

Pimelea arenaria). On the Wellington dunes under consideration the sand coprosma (*Coprosma acerosa*) and the tauhinu (*Cassinia leptophylla*) are the dominant plants, the sand pimelea (*Pimelea arenaria*) being much less abundant.

Where the sand-grasses have become well established they afford sufficient shelter for the seedlings of shrubs to establish themselves on the lee side. Thus, as already shown, shrubs occur to some extent on the sand-grass dunes, becoming more abundant with increase of distance from the shore, until finally they dominate, and a shrub association occupies the ground.

Besides capturing sand-grass dunes the shrubs under discussion are also dune-builders, their form favouring the accumulation of sand. Especially is this the case with the prostrate, spreading, much-branched *Coprosma* and *Pimelea*, which function as veritable sand-traps (see Photo. No. 30), the sand accumulating in their interior, but eventually, if the drift continues, burying them altogether. The tauhinu (*Cassinia leptophylla*) is a much taller and more erect plant than the two preceding. Its closely branching portion is at some feet above the sand-surface. The sand is at first held, but not strongly, by the basal stems, and as the drift continues it mounts up to the above twiggy portion, where it accumulates more rapidly, so that the shrub may be altogether buried, or a few twigs alone project above the sand, which, unlike those of the *Coprosma* or *Pimelea*, cannot lengthen to any noticeable extent. Even in that case the plant is not necessarily doomed, for the loosely held sand at its base is frequently blown away, the stiff naked stems being again exposed, and the shrub none the worse for its burial. On the other hand, sand held in the network of branches of the *Coprosma* or *Pimelea* cannot again be removed, except under very special circumstances. *Cassinia leptophylla* at all stages of burial and disinterment is a common feature of the shrub dunes.

To a minor degree the sand-shrubs function as sand-binders, since their upper branches sometimes put forth roots, thus enabling the plant to grow upwards with the drift, while the cord-like old stems are buried deep in the dunes. But, generally speaking, all the indigenous shrubs of the New Zealand dunes function as *sand-holders* rather than as sand-binders, such as are certain species of Europe or North America, whose upper stems root freely and grow rapidly (various willows (*Salix*), and dogwoods (*Cornus*)).

The association is grey or yellow in colour, according to the dominance of the *Cassinia* or *Coprosma*, but generally both colours are in evidence.

Certain other indigenous plants are common in this association. More or less *Scirpus frondosus*, or *Spinifex hirsutus* if near the sea, will be present, especially on the lee slopes, the accumulating of sand there being favourable to their development. Tussocks of the pale-green stems of *Scirpus nodosus* and shining green mats of *Calystegia Soldanella* will be sometimes abundant. The grass *Calamagrostis Billardieri* will be dotted about. There will be usually more or less introduced plants which are able to tolerate a dry station if there be sufficient shelter, *Trifolium arvense*, *Hypochaeris radicata*, *Sonchus asper*, *Bromus hordaceus* being especially common.

As for the stability of these *Cassinia-Coprosma* dunes, all depends upon their position and the degree of covering. Where the shrubs quite cover the sand—a not infrequent occurrence—and if, in addition, the dune is on the lee side of a well-fixed sand-plain, it is quite stable, and would remain so for years were there no advance of sand, or did no animals or fire disturb its surface.* This stability is important, inasmuch as it shows that *under certain conditions a dune exposed to wind-tearing action may be naturally covered with shrubs and rendered stable without any previous preparation, except such shelter as is afforded by sand-grasses.*

(2.) Heath Dunes.

The heath dunes are the third stage towards the evolution of the fixed sandhill, with its loam-covered surface. They occur at a greater distance from the sea than the sand-shrub dunes, or even quite close to the shore where the wind strikes with less power. It is the presence of manuka (*Leptospermum scoparium*) which gives the character to the association. The appearance of this shrub is an interesting plant-geographical phenomenon, since it seems at first thought that, the dune vegetation being correlated with the wind-velocity, manuka must be to a smaller degree wind-tolerating than are the dune plants proper. But it is nothing of the kind; on the contrary, it can tolerate more wind than almost any other indigenous shrub, a point plainly brought out in my report just published by the Lands Department on Stewart Island Botany (90). On a dune area it is clear that *the presence of the manuka is altogether dependant on the strength of the sand-drift and on nothing else*, not even on excess of sea-spray. *Thus, in selecting shelter-plants for dune-afforestation purposes, tolerance of drifting sand is a matter of prime importance, without which drought or salt-resisting power are as nothing.*†

Besides the dominant plant, manuka, a considerable variety of species may make up the association. The great tussocks of the toetoe (*Arundo conspicua*) and the New Zealand flax (*Phormium tenax*) will be present. These two can tolerate a certain amount of sand-burial. The toetoe, for instance, grows upwards, as it is buried, and thus ascends a slowly advancing lee slope, finally possibly capturing it and leading to its fixing (see Photos. Nos. 31, 32). If such lee slopes were not interfered with, and beyond the influence of cattle and burning, many which are now advancing, menacing fertile land, would be naturally fastened. Even under the present adverse conditions stability is in some places being established.

Occasionally certain trees appear along with the manuka—e.g., the cabbage-tree (*Cordyline australis*), the ngaio (*Myoporum laetum*), the mahoe (*Melicocytus ramiflorus*), the mapau (*Rapanea Urvillei*), and others.

* Such disturbance is bound to come sooner or later on dune areas used for grazing purposes.

† The converse of this also holds. Eliminate, by artificial means, the sand-drift, and a considerable choice of plants suitable for dune culture is available.