

(9.) *Crowding of Leaves at Ends of Branches, and Bareness of Stems.*—This is another case of leaf-reduction through reducing the number but not the individual area of the leaves.

(10.) *Isolateral Leaves.*—This is shown in the grasses, sedges, and those epacrids with erect or semi-erect leaves, such as *Dracophyllum Urvilleanum* var. *montanum*.

(11.) *Long Roots.*—Many of the desert and steppe plants have excessively long roots. Those of *Veronica spathulata*, for instance, are immensely long.

(12.) *Wiry Underground Stems.*—These are advantageous for creeping in the loose substratum.

(13.) *The Rosette Habit.*—This crowding of leaves depends on shortening of internodes, which is distinctly correlated with poorness of soil, wind, &c., just as lengthening is the result of a moist and still atmosphere (Photo. No. 21).

There are other interesting adaptations, such as the water within the leaf-buds of *Veronica*, the resin on the buds of *Olearia nummularifolia*, incurving of leaves, persistence of grass-sheaths, &c., but space forbids further details. Suffice it to say that usually a number of the above adaptations are to be found in one and the same plant. And it must also be pointed out that plants which have no special adaptations at all can live under severe conditions, and that plants apparently highly specialised for certain circumstances are to be found where their adaptations are of no benefit whatsoever, but rather the contrary.

(c.) THE DESERTS (Photo. No. 22).

(1.) General Remarks.

To speak of deserts at all in a rain-forest climate seems a paradox, and the truth is that those of New Zealand are edaphic rather than climatic. Still, were the rainfall greater the desert areas would be less. As an example, true oases exist on the otherwise barren scoria slopes of Ruapehu in places where a spring gushes from the ground. Also, on the great scoria fan from Ngauruhoe actual bog-plants such as *Drosera spathulata* dot the black cinders with red where the waters issue from beneath the ground. Desert in this region, too, has an historical meaning, and is merely a very early phase of the development of vegetation. But to this latter there are exceptions, the most extensive of which is the sandy Onetapu Desert, where rain, snow, and wind have changed the face of the country, reducing the shrubby steppe back to its primitive desert condition.

(2.) Physiognomy, Distribution, &c.

Desert is, on the whole, the most abundant and characteristic formation of the volcanic plateau. It occurs in valleys, in broad river-beds, on scoria slopes, and in "wash-outs." There may be quite small patches, or, in the higher regions, no other formation. Some of the mountain-slopes, such as those of Ngauruhoe, are absolutely without plant-life, and loose black scoria is alone present. But usually, if the ground is not too steep and unstable, are certain plants, which, far-distant and dotted about, are at first hardly noticeable and affect the landscape not at all, except when in bloom during a limited period. These ultimate desert plants are *Veronica spathulata*, *Claytonia australasica*, *Gentiana bellidifolia*, and *Luzula Colensoi* (Photo. No. 4). Flatter slopes bring in the round silvery cushions of *Raoulia australis* and the small straw-coloured tussocks of *Danthonia semiannularis* var. *setifolia*, also *Pimelea laevigata*, *Ligusticum aromaticum*, and *Gaultheria rupestris*. A further advance is made where ashes, disintegrated andesite, pumice, or scoria make a sand easily carried by the wind. A shrub whose seeds can germinate, producing a seedling that can tolerate the station, may arrest such a drift, and, provided it can increase by rooting near its growing-point, will build up smaller or larger mounds where other plants can settle. Thus we have *Pimelea laevigata*, *Carmichaelia orbiculata*, building up small dunes, frequently all to themselves (Photo. No. 20). Likewise *Dracophyllum recurvum* can settle on the scoria desert, and the reddish colour of its roundish masses, quite flattened to the ground, is the physiognomic feature *par excellence* of the desert flats or slopes, as indeed it is of a large part of the region under consideration. A slightly less unstable substratum or a more sheltered position, and true desert dunes are formed, either rounded low hills a foot or two in height, or actual mounds or ridges 6 ft. or more tall. The dune association is a very constant one, and will contain usually nearly all the following plants: *Podocarpus nivalis* and *Dacrydium laxifolium* round the periphery, the former putting forth its rooting, prostrate shoots on to the scoria, and occupying the bare ground, a most characteristic habit. *Carmichaelia Enysii* var. *orbiculata*, though not present everywhere, plays a similar role. Right on the dune will be the yellowish-green *Veronica tetragona*, a great deal of *Dracophyllum recurvum* (its peculiar colour noticeable as usual), *Coprosma depressa* (flattened close to the sand), *Gaultheria rupestris*, and another form of the species with small leaves whose far-creeping underground stems help to bind the unstable substratum. *Dracophyllum Urvilleanum* var. *montanum* and *D. subulatum* are common. High above the other plants is frequently the stiff-branched *Olearia nummularifolia*, and, in the centre of the dune, *Phyllocladus* often becomes established, while even in some places there may be a stunted plant or so of *Nothofagus cliffortioides*. *Coriaria thymifolia* is not an uncommon plant, thanks to its spreading underground stem. As for herbaceous plants, *Celmisia spectabilis*, *Wahlenbergia saxicola*, *Fostera Bidwillii*, and *Euphrasia cuneata* var. *tricolor*—this latter very abundant—will be present, and occasionally *Drapetes Dieffenbachii*. Very common are *Epacris alpina*, *Styphelia Frazeri*, and *Pentachondra pumila*. The grasses are *Danthonia semiannularis* var. *setifolia* and *Poa Colensoi*. In dune-fixing, finally, *Muehlenbeckia axillaris* and *Podocarpus nivalis* play an important part, and the former makes a close mat over the sand, spreading most extensively with its wiry underground stems. In short, the dunes or the islands of shrubby and herbaceous plants of the desert are nothing more or less than isolated, or, if you like, embryonic, patches of shrub-steppe, and a change in conditions would easily cause the desert to be occupied by plant-life. It is not the porous substratum and the absence of humus or clay which cause the desert conditions, but the presence of wind and the absence of water. If this latter be present, what a change ensues! Then will come in a true oasis. At a height of 6,500 ft. on Ruapehu, on an unstable scoria slope