to a degree that would have taken the interrupted plant succession at least one hundred years and probably more to bring about.

These changes have been to the good and have made the conditions suitable for the regeneration of *Pinus radiata* without allowing the competing vegetation to become strong enough to have an adverse effect on the pines. This is an occasion when the changes have been to our advantage. There will be changes also on the better sites and on these foresters will need to keep a watchful eye in case the bracken and other ferns are stimulated to a stage where their competition will have a detrimental effect on regeneration of forest trees.

SOME CHARACTERISTICS OF PINUS RADIATA THAT CONTRIBUTE TO ITS IMPORTANCE IN AFFORESTATION IN OTAGO AND SOUTHLAND.

By C. R. CRUTWELL

(Paper read at Annual Meeting)

The object of this paper is to discuss some characteristics of *P. radiata* which contribute to its importance in Otago and Southland. The six features to be described are not given in order of their importance, nor are they put forward as being the only special attributes of the species.

(1) The relative immunity of *P. radiata* to serious damage by vermin. This is an attribute that may prove to be indispensable in western Southland because in that region very serious damage has been done to species that are in other respects well suited to our requirements. Such damage may be considered under the following three classes :—

(a) DAMAGE TO PLANTING STOCK : Deer, rabbits, and hares may be expected to bite off leading shoots of almost all species. Therefore, the tree that quickly grows beyond their reach always suffers the least. In this respect *P.* radiata is far more suitable than are most species. Deer in western Southland are menacing beech forests to an extent that should emphasise the value of less palatable exotics in the role of alternative timber resources that might be used until deer are adequately controlled. Only at that very uncertain date in the future, will a serious obstacle to management of hardwood forests be removed.

(b) DAMAGE TO SAPLINGS : *P. radiata* saplings are rarely damaged by browsing. While this is true of most species of pine,

there are some important exceptions, one of which, *Pinus strobus*, has been largely destroyed by deer wherever it was planted. All trees that bear thin bark near ground level for a long period of years, say 20 years, are in much greater danger than is *P. radiata*, and the use of Douglas Fir for interplanting on cut-over bush has proved very hazardous for this reason.

(c) DAMAGE TO CROWNS: P. *radiata* is occasionally damaged when opossums are very numerous. It is however, much less severely attacked than is *P. ponderosa*, Douglas Fir, *Thuya plicata* and most indigenous trees.

(2) *P. radiata* has a wide tolerance of planting sites. In New Zealand *P. radiata* has succeeded wherever soils are moderately fertile and the climate free from extremes. Though the geographical limits of its range in this country has not been fully examined they appear to correspond closely with the natural distribution of manuka, especially in respect of rainfall requirements and tolerance of frost. Areas outside this climatic range are largely mountainous, thinly populated and relatively inaccessible. Thus the unsuitability of *P. radiata* to these areas is of little importance while economic considerations demand that production forests be located near centres of population.

In considering further the influence of climate upon afforestation it should be noted that none of the exotic species hardier than *P. radiata* have yet proved so well suited to forestry practices and market requirements in New Zealand. The only hardier species as yet planted extensively are Corsican Pine and Ponderosa Pine, in both of which rates of growth, even on more favourable sites are no more than half that obtained in *P. radiata*.

It is also remarkable that in very dry and frosty regions, such as Central Otago, where *P. radiata* cannot be relied upon for timber production, it is still an indispensable shelter-tree, and provides effective shelter more speedily than any other species.

The vigor with which *P. radiata* stocks grow in the first decade after planting is well known to foresters, but it is important also in its influence on the most casual observer among the general public, as it is largely this capacity that has led to the recognition of a planted forest as a growing crop worth tending and attracting investment. Silviculturally this quality is a tremendous asset, and in the establishment of first forest cover there is very rarely the prolonged uncertainty over prospects of success that often occurs where shade tolerant species are held in check, or come away in patches.

It is significant that in State forests in Southland and Otago *P. radiata* has been chosen almost exclusively for replanting failed areas. The following figures illustrate the extent to which this has occurred at Conical Hills and Dusky Forests, the location of the

most prolonged large scale afforestation in the two provinces :

Total area replanted after failures, since 1900=512 ac.
Total area replanted in P. radiata 334 ac. or 65.3%
Total area replanted in other species 178 ac. or 34.7%

(3) The relative freedom from disease of *P. radiata*. Within the coastal belt of Otago and Southland and also within those areas receiving over 30" of rain per annum, conditions are eminently suitable for forest growth. In exotic forests within this extensive region the incidence of tree diseases is very small. That this condition persists in *P radiata*, the most widely planted species, demonstrates that *P. radiata* is thoroughly well adapted to this region. It may also be that cool humid conditions in this region have been the decisive factor in preserving these forests from the serious insect epidemics to which forests further north are subject.

The high stocking that can be maintained in *P. radiata* stands in Southland and South Otago is a measure of the health of this species there. Detailed enumerations of 20-year old stands planted at 8 ft. by 8 ft. commonly disclose 500 living trees per acre.

(4) Relatively low costs of tending *P. radiata*. Tending operations are an inevitable but unwelcome increase in capital expenditure. It is therefore of particular importance that in *P. radiata* costs are relatively low in the following operations :—

(a) Pruning. Pruning costs per acre are low in relation to those in other species because *P. radiata* is initially widely spaced and has a branching habit that presents relatively few branches per unit of height of the stem.

(b) Supervision. It is characteristic of *P. radiata* that dominance is asserted very early and vigorously throughout life. This is of great assistance in the marking of thinnings. Also, where no thinning is done, dominant trees progress without any severe set-back, and there is not the tendency to stagnate that would occur in Larch or Poplar stands.

(c) Thinning to waste. One direct consequence of the wide initial spacing permissible with *P. radiata* is that unproductive thinning operations are never as intensive as closely planted stands of other species, nor need they be repeated. The rapid decomposition of slash of *P. radiata* also facilitates these operations.

(d) Utilisation thinnings. Revenue from intermediate yields can be expected at about 20 years when about 1500 cu. ft. per acre of sawlogs are produced. Douglas Fir and Larch are the only other species that yield profitable thinnings of this age, but even then may not produce enough posts, poles and props of marketable size. The revenue from adjacent stands of *P. radiata* and *P. laricio* of equal age

treated simultaneously in Tapanui Forest shows that a higher yield per acre in *P. radiata* would more than compensate for a better price paid for Corsican Pine.
Yield from 27 yr. *P. laricio* : 800 c. ft/ac
Yield from 27 yr. *P. radiata* : 1360 c.ft/ac

(5) Ease of handling in nursery operations. The success of an introduced tree species depends greatly on its performance in the nursery stages. At present there can be few species that offer as little difficulties in preliminary operations as does *P. radiata* for the following reasons :—

(a) Seed is plentiful. Viable seed is produced early in life, and in great quantity. The results of a bad seed year are diminished by the persistence of viable seed in cones for up to 6 years.

(b) Seed is cheap. Because it has been widely planted stands of *P. radiata* are continually being felled and offer plentiful seed that can be collected cheaply. Collection of seed in most other species involves climbing. The fact that *P. radiata* seed is not shed as soon as it is ripe is also an immense advantage to the forester who has to undertake seed collection according to the demands of other duties and the availability of labour.

(c) Local seed is of good quality. Complete failure to germinate is virtually unknown in *P. radiata* seed locally collected.

(d) Seedlings grow vigorously in the nursery. The rapid growth of *P. radiata* seedlings has dispensed with the necessity and expense of lining out in transplanting beds as a condition in obtaining well grown stock. While this practice is not confined to *P. radiata*, it cannot be relied upon for such good results in other species.

(e) *P. radiata* transplants well. A low planting mortality is usually obtained on moderately fertile soils without any special preparations and with the employment of unskilled labour. In this respect *P. radiata* compares particularly well with the other species mainly used in farm forestry.— *Eucalyptus sp.* and *Cupressus macrocarpa.*

(6) The ability of *P. radiata* to suppress weed growth. In Otago and Southland the most fertile and sheltered planting sites are unfortunately those on which the most serious weed growth is met ; and conversely the absence of vigorous weed growth normally indicates severe climate or poor soils. Thus successful afforestation requires species that are either capable of suppressing heavy weed growth or of thriving on poor sites.

In attempting to reduce costly release cutting the forester has had the chance of planting either shade-tolerant species that will

persist when partially overgrown or light demanding species that will immediately outstrip the weed growth. Entirely suitable shade-tolerant species have not been found. Of these the most promising, Douglas Fir, has suffered severe damage from the animals that frequent second growth bush and scrub, whilst the less palatable *Ch. lawsoniana* and *Thuya plicata* prove very slow to emerge, and have only become established in patches. Among light demanding species *P. radiata* alone can be planted with any confidence where there is severe competition from broom, gorse, bracken, manuka, tutu, Fuchsia and Himalayan Honeysuckle. Rapid height growth takes it clear of these weeds, which are effectively suppressed by its heavy shade. That the canopy of *P. radiata* is more effective in killing manuka than is that of either Corsican or Ponderosa Pine may be seen in the hundreds of acres of the latter species between 20 and 30 years of age which cannot be adequately tended because dense green manuka renders them impenetrable.

The most important aspect of planting in dense weed growth is the cost of line cutting and release cutting, and this consideration again emphasises the value of *P. radiata*. Firstly there is an economy in the number of lines per acre required because forest cover is quickly established when lines are as wide as 8 feet apart while in other species closer spacing is needed to compensate for the increased mortality associated with such planting sites. Secondly, it has been found that costs of release cutting in *P. radiata* are lower than in other species. On sites infested with bracken, manuka and tutu release cutting has often proved unnecessary. In contrast to this it has often been necessary to release *Thuya plicata* and Douglas Fir held in check by herbs and grasses. In the humid areas of western Southland, where relatively little planted forest has yet formed, establishment costs are raised so high by weed competition that they may well prove fatal to the future of this work. Therefore, more knowledge of the relationship betwen ground flora and planting sites will assist in afforestation of marginal land. To show some aspects of this problem observations on planted areas that require more than one release cutting were made at Herbert Forest, North Otago; Berwick Forest, South Otago and Longwood Forest, Western Southland. The species examined were *P. radiata* and Douglas fir which have been planted on similar sites.

The area treated more than once is expressed as a percentage of the total area planted in the species named.

Species	Forest	Percentage Treated Twice	Percentage treated Three times	Predominant Seed Species
P. radiata	Herbert	Nil	Nil	Bracken and gorse
	Berwick	1.8%	Nil	Bracken, tutu, manuka
	Longwood	2.9%	Nil	Bracken
Douglas fir	Herbert	25.9%	Nil	Bracken, tutu and gorse
	Berwick	5.6%	Nil	Bracken and manuka
	Longwood	45.7%	15.7%	Bracken, gorse, broom

CONCLUSION.

The useful quantities of *P. radiata* just described are at once an asset and a danger. 'Pinus radiata' is now almost synonymous with high production and rapid returns on investment. However, these properties must be exploited with discrimination and should not cause us to be impatient of other species, as natural causes may yet greatly reduce its range. Every effort should therefore be made to develop species capable of replacing *P. radiata* in its varied and important role in Southland and Otago.

PINUS RADIATA: A SPECIES OF ULTIMATE MINOR SIGNIFICANCE IN SOUTH ISLAND FOREST PRACTICE

J. T. HOLLOWAY

(Paper read at Annual Meeting)

A map of the South Island is presented on which five broad 'radiata capability' land-use classes have been delimited.

(1) BROWN LAND. Zero capacity for commercial growth of *radiata* forests. Land wholly exceeding 2,000 ft. in altitude.

(2) MAGENTA LAND. Zero capacity for commercial growth of *radiata* forests. Semi-arid intermonts of Canterbury and Otago. Sub-marginal in respect to rainfall and winter frost, marginal in respect to altitude.

(3) GREEN LAND. The land of high rainfall regions to the west of the main divide. Essentially permanent indigenous forest land. Sites and soils suited to *radiata* of strictly limited extent, principally, (a) local soil enclaves required for agriculture and (b) topographically difficult terrain in the Inangahua and Grey Valleys. No significant stands of *radiata* established to date and the greater portion of all present planting of species other than *radiata*.

(4) BLUE LAND. Land within the Conservancies of Canterbury and Otago and wholly exceeding an altitude of 1,000 ft. *Radiata* can be grown on Blue Land but must be sited with extreme care. In any specific forest established, or to be established, on Blue Land, *radiata* must remain a secondary species. Land within the altitudinal range of 1,000-2,000 ft. in Nelson Conservancy and on Banks Peninsula has a higher growth potential for *radiata* and is included in Class (5) land, below.