Chapter (non-refereed)

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Biological Influences in some Units of Sand Dune Landscapes

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INTRODUCTION

Vegetated dune landscapes can be subdivided into distinctive topographic units created or modified by biological activity. For example, we can distinguish dunes, and damp hollows (slacks), salt-affected zones, lime-rich and lime-deficient zones, and easily distinguishable hummocks, warrens; or gulleries intimately associated with individual species of plants or animals. There are also cultivation units like grazing paddocks, arable fields and forest plantations, associated with human activities.

Study concentrated on particular types of unit can help us to understand processes and time scales at work in dune landscapes and gain information of practical use for their management. Units considered briefly here include: the strandline; the dune mound; the dune ridge; the rabbit warren, and machair old field.

STRANDLINE

The strandline is a linear unit formed of sand and tidal litter cast up by the sea. Where blown sand accumulates on it, the level may be raised free of wave disturbance. If this occurs for a sufficient period of time for annual plants to complete a cycle of growth, they may trap enough blown sand to raise the level permanently above sea level. It is therefore the critical level where plants have an opportunity to gain mastery over a salt-affected, potentially mobile, and immature soil.

Strandlines are essentially ephemeral in space and in time. A vigorous strandline flora is unlikely to persist on a particular shoreline for more than a few decades because it either gets washed away, shifts gradually with cyclic chordal adjustments of bay deposits, or becomes engulfed in the coast dune it helps to create. There is little information about how long strandline floras actually do persist at sites. The vigorous strandline vegetation at Morfa Harlech (Merioneth) illustrated in Salisbury (1952, see Plate 22) was converted to dune in little more than a decade or so. Elsewhere, at Ferry Links (East Sutherland) for example, vigorous strandline vegetation may not be associated with dune formation, and may be more persistant. Mather (***pers. comm.***) suggests, "that one of the variables influencing strandline vegetation is the role of the beach unit as a debris catchment area — with strandline vegetation tailing off with too little or too much debris." This role may be much less important in dune building, where blown sand supply is a key variable.

Most Hebridean shores are accessible to stock which graze and trample strandline vegetation; most southern shores are heavily trampled by people. It is possible to find quite vigorous growths of ***Cakile maritima*** on some of the most heavily used recreational shores in Britain, for example at Caister in Norfolk. People tend to avoid an established strandline growth, but cattle do not, and they actively graze and damage such dominant strandline species as ***Cakile***. Some of the best current strandline growths seem to occur on shores adjoining golf courses (e.g. Ferry Links) or aerodromes (e.g. Macrihanish, Argyll) where grazing is controlled. The harmful effects of trampling and grazing on strandline vegetation could be significantly delaying dune formation and therefore increasing coastal erosion risks in the Outer Hebrides, so this would be a useful line of study

DUNE MOUNDS

Many plants in different parts of the world are capable of building dune mounds. They are one of the most characteristic and universal small scale units of the dune landscape. Such mounds are built in South Africa by sea wheat (***Agropyron distichum***). On the eastern North American seaboard they are built by American beachgrass (***Ammophila breviligulata***), while sea oats (***Uniola paniculata***) and ***Panicum amarum*** take over further south on the Gulf Coast. ***Sand spinifex*** (***Spinifex hirsutus***) builds mounds in Australia and New Zealand, and in Europe so do marram (***Ammophila arenaria***), sea lyme grass (***Elymus arenarius***) and sand couch grass (***Agropyron junceiforme***). It is the last of these that is discussed here because it is believed it has particular significance in helping us to interpret the origin of certain types of machair landscape.

There are rather few dune systems in Britain where isolated actively-growing sand couch grass mounds can be seen at the present time. In Scotland, they occur well to landward of a sand flat behind the storm beach at Europie in Lewis, on the high level sand flat near Northton in Harris, and on sandflats of prograding systems like Morrich More, Easter Ross and Tentsmuir, Fife. These very different situations have the following characteristics in common: they are damp to dry sand flats near high water mark spring tides not long isolated from (or even still liable to) occasional tidal flooding, and they occur near the seaward limit of dune systems. In this latter respect, they differ from the more landward, secondary damp slack sand surfaces with a fresh water table recently exposed by the passage of wind eroded parabolic dunes or dune ridges within a dune system. Sand couch grass captures wind blown sand and raises the level locally in very characteristic low circular mounds, 5 m or more in diameter, which stand out of the sand plain. A rare sedge (***Carex maritima***) is a characteristic colonist of the open damp sand between the mounds in North Scotland, and forms a very ephemeral plant community (like strandline vegetation). Once the sea is excluded by a natural barrier (or by isostatic adjustment), the damp sand between the sand couch mounds becomes very rapidly colonised by typical damp slack species like creeping bent (***Agrostis stolonifera***). These lock the dune mounds into a landscape highly reminiscent of hummocky machair superimposed on a flat plain. If this interpretation is correct, we might consider that the extensive hummocky machair we see at places like Baleshare could indicate sites of former sea overwash and subsequent rapid recolonization. Whether these resulted from unusually severe storms, or whether from isostatic adjustment and relative uplift of former foreshore areas, or both, are intriguing questions. They seem to indicate conditions of origin in the past that are not commonly found in the Hebrides today. Possibly recognizable buried fruits or rhizome fragments of the now rare ***Carex maritima*** might be recoverable from the peaty deposits in the damp slacks between mounds in this type of hummocky machair – it might be worth looking. One consequence of this hypothesis is that the mounds, which must have formed in a short time in conditions of limited sand feed, are likely to be little older in time of colonisation than the sand flat between them (cf. Ranwell 1975 p. 384).

DUNE RIDGE

Three perennial grasses are the main builders of coast dunes in Britain. Two of them, sand couch and sea lyme grass, can build dunes at a vertical rate of about 0.5 m per year; the third, marram, can do so twice as fast, up to 1 m per year. However, conditions of sand supply and wind erosion rarely allow the maximum rate of dune building to be expressed. Unlike the sand couch grass mound, which probably takes less than a decade to build, and strandline vegetation which rarely persists in one location for more than a decade or two, growth to maximum height of a coast dune ridge can take between half a century to a century on British coasts.

Once the dune-building grasses colonise the embryo dune formed by strandline vegetation, and providing there is adequate sand feed, strandline vegetation will be engulfed by the increasing basal width of the growing dune. It may not reappear (except as sporadic plants) for a very long period of time. The initial colonisation by these dune grasses on the East Anglian coast seems to be very largely by regeneration from fragments, but seedlings of sand couch grass have been seen in the first week of July locally on Scottish strandlines (e.g. at Tentsmuir, Fife). Marram is much less tolerant of salt than the other two grasses so only gets a hold when the level has built up above high water mark. Tidal flooding does not necessarily kill sand couch grass. After the tide had ripped off surface growth at Holkham (Norfolk) in January 1978, sand couch grass grew again strongly from shoot bases and rhizomes still ***in situ*** in shore sand (Harris, D. – ***pers. comm.***)

No one, so far as I know, has attempted to calculate the sand feed from the shore and compare it with the sand catch of a growing marram dune. Nor do we have measurements to tell us how it happens that dunes reach different maximum heights at different places within and between sites. Mather (***pers. comm.***) comments, "The relationship between exposure and dune

height is a very complex one. It seems that where wind direction is consistent, or where strong exposure is in one direction only, dunes tend to be low (e.g. Oldshoremore, Sutherland), and, conversely, that where there is exposure to two or more strong wind directions (e.g. Sinclair's Bay, Caithness or Feall Bay, Isle of Coll), dune height and dune steepness increase."

The time inevitably comes when marram at the crest of the ridge no longer traps as much sand as it loses in the wind conditions that prevail at the critical elevation. Then; the ridge (or a parabola of it) can begin to move inland at horizontal rates up to 10 m per year in Britain, smothering slacks to leeward and creating new slack surfaces to windward. The base of the lee slope of the coast dune characteristically develops another type of hummocky machair, this time formed on an inclined plane. It may result from the rejuvenated growth of dune slack shrubs like ***Salix repens,*** growth of ***Ammophila*** from seedlings, or renewed growth of the small 'counter dune' ***Ammophila*** patches left by variable parabola passage in the floor of the slack. The landward movement of whole ridges in a large exposed dune system like Newborough Warren in Anglesey may continue for several centuries under the influence of south west prevailing winds on an exposed shore. Ultimately, the ridge comes to rest in more sheltered landward regions and the vegetated dune is levelled by the slow natural processes of aerial weathering which may continue for thousands of years. Similar long term ridge movement inland is thought to occur on the South Uist machairs (Ritchie – ***pers. comm.***), and the ridge finally becomes dissipated into the line of lochs at the landward limit of the machair, as parts of the Newborough Warren dunes have done at Penlon lake.

WARREN

Not all parts of dune and machair systems are suitable for rabbit warrens. Mobile dunes are too unstable and burrows cave in. There has to be at least 1.5 m of sand above the maximum height of the winter water table level for warrens to persist. Much of the Bettyhill (Sutherland) machair is too thin over rock for burrowing, and the greater part of the Loch Bee (South Uist) machair is too wet for effective development of warrens.

Parts of Barvas (Lewis) and Melvich (Sutherland), however, had some of the most intensively burrowed warrens seen in any of 72 dune systems visited in Scotland in the period 1975-77. At both sites, burrow collapse, wind erosion, and eat out of palatable species seemed likely to lead to such warrens becoming uninhabitable. Rabbits are essentially back-door gardeners and do not normally graze far from warrens, so grazing intensities are likely to be closely related to radial distance from warrens. Results from rabbit exclosures studies can be very misleading if this effect is not taken into account. Rabbits do range more widely in cold weather when the nutrient-rich shoot bases of strandline grasses like sand couch may be a vital food resource. At the present time, rabbit populations on dunes are fluctuating rapidly from year to year as a result of recurrent myxomatosis. I believe we are likely to get more meaningful estimates of rabbit influences on dunes by deducing potential population maxima from censuses of potentially warrenable ground and burrow densities than from difficult and time-consuming direct measurements of rabbit populations at any one time.

The efficiency of traditional methods of rabbit control was clearly demonstrated at Macrihanish (Argyll), where it was estimated that some 10,000 rabbits infested the site prior to 1954 when myxomatosis became active in Britain (Colville and Gibson 1974). A pair of adjoining air photographs of almost identical warrenable hummocky machair taken on the same day in 1951 (Plate 12) show intense burrowing activity seaward of the aerodrome (where rabbits were not controlled), side by side with almost burrowless ground opposite the golf course, where they were regularly controlled by Campbell town trappers.

Once rabbit activity has created sand cliffs in machair, these continue to erode and can lead to blow-outs 10 m or more deep, as at Oldshore More (Sutherland). Studies on the sequence of physiographic and vegetation changes associated with dune warrens, and on desirable rabbit population levels and how to achieve them, would be of particular value to dune managers.

OLD FIELD

In many parts of North America (e.g. South Carolina) one can see all stages of old field recovery from former cultivation. Succession starts with herb-rich swards and leads on to secondary forest. There is a whole school of ecological studies on these North American old field successions.

The Hebrides is one of the few areas where old field successions (up to a century or more old) can still be seen in the British Isles. Few areas are more richly endowed with colourful flowering plants than these old field sites in Hebridean machair and they attract tourists from many parts of the world.

Plate 12a. Hummocky machair intensively rabbit-warrened where rabbits were left uncontrolled opposite aerodrome, Macrihanish, Argyll, June 1951, (Crown Copyright).

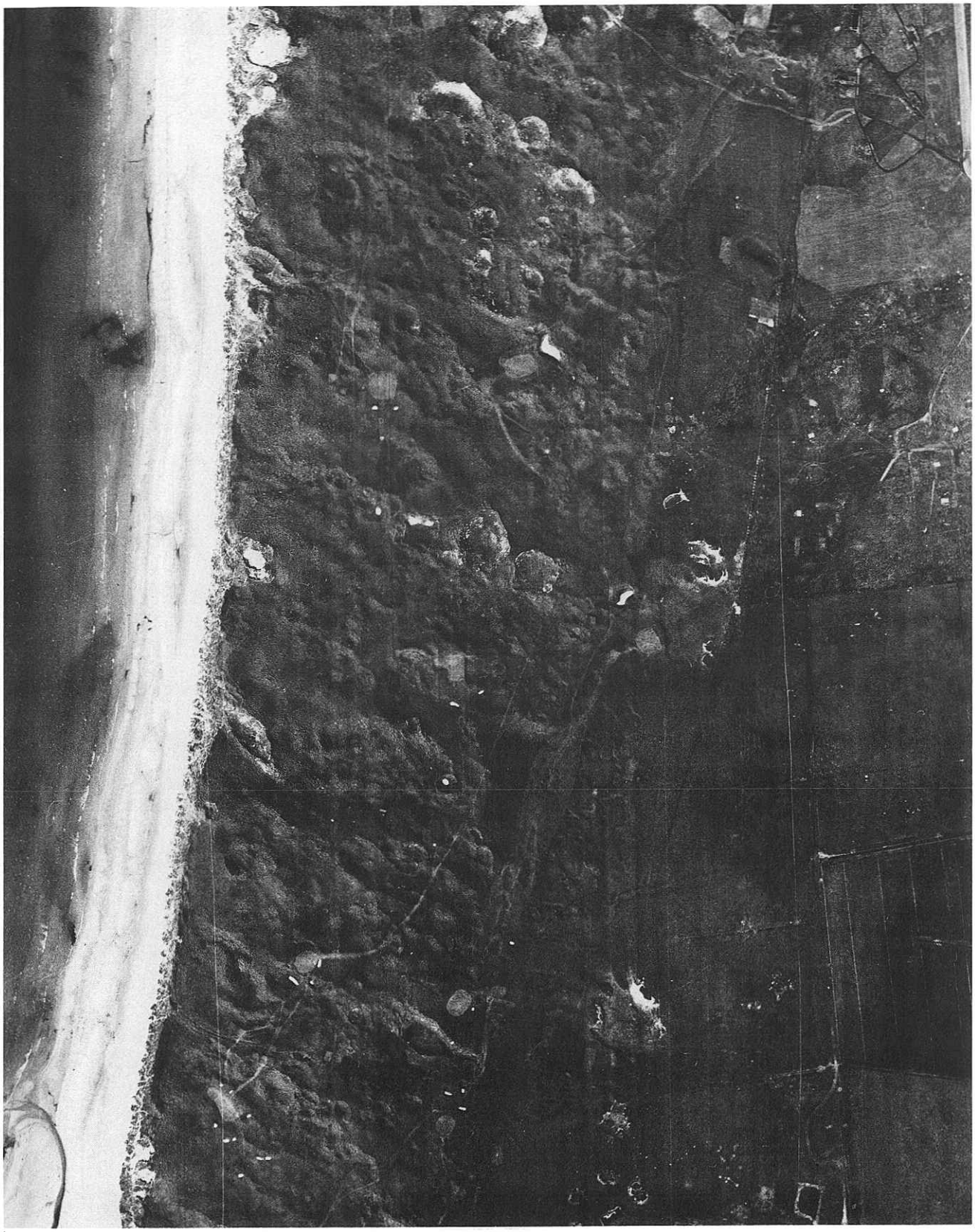

Plate 12b. Adjoining hummocky machair almost free of rabbit warrens where rabbits were regularly trapped to protect golf course, Macrihanish, Argyll, June 1951, (Crown Copyright).

Available evidence suggests it takes about 30 years for the commoner marsh orchids to establish in formerly cultivated machair and about 100 years for almost the full uncultivated machair flora to return.

Study of succession and soil development in these old field sites would provide valuable information for the management of nature reserves on machair, for the dating of buried soil horizons in Scottish dune systems, and for studies on the origin and development of one of our most ancient weed floras.

CONCLUSIONS

Five dune landscapes units, and problems of practical interest associated with them, are discussed. The following priority areas of study are identified: –

1. Rabbit warren distribution and evolution in relation to rabbit density and dune vegetation.
2. Influences of cultivation on the development of machair soil and vegetation.
3. The role of stock trampling on strandline vegetation and its impact on coast erosion.
4. The interpretation of historical dune landscapes, from a study of vegetated dune mound development.
5. Factors controlling the growth of vegetated dunes to maximum height.

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