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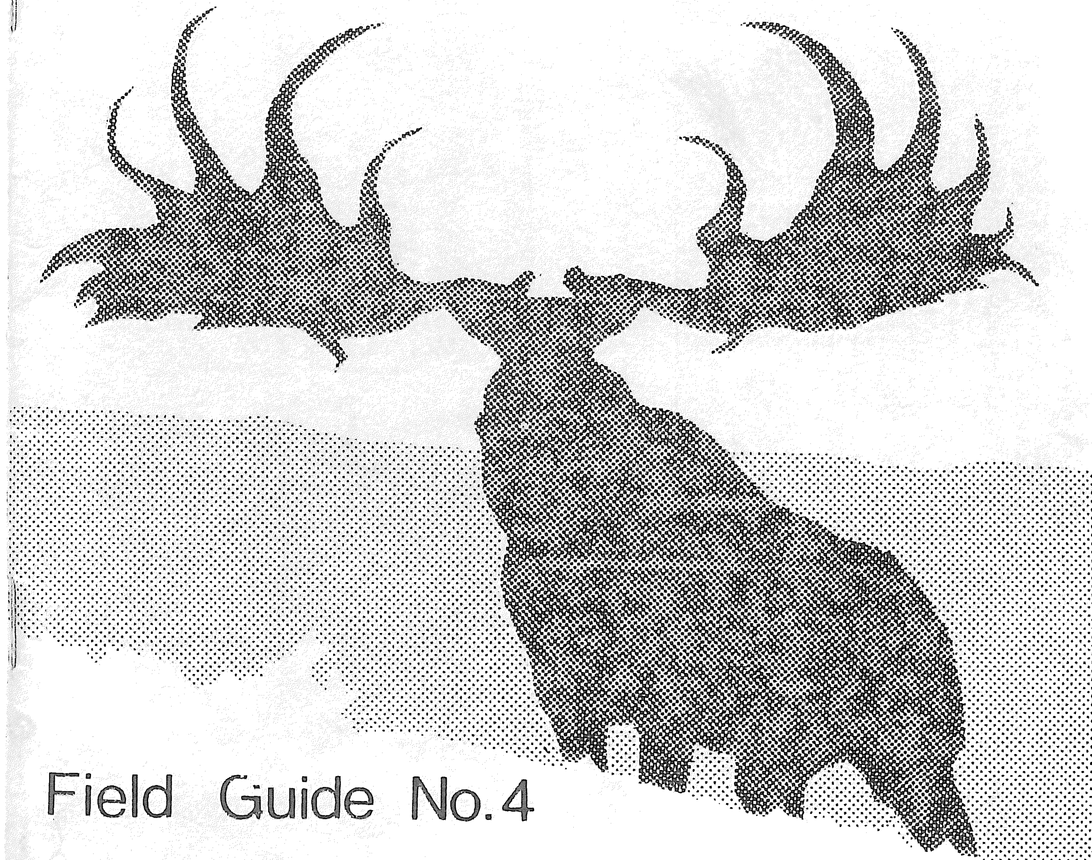

Field Guide No. 4

THE SOUTH AND EAST COASTS OF COUNTY WEXFORD

IRISH ASSOCIATION FOR QUATERNARY STUDIES

Field Guide No. 4

The south and east coasts of Co. Wexford

(1981)

Compiled and edited on behalf of IQUA

by

R.W.G. Carter and J.D. Orford

IRISH ASSOCIATION FOR QUATERNARY STUDIES

1981 Field Meeting 16th-18th October

South and East Coasts of Co. Wexford

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Ordnance survey ½" sheets 19 and 23 may be used in conjunction with this Guide.

P R E F A C E

This Guidebook has been compiled as part of the IQUA Field Meeting in Co. Wexford from 16th-18th October 1981. Much of the material included in the Guide is of an informal, unpublished nature and should be treated as such in future citations.

The basic aim of the trip was to examine the sections and structures of Quaternary age along the south and east coasts of Co. Wexford, and to promote discussion in the light of recent fieldwork. While most of the sites mentioned in the Guide are easily accessible by car and foot it should be emphasised that some fall within or across private property for which access permission must be sought. Furthermore some sites, particularly the cliff sections on the east coast, should be approached with extreme caution due to their dangerous, unstable nature. Appropriate safety measures should therefore be taken.

We would like to acknowledge the help of the contributors in compiling this Guide, and also those cartographers, photographers and typists for their production work.

C O N T E N T S

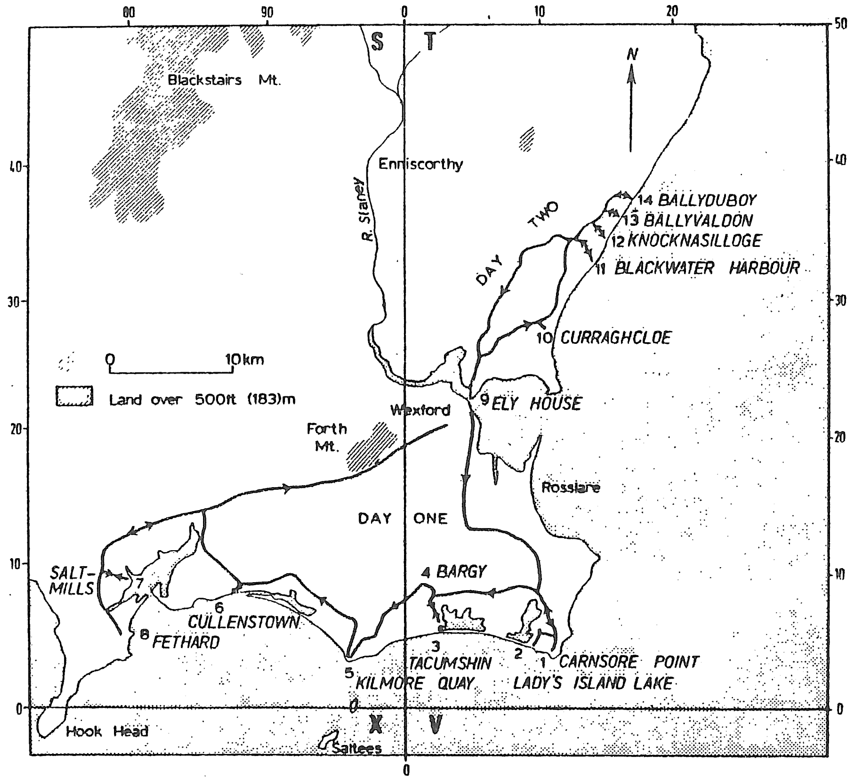

Fig. 1. Map of Co. Wexford showing excursion routes and site locations

QUATERNARY HISTORY OF SOUTH AND EAST CO. WEXFORD: A BRIEF RESUME

Glacial episodes

The glacial legacy of south and east Co. Wexford poses a series of intriguing questions for students of the Irish Quaternary. The relatively flat, low-lying Lower Palaeozoic basement has provided a stage across which various ice-masses have acted without major constraint. As a consequence they have left a complex series of glacial deposits, both in terms of spatial variation and facies variation within individual members. The nineteenth century work of the Geological Survey, followed by that of Farrington in the 1930s unravelled the general sequence of events. In particular the main stratigraphic groups and horizons were identified and dominant directions of ice movement deduced. However the timing of these events is still considered contentious and many of the finer details of palaeoenvironmental reconstruction are only now being investigated.

Two major glacial episodes are readily apparent; the earliest characterised by deposits of relatively stone-free, shelly Irish Sea till underlying till of inland origin and mantling much of the Palaeozoic basement. The later episode comprises glacial and proglacial sedimentation covering the eastern half of Co. Wexford.

The earlier deposits suggest that ice moving southwards across the landmass came into association with westward moving ice from out of the Irish Sea basin. The "inland" deposits are represented by a series of stony till members - the Clogga Till in Co. Wicklow, the Ballyvoyle Till in Co. Waterford and the Bannow Till in Co. Wexford. Each till consists of local material with few far-travelled erratics. Irish Sea ice deposition is characterised by the Ballycroneen formation, which although named after a type-site in Co. Cork is a pervasive shelly till deposit with a widespread distribution along the east and south coasts of Ireland. It normally underlies, and therefore predates, the inland tills. Both the inland and Irish Sea tills are exposed in the cliff sections at Nemestown near Kilmore Quay. The subdued surface topography, the weathered till surface and the apparently common occurrence of periglacial cryoturbations, led Farrington (1959) to postulate a Munsterian, or penultimate glaciation, age for these tills. In Co. Wexford, Midlandian, or last glaciation, deposits were considered by Farrington to be confined to the moranic ridges of the Screen Hills area on the east coast, north of Wexford Harbour. Recently this moranic complex, which includes text-book examples of "fresh" kettle-hole and kame topography, has been assigned to the Glenealy stage of the late-Midlandian by Synge (1977). This correlates with the Hacketstown readvance to the north and north-west (Table 1). The Screen Hills complex appears to have been deposited by a retreating ice-mass moving south along the coast and expanding westward.

Recent investigations have tended to reinterpret many of these deposits. The Munsterian age for the Bannow and Ballycroneen tills is not universally accepted (Huddart 1977, Synge 1977, Culleton 1978a), and it is possible they represent earlier stadial advances in the Midlandian. Such an interpretation neatly sidesteps the problem created by a lack of interglacial deposits, while retaining an explanation for the weathered till profiles and periglacial phenomena. Huddart (1977) considers that the Bannow till member, and its local equivalents, are in fact a Midlandian lodgment (sub-glacial) till, so accounting for the relatively subdued topography in the west of the county. Huddart (1977, p.6) goes on to suggest that only the highly weathered Nemestown beds which crop out at the base of the Irish Sea till at Kilmore Quay (S 974 035, site 5) and Ballytrent (T 146 086) are of Munsterian age (Table 1). The debate appears to centre on the paucity of analytical work on Irish Sea ice facies. Thomas (pers. comm.) argues that close similarities seem to exist between east and south coast deposits but that the latter have been relatively poorly investigated, so precluding satisfactory correlations.

On a broader canvas, embracing all southern Ireland, Synge (1981) has proposed that Munsterian deposits are in fact the equivalent of the Anglian Stage rather than the Wolstonian Stage in Britain. Thus they are separated from the Midlandian by two interglacials and one glacial (Table 1). Synge suggests that evidence of the Munsterian (± Connachtian) Stage has been obscured everywhere by the later Midlandian ice advance. Considerably more evidence will be required

TABLE 1. Proposed Quaternary successions for S.E. Ireland

Stages	Mitchell et al. 1973	after Culleton 1978a	after Huddart 1981a,b	Synge 1981
Littletonian				Raised beaches N. of Wicklow
Midlandian	Nahanagan cold sub-stage Shortalstown Upper silt Shortalstown Lower silt Irish sea formations including Screen Hills formation, Rosslare till formation	Forth Mountain Gravels Blackwater formation Ballinaclash member Screen member Knocknasillоge member Macamore member Greenore member Bannow formation includes Blackhall member Old Ross member	Screen hills complex	W6 Nahanagan sub-stage W5 ? cirque glaciers W4b Wicklow/Colbinstown sub-stage W4a Blessington/Athdown/Glenealy sub-stage W3 Hacketstown/Brittas/Screen Hills sub-stage W2 Kilmore Quay stage W1 Ballycroneen sub-stage
Ipswichian	Shortalstown Estuarine sands		Knocknasillоge member Shortalstown Estuarine sands	Shortalstown Estuarine sands Courtmacsherry Raised beach
Munsterian	Shortalstown shelly till Bannow till Kilmore Quay Upper till Kilmore Quay shelly till Kilmore Quay head		Castleannesley Till Kilmore Quay shelly till Head	? Aughrim sub-stage (Connachtian)
Gortian	Courtmacsherry raised beach		Courtmacsherry raised beach and platform	Marine rock platform
pre-Gortian			Ballytrent and Nemestown tills	Bannow-Clogga tills (Munsterian)

before this proposal finds widespread acceptance.

Despite a number of searches the only Ipswichian interglacial deposit so far described in the area is at Shortalstown (T 303 114) (Colhoun and Mitchell 1971). Recently Huddart (1981a,b) has put forward the suggestion that the Knocknasilloge member of the Screen Hills complex is an interglacial marine deposit. This somewhat radical idea is discussed in detail later. At Shortalstown estuarine sands and beach gravels, containing interglacial faunal and floral remains, are sandwiched between two till units. Unfortunately the highly disturbed nature of this limited exposure tends to diminish its regional significance.

The westward extension of the late-Midlandian ice limit from the prominent Screen Hills moraine complex was initially based on evidence provided by the soil survey of the 1960s (Colhoun and Mitchell 1971). It is now generally accepted (Mitchell 1976, p.62, Culleton 1978a) that the later Midlandian ice covered much of east Co. Wexford (Fig. 2)

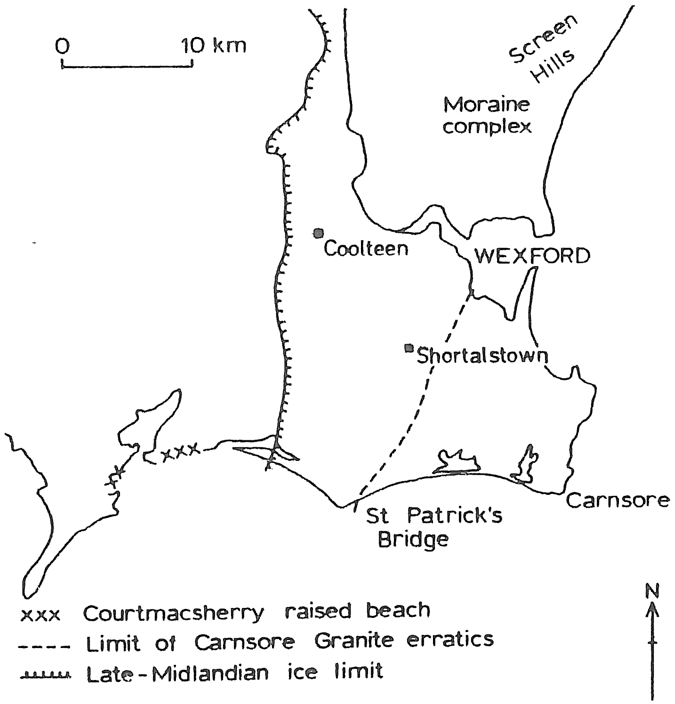

Fig. 2. Glacial limits in S.E. Wexford and sites mentioned in the text.

with a north-south limit crossing the south coast at least as far west as Ballyteige Bay. The spectacular Screen Hills moraine complex would have been created by a major still-stand during the early retreat phase. Overriding of the Carnsore peninsula by westward-moving Midlandian ice has produced a distinctive distribution of Carnsore Granite erratics (see Fig. 7) across south Wexford. (Carnsore granite is also found, paradoxically, in the Screen Hills moraine complex (Blackwater formation), which would indicate some kind of northward transport. Whether or not this transport was by ice is not known.)

The previously mentioned reassignment of the Ballycroneen and Bannow drifts to the Midlandian has reopened debate about the chronostratigraphic significance of the Courtmacsherry Raised Beach, which is represented on the south Wexford coast by deposits resting on a shore platform, at Clammers Point (S 832 063) and Fethard (S 803 600). Previously these deposits, by virtue of the overlying "Munsterian" glacial material, were assumed to be Gortain in age. In 1973 Bowen, somewhat preempting later work, challenged this long-established view, largely on stratigraphical incompatibility with the equivalent non-Irish deposits. Bowen (1973) applying the principle of "Occam's Razor" claimed that the Courtmacsherry Beach deposits must be of Ipswichian age. While such an interpretation was, by itself, perfectly in order, it did mean that overlying sequences must, by implication, be younger, so upsetting the well-established glacial chronology for south-east Ireland. The raised shore platforms, on which the beach deposits rest, are probably reoccupied features of indeterminant age. Synge (1977, p.201) has gone further than Bowen by suggesting that the raised beach deposits may reflect Midlandian inter-stadial sea levels, with some type sites showing displaced rather than in situ sequences. The raised beach, but not the basal platform, does not extend west of Cullenstown (S 880 078) (Fig. 2), and may therefore relate to shelly Irish Sea till formations.

It is obvious that detailed examinations of representative beach facies are needed to help resolve these dilemmas. More recently Synge (1981) has proposed a two-phase model for the development of the Courtmacsherry Beach, involving the cutting of a rock platform at 12-13 m above mean sea level (m.s.l.) in the Gortian followed by a reoccupation by the lower, 3-5 m, Courtmacsherry sea level during the last interglacial. Synge feels that many of the raised beach sites need reinterpretation.

Recently a further bone of contention has arisen over the environments of deposition responsible for various stratigraphic members of the Screen Hills complex, in particular the Knocknasilloge member. This contention reflects on the age of the Screen Hills complex.

Huddart (1981a) has identified a diverse, shallow water, interglacial foraminferal assemblage from both the Clogga Member in Co. Wicklow and the Knocknasilloge Member in Co. Wexford. Among the 30 to 40 species present is a large (12-20%) proportion of Elphidiella hannai, currently restricted to the west coast of North America and unknown in post-Ipswichian deposits in Europe. If these inter-till members are in situ then the chronology of the Screen Hills complex would be thrown into doubt. However, as Huddart (1981a,b) notes, there is more than a slight probability that the deposits comprise reworked marine sediments. The somewhat truncated, immature nature of many of the E. hannai population suggests they are allochonothous in origin. Also the presence of an unequivocally reworked marine mollusc fauna in the nearby terrestrial sandur sediments (Huddart 1977) heightens the possibilities for a similar origin of the Knocknasilloge and Clogga foraminfera.

Huddart's (1981a) now preferred explanation is that the two members are of Ipswichian interglacial age (see Table 1). Furthermore he suggests that the Knocknasilloge Member may be the equivalent of the enigmatic estuarine facies at Shortalstown (Colhoun and Mitchell 1971) and an inter-till, interglacial (?) marine formation located in the southern Irish Sea by Garrard (1977).

However Huddart's views have been criticised on three grounds by Thomas and Summers (1981). First, they consider that sedimentological evidence points to a quiet-water, lacustrine, rather than a marine origin for the Knocknasilloge Member. Second, they suggest that Elphidiella hannai and other diagnostic interglacial species are pervasive elements throughout the Irish Sea glacial successions, and are

often associated with derived molluscan faunas. Lack of molluscs in the Knocknasilloge sediments, which would be surprising if it was genuinely marine, is attributed to the low energy lake environment precluding deposition of larger material. Third, Thomas and Summers note the absence of major stratigraphical breaks above and below the Knocknasilloge Member, which might be expected if the sediments represented a glacial-interglacial-glacial sequence.

In a rejoiner, Huddart (1981b) rejects the idea that the Knocknasilloge Member is of glacio-lacustrine origin on the basis of inappropriate litho- and biostratigraphic facies. Huddart goes on to reaffirm his views outlined in the earlier paper.

Post-glacial events

The final retreat of the ice from Co. Wexford was marked by the formation of Kettleholes and general periglacial activity. Pollen-analytical evidence from various sites (Mitchell 1951, Craig 1978) has traced the vegetational history of the area. Craig's recent work is interesting inasmuch as it shows few differences in stratigraphy at sites within or without the limits of the last glaciation. Craig notes that if south-east Ireland remained largely unglaciated in the late-Midlandian there is no ecological distinctiveness in the late-glacial pollen record to indicate it. At both sites studied by Craig, Colteen near Wexford and Belle Isle, south of Waterford (Fig. 2), dated sequences occur back to 12000 B.P. A warming peak occurs in the Regional Pollen Assemblage Zone 1 followed by a climatic deterioration in Zone III equivalent to the Nahanagnan Stadial sub-stage in the Wicklow mountains (Synge 1981). After this, vegetation indicates rapid amelioration into the Littletonian Stage.

The early Littletonian (10000-7000 B.P.) was a period of rapid sea level rise. Co. Wexford lying well to the south of the main centres of isostatic adjustment was probably little affected by delevelling during this period. From the evidence compiled for the Welsh coast of the Irish Sea (Kidson and Heyworth 1978), it seems likely that sea level rose exponentially, with little or no deviation from the "normal" eustatic curve, along the coasts of south-east Ireland. Synge (1977, 1981) records no Littletonian raised beaches south of Arklow.

As sea level rose the geomorphic evolution of the coast proceeded rapidly. Whittington (1977) describes how the rising sea level rapidly flooded the late-glacial drainage system that had been eroded into the underlying glacial till. During this period of shoreface retreat reworked material was undoubtedly swept up to form the Leaches. The N-S current-swept tidal ridge structures off the east coast of Wexford are known to consist of loose sands and basal lag gravels and began to form around 9000-8000 B.P. Perhaps these are the remnants of early Littletonian barrier, unable to keep up with the rapidly rising sea level?

Sea level stabilised around 7000-5000 B.P. and it is likely that sediment supply would have fallen with the development of equilibrium shorelines. The emergence of sub-drift resistant headlands (Carnsore Point, Crossfarnoge Point (Kilmore Quay)) would have led to segmentation of the littoral transport system and the appearance of mature crenulate planform and size-graded beaches would have taken place.

We can observe something of the transgressive nature of Littletonian coastal evolution via the examination of the barrier beaches along the south coast of Co. Wexford. Between Carnsore Point and Tacumshin Lake, and again west of Kilmore, the coast comprises fringing, spit and bar barrier forms (note that the word spit is used solely in a descriptive sense). A number of people (Lamont 1938, Stephens 1970, Whittow 1974, Culleton 1980, Dantec et al. 1981) have suggested that these beaches are typical westward prograeding spits which have progressively cut off the lagoons at Lady's Island, Tacumshin and Ballyteige. However the barriers show far more evidence of transgressive (landward) motion rather than lateral (longshore) motion. (Carter and Orford 1980, in prep.). Back barrier facies include washover, overtop and seepage assemblages, all of which have been rarely recorded for sizes greater than sand, but indicate transgressive facies by analogy with the finer clastic shorelines. It would appear that the barrier is still moving landward despite the apparent still-stand in sea level. Terrestrial sediments are thus exposed on the seaward sides of the barriers. The rolling-over process comes about through the

inability of the ridge crest to stabilise at the maximum possible height, so allowing storm surge penetration of the back barrier.

As the barrier migrates inland so its plan shape is controlled by the emergency of resistant headlands as well as by the vagaries of longshore sediment supply. (RWGC, JDO).

DAY 1 South coast of Co. Wexford

SITE 1 - CARNSORE POINT (T 120 035)

The site lies on the gravel barrier immediately west of the granite headland at Carnsore Point. Access is via an unsurfaced track which leaves the minor road from Lady's Island Village at T 116 049. Vehicles may be parked at the side of the track near the coast. Wellington boots are advisable as the back barrier area is usually saturated.

The Carnsore section of the Lady's Island - Tacumshin Barrier includes the coarsest material (mean clast size - 3 ø, 32 mm). The barrier itself is partly hidden by the development of back barrier dune and interdune deposits, but examination of beach outcrops and shallow boreholes have indicated that the main structure (Fig. 3) comprises landward dipping washover sand and

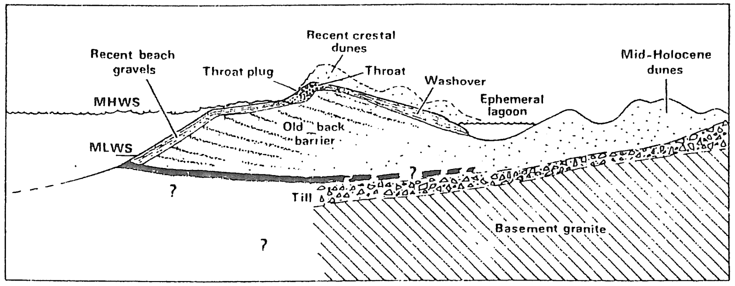

Fig. 3. Sketch cross-section of the barrier.

gravels typical of a transgressive ridge rolling onshore.

Recent (1977 and 1979) washover fans formed of coarse gravel may be seen to the west of the beach gravel extraction site. These fans, which occupy low breaches in the crestal dune ridge, contain unusual facies assemblages caused by scouring and infilling of the throat section during formation (Carter and Orford 1981, Orford and

Carter 1982a). These washovers should be compared with those further west at Tacumshin.

In addition to washover sedimentation, the dune crest, in places, is overlain by marine gravels. Such "inverted" sequences, which can be seen exposed in the low dune cliffs, are the result of high-level (up to 6 m above H W MOST) swash action. (These are not to be confused with gravel dumped by extraction.) Periodically, beach and wave conditions favour the development of swash ramps, which build up in front of the eroding dune cliffs. Repeated swash excursions during storms create hydraulic conditions capable of transferring marine sediment up and over the dune crest. Overtopping veneers of this type produce these seemingly paradoxical "raised beach" sequences in the subsequently reexposed clifflines. The processes leading to the formation of dune armour and overtop deposits have been described by Orford and Carter (1982a,b). (RWGC, JDO)

An investigation is being undertaken of the back barrier structure at various sites along the coast in order to examine aspects of the Holocene sedimentation and development. In 1981 a number of shallow (3-6 m) boreholes were sunk in the back barrier zone at Carnsore, and the material recovered is being subjected to palaeoecological and sedimentological analysis. Preliminary results (Fig. 4) suggest that an early or mid-Holocene shallow back barrier freshwater lagoon, characterised by pollen of Typha latifolia and Mycrophyllum alternifolium, and formed on the boulder clay, was suddenly engulfed by marine overwash episodes, as the barrier moved inland. Following this, the lagoon (?) refilled, depositing an unfossiliferous blue clay which passes upward into an oxidised interdune soil representing a period of comparative stability. Finally 3.5 m of washover gravels, possibly of comparatively recent origin, have covered this interdune area. A preliminary analysis of the polleniferous sediments (Fig. 4) also shows the transition from open (?) acid duneland with grasses, Pteridium, Erica sp. to gravel substrate dominated by plantago. Aquatic pollen decreases as the lagoon is engulfed. We are currently (November 1981) awaiting the results of ^{14}C determinations for this sequence. (BM, JDO)

SITE 2 - LADY'S ISLAND LAKE

This site lies at the point where the gravel barrier cuts off large (9.2 km^2) Lady's Island Lagoon. It may be reached by following the minor road direct from Lady's Island village, or turning left onto the macadamed road immediately on leaving Site 1. The road passes into a track which extends onto the barrier. Parking is available at the eastern end of the barrier. The site is well drained.

At Lady's Island the transgresive gravel ridge has moved onshore (not alongshore as has been suggested) to cut off the coastal embayment, which has now become a stream-fed coastal lagoon. Under natural circumstances it is likely that the lagoon would rise to a height of +5 to +6 m IOD before seaward seepage through the gravel balanced the net precipitation input (Carter and Orford, in prep.). However the barrier has been artificially breached on numerous occasions to alleviate flooding of the lake shore. This "cut" affords an excellent dip section of basal washover sequences which make up the barrier. Persistent landward-dipping coarsening-upward gravel units, < 20 cm thick, traverse the barrier, fining by material size only at the landward margin where they may have been deposited as a deltaic facies in the lagoon. Over 50 of these units have been counted in a vertical section. They would normally be formed by frequent sluicing overwash, during a period of rapid barrier migration. As the barrier height increased so the frequency of overwashing decreased and washover forms were limited to the small crestal types which can be seen just to the east of the "cut", at Carnsore and at Tacumshin.

It is worth noting that the barrier crest which comprises a mosaic of washover fans and eolian dunes is the only recorded site in the

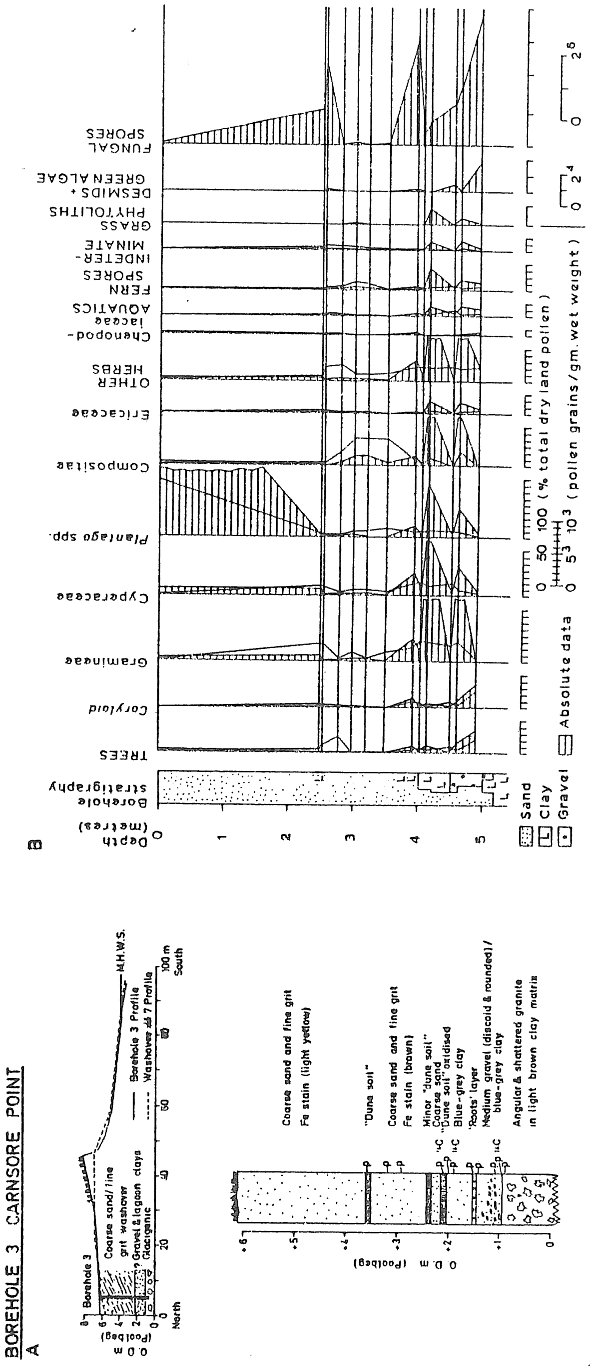

Fig. 3. Preliminary stratigraphy (A) and pollen diagram (B) from the Carnsore fringing barrier.

British Isles of the cottonweed Otathus maritimus. This plant survives here due to the unusual geomorphological and sedimentological processes operating at the barrier crest (Carter et al. 1981). (RWGC, JDO)

The beach foreshore at Lady's Island is often strewn with sizeable (< 1 m across) and angular peat blocks (Carter and Orford 1980). These blocks of terrestrial origin provide further evidence for the landward transgression of the barrier, as they have presumably "passed beneath" the barrier before being eroded during storms.

Two blocks of peat, collected by JDO, have been examined; the first was ^{14}C dated (UB-2429) to 4900 ± 85 y BP and the second analysed palynologically. Alder (Alnus), oak (Quercus) and pine (Pinus) were the main tree pollens present, while hazel/myrtle (Coryloid), grass (Gramineae) and sedges (Cyperaceae) were the important ion-arboreal types. Some pine wood occurred together with multiple perforation plates of alder. The persistently corroded willow (Salix) pollen present may suggest either inwashing or a long post-depositional surface exposure.

Again the material collected is indicative of a back barrier freshwater lagoon or 'carr' surrounded by alder and, at a higher altitude, pine. It is proposed to renew attempts to locate these deposits in situ to enable a detailed palaeo-environmental reconstruction of the area. (BM)

SITE 3 - TACUMSHIN LAKE (T 032 052)

The site is reached by following the minor road south through Tomhaggard (T 015 070) and taking the first metalled road to the left after the village. Follow this road to the end. Parking is limited and it is difficult, although not impossible, to turn a minibus. After parking it is necessary to cross the lake to the barrier. In dry weather this is no problem as the lake is completely drained apart from small channels which can easily be jumped. In wet weather it is necessary to take the farm track to the west of the road terminus and walk along the top of the low cliff for about 400 m. It should then be possible to cross onto the barrier. The site is privately owned although visitors are normally tolerated providing they behave! Waterproof boots are normally essential.

At Tacumshin the transgressive nature of the barrier is seen most clearly. The western end of the barrier comprises a magnificent set of 53 washover breaches, channels and fans. Fine sediment has been eroded from the beach face, passed over the crest (at c. + 8 m IOD) and deposited as lobate fans on the lower back barrier (Fig. 5). Washover channels have been eroded into the back

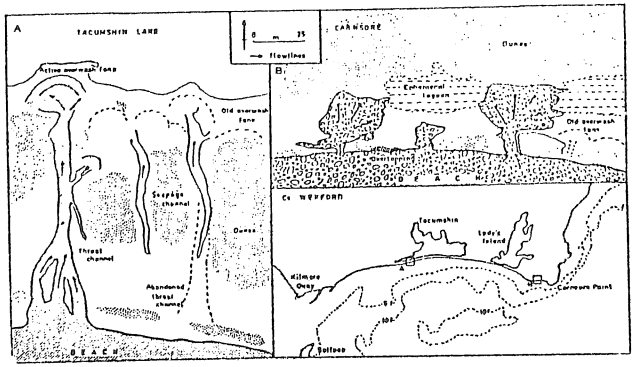

Fig. 5. Types of washover structures at Carnsore and Tacumshin.

barrier to depths of 1 to 2 m. The dimensions of these channels decrease down the back of the barrier as overwash seeps into the porous substrate. In many cases the channels have become choked with washover sediment during the waning phase of a storm.

The fans display the "classical" lobate shape widely described on the barrier islands of eastern North America. They are composed of near horizontal stratification, with small delta foresets at the lake margins. It is likely that much of the deposition of the lower fans took place into a rapidly rising back barrier lake. Subsequent reworking of the fan margins by lakeshore processes has formed a series of looped bars, spits and cuspate forelands.

In addition to washover fans, there are a number of seepage fans formed when storm water passes through, rather than over the barrier. As far as we know the depositional seepage structures are unique inasmuch as they have not been described in the literature. Seepage through the barrier causes an ephemeral spring line which in turn leads to sapping and headward erosion. Eroded materials pass downslope and are deposited as small lobate fans. It is considered that seepage sapping may be an important process in causing crestal instability.

The barrier at Tacumshin emphasises the importance of shore-normal (landward) migration as opposed to shore-parallel (alongshore) migration. Although described as an east-west extending spit by many authors there is no evidence to support this. We subscribe to the view that the coast has been formed largely by onshore sediment transport, and that stream outlets occupy suitable low wave energy positions (Lowry and Carter 1981, Carter and Orford, in prep.). (RWGC, JDO).

SITE 4 - LITTLEBRIDGE TOWNLAND, BARGY (T 032 089)

An exposure on the north side of the minor road just east of Bargy Castle. Limited roadshire parking.

A roadside section in gravels shows erratics of Carne granite, limestone, sandstone, Leinster granite and flint; shell fragments may also be found.

On the opposite side of the lane a gravel deposit of local origin occurs. The deposit represents fluvio-glacial gravels associated with the Midlandian ice limit.

<u>Stone count on gravels at Littlebridge</u>

<u>Stone count</u>		%
	Shale and schist	61
	Sandstone	4
	Leinster granite	2
	Carne granite	12
	Trachyte	1
	Limestone	4
	Flint	4
	Shell fragments	< 1
	Quartz	10
	Chert	1

(EC)

SITE 5 - KILMORE QUAY AND NEMESTOWN (S 958 030 to S 973 035)

A coastal section stretching east from the harbour at Kilmore Quay. Cars etc. may be parked in the small park adjacent to the harbour. Reasonably easy walking except at high water.

The succession is as follows (Fig. 6):

Irish Sea till
Head
Raised beach
Rock platform

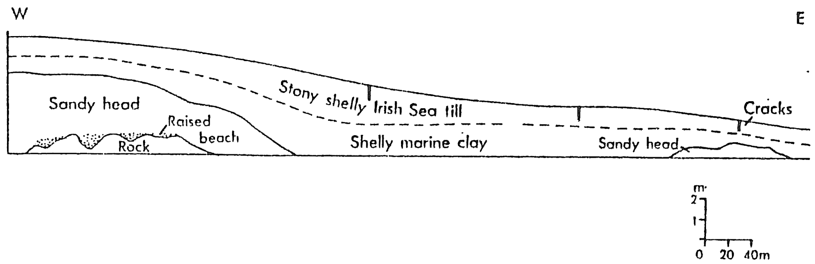

Fig. 6. Section at Kilmore Quay.

<u>The rock platform</u>

This is cut in pre-Cambrian gneisses reputedly over 2,000 million years old. Paradoxically dating of these rocks is probably relatively firmer than that of the platform and the overlying deposits. Eastwards the rock dips below sea level to reappear at Carnsore Point.

<u>Raised beach deposits</u>

These have been preserved between some small rock bosses at the base of the cliff. They include rounded discoid pebbles - horizontally bedded - but evidently disturbed by cryoturbation.

<u>The head</u>

This consists of stratified, sandy, rust brown material, similar to that seen at Cullenstown. Further east, towards Nemestown, where it dips to sea level the colour changes to greenish grey, indicating gleying reducing conditions.

<u>The till</u>

This is calcareous at 0.90 m and contains shell fragments at 1.20 m

A description and analyses for a profile sampled some 200 metres further east are given below. At Nemestown the upper, relatively stony till is underlain by marine clays.

Discussion

The Kilmore sections epitomise the problems of age, origin and sequence of Pleistocene deposits in south-east Ireland. What are the ages of the platform, beach, head and till? Are the so-called Nemestown beds glacial or periglacial in origin? Is the upper till of inland or Irish Sea provenance?

Taking the last question first, both Mitchell (1962) and Synge (1964) considered the upper part of the till to be of inland origin because of the erratic content of Leinster granite and sandstone. More recently Huddart (1976) recorded a macrofabric mean of 338°, which also indicates an ice movement from inland. Culleton (1978a), however, places the till in the Irish Sea provenance because of the calcareous nature of the material, even at 0.90 m (the mean carbonate content of unweathered inland till is 2.3%), the presence of shell fragments at 1.20 m and the occasional erratic of Carne granite (see profile description). He does not consider the erratics content as conclusive evidence of inland origin as these are also ubiquitous in the Irish Sea deposits.

Farrington (1954) and Mitchell (1972) date the till to the Munsterian but Bowen (1973) attributes it to the Midlandian on the basis that tills cannot be separated on geomorphic evidence. Culleton (1976) also places it in the Midlandian, mainly on the depth of leaching of carbonates which is around 1.0 m at Kilmore, as in the supposedly younger till further north.

Opinions also vary on the origin of the underlying sandy deposit at Nemestown. Farrington (1939) considered it a gumbotil while Mitchell (1962) thought it gleyed head. Huddart (1976), because of the flint erratics and clay matrix, saw it as a weathered till. In 1975 the section revealed wisps, lenses and large blocks of stratified, gleyed sandy material caught up in the marine clays.

Without firm dating of the overlying deposits it is obviously impossible to postulate dates for either the cutting of the platform or deposition of the raised beach. If the till is Midlandian then the beach deposits must belong to the previous interglacial period. But the till at Cullenstown is considered Munsterian and the underlying beach deposits to be Gortian. Is it conceivable that beach, head and till deposits in similar stratigraphic positions and in such close proximity could be of different ages?

Distribution of Carne granite

An enigmatic feature of the Irish Sea ice movement is reflected in the distribution of boulders of Carne granite. It has generally been accepted that the Irish Sea glacier moved in a southerly or south-westerly direction. But many large boulders may be seen on the beach at Nemestown; they are also found on the Saltee Islands, though not on the Keeragh Island (Mitchell and Culleton inspection 1981). Culleton (1978b) also found large boulders several kilometres to the north-west (Fig. 7)

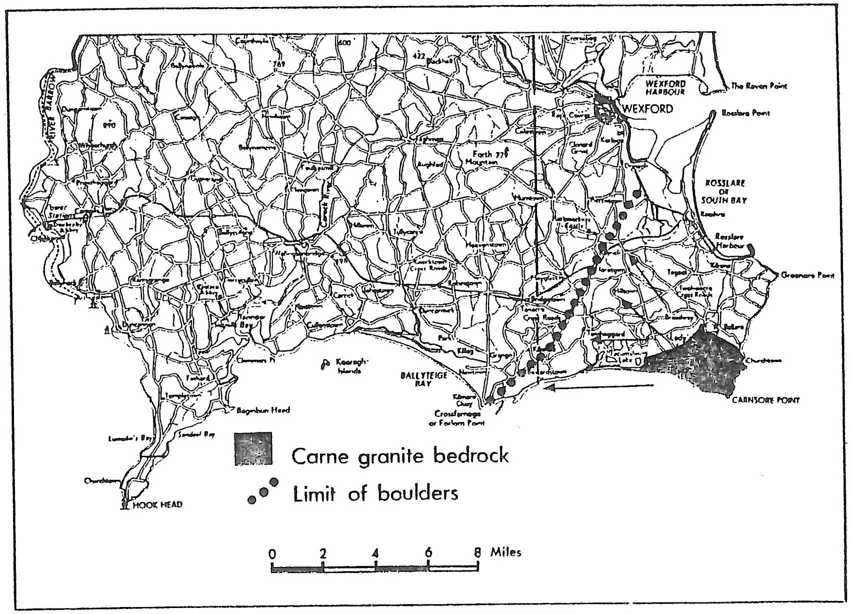

Fig. 7. Limit of distribution of large Carne granite boulders.

KILMORE QUAY AND NEMESTOWN (S 974 035) - profile description

Depth (m)	Stratigraphy
0. - 0.85	Loam; stony near surface; yellowish-red 5 YR 4/6; stones mostly local with erratics of flint; Leinster granite and sandstone; some narrow vertical cracks
0.85 - 1.20	As above but calcareous at 90 cm, secondary carbonates on ped faces
1.20 - 3.30	As above but shelly
3.30+	Modern beach

Particle-size and chemical analysis of till

	Depth sampled			Stone count
	1.0 m	3.0 m		
	%	%		%
Stones and gravel (> 2.0 m)	13	19	Local shale and metamorphics	37
Coarse sand (2.0 - 0.2 mm)	20	14	Sandstone	19
			Leinster granite	8
Fine sand (0.20 - 0.05 mm)	16	19	Carne granite	2
			Quartzite	16
Silt (0.05 - 0.002 mm)	38	39	Flint	12
Clay (< 0.002 mm)	26	28	Chert	4
			Quartz	2
Carbonates	5.6	16.3	Shell fragments	1
pH	8.3	8.4		

(EC)

SITE 6 - CULLENSTOWN (S 880 078)

The sites are adjacent to the beach at Cullenstown. The road through the village leads down onto the beach where there is ample parking. The eroding till cliffs are liable to collapse.

A deep section of Munsterian (GSPT suggests that there is no evidence to indicate a Munsterian age; the deposit could equally represent a facies variation of the Midlandian) till of inland origin exposed in the backshore cliffs, shows leaching out of carbonates to a depth of 3.70 m. The lithology is maintly of local origin but erratics of Leinster granite, volcanics and limestone testify to an ice advance from north-west of the Blackstairs mountains. Texture is a stony clay loam. Usually only a few metres of till occur above the head or bedrock and this is leached, weathered and in places cryoturbated.

Particle-size and chemical analysis of unweathered till

	%	Stone count	%
Stones and gravel (> 2.0 m)	27	Shale and Schist	75
		Quartizitic schist	11
Coarse sand (2.0 - 0.2 mm)	19	Sandstone	2
Fine sand (0.20 - 0.05 mm)	14	Leinster granite	4
		Volcanics	4
Silt (0.05 - 0.002 mm)	39	Limestone	2
Clay (< 0.002 mm)	28	Shell fragments	1
Carbonates %	2.7		
pH	7.8		

Frost or desiccation cracks

Along the south coast from Carnsore Point to Hook Head and on the east coast at St. Margarets, narrow vertical or near vertical cracks are common in the upper part of the till. The mechanism for their formation is not clear; they may be due either to frost cracking under periglacial conditions (Taylor in Mitchell 1962) or to desiccation under warm conditions. Péwé (pers. comm. 1977) thought the latter mechanism the most likely. In the coastal sections these cracks are sometimes seen to reach 2.0 m in depth; they are usually less than 10 cm in width but sometimes may reach up to 15 cm. They are characterised by the light-grey colour of the material within the cracks and sometimes by ironpans on both sides. No stratification or downturning at the edges is evident and small stones and cobbles are plentiful. In plan the cracks form a small polygonal pattern, varying in cross-section from 12 to 50 cm. At Grange, Fethard, these polygons are seen at low tide in till cemented to the bedrock. (EC)

Looking east a fine view of the Ballyteige barrier spit may be obtained. Like its counterparts further east there is little evidence that the "spit" has prograded westward. Again it appears that the Ballyteige inlet is formed at a low energy point on the coast, where the Keeragh Islands afford a degree of shelter. A good example of an ebb delta complex has formed seaward of the Lough entrance. (RWGC, JDO)

SITE 7 - SALTMILLS (S 804 088)

A low section is seen around the margins of a hillock on the foreshore. The till at the base is deeply weathered and frost-disturbed, and shows splendid polygonally arranged 'wedges'. On the west the till is buried by gravel, and on the east it has deep solifluction pockets or channels. The tops of these structures are truncated, and still later solifluction must have removed the upper layers, and produced the remarkably flat surface which conceals the dramatic disturbances below. (GFM)

SITE 8 - FETHARD (S 803 600)

This cliff is in low cliffs below the minor road at Wood Village about 1.5 km west of Fethard village. Cars may be parked by the roadside. Beach access is by a steep and slippery track down the cliff face - be warned!

At the south end of the section (Fig. 8) we see the shore-platform

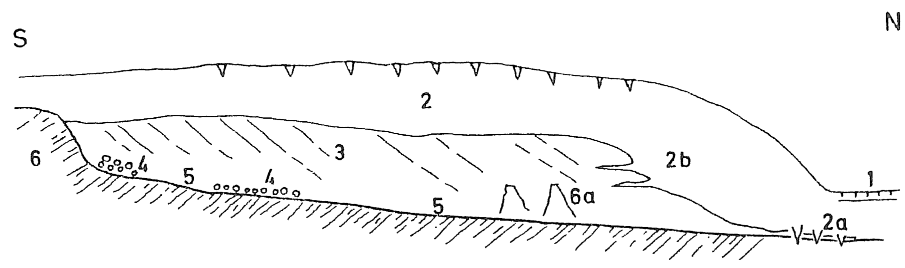

Fig. 8. Section at Fethard.

abutting against the old cliff. Beach deposits (JDO comments that the beach deposits bear little relationship to modern counterparts as they comprise angular, stratified grits more reminiscent of head deposition) of Courtmacsherry age lie on the platform, and are also seen at the base of the cliff further north, where the shore-platform has dropped below the modern beach. The shore-platform can be traced seaward to low-tide mark, and has patches of beach gravel cemented to it. Erratics can be seen in the beach material.

Stratified head lies on the beach, and builds up the bulk of the cliff section. The head is an intimate mixture of small plates of the local rock set in a loamy matrix. Snapped across, the plates show a colour of 2.5Y 7/2; the loam is red (2.5YR 4/8). In the opinion of Catt and Weir (1974) such rubification cannot be postglacial, but must be a palaeosol feature inherited from an earlier interglacial period of soil development; the rubification at Fethard is probably Gortian in age, translocation occurring in the Munsterian Cold Stage. In places the head is very coarse, and here the rock-cliff can be seen protruding through it. The head moved downslope in a viscous state, and in places the section gives an impression of folding.

The overlying till is calcareous and sandy; it contains many boulders of Leinster granite, which suggests that the ice-stream came from the north. At the north end of the section it can be seen that ice pushed into and distorted the head.

In the till many stones stand vertically, and thin grey 'wedges' (discussed elsewhere by Culleton) pierce it from above. Occasionally at low tides the wedges can be seen arranged in small polygons; tree roots in the wedges were dated at 4030 ± 120 BP (D-119). Other Irish dates for 'young' submerged forests are 4100 BP, 3730 BP.

Charlesworth regarded the great moraine here as part of his South Ireland End-Moraine, but more recent work has shown that Midlandian ice went further to the wouth-east. The moraine must represent a stillstand or a readvance. It has a tumultuous surface with many kettle-holes. Some of these are deep and conical in form. (GFM)

DAY 2 East coast of Co. Wexford

SITE 9 - ELY HOUSE (T 055 225)

This site is on the north-west side of L29 road just across the "new" bridge from Wexford town, opposite the Hospital. Parking is possible by the side of the road. The site is wet under-foot especially around high water.

A sequence of well-bedded diamicts are exposed in coastal cliff sections north of Ely House. Individual beds are separated by thin intra-beds of clean sand and some cyclic variation in thickness is seen. Clast proportion is highly variable and localised gravel lenses, clusters and till clasts are common. Many of the larger clasts have dimensions greater than the bed thickness and show penetrative deformation of stratification in the form of drop-stones (Fig. 9). Fabric studies indicate that, whilst a-axis orientation has a pronounced north-south peak, a high proportion of ab planes are sub-vertical. Calcareous concretion structures, similar to imatra stones (Pettijohn 1975), and dimict clots (Ovenshine 1970) also occur. Culleton (1978a) assigned these deposits to the Macamore Till Member but we consider that due to their particular lithological character they are best referred to a separate Ely House Member. In our view, the deposits are lacustrine waterlain tills, derived by bottom-melt from a floating ice-shelf or floating bergs. Further exposures in these deposits are seen along the north shore of the Slaney inner estuary where they are succeeded by poorly developed rhythmites. (GSPT, AJS)

SITE 10 - CURRACLOE (T 091 284)

A textbook example of a kettlehole formed during the late Midlandian after the ice had withdrawn to the north-east.

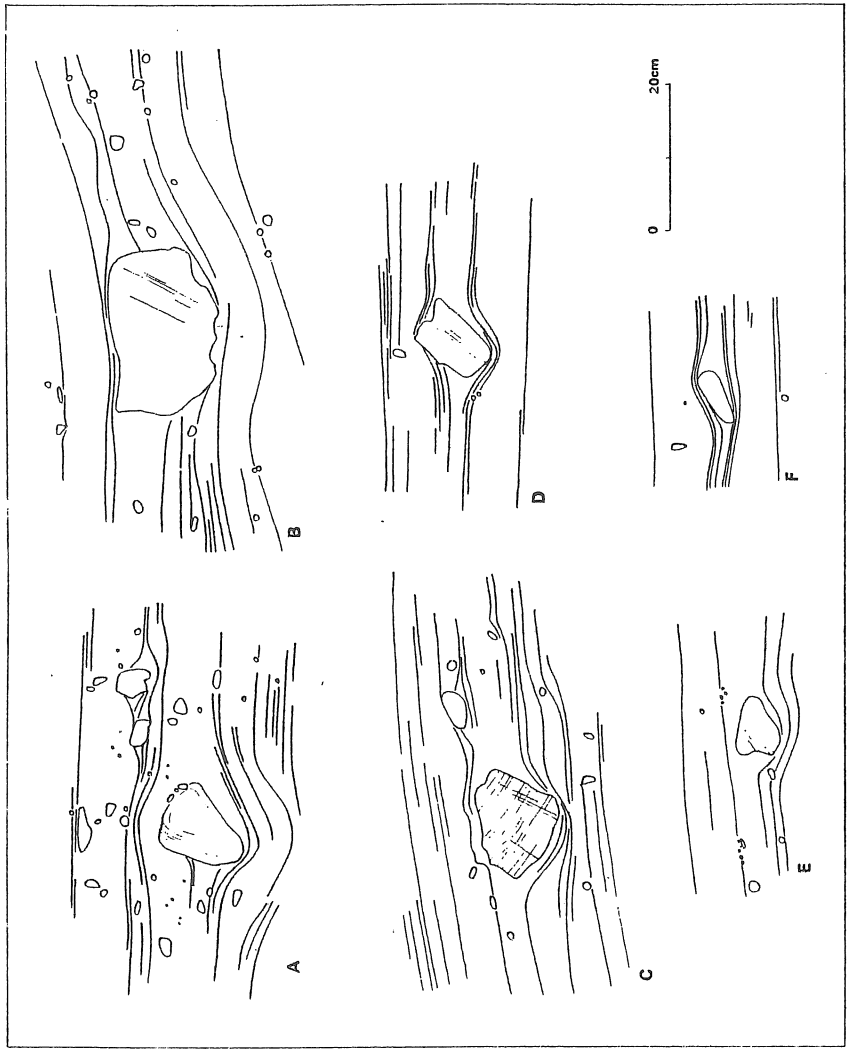

Fig. 9. Drop stone facies in the Ely House Member.

SITE 11 - BLACKWATER HARBOUR (T138 322)

Access to this cliff section is via the L30 road, turning right in Blackwater Village, parking on a low field by the shore. The cliffline is eroding rapidly and extremely dangerous. It is highly inadvisable to climb on the cliffs or walk to near the cliff top.

The 9 km of cliff section north and south of Blackwater Harbour truncate the kame and kettle moraine of the Screen Hills. The sections are complex (Figs. 10 and 11) but the basic succession, revised and extended from Culleton (1978a), is:

Ballinclash Member)	
Screen Member)	Blackwater Formation
Knocknasilloge Member)	
Macamore Member)	

The sections are interpreted as representing a response to cyclic minor readvance during the main retreat of Midlandian Irish Sea ice. Ten major phases of readvance can be identified in cliff section (Fig. 12), though many are lateral duplicates of the same readvance episode. Each episode has generated distinctive stratigraphic and structural characteristics. In the ideal case, a large wedge of Ballinclash basal till terminates southward above a rising shear plane that deforms underlying units and drags up sheets of basal Macamore Till. Forward, is a thickening wedge of proximal Screen Member outwash that includes intercalated flow-tills derived from the break-up of the adjacent ice-margin. This pattern is repeated through the sections such that individual units of Screen Member outwash and Ballinclash Till occur as separate sheets off-lapping one another to the north. We shall examine four sites through the sections and demonstrate various stratigraphic and structural features.

At Blackwater Head, the base of the sections is occupied by Macamore Till. This is a clay-rich, compact, calcareous till with a very low stone content. Lithological variation is limited

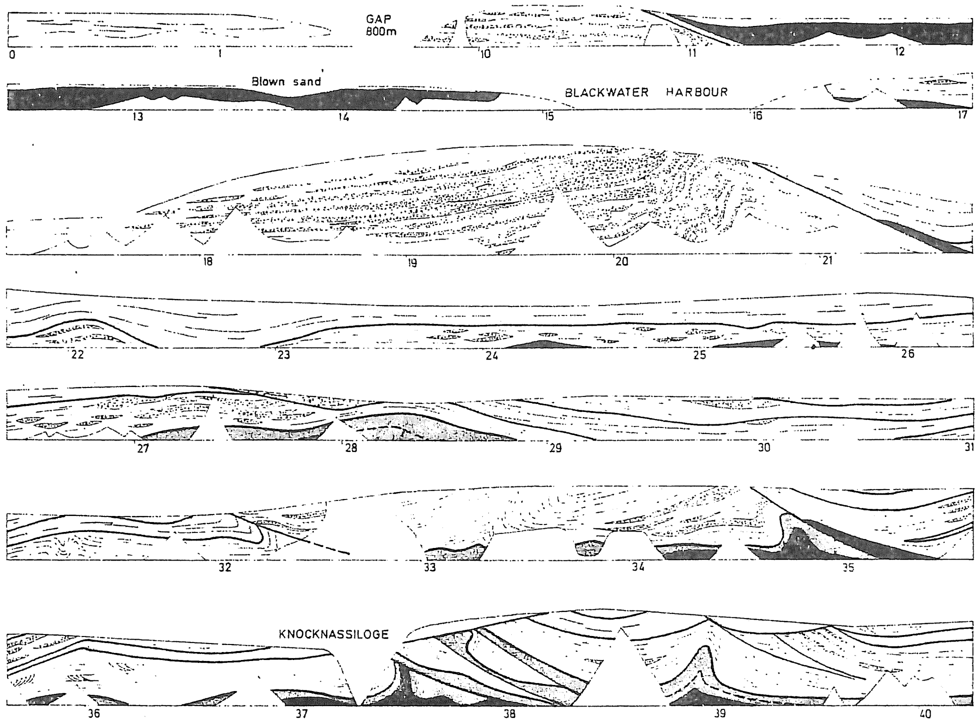

Fig. 10. Facies variations in the Screen and Knocknasilloge Members.

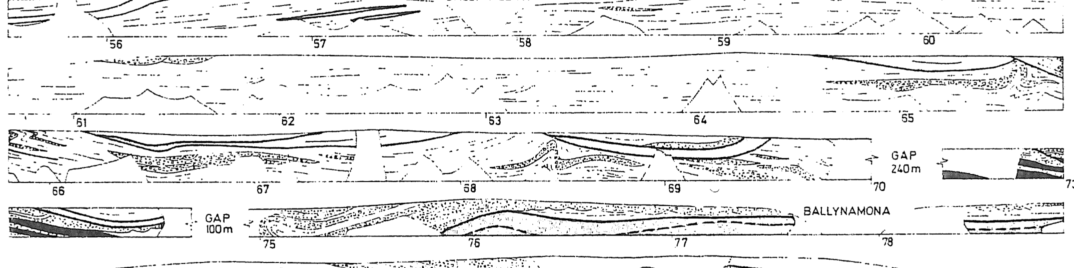

Fig. 11. Simplified facies variations in the Blackwater formation.

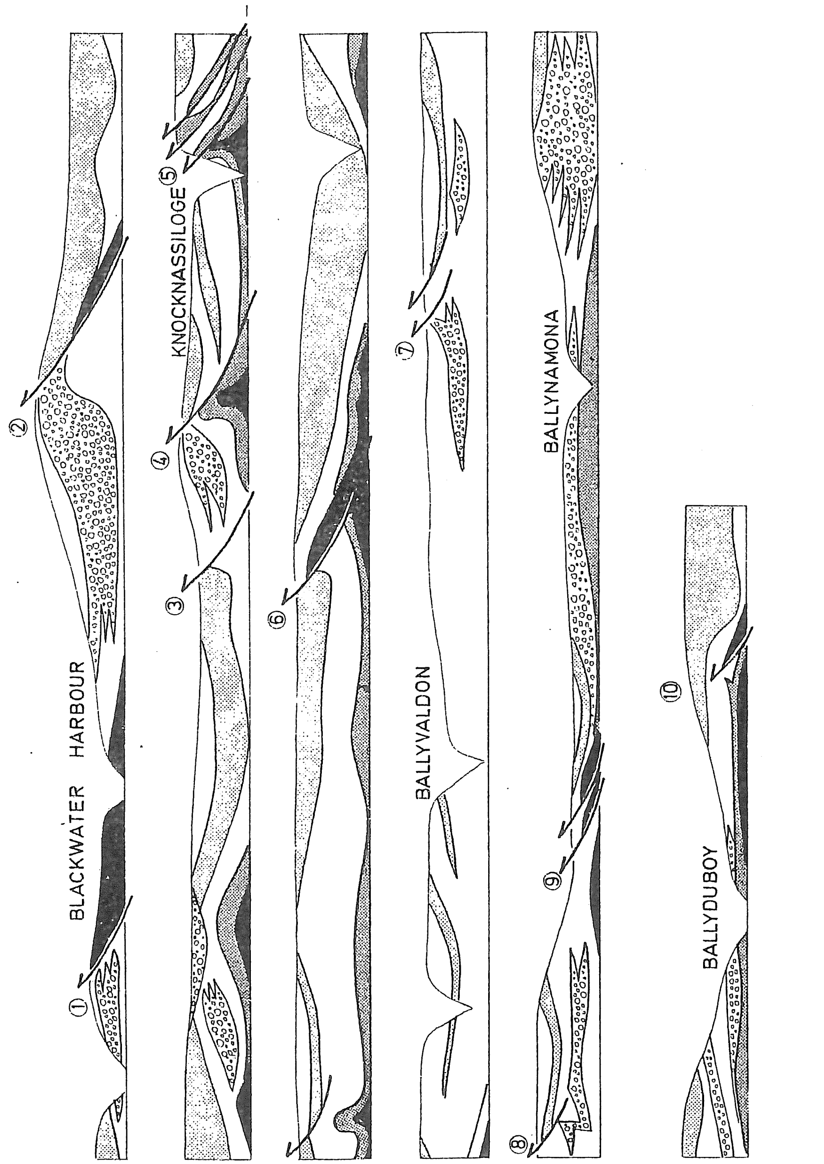

Fig. 12. Cliff sections from Blackwater Harbour to Ballyduboy.

to occasional weak lamination. The till is interpreted as a lodgment till emplaced during Midlandian advance to well beyond the Blackwater area. The Screen Member above is divisible into two major facies. A gravel-rich facies, consisting of massive or flat-bedded coarse gravel with interstratified flat-bedded sand, is interpreted as very proximal braided outwash with longitudinal bar and sheet flood deposits laid out very close to melt-water exits. A sand-rich facies, dominated by planar cross-bedded and cross-laminated sands, represents high-flow linguoid bar growth and low-flow ripple deposition in a more distal environment. To the rear of Blackwater Head the gravel facies become progressively deformed by the sheared over-ride of Macamore and Ballinclash tills. (GSPT, AJS)

SITE 12 - KNOCKNASILLOGE (T 148 341)

The cliff sections are reached by a small road leaving the "main" Blackwater to Gorey road at T 137 354. Parking near the beach is limited.

A characteristic readvance assemblage is seen here with complex structural deformation affecting all members. To the north is a thickening wedge of Ballinclash Till. Below it, the Screen, Knocknasilloge and Macamore Members are dragged up into a series of thrust slices. To the south, a thickening wedge of Screen sand facies is seen intercalated with some major flow tills. The Knocknasilloge Member itself consists of a coarsening upwards succession from massive grey clay, through parallel-laminated fine sand into trough cross-bedded sands and flat-bedded gravels of the overlying Screen Member. Interbedded flow-tills occur throughout the sequence.

Some considerable dispute exists concerning the stratigraphic definition and origin of this member and the status of the contained micro-fauna. In our view we see the sequence as representing fluctuating current velocities resulting from density underflow sedimentation in a glacio-lacustrine environment (Thomas and Summers 1981). We consider the micro-fauna to be wholly derived. Huddart (1977 and 1981a,b), on the other hand, considers the fauna to be <u>in situ</u> and has variously suggested that they represent either glacio-marine conditions or full Ipswichian interglacial marine shelf conditions. The implications of these views for the stratigraphy of Wexford are considerable. (GSPT, AJS)

SITE 13 - BALLYVALDON (T 159 360)

Leave the main road at T 147 363 and follow the minor road for 2 km to the coast. Parking is easy in a small car park on the cliff top. To reach the cliffs to the south a small stream needs to be crossed.

Both north and south of Ballyvaldon is a thick succession developed in sand facies of the Screen Member. Of importance are the numerous interstratified flow-tills indicative of sedimentation adjacent to an active margin. Further south, the sections are dominated by thick sequences of Ballinclash Till. The contact between the two is sharp and disconformable and there is little interdigitation or mixing. The Ballinclash till is red/brown, stony and sandy and shows discontinuous bedding, much internal deformation and significant facies variation locally. It is interpreted as a basal lodgment till associated with successive phases of minor readvance of Irish Sea ice. (GSPT, AJS)

SITE 14 - BALLYDUBOY (T 173 380)

Most easily reached by taking the minor road east at T 152 380, parking at the coast and walking north to the section.

Further sections in the deposits of the Knocknasilloge Member occur here. The sequence is undeformed and two major sub-facies are seen. At the base is a massive grey clay that passes gradually upwards from the Macamore Till. Above, are a sequence of cross-laminated silty sands that show evidence of collapse of the sub-strate pene-contemporaneous with deposition through the melt of buried ice. Palaeo-current indicators here show derivation from the north-east, a direction consistent with the directional properties of the overlying Screen and Ballinclash members.

<u>Discussion</u>

The principal question in east Wexford is whether the succession can be divided into deposits representative of separate glacial stages. If it can, via the assignment of the Knocknasilloge Member to the Ipswichian, then it carries the implication that the Macamore Till is of Munsterian age. This, in turn, implies that the raised beaches of south Wexford, which are overlain by this till, are older than the Ipswichian. The assignment also indicates that Midlandian Irish Sea ice passed no further south than the limit of the Screen Hills kame-moraine. If the succession cannot be so divided, as we would argue, then the sequence of events is much simpler and all members above the raised beach are of Midlandian age with the Screen Hills representing a complex still-stand or minor readvance phase during retreat.

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