MANAWATU SAND PLAIN VEGETATION

A. E. ESLER

Botany Division, D.S.I.R., Palmerston North

INTRODUCTION

Sand plains are low-lying areas where wet sand near the water-table is exposed by wind. In the literature the plant communities of sand plains have received only brief mention (Cockayne 1911, 1928; Pegg 1914; Carnahan 1957; Moore & Adams 1963). Along the Manawatu coast some sand plain communities have retained their identity uninfluenced by the factors which have altered the composition and vigour of almost all other New Zealand vegetation. They remain both in spite of, and because of, the extreme environment. The species are not equally attuned to the environment of the sand country and each expresses its responses, in part, by its pattern of distribution.

This paper examines these patterns in relation to the position of the water-table, which has a critical influence because of the limited ability of the sand to store water or to lift it above the water-table in appreciable amounts.

THE HABITAT

Sand is deposited in large quantities along the prograding Manawatu coast and is carried inland about two miles by the strong, prevailing on-shore winds. This belt of sand has probably never been stable but movement was accelerated last century by cattle grazing on the dunes. *Spinifex hirsutus*, the most palatable plant and the most important stabilizing species on the foredune, was eliminated (Wilson 1959). Its reintroduction by artificial seeding and the establishment of marram brought a degree of stability, but the dunes are still very active.

From aerial photos it is apparent that there have been gross changes in the pattern of deposition of sand in the last 25 years. In 1942 the foredune was undeveloped between Foxton and Himatangi Beach and a mass of irregular dunes extended far inland. These dunes enclosed small, wet flats mostly about 30 chains from the sea, and a few nearer the shore. Since 1942 a more defined topography has developed. The foredune now forms a ridge about 25 ft. high but breached in many places. Long, parallel dunes running 113° E. of true north extend inland and join transverse dunes, almost barchan in nature, to form basins (Fig. 1). It is convenient to regard this dune-and-basin topography as an incipient parabolic dune system hindered in its development by a surfeit of sand and a deficiency of vegetation. This conception is complicated by the overlapping of dunes further inland in a belt one-half to two miles from the beach and parallel to it, but beyond this belt the parabolic formations become very pronounced.

Each basin has short irregular dunes adjacent to the blow-outs of the foredune. These tail off into ridges and hummocks a few feet high over most of the central part of the basin. In part, these undulations are relics left after deflation of the larger dunes which previously occupied the area, but some have formed from recent accumulations.

Against the longitudinal dunes on the northern and southern margins of each basin sand has deflated to near the water-table and lateral sand plains have developed. These are moist in summer but in rainy periods water flows several inches deep across the surface which slopes 12 feet per mile toward the coast. Water gathers at depths of a foot or more in the lower reaches against the short irregular dunes. On the eastern margin of each basin the water-table is usually exposed at the base of the windsweep of the transverse dunes. In some places low sand ridges restrict movement of surface water from the terminal sand plains to create ponds sufficiently permanent to support *Typha* and the snail, *Limnaea stagnalis*.

The topography is static only in winter. In drier periods sand moves over the basin and the encompassing dunes. The longitudinal dunes, being higher than the foredune, are little protected by it and the moving sand is only slightly impeded by the very sparse cover of *Desmoschoenus spiralis*, *Spinifex* and marram. The lateral sand plains are influenced by this sand moving off the dune flanks. Sand accumulates on the wet surface until drying is sufficient to allow it to be driven away by wind, but in high winds the sand races across the surface

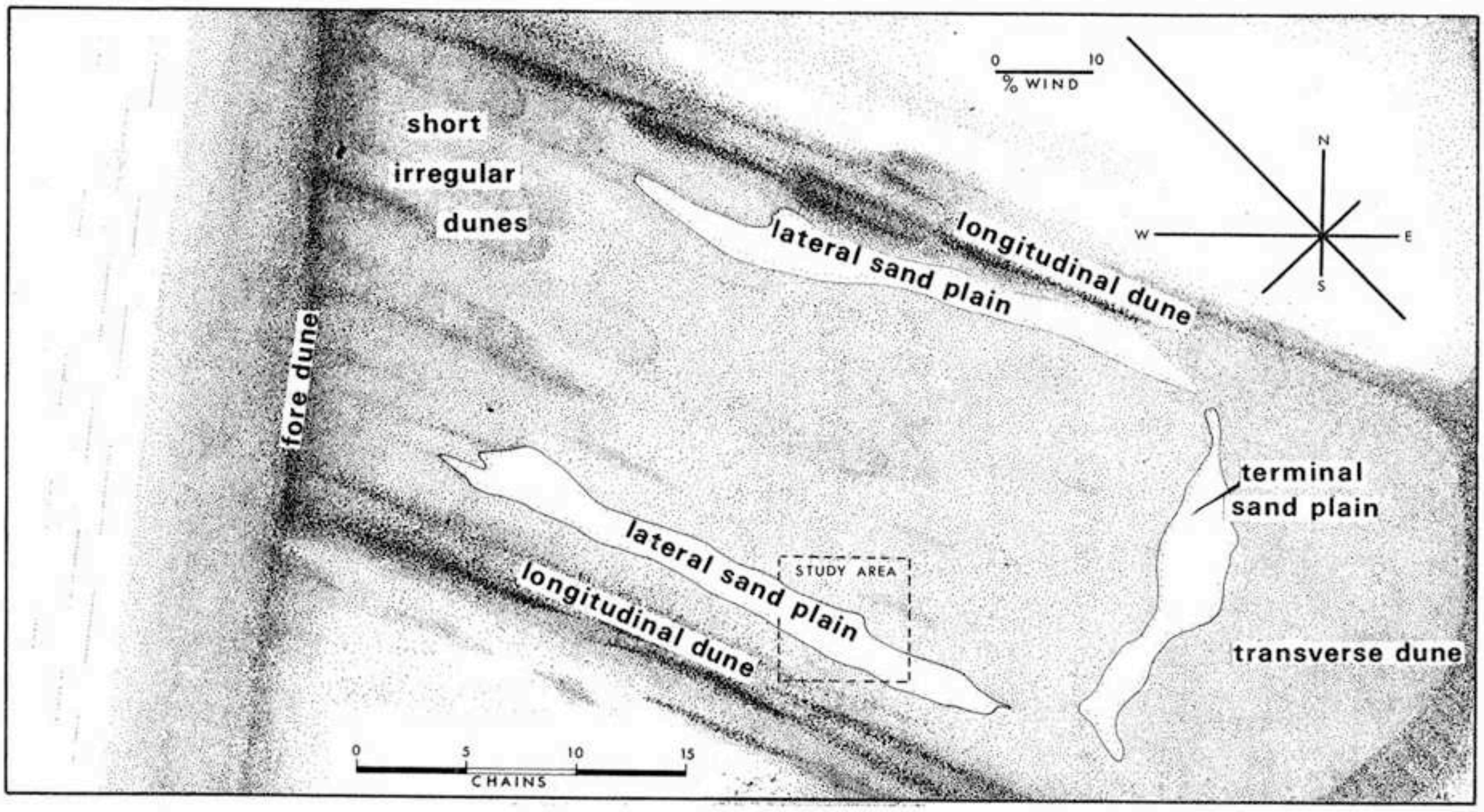

FIGURE 1. *Form of typical Himatangi sand basin. Wind data are for Ohakea.*

without being deposited, except where plants form a barrier.

Some terminal sand plains are migratory in dry windy weather. Sand from the centre of the basin gathers on the windward side and is removed from the other side unless vegetation is well established around the plains.

THE PLANT COMMUNITY

There are fewer than 20 significant plant species on these sand plains but they make a complex community because of their diversity of tolerances and requirements. There are obligate water plants and plants normally growing on higher ground restricted here in their distribution by the wetness of the habitat. Others, although not typical water plants, are dependent on this wet habitat for perpetuation by seed. Still others have a wide ecological amplitude and grow on the plains and on the dunes. Thus is brought together an assemblage of plants some specific to the habitat and others usually associated with many different habitats.

The most striking feature of the community is the zonation and the limited intermingling of some of the species. Moisture is the main factor determining the presence or absence of species but the pattern is modified by varying tolerance of deposition and removal of sand. It is apparent that position of the water-table is critical to the success of many species because the sandy substrate without topsoil is not very effective in supplying the water requirements of plants. Fluctuations of the water-table make it difficult to determine the limiting factors with certainty. The critical period for obligate water plants is in summer. Some other species are restricted to higher ground because they do not tolerate periods of submersion in winter.

THE INVESTIGATION

In the summer of 1967-68 a dumpy level and staff were used to record the altitudes of 290 sampling points relative to the datum line taken as the estimated mean water-table in summer. At each of the sampling points, which were arranged in traverses parallel to the coast and in grids, the species within a radius of 2.2 ft. were recorded with notes on the habitat. The study area was about half a mile south of Himatangi Beach in a basin of the type described above.

RESULTS

Figure 2 shows the altitudinal distribution of the major sand plain species in relation to mean summer water-table in this particular site. *Limosella*

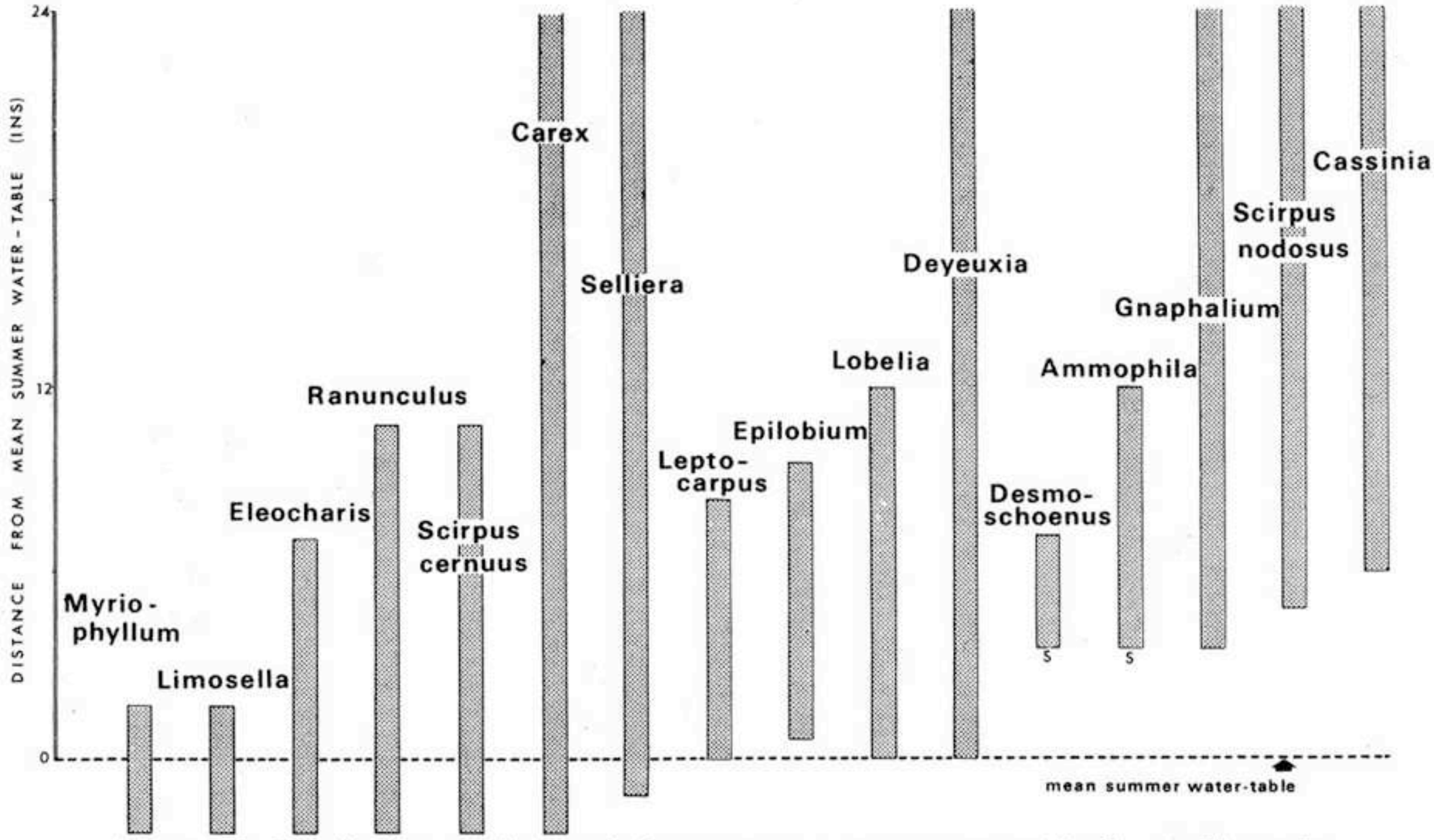

FIGURE 2. *Distribution of plants relative to mean summer water-table. S = seedling only.*

lineata and *Myriophyllum votschii* exist in a very narrow habitat range and usually occur together, tolerating large quantities of sand blowing across the surface in summer and dense mats of filamentous algae blanketing the surface in shallow water in winter and spring.

Eleocharis neo-zelandica, Ranunculus acaulis and *Sirpus cernuus* thrive on the moist sand. All of these are less than one inch tall and the environment is not greatly changed by their presence. The small amount of sand that accumulates is removed when the surface dries sufficiently to allow mobility. *Eleocharis* and *Ranunculus* almost invariably occur on sites with moving sand but *Scirpus cernuus* is less specific.

Carex pumila grows on the wet parts of the sand plains and extends to about 2 ft. above the mean summer water-table onto adjoining fresh accumulations of sand. No other plant of the plains has greater ability to gather sand, a feature which leads to its own extinction where the sand supply is plentiful. Variations in vigour and seeding capacity within a single patch suggest response to differences in micro-habitat. This offers an interesting line of research.

Selliera radicans is the most widespread of the sand plain species and also occupies moist sites near the foredune where few other species grow. It tolerates submersion in winter and can survive where the water-table is more than 2 ft. below the surface in summer.

Leptocarpus similis establishes from seed where the water-table is near the surface most of the year and not more than a foot below it in summer. If massive movement of sand does not occur the species spreads extensively by rhizomes to become dominant in other communities. The same habitat favours *Epilobium billardierianum* and *Lobelia anceps*. *Deyeuxia billardieri* usually grows with them but is not confined to the same habitat. It occurs also on the dunes wherever other plants arrest the sand movement sufficiently to allow seedlings to establish.

The remaining species in Figure 2 are characteristic dune plants. There are two reasons for the presence of *Desmoschoenus* and marram (*Ammophila arenaria*) on the sand plains. Firstly, the older plants are relics of the vegetation of the dunes which covered the area before deflation. Secondly, the sand plains provide suitable conditions for the seedlings of both species. The success of these dune plants in this environment depends on their ability to accumulate sand. Even in the most favourable circumstances *Desmoschoenus* is a poor collector and binder. Few seedlings survive on the sand plains. Marram, on the other hand, establishes freely. Seedlings occur most abundantly on the flanks of the longitudinal dunes where they collect sand to form low berms which sometimes develop into subsidiary lateral dunes. Seedlings also establish on similar moist habitats at the base of the slip face of transverse dunes advancing across wet flats. Here marram slows the movement of the sand and plays a part in revegetation of the dune. However, marram seedlings are palatable and establishment is hindered by rabbits. Thus rabbits, although few in number, may play a significant part in shaping the topography of the sand country.

The effects of water-table on the distribution of *Gnaphalium luteo-album* is apparent from the aggregations of plants on what look like "high-tide marks" following contours around the low hummocks. It reaches a little closer than seedlings of *Cassinia leptophylla* to the mean summer water-table but has much more limited range on the dunes.

Scirpus nodosus seedlings occur in abundance on the sand plains, but this species is less dependent than *Desmoschoenus* and marram on a high-water-table for germination of its seeds.

On some terminal sand plains there are greater complexities brought about by ponding and the growth of filamentous and globular algae which form a skin over the sand when the water level falls. These areas support a much larger flora with a high proportion of exotics. The sand plains near the foredune, on the other hand, have a smaller range of species because of the greater effect of moving sand and the wider fluctuation in the water-table between summer and winter. Here, *Selliera radicans* and *Carex pumila* are the major species.

Other sand plain species such as *Lilaeopsis orbicularis, Gunnera arenaria* and *Triglochin striatum* have not received mention in this account. They were present in the study area but not in sufficient quantity to give reliable information on their requirements and tolerances. The only exotic plant of note, other than marram, is *Leontodon taraxacoides*. It occurs on the low hummocks and extends down to the mean summer water-table.

SUCCESSION

Natural changes in sand plain vegetation are towards extinction by advancing dunes or by sand accumulated by marram, or towards *Leptocarpus* communities. Pioneer sand plain vegetation of the type described above remains while *Leptocarpus* is absent or is in the early stages of invasion. Once established, *Leptocarpus* arrests sand movement at the margins of the plains. At the same time *Scirpus nodosus* occupies the margins of the hummocks which, having their supply of sand cut off, are often levelled by wind. Nearly all other pioneer plants disappear as the sand surface becomes shaded and stable. These are replaced by *Schoenus nitens* which makes its appearance soon after *Leptocarpus* becomes dominant. *Juncus maritimus* var. *australiensis* appears in some places and later, *Cortaderia toetoe*, followed by *Phormium tenax*.

At the *Leptocarpus* stage of succession organic matter begins to accumulate and in time this forms a topsoil two or three inches deep and overlying grey sand. Sand plain soils of this nature are gleyed yellow-brown sands and have been mapped in the Hokio series by Cowie and Smith (1958) and Cowie (1967). As these soils are sufficiently developed for agricultural use the native vegetation has been replaced by pasture and there is no evidence remaining of later successional stages.

ACKNOWLEDGEMENTS

I am grateful to J. M. Stewart, Department of Lands and Survey, Palmerston North, to H. J. Esler for his stimulating interest and assistance in the field and to Mrs M. J. A. Bulfin and R. M. Greenwood for help in the preparation of this paper.

REFERENCES

CARNAHAN, J. A. 1957. Botany of the Manawatu sand country. *Proc. N.Z. Ecol. Soc.* 5: 17–18.

COCKAYNE, L. 1911. Report on the dune-areas of New Zealand, their geology, botany and reclamation. *Append. J. N.Z. House Repres. C* 13: 1–76.

COCKAYNE, L. 1928. *The vegetation of New Zealand.* in *Die vegetation der Erde* XIV. Engelman, Leipzig. (2nd Edit.)

COWIE, J. D. 1967. Soils of the Manawatu-Rangitikei sand country. *N.Z. Soil Bur. Bull.* 29. Govt. Printer, Wellington.

COWIE, J. D., and SMITH, B. A. J. 1958. Soils and agriculture of Oroua Downs, Taikorea, and Glen Oroua districts, Manawatu County. *N.Z. Soil Bur. Bull.* 16. Govt. Printer, Wellington.

MOORE, L. B., and ADAMS, N. M. 1963. *Plants of the New Zealand Coast.* Paul's Book Arcade, Auckland and Hamilton.

PEGG, E. J. 1914. An ecological study of some New Zealand sand-dune plants. *Trans. N.Z. Inst.* 46: 150–177.

WILSON, R. A. 1959. *Fifty years' farming on sand country.* Keeling and Mundy, Palmerston North.