Newborough Warren, Isle of Anglesey (Ynys Môn)

[SH 367 648]–[SH 444 615]

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Introduction

The shoreline of the major coastal dune system of Newborough Warren is controlled by the Menai Strait to the east, Mon Cefni to the west and Llanddwyn Island (Ynys Llanddwyn), which divides the shoreline between Malltraeth Bay and Llanddwyn Bay. There are large expanses of actively evolving and stabilized dunes, although much of the latter is afforested. East of Llanddwyn Island, parts of the dunes are cliffed and these are in a state of net sediment deficit, as sand is transported eastwards towards a spit that extends (in association with an artificial breakwater) to Abermenai Point. In Malltraeth Bay, the dunes exceed 30 m OD and rest upon and mask the rock outcrop landward of Llanddwyn Island. North-westwards, the beach extends into extensive intertidal sandy flats in the Malltraeth estuary. Like many coastal dunes, Newborough Warren was described by Steers (1946a), but Ranwell (1955, 1958, 1959, 1960) provided the most complete study of dune formation. The orientation of dunes to wind direction is demonstrated well here (Landsberg, 1956). More recently, Robinson (1980b) examined the links between the development of the dunes, the spit and the sandbanks at the mouth of the Menai Strait.

Description

The sand dunes at Newborough Warren are very mobile and it is one of the most-exposed west-coast dune areas; in the past sand travelled inland to cover agricultural land several kilometres from the shoreline (Wortham, 1913). Much of the western area of dunes has been planted with conifers masking the underlying geomorphological interest. This area is excluded from the GCR site. The site comprises six main morphological units.

1. The lower estuary of the Afon Cefni, much of which is formed by sandy, intertidal banks. The western side is formed by cliffs in Precambrian rocks.
2. Malltraeth Bay, where a large area of dunes extends about 2 km into, and about 1.5 km across, the Malltraeth estuary
3. Llanddwyn Island (Ynys Llanddwyn), which projects about 1.75 km seawards of the beaches and divides the site into two separate beaches.
4. The beach and frontal dunes in an area stretching for about 2 km east of Llanddwyn Island; the area behind this is afforested and now has little geomorphological interest.
5. The eastern dunes of Newborough Warren.
6. The Abermenai spit, which is about 2.5 km in length.

Except for part of the afforested dune area within Malltraeth Bay, the GCR site area falls within the boundary of the Newborough Warren–Llanddwyn Island (Ynys Llanddwyn) National Nature Reserve.

Malltraeth Bay occupies the largest of the low valleys (traeths) that cross Anglesey (Ynys Môn) from north-east to south-west. Precambrian rocks of the Gwna and Fydlyn groups crop out along the western side of the bay and are overlain by dunes on its eastern side (Figure 11.21). The crests of the dunes are generally about 10 m OD, but there are three zones of higher dunes. The first (from [SH 398 649] to [SH 390 653]) lies at the northern end of the dune area and is dominated by an undulating ESE–WNW ridge that exceeds 20 m in height. About 600 m seawards of this ridge, there is a second, more linear, feature (from [SH 395 645] to [SH 391 649]), again exceeding 20 m in height. The present-day shoreline is backed by a wide zone of dunes generally higher than 15 m (between [SH 392 639] and [SH 388 647]) but declining td about 10 m as the beach swings northwards into the Cefni estuary where it cuts across the ends of the two inner ridges. Each of these ridges becomes progressively aligned to SSE–NNW towards the alignment of the present-day beach. Whereas the earliest of the three ridges appears to have faced the dominant direction of wave approach, the later

ones were less well adjusted to it. This may be a function of changing water depth and reduced sand supply. Robinson (1980b) suggests that it is probably a result of the sediment circulation within the estuary.

Parts of the shore west of Llanddwyn Island have been artificially nourished in the past to reduce erosion and prevent loss of the forest. Of the three ridges constructed, the outermost was removed by storms in the 1970s, but the other two ridges remain fairly stable (Hansom, 1988).

Llanddwyn Island reaches about 12 m OD and is tied to the mainland by sand beaches that are banked on its landward connection with the rocks that underlie the rocky hill at Cerrig-Mawr. It not only divides the beach into the two bays (Figure 11.21), but also provides some protection to the western end of the beach in Llanddwyn Bay. As a result, the beach shows some of the characteristics of zeta-curve beaches in which wave energy is reduced by refraction and the planform of the beach is controlled by waves approaching from an easterly direction (Figure 11.21). But for the underlying rock ridge, this would be an excellent example of a sand tombolo.

Eastwards from Llanddwyn Island [SH 392 635] to [SH 410 632], the GCR area comprises the beach and the fringing dune ridge only; the old dunes behind the line of younger 'yellow' dunes have been afforested. The fringing dunes are affected by erosion both from wave action and from recreational trampling, which is most concentrated in this area. The retreat of the beach is geomorphologically important to the beaches to the east, since it releases sand into the intertidal zone from where it is transported alongshore to feed both the active dunes of the eastern block of Newborough Warren and the Abermenai spit. Some parts of the intertidal area of Llanddwyn Bay are characertised by gravels underneath the sand. These are lag gravels produced by erosion of till deposits.

The eastern part of Newborough Warren is characterized by fine examples of migrating dune systems (Ranwell, 1955, 1958) that extend about 2 km inland. As on the western side of the site in Malltraeth Bay, the dunes tend to form linear sub-parallel ridges, although they are broken by areas of erosion and separated by well-developed slacks. As a result of the differential growth towards maximum height, and irregular erosion, much of the area is composed of parabolic dunes (Figure 11.22), the more landward of which stand above a sand plain.

The Abermenai spit is formed by two areas of low, recurved sand ridges on a shingle and gravel base. The spit was breached in 1868 and the distal part of the spit was separated from the mainland. After another breach in 1889, the Caernarfon Harbour Authority constructed protective works, now represented only by a line of broken stakes (Robinson, 1980b), which link the two areas of sand ridges. The spit, which exceeds 2.5 km in length, has an inner section about 1 km in length comprising several recurves almost at right angles to the main beach that are up to 450 m in length. Eastwards, for a further 1 km, the spit is dominated by washover forms and many low recurving ridges that represent steady extension eastwards along the line of the artificial breakwater. They are, in effect, a new distal part of the spit that is growing eastwards as sand is carried alongshore from the west.

Abermenai Point is the pre-breaching distal end of an older spit. The feature appears on all Admiralty charts and Ordnance Survey large-scale plans since the early 19th century (Robinson, 1980b), but is much older. The recurred end of the spit was named 'South Crook' during the late 13th century (Davies, 1942 quoted by Robinson, 1980b), but Robinson believed that other historical evidence, notably visits to the harbour of Abermenai by Grffydd ap Cynan in the late 11th century, suggests the possibility of an even older feature at this point. Although the breakwater has provided some armouring to the gap that existed after breaching, the growth of the western part of the spit demonstrates that sufficient sand has been available for continued growth to occur.

The presence of two relatively erosion-resistant points in the shoreline of Llanddwyn Bay, at Llanddwyn Island and an intertidal area of lag gravels produced from till erosion fronting the western set of recurves on Abermenai spit, has maintained the shoreline in its alignment towards the prevailing and dominant waves and there has been some growth of the dunes eastwards in the lee of the spit. Substantial amounts of sand also travel over the spit into Traeth Melynog, but there is at present no direct evidence of the volume or location of the seabed sources that are still capable of feeding the beaches.

Interpretation

Newborough Warren is of particular geomorphological interest because (i) the processes of dune-building and migration have been examined in detail (Ranwell, 1955, 1958, 1959, 1960, 1972), (ii) there is a marked contrast in the development of the beaches east and west of Llanddwyn Island, and (iii) the Abermenai spit is a good example of a major feature at the mouth of an estuary that has grown, been breached and rebuilt. In this respect it provides a good contrast with Spurn Head, Yorkshire, both in its relationship to wave conditions and in the pattern of breaching and rebuilding. First, it faces directly into the dominant and prevailing waves.

Second, the tidal range is less (by about 2 m) than that of the River Humber, and third, the sediment supply to the Abermenai spit is substantially less, not least because much of the sand is blown inland. Steers (1946a) commented that there was no physiographical description of the site. There is still no interpretation of the ridges in Malltraeth Bay, but this is essential if the relationship between events on both sides of the Menai Strait are to be interpreted. Despite Ranwell's (1955, 1958) description of the key physiographical features of the dunes, there is no detailed analysis of the dynamics of the spit, although Robinson (1980b) describes the historical changes in the spit and the seabed in the approaches to the Menai Strait.

The migration of the dunes was examined by Ranwell (1955, 1958) who argued that the mechanics of dune development could be understood by studying a location where maximum erosion could be expected. Such a situation occurs at Newborough Warren where the prevailing and dominant south-westerly winds flow across a coastline oriented at right angles to its direction. Landsberg (1956) found a perfect correlation at this site between a calculated wind resultant and the orientation of parabola- or U-shaped dunes. Subsequently the rate of dune-building and dune travel in a region where entire dune ridges are successively moving landwards were measured by means of time-series levelled transects (Ranwell, 1958). The theoretical point of maximum erosion was shown to be at 18 m to windward of the crest of 15 m-high dunes. Zones of maximum accretion varied from 0 m to 18 m behind the crest in low, stable dune sections, to as much as 164 m to 183 m to leeward of the crest in high, unstable sections. Ranwell estimated that the dune nearest to the shoreline would need at least 50 years to grow to maximum height. Its mean rate of travel inland near the coast was estimated at 6.7 m a^{-1}. At least another 20 years or so would elapse while the dune travelled sufficiently far inland for a new embryo dune to develop. As a result, the cycle between the start of successive episodes of dune-building would take some 70 to 80 years to complete. Linear ridges, such as those found at Newborough Warren, reflect its ideal position for maximum uniform erosion, but it is rare for whole ridges to migrate uniformly (Ranwell, 1972). More commonly, blowthroughs occur in parts of the ridge (as occurs, for example, at Braunton Burrows, Morfa Harlech, Morfa Dyffryn and Ainsdale — see GCR site reports in Chapter 7). Even in this optimally located system, parts of the coastal dunes reach maximum height more rapidly than others. As a result, irregular erosion of ridges produces parabolic or U-shaped dunes. Ranwell (1960) suggested that the cycle between dune-building and slack formation is about 80 years, i.e. very similar to the coastal dune-building cycle, but did not examine the implications of this similarity.

The volume of sand supplied to the dunes has been substantial. There is evidence of considerable deepening of Caernarfon Bay since the mid 18th century (Ranwell, 1955). During this period, the shallow-water seabed profile moved landwards; Ranwell argued that this probably accounts for much of the sand transported into the dunes. Robinson (1980b) argued that the continuing stability of the recurved end of Abermenai Point indicates that most of its sediment is derived from the tidal streams at the mouth of Menai Strait rather than from long-shore sediment transport.

The beach systems of Newborough Warren also warrant considerable further investigation both with regard to their geomorphological history and their present-day dynamics. In particular, the effects of further retreat of the shoreline around Llanddwyn Island, perhaps isolating it from the mainland, should be investigated in order to assess the effects upon sand transport between the two bays. Robinson (1980b) argued that the varying curvature of the shoreline of Newborough Warren reflects the differing degree of shelter from dominant south-westerly waves, the full impact of the dominant waves in the central part of the spit and finally the influence of the transportational efficiency of tidal streams in the entrance to the Menai Strait. He regarded the complex system of sandbanks and channels as demonstrating the influence of ebb and flow channels on shallow-water sediment transport. The flood channels cross North Sands and run eastwards along the Abermenai spit and so may carry sand to the stable end of the spit.

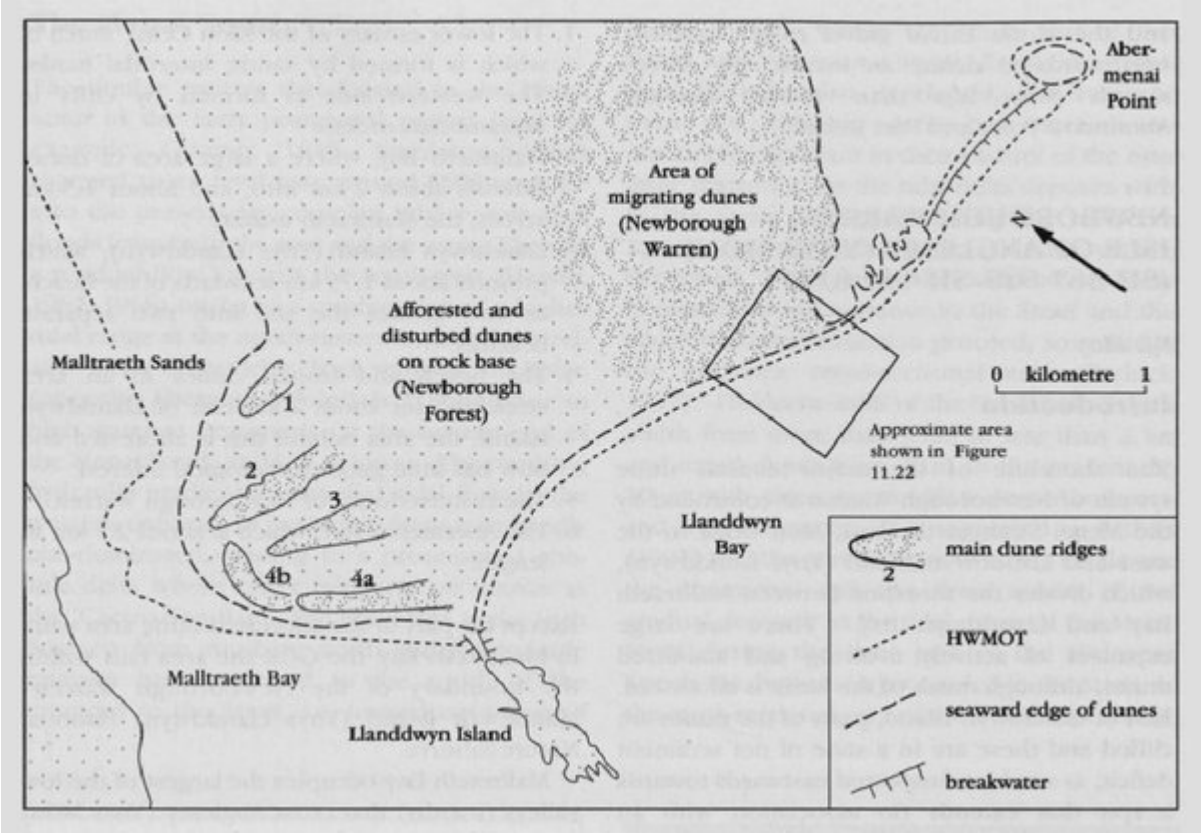
Newborough Warren differs from the other large dune systems at Ainsdale and Braunton Burrows (see GCR site reports in Chapter 7) in the contrasts between its east and west parts. The western part of Newborough Warren is partially

underlain by bedrock and extends into a small estuary, in contrast to the eastern part, which includes a recurved spit that extends into a large, deep channel. The dune cycle is better understood than in many other dune systems. The western part of the site has been marked by several separate phases of ridge building, a feature found in other dune systems such as South Haven Peninsula (see GCR site report in Chapter 7). The site is most important because it is possible to relate the dune succession to the geomorphological processes associated with dune-building and erosion (Ranwell, 1972).

Conclusions

One of the largest west-facing dune systems in England and Wales, Newborough Warren includes a recurved spit at the mouth of the Menai Strait, which has been breached periodically but has a distal end that is probably about 700 years old. Newborough Warren includes both very dynamic and very stable and long-lived features. The effects of two estuaries on the dynamics of the beach, especially in providing major nearshore sources of sediment, makes this site particularly important for geomorphological studies. The breaching and rebuilding of the Abermenai spit indicates the availability of large sediment inputs, as do the continuing growth and migration of the dunes where they have not been stabilized by afforestation. The site combines in one location features seen at Spurn Head (breaching and rebuilding, see GCR site report, Chapter 8) and Hurst Castle Spit (the effects of different wave directions at the mouth of an estuary on the development of recurves, see GCR site report, Chapter 6) with the major dune-building processes of large west coast dunes such as Braunton Burrows (Chapter 7) and those in Carmarthen Bay (Chapter 11) and Cardigan Bay. Its particular interest comes, then, from its hybrid form rather than from any single feature. Within the coastline of England and Wales, it forms an important member of the network of dune-beach-spit structures that range from the simple (e.g. East Head, see GCR site report, Chapter 8) to this complex site.

Its ecological importance (it is a National Nature Reserve and part of a Special Area of Conservation) depends on the relationships between sand supply and colonization and stabilization by vegetation. With a steepening near-shore slope, there is the likelihood of increased change and retreat associated with migration inland of the dune system, and this is already occurring in both the south-east and west parts of the site. Long-term conservation management of the site will depend on a better understanding of the shallow-seabed processes that control sediment supply.



(Figure 11.21) Key features of Newborough Warren. The western part of the site has a series of sand spits and dunes extending from a former rocky shore, of which Llanddwyn Island (Ynys Llanddwyn) is a seaward extension. The eastern shore changes from low, climbing dunes on a rock base to an extensive area of migrating dunes on a sandplain. The Abermenai spit owes its form in part to strengthening by an artifical breakwater.

(Figure 11.22) Aerial photograph of part of Newborough Warren (see Figure 11.21 for location), which shows the contrasts between the coastal active and migrating dunes, the linear sub-parallel ridges that extend inland and area of mostly stabilized parabolic dunes. Intertidal sand ridges may provide a pathway for sand transport feeding the dunes in the east, but gravels underlie parts of the intertidal area in the west. (Photo: courtesy Cambridge University Collection of Aerial Photographs © Countryside Council for Wales.)