

THE LIFE HISTORY OF THE WESTLAND RIMU STANDS.

(F. E. HUTCHINSON.)

Introduction:—

The rimu (*Dacrydium cupressinum*) is the most important timber tree in New Zealand, forming 65 per cent. of the total timber production, over 40 per cent. of the present visible supply of all timbers, and 75 per cent. of the present visible supply of softwoods. It is found throughout New Zealand in all parts having a rainfall in excess of 50 inches annually. In the North Island it occurs usually as the dominant member of a mixed type including other conifers and several hardwoods. In Westland, however, it occurs as a pure type over extensive areas of coastal plain. There are at present about one million acres of commercial forest of this type in Westland, mostly in large compact areas of State Forest, all relatively easy of access. From the viewpoint of permanent forestry, therefore, this is the most important of native forest areas.

The Westland rimu stands occupy a terrain of hummocky morainic detritus stretching from the coast inland to the spurs of the mountain ranges, a maximum distance of twenty miles, and rising up to about 1,000 ft. elevation. The formation is an impervious boulder clay on which forest growth has developed a deep raw humus, which, with a relatively low temperature, and a heavy rainfall (100-120 inches annually) is marked by slow decomposition, leaching of soluble substances from the upper horizons and subsequent deposition as a hard pan below the surface. Root systems are therefore entirely superficial, and windfall is an important factor in forest development.

1. The Natural Life Cycle without any Human Interference:—

In presenting the life history of the rimu stands, the point for taking up the cycle will be that of a stand of young mature rimu of fairly full density, with an average D.B.H. of 24". The forest will be made up of:—First, a top tier of pure rimu, whose crowns fill the space from 80 to 110 feet from the ground. The density of this will be taken as fairly full. Second, a tier composed of hinau and miro whose crowns occupy from 60 to 80 ft. from the ground, and whose density is always low—2 to .3. Third, a tier of kamahi and tawheowheo of full density occupying the tier from 20 to 60 feet. Fourth, a shrub association—hupiro, toro, suckering kamahi, etc., and finally, a ground tier of mosses, ferns and creepers. [Note: Rata, where present, enters the top tier with

rimu, but is only of minor proportion below 800 feet elevation. Above that elevation it may form up to 50 per cent. of the top tier, to become the dominant species on the mountain spurs.]

From this condition pictured above, which is that existing just at the opening stages of definite maturity, one of two alternative lines of development will be taken, depending on topography, exposure to wind, and density of the stand.

First Alternative: The "selection" life history.

This life history is the characteristic one on all hummocky and sloping ground, and is also found to some extent on flats, though it is not characteristic of the flats.

In this case the fairly complete density of the mature stand begins to thin out gradually through the death and overthrow of various individuals singly, from either insects or butt rot, followed by windfall. This takes in the stage typed as "Mature, low density" (in the 1932 forest survey on the Waitaha), and then enters the stage classed as "Overmature." Here the density is definitely low, and under the gaps in the top canopy, clumps of regeneration which began in the "Mature, low density" stage as seedlings have become generally apparent as clumps of saplings and small poles.

Plot C 4, Experimental Area is typical of this stage. One large gap is filled with large saplings. Another, where the dead trunk of the mature rimu still stands, the bark just dropping off in 1928 and most of the limbs gone, has a dense growth of seedlings.

Overthrow by windfall may smash much of the kamahi thicket. Death by insects or other cause where the dead trunk stands for many years does not. In either case, regeneration of rimu commences successfully, develops slowly but steadily in competition with the broadleaved fourth and third tiers, and eventually, in the small pole or large sapling stage, emerges above the 60 ft. level and is free from further competition. In a gap of about one square chain left vacant in the top canopy by the death of one mature tree, a seedling stocking of twenty-five rimu and twenty-seven other podocarps will give a group of three to eight small poles, and probably at early maturity, one or two dominant trees with three or four suppressed individuals close beside and beneath.

The germination of seed in such gaps takes place seemingly on top of the duff. Competition from the broadleaved shrub and third tier members, while it may retard growth, certainly seems not seriously deleterious.

The stand renews itself in this way in clumps, forming a typically all aged or selection type.

Of the area studied in 1932, the "Overmature" type or age class was mainly of this form, or going into it, while most parts

of the "Mature, low density" type were also tending in this direction. The "Overmature" age class or type comprised 15 per cent. of this area, while the addition of 90 per cent. of the "Mature, low density" type brings the proportion of the area developing along the selection course to roughly 35 per cent. of the total area studied. All this area studied in the 1932 Inventory was of flats. On broken ground, however, such as found on the Mananui areas, this life history is the general one.

Second Alternative: The "evenaged" life history.

This is the life history characteristic of flats, more particularly those exposed to wind. Stands developing along this course formed 65 per cent. of the total area studied on the Waitaha flats in 1932, (the "Submerchantable," "Young merchantable" and "Mature, dense" types) so that it is numerically the more important on the coastal plains with their high stands per acre.

Starting from the same point as in the previous case (the stand of high density just becoming definitely mature), a heavy wind will bring about a "blow down" of some size. The area involved may be from one acre to 200 acres. Cases investigated have been 10, 20, 30, 50 and 70 acres. They occur usually in a long narrow belt, beginning at a focal point and tending to widen to leeward in a narrow cone. The mechanism is that one tree in falling strikes another, and so on, with added momentum, in the form of a drive. The conditions necessary are a high wind, a high density, and crowns about level. It is not usual therefore for drives to develop on broken ground, nor in stands of low density, so that in such cases the selection or all aged development will follow.

On the blowdowns, however, destruction of all tiers is surprisingly complete. The upturned root systems expose much mineral soil, while the complete levelling of the stand is followed by severe drying out so that the third and fourth tier shrubs are fairly thoroughly killed. The blowdowns occur, as stated, in long narrow belts as a rule, so that the distance from seed source is not great. The exact mechanism of initiation is not known just here from actual study of the blowdowns, but the gap in sequence is filled from the study of cutover lands. The general result is a uniform and very dense stand of evenaged rimu and silver pine arising on the area. Such stands have been studied from sapling stage onward. From the study on cutover areas it is presumed that the bulk of the rimu and silver pine seed falls on a floor containing much bared mineral soil, and germinates there in full light. It becomes well established in the two-year period required for the light-loving ferns *Blechnum*, *Histiopteris* and *Pteridium* to establish themselves. The young seedlings are able then to develop successfully and hold their own in competition with the fern, the manuka,

Coprosma and myrtle scrub, and the seedling kamahi, tawheowheo, etc., which come on rather slowly behind the rimu, overtake it in a rush of height growth, but are later overtaken and suppressed by a dominant podocarp stand.

If the ground is at all uneven, rimu will be the only podocarp to develop to the sapling stage, but if the ground is flat, silver pine will in all probability be disseminated and germinate much more freely. The silver pine will make more rapid height growth, and a typical condition in the large sapling stage will be a stocking of about 1,000 silver pine and 500 rimu per acre, at about 15 to 20 feet in height, closely surrounded but little suppressed by manuka, myrtle scrub, etc. The stand continues into the small pole stage, and then into the large pole stage with the silver pine dominant, the rimu somewhat shorter and hidden but not over-topped, the stocking being 500 silver pine to about 200 rimu per acre. Kamahi will be present but rather subordinate to the silver pine. The silver pine will now have almost completed its height growth at about 60 feet and 8"-12" D.B.H. The tops will be flattening off. Above them will rise the narrow pyramids of the rimu, in full light, to form the upper tier at a height above all further competition. By the time the rimu is definitely entering the standard stage, the silver pine will be suppressed. Many dead trunks will be standing, while others will be strewing the floor. (When the sap has rotted, they may be removed for posts, etc. Much of the silver pine extracted in Westland is obtained in this way.) The rimu will then form evenaged stands of "Young Merchantable" class of high density and high yield. The range of D.B.H.'s will be narrow, and crown classes sharply defined. The volume may run from 20,000 to 50,000 sup. ft. per acre.

If now another windstorm strikes such a stand in this condition of high density, there will probably be a repetition of this cycle, and the formation of young evenaged stands again. Should such visitation not occur, density will be lowered gradually by suppression, insects and butt rot and the first or selection cycle would be entered upon.

In concluding this section the following notes might be made in amplification.

When in this second cycle, following a blowdown, silver pine does seed up an area, it is usually most profuse. However, in a number of cases it does not appear even on flats apparently well suited to it. In such case the evenaged stand of rimu will develop as set out, without this first temporary crop.

In practically all cases where silver pine does form a stand it is followed by rimu, and it seems that the former species may be classed as a temporary type wherever it occurs, to be succeeded by an evenaged rimu stand.

Where silver pine seeds into gaps in the Overmature type developing along the selection cycle, it rarely reaches more than small pole size before being suppressed, though seedlings may be very numerous.

2. Some changes taking place consequent on Logging:—

After logging the area may be burnt or it may not. Under present practice the former is the more common.

A.—*Where fire follows* all living material is killed, and much debris left to feed subsequent fires, so that areas may be burnt many times. Where a large area is involved, sterile conditions result. The land is occupied by bracken fern, myrtle and Coprosma scrub, with little to no podocarp regeneration. If a seed source is close at hand, however, a cessation of burning may usually be expected to permit a slow but sure occupation of podocarp seedlings. Many good local strikes about seed sources have been observed after the exclusion of stock on land formerly burnt and grazed. Here rimu gets away on mineral soil, and develops well in a scrub thicket to emerge above it at about 20 feet in height. In other cases, areas occupied by heavy growth of four-foot-high bracken, within 5 chains of dense pole stands, were seemingly devoid of regeneration in 1928, which was about 5 years after the last fire. By 1931 rimu and silver pine heads were emerging above it in quantity sufficient to promise a well stocked large pole stand. Whether these germinated before or after the fern is not known, but their power to come up through it seems established.

In one case, a hot fire in December immediately after logging in September was followed by an abundant local regeneration of rimu seedlings on the bare black mineral soil. The rush of fern two years later enclosed this, but did not overtop it, and now, four years since, it is developing well. This is an exception, however, and it seems the fire was not the causative factor. Better germination was obtained on unburnt areas close at hand.

B.—*Where fire does not follow* three types of cutover land may be distinguished. About the logging winches in a circle of about ten chains diameter, and radiating thence outward along the snig tracks to the back boundaries of the blocks, overthrow of practically all living material is complete. The broadleaved third and fourth tiers are uprooted, much mineral soil is exposed, full light and warmth are let in, and the ground tier shrivels and dies. This type is called "Smashed flat" and constitutes 30 per cent. of the area.

In the wedge-shaped sectors between the snig tracks, the mature rimu is felled and pulled out without great damage to the third and fourth tiers. This type is termed "Cutover standing" and embraces 60 per cent. of the area.

The third type embraces areas on which no great number of milling trees existed, and which are largely in their original condition. This type is called "virgin or nearly so," and constitutes 10 per cent. of the area.

On the smashed flat type, extremely uniform and profuse silver pine has been noted on the bare ground in January, less than 12 months after logging. It was the only vegetation on the ground, and seemed well established in the full light. Abundant but patchy rimu regeneration has also been observed in the same manner within 12 months after logging, coming up in full light on the bare soil. The latter rimu area has been followed for three years since. Two years after logging came the rush of fern, but the rimu are doing well among it, growing appreciably, and with an extremely low mortality since the fern cover protected them from frost and excessive drying out. At four years since logging there is still no cover save the *Blechnum*, *Pteridium* and *Histiopteris* ferns.

Adjacent areas logged later show the smashed flat type still almost bare, but no rimu regeneration. Other areas logged previously however, up to ten years ago did show a satisfactory stocking of rimu seedlings doing well, seemingly, in a fern cover. *Coprosma* scrub, five finger and other shrub plants were here in scanty evidence at up to 3 ft. in height. Judging from the evenaged stands originating naturally such areas can presumably be considered stocked. Intermittent seed years may explain why the recently logged areas have not yet responded, but given an adequate seed source, they may yet do so. The chief obvious difference between these smashed flat areas and the blowdown areas is only that most seed sources have been removed over rather wide distances.

On the "virgin or nearly so" type, comprising 10 per cent. of the area, a fair to dense stocking of large or small poles, together with a few small standards may be found. Sapling areas are usually more numerous, however, and in most cases are present to fairly full stocking. They represent thus a small proportion of the area already occupied by advance growth. The older trees, such as the small standards, may serve as a seed source for adjacent areas of the other two types. These "virgin or nearly so" areas are mainly on flats, and are usually evenaged in form. They may be rimu only, or rimu-silver pine and have evidently originated on comparatively recent blowdowns.

The "cutover standing" type is dominant by area, and presents the least favourable conditions so far as regeneration goes. Here the kamahi is not destroyed, and following logging, suckers vigorously. Other fourth tier shrubs swell the volume of this growth, so that by ten years from logging a dense cover

up to ten feet in height is in possession. Under this cover no rimu seedlings can be found up to ten years from logging. Eventually, however, this cover finishes its height growth and opens out beneath. Rimu seedlings then seemingly germinate on the floor, and develop slowly but surely through this material to emerge finally above it, and form once more the upper canopy. The time lost by this temporary broadleaved cover may be considerable, however. Areas said to be 40 years since logging near Rimu are in the large seedling and small sapling stage. Another area said to be 60 years since logging is entering the small pole stage, the rimu tops just emerging above the kamahi at about 40 feet from the ground. How these compare in time with smashed flat areas immediately regenerated cannot now be said.

Summary.

In summarising the data given here, it may be said that while certain parts of the cycles are lacking, the evidence to date is far from contradictory and baffling, but is corroborative and fairly definite. The life cycles set out are, it is believed, fairly fully and clearly substantiated.

It is shown clearly that the rimu will develop naturally along either an evenaged or an all aged form, the first being the more general on the terrace flats. It will regenerate freely in most cases on exposed mineral soil in full light, and suffer no great damage from the great density of light loving ferns. It will also regenerate on the thick leaf mould under gaps in the canopy, and will emerge eventually triumphant over the broadleaved third tier. It shows therefore considerable versatility in its silvical requirements, and there is little doubt that it is the final or climax type on practically all parts of the morainic terrace areas.

From the management standpoint, the following matters might be especially stressed.

First, the evenaged character of much of the best logging stands. On these areas it should be possible to reserve areas of young growth practically intact, while logging the older age classes.

Second, the interrelation of the rimu and silver pine life histories which seems to promise two crops on the area in one rimu rotation.

Third, the smashed-flat type seems to provide the best seed ground provided the distance from a seed source is not great. Reservation of areas of young-mature material might make possible a better seeding up than now obtained in many cases.

Fourth, in the all aged stands a considerable advance growth of saplings and small poles is often present. Logging by a mobile power unit as the caterpillar tractor might enable much of this to be preserved.

LIST OF BOTANICAL NAMES OF TREES MENTIONED.

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| Bracken fern: <i>Pteridium esculentum</i> | Myrtle: <i>Myrtus pedunculata</i> |
| Coprosma scrub: chiefly <i>C. parviflora</i> | Rata: <i>Metrosideros umbellata</i> (syn. <i>lucida</i>) |
| Five-finger: (Whauwhau) <i>Nothopanax Colensoi</i> | Rimu: <i>Dacrydium cupressinum</i> |
| Hinau: <i>Elaeocarpus dentatus</i> | Silver pine: <i>Dacrydium Colensoi</i> |
| Hupiro: <i>Coprosma foetidissima</i> | Tawheowheo: <i>Quintinia acutifolia</i> |
| Kamahi: <i>Weinmannia racemosa</i> | Toro: <i>Suttonia salicina</i> |
| Miro: <i>Podocarpus ferrugineus</i> | |

THE RIND OF THE PODOCARPS, WITH SPECIAL REFERENCE TO THE BARK.

(O. CRADDOCK.)

[An abstract of a Thesis presented for M.A. Degree, University of New Zealand, 1932.]

This research was undertaken in order to ascertain the underlying causes of the characteristic bark formations found in the different species of podocarps. Broadly speaking, the barks fall into two distinct types: (1) the scale type, e.g., kahikatea, in which flakes of various shapes and sizes are shed from time to time; and (2) the fibrous type, e.g., totara, in which the bark peels off in large stringy or papery sheets.

In both bark types there are many variations as to size, shape and hardness in the various species and also in different parts of the same species; and these variations were found to be closely correlated with their histological structure.

The term "rind" is used to designate all that tissue outside of the wood, and the term "bark" all the tissue cut off by the formation of cork.

For various reasons seven species were selected for detailed study, e.g., kahikatea, totara, rimu, matai, miro, silver pine and tanekaha.

The method adopted was to take representative samples of bark from the tip of the youngest twigs down to the base of the trunk, to cut sections and examine them microscopically. In this way representative series were obtained, showing the time and place of origin of the first formed cork, down to