

Results.—The following table shows the results of the sex determination on the six sample plots investigated:—

Plot No.	Area	Male Trees	Female Trees	No Sex Characters	Total
C 4	1 acre	14	16	1	31
C 6	1 acre	13	8	0	21
C 12	1 acre	7	11	0	18
C 13	1 acre	12	9	1	22
C 14	$\frac{3}{4}$ acre	16	15	4	35
Midland Sawmilling Co.'s Area	1 acre	10	10	0	20
TOTAL	72	69	6	147

It is thus seen that out of 141 trees showing sex characters 72 were male and 69 female. This is approximately 50 per cent. of each, and as far as the areas investigated are concerned, the numerical distribution of the sexes is approximately equal.

It is intended as opportunity occurs to make further sex determinations in sample plots of rimu and other podocarps, but the above preliminary results may prove of interest to those engaged in similar investigations elsewhere.

THE GROWTH AND YIELD OF EXOTIC CONIFERS IN CANTERBURY.

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1. INTRODUCTORY.

NOTE.—This is the first section of an exhaustive article being prepared from the records of an extensive study of this subject inaugurated by the School of Forestry in 1925 and still in progress.

A. The Climate and Soils of Canterbury:

The province of Canterbury lies between 43° and 45° south latitude, occupying the central half of the eastern watershed of the South Island of New Zealand, from the Conway to the Waitaki Rivers (a length of 200 miles), and from the eastern coast to the summit of the Southern Alps (a width of roughly 75 miles). Topographically the province may be divided into

three main units, as follows: First is a rounded isolated system 30 miles across of steep volcanic hills covered with loess clay forming Banks Peninsula, the most characteristic feature of the eastern coastline. The drowned craters form the two natural harbours of the province, Lyttelton and Akaroa. From these shores the land rises in lava cliffs to the summits, 2,000 to 3,000 feet, thence to fall away relatively easily to the outer sides.

The second division is that embracing the lowlands from the coast to the foot of the mountains, an area 200 miles long by 20 to 50 miles wide. This may be further subdivided into three distinct soil types—a littoral of sand, both stabilised and wandering dune, extending for 50 miles along the central portion of the coastline, and penetrating perhaps two miles inland at most; a broad shingle plain of alluvial formation, roughly 100 miles long by 30 to 50 miles wide; and an area of gently rolling clay and limestone downs and low hills between the shingle plains and the mountains, reaching to the sea coast at both the north and the south ends of the province.

The third division is the mountainous area extending the whole length of the province, and 20 to 50 miles wide. The mountains rise sharply from the gravel plains and clay downs at about 1,000 ft. elevation, to form a frontal range 7,000 feet high, behind which lies an extensive mass of lateral ranges and deep river basins, culminating in the main range of the Southern Alps, which runs up to 12,000 feet and carries an extensive system of glaciers.

Planting of exotic trees has been carried out on the Peninsula, on the sand areas, the plains, the downs, and in the mountain basins. It is naturally with the second division, however, that this paper has the most concern, and the mountain division will receive little further mention.

With such marked variation in topography, the climate is windy and changeable, though the seasons show a well-marked difference in temperature. Three prevailing winds may be mentioned—the light easterly sea breeze, most noticeable and most disagreeable in the spring-time, when growth is distinctly retarded; the south-west, a rain-bearing storm wind most common in winter; and the north-west, a hot parching wind of the föhn type, the anti-trade wind robbed of its moisture and compressed in passing over the mountain range. Both these latter winds reach gale force, and do considerable damage in forest plantations. Temperature is on the whole equable, the lowest level being reached in still, clear weather in June and July, when night frosts of 20° F. may be experienced, followed by warm clear days. Snow occurs on the lowland division only in light temporary falls lying for a few days, though in periodic bad winters falls of over a foot may occur in a wet clinging

snow causing considerable breakage, particularly in pole stands. Rainfall varies from over 200 inches at the summit of the Southern Alps to 25 inches on the eastern coast. On the plains or lowland division it increases from the latter figure at the coast to 40 inches at the base of the mountains. The plains area thus shows in its narrow width a very considerable difference in rainfall, while, rising as it does to 1,000 feet at its western margin, increasingly severe frosts are experienced proceeding inland, though the retarding effect of the cold easterly sea breeze becomes progressively less felt also proceeding in the same direction.

The principal factors of site influencing tree growth in the province (excluding the mountain division) are therefore the three soil types of the sand of the coastal belt, the clay of the downs and the Peninsula loess, and the shingle of the plains. The first two soil types, by reason of location and smallness of area, have practically uniform climatic conditions as well as fairly uniform soils. The third soil type, by far the greatest in area, shows not only a considerable variation in depth, texture and moisture retentivity, but a marked gradation in rainfall and temperature.

B. Forest Planting in Canterbury:

The organised settlement of Canterbury began in 1851. At this time the Peninsula was densely forested, and the frontal ranges were fairly well clothed in forest. On the downs of South Canterbury were various small forest areas. The wide expanse of shingle plain supported only a tussock grassland.

Settlement naturally began on the plains, and an acute timber shortage developed early. The forests of the Peninsula and South Canterbury were exploited and destroyed in a relatively short time, and timber was imported from other parts of New Zealand and from Australia.

The windy climate also made sheep-farming hazardous and cropping impossible on the bare plains.

Extensive planting began, primarily for shelter, and also for fuelwood and future timber supplies. Large landholders had begun the formation of plantations about the homesteads as early as 1860. Plantation reserves were set aside by the Provincial Government, and later by the General Government. In 1886 such reserves were vested in the local authorities to the extent of 15,000 acres in Selwyn County,* 10,000 acres in Ashburton County, and 5,000 acres in Mackenzie County, the three chief plains counties. The reserves were in the form of belts and blocks of 50 to 100 acres scattered about so as to render greatest protection from the wind. These were to be afforested

*Now controlled by the Selwyn Plantations Board.

by the counties and no revenue received from the reserves was to be diverted to any purpose other than forestry. With slight changes, these provisions are still in force. Private planting of shelter belts and small blocks continued steadily with closer settlement, until now few farms on the plains are without a certain minimum of trees.

On the sand dunes of the coast other local bodies such as Christchurch City began on their own initiative to start afforestation areas of greater or less extent, both to stabilize the dunes and reclaim waste land, and to provide employment in times of social stress.

The aggregate area of plantation in the province is therefore comparatively great. The local authorities alone have over 15,000 acres already formed with reserves of equal area yet unplanted, while private plantings are difficult to arrive at but are estimated at 11,000 acres, though much of this is definitely not commercial in character.

In the early planting a great variety of tree species was experimented with, established usually in mixture. Some of these oldest blocks contained upward of twenty species of European, American and Australian origin. The urgent need for shelter and fuel put a premium on rapidity of growth, while the low rainfall and parching summer winds soon demonstrated many species to be unsuitable on the plains. Later plantings were therefore simpler in character. In the 80's and 90's the Selwyn and Ashburton Counties were forming the following types:—Wattle (*Acacia dealbata*), a quick-growing scrub, later to prove of no value other than shelter, and almost a noxious weed; Eucalypts, mainly *E. Globulus*, quick-growing, frost-hardy and extremely useful for fuel and farm timber, though later to be badly attacked by insect epidemics; and mixed conifers, containing several pines, larch, spruce and Douglas fir. Insignis pine (*P. radiata*, Don.) was always an ingredient in these mixtures, and in all cases through its rapidity of growth dominated the whole stand. Blocks of this type now being milled contain about 15 to 20 per cent. numerically of insignis pine, but this species forms over 90 per cent. of the saw timber volume, the remaining species being badly suppressed, and mainly of fuelwood size.

Recognition of the rapidity of growth of the insignis pine, and of its general suitability to the plains, led to its use in pure stands, beginning about 1900 and becoming very well marked after 1915 when the war-time exploitation of the older plantations for saw timber showed the commercial possibilities of these artificial forests, and concentrated attention on high yielding species.

Since 1920 the general trend among local bodies and private

owners has been to plant insignis pine on all the drier parts of the plains, with Douglas fir, ponderosa pine, Corsican pine, larch, etc., close to the hills with their higher rainfall. Pure stands are now the rule for all species. Planting spacing is usually 8 x 8 for insignis pine, to 6 x 6 for the slower-growing species. Little thinning is done. A recent trend is the conversion to pure conifer stands of areas previously in wattle and in eucalypts, by various schemes of under-planting, line-cutting, etc.

C. Utilisation of Exotic Plantations in Canterbury:

The earliest use of the plantations was secured from the quick-growing eucalypt stands in the form of fuel, stakes, posts, poles and similar round timber, often obtained as thinnings. The sawing of exotic timbers had certainly been begun in a small way prior to 1910. The war years, however, with their shortage and high price of native building timbers from Westland and Southland, caused a small boom to develop in milling the coniferous plantations. The stands were close to the consumer with good road access, firm bottom free from underscrub, and returning surprisingly high yields per acre. At first the timber was obtained very cheaply from farmers having little idea of the value of coniferous timber. Later, competition for the rather limited supplies of older timber forced royalties up sharply. Small mills, mainly of second-hand and inadequate machinery, powered by steam traction engines, became numerous. The product was badly and wastefully cut, and was inferior in quality, but, being cheaply obtained and transported, was sold readily in rural districts as a second grade building timber.

The cessation of the war, and then in 1923 the opening of the Otira tunnel giving direct rail access from the Westland forests, brought about a drop in the price of rimu so that the exotic product could no longer compete even in rural districts as a building timber. It had by this time, however, established a definite place for itself as a boxing and crating timber, and now may be considered almost entirely from that point of view, competing in consumption and price level not with rimu, the staple building timber, but with imported American and Baltic box shook. The recent severe depression in the native timber sawmills, caused by the cessation of building, has therefore hardly affected the exotic mills, as production of fruit and similar commodities has been well maintained. The exotic mills have, however, been meeting very severe competition from imported shook, which has necessitated a great improvement in methods of sawing, drying and finishing the local product, and has brought the price level down to a point where only the soundest mills have been able to remain in the business.

The insignis pine, which furnishes the great bulk of the exotic timber, is an intermediate pine, soft, light, and low in strength, coarse grained, but fairly fine in texture, tough, and giving a clean white surface. It holds nails well, does not split easily, is light, springy, and takes a good brand. It is characteristically knotty, the tree being a bad natural pruner, and the timber being frequently from heavily-limbed trees in single rows or long narrow belts. Debarred from use in all permanent buildings by practically all city and borough building codes, due to its low strength, its knottiness and its proneness to attack by the borer *Anobium domesticum*, it is nevertheless the most suitable timber in New Zealand for boxing and crating, entering every field of local and export container except butter boxes, where a non-tainting wood is essential. It is also used for concrete forms, for brush handles, toys, and various lines of turnery and woodenware, having become in fact a lower grade but satisfactory substitute for kahikatea in almost every line of use.

Improvement in manufacturing technique has recently enabled the local exotic to secure from the imported shook a number of large casing lines such as for cased motor spirit, the Island fruit trade, etc., so that production in New Zealand as a whole has increased. In Canterbury, however, the saturation point has been reached, and there is now in sight a volume of available timber far greater than the market can absorb. Most casing is secured by contract, and there is very keen competition for the industrial and fruitgrowers' contracts about Christchurch. Loss of a large contract now usually means cessation of production to a miller, if not bankruptcy, and stands of timber of fair quality have recently been offered for sale to millers and found no buyers, while the salvage of windfallen timber, always a big item on the plains, has become absolutely impossible, both the sawmill and the fuelwood markets being glutted.

Royalties have naturally fluctuated. They reached their peak about 1924, when the older plantations were being cut out rapidly, and the demand was still expanding. Blocks of some size went then to as high as 5s. 3d. per 100 superficial feet sawn out with 5s. a cord paid on slabs and limbs sold for fuel. A downward movement began with the opening of the Otira tunnel (end of 1923), and continued as the demand ceased to expand, as the general price level fell, and as great volumes of available timber came in sight as the extensive plantings of pure insignis pine stands approached exploitable size. Present royalties range, therefore, from 6d. to 2s. 6d. per 100, the latter figure being reached only in blocks of some size, containing trees of fairly clean trunk, and located fairly close to city or rail.

The future is rather difficult to predict. The local bodies are extending their plantations steadily, and increasing their yields through the higher proportion of pure stands of the quick-growing insignis pine. The present annual production from the local mills in Canterbury is 3,000,000 super. feet according to 1930-31 statistics. Well over half of this production could now be continuously supplied from the Selwyn plantations alone with only 10,000 of their 15,000 acres so far planted. The Ashburton areas are extensive, while the Christchurch city plantations are not far short of exploitable size.

The demand for casing will seemingly not only cease to expand, but is actually diminishing as plantations in Otago and Nelson are now being milled to supply cases formerly sent from Canterbury. So long as rimu is available it is not likely that the insignis pine will find a use as building timber. It is advocated by some that insignis pine should give way in the local body planting programmes to slower-growing species likely to produce good building timber, such as ponderosa and Corsican pines, Douglas fir, and cedar (*Cedrus spp.*). Planted now, they might be ready on exhaustion of the virgin forests of Westland. Against this are put the following arguments—that the soil and climate of the plains are distinctly trying, and the insignis pine is the only species that may be definitely relied upon to develop successfully; that where the other species mentioned have been milled, they have not produced good building timber, being extremely coarse in grain and texture, light, weak, knotty and not durable, so that they have been fit only for casing; and that the Westland forests can very probably produce rimu perpetually under management, so that growing exotic timbers on good agricultural land may not be economical. A future extensive demand for an export pulpwood industry is of course widely discussed as a possibility that may eventuate.

These are matters for the various local authorities to consider. They are simply presented here to show that although organized forestry is now an actual completed fact in Canterbury—the Selwyn Plantations Board, with an expanding planting programme, has been on a commercially profitable basis for nearly two decades—it cannot be accepted that there are large profits in it, or that our markets and uses, as well as our silvicultural practice are on anything like a stable and permanent basis.

With so much introductory matter, which it is hoped gives an accurate if brief bird's eye view of forestry conditions in Canterbury, attention will now be confined to the actual records of growth and yield in these exotic plantations.

(To be continued.)