

blown away. Also, as Shaler has shown, the rubbing-together of the sand-grains leads to the formation of dust, which will, with much very fine sand, be blown away from the dune-area altogether (55). But with the destruction dune-building goes hand-in-hand, new dunes arise, and fresh chains of hills are formed, these in turn to be destroyed. All this round of destruction and regeneration is the work of the wind, modified by the plant-life.

(ii.) WIND AS A DESTRUCTIVE AGENT.

So long as the wind brings a sufficient sand-supply, and the sand-binding plants form a close-enough and even-enough covering, will the dunes remain intact. But with increasing stability of the surface so does the sand-supply decrease, while in any case the tendency of the plants is to raise prominences and hillocks, nor do they usually in a state of nature grow closely, there being many isolated tufts or tussocks.

The wind performs a dual function : it transports material, and it erodes. When there is less than a certain amount of material brought the erosion will predominate. So, too, will this be the case with winds of abnormal intensity. Where a high wind blows over a well-fixed area it transports little, but attacks every bare spot.

A certain velocity of wind does not act everywhere with uniform power ; on the contrary, it is a variable factor, depending on circumstances. First of all, the nature of the ground-surface is a matter of great importance, all irregularities tending to break the force of the wind, as the observations of King and Olsson-Seffer have shown, the experiments of this latter author demonstrating that *the velocity of wind over a smooth surface is at least 34·7 per cent. greater than on uneven ground* (44, p. 560). Grassy ground, then, can be seen to have a powerful influence in restraining the wind, while the effect of rows of sticks, &c., fixed in the soil, small as it might be thought, is very great indeed, and on such depends some of the methods of sand-reclamation discussed in Part II of this report. When the wind strikes on a solid object, such as a dune, its power is greater at the sides than in front, while in the lee an eddy is formed varying according to the force of the wind. Each obstacle, then—every sand-mound and isolated tussock or shrub—favours erosion. Still more is the erosive power of the wind increased by the proximity of two objects, as two adjacent mounds, making a channel (see Photos Nos. 15 and 17). Through such the compressed air blows with increased erosive power, making ever-deepening cuts into the sand, until finally what were at first but bare sand-patches become gullies, these latter varying from merely saddles to miniature gorges. In such wind-channels there is nothing but bare sand ; the sand-binding plants are uprooted in the first place, and it is impossible for them to gain a foothold again without shelter (see Photo No. 15). Nor is it simply a direct wind-current which operates when the wind strikes a solid obstacle : there is always the lee eddy playing a powerful part, and there is a vertical as well as a horizontal stream of air ; in fact, an air-current is a most complex matter (see Langley, 37). Moreover, as shown before, air-vortices are caused by impact upon certain obstacles. The erosive power of the wind is therefore frequently much intensified, and a dune unprotected, or partially protected, by vegetation is by degrees cut into deeply, and finally may be quite blown away, the only trace of its former presence being dead rope-like rhizomes of the pingao (*Scirpus frondosus*). Dunes in all stages of destruction may be seen in any area, from a tiny bare sand-hollow between two tussocks to a sand-plain without a trace remaining of the former dune-chain which occupied the ground.

From the above it may easily be seen that the natural fixing of sandhills by tussock-forming plants or by shrubs may lead finally to the destruction of what one would expect to be stable dunes, any irregularity of surface favouring the erosive power of the wind. Irregular planting of marram-grass, or its spontaneous spreading from seed, may for the above reason not only be useless but dangerous (see Photo. No. 5). The frequently expressed opinion that any plant is useful on the dunes is an erroneous conception, based on ignorance of the behaviour of plants with regard to erosion. "Well-fixed" summits of hills are not infrequently a source of danger. An interesting example was afforded in the planting of the foredune of the Kurische Nehrung (Gerhardt, 18, pp. 343-44) with the Caspian willow (*Salix caspica*), a plant which tolerates sea-spray and wind, and is an excellent sand-binder. For a number of years the plant grew excellently, doing all that was required, but finally its irregular growth led to the forming of thickets and mounds and the resulting wind-channels, so that the dune became subject to erosion, the willow causing the very destruction it was planted to check. In consequence, at great expense, the whole of the willows were uprooted, and a new beginning had to be made with other material.

The erosive power of the wind leads to the forming of various land-forms in the dunes. Thus there are the saddles and gullies mentioned above. Hills may be quite wasted away below, the plant-covered summit remaining, mushroom-like. There may be rounding of ridges, or hills may be cut vertically, exposing the strata. Various hollows may be cut in the sand, of which "wind-troughs" formed by eddies, as already explained, are frequent (see Photo No. 5). When a strong wind is blowing, the eddy on the steep lee side of a high dune is very powerful, whirling the sand high into the air, scouring out its base, and probably increasing the steepness of the slope. Such eddies may be met by the strong current of a wind-channel, when a combination of the two forces leads to the building-up of slopes, the heaping-up of mounds, the formation of appendages to the main dune, the cutting of channels, or erosion of basins, whose origin, if viewed during a period of calm or when a contrary wind is blowing, would seem inexplicable, so complex is the effect of the diverse currents. Spots where this complexity of wind-action takes place are extremely critical with regard to dune-cultures, and the conditions require modifying artificially before a successful planting of sand grasses or trees can be undertaken. The most important form perhaps is the wind-basin. Here the wind, having removed the dune piece by piece, continues its work of hollowing out the dry sand into a shallow basin-like hollow, until finally the ground-water is neared, the sand becomes damp, and all further erosion ceases