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## Morfa Dyffryn, Gwynedd

[SH 557 271]–[SH 579 213]

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### Introduction

Wave conditions in Cardigan Bay are dominated by Atlantic swell from the south-west, but locally generated waves may approach from the west or north-west. Cardigan Bay is bounded by the Lleyn Peninsula in the north and St David's Peninsula in the south; the bed of the bay is marked by three major SW-trending cobble and boulder banks, known as the 'Sams', which are believed to be of glacial origin (Foster, 1970; Bowen, 1974) and thought to confirm an extensive westward flow of Late Devensian Welsh ice from the uplands (Campbell and Bowen, 1989). These sarns affect both wave behaviour and sediment movement in the bay. Morfa Dyffryn is linked geomorphologically to Sarn Badrig (see (Figure 8.16)).

The beach and dunes at Morfa Dyffryn front a cusped foreland, which is about 3 km wide at Llanbedr. The beaches developed as a spit extending across the mouth of the Afon Artro, but today they link the morainic hill of Mochras to the mainland, following diversion of the river by an embankment in 1819. Near its southern end, Morfa Dyffryn comprises a narrow fringing beach of shingle, cobbles and sand upon which there are low dunes. Northwards, the dunes are wider and higher enclosing large slacks. At Mochras, the shoreline is formed of low cliffs of glacial material and the beach is dominated by cobbles and boulders. To seaward, Sarn Badrig extends from Mochras as a shallow, submerged ridge for about 17 km. Like many of the spits and cusped forelands of England and Wales, Morfa Dyffryn was first described by Lewis (1938) and Steers (1939b; 1946a), but has subsequently received little detailed attention. Guilcher (1958) regarded it as a good example of a cusped foreland, although this ignores the position and role of Sarn Badrig and the historical development of the feature.

### Description

Morfa Dyffryn (see (Figure 8.2) for general location) is a broadly triangular area extending from Llanaber in the south to Llandanwg in the north. It is widest at Llanbedr where it extends westwards about 3 km from a probable former cliff-line to its apex at Mochras. At its northern end, it encloses the much-modified estuary of the Afon Artro. Much of Morfa Dyffryn is excluded from the GCR site because it is agricultural land or forms part of RAE Llanbedr, whose construction in the 1940s destroyed much of the area of inland dunes.

The beach is virtually straight, faces southwest and extends for about 5 km from its southern boundary at [SH 579 214] to about 0.5 km south of Mochras [SH 552 255]. At this point, it is aligned towards WSW before a sharp change of direction (at [SH 550 262]) so that the northern side of Mochras faces north-west. The southernmost part of the site is formed by a spit of sand and shingle that diverts the mouth of the Afon Ysgethin northwards. The spit is progressively extending northwards (Figure 8.20). North of the Ysgethin's outlet, the dunes gradually widen from a narrow fringing ridge about 120 m to over 1.2 km wide in the north. The dunes were described by Steers (1939b) as gradually extending inland.

The geomorphologically active dunes attain heights in excess of 20 m, with semi-parabolic ridges enclosing large slacks. Once the dunes reach a critical height (Ranwell, 1972), they tend to migrate inland and blowthroughs become dominant (Figure 8.21). The lowered areas are gradually replaced by new dunes (Ranwell, 1972). The northern area of the dunes first began to accumulate after the mouth of the Afon Artro was diverted in 1819. The 1838 first edition of the Ordnance Survey One Inch map shows Mochras as an island. With the opening of the present-day river mouth, the sand beach extended northwards to the low cliffs at Mochras. Apart from some changes in direction around the mouth of the Artro, the low-water line followed a very similar alignment to the present-day shoreline. The dunes have continued to migrate inland, but the beach is now stable in position. Sufficient sand is reaching the beaches to maintain their position and to continue to supply the landward-moving dunes.

## Interpretation

Large cusped features are rare on the British coast. Standard texts on coastal geomorphology from Johnson (1919) to Pethick (1984) refer to three such features: Benacre Ness, Dungeness and Morfa Dyffryn. Lewis (1931) regarded this beach as a good example of orientation towards the dominant waves. Others, such as Morfa Harlech to the north, show less well-developed orientation towards the dominant waves, as these other sites are more affected by the refracted waves and currents at the mouths of the estuaries. Other examples of similarly orientated beaches occur in Carmarthen Bay. King (1964) considered that this beach was controlled by dominant waves related to the coastal outline, but that Sarn Badrig also played a part in affecting wave alignment and energy. Morfa Dyffryn is one of several beaches in Cardigan Bay in which the coarse sediments are dominantly made up of slate and shale derived from local sources (Guilcher, 1965). The beach at Morfa Dyffryn is, nevertheless, predominantly sandy, particularly towards its northern end. Moore (1968) described the patterns of sedimentation in Cardigan Bay between Aberystwyth and Mochras. Sand was transported northwards along Morfa Dyffryn, but also entered the sand-floored area south of Sarn Badrig at both its shoaling and seaward ends. Moore regarded tidal streams as the most important agents of sediment dispersal in Cardigan Bay. Geochemical and mineralogical analyses suggested that the estuaries of both the Afon Mawddach and the Afon Dyfi were being filled by sediments from the sea rather than from the rivers.

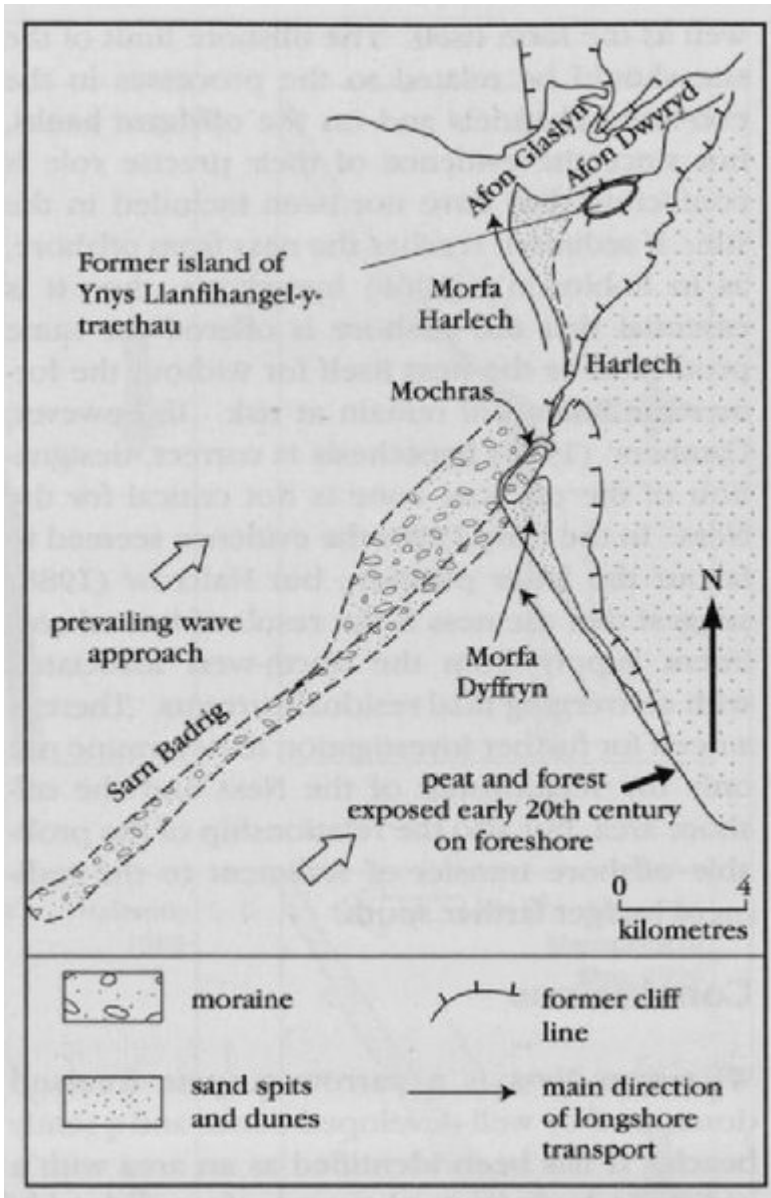
The relative stability of the shoreline, despite a strong tendency for the dunes to migrate inland and a limited supply from littoral drift, poses questions about the sediment supply to Morfa Dyffryn. There is no longshore source of any volume to the south and the southern part of the beach shows signs of being generally in deficit. There is little evidence to support the hypothesis that sand may be transported from the north into this site. Moore (1968) supported the possibility of offshore sources. Sediment movements across Sarn Badrig from the northern part of Cardigan Bay would provide one mechanism for maintenance of the sediment supply to Morfa Dyffryn. Sarn Badrig and its landward expression at Mochras have been effective in providing a promontory against which the low-water beach has been aligned.

Despite its description in textbooks, Morfa Dyffryn cannot be regarded as a good example of a cusped foreland, for the ness form is a cuffed headland rather than a coastal depositional structure. The presence of this relatively resistant headland has produced a situation in which the beach has tied the headland to the mainland and the beach has attained its present-day alignment as a result. The dune and beach system is better described as a tombolo, which makes Morfa Dyffryn a particularly large example. To some extent its size and alignment have been affected by the shallow area upon which it is built. There are many beaches whose low-tide alignment appears to be particularly influential in the long-term development of the position of the shoreline. It is apparent both at Holy Island, Northumberland, and at Morfa Dyffryn, for example, that there has been much less change during the last 150 years in the alignment of the low-tide shoreline than of the high-tide shoreline. Because waves approaching the high-tide shoreline are refracted by the intertidal features especially on the low angles associated with sandy foreshores, the low tide shoreline plays an important role in the long-term development of the beach itself. At Morfa Dyffryn the low-tide alignment of the shoreline is strongly controlled by swell and the presence of Sarn Badrig, Mochras and the shoreline at Llanbedr, features that have not changed their positions significantly during the last 150 years. As a result, Morfa Dyffryn is not only a fine example of the process by which beaches align normal to the dominant waves (first outlined by Lewis, 1931, 1938), but also demonstrates the importance of the low tide coastal outline in controlling the alignment of the shoreline.

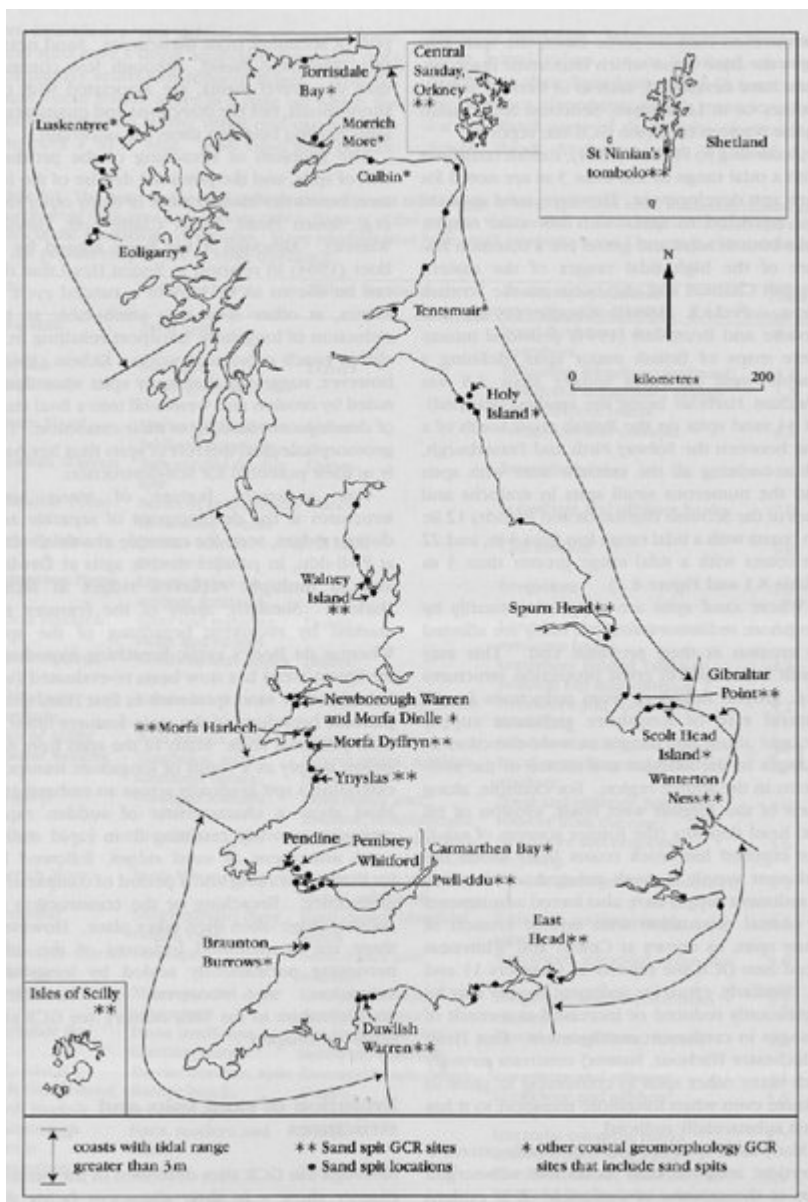
It is also a good example of sediment supply from the seabed. In this respect it is a comparatively rare feature in global terms for most sandy beaches are in deficit having passed the stage of sediment storage that characterized the Holocene transgression (Bird, 1985). Only about 20% of the world's sandy beaches are pro-grading, but Morfa Dyffryn has a shoreline that is maintained naturally, despite considerable transport of sand by wind into the dunes (Figure 8.22). Morfa Dyffryn differs from other features with which it has been compared such as Dungeness, Kent, and Benacre Ness, Suffolk, in being (a) dominated by extensive dunes, (b) tied to a headland, and (c) comparatively stable in position, although its dunes individually migrate inland at rates in excess of  $6 \text{ m a}^{-1}$  (Ranwell, 1972).

## Conclusions

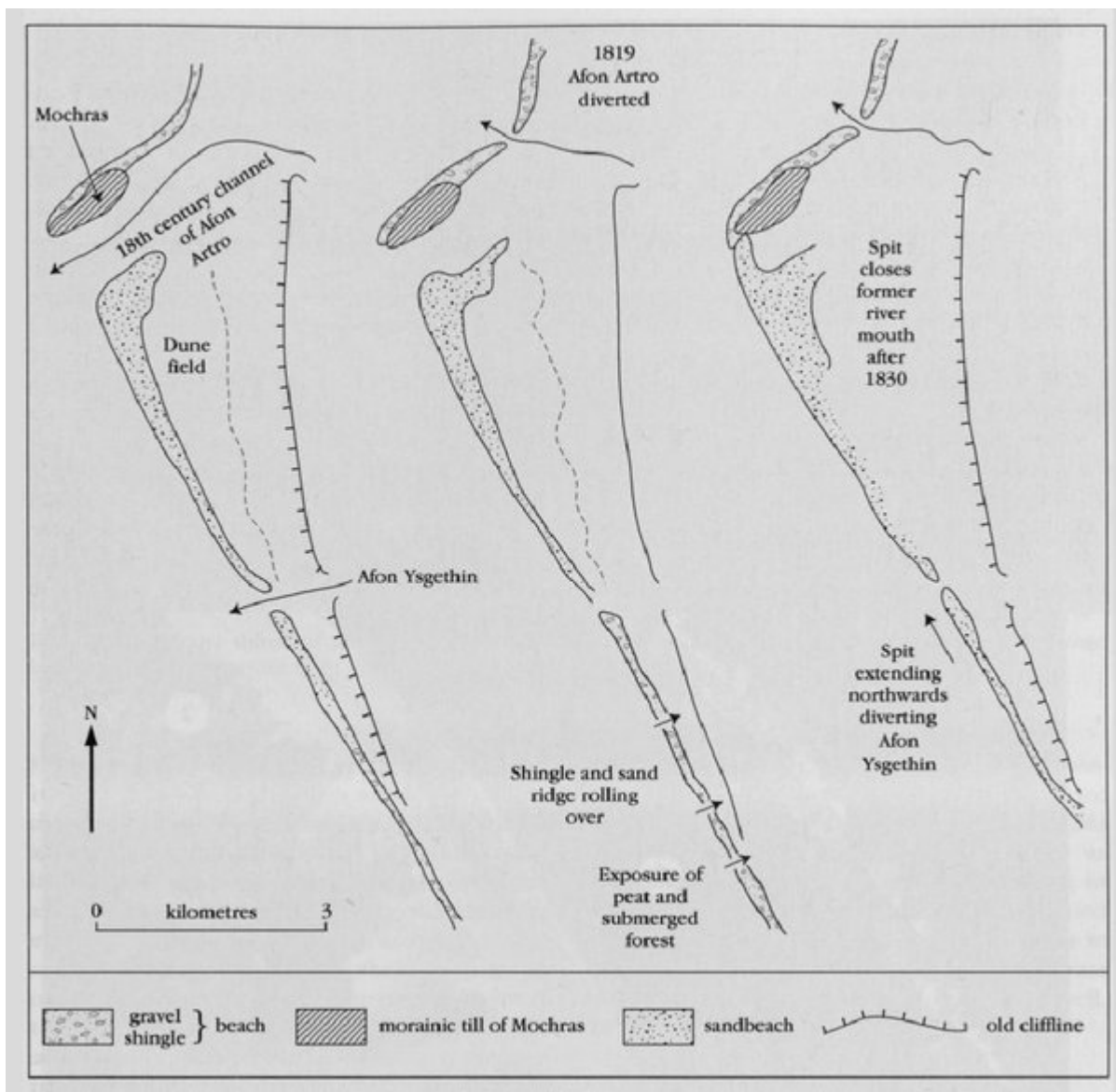
Morfa Dyffryn is distinguished by a beach and dunes whose alignment towards the dominant south-westerly waves is controlled by a till headland and the alignment of the low-tide shoreline. Its interest lies in its association with the subtidal and intertidal ridge of Sarn Badrig, its dunes and its comparative stability. The main present-day source of sediment appears to be the seabed. Morfa Dyffryn has been wrongly described in the past as a cusped foreland because although its form is cusped, this results from the presence of the headland at Mochras rather than from the realignment of beach sediments as occurs in true cusped forelands. However, it is a fine example of a large sand tombolo and so an important and unusual feature of the British coastline.



(Figure 8.16) Context of Morfa Harlech and Morfa Dyffryn — key geomorphological features.



(Figure 8.2) The location of sand spits in Great Britain, also indicating other coastal geomorphology GCR sites that contain sand spits in the assemblage. (Modified after Pethick, 1984).



(Figure 8.20) The historical development of Morfa Dyffryn. During the eighteenth century the sand beach was separated from the morainic hill of Mochras by the channel of the Afon Artro and formed a spit with recurves at its northern end. In 1829, the Afon Artro was diverted to the east of Mochras. About the same time, the southern beach was transgressing inland. By 1830, the spit had closed the former river mouth and had joined Mochras. In the south, a new spit was developing northwards across the mouth of the Afon Ysgethin.



(Figure 8.21) Aerial photograph of part of the northern sector of Moth Dyffryn with sand transfers and the main geomorphological features numbered. 1 = till boulder and cobble beach derived from erosion of Mochras; 2 = main active zone of dunes and spit distal link with former island; 3 = major blowthrough; 4 = bar merging with beach — maintains sand supply to dunes; 5 = intertidal ridge and runnel; 6 = prevailing and dominant wave direction. (Photo: courtesy Cambridge University Collection of Aerial Photographs, Crown Copyright, Great Scotland Yard.)



*(Figure 8.22) Active dunes of Morfa Dyffryn migrating eastwards (in the foreground) are affected by a large blowthrough to the centre right. (Photo: V.J. May)*