

greater and lesser degree in different species, so that one may speak of *major* and *minor sand-binding plants*. This "sand-binding" form is so admirably in harmony with the conditions of life that one may well conclude it has risen by degrees in ordinary rhizomatous plants subject to a sand-burial, while the presence of the form to a most intense degree in an endemic subgenus in New Zealand, an isolated land-mass, can be better explained as an hereditary acquired character than it can by either the principles of mutation or natural selection. All sand-binding plants are perennials.

Other dune-plants only catch the sand, or at best can lengthen their shoots to some limited extent, and either are finally buried and die or the sand is blown away. These may be called *sand-collecting plants*. These latter may really seem as if adapted for the purpose, as in the case of certain low-spreading shrubs resembling thick mats or cushions made of many wiry or flexible branches; or they may simply arrest the sand, as do certain plants of the tussock-form (see, however, p. 33).

Finally, there are the plants of moist hollows, which have no special dune "adaptations"—though one (*Gunnera arenaria*) is very characteristic of the above station—but are merely species of other wet or moist stations without the dune-area.

As for the plants of the stable dunes, the heaths, swamps, and lakes, their growth-forms, &c., have evidently nothing to do with dune conditions, and so receive no treatment here. A brief mention of their growth-forms is given, however, for comparative purposes, along with the more specialized species, in the list of dune-plants, as well as for the information of those not well acquainted with the New Zealand flora. Further, it is obvious that a knowledge of the growth-forms of the indigenous plants give important suggestions as to what foreign species can be used for cultivation on the dunes.

In what follows a brief account is given of each characteristic species, there being altogether too few to allow of generalizations as to growth-forms and plant-organs. Here it need only be said that the New Zealand dune-plants—though several belong to genera unknown in most dune-areas of the world, and the leading sand-binding plant *Scirpus frondosus* belongs to *Desmoschoenus*, an endemic section of the genus—for the most part possess growth-forms and "adaptations" similar to those of dune-plants elsewhere. The species peculiar to dune-areas are marked with an asterisk.

(ii.) THE LEADING DUNE-PLANTS.

(a.) Sand-binders.

(a.) Major.—**Spinifex hirsutus* (Gramineae); **Scirpus frondosus* (Cyperaceae); **Euphorbia glauca* (Euphorbiaceae).

(b.) Minor.—**Carex pumila* (Cyperaceae); **Calystegia Soldanella* (Convolvulaceae); *Arundo conspicua* (Gramineae).

(β.) Sand-collectors.

(a.) Major.—**Coprosma acerosa* (Rubiaceae); **Pimelea arenaria* (Thymelaeaceae); *Cassinia leptophylla* (Compositae); *Cassinia fulvida* (Compositae); **Cassinia retorta* (Compositae).

(b.) Minor.—**Festuca littoralis* (Gramineae); **Calamagrostis Billiardieri* (Gramineae); *Scirpus nodosus* (Cyperaceae).

(γ.) Wet-ground Plants.

Leptocarpus simplex (Restionaceae); **Gunnera arenaria* (Haloragaceae).

(iii.) DESCRIPTIONS OF PLANTS.

(a.) *Spinifex hirsutus* (the Silvery Sand-grass).

Found in New Zealand in the northern and central floristic provinces only. Also indigenous in Australia and New Caledonia.

The special sand-drift "adaptation" of *Spinifex hirsutus* is the extremely long, quickly growing, much-branching rhizome, which, if all the branches of an old plant were taken, would measure many yards; indeed, it seems capable of quite unlimited extension. Normally, the rhizome creeps over the surface of the ground, putting forth roots at the nodes; but it is soon buried by the drifting sand, in which case its apex may again emerge, but more usually branches or leafy shoots pass upwards to the light. Such a stem creeping on the surface is a runner rather than a rhizome, since its roots at the nodes, also putting up erect shoots, each of which is virtually an independent plant. These creeping stems, which frequently extend to the flat ground along a windward dune-slope unbranched and perfectly straight for many feet, are soft and juicy for their three or four apical internodes, but elsewhere hard, smooth, woody, and of a pale-brown or yellowish colour. The soft portion is well protected from damage by the strongly developed leaf-sheaths closely pressed to the stem, the sheaths themselves being also protected by a close almost tomentose covering of adpressed silky hairs.

The path of a subterranean stem is indicated by the bunches of leafy branches which at intervals pierce the sand, the leaves reaching a variable height above the surface; they are not crowded together, as are those of marram-grass (*Ammophila arenaria*), but sand is always visible through a bunch of leaves. The leafy shoots may descend 20 in. or more to the rhizome from which they branch, and such, rooting and deeply descending, binds the sand to an extraordinary degree. The leaves consist of blade and sheath; they are of two kinds, protecting leaves and ordinary leaves, the former having much broader sheaths and very short blades, and function as already described. An ordinary leaf has a blade about 19 in. long and $\frac{1}{10}$ in. broad; it terminates in a fine, tapering, but usually dead point. In texture it is flexible, coriaceous, and thick; the margins are much incurved, so much so as to frequently make the apical half or third into a pipe. Both surfaces are thickly covered with adpressed silky hairs. The sheath is about 5 in. long, pale-coloured, thick and fleshy, especially at the base, and rather brittle. The flowers are dioecious. Frequently extensive patches are all of one