marram grass, or its spontaneous spreading from seed, may for the above reason not only be useless but dangerous (see Photo. No. 15). 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, 15, pp. 343–44) with the caspian willow (*Salix caspica*), a plant which tolerates sea-spray, 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. 16). When a strong wind is blowing the eddy on the steep leeside 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 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 take 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 as by magic. Large areas may be so eroded, the hills having been blown quite away, and flat "sand-plains" result. These may be seen in all stages of formation, and though it seems hard at first to believe that comparatively fertile plains of large extent were once the seat of dune complexes, remnants of hills marked chiefly by rhizomes of the pingao mark the position of former sandhills (see Photo. No. 20).

Owing to the proximity to the water-table sand-plains are fairly moist all the year round, though during dry weather a sandy crust will lie on the surface. In winter, water collects in pools in many places. Even shallow lakes may arise, the aquatic vegetation making humus, which forms in time a more impermeable bottom than does the sand.

Though hardly present, so far as I have noted in the New Zealand dune areas, a quicksand may be formed on the sand-plain near the base of a high dune, owing to the special water-supply from this latter being added to the subterranean water of the plain.

Sand-plains within the dune complex may remain for many years undisturbed, as evidenced by the age of their vegetation, and in places they become occupied by good pasture plants. But sooner or later there will be a sand invasion, and a new dune complex or dune chain occupy their site.

(*c.*) Dune-wandering.

The wind blowing up the long windward slope of a dune carries with it the rolling and hopping sand to the summit, which, as before noted, falls down the leeward slope, leading to its gradual advance. Where the incoming sand-supply is small, as is that of a dune chain on the leeward side of a grass or "rush" covered sand-plain, then there is a comparatively rapid advance, the wind carrying the sand of the windward to the leeward slope whenever it blows, and bringing no fresh material to supply the constant waste. Generally speaking, there is a gradual but usually very slow advance of the dunes, the sand-plains being buried at their seaward and extended at the landward boundaries. The movement landwards is much checked where there are powerful antagonistic land winds, and it is not unusual to see a dune advancing in two directions. Great quantities of sand may blow back into the sea, as I observed on the shore between the Rivers Manawatu and Rangitikei, where all day a constant cloud of sand looking like smoke blew along the shore into the water.

The rate of movement is governed by a number of factors. The shape and height of the dune is of great importance, a high dune, other things being equal, moving more slowly than a lower one. Climate, specific gravity of the sand, size and shape of sand-grains, velocity of wind, plant-covering of the dunes, disturbance by grazing animals—all these affect the rate of movement. Where the dune is absolutely bare sand the question is less complex; but here the height of the hill, and whether its advance is checked by trees or shrubs, much affect the case. A stream, again, may stop a dune altogether (see Photo. No. 17). So far as New Zealand is concerned, there are few statistics as to dune advance. On the dunes of East Canterbury I have measured a lee slope 10 ft. high, which moved horizontally 2 ft. in ten hours with a very powerful east wind, but such rapidity of movement would only take place a dozen times or so in the year. Speaking generally, my investigations show that in certain seasons the dune movements are greater than in others, and that where a plant-covering is present they are usually very slow, perhaps a foot or two yearly. Foreign statistics give very variable results. They concern chiefly the wandering dune, which, according to them, may move in some places only a few feet and in others many yards.

Dune-wandering is especially dangerous since it is slow and insidious, but in its very slowness lies the security to those *who recognise the danger*, since it gives abundance of time for permanent reclamation work.