THE DEVELOPMENT OF NATIVE VEGETATION ON PUMICE COUNTRY, AND ITS RELATIONSHIP WITH EXOTIC PINE FORESTS*

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Prior to 1924 the pumice country in the Putaruru-Taupo district was covered with heath associations of which the principal components were *Leptospermum scoparium, Dracophyllum subulentum, Pteridium esculentum* and *Poa caespitosa.* On most boundaries these changed abruptly to mature and overmature podocarp-broadleaf forest associations. Attempts have been made to explain the presence of these contrasting plant associations by geological and climatic conditions, but neither of these provide adequate reasons as it can be shown that the areas are quite capable of, and have in the past, sustained high forests.

According to Baumgart it is now 1,700 years since volcanic eruptions occurred in this area and McKelvey, following Holloway's hypothesis of climatic change, has shown that the climate of the area was suitable for prolific podocarp growth and regeneration until about 300 years ago, but that since then the conditions have become unsuitable for the formation of dense podocarp associations and their place should have been taken by native broadleaf forest associations containing podocarp remnants. That this assumption is correct is shown by the existence of small pockets of such forests scattered throughout the district. It is significant that these are mostly situated on south and south-easterly slopes or on the bottoms of gorges.

The presence of these natural high forest outliers in this otherwise heathland is evidence that the soil is not the prime cause of this distribution of plant associations. It may be held that surface erosion has been rapid enough to prevent the establishment of a forest, but the fact that high forest exists on a number of hilltops and in gorges —both places subject to accelerated soil movement, shows that this is not the reason. Nor can lack of seed of native broadleaf species be a reason for their non-establishment, because all species have succeeded in establishing themselves on the outliers mentioned previously and, as will be shown later, ample seed is reaching the areas at the present time.

In the early nineteen twenties, large areas in the district were planted with *Pinus radiata,* and it is this species of pine that is referred to throughout this paper. With the establishment of these forests, rigorous fire control prevented the uncontrolled burning-off that had destroyed the vegetation at regular intervals in the past.

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The remarkable growth of these trees shows that this area is quite capable of supporting high forest.

For the first twenty years after planting, these pine forests were too dense to allow any plants to grow on the forest floor, and all this time the falling pine needles were building up a layer of humus. When the pines had passed their twentieth year, the number per acre and the denseness of their crowns had decreased sufficiently to allow enough light to penetrate to the forest floor to permit a number of broadleaf shrubs and herbaceous plants to thrive. Now, with the pines approaching their thirtieth year, the quantity of native broadleafed shrubs and tree ferns that are thriving beneath the pines is amazing. The principal genera are *Coprosma, Nothopanax, Coriara, Schefflera, Weinmannia, Cyathea, Dicksonia, Aristotelia* and *Brachyglottis.* These are forming a dense understory, often up to fifteen feet high, with numerous herbaceous plants and small ferns growing on the floor.

At present it is not possible to offer any definite evidence as to how the vast quantity of seed for the establishment of these native species has reached the interior of the pine forests, but there is no doubt about the quantity present. From this it can be assumed that in earlier times there has always been sufficient seed arriving for the establishment of broadleafed native species over all these areas, and there is substantial evidence that broadleaf species have been able to establish themselves in relatively large numbers on all areas whether covered with pines or not, so long as these areas have been protected from fire.

Many writers have postulated a slow spread of native broadleafed shrubs from the existing forest edge into the heath association, but they appear to be wrong in assuming that this movement will be slow and only from the high forest edge outwards, as it is evident that widespread conversions from heath to broadleaf associations would take place in the event of the area being completely protected from fire.

There is ample evidence that in pre-European times, the Maoris used fire extensively to clear land for agriculture. Bidwell in 1839 estimated the native population on the shores of Lake Taupo to be about 5,000, therefore considerable burning would be necessary to clear sufficient land for their agricultural activities. He described how the Maoris burnt off the forest and then used the land for three years for growing potatoes, after which it was abandoned for a new clearing. Fairly luxurious bracken fern growth followed, but with repeated burning this got shorter and sparser, until it was finally replaced by scattered tussock.

Assuming that this is correct, it means that the tussock associations are man-induced and they indicate a soil deficient in plant nutrients. These soils, through the destruction of the humus, have been reduced again to a condition similar to that which must have existed shortly after the falling of the pumice showers.

An example of an area that has reverted from podocarp forest to tussock is that which lies to the east of the Waikato River between Aratiatia Rapids and Lake Taupo. This area, once covered with heavy podocarp forest (Fletcher 1914) was, prior to the invasion of pine in recent years, considered to be completely useless. Further confirmation that the tussock associations are brought about by constant burning is to be seen in the large basin to the west of Horohoro trig. In 1920, this area was covered by broadleafed shrubs too tall and thick for a man on horseback to ride through. Repeated burning to clear the boundary of an adjacent exotic forest has changed this area to a predominantly tussock association, interspersed with stunted bracken fern and ti-tree.

Conversely, an area which in 1925 was sparsely covered with tussock was planted in pines in that year. These were felled 23 years later, and five years after that, a prolific growth of tall bracken fern covered the area, showing that where humus had been allowed to accumulate, the area is still capable of fern growth as the first step in the succession to high native forest.

From this it is evident that repeated burning caused this district to be clothed with a heath association instead of high forest.

This point is an extremely important one to ecologists, because it means that any area in this district which is protected from fire will, in time, succeed from a tussock and heath association to a broadleafed shrub association consisting principally of *Nothopanax, Coprosma* and *Coriara* and so on to taller broadleafs such as *Weinmannia* to form a high forest.

With this in mind it is interesting to turn our thoughts to the areas at present covered with pine forests and to speculate on the probable development of plant associations that would take place, assuming that these were allowed to develop without interference. The density of the broadleafed understory leaves little doubt that pine seedlings will be unable to develop and replace the parent trees so that the native plants would take over. No doubt many will question this assumption and will quote areas where pines appear to have invaded native vegetation, but I am certain that if these areas are critically examined it will be found that the invasion has been assisted by fire or some major disturbance that has exposed the soil to full light.

Next let us consider the position when the succession is interrupted by the clear felling of the pine forest so that the understory is destroyed along with the high forest. The soil is partly disturbed and pine seed is released in abundance on the areas. For the first year the ground cover is mostly annual weeds, which are followed in the second year by young pines associated with *Pteridium esculentum* on warm slopes and *Blechnum capense* on cold and damp slopes. On undulating areas broadleafed shrubs are present in varying densities, and on flat areas grasses and herbs form the main cover. Providing that the *Pteridium* and *Blechnum* are not too dense the pines quickly dominate the areas, but anywhere where conditions are

favourable for these ferns they suppress the pines almost completely. Wherever these ferns are absent the pines dominate the scene fairly rapidly although some dense patches of broadleafed shrubs, particularly *Coriaria, Coprosma* and *Nothopanax,* are capable of providing strong competition, and in some cases of suppressing many pines. In areas where grasses and herbaceous plants form the main ground cover the pines have no difficulty in successfully establishing themselves and dominating the area.

It is still too early to be certain of the make-up of the second rotation, naturally regenerated pine forests, but it is certain that they will bear little resemblance to the orderly plantations of the first crop. The timber yield will be lower, due to the unevenness of the distribution of the timber trees as well as to the increase in the percentage of the unproductive areas due to the intrusion of the native vegetation. However, this loss will not be as great in the long run as it first appears, because the litter from the native plants and shrubs will cause less leaching than pure pine litter and they will circulate soil nutrients that otherwise would be locked up in the acid mor and will, in this way, help to retard soil exhaustion. This is a matter that will require intensive study and it will need to be remembered that in trying to perpetuate the pine forests through natural regeneration, we are bucking against an ecological trend and must devise methods of holding the succession in an early stage. Each crop of pines with its addition of humus to the pumice soil, will improve conditions for native species, and increase the competition from them. The trend of forest development will be away from species of *Pinus,* all of which have pioneer characteristics. Silviculturalists will need to take cognizance of all ecological factors and understand the natural vegetation trends if they are not to engage in a bitter and forlorn struggle against nature. The prosperity of the utilization industries will depend on the economical production of wood and this in turn means the maintenance of a vigorous forest growing in harmony with its environment on a healthy and productive soil.

This paper is but a brief outline of a position that will require much research before the answers necessary for the intelligent management of the vast exotic forests can be found. In the past, a definite line has been drawn between indigenous and exotic forests, but it is apparent that this can no longer be the case, because of the intermixing of native and exotic vegetation. Ecological studies in exotic forests are necessary, and it will need to be realized that regeneration and silvicultural studies in exotic forests are essentially ecological in character.