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 in some instances mark the position of former sand-hills (see Photo No. 18).

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 the presence of a humus-layer, and in places they become occupied by good pasture plants. But sooner or later there may be a sand-invasion, and a new dune-complex or dune-chain occupy their site.

(iii.) 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-covered 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 unstable 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 in general, 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. 19). 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 a year. Mr. Hoe, of Woodhill, in the Kaipara district, Auckland, was able to furnish me with some accurate particulars regarding the dunes of his locality, based on measurements made during certain surveys. Thus, one wandering dune, the position of which was fixed in 1866, had advanced 132 yards by the end of 1910—*i.e.*, an advance of 3 yards a 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 yearly.

Dune-wandering is especially dangerous, since it is slow and insidious; but in its very slowness lies the security to those who *recognize the danger*, since it gives abundance of time for permanent reclamation-work. So slow is it, indeed, in certain cases that a semi-sand-binder (see botanical section) such as *Arundo conspicua* (toetoe) can gain a footing and establish itself on a dune-fall. Its presence, however, does not indicate that the dune is stationary, as many suppose, but rather that the upward growth of the grass is equivalent to the sand-supply.

(iv.) Sand-drifting.

By sand-drifting, as opposed to dune-wandering, I mean the blowing of a flat layer of sand along the ground-surface. It is sand-drifting which leads to dune-building, dune-wandering being a secondary phenomenon.

During gales extensive drifts take place, the sand coming from naked dunes, and also from hollows where the wind has full power (see Photo No. 20). These drifts are particularly dreaded by owners of sand-areas, since when merely an inch or two in thickness they quite destroy any grassy sward on which they fall. The drift also, when once it has commenced, continues to advance with even moderate winds, the distance reached being determined by the sand-supply. Contrary to the advance of a wandering dune, the sand drift is extremely rapid, acres at a time being covered with a layer of sand, thus killing all the grass during one heavy gale. Sand-drifts, though the worst-dreaded form of invasion, are of considerably less moment in the long-run than dune-wandering, and can be much more easily stopped. *It is the stopping of these which is nearly always shown as an example of how to control dunes in general—a quite misleading object-lesson.*