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TASMANIAN BEACH RIDGE SYSTEMS IN RELATION TO SEA LEVEL CHANGE

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(With 1 plate and 8 text figures.)

ABSTRACT

Both sand and pebble beach systems in Tasmania show an overall decrease in height seaward which may be correlated with a fall of sea-level occurring while they were being formed. This fall from the postglacial Milford shoreline was of the order of 2 or 3 ft. in south-eastern Tasmania, but about 5 or 6 ft. elsewhere.

INTRODUCTION

At several points along the northern and eastern shores of Tasmania (Fig. 1) are systems of numerous, low, sub-parallel, frontal dunes to which the name of sand beach ridges is usually given. Their general appearance is shown by Plate 1. The ridges may vary in amplitude from a few inches to about 20 feet and represent stages in a gradual progradation of the shore. The factors affecting their development have been discussed previously (Davies, 1957).

The ridge systems always lie between the present shore and the older, slightly higher, shoreline of the Milford sea level, which, although it has not yet been precisely dated, seems certainly to represent the limit of postglacial marine transgression (Davies, 1959). The ridges may thus have formed at the Milford level, at the present level, or during the fall in sea level from the one to the other. On this assumption their initiation must have been at some time in the last 6,000 years and such a maximum age is supported by the evidence of profile development in the sands, which shows that shell content decreases and humus content increases gradually to landward.

Material coarser than sand is rare on Tasmanian beaches and the only extensive pebble beaches are those on the north coast between and around the mouths of the Forth and Mersey rivers. Their localisation here is probably associated with the function of these two rivers as important outlets of glacial meltwater in the late Pleistocene. Immediately east of the Forth at Lillicos Beach is a well marked complex of pebble ridges representing a series of storm beaches on a prograding shore. As with the sand ridge systems, the Milford shoreline runs to landward and it would seem that the pebble ridges are more or less contemporary with the sand ridges described above.

SAND RIDGE SYSTEMS.

Each ridge in a sand ridge system comprises a wave built berm of sand or shell on top of which wind driven sand has accumulated in the form of a low dune. The relative amount of dune sand present varies within individual systems and also between systems. The sand ridges of the Bass Strait coast, which are open to strong sand-shifting winds from the north-west, contain notably more aeolian sand than do those of the east coast. The amplitude of the ridges at Black River, Port Sorell and Greens Beach (Figs. 2, 3, 4) is consequently greater than those at Swansea, Rheban, Seven Mile Beach and Roches Beach (Figs. 5, 6 and Davies, 1958). One may note too that the Bass Strait ridge systems are more irregular in height, since the amount of wind blown sand in a ridge varies much more than the

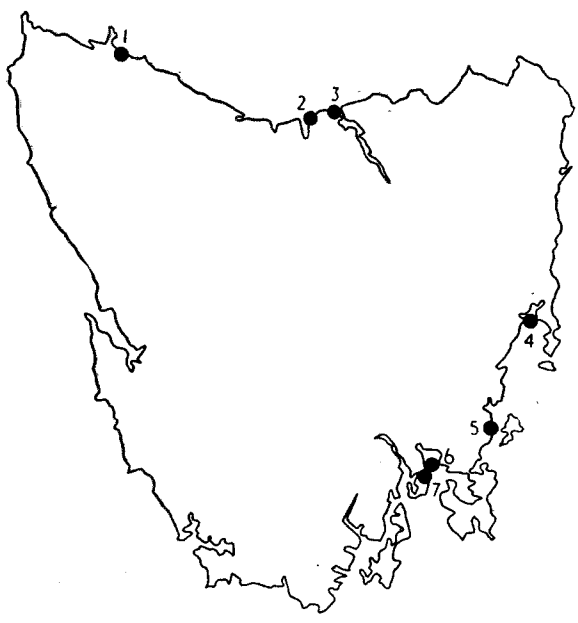

FIG. 1.—Location of sand ridge systems.

amount of wave deposited material. The height of the beach berm is almost entirely controlled by the maximum height of the constructing waves and this factor will not show great and erratic variation from ridge to ridge. On the other hand the thickness of the wind blown material will depend mainly on the length of time that the ridge operates as an accumulation form, which in turn will depend on the length of time which it takes for a new ridge to establish itself to seaward. This factor is potentially much more variable.

It could be expected therefore that the height of the hidden beach berm nucleus would reflect wave height at the time of construction and, provided other factors such as tidal range and offshore wave refraction patterns remained constant, any variation in the height of the berm from ridge to ridge would be an approximate measure of sea level change. However, this record is submerged beneath the wind blown material capping the berms, which, because it varies with a different factor, tends to mask trends which might otherwise be discernible. Even so, it has been suggested that variation in height of the ridges can be used as evidence of sea level change and Gill and Banks (1956) pointed to the apparent significance of the Black River ridges in this connection. Ideally an exact assessment of trends would necessitate the identification and levelling of the top of the wave built section in each ridge, but the writer has suggested (Davies, 1958) that the calculation of a line of best fit for surface ridge and swale heights would give an approximation to sea level trends over the entire period of ridge formation. The calculation of lines of best fit by the method of least squares for ridges and swales at Seven Mile Beach and Roches Beach showed a gradual overall slope seaward of about 2 to 3 feet.

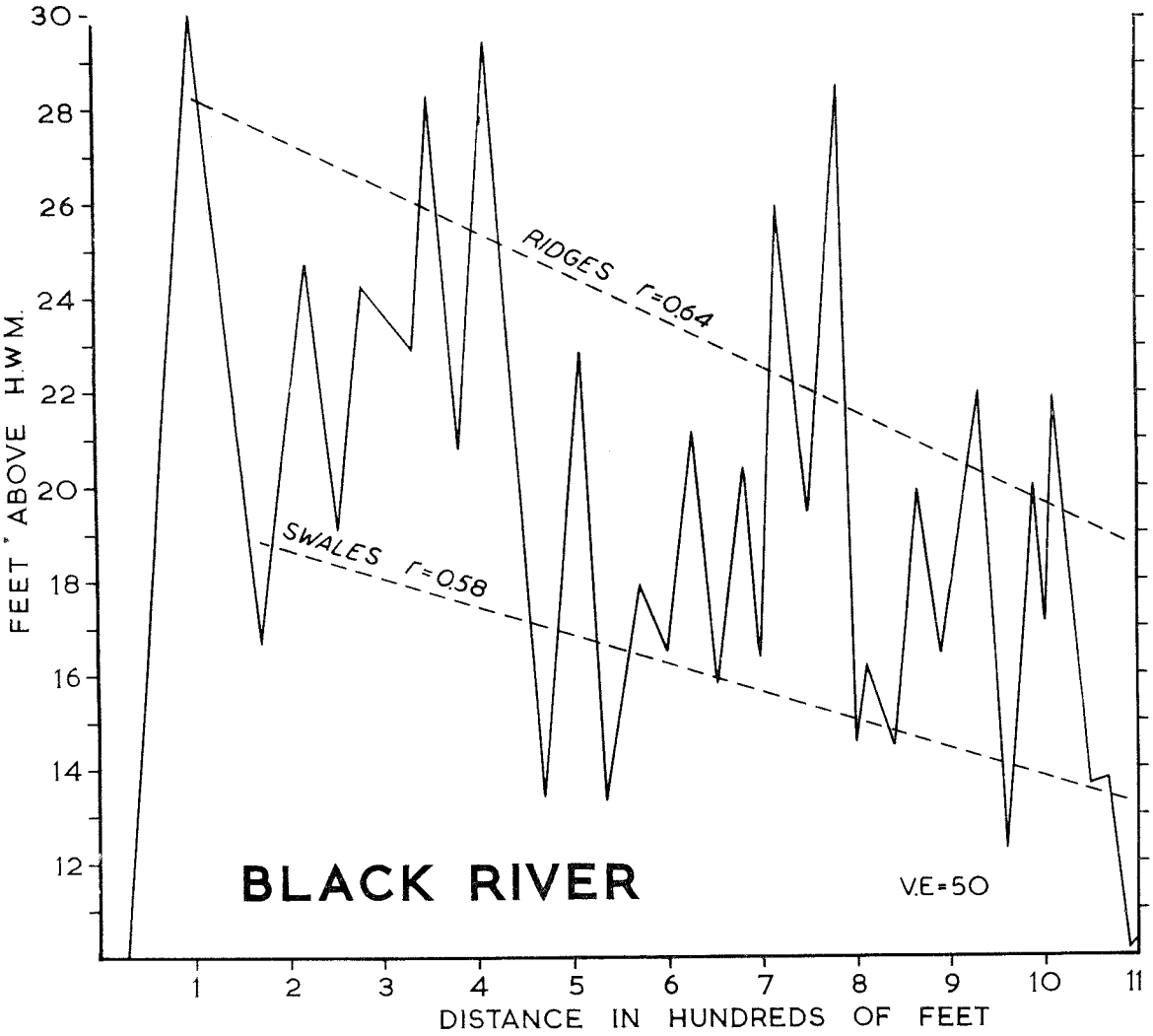

FIG. 2.—Profile of sand ridge system at the Black River, with lines of best fit and product moment correlation coefficients (r.).

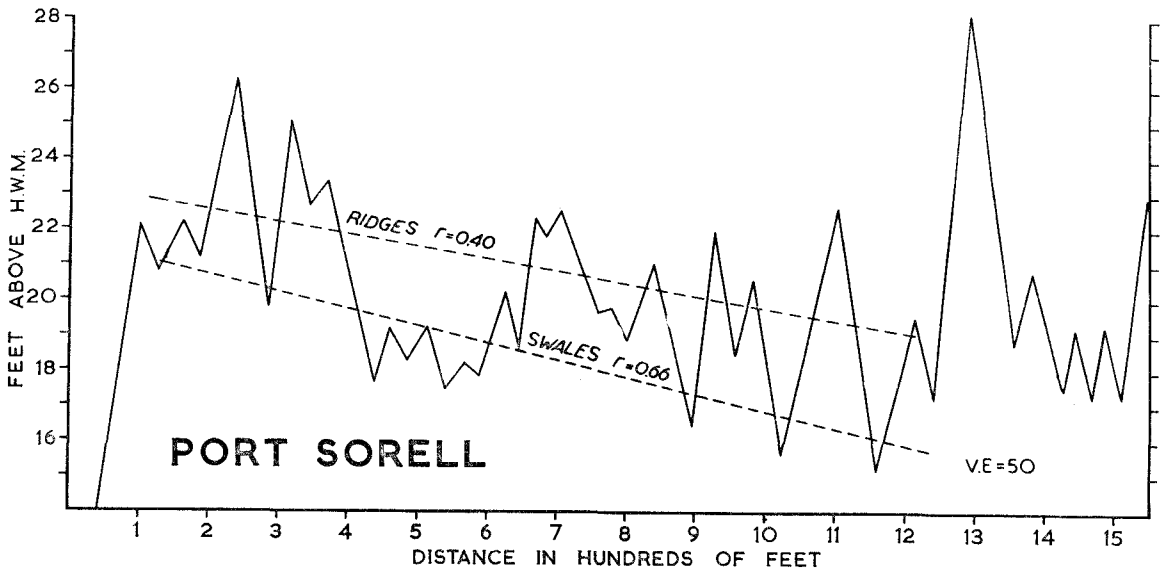

FIG. 3.—Profile of sand ridge system at Port Sorell.

Survey and analysis of other sand ridge systems has since shown that such simple statistical analysis of surface form provides an almost consistent story of correlation between ridge building and sea level fall. The additional systems analysed were those of Black River, Port Sorell and Greens Beach on the Bass Strait coast and of Swansea and Rheban on the east coast.

Black River (Fig. 2).—The ridge system at the mouth of the Black River has been described and figured by Gill and Banks (1956). There is a ridge amplitude of up to about 17 feet and this results from the comparatively large amount of dune sand contained in the ridges. This in turn is reflected in the irregularity of ridge height. As a result, although the lines of best fit suggest an overall seaward slope of the system of about 9 feet for ridges and 5 feet for swales, the fit is not a particularly good one and the product moment correlation coefficient (r) in each case, while satisfactory, is not very high.

Port Sorell (Fig. 3).—The wide Rubicon ria at Port Sorell is partly closed by a large baymouth bar, progradation of which has given rise to an extensive sand ridge system (Plate 1). The ridges show great variation in amplitude and the surveyed profile poses some difficulties. The greatest of these perhaps is due to the presence of the highest (28 ft. above H.W.M.) ridge close to the seaward edge of the system. In calculating the lines of best fit only the ridges and swales behind this ridge have been used, on the assumption that the exceptionally large ridge marks a point of sudden and marked slowing in the ridge building process with the consequent accumulation of a much larger mass of dune sand. Such a procedure is open to criticism on grounds of subjectivity and since the correlation coefficient for ridges here is a low one (0.40), it would seem preferable anyway to treat the evidence of the Port Sorell ridges with some reserve.

Greens Beach (Fig. 4). Greens Beach is near Kelso, immediately west of the Tamar mouth, and here there is a well defined system of over twenty ridges with amplitudes of 1-6 ft. They contain a smaller amount of dune sand than do the ridges at Black River and Port Sorell so that the correlation coefficient for the line of best fit is very satisfactory (0.81). The lines of best fit suggest an overall drop in height seaward of 10 ft. for ridges and 8 ft. for swales.

Swansea (Fig. 5). The ridge system at Swansea occurs on the large spit of Nine Mile Beach which almost closes the head of Oyster Bay. The system is a large one, being about three-fifths of a mile wide, but the ridges are the lowest and least distinct of any surveyed. The amount of wind blown sand which they contain is very small and excavation suggested that it does not cap the underlying beach berms to a depth of more than 2 feet.

The result is that correlation coefficients are very high (0.88 for ridges and 0.92 for swales) and the system shows a very clear and steady slope seaward of about 5-6 ft.

Rheban (Fig. 6). The Rheban system, while genetically similar to the others, is different in two main ways. In the first place, two cross profiles of this system showed an overall tilt to landward instead of to seaward as in all other instances. One of these profiles is analysed in Fig. 6 where a tilt of 2-3 ft. is suggested by lines of best fit. The second difference, which is undoubtedly connected with the first, lies in the much more complicated history of this system. The ridges comprise a bar in Carrickfergus Bay at the mouth of the Sandspit River

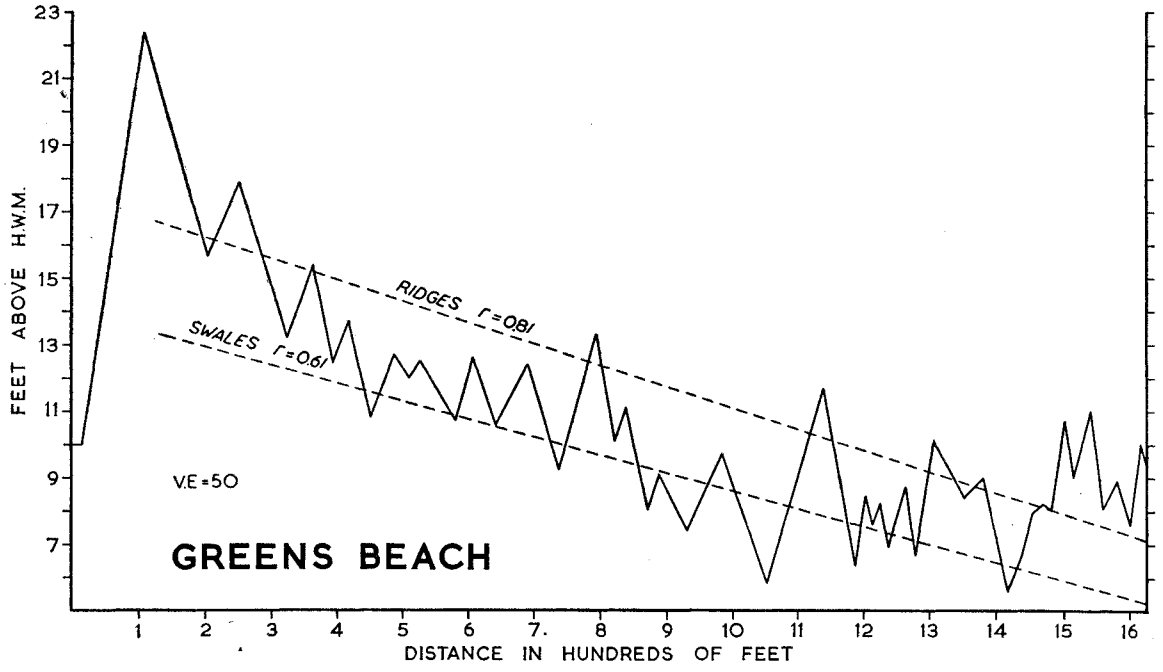

FIG. 4.—Profile of sand ridge system at Greens Beach.

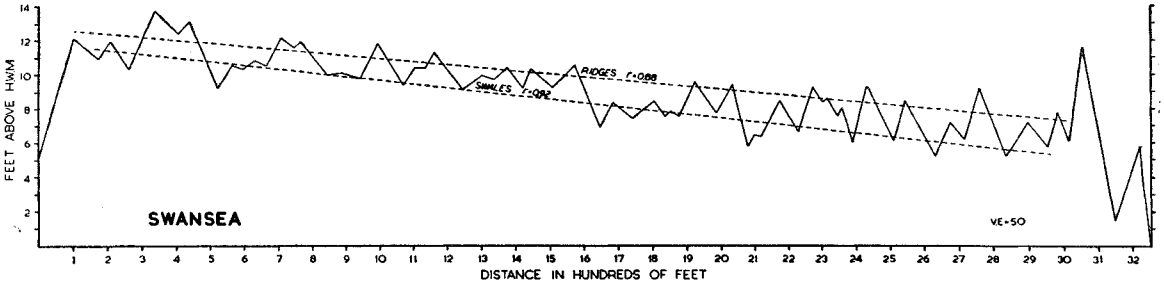

FIG. 5.—Profile of sand ridge system at Swansea. Dunes at the extreme right have been omitted from calculations because they are actively accumulating at the present sea level.

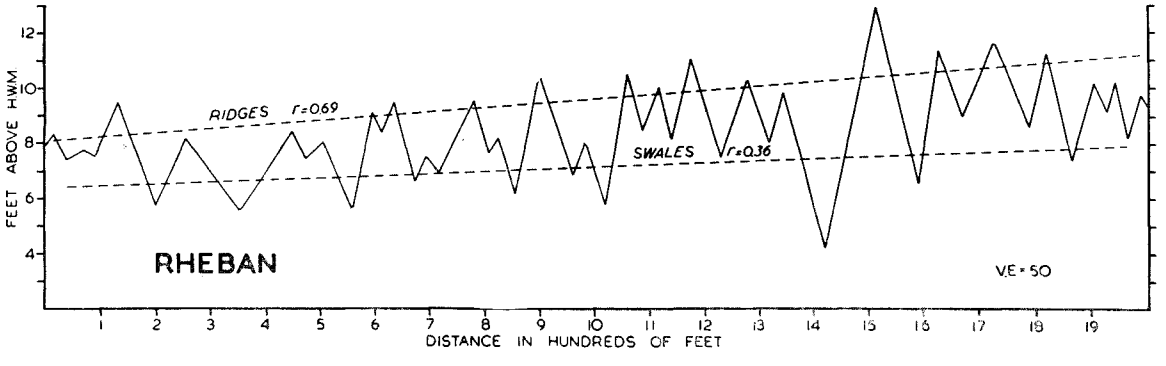

FIG. 6.—Profile of sand ridge system at Rheban. As in all sand ridge profiles the sea is towards the right.

and their development has been controlled by two sets of waves—one approaching from north of Maria Island and one from the south. The interaction of these two sets of waves, varying in character with time, has given rise to considerable unconformity in plan which is not found in other ridge systems. A detailed study of the evolution of this system seems necessary before the significance of the apparent tilt can be properly appreciated.

PEBBLE RIDGE SYSTEMS.

Unlike the sand ridges, pebble ridge systems contain no wind-blown component and owe their total height directly to the height of the constructing waves. One would therefore expect their surface form to be a much better reflection of the height of the sea at the time of their construction.

Lillicos Beach.—A cross profile of the Lillicos Beach pebble ridges about half a mile east of the mouth of the Forth (Fig. 7), shows that they decrease generally in height seaward by a total of about 5 feet. Other profiles are consistent with this, but nearer the river mouth the drop in height is rather less.

DISCUSSION

The evidence derived from analysis of the sand ridge systems is summarised in the Table below, where the figures for Seven Mile Beach and Roches Beach have been added to those of the systems figured here.

System		Tilt in ft.	r
Black River	Ridges	9	0.64
	Swales	5	0.58
Port Sorell	Ridges	4	0.40
	Swales	5	0.66
Greens Beach	Ridges	10	0.81
	Swales	8	0.61
Swansea	Ridges	5	0.88
	Swales	6	0.92
Rheban	Ridges	3	0.69
	Swales	2	0.36
Seven Mile Beach	Ridges	4	0.70
	Swales	2	0.70
Roches Beach	Ridges	3	0.93
	Swales	2	0.74

All except the Rheban complex show an overall tilt to seaward of both ridge and swale heights and this tilt also appears in the pebble ridges of Lillicos

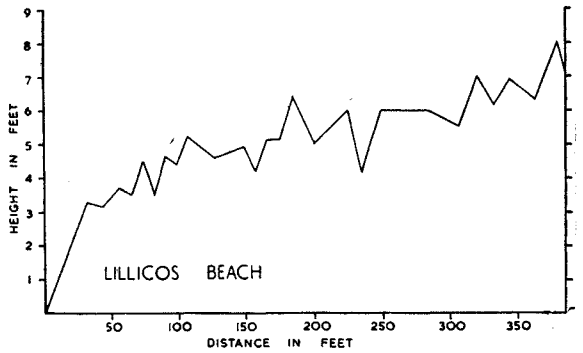

FIG. 7.—Profile of pebble ridge system at Lillicos Beach

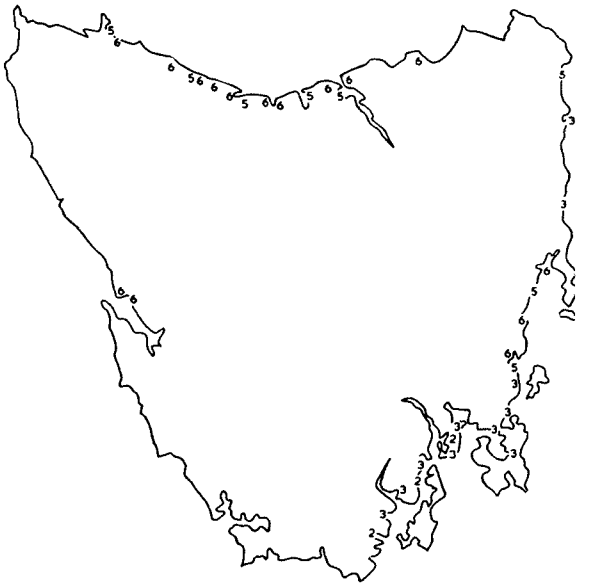

FIG. 8.—Height of the Milford Shoreline above high water mark.

Beach. There is consequently, and for the reasons suggested ealier, a very strong presumption that sea level was falling while the ridges were being formed.

The extent of this sea level fall may be gauged approximately from the table and would appear to have been about 2-4 ft. in south-eastern Tasmania, but about 5-10 feet elsewhere. Such figures agree extremely well with figures obtained by other methods for the difference in height between the Milford sea level and the present. The figures for the height of the Milford shoreline plotted in Fig. 8 have been derived from instrumental levelling of the foot of Milford cliffs and the head of Milford beaches and salt marshes and comparison with comparable features controlled by present sea level. These figures also show a smaller fall in the south-east (2-3 ft.) compared with a slightly higher fall elsewhere (5-6 ft.). A similar, but somewhat greater, difference is noticeable in heights obtained from Llanherne shoreline, formed at an older higher level. In south-eastern Tasmania this lies at about 12-15 ft. above present high water mark, but elsewhere figures of 18-22 ft. have been recorded for what appears on all the evidence to be the same shoreline.

The exact significance of this apparent tilt of the Milford and Llanherne shorelines cannot yet be assessed. It may reflect an actual downward movement of the land in the south-east, but it could also conceivably be brought about by other factors such as local changes in tidal range. Since differences in height between the Llanherne levels are somewhat greater than those between Milford levels it might be deduced that, whatever the process may be, it has been going on since before the time of the Milford sea.

In summary then, there are three lines of evidence which, taken together, strongly suggest that the ridge systems were built during the fall from the

Milford sea level. First, the ridges are all seaward of the Milford shoreline and were consequently built since it was initiated; second, they display a drop in height of the same order as that recorded for other features of the Milford shore; and third, they show the same difference in this drop as between the south-eastern coast and the other coasts of Tasmania.

ACKNOWLEDGEMENTS

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PLATE 1.—Sand ridge system at Port Sorell. The sub-parallel ridges are crossed obliquely by parabolic or "blow-out" dunes initiated by burning and grazing of the ridges in the latter half of the nineteenth century. Agricultural land behind the ridges mostly comprises raised Milford salt marsh and the Milford shoreline runs approximately along the inner edge of the cleared land.