga and Mallotus spp. 1.76, Machilus edulis 1.58, Beilschmiedia spp. 1.41, Brassaiopsis spp. 1.38, Reevesia pubescens 1.19, Elaeocarpus lanceaefolius 0.91, Evodia fraxinifolia 0.88, Symlocos spp. 0.82, Michelia Cathcartii 0.79, Pyrularia edulis 0.71, Prunus nepalensis 0.57, Buxlandia populnea 0.56, and Acer laevigatum 0.51.

(b) Density per acre: 76.2.
Betula spp. 8.3, Engelhardtia spicata 7.65, 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, Sarcospermum arboenum 1.53, Cinnamomum Cecidodaphne 1.32, Melia composita 1.25, Cedrela febrifuga 1.11, Mangifera sylvestica 0.93.
Beilschmeiedia spp. 38, Castanopsis indica 83, Evodia fraxinifolia 79, Acrocarpus fraxinifolius 77, Gynocardia odorata 74, Caseria glomerata 74, Fraxinus floribunda 73, Andromeda ovalifolia 68, Rhus spp. 68, Cinnamomum obtusifolium 63, Dysoxylum spp. 63, Echinocarpus dasycarpus 57, and Litsaea spp. 5.

The Ostodes Hylium.

At elevations between 4,000 and 6,000 ft., 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 west slopes of Lulygaon ridge, especially in Bokhirm block. The percentage composition is as follows:

1. Species over 1 per cent.

Ostodes paniculata Bl. 11.5, Machilus spp. 8.1, Beilschmeedia spp. 5.8, Andromeda ovalifolia Wall. 5.2, Schima Wallitchii 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, Harriata Wallichiana Hk.f.& T. 2.5, Elaeocarpus lanceaefolius Roxb. 2.5, Turpinia nepalensis Wall. 2.4, (Brassaiopsis and Schefflera spp.) 2.1, Sterculia lancifolia Roxb. 2.0, Syzygium claviflorum Wall. 2.0, Litsaea spp. 1.8, Talauina Hodgsoni T. And. 1.7, Gynocardia odorata R.Br. 1.6, Nyssa javanica Wangerin. 1.6, Caseria glomerata Roxb. 1.5, Machilus edulis 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. & T., Quercus spicata Sm.,
Laurocerasus acuminata Roem., Quercus lanceafolia,
Quercus lineata, Michelia Cathcartii Hk.f. & T.,
Glochidion spp., Ficus Roxburghii Wall., Cinnamomum obtus-
sifolium Nees., Eurya spp., Terminalia myriocarpa Heurck.
& Muell. Arg., Wendlandia puberula DC., Briedelia spp.,
Ailanthus grandis, Helicia erratica, Ficus Cunia, Elaeo-
carpus spp., Hovenia dulcis and Morus laevigata.

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 Con-
sociations are in West Nar block; others are found in
Ambiok, Dalingkot and Fagu blocks. They are not uncom-
mon on parts of Lulygaon ridge, and are occasionally
observed in the Tista Valley, principally in Bhalukop
and Tunang, in the Castanopsis-Schima Hylium.
Societies.

Schmanthera tomentosa Nees. A small gregarious shrub of the Castanopsis-Schima Association, which flowers at irregular intervals.

Sichrea 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.

Carya japonica Thunb. Open societies of this small tree are very common in the Engelhardtia Association and, mixed with Schima Wallichii, this species is one of the commonest on abandoned cultivation at these elevations.

Faulcia erratic a 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 Rinkingspong 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.

Jassa 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 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.
Chapter VIII.
THE TEMPERATE OR UPPER HILL ZONE.

The Temperate Zone ranges from an elevation 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 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 3 to 4 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., Schiumcarpus desmocarpus 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 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.

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 Lulygann spur, 6,000 on the Rissum, Khampong and Pankasari hills and 5,000 acres in the upper parts of Chichu, Mo, East and West Nar blocks. Michelia Cathcartii Hk.f. & 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., Symlocos theasfolia Ham., S. ramossissima Wall. many Aralias.
several species of Ilex, Acer Thomsonii 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 Arundinaries.

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

Species over 1 per cent.

Machilus edulis King. 12.3, Michelia Cathcartii Hk.f. & T. 8.1, Engelhardtia spicata 7.2, Schima Wallichii Choisy 4.6 and Beilschmiedia spp. 4.6, Ehrertia Wallichiana Hk.f. & T. 3.0, Eurya spp. 3.0, Castanopsis tribuloides A.DC. 2.7, Prunus nepaulensis C.K.Sch. 2.7, (Brassaiopais and Macropanax spp.) 2.6, Macaranga pustulata King. and Mallotus nepalensis Muell.Arg. 2.5, Betula alnoidees Ham. 2.5, Symlocos spp. 2.4, Acer Thomsonii Miq. 2.3, Magnolia Campbellii Hk.f. and T. 2.0, Cinnamomum obtusifolium Nees. 1.7, Quercus spicata Sm. 1.7, Casearia glomerata Rxb. 1.7, Litsaea spp. 1.5, Machilus spp. 1.5, Vitex heterophylla Rxb. 1.5, Nyssa javanica Wangerin 1.4, Acer laevigatum Wall. 1.3, Cedrela febrifuga C.DC. 1.3, Saurauja napaulensis DC. 1.3, Acer Campbellii Hk.f. & T. 1.3, Reevesia pubescens Mast. 1.2, Alnus nepalensis Don. 1.2.

Species under 1 per cent but above .1 per cent in order of frequency:--

Glochidion spp., Juglans regia Linn., Croton Tiglium Linn., Meliosma Thomsonii King., Quercus lanceae-
folia Roxb., Eleocarpus lanceaefolius Roxb., Macaranga pustulata King., Echinoecarpus dasycarpus Benth.,
Symlocos apicata Roxb., Quercus lineata Bl., Evodia fraxinifolia Hk.f., Ficus nemorialis 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, Litsea spp. 7.4, Quercus fenestrata Roxb. 7.1, Castanopsis tribuloides A.DC. 6.0, Brassaeopsis and Macropanax spp. 3.8, Symlocos spp. 3.8, Prunus nepalensis C.K. Sch. 3.6, Acer Campbellii Hk. f. and T., Beilschmiedia spp. 2.6 and Schima Wallichi Choisy. 2.6, Nyssa javanica Wangerin 2.5, Machilus spp. 2.5, Betelia Wallichiana Hk.f. and T. 2.5, Betula alnoides Ham. 2.2, Meliosma Thomasoni King. 2.0, Magnolia Campbellii Hk.f. and T. 1.8, Acer laevigatum Wall. 1.7, Echinoecarpus casycarpus 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:

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

The following figures illustrate the frequency of
the species in various blocks where this associa-
tion is found.

(b) Density per acre: -- 41.88.

Cinnamomum obtusifolium 6.25, Michelia Cathcartii
4.97, Machilus edulis 3.54, Litsaea 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, Heptapleurum spp.
1.26, Meliosma simplicifolia 1.25, Acer Campbellii 1.22,
Beilschmiedia spp. 1.18, Eurya spp. 1.01, Macaranga spp.
0.94, Elaeocarpus spp. 0.54, Echinocarpus dasycarpus 0.53,
Acer laevigatum 0.5 and Michelia lanuginosa 0.5.

(b) 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 napaulensis 3.18,
Litsaea spp. 3.12, Acer Thomsoni 2.84, Castanopsis
tribuloides 2.44, Schima Wallichii 2.41, Betula alnoides
2.34, Symplocos spp. 2.33, Heptapleurum spp. 1.61,
Reevesia pubescens 1.56, Caesaria 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 laevigatum 1.14, Eurya spp. 1.07, Juglans regia 1.0, Macaranga spp. 1.0, Croton Tiglium 0.92, Quercus lanceaefolia 0.77, Nyssa javanica 0.72, Mallotus nepalensis 0.67, Glochidion acuminatum 0.56, Echicarpus dasycarpus 0.55, and Meliosma Thomsoni 0.55.

Paktham.

(b) Density per acre: -- 43.5.

Michelia Cathcartii 6.48, Litsaea spp. 4.56, Machilus edulis 3.72, Symplacos spp. 3.22, Schima Wallichii 2.86, Prunus napaulensis 2.55, Heptopleurum 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 0.85, Acer laevigatum 0.69 and Castanopsis indica 0.62.

The Quercus Hylium.

Between 7,000 and 9,000 ft. the dominating species are Quercus lamellosa Smith and Quercus pachyphylla Kürz. The former is the commoner at the lower level, the latter at the higher and both form Associations 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. The
The number of dominating trees is small. Next in frequency to the Oaks, in the upper storey come Acer Campbellii Hk.f. & T., Michelia excelsa Bl., Echinocarpus dasycarpus Benth. and Michelia Cathcartii Hk.f. and T. The second storey contains many Laurels, principally Machilus and Litsaea spp. and other trees enumerated below. The undergrowth is bamboo. Arundinaria Maling Gamble., A. Griffithiana Munro. and A. Pantlingii Gamble. are all common, the former especially at lower, the latter 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, Litsaea 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 nemo-
ralis Wall. 4.1, Eriobotrya petiolata Hk.f. 4.0, Meliosma Thomsonii 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, Elaeocarpus lanceaefolius Roxb. 1.3, Michelia Cathcartii Hk.f. and T. 1.3, Evodia fraxinifolia Hk.f. 1.3, Echinocarpus dasycarpus Benth. 1.1, Quercus lanceaefolia Roxb. 1.1.

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


As the identification of the Laxaceae is still very far from complete 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.

The Rhododendron Hylium.

The principal species in this Association are Rhododendron arboreum Smith. and R. campanulatum Don., R. grande Wight. forms smaller associations 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.

The *Tsuga-Abies Hyliaum*.

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 forms small Consociations within the Kalimpong area are *Tsuga Brunonianae* Carr. and *Abies daussi* 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.

*Rhelia 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 Hylium on the Damsong hills, as well as in the *Rhododendron* Hylium.

**Tsuga Brunoniana** Carr. See under the *Tsuga*-Abies Hylium.
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 ft. 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, however, reach the summit.

Arundinaria Hookeriana Munro. This species is not so common as 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 elevations 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 Saihur 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 Meissan. A shrub found often near the edge of the forest and on open ground. It occasionally forms small open Societies.

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.

Laurocerasus 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.

Maesa Chisia Don. See page

Pilea smithagifolia 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 on open places. It frequently grows gregariously especially after forest fires.

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

Polygonum molle Don. A large trailing shrub which frequently forms Societies 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 Chumsang, on the Lulygaon ridge.

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

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 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 shrubby and herbaceous undergrowth appears, when the trees have reached 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 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 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 described 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 Hyles 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 formed. It appears to have arisen on river bed on which the first trees were probably Dalbergia Sisco and Acacia catechoides. 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

Troup. l.c. pages 307-309.
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 probably the commonest. There are also, however, several scandent Acacias, various species of *Capparis*, especially *C. multiflora* Hk.f. & T. and *C. olacifolia* Hk.f. & T., *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. *Convolvulaceae-Argeirsia* 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., *Treema orientalis* Wall., *Brideliae, Callicarpa arborea* Roxb. and *Anthocephalus indicus* A. Rich. Most of these are short-lived 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 trees which first force their way through are *Amoora Wallichii* King., *Duabance sonnertioides* Ham., *Michelia Champaca* Linn. and *Acrocarpus fraxinifolius* Wand. A on loamy clay, and *Sterculia villosa* Roxb., *Tetrameles nudiflora* R. Br. and groups of *Duabance sonnertioides* Ham. on stony ground.
The Convolvulus Mictium seems also 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 Murdi 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 shrubs and climbers fail to survive. This process may be partially aided by fire protection and there is no doubt that on such areas evergreen forest is the climax community.
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 of 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 "jhum"s themselves. Dendrocalamus Hamiltonii Nees. is the undergrowth over large areas in these forests and as the culms 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 such 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 salida Roxb. are among the first species to invade such areas. All these grow gregariously forming considerable societies and have perennial root stocks which enable them to survive frequent fires. Where Dendrocalamus Hamiltonii forms the undergrowth its under-ground rhizomes enable it to survive and new culms appear

Troup l.c. page 307 to 309.
Greive and Shebbeare. Indian Forester Vol.XI. No.4. 1904.
Glasson. Indian Forester Vol.LIII No.2. 1927.
the following season. They shoot up very quickly and soon the area becomes covered with bamboos 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 area 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 where Arundinarias form a dense undergrowth in Rhododendron
Forest the dead culms of the bamboos become very inflammable 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.
When forest has been felled and the land cultivated and then abandoned a member of very typical communities are to be found. First of all herbaceous species, mostly Compositae, 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. 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 west 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 occuring 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, are 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 societies. The largest shrub is Zizyphus jujuba Linn. which grows either in solitary slumps or in dense thickets forming Consocieties. Callicarpa macrophylla Wahl. and Buddleia asiatica Lour. are common. In addition to those mentioned the following species form typical Societies on waste land in the Lower Hills. Acacia cassin Willd, Acacia concinna DC., and Acacia Cacageana Craib. All three species form tangled thickets very difficult to penetrate on account of their thorns.

Cassia Sophora Linn. and Cassia Tora Linn. Both form small or sometimes fairly large Societies on waste land, particularly along road sides.

Clerodendron infortunatum Gaertn. 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 Societies and is very common in the Lower Hills.

Desmodium floribundum DC. is a very common shrub especially on abandoned cultivation.

Grewia disperma Roxb. It is found in dry places in the
Lower Hills. 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 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 veronicaefolia Linn. Both occasionally form small Socies.

Solanum indicum Linn. and Solanum Torvum Swartz. are both common, 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.

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 grow 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 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 Maesa 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.

Maesa Chisia Don. which is much less local in occurrence than the former grows gregariously oustim the Artemisia, especially near the forest boundaries. Areas dominated by Maesa 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 ellipticus Smith. by Inula Cappa DC. by Osbeckia grunata Benth. and by Clerodendron bracteatum Wall. at elevations upto 4,000 ft.
Dichroa febrifuga Lour. very commonly forms Societies at the higher levels. Over certain areas Pteris aquilina 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 Societies. Ehretia Wallichiana Hk.f. and T. and Evodia fraxinifolia Hk.f. also are frequently found, especially the latter, which grows gregariously. Ditsea oblonga Wall., Saurauja nepalensis DC., Helicia erratica Hk.f., Ficus hispida Linn. and Ficus Roxburghii Wall. are also common, scattered over the area.

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 Societies, already mentioned as occurring in the Middle Hill Zone, are to be found in the Temperate 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 Societies. 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 Myrsine semialata Merr. which ranges from 6,000 to 10,000 feet. \textit{Prietropis cytisoides} \textit{W} and \textit{A.} is a much branched shrub, very common about Damsong. Societies of \textit{Leycesteria stipulata} Fritsch. are common from 7,000 to 8,000 feet. \textit{Broussonetia papyrifera} Vent. which is spreading rapidly, is found in Societies on areas cleared in connection with Cinchona cultivation, at elevations of 6,000 feet. \textit{Hypericum petulium} Thunb. forms Societies in open land round Labah.

\textbf{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 \textit{Macaranga denticulata} Muell. Arg. in the plains or by \textit{Macaranga indica} Wight. at the foot of the hills. Both form extensive Consocieties 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 \textit{Alangium beco-naefolium} Bail. and \textit{Kydia jujubifolia} Griff. and
extensive Societies of Avenanthera pavonia Linn. or occasionally of Acrocarpus fraxinifolius W. and A. if seed bearers are present.

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

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

An area of secondary growth forest, 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:--

Species over 1 per cent.

- Mallotus nepalensis Muell. Arg. 22.3,Betula alnoides 13.7,Araliads 8.9,Castanopsis tribuloides A.DC. 7.4,Saurauja 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,Picus Roxburghii Wall. 1.6,Andromeda ovalifolia Wall. 1.4,Bucklandia populnea R. Br. 1.3,Elaeocarpus lanceaefolius Roxb.1.2,
Ficus nemoralis Wall. 1.2, and Magnolia Campbellii Hk.f. and T. 1.0.

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


Seral Communities on landslips.

Two seral communities require to be mentioned as occurring on landslips. In the Lower Hills Consocies of Duabanga sopperatioides Ham. are invariably to be found in such places, an occasional Anthocephalus may be present and sometimes Woodfordia fruticosa Kurz. forms the undergrowth when the Consocies is open.

In the Middle and Upper Hills to about 6,000 feet fresh land is sometimes invaded by Socies 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.
Bibliography.


Bose. P. N. The Darjeeling Coal between the Lisu and Ramthi rivers. 1889-90.


Cathcart and Hooker. Himalayan Plants. 1885.

Two ferns from Sikkim Jour. Linn. Soc.XIX.pg.230.1882

Bruhl. P. Key to the Sikkim Orchids. 1927.


Falahault. Ch. Phytographical Nomenclature.

Gamble. T. S. Darjeeling Forests.
Ind.For.Vol.I. 1875.
List of Trees, Shrubs and Large Climbers of the Darjeeling District 1895.


Rhododendrons of the Sikkim Himalaya. 1849.


Himalayan Journals.


Berner. A. Nova plantarum species Himalayae montibus. 1870.

Proceed. Linn. Soc. 1875-1880 p. 3.


The Magnoliaceae of British India. 1891.

Oaks from Sikkim.

Proceed. Linn. Soc. 1875-1880 p. 3.

List of Sikkim Plants.
Jour. Linn. Soc. XLIII. pg. 466.

On the occurrence of Palms and Bamboos with pines and other forms considered Northern, at considerable elevations in the Himalaya.


The fundamental units of vegetation.


Some additions to the Flora of the East Himalaya.


A note on the Himalayan species of Daphne.

A note on the Himalayan species of Alangium.


The Vegetation of Burma, 1926.

The Classification of Vegetation and the Concept of development.

Practical Plant Ecology. 1923.
Tansley and Chipp. Aims and Methods in the Study of Vegetation. 1926.


Waddell. L. A. Among the Himalayas 1899.

Warming E. Geology of Plants. 1909.

White J. C. Sikkim and Bhutan. 1909.