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THE SAND DUNES OF THE DARGAVILLE COAST.

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The sand dune fixation work to be described in this paper represents an unusual feature in that the fresh supplies of moving sand to be dealt with are derived not from the sea shore, but from the breaking down of a series of sandstone cliffs of Pleistocene age.

The area affected is a fifty mile strip of the west coast of the North Auckland peninsula, stretching from Mangani Bluff to the North Kaipara Head. At the northern end the cliffs, which average about 160 feet in height, rise straight from high water mark, but proceeding south a strip of coastal sand intervenes between cliff and sea, gradually widening until at the southern end it is about five miles wide. This intervening coastal strip is fronted over most of its length by a low regular natural foredune well covered with native vegetation, and needs no attention. The work described is concerned only with the cliff dunes, and is at present being carried out over a front of eight miles about Red Hill.

The frontal line of cliffs rises steeply, clothed in some places but not in others, and breached at intervals by stream courses. Behind the frontal line of cliff the ground rises less steeply to a second smaller line of cliffs. The slopes between the two lines of cliff are of sand, peppered over with lumps of sandstone which have broken off and fallen down. These are soft, and break up easily, forming the main source of supply of sand. Breaches of the upper line of cliffs allow the sand to blow up on to the main drifts beyond.

Inland of the cliffs is an ancient system of dunes formerly well fixed by native vegetation, but on many parts of this system the cover has been destroyed, probably by burning and grazing, setting up a fresh movement which has resulted in a number of more or less isolated drifts, varying in size from a few square chains up to 500 acres, and extending from the cliffs up to three-quarters of a mile inland. These are interspersed among ancient dunes still completely fixed by a covering of shrubby plants; while intermediate between the old fixed dunes and the new unstable moving dunes are partially fixed types characterized by mounds covered with *Scirpus frondosus* or *Spinifex hirsutus* together with clumps of *Arundo conspicua* and flattened cushions of *Coprosma aerea*, giving a greater or less degree of fixation.

The Work of Fixation.

When the work was started most of the dunes were in active movement landward and several had extended over the boundary of the sandhills reserve on to settlers' land. Fixation was therefore an urgent matter. Some planting of Marram grass (*Ammophila arenaria*) and sowing of tree-lupin (*Lupinus arboreus*) had been carried out spasmodically over the last ten years or so. This had not been systematic enough to stop the drift, except in one case, but, nevertheless, provided a fair supply of plants. Apart from Glinks' drift, which had been extensively planted early, the first serious planting was carried out in 1931, about 40 acres being planted in that year, mostly on one drift—Searle's. In 1932 the Public Works Department commenced operations; 350 acres were planted with marram and a small area sown with lupin. The work has been extended in 1933, the blanks in the previous season's planting being filled and most of the remaining bare sand planted. Lupin has been sown more extensively and a start made with tree planting. This covers the dunes on eight miles of coast line with an additional dune nine miles north.

Fixation is divisible into three stages:—

- (1) Establishment of marram grass by planting.
- (2) Establishment of tree lupin by sowing.
- (3) Sowing and planting of trees.

The three stages necessarily overlap but, generally speaking, marram must be established before lupin will do well, and there must be a good covering of lupin before trees can be planted with success.

The Establishment of Marram.

The method adopted in planting marram is to insert small but strong sets singly, weaker sets two or three together, 18 inches deep in holes spaced four feet apart each way. A strong set is one with a substantial single stem or two or three smaller stems and in each case, several good basal buds. Weak sets are thin single stems with few basal buds.

The holes are made by one man and the sets inserted and tramped firm by another. A good gang averages about 1,800 sets per man per day of 9½ hours. The work is done on contract. For planting draining spades are used. They have a tapering blade 18 inches long and are easily driven into the sand to this depth by exerting downward pressure and a backward and forward rocking movement.

The best planting sets are obtained from marram

grass two or three years old. Younger grass is not strong enough, older frequently too decadent. The grass is dug or pulled out, divided into sets of the proper size, cleaned if necessary, counted and tied in bundles, and heeled in until required for planting. The tops are shortened back, leaving the sets about two feet long. Though the tops die back and new growth comes chiefly from the basal buds, it is advisable to keep the root ends moist by heeling in and by avoiding unnecessary exposure during transport.

Good results have been obtained by planting strong single-stem sets. In some cases these have produced from the one set large clumps a foot and more in diameter in one year. The rate of growth, however, depends largely on the site. The most rapid growth occurs on lee slopes or sheltered flats, particularly when there is a small amount of sand drifting on to the area. On slopes facing the sea growth is very slow. These places receive the full force of the westerly gales, which are not infrequently experienced. Much sand is commonly blown away from such locations, and piled up elsewhere. The surface of the sand may thus be lowered by a foot or more, leaving the marram wholly or partially uncovered. Hence the necessity for deep planting, since it has been found that the loss caused by blow-out is much greater than that due to burying. In two seasons' experience of the district there have been two stiff gales each year with several lesser blows. The former do great damage.

The difficulties of vegetating the exposed parts of the dunes are considerable. It will probably take a long time to overcome them. Much of the growth is destroyed year after year on the seaward slopes. In such places it will be necessary to persist in planting in the hope that the objective will finally be gained. It is, of course, useless to sow lupin until there is enough marram to protect it in the young stage. Timber trees will almost never succeed under such conditions. The best that can be done will be to establish finally the small native shrubs and grasses which occur on the ancient dunes and which are adapted to the conditions.

On the other hand, there are many parts of the dunes where marram and lupin grow well and rapidly and where trees should succeed. These are semi-sheltered and sheltered places such as flats and lee slopes. Some of these parts—dune hollows particularly—could probably be grassed. In fact, there is already a fair growth of York-