Further, there are places where planting is much easier than in others, and success on these areas must not be taken as measures of what are suitable elsewhere. For instance, although buffalo-grass (*Stenotaphrum glabrum*) is used with great benefit on the dunes near Tewaharoa, and the so-called ice-plant (*Mesembrianthemum edule*) grows on the foredune near Ahipara, it is certain that both these plants would be useless in most parts of the dunes of western Wellington, eastern Canterbury, or the north Waikato Head. Even the great success of the tree-lupin at New Brighton, Canterbury, and at Ocean Beach, Dunedin, does not sanction that shrub for universal use.

The New Zealand climate allows a very much wider choice of plants than do the dunes of Europe generally or of eastern North America. The tree-lupin (*Lupinus arboreus*) is a case in point. It can be grown with the greatest ease on pure sand in virtually any part of New Zealand. It forms dense thickets, grows readily from seed, and allows no sand to move where it is established, thus seeming an ideal sand-plant. And in consequence it is planted most extensively and bracketed along with marram-grass as a plant *par excellence* for sand-planting. This opinion, though true enough in certain cases, is equally false in others. It therefore seems well, before dealing specifically with methods of sand-planting, to compare the relative values of marram-grass and tree-lupin, and to explain the correct application of each.

(*b.*) MARRAM-GRASS AND TREE-LUPIN AS PLANTS FOR DUNE-FIXING.

(i.) MARRAM-GRASS.

Marram-grass owes its efficiency to its being a true sand-binding plant. It possesses a far-creeping and branching, stout, rather rigid, underground stem which gives off, so closely together that tussocks are formed, erect leaf-bearing branches. It also, but somewhat irregularly, puts out other underground stems of great length, which, extending horizontally, can build colonies of plants at a considerable distance from the parent tussock. The leaves are of a greyish-green colour tinged with blue. Their texture is thick and somewhat hard. The blade is rolled into a narrow pipe, so that the upper surface is quite hidden; but on moist cloudy days it can unroll and become more or less flat.* The under-surface is turned outwards, and is alone exposed to the wind and blowing sand. There is a long leaf-sheath which protects the young bud. The tussocks are about 3 ft. tall, but may be much smaller. As the shoots become buried by the drifting sand new roots are put down from the nodes, and the plant grows upwards above the sand, provided the drift is not too severe and prolonged. If this should happen, the leaves may be altogether buried, in which case the plant will probably die. But this is the exception rather than the rule. The grass is thoroughly attuned to the drifting sand, *without which it cannot exist*, and if the sand-supply fails altogether it will turn yellow, and finally succumb. When planted at a suitable distance the grass-bunches become sufficiently close in a year's time to virtually stop all surface-movement, and at the same time they will arrest the flying sand, and the ground-surface will be gradually raised.

There are many other foreign sand-binding grasses or grass-like plants besides marram—*e.g.*, the lyme-grass (*Elymus arenarius*), the Baltic marram (*Ammophila baltica*), the sand-sedge (*Carex arenaria*), the Chilian *Distichlis thalassica*, the North American *Agropyron dasytachyum*. Further, there are the indigenous sand-binders cited in Part I. *Elymus arenarius* is the only one of the above which has been introduced into New Zealand, but although an admirable plant in many ways, it is hardly needed where marram is available.

(ii.) TREE-LUPIN (see Photo No. 67).

Tree-lupin (*Lupinus arboreus*), a native of California, where it grows on the dunes of the Pacific coast, is not a sand-binder at all. *It consequently cannot exist where exposed to moving sand* (see Photo No. 43), *and is therefore worthless as a plant for such circumstances. When this fact is generally appreciated in New Zealand much money, time, and annoyance will be saved for the sand-planter.* The tree-lupin is a much-branched shrub of dense growth 8 ft. tall. The older branches are stout and brittle, the youngest slender, straight, flexible, juicy, and little-branched. The bark is purplish and smooth on branches of medium age, but finally becomes furrowed, on young branches it is purple on the upper and green on the under part. The leaves are rather distant, and are frequently borne on very short lateral stems. They have long, slender, flexible stalks. The blade is digitately divided into seven or eight linear-lanceolate leaflets, which are slightly glaucous-green in colour, and pubescent on the under-surface. The sides of the leaflets are frquently more or less folded together. It is by no means long-lived. When a number of these shrubs are growing closely side by side they form a most efficacious covering to the sand (see Photo No. 70), and, moreover, their dead twigs and leaves give rise to a considerable amount of humus. Further, the nodules on their roots contain bacteria which add nitrogen to the soil. Thus far tree-lupin is much better than marram-grass as a sand-fixer, and plays exactly the same *rôle* as a covering of trees, which is the ideal sand-holder. But when a body of sand advances, or a rapid drift attacks the lupin thicket, the sand first of all piles up against and among the marginal plants which arrest its progress, and, rising higher and higher, by degrees buries them, the ultimate branchlets alone jutting out of the sand. Were these able to root in the moist sand the plant would have a fresh existence, and, rising with the drift, would check the advance; but they can do nothing of the kind. If the drift continues, the sand advancing will, in time, submerge the whole plantation, pouring over its lee as a naked and wandering dune.

* This statement, which I take from Abromeit (18, p. 207) is questioned by F. W. Oliver, who has only noted the rolling of the leaf after it is plucked (126A, p. 296).