SILVER BEECH IN SOUTHLAND.

(T. T. C. Birch.)

In this paper it is proposed to discuss briefly the chief factors governing the growth and regeneration of silver beech as found in a typical Southland mixed forest. The forest under discussion lies in the Wairio Survey District, Southland, and is known locally as Woodlaw Forest (S.F. No. 34), covering 1,385 acres.

In the eastern corner of this forest, an Experimental Area was laid out in the summer of 1930. The area is situated on rising ground with an East to South-east aspect, and has an average elevation of 400 feet above sea level. The subsoil is stiff clay of considerable and varying depth—a very poor soil type frequently occurring in Southland beech forests.

Two distinct forest types occur in this area, Virgin forest, and Second-growth forest after burn.

Virgin Forest.

Although occasional rimu (Dacrydium cupressinum), Kahikatea (Podocarpus dacrydioides), miro (Podocarpus ferrugineus), and totara (Podocarpus totara), occur, they are widely scattered, and silver beech (Nothofagus Menziesii) is the dominant species occupying the entire upper canopy in most localities. Below the beech in what may be called a middle storey, the following species occur:—Elaeocarpus Hookerianus, Suttonia australis, Fuchsia excorticata, Pittosporum tenuifolium, Carpodetus serratus. Below or partly in association with this storey occur the following shrubs and small trees:—Wintera colorata, Aristotelia serrata, Coprosma robusta, C. foetidissima, Myrtus pedunculata, Pseudopanax crassifolium, Nothopanax arboreum, N. Edgerleyi, Rubus australis, Griselinia littoralis, and Dicksonia squarrosa.

As a ground covering, the crown fern, Blechnum discolor very frequently occurs, together with numerous herbs, mosses and other ferns.

The Natural Regeneration of Silver Beech.

Amongst the lower storeys, silver beech regeneration in all its stages occurs irregularly throughout the forest. The groups of seedlings and saplings are often widely spaced apart, but are usually in dense formation.

The presence or absence of beech regeneration is undoubtedly governed chiefly by "light conditions" as influenced by the canopy and ground vegetation; the for-
mer being composed of the dense crown foliage of the upper storey and the latter of a thick soil covering.

The crowns of closely growing over-mature silver beech cast a deep and extensive shade, which is intensified by such middle storey trees as pokaka (*Elaeocarpus Hookerianus*), *Pittosporum eugenioides* and the tree fern, and beneath these, not infrequently a dense growth of *Blechnum discolor*.

In the shade of such a dense canopy silver beech regeneration does not develop. It is only in sites where direct light is able to reach the soil that regeneration is found to occur, and in almost every case, such sites were formerly occupied by heavily crowned over-mature standards. In the normal course of natural rotation such over-mature trees fall to the ground through the agency of wind and decay, the branch system destroying in its downfall small lower storey trees. In the resulting open space entirely different light conditions prevail, potentially suitable for beech regeneration. The fall of over-mature trees is, however, invariably much overdue, and in portions of forest where there is a majority of such trees, regeneration is almost completely absent. It is apparent, therefore, that the extremely slow natural rotation must be accelerated by artificial treatment if the areas of beech regeneration are to be materially enlarged.

It is not unreasonable to expect that on the introduction of direct light, the dense ground covering of *Blechnum* fern would be rapidly replaced by more light demanding species; this process of replacement is, however, very slow, and though it does occur eventually, almost pure *Blechnum* crops have frequently been observed in an apparently healthy condition many years after the canopy had been broken. This persistency in spite of adverse light condition is attributed to the stolon habit of *Blechnum discolor*.

One plot (C3) of the Woodlaw Area illustrates very clearly the transitional stages from pure *Blechnum* covering to the development of light-demanding shrub thicket and beech regeneration. This open space, caused by the fall of a large beech many years ago (the stump is in an advanced stage of decay) measures 94 by 140 links. The area divides itself into three types. The southern portion, on flat ground, was covered entirely with *Blechnum discolor*; the centre section with a slightly northern aspect, shows the gradual replacement of *Blechnum* by various *Coprosma* species (chiefly C.
foetidissima), Winter colorata and some silver beech seedlings; the northern section with a steep northern aspect (thus gaining a more direct sunlight) is covered with a dense thicket some 8 feet high, 75 per cent. of which is Coprosma foetidissima with some Griselinia littoralis, Pseudopanax and Fuchsia. Beneath this dense thicket beech germination has taken place in plenty, and from the evidence of more advanced seedlings it is apparent that this species is capable of eventually pushing through the dense Coprosma thicket to direct light.

To what extent shrub growth is beneficial or even essential to beech regeneration is a matter which must be given a great deal more attention before definite conclusions can be drawn, but there is every probability that by a judicious thinning of such "nurse associations" a more rapid development of beech regeneration would be secured. Regeneration frequently springs up on bare soil, such as disused "snig tracks" in dense profusion, which suggests that under certain conditions, protective shrub growth is by no means necessary.

A further important factor of regeneration must be considered, namely, the frequency of fertile seed years. Seed collections and the occurrence of thick groups of very even sized beech seedlings suggest that seed years occur only at irregular and often wide intervals; consequently, if useful research on regeneration is to be carried out, experiments must be timed to coincide with the seed years.

To summarise the points arising from the above discussion, it would seem that experiments along the following lines would contribute materially towards the solution of these problems:

1. The clearing of Blechnum discolor from forest sites exposed to direct light and surrounded by Nothofagus Menziesii seed-bearers.
2. The recording of fertile seed years in co-ordination with (1).
3. The recording of the re-establishment of vegetation in the cleared forest sites (1) and its relation to beech regeneration.
4. The thinning of undergrowth (e.g., Coprosma thickets) over beech regeneration.
5. The maintenance of control areas under natural conditions.
The removal of selected over-mature trees in localities where natural openings (with the accompanying regeneration) are absent, must sooner or later be seriously considered if it is desired to obtain maximum productivity from the soil. The majority of the natural openings observed in the Woodlaw Forest are undoubtedly too small for the proper development of more than one or two mature trees, often occupying only 1 square chain or less. The most suitable area for such a "group" has yet to be determined, but it is considered that an area not less than 1-10 acre is desirable, since allowance has to be made for the overhanging crowns of the surrounding seed-bearers.

In the following section consideration will be given to the more advanced stages of silver beech regeneration in natural groups on the sites of fallen seed-bearers.

Three plots, each 1-20 acre in area, have been established in the Woodlaw Forest to enable measurements and treatment of middle aged silver beech to be carried out. It is proposed first to summarise the records of each plot in turn and subsequently to comment on the results in general.

In the following summaries, all figures and dimensions refer to silver beech.

**PLOT A 2.**

**Summary of 1930 Measurements.**

<table>
<thead>
<tr>
<th>No. Trees per acre</th>
<th>D.B.H. in inches</th>
<th>Height in feet</th>
<th>Age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>260</td>
<td>740</td>
<td>1,000</td>
<td>7.1</td>
</tr>
</tbody>
</table>

**General:** This plot is closely surrounded by over-mature trees, portions of the 1-20 acre being overshadowed by adjoining crowns. So marked is the difference between the dominant and suppressed trees that separate classification is shown above. Dead and broken saplings were removed in an initial cleaning.

**Height and Diameter:** 22½ feet separate the average heights of dominant and suppressed trees: development of the latter has almost ceased, as shown by the D.B.H. The heights were based on two mean trees of each class and were found to differ little from the average.
Age: From the borings at B.H. of four mean trees, the average number of rings for each class was 52 and 40. Adding 10 years for growth to 4’ 6”, the ages of the dominant and suppressed trees were estimated to be 62 and 50 years respectively.

PLOT C 1.
Summary of 1930 Measurements.

<table>
<thead>
<tr>
<th>No. of trees per acre</th>
<th>Before thinning</th>
<th>After thinning</th>
<th>Av. D.B.H.</th>
<th>Height</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>3440</td>
<td>1260</td>
<td></td>
<td>4.9&quot;</td>
<td>45½&quot;</td>
<td>57</td>
</tr>
</tbody>
</table>

Density: This plot is in a fairly open site and less affected by the shade of surrounding trees: the original crop of saplings was very dense, and if broken and dying stems had been counted the density would have greatly exceeded 3440 trees per acre.

Thinning: A 50 per cent. thinning chiefly amongst suppressed saplings of 2 inches D.B.H. and under, was carried out, 1700 per acre being removed, which amounted to 24 cords per acre. This thinning included some dominant trees to relieve the canopy, which was over-crowded.

Diameter and Height: The heights of 9 mean trees of D.B.H. 4.9 inches were measured, ranging from 43 feet to 48½ feet, and averaging 45½ feet.

Age: Borings at B.H. of three mean trees showed 45; 44; 52 rings respectively. After adding 10 years the average age was therefore 57 years.

PLOT C 2.

<table>
<thead>
<tr>
<th>No of trees per acre</th>
<th>Before thinning</th>
<th>After thinning</th>
<th>D.B.H.</th>
<th>Height</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1220</td>
<td>420</td>
<td></td>
<td>6.2&quot;</td>
<td>46½&quot;</td>
<td>57</td>
</tr>
</tbody>
</table>

General: This plot, prior to treatment, closely resembled plot A 2 both in density and in its relationship with surrounding trees.

Thinning: In contrast to A 2, however, a 66 per cent. thinning was carried out. The majority of such thinnings were, however, 3” D.B.H. and less, their absence not affecting the canopy.

Diameter and Height: The heights of nine trees were measured, ranging from 37’ to 54½’, the average being 46½ feet.

A wider crown spacing of dominant trees is reflected in a larger mean diameter.
Age: The borings of three mean trees, showed 46, 47, 47 annual rings respectively, the average of which, plus 10 years, gives the mean age of 57 years.

General Discussion:

The evidence of ring counts points to a very even age of all pole crops examined, though the rate of growth, as reflected in diameter and height, is very irregular. The unevenness of development is the natural result of the severe struggle for existence, the intensity of which is illustrated in C 1, where, after nearly 60 years of growth, there existed over 3,000 stems to the acre. At least 50 per cent of such a crop is found to be already suppressed, however, and it is towards the crown spacing of the dominant trees that the silviculturist should look in order to decide what steps be taken to improve the growing conditions of the final crop trees. The density of dominant tree crowns varies to such an extent that each group must be studied on its own merits; thus in C 1, after a 50 per cent. thinning, 1,260 trees per acre have been left, since it was considered that a more severe opening up of the canopy at the present time would be detrimental to the crop, introducing danger of wind damage and weed growth. In C 2, however, fewer trees occur, but with larger crowns. After removing 66 per cent., the remaining stand, only 420 trees per acre, is sufficient to fill the canopy.

Increment:

In the following discussion it is not intended to convey an unqualified acceptance that growth rings in silver beech each represent an annual increment, but the writer is of the opinion that with care, "false rings" can be differentiated from "true rings." In any case, the age estimations have at least a comparative value.

Plots C 1 and C 2, though separated by several large over-mature trees, are only 2 chains apart, and it is significant that the estimated ages of each are identical (namely, 57 years), based on the ring counting of three mean trees in each plot.

In Plot A 2, some 7 chains from C 1 and C 2, a difference of 12 years was found to exist between the dominant and suppressed trees—62 and 50 years respectively. The average age of both classes is, however, 56 years—differing only by one year from the age of Plots C 1 and C 2.

The similarity of the estimated ages of these three groups suggests the occurrence of a severe storm causing simultaneous downfall of many over-mature trees. How soon after the introduction of light regeneration established itself cannot be ascertained.
As a result of dense growth the height increment has been rapid and clean stems have usually resulted; thus the mean annual height growth of Plots C 1 and C 2 is 9.6 inches, whilst that of the dominant trees in A 2 is 11 inches.

In diameter increment, however, the effects of poor crown development due to overcrowding are found. Thus in the plot of the greatest density—(C 1)—the mean D.B.H. of 4.9 inches shows a mean annual increment of .084 inches, whilst in the slightly less crowded, C 2, the mean annual increment is .108 inches.

In A 2, where heavy suppression has allowed the few dominant trees to develop their crowns, a mean annual increment of .114 inches is found.

To summarise, these increments show that silver beech in the Woodlaw Forest developing through a severe struggle for existence, at the age of approximately 57 years may attain the height of 46 feet and a mean diameter at B.H. of 5.2 inches.

**Second Growth Forest After Burn.**

Some 50 years ago, fire destroyed 10 acres of virgin forest to within 3½ chains of Area A referred to in the previous section.

At the present time, this burnt-over area is stocked with an almost pure crop of silver beech of fairly even age. The density of beech in this area varies in relation to the severity of the struggle for existence with manuka and gorse.

Frequent and scattered groups of these species, suppressed or killed in almost every case by surrounding saplings, suggest that some gorse but more manuka sprang up over the area soon after the fire. At what period the beech regeneration entered the competition it is impossible to determine, but it seems probable that a heavy seed year occurred soon after, originating from the large seed-bearers in virgin forest to the west.

In parts where fertile seed has fallen in profusion, the density of saplings is remarkable, thus in one demarcated plot of .17 acre (B 2) the vegetation is composed entirely of silver beech averaging 2 inches D.B.H. and 25 feet high, the density of which was estimated to be 1 tree per square foot or 43,000 trees per acre.

Heavy suppression is already operating in this and similar groups, and poorly developed crowns indicate the urgent need for selective thinnings to encourage development of diameter increment.
In an older and less crowded portion of this second growth area, an experimental plot (B 1) was established with the object of determining the difference in increment between thinned and unthinned stands of silver beech.

An area of 1-10 acre was divided into two equal subplots of similar type and density.

**Unthinned Plot:**

No trees were removed from the first sub-plot and a complete classification showed a density of 2,700 trees per acre of average D.B.H. 3.7 inches.

Well formed trees were then selected to represent the remaining crop, in the event of the execution of a suitable thinning. These selected trees, amounting to 880 per acre, were marked with white paint at B.H. and numbered with zinc tags. Their mean D.B.H. in 1930 was 4.75 inches.

**Thinned Plot:**

In the second sub-plot, the procedure was as above, 880 trees per acre being carefully selected, marked and numbered. The mean D.B.H. of these trees was 5.1 inches. All remaining unmarked trees were then removed—a 66 per cent. thinning amounting to 30 cords per acre.

Two mean trees from each sub-plot were ring counted, proving that the two stands are of even age.

The following table summarises this experiment:

**Summary of Plot B 1.**

<table>
<thead>
<tr>
<th>Subplot</th>
<th>Tree No.</th>
<th>No. of Rings at B.H.</th>
<th>*Age in Years</th>
<th>D.B.H. in Inches</th>
<th>Mean annual diameter increment (Inches)</th>
<th>Total height in feet</th>
<th>Mean annual height increment (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>54</td>
<td>32</td>
<td>42</td>
<td>5.14</td>
<td>.122</td>
<td>39' 9''</td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>79</td>
<td>33</td>
<td>43</td>
<td>5.4</td>
<td>.125</td>
<td>38' 6''</td>
<td>10.8</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>34</td>
<td>44</td>
<td>4.88</td>
<td>.110</td>
<td>41' 6''</td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>32</td>
<td>42</td>
<td>4.84</td>
<td>.115</td>
<td>38' 4''</td>
<td>10.9</td>
</tr>
</tbody>
</table>

*Number of growth rings at B.H. plus 10 years.*

From the above it will be seen that prior to treatment these two sub-plots were in a very similar stage of development and it will be possible to compare accurately the effects of thinning at future remeasurements.