(iv.) Quicksands.

Where a stream passes over a sand-plain, or where the wind has cut almost to the water-table, there may be a superabundance of water and the wet mass be so fluid as to be no longer a solid, but governed by the laws of hydrostatics Generally, there is too little water for the formation of quicksands, but the water-content may be much increased by the flow from the body of a wandering dune. Quicksands are not at all common in the dune-areas. The worst occur on the Aupouri Peninsula, Auckland. So far as human beings on foot are concerned quicksands are of little moment, but when on horseback, or for horses themselves, they are dangerous enough.

(v.) Swamps.

Swamps are formed either by a shallow lake becoming occupied by vegetation, or through the natural drainage being blocked or checked by the sand-movement. In some places there are hundreds of acres of swamp right in the centre of a dune-area, but generally it is nearer the landward than the sea boundary.

(vi.) Lakes and Ponds.

Dune-lakes originate in exactly the same manner as swamps, being really an earlier stage of the latter's development Both lakes and swamps assist in checking the sand-advance for a time, but finally the surface becomes dry, the sand drifts over the site of the swamp, and no trace of it remains visible.

(*h.*) THE VIRGIN DUNES.

At the present time it is not altogether easy to present a picture of the virgin dunes of New Zealand Excepting on the sand-grass dunes themselves, and perhaps some of the semi-stable shrub dunes, there are few places where man, his fires, and his grazing animals have not wrought great changes. These changes have been twofold : they have brought about a state of very much greater instability, and they have altered the composition of many of the plant associations. This latter is most marked in the plant covering of the stable dunes, whether that be heath or grass.

The opinion expressed by many that the present instability of the dunes and their wandering is entirely the work of man, due to using the dunes as grazing-land, is certainly incorrect. Even before the white man arrived, the Maoris lived much among the dunes, as remains of dwellings, heaps of shells, stones, and ancient burial-places testify. Their presence would conduce to considerable dune-movement.

But, apart altogether from man, the dunes could never have reached their present breadth had not their wandering been of long duration. The presence also of the endemic sand-binding plant *Scirpus frondosus* is significant, since its well-being depends upon the coming of drifting sand, and its endemism proves that such a drift has been taking place for a long period.

The distance a dune-area can penetrate inland depends upon the general topography of the coast-line, the extent of the sand-supply, and the counteracting effect of land winds. At any rate, a point is finally reached where the velocity and erosive power of the wind so much decrease that non-dune plants can get a foothold, increase in number, and finally absolutely fix the dune, giving it by their decay, in course of time, a coating of loam. Thus the virgin dune-areas were well fixed and beyond the power of the wind to disturb, while the general plant covering of the dunes as a whole would prevent drifting sand to a much greater degree than is at present the case.

(*i.*) EFFECT OF MAN, ETC., ON THE DUNES.

Apart altogether from the natural struggle between sand, wind, and plants, which resulted not only in a steady movement of sand inland, but also in its ultimate fixation, man, by the aid of animals, fires, and cultivation, on the one hand, has brought about most powerful dune-movements ; but, on the other hand, he has to some extent counteracted these by the planting of various sand-fixing plants.

The early settlers, tempted by the numerous extensive well-grassed sand-plains, made use of them as grazing-grounds. Also, in order to make room for better growths, they burned the " rushes " and shrubs which appeared to be occupying good ground. Moreover, the cattle and sheep did not confine their attention to the flats, but, as food got scarce, wandered over the dunes, breaking the surface, and pulling up some of the sand-binding plants. The result was soon manifest. The unstable hills were turned into wandering dunes, the fertile flats were buried with sand, and desert conditions grew apace. Introduced plants also made their appearance, but economically were generally of a worthless kind.

With the stable dunes it was worse. These were clad with various indigenous grasses, shrubs, and bracken-fern, and beneath a layer of loamy sand. Burning the shrubs, &c., helped to lay bare the sandy surface and to destroy the accumulation of humus, its most important possession. Later on, overstocking played its part, and, notwithstanding their quite stable character, the fixed dunes gradually began to revert to the active conditions (see Photo No. 12).

It is quite astonishing how little will set even the most stable dune in motion. A sheep rubbing its back, irritated with ticks, against the surface soon lays bare a patch of sand, which, attacked by the wind, may rapidly develop into intense activity. Such a hole as that shown in the photograph (Photo No. 26) would, if not checked, set in time the whole hillside in motion. Rabbits also work considerable harm. It is worst of all when the damage commences in a gully, where, as shown before, the wind has special erosive power. Such gully wounds are most difficult to heal (see Photo No. 15), and on that account are neglected after one or two failures, and so the contiguous slopes are undermined,