> higher and less variable density in the great bulk of the timber (which at the same time reduces the low density defective core timber to a percentage which may easily be absorbed in the less exacting uses). Fifty years or more for final crop trees may be envisaged.

Can we afford *not* to prune and thin the stands when the resultant products of such treatment appreciate in value to the extent that may be expected with this species.

If it is practicable to envisage pruning of a proportion of trees in a stand which will be removed as thinnings there is a limited market for natural rounds. But they will no doubt still possess the disadvantage of low strength inherent in the low density core. Other species have obvious advantages when items such as poles are considered. One of them is the desirability of getting a high retention of preservative in the outer layers without having to go to excessive absorptions ; resistant heartwood is an obvious advantage there.

Finally, there must be the thought that whatever silvicultural treatment is given to *P. radiata* it will not rate higher than second or third choice for many wood uses. One falls easily into the trap of thinking, just because we have a lot of *P. radiata*, that the wood technologist is morally obliged to adapt the timber or methods so that it may suit all needs. That is unhealthy ! It may not be untimely to suggest that the Institute should accept its responsibility as the professional body concerned with forestry in the wide sense, for pointing out that national timber needs can be met only by having a range of timbers.

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# ANALYSIS OF THE GROWTH MEASUREMENTS OF YOUNG PINUS RADIATA D. DON.

## I. AN INTRODUCTORY ACCOUNT OF THREE OBSERVATION PLOTS AT ATHENREE, BAY OF PLENTY

By C. S. BARKER

In March 1949 it was becoming apparent that precise information on the growth of young *Pinus radiata* was lacking, at least as regards Athenree. During 1948 some plots had been established in what were then 6 and 12 years old trees. On reflecting on the information derived from these plots at that age, it became clear that they would yield only some *conventional* information beginning at the age of 6 and 12 years respectively. The chances were that much valuable information and perhaps the most important data had been irrecoverably lost previous to these measurements. On further reflection it could be seen that in the 6 and 12 years old stands some trees were more vigorous in growth than others. Supposing that the source of the seed, aspect, microclimate and soil were similar for both plots, would the poor and good trees in the younger plot still be the same poor and good trees after another six years and howwould they compare in six years' time with the general look of the present 12 year old trees ? It then became obvious that plots should be established in young stands and the growth followed through fromthe time of planting. These plots could also be used to obtain observational evidence regarding a deep seated conviction of long standing that trees in their seedling stage would show some indication of what they would do in the future. This latter proposition would be intriguing if it were proved to be so, for besides having basic interest it would have practical importance in the selection of planting stock. So, in March 1949, a $1\frac{1}{2}$ x $1\frac{1}{2}$ chain plot was established in 9 ft. x 7 ft. spaced *Pinus radiata* that had been planted in July 1948 and the following August another $1\frac{1}{2}$ x $1\frac{1}{2}$ chain plot was established in $9\frac{1}{2}$ ft. x $5\frac{1}{2}$ ft. spaced trees that had been planted the previous month. These two plots were added to in 1950 by a 3 x 3 Latin square plot (one acre approx. in area, 10 ft. x $9\frac{1}{2}$ ft. spacing) that was established in freshly planted trees to observe the effect of superphosphate and rock phosphate on the growth of the trees. Up to the present time the fertilizers have not made any outstanding difference to the growth of the trees.

The two $1\frac{1}{2}$ x $1\frac{1}{2}$ chain plots were measured annually in July after the initial measurements and the fertilizer plot was measured half yearly in January and July after the initial measurement. It is hoped to continue the measurements at these dates.

Up to July 1953 the following information has been derived from the three plots.

(a) RETARDED LEADER

From one source of seed (Methven Canterbury) retarded leader trees were derived from tall seedlings and throughout subsequent measurements are taller than the normal trees. The two remaining plots were derived from Foxton seed, but unfortunately the 1949 plot may have been derived from mixed seed. In the 1948 plot it is the normal trees that are significantly taller than the retarded trees with the exception that when the trees are based on the July 1950 classification then the state is reversed. In the 1949 plot there is evidence which conflicts as to which class was initially the tallest or is the tallest at a given date.

To examine the two classes of trees, the trees were arranged in tables of their classes at the dates of measurement, and the same trees were traced throughout former and subsequent measurements.

To examine the differences between the two classes the pooled standard deviation was used leading to Fisher's t test of significance of the means of the classes.

## (b) INITIAL HEIGHT COMPARED WITH SUBSEQUENT HEIGHT, DIAMETER AND VOLUME.

To examine the relations between the initial heights and subsequent heights and initial heights with subsequent diameters and volumes, the initial heights were arranged in descending order of height, and the same trees traced throughout subsequent measurements. A percentage of the shortest and the tallest trees of this order in height was examined. By arranging the heights in order of height, it is the two tails of a frequency curve which are being examined, if a percentage of the shortest and the tallest trees is taken. For the purposes of the analysis each tail was split up into four lots of 10% and examined in the form of 10%, 20%, 30%, and 40% of each tail. The remaining 20% grouped about the median was also examined.

In all these plots, it was found that the shortest trees and the tallest trees of the initial measurement on an average, were giving rise to the same class of tree. Two of the plots are now old enough to measure diameter and volume and the same corresponding differences are found.

The basal area volume relationship of the two initial classes of trees was examined for the July 1952 measurement of the 1948 plot. It was found that the resultant curves cut the basal area axis at different points indicating that the subsequent form of the initially tall and short trees is different. The 1953 measurements have not yet been examined with the exception that a preliminary investigation appears to confirm the 1952 measurements.

The initial heights can be examined in a different way by arranging in order of magnitude based on subsequent measurements. At the time of writing this has been done only for the 1952 diameter measurements of the 1948 plot. It was found by this method that there is a most pronounced relationship between the large diametered trees and tall seedlings and a corresponding relation with the small diameter trees.

## (c) WINTER SHOOT DEVELOPMENT

In the work done so far, only a little attention has been paid to observing whether growth is actually taking place at the dates of measurement because of the difficulty of interpreting what one sees in terms of growth, more particularly when compared with a retarded leader tree. In work of this nature, information on early and late flushing may be of great importance. In this connection the following paragraph would appear to be of basic interest if adequate explanation could be given.

When the 1948 plot was measured on the 28.7.1950 it was observed that some trees appeared to have growing terminal shoots while other trees appeared to have dormant terminal shoots. This was noted on the field sheets, but not examined until November 1953. Tables were prepared setting out the two classes in such a way that the same trees of the 28/7/1950 measurement could be traced throughout the former measurement and subsequent measurements. Fisher's t test was applied to the differences of the means of the two classes for all the annual dates of measurement for height and to the last two dates for diameter (July 1952 was the first date at which the plot had measurable diameter.). In all cases the mean of the dormant class was found to be greater than the mean of the growing class both for height, diameter and volume. In all cases this difference between the means is very highly significant with the exception that at the date of classification the difference is not significant. In section (a) of this paper it was noted that the July 1950 classification of retarded leader for this plot did not conform to the subsequent classifications in that the retarded trees were taller than the normal when classified on the July 1950 observations only. A further point of interest is that in both cases the differences are not significant at the date of classification but significant throughout the remaining dates of measurement.

## DISCUSSION

This paper deals with observational work that is still being gathered The oldest plot is only 5 years of age and in consequence it will be another ten years or so before any real conclusions can be drawn. However by studying graphical representations of the data of the oldest plot, it may be seen that in another two or three years some very interesting results may arise when root and crown competition becomes severe. If the trees had been planted at the usual 6 ft. x 6 ft. spacing it would be safe to say that tentative conclusions could be drawn at a much earlier date.

It appears that by establishing plots in young *Pinus radiata* some very useful information can be derived. The amount and degree of information appears to be proportional to the fineness of observations both in time and measurement. By beginning observations on seed of known origin and purity before germination, a great deal more valuable information could be derived than by starting observations after planting, as has been done here. The essential part of this work should be measurements and observations made at the beginning on the seed, set out in such a way that they may be referred to, tree by tree, for future reference and tabulation. Each attribute as it arises should be compared and tested with past measuremets.

On reflecting on work of this nature in terms of the two tails of a frequency curve with a limited number of variates (seed or trees), it would appear that much greater value would be derived from an increase in the number of variates per plot rather than a restriction of the variates per plot to give an increased geographical range.

This is observational work that is in progress. What is found today may not be found tomorrow. However, in the future, if this is found to be so, it does not affect the importance of the present findings if they have been proved significant at the time. For instance, retarded leader which at present manifests itself in the Methven seed as the more vigorous class may merely be a *juvenile phase* of some other attribute that may be desirable or not. It may be found that the first one or two per cent of the initially tallest seedlings may develop into large branched monstrosities or emerge into the realms of the elite. Again, it might be found that it is the seedlings grouped about the mean that are the favoured ones of the future, small branched and yielding good clean timber.

## SUMMARY


1. It is suggested that conventional sample plots do not bring to light all the information that should be collected for silvicultural purposes and that perhaps the most important data has been irrecoverably lost before sample plots are established.

2. An hypothesis is put forward for consideration that seedlings and very young trees will give an indication of their future growth if a key can be found to unravel their juvenile attributes.

3. Three observation plots have been established to prove the ideas given in paragraphs 1 and 2. The oldest of these plots is now 5 years old. To date several trends of growht have become apparent and if these trends hold into the future, then it could be said that some useful information has been obtained.

# INSECT EPIDEMICS ON FOREST TREES IN NEW ZEALAND

G. B. RAWLINGS

## FOREWORD

This paper, which does not set out the results of any particular piece of research, was presented as a contribution to a symposium on Forest Communities at the Second Annual Meeting of the New Zealand Ecological Society held in Wellington in May 1953. It was written largely for botanical ecologists, to illustrate the important part played by insect epidemics in the normal development of forest communities, a point which tends to be overlooked by most botanists. As it had to be restricted in length to keep within the time limits set for reading papers, it may be found wanting in detail and also over-positive in certain unproven statements. Nevertheless it is felt that, even removed from its context, it may prove sufficiently useful to practical foresters to justify its publication.

## I. INTRODUCTION

Before dealing with specific cases of insect epidemics in New Zealand forests, it is proposed to treat briefly with the causes of epidemics and the sequence which they may be expected to follow. As this sequence is complicated and too varied to be discussed fully the generalisations made must not be applied unreservedly to specific cases.

An insect may normally maintain its population at a high level or at a low level, and the level will fluctuate both throughout the year and as between one year and another. Fluctuations within normal limits usually pass unnoticed, but occasionally abnormally large numbers of insects are produced, giving rise to the condition known popularly as an epidemic or plague.

Such epidenics may be brought to the notice of the casual observer through the defoliation or killing of plants, the pollution of reservoirs or even through the stopping of trains. Many epidemics of small harmless species, such as Psocids, pass entirely unnoticed. Epidemics are transitory in nature and have a recognisable course characterised by a rapid rise in population, a peak period, and a sudden decline.

In the conventional treatment of insect epidemics it is usual to recognise a number of developmental stages which may be summarised as follows:—

1. *The biotic balance*; this is the normal state, previous to the epidemic, in which a balance is maintained at approximately the normal level.