IRISH ASSOCIATION FOR QUATERNARY STUDIES

Field Guide No 8

SLIGO AND WEST LEITRIM

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Sligo and West Leitrim

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by

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SLIGO AND WEST LEITRIM

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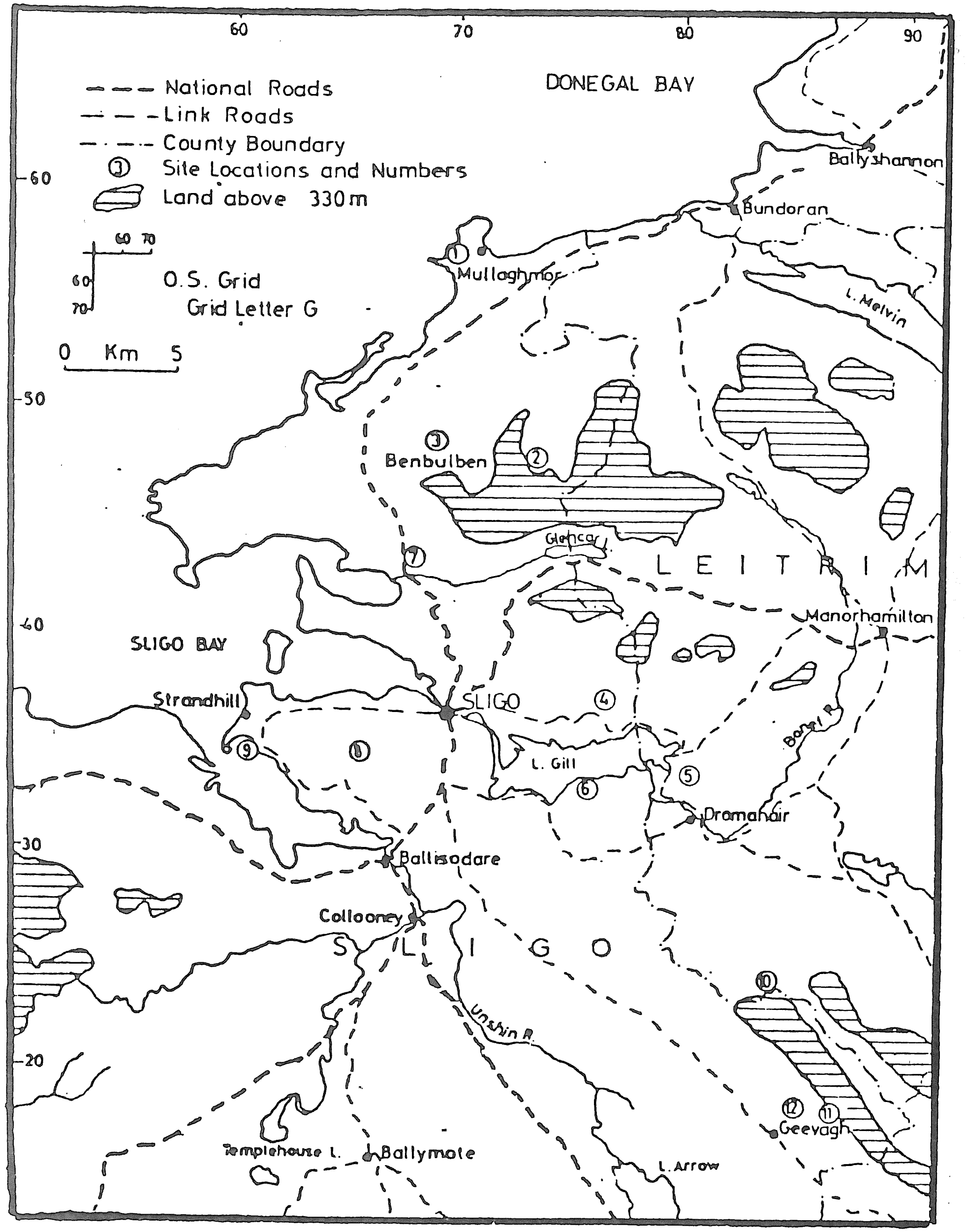
Sites 7, 8 and 9 - Sunday a.m. Sites 10, 11 and 12 - Sunday p.m.

Site locations are given on a location map overleaf.

Ordnance Survey 1:126,720 Sheet No 7 (Sligo) is recommended for use in conjunction with this guide.



Site location map

GEOLOGY AND GEOMORPHOLOGY

(P.B., P.C. and R.T)

General Review (P.B. and R.T.)

Solid Geology

The solid geology of Sligo and west Leitrim is dominated by Carboniferous lithologies and the metasediments and igneous rocks of the Ox Mountains and Rosses Point inliers (Fig. 1). The Ox Mountains inlier, which can be traced from Clare Island in west Mayo to Manorhamilton in Co. Leitrim, is composed of Moinian metasediments in the eastern section of the inlier and Dalradian metasediments and a Caledonian intrusion i.e. the Slieve Gamph Igneous Complex, in the central section. The Rosses Point inlier is composed of Moinian metasediments.

The Carboniferous sediments can be divided into those north of the Ox Mountains and those to the south. Dinantian sediments are present to the north of the Ox Mountains while both Dinantian and Silesian sediments are present to the south. The sediments north of the Ox Mountains were deposited in a deep basin, referred to as the Sligo syncline, between the Ox Mountains and the mountains of Donegal and Derry (Oswald, 1955). The Carboniferous sediments between the Ox and Curlew Mountains provide a link between the sediments of the Sligo syncline and the Carboniferous successions in central Ireland (Dixon, 1972). The Carboniferous successions north and south of the Ox Mountains are composed of thick conformable sequences of deposits which are readily divisible into lithological units.

Glacial Geology

Sligo and west Leitrim contain a rich suite of glacial deposits on which, unfortunately, little work has been carried out to date. In south and west Sligo Charlesworth (1928) provides some

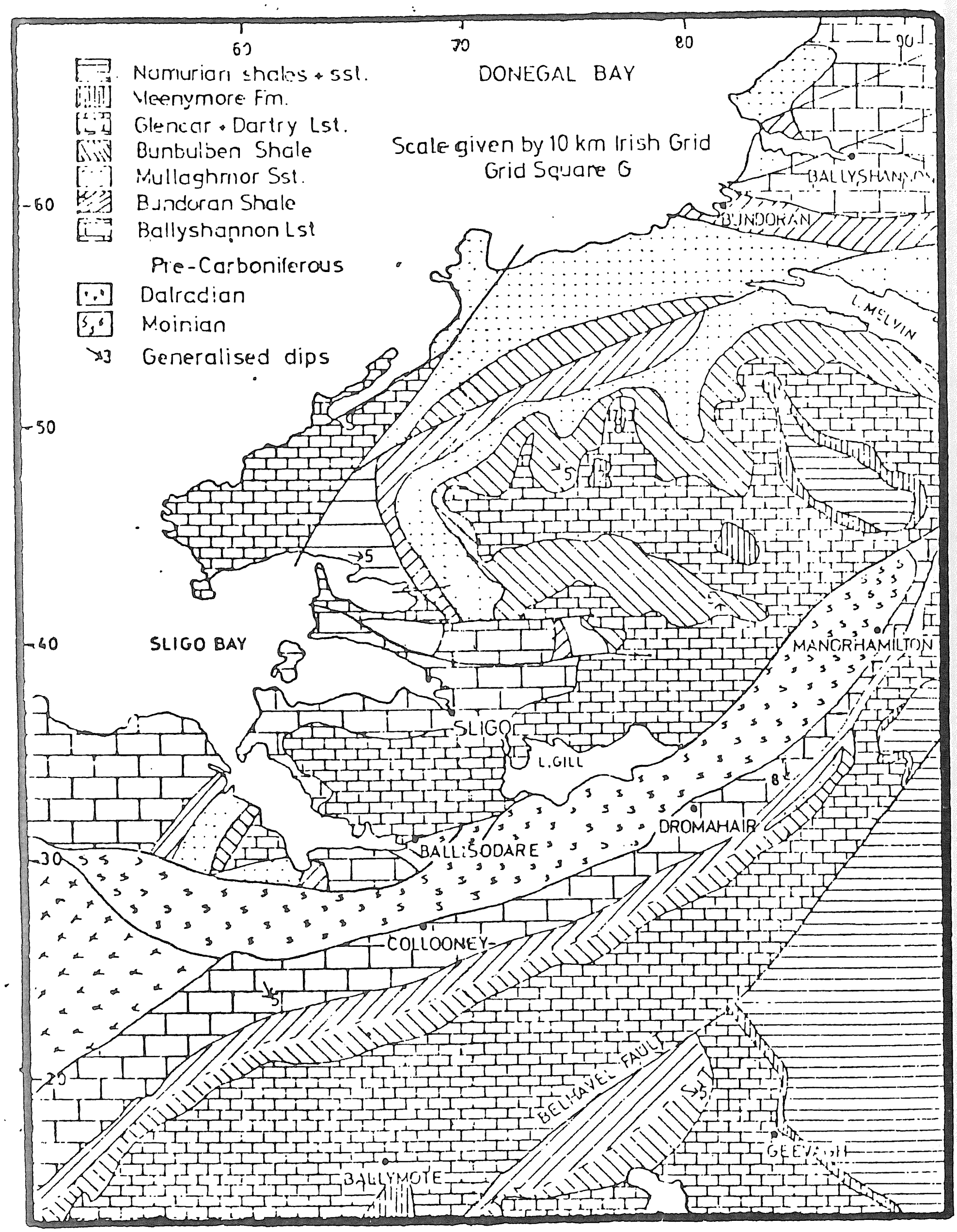


Figure_1 Solid geology of Sligo and west Leitrim

indication of the patterns of ice movement and decay. In north Sligo and north-west Leitrim Browne (1982) and Browne and Coxon (Sites 1, 2 and 3; this volume) provide a more complete picture of the glacial geology. Synge also undertook work in Sligo but unfortunately most of this work remains unpublished. Notwithstanding the lack of research it is possible to present a general picture of the glacial geology of this part of north-west Ireland by combining data from the above sources with information from Donegal and Mayo.

The Munsterian Glaciation in Sligo and west Leitrim is not evident as the area is obscured by the more recent Midlandian drifts. Information from Donegal and Mayo suggests a general picture of Irish ice expanding westwards from an ice axis in central Ireland. In Mayo the Erris Drift which is ascribed to the Munsterian (Synge, 1963, 1968) is found beyond the limit of the last glaciation and is deeply weathered. Synge also notes some degraded corries in Achill, Co. Mayo and associates them with the Munsterian. In Donegal a more complex picture emerges. The main advance of Irish ice was followed by an advance of Scottish ice which affected both north-east and north-west Ireland. Shelly tills found at Malin Head in north Donegal, Malin Beg on the Slieve League Peninsula and in north Mayo at Belderg have been tentatively associated with the Scottish ice (Davies and Stephens, 1978 and Colhoun 1973). A readvance of Irish ice occurred from ice centres in south Donegal and the Lough Neagh basin. Davies and Stephens suggest that part of this second Irish ice sheet almost certainly moved westwards into Donegal Bay. Although there is no direct evidence of Munsterian ice in Sligo it is likely that the area was covered at least once during the Munsterian.

Understanding of the Midlandian Glaciation of Sligo and west Leitrim is helped because of the presence of fresh well developed deposits. Charlesworth (1928), who dealt only with north Mayo and west Sligo, suggested that these areas were overridden by ice coming from two directions; from the area east of the Twelve Pins and south of Killary Harbour in Connemara and from the mountains in south-east Leitrim. It seems clear from Charlesworth's observations that there was a general northwesterly movement of ice from an axis in central Ireland. This movement is substantiated by the presence of drumlins in the lowlands between the Curlew and Ox Mountains which indicate a northwesterly moving ice mass. It is probable that the drumlins belong to the Drumlin Readvance stage (Davies and Stephens, 1978). The retreat of ice from west Sligo, according to Charlesworth, resulted in the formation of a number of lobes which occupied the Easky and Talt valleys in the Ox Mountains and Sligo and Ballysadare Bays and which left morainic deposits upon melting.

In north Sligo and north-west Leitrim work was recently carried out in the Benbulben Range and its associated coastal plain by Browne (1982). The study was undertaken for presentation as an undergraduate dissertation and involved the measurement of till fabrics and palaeocurrent directions and the mapping of geomorphological features. Whilst recognising the limitations of undergraduate research, Browne's work enables a more complete picture of events in north Sligo and north-west Leitrim to be presented. Browne suggests that the glacial deposits are of Midlandian age as the land forms are all fresh and unsubdued. However, no biogenic deposits were located which would allow a stratigraphy to be developed. Fabric analyses carried out on suitable till sections revealed two trends (Fig. 2). First, sections along the coast revealed distinct north-east to south-west orientations. This trend is supported by glacial striae at

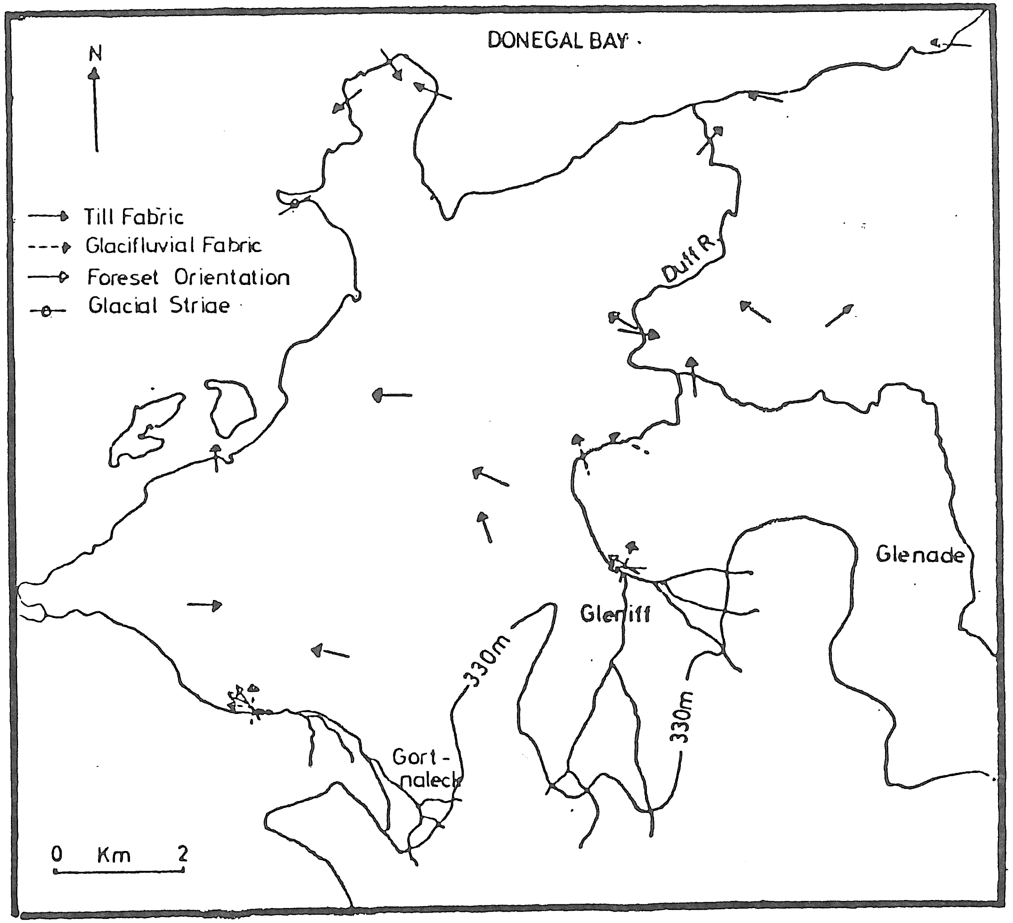


Figure 2 Fabrics from north Sligo/north-west Leitrim

(After Browne, 1982)

Rooskeragh Point (G 685 562) and some 'crag and tail' features at Mullaghmore (Site 1). This would suggest a southwestwards flow of ice in Donegal Bay and ties in well with the picture of ice moving out of the Erne Basin and out through Donegal Bay as suggested by Chapman (1970). Pebble counts from two of the coastal sites revealed a lithology which included Coolmore Shale and Kildoney Sandstone both of which outcrop to the north of Ballyshannon, again inferring a southwestwards flow of ice. The second trend of fabrics is found near the Benbulben Range (Fig. 2) and indicates ice emerging from the valleys. Ice in Glencar and Glenade valleys almost certainly originated from the Erne lowlands while morainic complexes at the mouth of Gortnaleck valley (G 701 473) could be used to support a picture of valley glaciers emerging from corrie sources within the plateau. Both in Gleniff (G 730 465) and Glenade (G 761 468) there are fine examples of corries with north-east aspects. Large, fresh moraines are found at the mouths of the corries. However, in the Nephin Begs of Mayo the local corrie glaciation did not extend out of the mountains. Did the corries in the Benbulben Range operate in the same way or did they expand further from their basins? Further work, especially in Glenade where the corries are much closer to sediments of the main ice sheet, may help to solve the problem.

Browne (1982) suggests that the Benbulben plateau itself was probably mainly ice free during the Midlandian. Certainly in Glenade the presence of a large number of well formed tors would indicate a considerable period of exposure to periglacial conditions. Throughout the area there is a well developed scree above the 330 m contour. Davies and Stephens (1978) suggest that the lower limit of the scree is the trim line of the ice with the scree developing in the periglacial conditions adjacent to the ice. A protalus rampart in Gleniff (Site 2) at the trim line was formed

under periglacial conditions. Coxon (this volume) does not rule out a date older than the Nahanagan Stadial for the feature although he deems this unlikely. The extensive solution of the limestones on the plateau surface, the associated collapse features and the peat cover makes it difficult to determine the extent of ice coverage of the plateau. However, to date there is certainly no evidence to suggest extensive coverage by ice. Undercutting of the scarp by ice below the trim line may have been partially responsible for the formation of the large number of rotational landslips in the area, the origin of which is dealt with further in Thorn (1984).

The majority of landforms on the lower ground and coastal plain are glacifluvial in origin. At the mouths of Gortnaleck and Gleniff valleys kame deposits are found. The deposits at Gortnaleck (Site 3) contain westwards dipping foresets and these, together with a series of delta kames in the same vicinity, suggest the presence of ponded water, possibly a proglacial lake (Browne, this volume). At the mouth of Gleniff valley at Ballintrillick (G 741 601) a less well developed kame deposit is found. Evidence for glacifluvial erosion is seen in the form of meltwater channels, one of the larger being that at Moneylahan (G 905 495). At Gleniff, behind the moraine (see above), a preliminary probing of the corrie floor has revealed the existence of lacustrine clays beneath peat. These are probably of Late-glacial age though an analysis of the sediment has yet to be carried out.

In conclusion, Sligo and west Leitrim may have been glaciated twice although there is direct evidence only for the last glaciation. Donegal Bay was invaded by ice in both the Munsterian and Midlandian. During the Midlandian evidence suggests that north Sligo and north-west Leitrim were affected by southwesterly flowing ice from Donegal and the Erne Basin. South Sligo and west Leitrim were affected by ice moving north westwards into Sligo Bay. A local corrie glaciation also occurred in the Benbulben Range. Subsequent deglaciation produced a series of delta kames and meltwater channels.

SITE 1 (G 695 754) - Mullaghmore - Till and 'Crag and Tail' - (P.B)

This is a coastal section at and above highwater level. It is part of a 'crag and tail' feature the downstream end of which has been removed by coastal erosion to reveal a section consisting of 10.0 m of till lying on sandstone bedrock overlain by 0.8 m of dune or wind blown sand which is in turn overlain by 0.2 m of peaty soil. The till is subdivided into a lower unit of 9.0 m of matrix supported till with large subangular clasts of cobble to boulder size set in a sand matrix and an upper unit of 1.0 m of finer till in a sand matrix. There is some degree of stratification in the tills which have a dip of 30° away from the rock core. The lower till yields a fabric with a major mode of 230°. A pebble count shows that the content is entirely of Mullaghmore Sandstone. The till appears to be a lodgement till and is stratified because as low pressure was created by the moving ice on the lee side of the rock 'crag' lodgement of material occurred within the low pressure zones.

Browne (1982) identified two till units in north Sligo and north-west Leitrim, a melt-out till, which he informally named the Liscally Till and which is found at most inland sites and a lodgement till, informally named the Bundrouse Till, which is found at coastal sites. The relationship between the tills is not clear as nowhere have they been found to be juxtaposed. The Bundrouse Till contains a pebble content derived from north of Ballyshannon, including the Ballyshannon Limestone, the Coolmore Shale and the

Kildoney Sandstone. The fabric of this section at Mullaghmore precludes it being termed the Liscally Till yet its pebble content is entirely different from that of the Bundrouse Till. A possible explanation lies in the fact that the Mullaghmore Sandstone outcrops between Tullaghan and Ballyshannon to the north-east. Thus as ice moved from Ballyshannon to Mullaghmore it could easily have picked up Mullaghmore Sandstone.

SITE 2 (G 726 477) - Gleniff - Protalus Rampart - (P.C.).

Protalus ramparts are produced when frost shattered debris and the products of nivation falling from a hillside slope slide across an area of snow and come to rest at the base of the snow bank. Such features are widespread in Scotland, Wales and upland Ireland (Colhoun, 1981) but they have frequently been confused with morainic landforms, especially lateral moraines.

The rampart described here is located on a north-east facing slope at c. 310 - 340 m. The feature was mapped as part of an undergraduate fieldcourse and consequently Figures 3 and 4 (showing the overall plan of the rampart and some cross sections respectively) should be used as a first approximation only.

The protalus rampart is composed of large boulders (0.5 - 1.5 + m diameter) of limestone. It is 230 m long and over 5 m high in some sections. The rampart is at a break in slope below steep limestone slopes and its proximal slope reaches over 45°, its distal slope, which is much shallower, c. 25° (Fig. 3). The feature is very similar in form to that described by Colhoun (1981) in the western Mourne Mountains although the Gleniff feature is at a lower altitude.

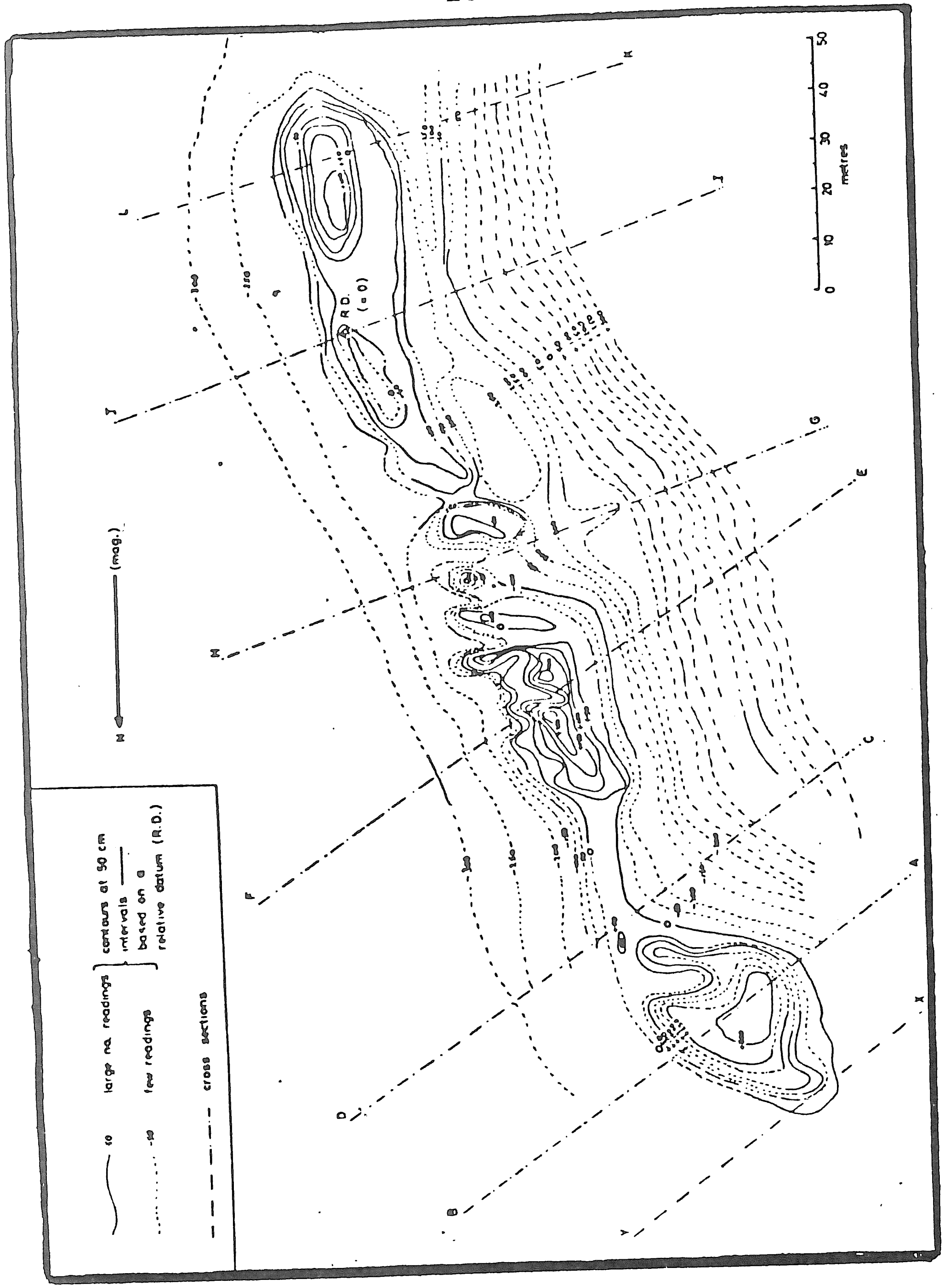


Figure 3. Plan of the rampart

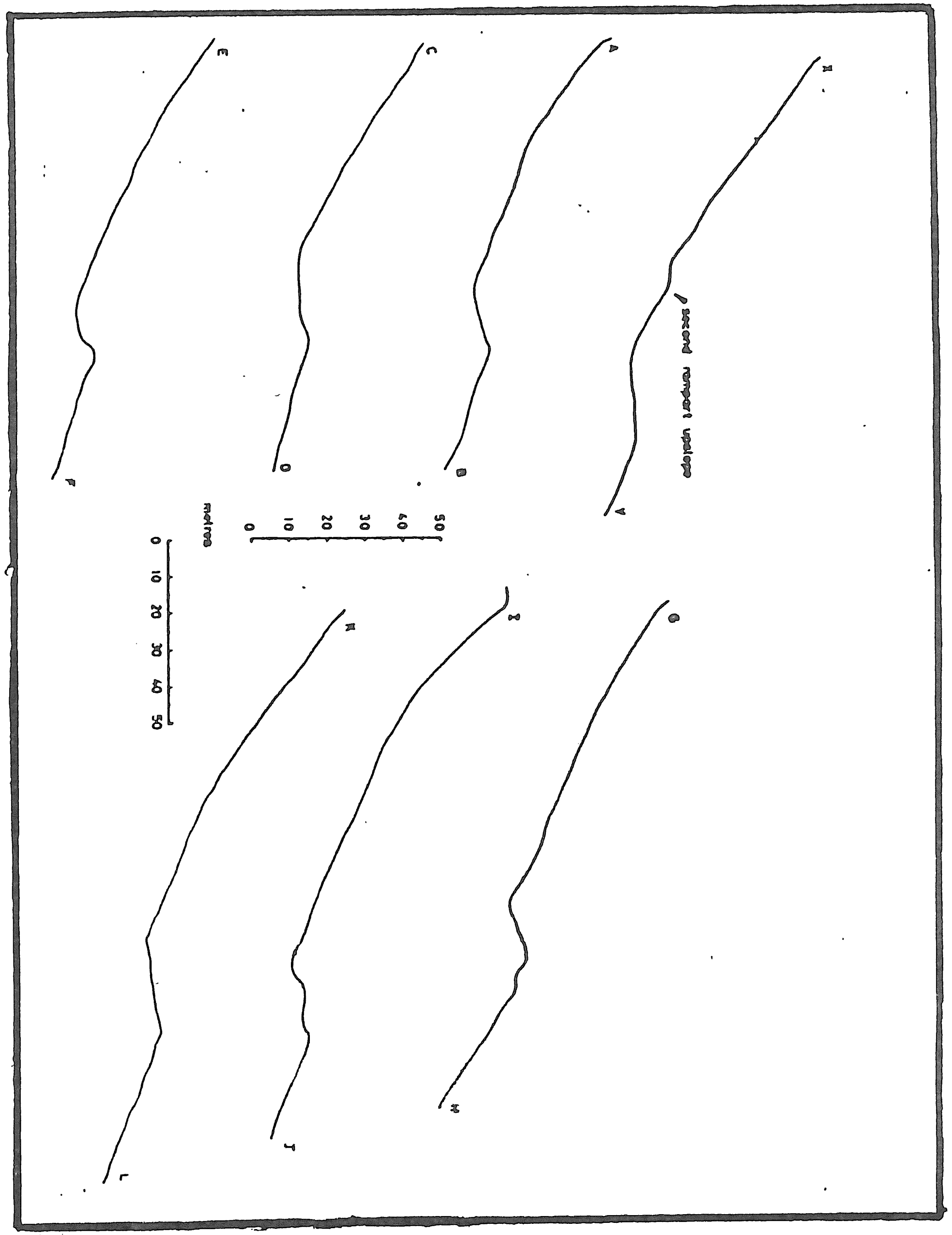


Figure 4. Cross sections of the rampart

The snowbank that produced the protalus rampart was probably present for reasons of aspect and topography (i.e. facing north-east at the foot of a steep frost shattered slope in the lee of a large mountain). The absolute age of the rampart is unknown although for reasons similar to those given by Colhoun (e.g. freshness of form) a Nahanagan Stadial age for the feature is likely. However, an older origin cannot be ruled out unless more precise information such as a radiocarbon date becomes available.

SITE 3 (G 677 480) - Gortnaleck - Delta Kames - (P.B.).

This area has a series of flat topped, steep sided kames containing ice proximal deposits. Sections (Fig. 5) in one of the kames show alternating gravel and sand units in large foreset beds. There are also large lobes of gravel within sand units. This suite of deposits is typical of braided stream channels with some larger channels accounting for the gravel lobes. The flow producing these deposits was probably highly fluctuating both in velocity and in direction. The fluctuating nature of the velocity or energy of flow can be seen in the alternating sand and gravel units. The sand units represent periods of low flow in which fine material was laid down. The gravel units represent periods of higher energy flows when the coarser deposits were laid down. These changing periods of flow energy are due either to seasonal effects in the mass balance of the ice, or else, perhaps, due to changing energy over longer periods of time.

The fluctuating nature of the direction of the flow is seen in the way in which channel fill deposits are laterally discontinuous and throughout the vertical sequence they appear in different places. There are also gravel beds with undulating

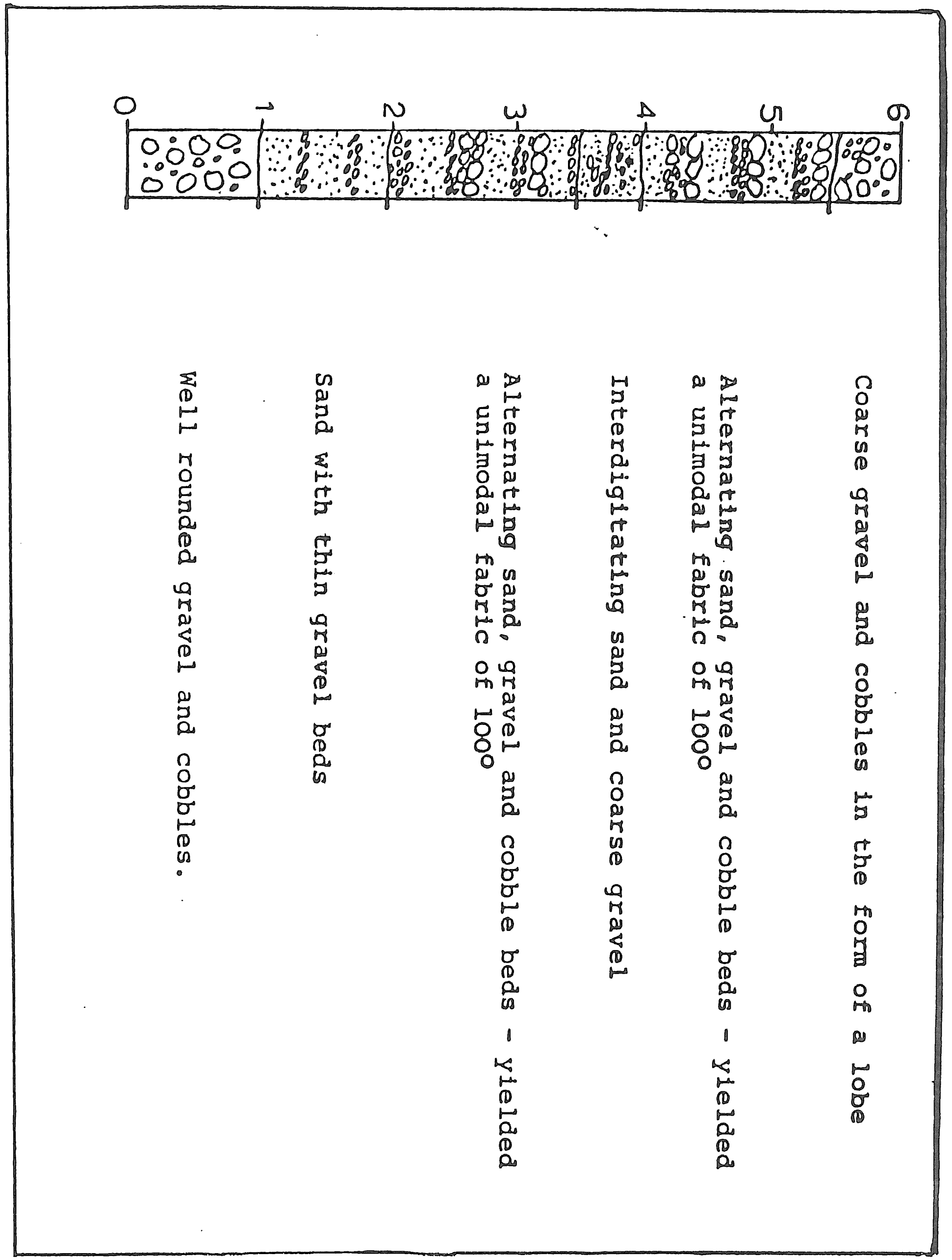


Figure 5 Section in the kame

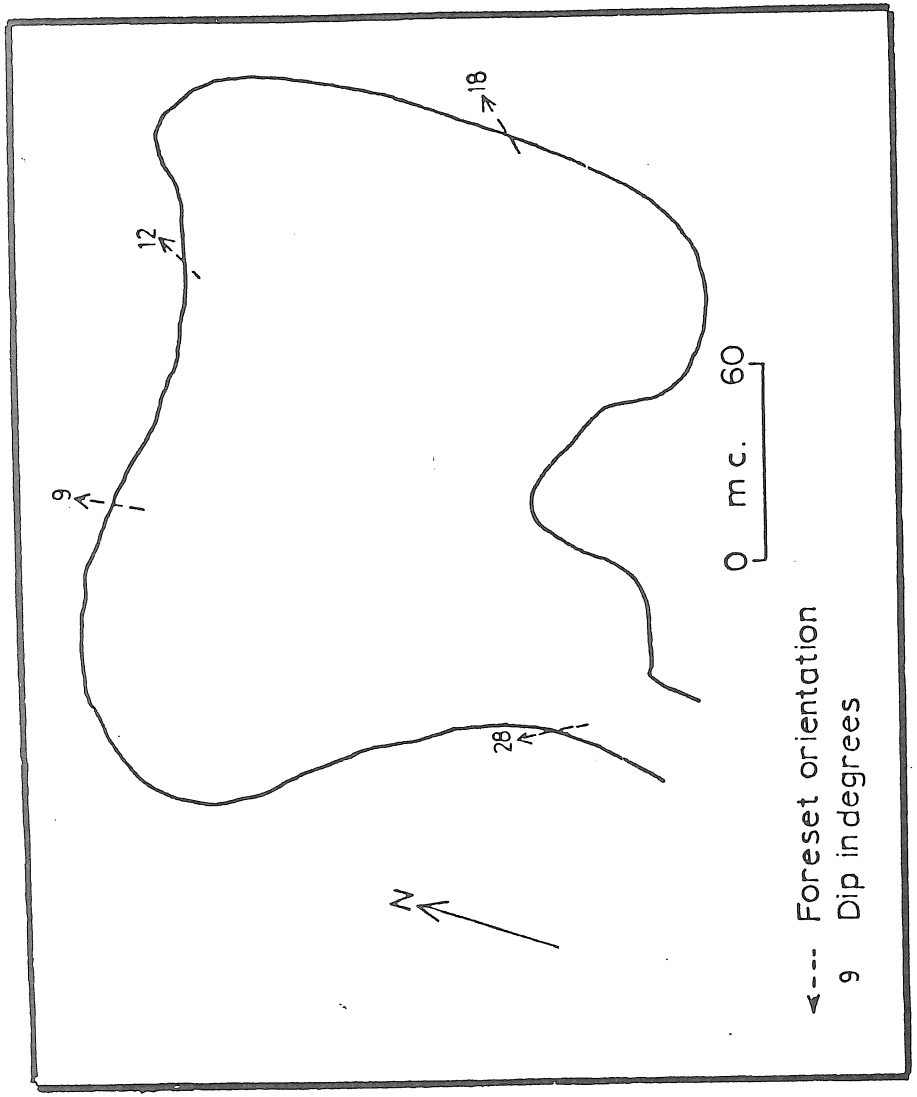


Figure 6 Foreset directions in kame

surfaces which are typical of high energy environments with fluctuating direction of flow. These deposits are typical braided deltaic deposits which formed at the glacier snout where water flowed out of the ice into the ponded water. The rapid drop in velocity of flow, due to this change in environment, led to delta formation with foreset development.

The fabrics from gravel beds and the dip and direction of foreset beds (Fig. 6) indicate that the ice front was to the south-east in Gortnaleck. The pebble content is entirely of local rock. This area must have been a major melt-water outlet and the series of delta kames in the vicinity provides evidence for a body of ponded water in front of a retreating ice front.

PALAEOECOLOGY

(R.B., J.D., M.T., P.T. and S.T)

General_Review (R.B)

Introduction

The present vegetation around Lough Gill is but a shadow of its former glory, and has not yet attracted the attentions of ecologists and palaeoecologists to the same extent as has Killarney - despite a number of similarities. Praeger (1934) drew attention to the geological contrast between the northern and southern shores of Lough Gill, and commented on the occurrence of Arbutus unedo growing far to the north of its main distribution in Kerry and Cork. Praeger noted the wooded islands holding Taxus, Arbutus and Sorbus, and singled out fine native woodlands at Slish Wood (now mostly coniferised), and at the mouth of the Bonet river. Only in the last two years has the palaeoecology of this area been examined in detail, and this recent work is discussed on the trip. Dodson and Bradshaw (In Prep.) have used pollen analysis to examine the recent history of some woodlands on the metamorphic rocks to the south of Lough Gill and to assess the relative importance of man, fire and climatic change on their composition during the last 6000 years. Their work complements that of Turbayne (Site 4; this volume), who investigated the Late-glacial and early Holocene vegetational development at a site on the limestone terrain to the north of Lough Gill.

Pollen analytical studies today are entering an exciting new phase. Early workers in the field were concerned with constructing a regional framework of pollen assemblage zones which could be broadly correlated from place to place, and subsequently interpreted in terms of large scale climatic change (Jessen, 1949). Radiocarbon dating provided a new stratigraphic framework and showed that many of the major changes seen in pollen diagrams were

time transgressive, forcing a revision of the interpretation of the major influences on recent vegetational history (Smith and Pilcher, 1973). Interest shifted away from regional generalisations towards consideration of the history of individual taxa, and the European pollen maps of Huntley and Birks (1983) exemplify this approach. Reconstruction of climate from pollen data has become more sophisticated, and involves the multivariate analysis of data-sets covering whole continents (Prentice, 1983),

Irish pollen studies can now proceed beyond the stage of primary reconnaissance, and can investigate specific problems of interest to the botanist, biogeographer, archaeologist or climatologist. On this trip problems relating to the Late-glacial period, the Holocene record of Pinus sylvestris, the influence of fire on Holocene vegetation and the role of man in shaping the present-day plant communities are discussed.

The_Late-Glacial_Period

Watts (1977) has comprehensively reviewed the palynological studies of the Late-glacial period in Ireland. Many of the Irish sites have substantial depths of sediment dating from this time, and western sites are the most suitable for correlation with the marine record which has received much recent study (Ruddiman and Duplessy, 1985). There is still uncertainty over the timing of climatic change between 15000 and 7000 years B.P. Recent work in north-west Spain has suggested that the 'Younger Dryas' is not expressed so far south (Hannon, 1985), and evidence is gathering of a short lived climatic deterioration observed at certain west European sites after the initial Holocene warming (P. Browne, Pers. Comm., Hannon, 1985). The classic tri-partite division of the Late-glacial period has proven to be too convenient a generalisation for interpreting pollen diagrams, and a site from

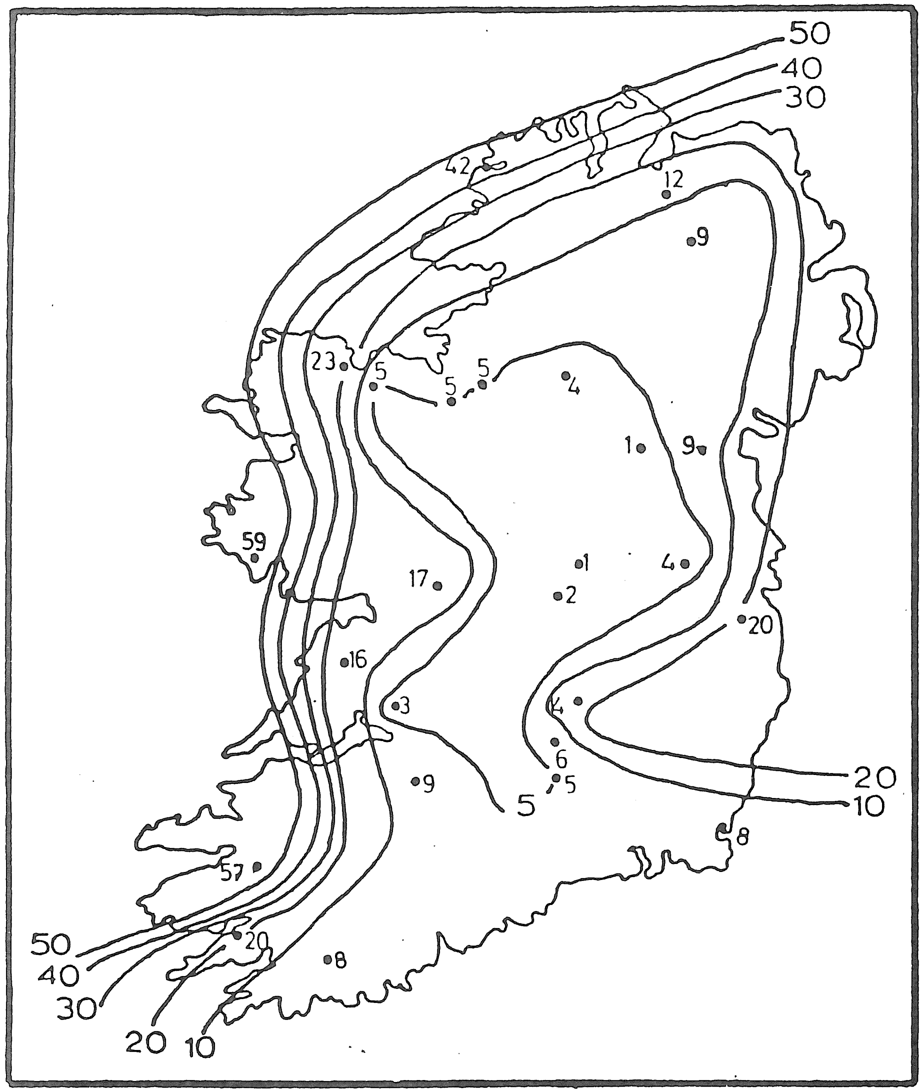


Figure 7 The distribution of *Pinus* pollen percentages in Ireland at 5000 B.P.

Sligo is needed to emphasise regional variation in Late-glacial vegetation, and add to our understanding of the nature of the climatic changes of that period.

The Holocene record of *Pinus sylvestris*

Bennett (1984) reviewed the history of *Pinus sylvestris* in the British Holocene using pollen and macrofossil evidence, but his study could be expanded by recent data from the Sligo area and the treasury of unpublished data that exists in Ireland. *Pinus* pollen expanded in many Irish sites between 9000 and 7500 years B.P. but was never a common tree in areas such as Westmeath (O'Connell, 1980), east Tyrone (Hirons, 1983) and at Lough Anelteen (Turbayne, this volume).

The timescale and geography of the *Pinus* decline in Ireland is complex, reflecting the gradual loss of the many different habitats in which it grew. The immigration of *Quercus* and *Ulmus* displaced *Pinus* from fertile soils, and the subsequent arrival of *Alnus* drove *Pinus* from peaty and waterlogged low-lying sites and river valleys. *Alnus* replaced *Pinus* at the Union Wood site between 6000 and 5000 years B.P. (Dodson and Brdashaw, Site 6; this volume). By 5000 B.P. the strongholds of *Pinus* were in the west of Ireland (Fig. 7), on acidic, predominantly upland sites, and on limestone in the Burren, Co. Clare (Watts, 1984). *Pinus* pollen disappeared from Glenveagh, Donegal around 3220 B.P. (Telford, 1977), but minor resurgences at Union Wood between 3000 and 2000 B.P. confirm its survival in the Sligo area. Significant quantities of *Pinus* pollen were found at Slish Wood (Dodson and Bradshaw, Site 6; this volume) at 1850 B.P., but declined soon after. *Pinus* stumps have been dated from several parts of Ireland between 1800 and 1000 B.P. as the final *Pinus* populations were engulfed by blanket peat. Recent macrofossil finds and historical documents suggest that individual trees survived into the historic period.

The influence of fire on Irish vegetational history

Few charcoal counts have been carried out in Irish pollen studies, but the correspondence between the charcoal records and the *Calluna* and Poaceae pollen curves at the Union Wood and Slish Wood sites, suggests that fire has been a controlling factor on the vegetation. The pattern of high charcoal values in the Slish mor diagram (Fig.16) suggests that fire destroyed the tree cover at the site and woodland was only re-established when frequent burning ceased.

Current research in Killarney is suggesting that the shape and composition of certain woodlands in that area has been controlled by fire, and charcoal and fire scars associated with buried *Pinus* stumps (J. Pilcher, Pers. Comm.) indicate the presence of burning in the past. The role of fire, both natural and set by man, deserves further study in the Holocene of Ireland.

The role of man

Palaeoecological studies have an important role in complementing archaeological research, by providing the environmental background, and assessing the impact of man on the environment. Goransson (1980, 1981) has presented pollen diagrams in conjunction with the excavations at Carrowmore, Co. Sligo (See Enright, Site.8; this volume). The sites discussed in this volume show a number of vegetational changes attr table to man, or to the spread of blanket peat - it is hard to disentangle the two factors. There are isolated occurrences of weedy pollen types prior to the *Ulmus* decline at Union Wood, and the general increases of non-arboreal and Coryloid pollen after this decline reflect the pressure of man on the landscape. Specific examples of local tree

clearance are always hard to detect in regional pollen diagrams but the localised Slish mor diagram (Fig. 16) contains details of a treeless period in a well-defined area. The early records of *Arbutus* pollen from Slish Wood suggest that this species is not a recent introduction.

SITE 4 (G 765 360) - Lough Anelteen - Late-glacial and early Holocene pollen stratigraphy - (S.T.).

Lough Anelteen lies to the north of Lough Gill on limestone bedrock, 44 m above sea level. The lake is 333 m x 212 m, with a depth of 4.1 m at the time of coring. The site was chosen in the context of a wider study that focuses attention on Late-glacial and early Holocene conditions on different bedrock types in this area.

Local Assemblage Zones

LA1: *Salix*-Gramineae-Cyperaceae zone.

The basal zone was characterised by relatively high values of *Salix* (21%), Gramineae (29%) and Cyperaceae (15%), moderately high values of *Artemisia* (11%), Ericales (10%) and *Empetrum* (10%), and lesser but noticeable amounts of Caryophyllaceae (total 10%), Cruciferae (8%), *Rumex acetosa* (6%) and *Thalictrum* (5%) (Fig. 8; see centre pages). Arboreal pollen was absent, apart from *Betula* and *Pinus*, which did not exceed 10%. Pollen concentration was low at the base of the profile (30,000 grains cm^{-3}) but increased to 500,000 grains cm^{-3} at the top of the zone. Many indeterminable crushed or corroded grains were recorded.

Lithologically, this basal section of the core was complex and varied. A basal gravel layer was overlain by predominantly inorganic bands of sands and silts, approximately 2 mm thick. This mine:.genic sediment was interrupted by a unit of more organic sediment, which in turn was overlain by inorganic bands of sands and silts similar in size and composition to the previous phase of deposition. In the upper part of the zone organic sedimentation increased in the form of a highly calcareous mud.

The basal portion of the pollen stratigraphy is incomplete and further analysis is needed in order for sub-divisions to be made.

LA2: Corylus zone.

A peak of Juniperus pollen (31%) was recorded at the base of zone LA2, coincident with a highly calcareous peak within the sediments. The taxa that characterised zone LA1 were either absent or substantially reduced in frequency.

The arrival of Corylus within this zone began the invasion of arboreal taxa into a previously herb-dominated environment. Corylus rapidly increased in frequency to produce the highest pollen concentrations in the core (930,000 grains cm^{-3}). The succession of trees began with Quercus, followed by Ulmus and later Alnus.

The sediments became more organic, rising from 5% to 80% organic matter, although silt was still found (Fig. 9).

LA3: Corylus-Quercus-Ulmus zone

High percentages of arboreal taxa dominated this zone, which also recorded the arrival of Fraxinus pollen within the profile. Herb pollen was still abundant, with a variety of taxa represented.

The sediments were organic calcareous muds although organic content fluctuated within the zone.

LA4: Graminae-Corylus zone

There was a marked decline in tree pollen frequency, and a

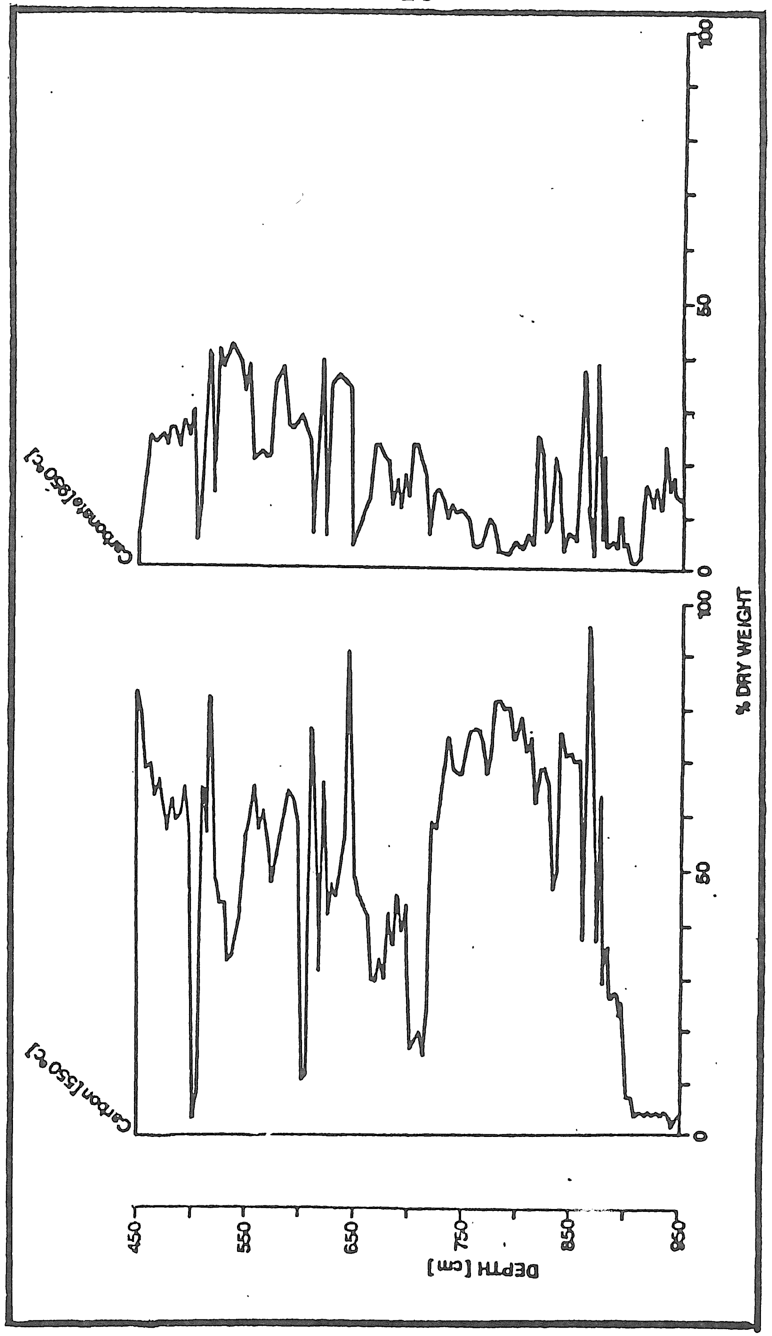


Figure 9 Organic and carbonate content for Lough Anelteen sediments

rise Graminae pollen within this zone. Pollen concentration was substantially reduced compared with the two previous zones.

Interpretation

Any interpretations based upon this profile are preliminary, as the pollen stratigraphy is incomplete and the core is as yet undated. However, given these limitations certain conclusions can be drawn.

Both sediments and pollen suggest that Late-glacial deposition did occur at this site. Lithologically it appears that there were two discrete periods of inorganic sedimentation separated by a period of more organic sedimentation. The banding observed within the inorganic layers is possibly attributable to water level changes. After the second of these minerogenic phases, more organic sediments were deposited, still with a high percentage of carbonate (38%).

The pollen assemblage within the basal section of the core (LA1), contains some of the typical Irish Late-glacial taxa (e.g *Empetrum*, *Juniperus* and *Artemisia*). At present only the later stages of the Late-glacial period have been analysed and further analysis is needed to reveal the whole sequence.

The arrival of arboreal taxa marks the beginning of catchment colonisation and stabilisation, culminating in the development of the woodland stage in zone LA3. Deforestation occurs in Zone LA4, reducing the extent of former woodland cover.

In summary, the assumed Late-glacial phase is incomplete and requires further analysis to reveal more detailed information on this time period. It is also necessary to establish an independent chronology to verify these assumptions.

SITE 5 (G 813 320) - Lough Nahoo - Man-made turlough - (M.T. and P.T.)

The turlough is situated c. 1.2 km north-west of Dromahaire (Fig. 10). It presently covers an area of 60 ha and fulfills the criterion for turloughs insofar as it fills in winter and empties in summer, leaving a small residual lake of c. 0.1 ha.

The lake is situated in an enclosed valley which is bounded by drumlins. The northern section of the area is underlain by gneiss and schist of the Ox Mtns. inlier. A fault runs through the southern side and this latter end is underlain by the Ballyshannon Limestone. A cave at the southern end of the area, known as the Cove, drains the lake. Optical brighteners were used in an attempt to locate where the water reemerges. However, to date all the sites tested have yielded negative results.

Developmental history of the lake - a hypothesis

Using a Russian corer samples of the sediments were collected at 10 m intervals along two representative transects. A stratigraphy was developed (Fig. 11) and pH and organic content determined. This sampling is considered to be a preliminary survey and no radiocarbon dating was carried out on the cores. However, it is envisaged that pollen analysis and radiocarbon dating will be carried out on selected cores in 1986.

The developmental hypothesis presented below has been developed using deposition rates of 0.5 mm of sediment year^{-1} and 0.5 to 0.7 mm of minerotrophic or fen peat year^{-1} as determined by Goransson (1981) for Ballygawley lake (G 695 281) and for fen and sphagnum peat at Carrowkeel in the Bricklieve Mountains in south Co. Sligo respectively. The recent developmental history of the turlough is based on O.S. maps of the area.

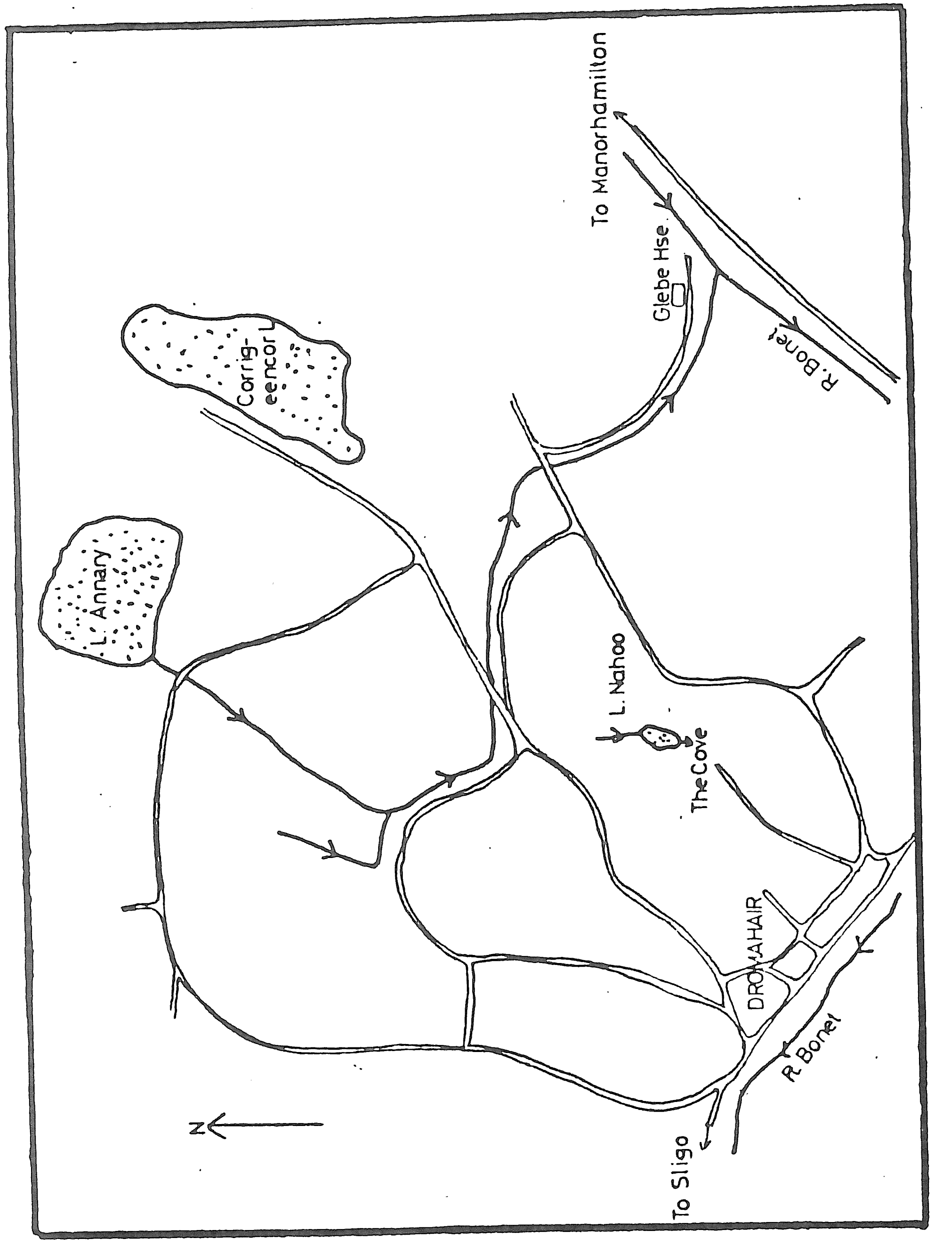


Figure 10 Location map for L. Nahoo (not to scale)

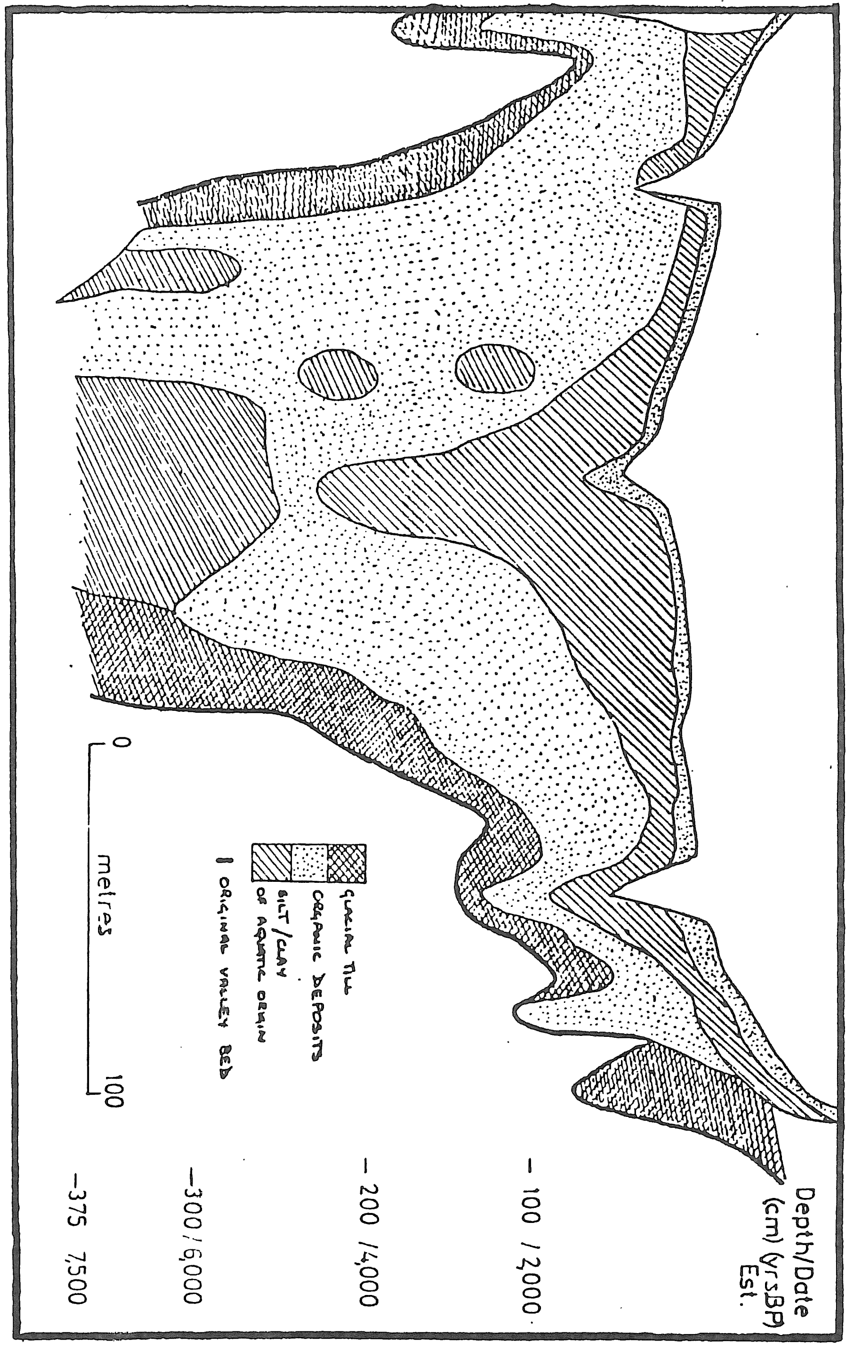


Figure 11 L. Nahoo stratigraphy

(After Timpson, 1985)

The corer used for sampling was capable of sampling only to 375 cm and so, on the basis of Gorannsson's deposition rates, sediments representing 7500 years were encountered. At 7500 B.P. more than 50% of the central region of the valley floor was occupied by water (Fig. 12 a) as indicated by the silt/clay deposits of aquatic origin.

Estimated 6000 B.P.: The area of open water has been reduced and covers less than 40% of the valley floor. Marginal plants or fen vegetation in the littoral regions of the water gave rise to extensive organic deposits surrounding the water body.

Estimated 5000 B.P.: A further reduction in the open water surface had taken place and up to 90% of the valley floor was covered by fen or fen-carr type vegetation. The presence of tree material in the organic deposits suggests the fen-carr bog development phase.

Estimated 4000 B.P.: The area of lake sediments had increased suggesting an increase in open water - the latter now covering c. 15% of the valley. Fen type peat made up the remaining surface area. The increase in open water area which began at this time and which continued up to 500 B.P. almost certainly was due to an increase in the inflow of water. If the authors' assumptions vis a vis the deposition rates are valid then the increase in inflow was probably due to an increase in surface runoff caused by forest clearance (see Dodson and Bradshaw; Site 6).

Estimated 3000 B.P.: A continued increase in surface water area is apparent in the centre of the valley and a second area of lake deposits is evident to the west. No remnants of tree material were found in the organic sediments but the peat is still of fen rather

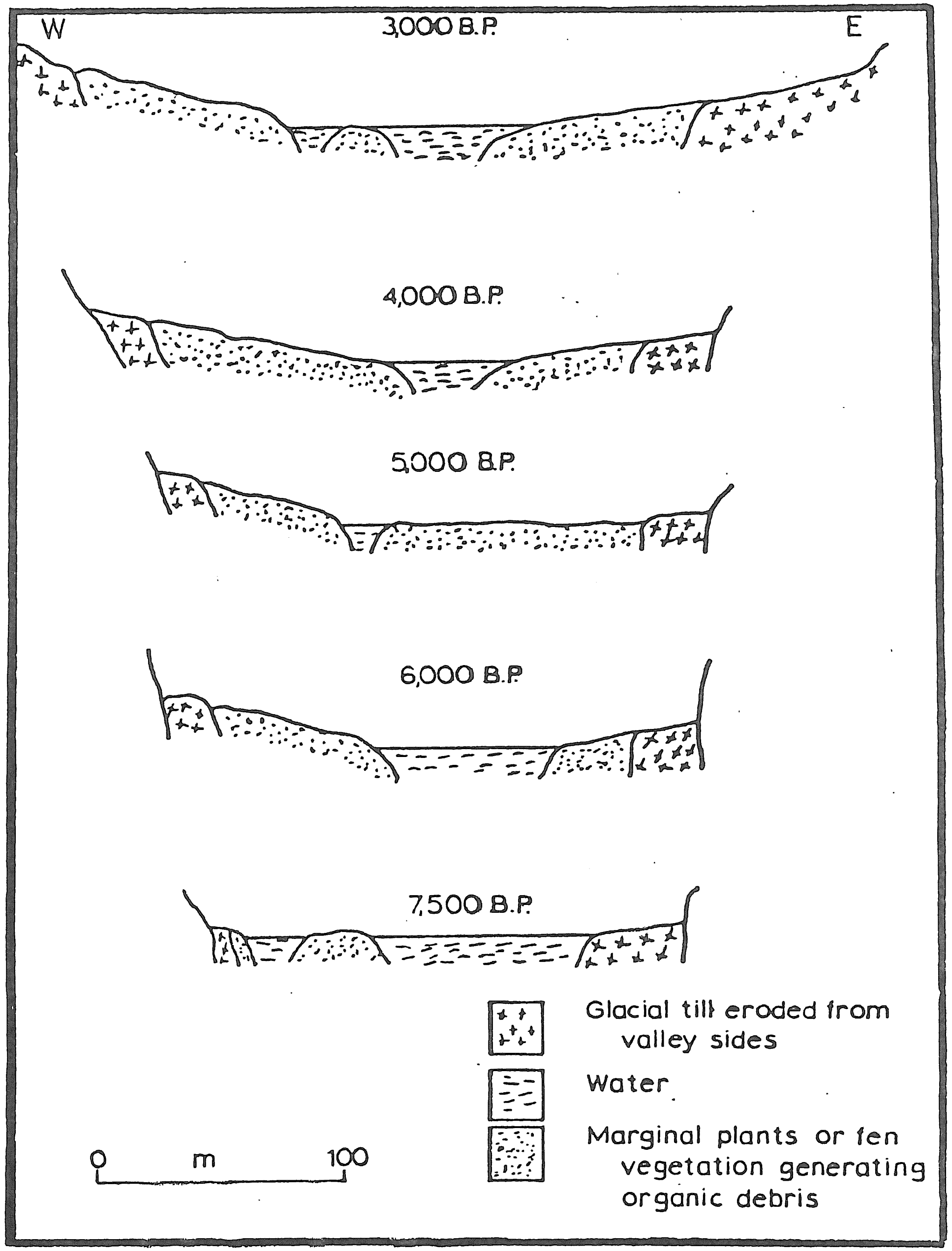


Figure 12 a Suggested development of L. Nahoo 7500 B.P. to 3000 B.P.

(After Timpson, 1985)

than of Sebagnum type. The sediments suggest a regression from the fen-carr stage due to a rising water table.

Estimated 2000 B.P.: The valley has widened greatly at this level from approximately 170 m at 3,000 B.P. to 250 m at 2,000 B.P. The organic deposits have increased dramatically and the open water surface area has also extended (Fig. 12 b).

Estimated 1000 B.P.: The increase in water surface area has continued and is now approximately 100 m wide. The organic material to the sides of the lake sediment is still of the fen peat type. The surface water in the valley is now at its most extensive since the beginning of the Holocene.

Estimated 500 B.P.: The presence of lake sediments stretching across the total width of the valley suggests that the valley was flooded at this period. The water surface level was considerably higher than present winter flood levels and was probably controlled by an outflow point to the north-east of the turlough (Fig. 10). An outflow in this area would have a natural fall along a valley towards the river Bonet.

The development of the lake from 7500 B.P. to 500 B.P. can be summarised as follows:-

(i) a gradual infilling of the lake by organic deposits up to 4000 B.P.,

(ii) an increasing open water area from 4000 B.P. to 500 B.P. probably due to increased surface runoff as a result of forest clearance.

From 500 B.P. to the present major changes have taken place resulting in a decreased open water area and the lake starting to

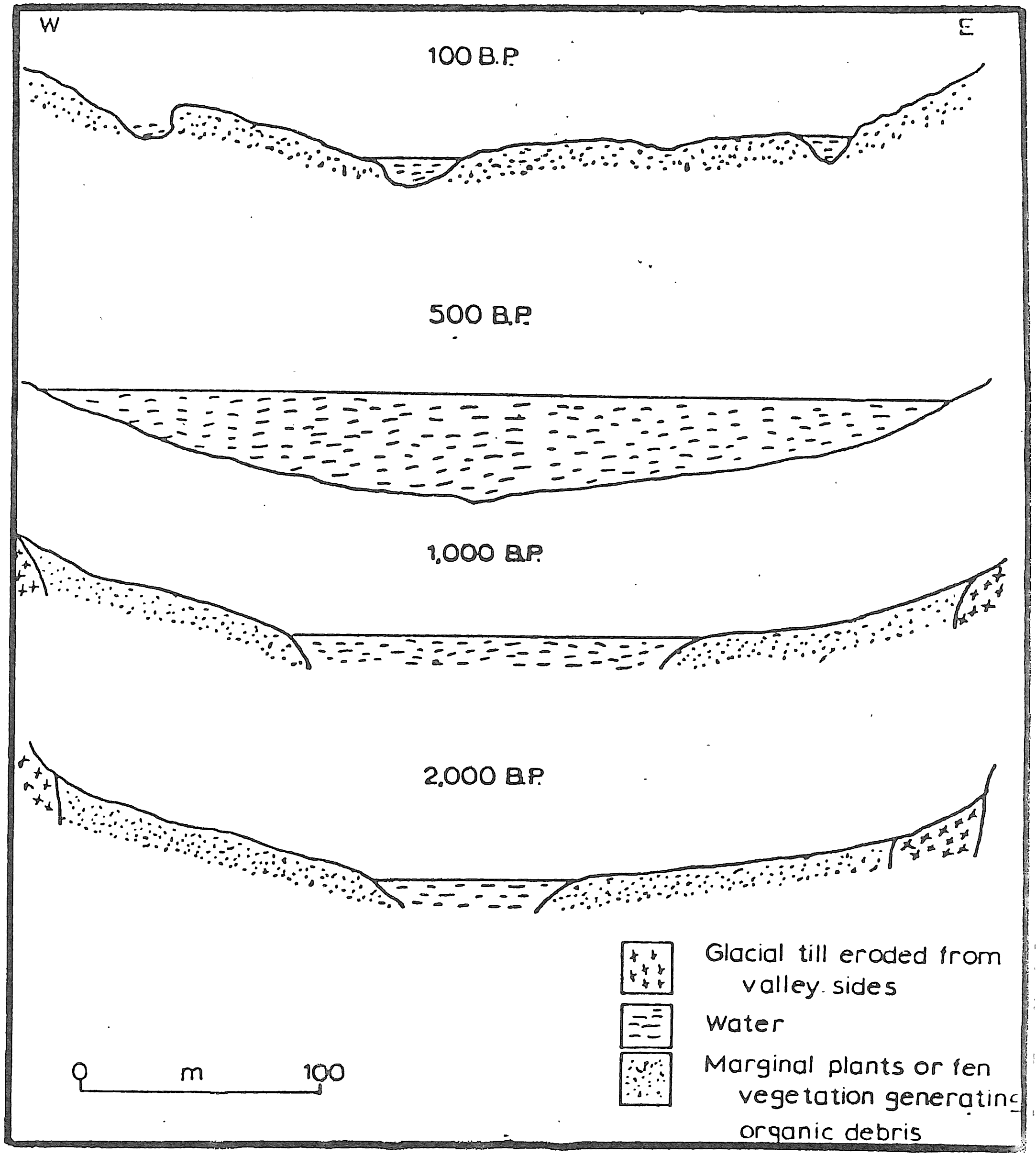


Figure 12 b Suggested development of L. Nahoo 2000 B.P. to 100 B.P.

(After Timpson, 1985)

act a turlough. Historical records show that prior to 1836 L. Annary to the north (Fig. 10) drained into L. Nahoo but by 1836 the stream draining L. Annary and another southerly flowing stream had been diverted to the east. These diversions reduced the inflow to L. Nahoo by approximately 30%. The 6" O.S. map of 1836 (Fig. 13) shows the extent of L. Nahoo at this stage. Between 1836 and 1886 the Cove floor was lowered by 130 cm and drains were inserted in the valley. As is clear from the 6" O.S. map of 1886 this lowering of the water table was carried out to allow a road to be built across the original L. Nahoo. A 1909 O.S. map shows the locations of the drains and the extent to which the original L. Nahoo had been reduced. The valley was now dry during summer months, allowing dense plant growth, and was flooded during winter months. Aerial photographs from 1972 indicate that between 1909 and 1972 the area of permanent water had increased and this was probably due to silting up of the drainage channels.

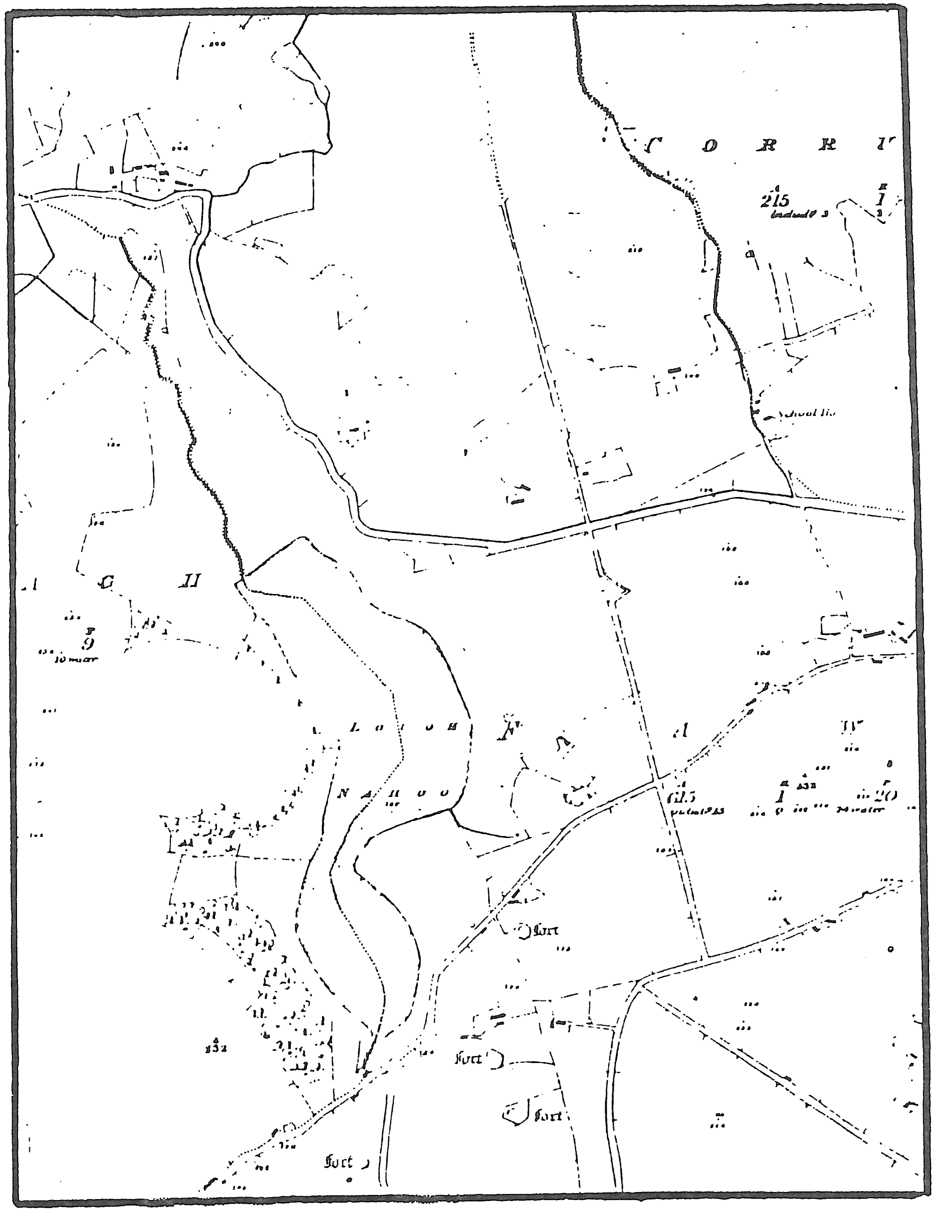
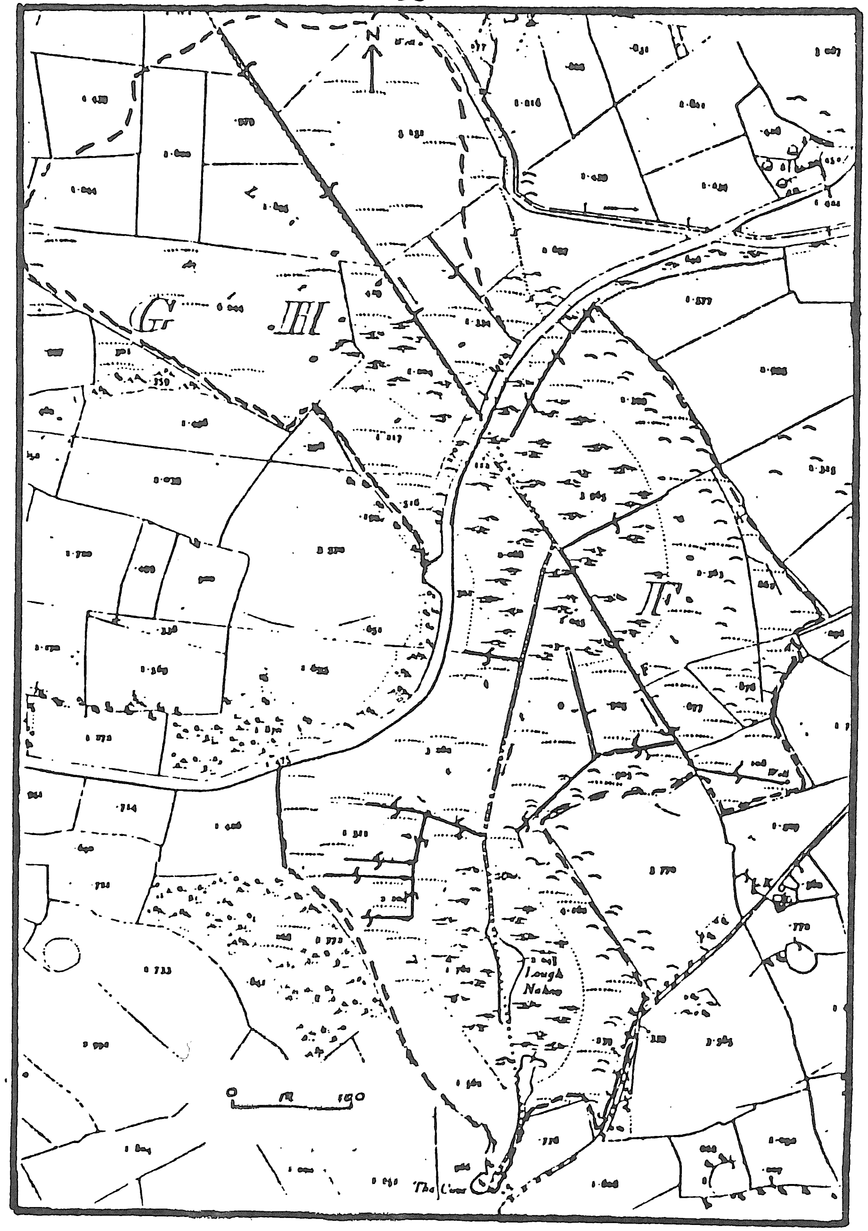


Figure 13 1836 O.S. 1:10,560 map (reproduced by permission of the Director-General Ordnance Survey - Permit No. 4500)

Figure 14 1886 1:10,560 map (reproduced by permission of the Director-General Ordnance Survey - Permit No. 4500)



Drains

Figure 15 1909 O.S. map (reproduced by permission of the Director-General Ordnance Survey - Permit No. 4500)

SITE 6 (G 760 330) - Slish Wood - Post-glacial vegetation and fire history. (J.D and R.B.)

Summary pollen diagrams are presented from a mor humus profile at the edge of Slish Wood (Fig. 16) and from Slish Lake (Fig. 17). These diagrams are compared with two diagrams from Union Wood lake, about 8 km to the south-west (Figs. 18 and 19). Nine radiocarbon dates were obtained from the lake sediments and gave ages as follows:-

Site	Depth (m)	Date No.	Age ± error B.P.
Union Wood 1	2.60-2.65	ARL 186	1920±200
	3.10-3.15	ARL 187	2160±135
	4.40-4.45	ARL 188	4950±290
	5.00-5.05	ARL 189	6600±270
Union Wood 2	1.15-1.25	ARL 191	2020±190
	2.15-2.25	ARL 190	3160±440
Slish Lake	0.55-0.65	ARL 183	820±160
	1.00-1.15	ARL 184	1700±140
	2.00-2.15	ARL 185	1850±130

Union Wood 1 showed a decline in *Pinus* pollen, mirrored by a rise in *Alnus* pollen between 6600 and 4950 B.P. After the *Ulmus* decline, there were increases in the frequencies of *Fraxinus*, *Calluna*, Poaceae and *Plantago* pollen. Union Wood 2 showed periods of increased *Pinus* and *Ulmus* values, matched by decreases in *Calluna*, Poaceae and *Plantago* - presumably reflecting periods of decreased pressure by man on the forests. The charcoal counts showed similar features to the *Calluna* and Poaceae curves, and charcoal values were highest when *Quercus* pollen values declined in

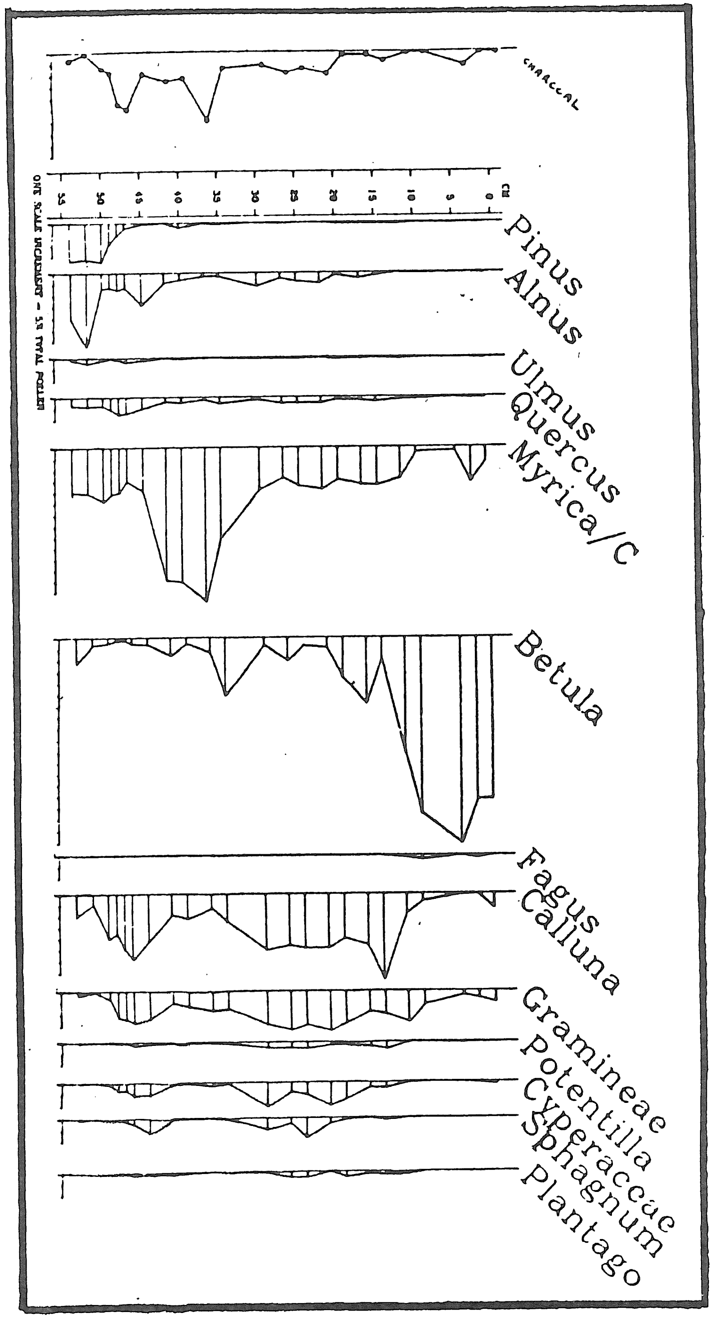


Figure 16 Summary percentage pollen diagram from Slish mor humus

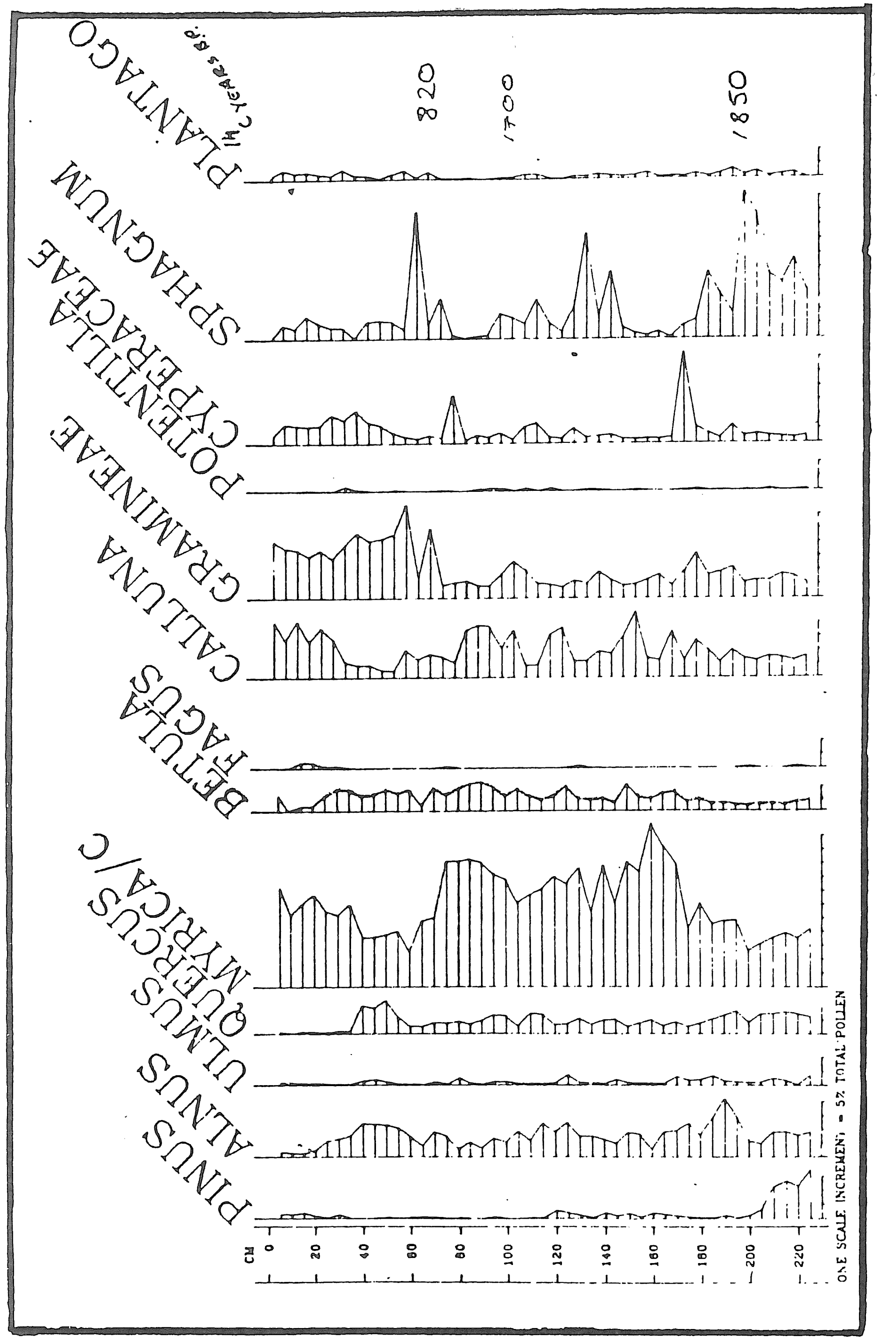


Figure 17 Summary percentage pollen diagram from Slish Lake

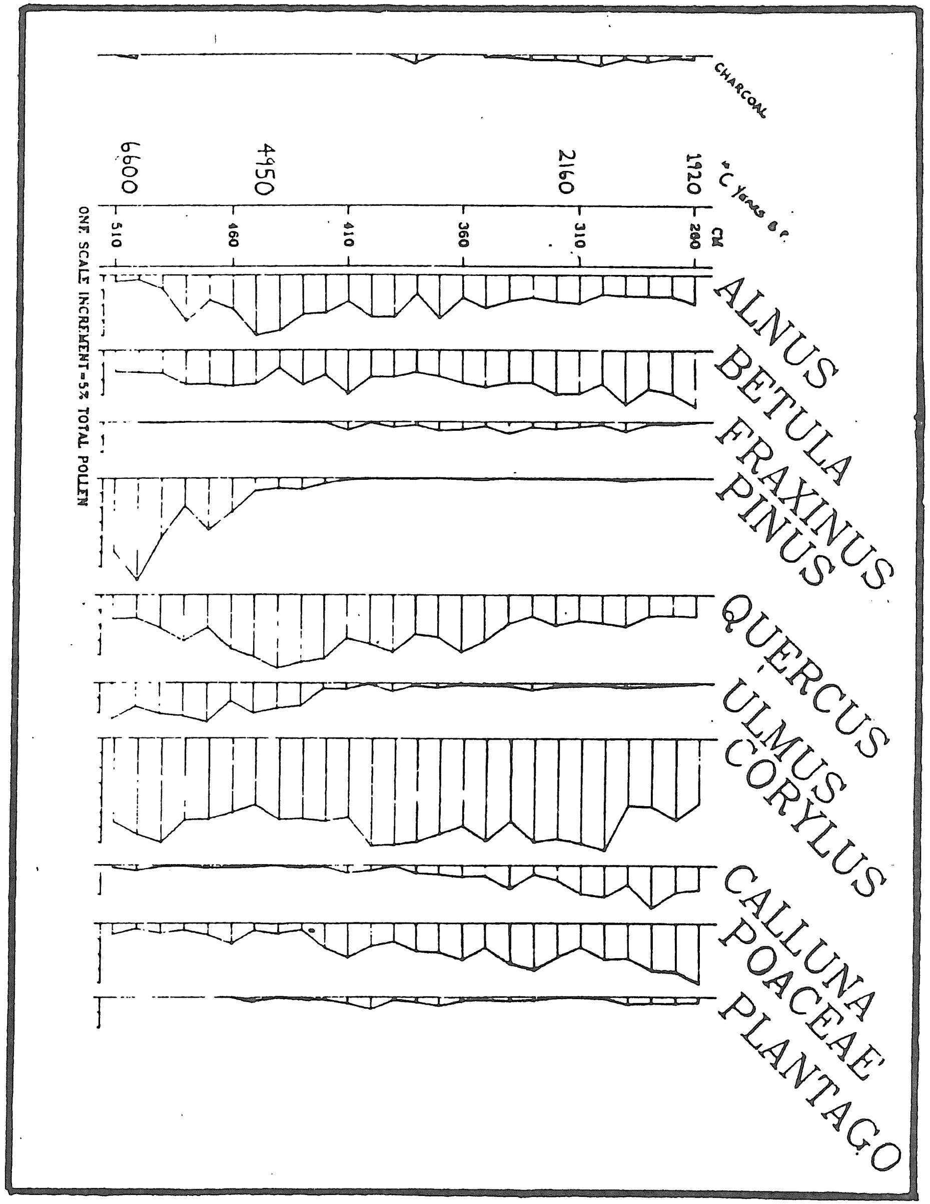


Figure 18 Summary percentage pollen diagram from Union Wood Lake 1

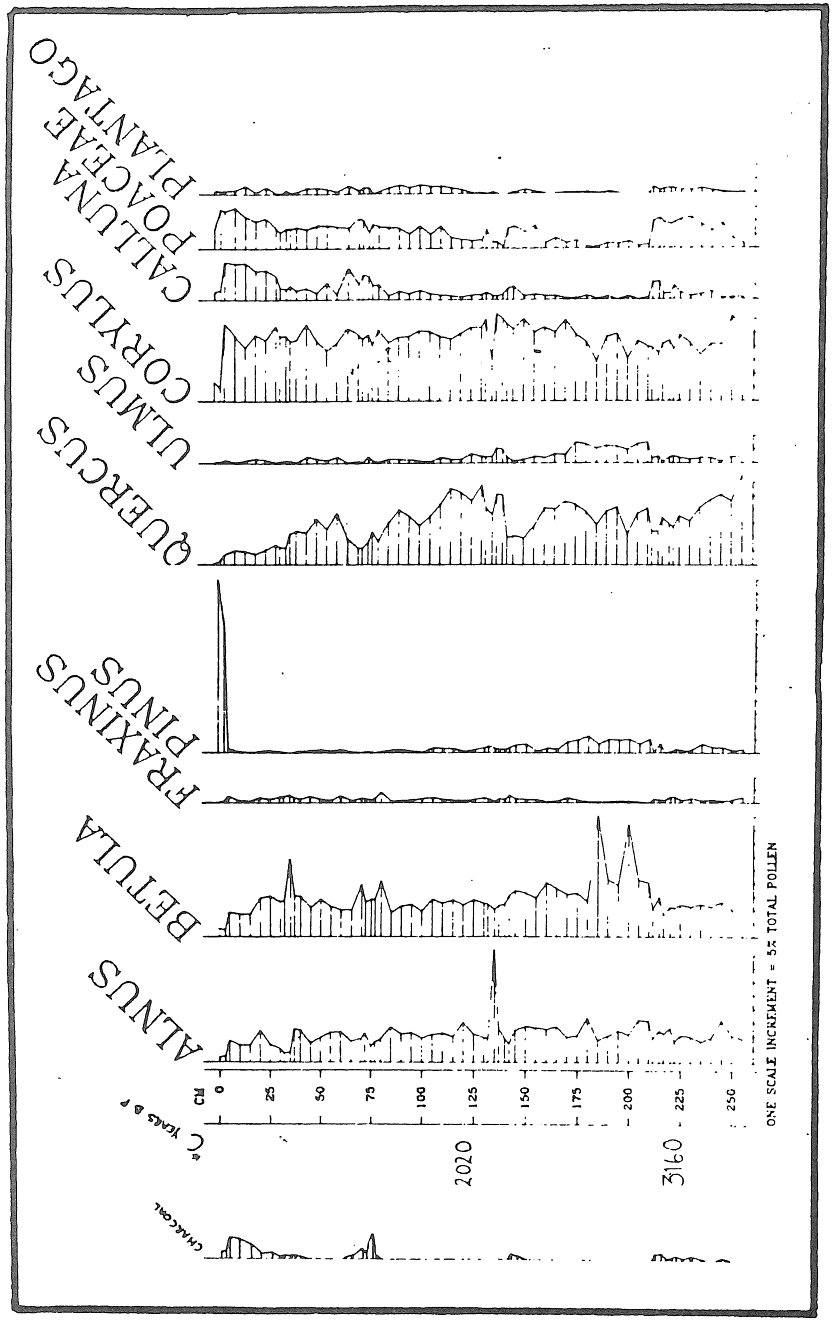


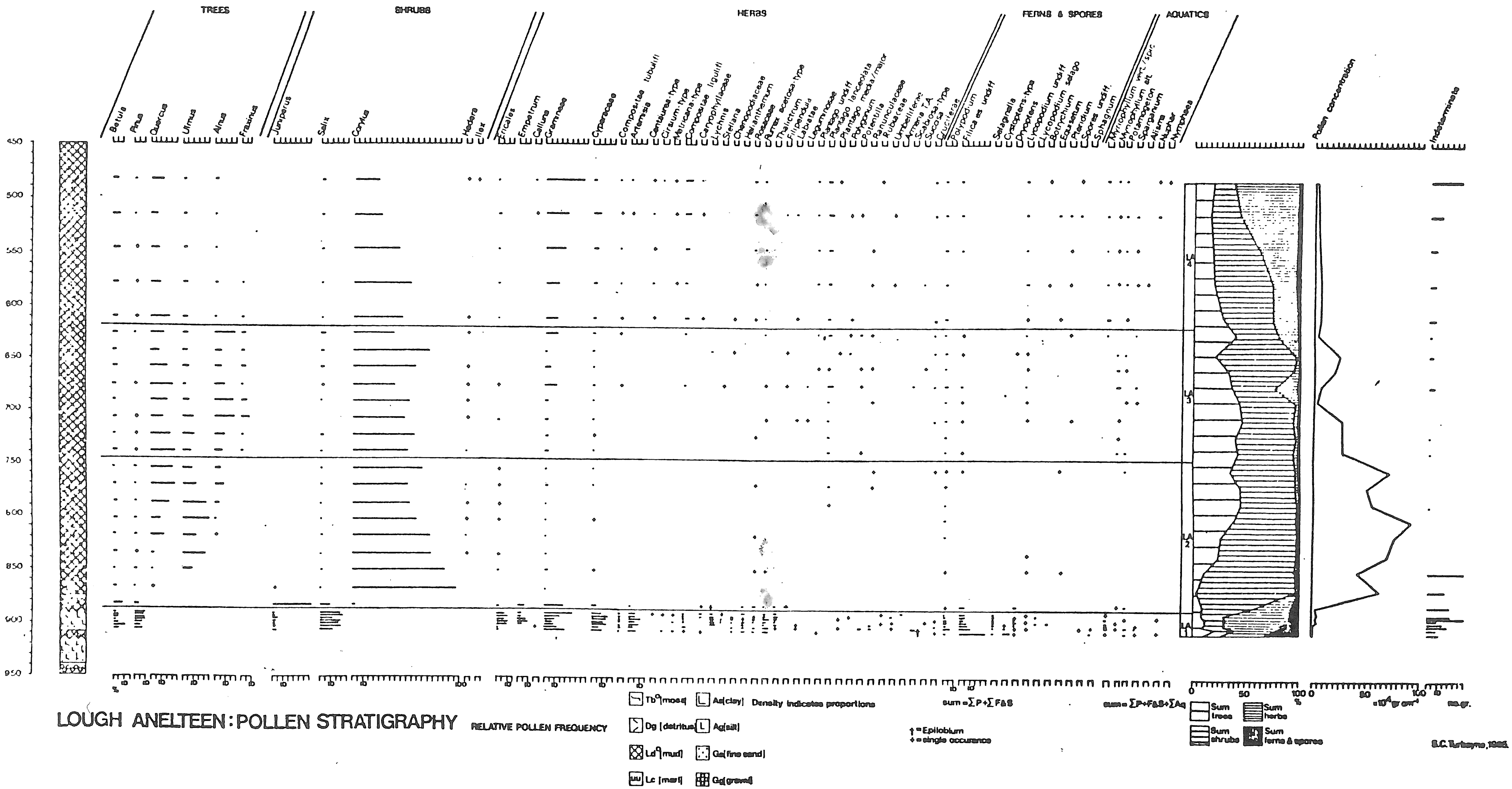
Figure 19 Summary percentage pollen diagram from Union Wood Lake 2

the youngest sediments. The recent plantation of Pinus was clearly represented. After the Ulmus decline, man was the dominating influence on the vegetation, and has probably used fire for clearance for over 3000 years. Man's influence was selective, as Alnus, Betula and Corylus have rather smooth, undisturbed histories.

Pinus pollen was present in significant quantities at the base of both Slish Wood diagrams as late as 1850 B.P., by which date it only had low values at Union Wood. The lake core recorded a marked increase in Poaceae, Plantago and charcoal content around 800 B.P., followed shortly by a major decline in Quercus pollen. Myrica/Corylus, Calluna and Poaceae were the commonest pollen types at the top of the diagram, which recorded the introduction of Fagus in eighteenth century plantations.

The Slish mor humus diagram gives a highly localised picture of vegetational change. The Pinus decline, which correlates with the lake core, was followed by a period of open, heathy vegetation. Trees were apparently excluded by frequent burning. Relaxation of fire led to the establishment of the present Betula woodland during the last couple of hundred years.

The diagrams emphasise the importance of man and fire on vegetational history since the Ulmus decline. The Pinus records in particular illustrate the often complex patterns that exist in vegetation both now and in the past. A single 'regional' pollen diagram integrates a frequently shifting mosaic of individual communities.



LOUGH ANELTEEN: POLLEN STRATIGRAPHY RELATIVE POLLEN FREQUENCY

Figure 8

ARCHAEOLOGY

(J.E.)

General Review (J.E.)

The modern landscape incorporates the sum total of all settlement patterns, one superimposed upon the other, minus those that are destroyed, consciously or unconsciously, when new patterns are emerging.

In general, the County boundary, based on an aggregate of baronial divisions, reflects Late Mediaeval and Early Modern territorial units; the diocesan boundaries, based on aggregate of parishes, reflect early historic and Mediaeval territorial units or chieftanships; and townland and other local and "ancient monument" names, together with the range and complexity of the ancient monuments themselves, reflect diverse elements and are indicators of settlement and land use at varying periods of time. For example, names such as "Maeve's Grave", "the holed stone", Rathaberna (Rath of the O'Beirnes), Moygara (the plain of the O'Garas), Cloonmullin (meadow of the mill), Sligo (the shelly river - originally), Cashel (stone fort), Castle, Cill (church), Carrownore (the big quarter of land) or Treanmore (the big third of land), all provide data for interpretation.

Archaeology attempts to identify and interpret human activity and the interrelationship between man and his environment both in the historic and pre-historic period. Archaeology also attempts to establish a chronology and typology insofar as these objectives can be achieved by examining man's material remains. It is necessary to bear in mind that the emerging story is, either in general or in any particular place, dependant on the quantitative and qualitative data to hand, the degree of use or abuse of scientific techniques and methodology and, primariliy, on the archaeological or

historical interpretation of the data.

The Ordnance Survey maps and letters of the 1830's and Wood-Martin's plans and descriptions in the 1880's, form the basis of modern research in Sligo and between them are often the only record of now destroyed sites. Some 438 sites have been detailed and located on a 1" map for Sligo Co. Council by the An Foras Forbatha Conservation and Amenity Advisory Service (Raftery (nee Enright), 1974).

Presented below is an outline of what is currently known about the archaeology of Co. Sligo, based on field monuments, set against a background of Irish archaeology in general.

Chronology

The Stone Age

No acceptable Palaeolithic settlement has been identified in Ireland. In 1929 claims were made that Mousterian implements were found at Rosses Point (Burchell, Moir and Dixon, 1929) but the claims were refuted by Charlesworth and Macalister in 1930.

Mesolithic

The earliest Irish evidence comes from a Mesolithic fisher/hunter/gatherer settlement at Mount Sandel, Co. Derry, dated to c. 7000 B.C. (Woodman, 1978). Based on the two major collections of Irish Mesolithic data (Movius, 1942 and Woodman, 1978) these semi-nomadic fisher/hunter/gatherer settlements are found mainly on coastal and river valley sites in the north and north-east of Ireland. The distribution of these sites has recently been extended by work at Boora Bog, Co. Offaly (Ryan, 1978) with indications in the Coolera area of Co. Sligo (Burenhult, 1984) and in Munster (Woodman, In Prep.)

No Mesolithic settlement site has yet been identified in Co.

Sligo although three or four areas producing Mesolithic-type material indicate that settlement sites must exist in the county. In the early 1950's "Mesolithic material" was recovered from Lough Gara in south Co. Sligo (excavated by Raftery and referred to in Cross, 1953). Most of the recognisable material from both Raftery and Mitchell's collections can be dated within the latest phases of the Later Mesolithic (Woodman, 1978). A ^{14}C date from a test hole at Woodpark of 7490 +/- 100 B.C. (9440 +/-100 B.P.) is not directly associated with occupation, though undated occupation material consisting of sea-shells and waste chert was found more than 100 m distant - further work is necessary.

Following a major recent survey and excavations on the "Carrowmore Peninsula" between 1977 and 1981 (Site 5; this volume) Burenhult postulates the theory that the Carrowmore Megalithic cemetary was built by an indigenous Mesolithic population in his "Carrowmore 11 Period, c 5000 - 4200 B.C.". Burenhult's theory was based largely on the early ^{14}C dates and the palaeobotanical investigation which showed that the primeval woods of the Knocknarea area were highly utilised at the time tomb No. 4 was constructed (c 4600 B.C.) and that coppiced woods had been created. Burenhult further argues that as no evidence of domesticated cattle was found it was more likely that the clearance was for big game and possibly for domestication of deer (Burenhult, 1984). Contra - arguments were expressed at the Carrowmore Conference 1982. Caulfield regards all the ^{14}C dates from the tombs to fall within a Neolithic date, except the early one from tomb No. 4, which he regarded as a problematical sample (Caulfield in Burenhult, 1984). Woodman can find nothing in the "Carrowmore Area" assemblages which can be readily identified as similar to the known Irish Mesolithic (Woodman in Burenhult, 1984). The argument goes on and it is hoped that further research will continue on this aspect.

Neolithic

Prior to Burenhult's chronology - Carrowmore 1 - 1V (1984) - the Neolithic in Ireland had been regarded as synonomous with the introduction of cereal cultivation, animal husbandry and particularly tomb building, to the extent that the four identified groups of Neolithic farmers were called Court Tomb builders, Portal Tomb builders, Passage Tomb builders and Wedge Tomb builders.

It was generally held that the primary Neolithic or Neolithic A was introduced into Ireland and into the Sligo area by the Court Tomb builders, and as ^{14}C dates were becoming available from excavated tombs, the date was gradually pushed back; from c 3000 B.C. in the 60's to 4900 B.C. (uncalibrated) at Ballymacdermot, Co. Armagh (Caulfield in Burenhult, 1984).

In the last 30 years the debate has centred on the question of the origin of the Court Tomb builders - did they land on the east coast at Antrim from the Clyde area, having travelled northwards from the Bristol channel via the Cotswolds and Yorkshire (Piggott, 1954) or did they land at Mayo -Sligo-Donegal and travel eastwards, with their landing on the north-west coast being contemporary to the Long Barrows arrival in the Bristol channel area (de Valera, 1960, 1965)? The arguments, in the absence of ^{14}C dates, were based on distribution, siting and morphology of the tomb plan. The "Megalith Survey of Ireland: Co. Sligo", the field work for which has been completed (O'Nuallain and de Valera, In Prep.), will make detailed plans available of c 60 Court Tombs in Sligo out of a national total of c. 350. Examples of various features occur in the Sligo sites:- classic trapezoidal full court at Creevykeel; tranceptal burial chambers at Treanmore; dual court at Moneylahan; dry stone walling in court facade at Bunduff; central courts at Gortnaleck and Deerpark; twin galleries and central court at Deerpark; subsidiary burial chambers in cairn at Creevykeel; massive entrance jambs at Carrowgilpatrick; and long mound under bog at Carrowreagh. Creevykeel, a superb example of an Irish Court Tomb, was reconstructed following excavation which showed that the grave goods included hollow scrapers, polished stone axe heads, leaf shaped arrowheads (flint) and Neolithic pottery (Henken, 1939).

Why is there such a relatively high perecentage of tombs in Donegal, Sligo and Mayo - between them about 55% of the total? Perhaps the work by Berg (Ph.D. Thesis, Lund, In Prep.) can shed some light on the question. Furthermore, about 25% of the known Irish Passage Tombs occur in Sligo, many of which dominate the local landscape by their typical hill top siting as at Knocknarea, Carrowkeel, Kesh, Knocknashee, Cairns Hill and several on the Ox Mtns. extending into Slieve Daeane and Slish Wood.

Until Burenhult's work at Carrowmore there was no east-west/west-east controversy regarding the origin of the settlement pattern of the Passage Tomb people. The four major cemeteries - Boyne Valley - New Grange ^{14}C dating to 3000 B.C. (O'Kelly, 1982), Lough Crew, Co Westmeath, Carrowkeel and Carrowmore, were generally assumed to have been built in that order. The decrease in size and stature of the tombs together with the gradual disappearance of art in the westward spread was intrepreted as a change from the urban community required to build the Boyne Valley tombs to a more dispersed rural population in the west (Herity, 1974). The earliest ^{14}C dates from Carrowmore for Tombs No. 4, 7 and 27 and Hut Site No. 2 on Knocknarea all pre-date the New Grange earliest date and raise new questions suggesting a development rather than a decline and provoke a re-assessment (Burenhult, 1984).

The Portal tomb is the characteristic burial mode of the Late Neolithic when communal burial was the norm with both inhumation

and cremation being recorded. Portal Tomb people are generally recognised as being related to the Court Tomb people. The connection is in the similarity of the ground plan, though not of the scale, of the subsidiary chamber of the Court Tomb to the Portal dolmen. About a dozen Portal Tombs occur in Sligo out of a national total of about 150. Tawnatruffaun is not only a classic example but its name literally means 'grassy mound by the stream' which describes the typical siting preference of these tombs (Eogan and Herity, 1977). No modern excavation of this type of tomb has been carried out in Sligo. Non megalithic, non-communal burial, known as Single Cist Burial, was also characteristic of the Late Neolithic. Stone lined cists. long or short, are often inserted into gravel ridges or under mounds.

On a national scale a disproportionate amount is known about the Neolithic people's attitude to death than to life - leading to the various settlers being called after the type of tomb they built. Comparatively few Neolithic habitation sites are known and hardly any can be directly linked to any particular tomb type at local or national level. Pre-bog habitations and field systems have been identified in Sligo. The best known is on the Sligo/Mayo border at Carrownagloch, Buniconlon where an oval stone enclosure surrounds extensive cultivation ridges dating to the 2nd Millenium (Herity, 1971-1976). Stone walls of field systems have been noted by turf cutters in the Dromore West/Easkey area and the foundation of a stone house (c 6 m in diameter) has recently been revealed in turf cutting in the vicinity of Croagh Court Tomb (Caulfield Pers. Comm.). A section of curving field wall has been noted on the side of Cruckaun in the Ox Mtns. near a Passage Tomb, recently excavated by Berg (Pers. Comm.). Groups of hut sites have been noted on several mountain sides; some 100 hut sites at Mullaghfarna (below Carrowkeel); aerial photographs revealed groups of huts on

Knocknashee and Knocknarea with two of the latter having been excavated by Burenhult (1984).

The pollen diagrams from Carrowkeel and Ballygawley provide vegetational sequences for the pre-historic landscape in the Sligo area and as such form an environmental back drop to the material culture (Gorransson, 1980 and 1981 in conjunction with Burenhult, 1984 - see also the palaeocological section of this guide).

Wedge Tombs would appear to have been used during the later Neolithic and Early Bronze Age when Beaker pottery was a characteristic feature of the funerary assemblage.

The Bronze Age

The Bronze Age was a technological breakthrough. Prospecting for copper and gold ores brought new groups of people into the country at about 2200 B.C. The earlier Bronze Age, down to c 1200 B.C. saw a gradual change-over from collective burial in Wedge Tombs to burial of the individual in small cist graves often inserted in already existing mounds or cairns. At Moytirra the inhumed remains of four adults and one child occurred (Madden, 1969). A destroyed Wedge Tomb at Breeogue yielded both cremated and inhumed bones (Rynne and Timoney, 1975). Numerous groups of Barrows occur in Sligo with only a group on the Carrowmore peninsula having been examined (Timoney in Burenhult, 1984). Only two examples, Knocknashammer (Timoney, In Prep.) and Ballyeeskan (Danagher, 1964) have been excavated in recent times - virtually nothing is known of their date.

A climatic change occurred about 1000 B.C. with a subsequent growth of blanket bog which rendered much of the west of Ireland uninhabitable and which swallowed up many earlier habitation sites. The later Bronze Age down to at least 500 B.C. seems to have been a period of considerable warfare with a large proportion of the

evidence coming from "hoards" of bronze and gold tools and ornaments. Crannogs were inhabited towards the end of this period strengthening that view. Only three locations were recorded in Sligo by Wood-Martin (1886). Several sites on Lough Gara were excavated by the National Museum in the early 50's when the level of the lake fell and exposed about 200 artificial islands. One crannog, Rathinaun, produced a hoard of gold, amber, tin and bronze ornaments and also a grain drying kiln with carbonised wheat and barley grains (Eogan and Herity, 1977).

The Iron Age

The Iron Age is generally taken to be synonomous with the arrival of the La Tene Celts, characterised by their art as seen on the Turoe stone in Galway, and also the stone figure sculpture of the Erne area. No example of this occurs in Sligo except, maybe, the Kiltura pillar. The habitation sites of the celtic farmers were rectangular and circular houses of stone or wood surrounded by an enclosure - variously called a rath, caiseal, crannog, promontory or hill fort. These are probably the best known of all archaeological sites in Ireland because of their abundance and widespread distribution. Many of these would have continued to be lived in well into the Late Mediaeval period, particularly in the west, as the normal dwelling of the ordinary small farmer. Probably 1,500 raths occur in Sligo alone. Rathmulcah, with its many souterrains, triple banked and ditched, Lisnalurg, Cashelore caiseal, Aughris promontory fort and booley huts and Muckelty hill fort are examples of different settlements of this period.

Adoption of Christianity in the 4th and monasticism in the 6th centuries is seen in the landscape by monastic sites which were similar to the rath or caiseal. Many sites were reused in the Mediaeval period or continued in use into the present time. One of the most easily recognised monuments from this period is the cross slab - a pre-Norman memorial. A unique site from this period is Drumcliffe (Site 4; this volume) in that it is the only example in the county of a high cross and a round tower together with a cross slab. Excavations at this site show Mediaeval habitation.

Inishmurray Island is unique in its quality of preserved structures (Wakeman, 1893) and the collection of 57+ cross inscribed memorial headstones is not only the largest in the county but one of the major Irish collections. Some 60 Early Christian sites existed in Sligo while between 1 and 7 cross slabs occur at over 20 sites.

Viking settlement or graves have not yet been identified in Sligo. Perhaps the townland names Altanelvick? (Alten Helvik) and Portavaud are good indicators? Both of these townlands are situated west of Ballysadare Bay.

The town was not a feature of the Irish landscape until Viking times and seems to have been introduced to Sligo by the Anglo-Normans who penetrated into the area in the mid 13th century, establishing Sligo town in the process. Romanesque and Gothic styles of church architecture appear in the landscape prior to and following Anglo Norman settlement. Some seventy castles have been identified from documentation which were built by both native and intrusive Anglo Norman, English and Scottish settlers between the 13th and 17th centuies. These were replaced in the 17th century by the military star-shaped fort and the Manor House, a good example of the latter is Ardtermon Castle which was excavated recently by Enright (In. Prep.).

In conclusion, Sligo is particularly well endowed with archaeological sites of virtually every period (Fig. 20 shows the location of significant archaeological sites). Researchers have been drawn particularly towards Stone Age sites and a comprehensive

survey of field monuments is urgently required.

SITE 7 (G 681 420) - Drumcliffe Townland - Early Christian and Medieval monastic site - (Excavated 1980 - ongoing)

A survey has shown the site to be of multi-valiate, earthen construction, partially visible above ground and about 15 ha in extent. Excavation of about 800 m^2 has been carried out by the author in advance of site development. The excavation shows exclusively domestic material and reveals good preservation of a variety of organic remains which include large quantities of animal bone and carbonised seeds as well as shell fish, nut shells, fish bones, insect remains, and minute mollusc and charcoal fragments. Cultivation ridges, storage pits, and cereal drying kilns indicate methods of cultivation and storage of food. Waste bone and antler offcuts together with fragments of bone combs, needles and pins and other objects indicate a bone industry on site. Vitreous waste and furnace bottoms indicate the manufacture of iron, bronze and probably glass and/or enamel on the site. Types of metal objects found include iron tanged knives, a variety of small tools, punches and nails etc., as well as bronze pins, buckles, mending strips, needles etc. Crannog Ware pottery in substantial amounts has been found.

The evidence indicates that the site was used into the 17th and 18th centuries, when a mill was in use. The material so far excavated would date mainly to the Mediaeval period though some Early Christian material has come to light. Material collected from the site is currently under analysis.

SITE 8 (G 663 336) - Carrowmore - Megalithic Cemetary

This site extends over six townlands and is one of the largest megalithic cemetaries in Western Europe. c 45 tombs are visible above ground and the cemetary may have contained up to 150 sites. Modern site descriptions include data recorded by previous workers, (Kitchin, 1983). The numeration is that of Wood-Martin (1882-1892). Recent excavation of four tombs in the period 1977-1981 by Burenhult (1980, 1984) show that the tombs do not fall readily into the category of Irish Passage Tombs but suggest separate consideration. In tomb no's 4, 7 and 27, excavation showed that these were used for communal burial and no. 26 for burial of an individual. (Harbison's "Guide to the National Monuments of Ireland" contains a map which shows the numbering of the tombs).

No. 4. Excavations showed that a sunken chamber was surrounded by several arcs and layers of stone and a low passage extended almost to the kerb. The passage could not have had more than ritual significance. A secondary cist burial yielded a ^{14}C date of 2370 B.C. (4320 +/- 75 B.P./ 2920-3190 B.C.) while the ^{14}C date of 3800 B.C. (5750 +/- 85 B.P/ 4570-4760 B.C.), if it can be used to date the construction of the tomb. would place the tomb as not only one of the earliest in Ireland but also in north-west Europe.

No. 7 Excavation showed that neither a cairn covered the chamber nor a passage existed but an inner arc of stone and a series of pits extend from the chamber east to outside the kerb. Cremated remains of eighteen young females were found together with male skull fragments. A ^{14}C date of 3290 B.C. (5240 +/- 80 B.P./3980-4080 B.C. came from the tomb.

No 27 Excavation showed a cruciform tomb in the centre of the stone circle with no evidence of a passage. The low layers of stone

suggest that the cairn did not cover the burial chamber. Cremated remains of c 20 people were found together with antler pins and pottery. Three ^{14}C dates from this tomb (i) 3090 B.C. (5040 +/- 60 Bp.p./ 3820-3880 B.C.), (ii) 3050 B.C. (5000 +/- 65 B.P./ 3820-3880 B.C. and (iii) 2990 B.C. (4940 +/- 85 B.P./3690-3700 B.C.). The tomb was re-used for burial in both the Bronze Age and the Iron Age.

No. 26 Excavation showed that this site was not used for communal burial. One Neolithic cremated burial accompanied by an antler pin was cast aside to accomodate a single inhumed burial, accompanied by a glass bead, c 680-490 B.C. Contemporary with the later re-use of this site are three short cultivation ridges and a number of ritual pits which contained charred cereal grain, a cup marked stone and human and animal bone. An internal ditch was also added at that time. Several ^{14}C dates exist for the period 680 - 490 B.C.

SITE 9 (G 611 340) - Culleenamore - Kitchen-Midden.

This site is one of many marked on the 6" O.S. sheets along Ballysadare Bay and is listed in the Sligo County Development Plan of 1974 as an "archaeological site to be considered for preservation or protection".

The site was excavated by a Swedish team in 1980-81. Excavation of settlement 15 showed the midden was up to about 3 m in depth and consisted principally of compact layers of Ostrea but also included Cardium, Mytilus, Litorina, Pecten and Patella. The stratification clearly showed a decline in width and thickness of the shells as time went on. The two C 14 dates from the site are 2760 +/- 100 B.C. (4710 +/- 100 B.P.) from stratum 17 and 1830 +/- 60 B.C. (3780 +/- 60 B.P.) from stratum 8. Burenhult dates three main shell layers containing charcoal with hearths and animal bones as follows:-

Strata 17-14 - Middle Neolithic

Strata 9-8 - Late Neolithic/Early Bronze Age.

In settlement 15 A, a child skeletal burial was revealed in a pit cut into the midden and underlying moraine about 3.5 m A.S.L. dated by an accompanying glass bead to a few centuries B.C.

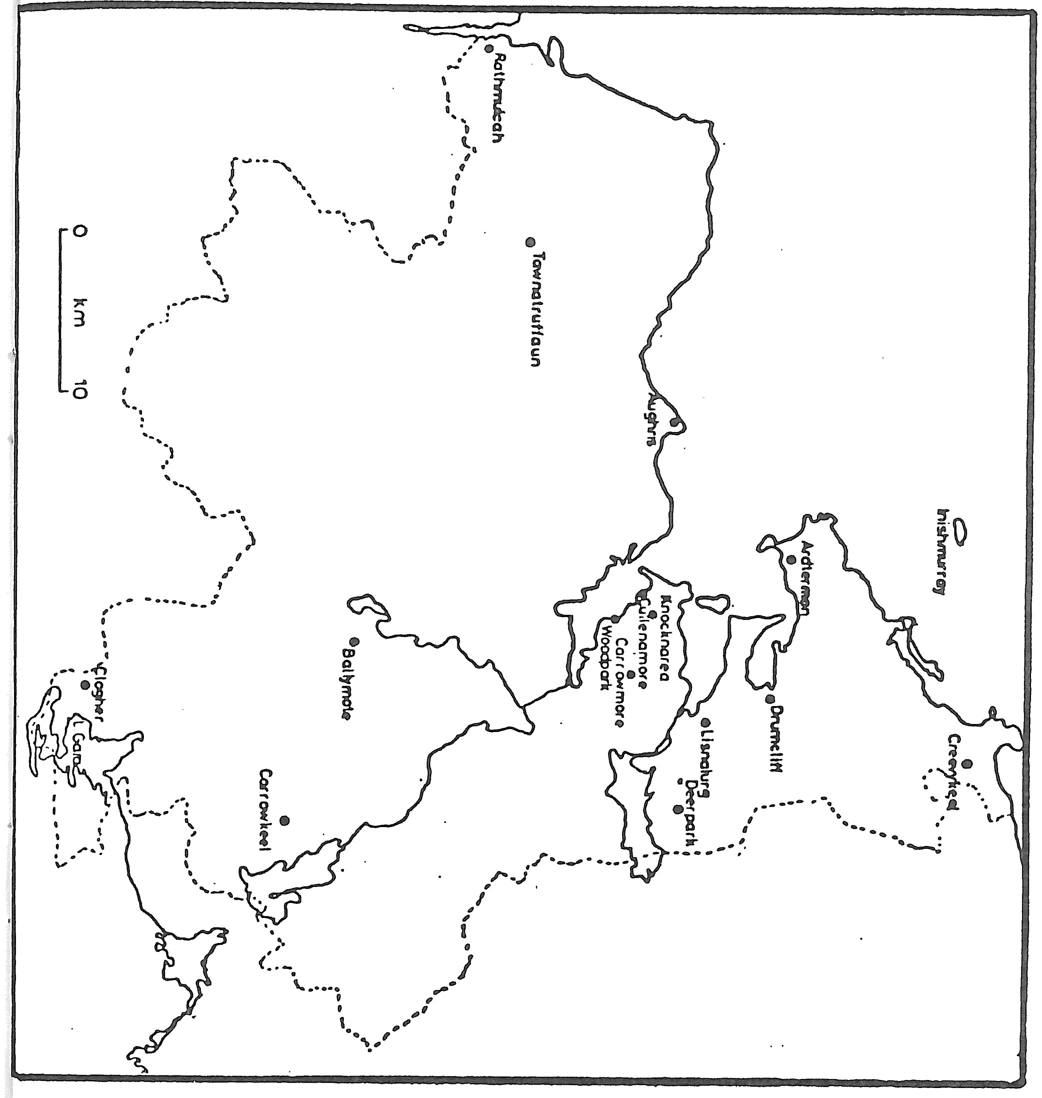


Figure 20 Significant archaeological sites in Co. Sligo.

BOG FLOWS IN SOUTH-EAST SLIGO AND SOUTH-WEST LEITRIM

(R.A., P.C. and R.T.)

General Review (R.A., P.C. and R.T.)

Although bog flows are not common phenomena in Ireland, records of 48 such events have been obtained from the scientific literature, local newspapers and field examinations at Geevagh, Co. Sligo (see below). (A series of flows occurred at Slieve-an-orra, Co. Antrim in August, 1980 (reported by Tomlinson and Gardiner, 1982) and these are treated as a single flow). Figure 21 shows that bog flows have occurred in over half the counties of Ireland and although they are not restricted to blanket bog the majority (37) have occurred in such material. Figure 22 shows that flows on raised bog exhibit no distinct seasonality while those on blanket bog have been most frequent in autumn and winter months (this figure includes only those bog flows for which data are available on the date the flow occurred and the type of bog affected). The size of bog flows show considerable variation, with the largest being an event recorded in Kerry in 1896 (reported by Sollas et. al., 1897) in which 5 M m^3 of material were released.

Several factors have been considered important in a causal sense. Peat cutting has been noted in the source area of some events, most frequently on raised bog (Sollas et. al., 1897), with marginal cutting by streams, ditches and gravel workings in a few others (Delap and Mitchell, 1939, Colhoun et. al., 1965 and Tomlinson, 1981). Breaks of slope (both concave and convex) in and around the source area, with concomitant influence on drainage and tension within the peat, have also been reported in some instances (Mitchell, 1938, Bishopp and Mitchell, 1946 and Tomlinson and Gardiner, 1982). The most frequently associated factor however, has been heavy antecedent rainfall sometimes accompanied by snow melt.

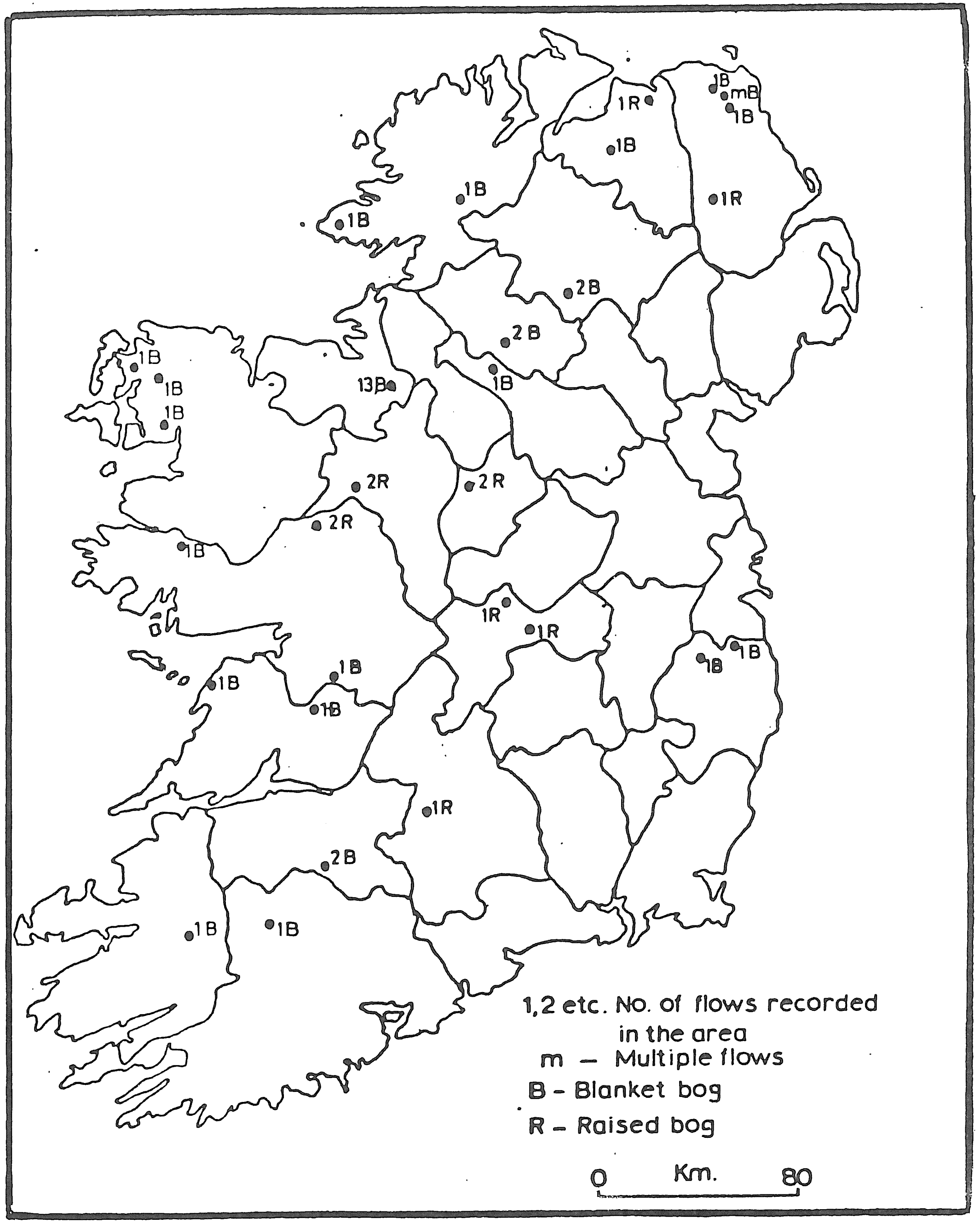


Figure 21 Distribution of bog flows and slides recorded in Ireland.

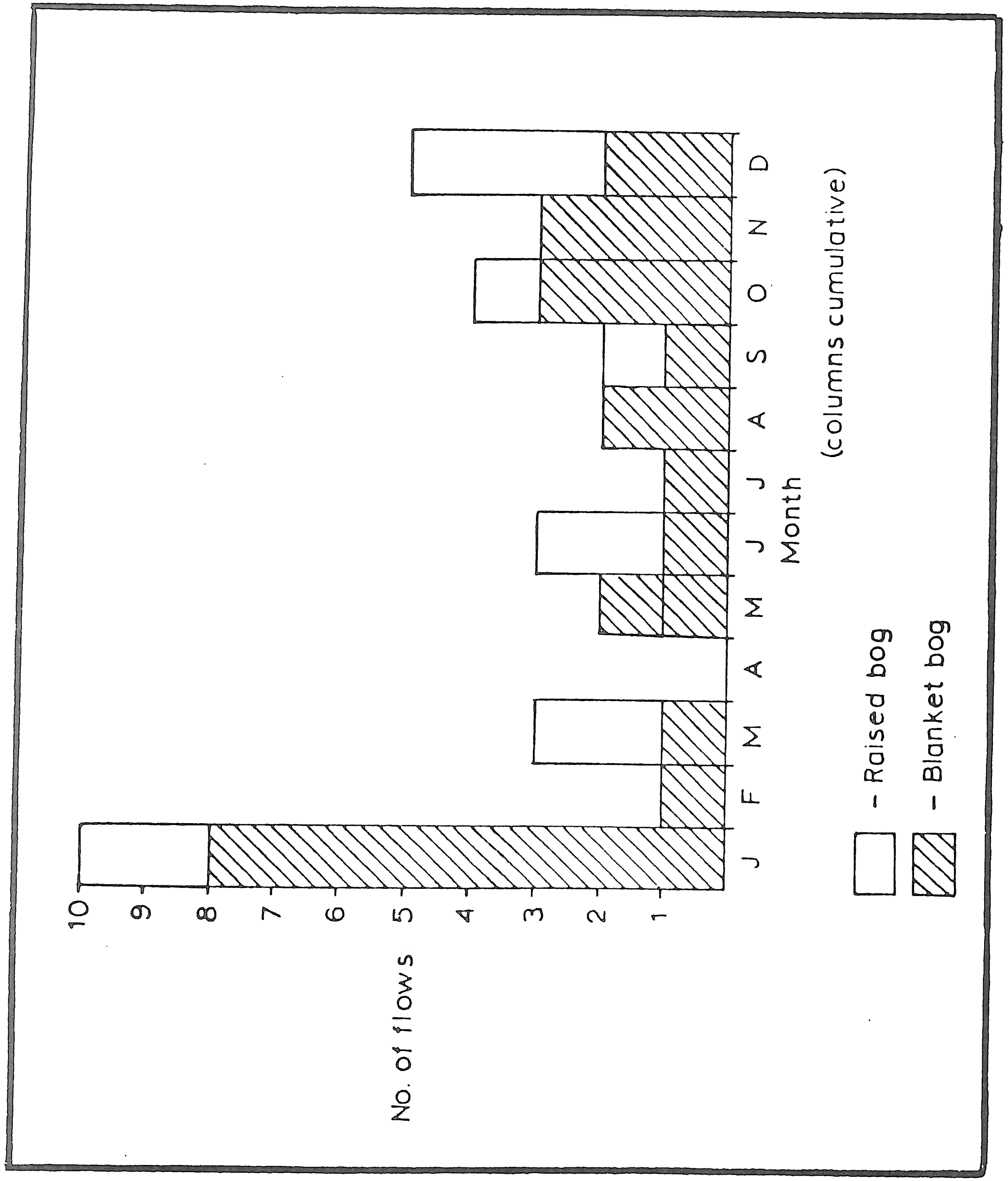


Figure 22 Seasonality of bog flows and slides

A bog flow which occurred in Straduff Townland (G 860 185) in the highlands to the east of the village of Geevagh, Co. Sligo on 18th October, 1984 was examined by the authors and in the course of the investigation it was found that the ridge on which the flow occurred had been the site of a number of such events. To date 13 bog flows have been identified and an examination of aerial photographs indicates that further flows may have occurred. The sources of the unconfirmed flows are currently being examined and three of the confirmed flows have been investigated. The most recent flow, on 26th May, 1985, is examined at Site 10; the source characteristics of an event in 1945 and the 1984 event are dealt with at Site 11 and the dynamics and morphology of the flow downstream of the 1984 event are dealt with at Site 12 a and b.

SITE 10 (G 820 238) - Tullynascreen Townland - May 1985 bog flow - (R.T., R.A. and P.C.)

Figure 23 shows the location of the flow which began at an elevation of 250 m on the northern end of a ridge which runs north-west to south-east. Much of the material that was released remained in or very close to the source area. The more liquid fraction became confined in the stream which flows to the north-west and which swings north to join the Bonet about 1 km south of Dromahair. This area of the ridge is underlain by Carboniferous sandstones and shales which are overlain by a clay rich drift of undetermined thickness. Mean annual rainfall in the area is approximately 1,300 mm and the area is covered with blanket bog.

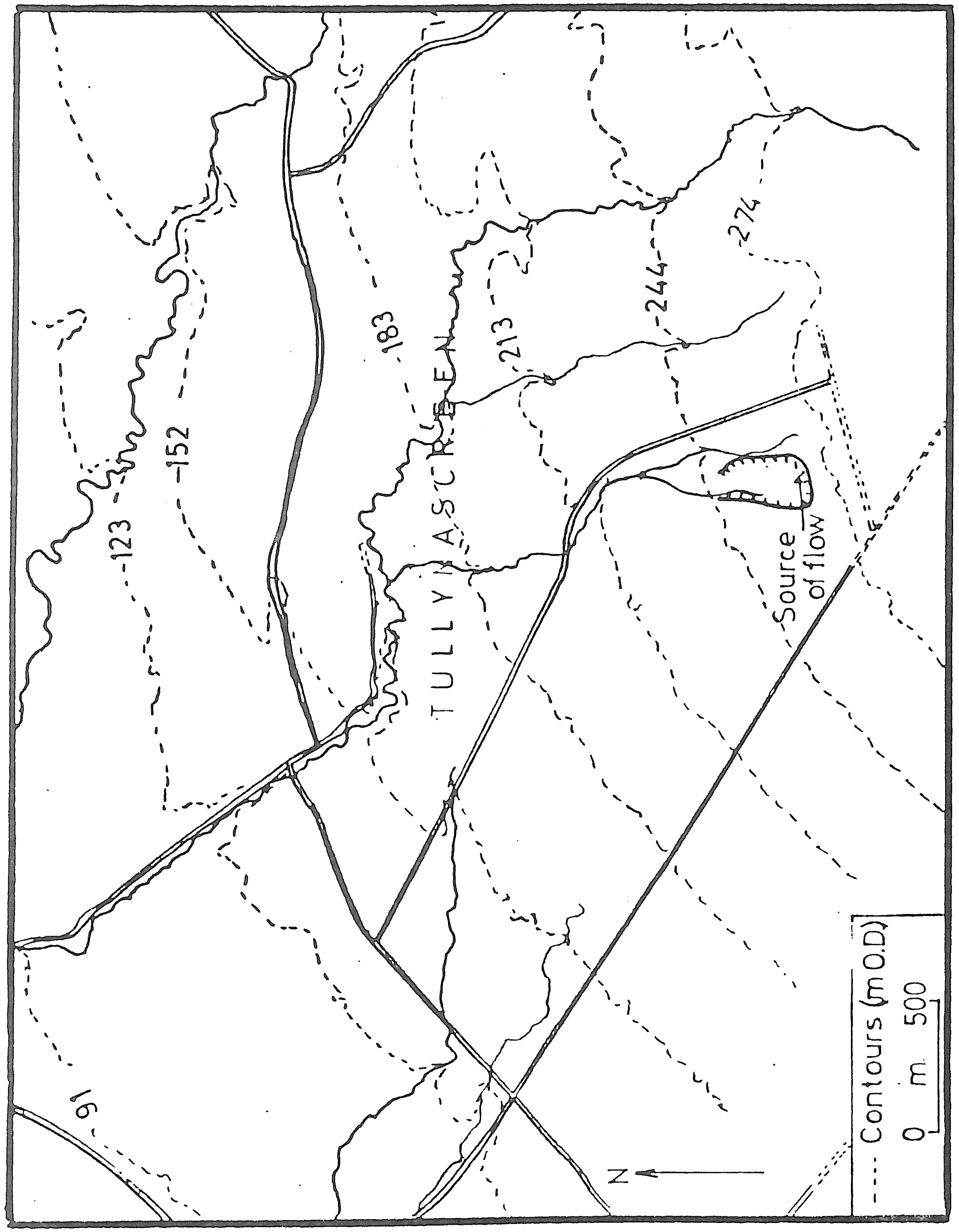


Figure 23 Location map of Tullynascreen flow.

The vegetation of this area is characteristic of blanket bog with a sward composed largely of Calluna vulgaris and Tricophorum caespitosum growing over hummocks of Sphagnum Spp. Erica Tetralix, Eriophorum vaginatum and Narthecium ossifragum are occasional in the sward and Cladonia portentosa is frequent on Sphagnum hummocks. Tricophorum caespitosum dominates the assemblage on rafts of peat remaining in the source area whilst Calluna vulgaris is more abundant on nearby undisturbed peat possibly reflecting differing drainage conditions. The peat is variable in thickness being c 2.0 m in the vicinity of the upper source area and 1.0 to 2.0 m around the edge of the mid and lower source area.

The upper source area is heavily crevassed with approximately 40-45% of the surface peat remaining in the form of rafts. The mid and lower parts of the source area are also heavily crevassed and, unlike the 1984 source (see Site 11), also have a high percentage of the surface peat remaining (40 - 60%). Some of the rafts of peat that were released broached the bank of the stream that comes in from the west and spread out onto rough grazing land to the north of the source area.

As yet a full topographical survey has not been carried out however, a basic tape, compass and abney level survey indicates that approximately 10,800 m^2 of bog were affected and an average of 1.0 m of peat removed. In the vicinity of the mid and upper source area the bog slopes gently to the north at 2-3^o while in the lower source area a marked break of slope occurs (c 7^o).

The cause of the flow appears to be related to two factors; heavy antecedent rainfall and turf cutting in the source area. Rainfall data for a nearby station are given in Figure 24 a and b. Figure 24 a shows that rainfall during the months of January, February and March was below the long term (1960-1980) average for these months while April and May were above average. Of more

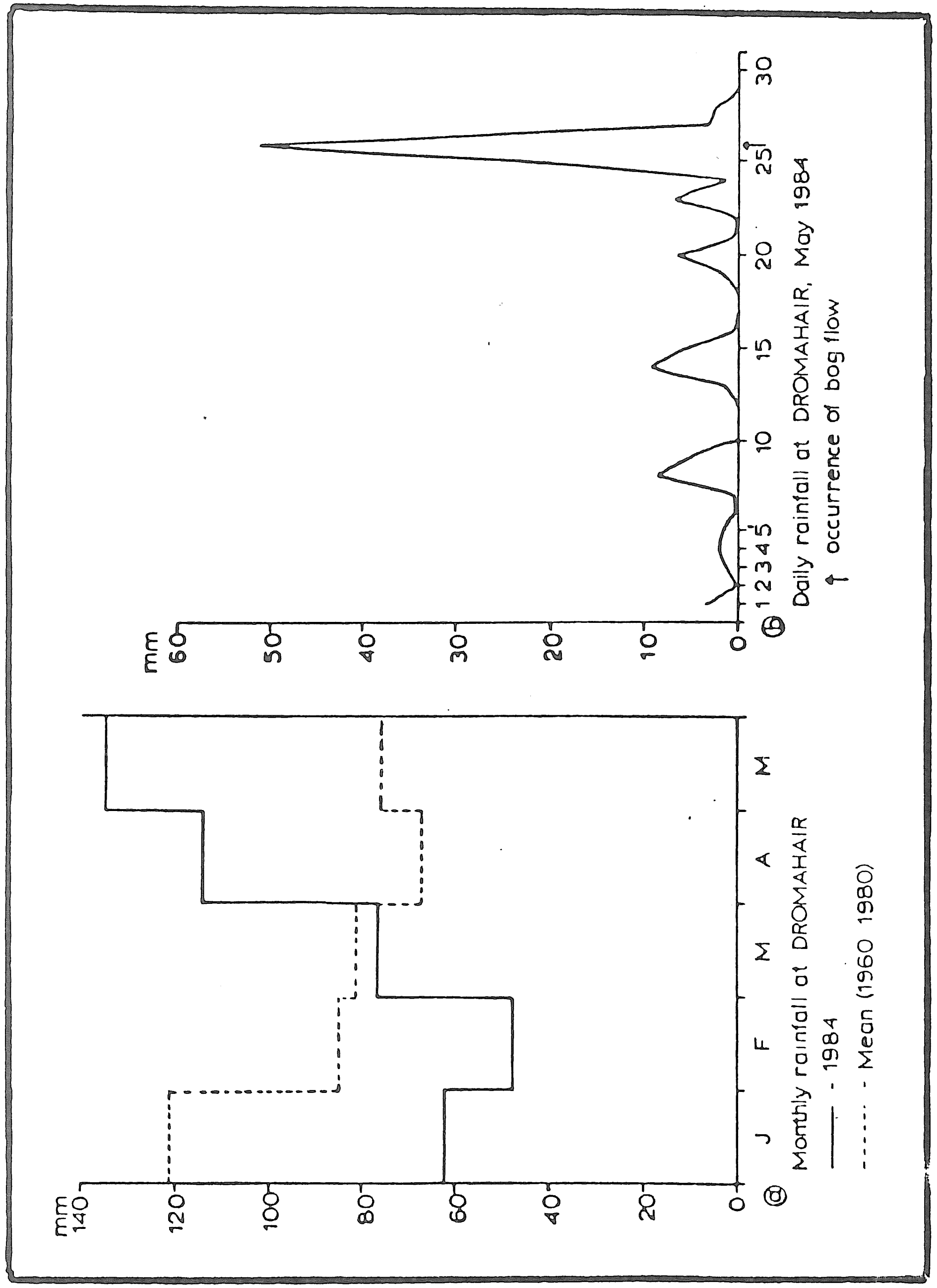


Figure 24 a and b Rainfall data for Dromahair, Co. Leitrim

significance are the daily rainfall data for May, 1985 shown in Figure 24 b. The rain which fell on 25th and 26th May accounted for 54% of the total rainfall for that month and 97% of the long term average for May.

Extensive turf cutting took place in the upper source area in early and mid May. The method of extraction was by the 'sausage turf machine' in which an extruder, attached to a vertical tine, is pulled through the bog and the peat is brought to the surface in 'sausage' form. This method of extraction leaves vertical slits of 1.0 to 1.5 m in depth, which can still be seen at the site, at spacings of 1.0 to 1.5 m. It is almost certain that the rainfall of 25th and 26th May moved down through these slits and was impeded by the clay rich drift thus causing a build up in pore water pressure and subsequent failure of the peat. Throughout the source area rafts with clean cut, vertical edges can be seen, some of which still have the 'sausage' turf remaining on them, indicating that once failure occurred removal of the peat was facilitated by the 'pre-cut' nature of the bog.

SITE 11 (G 860 185) - Straduff Townland - Sources of the 1945 and 1984 flows.-(R.A., R.T. and P.C.)

The flows began at an elevation of 390 m on the ridge which runs north-west to south-east, flowed over the escarpment to the west and became confined in the channel of the stream which flows north-westwards (Fig. 25). The ridge is composed of Carboniferous sandstones and shales which are overlain by a variable thickness of drift. Mean annual rainfall in the area is approximately 1,400 mm and the ridge is covered with blanket bog.

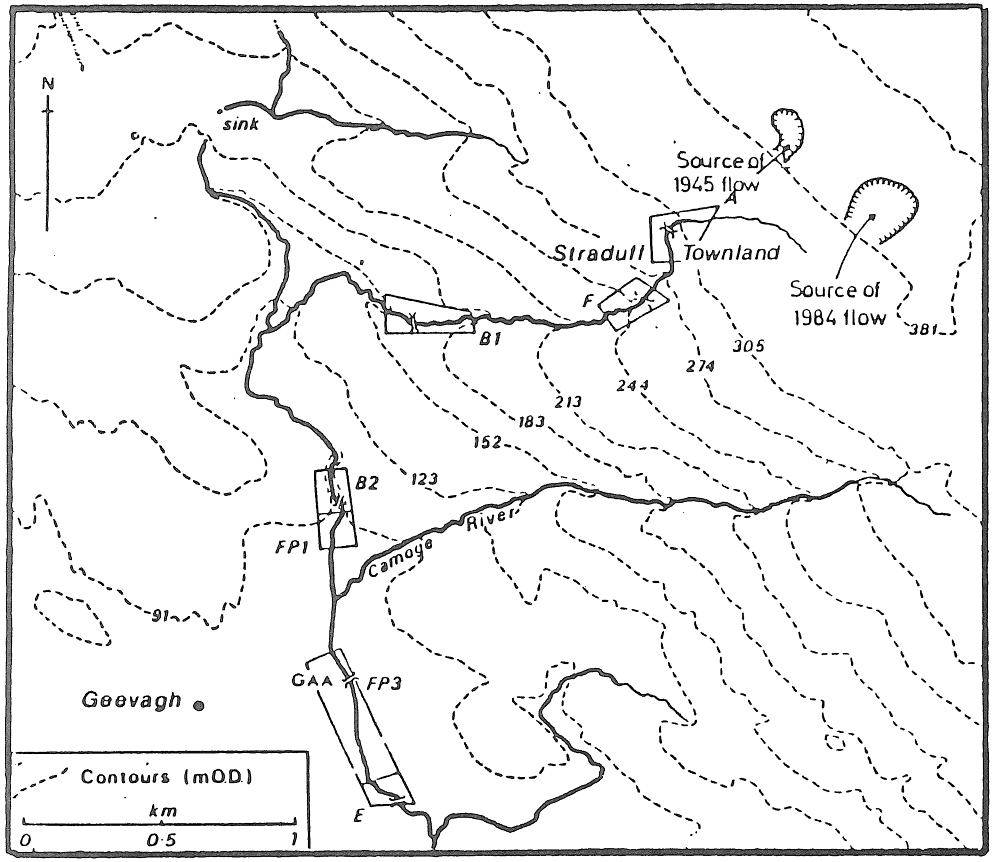


Figure 25 Location map of Straduff flows

The vegetation of the ridge is typical of blanket bog with the assemblage being dominated by Calluna vulgaris and Tricophorum caespitosum. At the site of the 1945 flow Calluna vulgaris is dominant. The depth of peat is variable and is generally thinnest (c 1.3 m) close to the edge of the escarpment, thickening to 3.0 to 3.2 m around much of the source of the 1984 flow and thinning again to around 2.5 m on the ridge crest. Over much of the ridge the peat appears to be underlain by a variable thickness of drift which analysis reveals to contain up to 70% clay. The drift is thinnest (0.1 m) close to the escarpment edge, averages 0.2 m around much of the source of the 1984 flow and has a maximum thickness of 0.55 m near to the ridge crest.

The 1984 Flow

The source of the flow was surveyed shortly after the event took place and the area contoured at one metre intervals (Fig. 26). In the lower source area isolated rafts of vegetated surface peat surrounded by basal peat can be seen while towards the upper source area the surface peat is more complete but is heavily crevassed.

The original ground level of the source area was estimated by interpolating between the contours on either side of the area affected thus enabling cross-sections to be drawn and an estimate made of the depth of material removed; approximately 1.63 m. About 49,700 m^2 of bog were affected giving an estimated 81,000 m^3 of material released. The bog was cored in a number of locations around the edge of the source immediately after the event took place in order to determine the depth, moisture content and bulk density of the peat as close to the edge of the source area as possible. These data are shown in Figure 27. Although these data do not reflect the conditions in the bog at the time the event took place they do enable an estimate to be made of the weight of peat

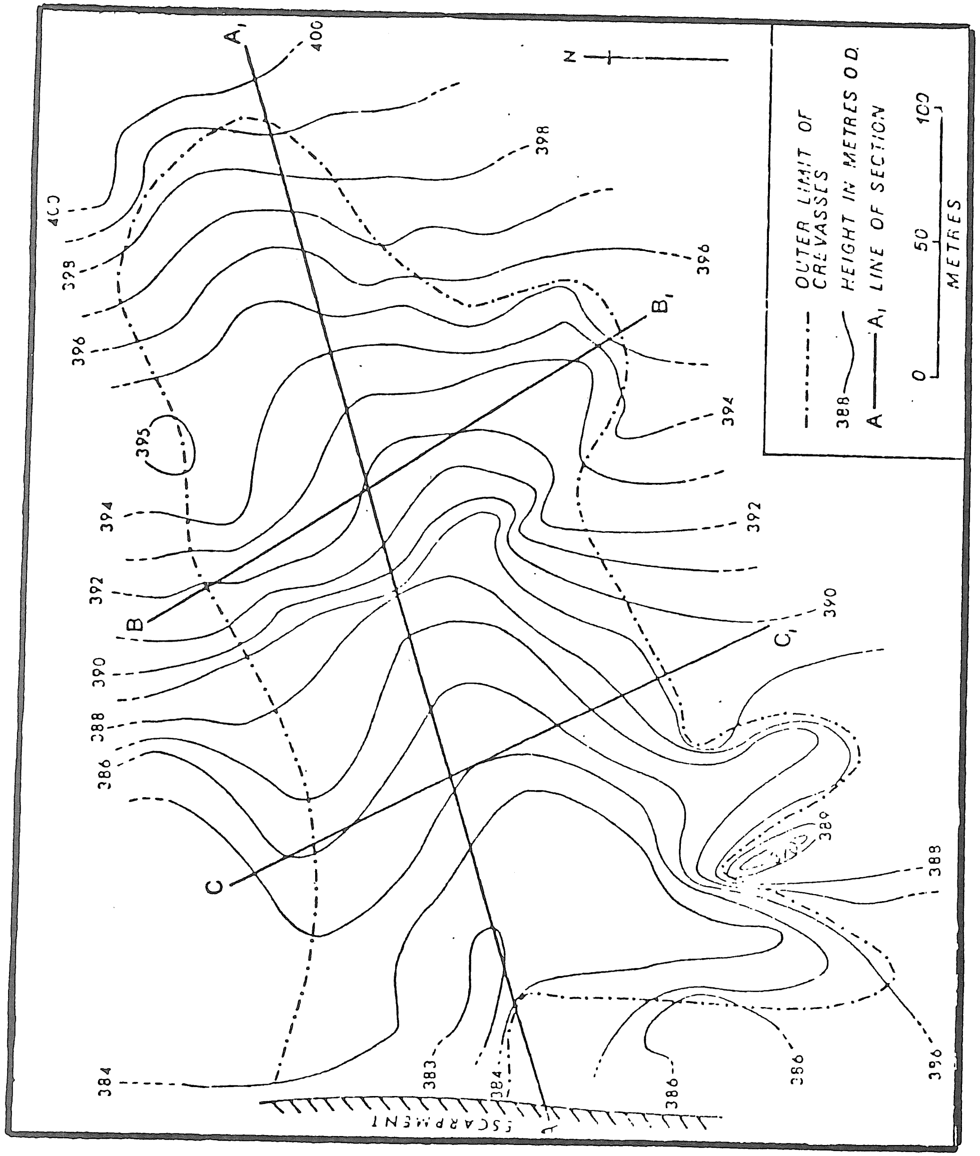


Figure 26 Map of the 1984 source area

(After Alexander, Coxon and Thorn, 1985)

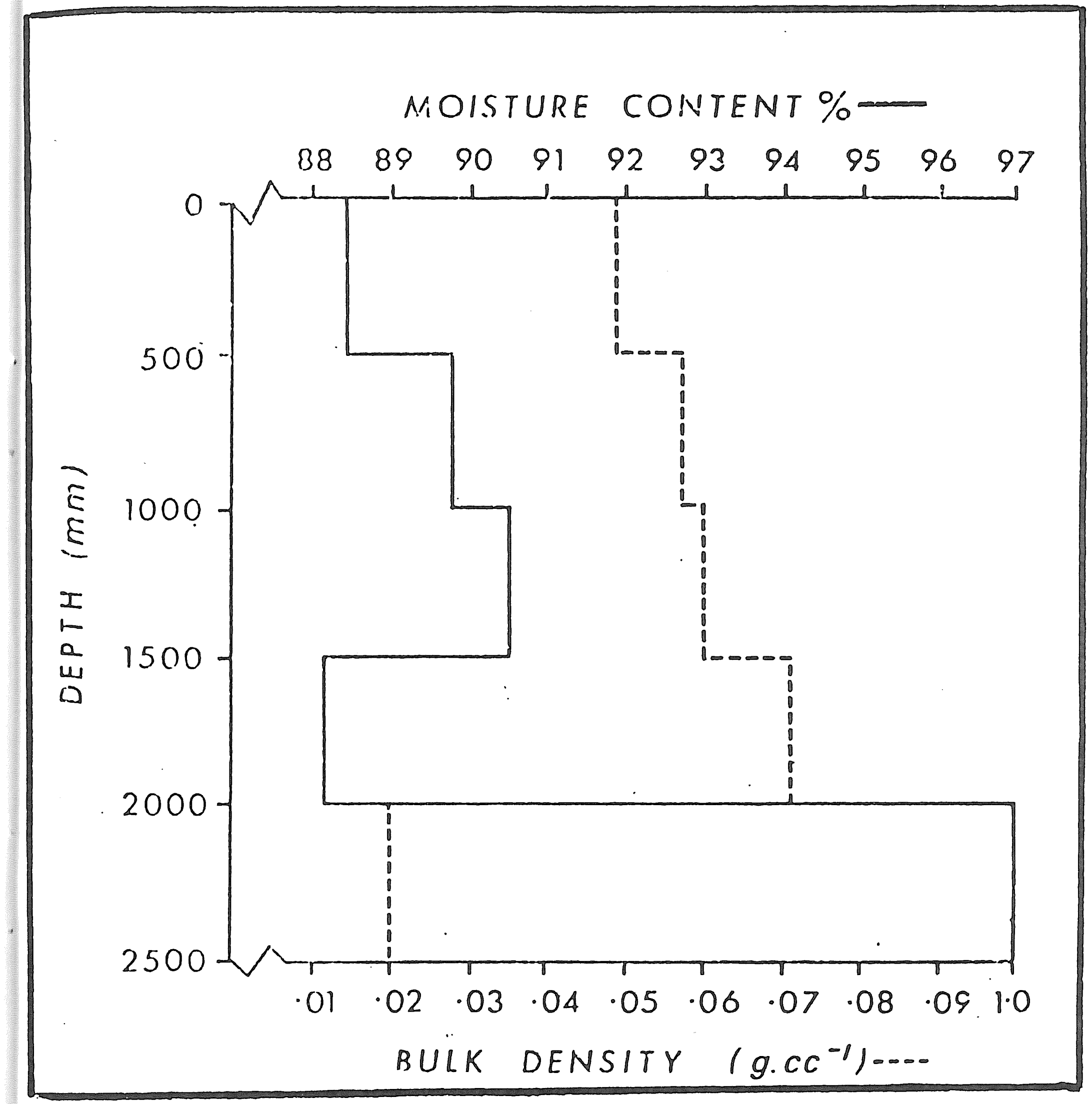


Figure 27 Moisture content and bulk density data in the vicinity of the 1984 source area

(After Alexander, Coxon and Thorn, 1985) and water released; approximately 73,700 tonnes of water and 4,200 tonnes of peat.

The 1945 Flow

The source of this flow was also surveyed and contoured at one metre intervals and the original ground level estimated in the same way as for the 1984 flow. Approximately 10,600 m^2 of bog were affected and about 0.69 m of peat removed; giving an estimated 7,300 ^{3} of material released. Assuming the peat at the time of the flow had bulk densities and moisture contents similar to those noted for the 1984 flow then approximately 6,600 tonnes of water and 400 tonnes of peat were released.

Cause of the Flows

The cause of the flows on this part of the ridge does not appear to be as straightforward as that at Site 10. In attempting to identify the cause several features merit consideration. In the case of the 1984 flow antecedent rainfall appears to be important (rainfall data for the 1945 event have not as yet been examined) while for both events the topography of the source area and the presence of the clay rich drift underlying the peat may have been influential.

In the case of the 1984 flow rainfall data for a nearby station (Fig. 28 a) show that the months of June, July and August, 1984 were dry with only 68% of the long term average (1941-1973) rainfall for that period. Approximately average rainfall occurred in September, whilst October experienced 25% more than average rainfall. Daily rainfall figures for October (Figure 28 b) show that although the early part of the month was relatively dry 25.9 mm of rain (25% of the October monthly average) fell during the three days immediately preceeding the event.

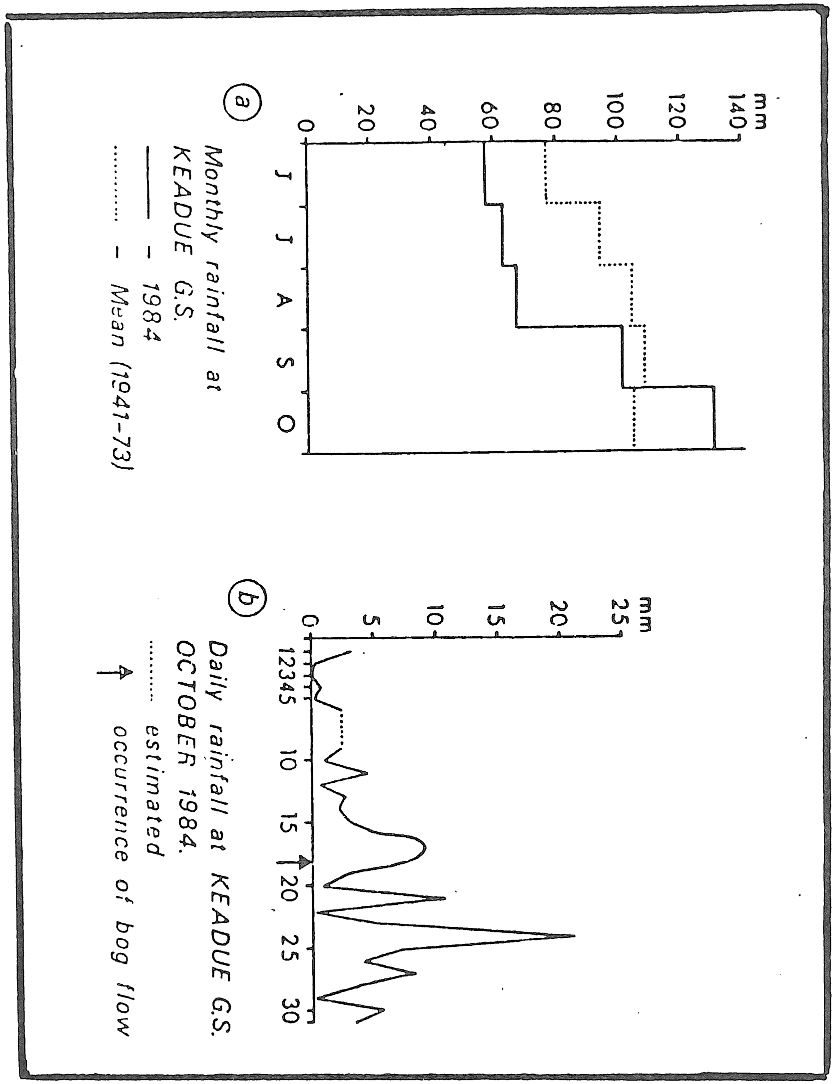


Figure 28 a and b Rainfall data for Keadue, Co. Roscommon
(After Alexander, Coxon and Thorn, 1985)

Part of the bog in the vicinity of the 1984 source area shows evidence of recent burning and thus a reduced vegetation cover which, taken in combination with a dry summer, may have led to drying out and possibly cracking of the surface peat by late August. If such were the case then subsequent rainfall during September and October would have moved rapidly down to the lower peat layers and percolation through to bedrock would have been prevented by the thin but impermeable layer of clay rich drift underlying the peat. The data in Figure 27 indicate that shortly after the event occurred the lower peat in the vicinity of the source area was extremely wet and it is reasonable to suppose that a similar situation prevailed within the source area at the time of the event. Given the slopes existing within the source area (Fig. 26) drainage would have been towards the escarpment where a thin wall of peat overlies the scarp edge. The heavy rainfall prior to the event may have caused sufficient pressure to be exerted on this bounding wall to cross a threshold of stability and thus lead to its rupture.

In the case of the 1945 flow the source area characteristics are similar to those of the 1984 source and, in the absence of the rainfall data, a similar cause may be postulated.

SITE 12 - (Site 12 a - G 854 183, Site 12 b - G 842 160) - Sections of the stream which the flows followed. (P.C., R.D. and B.T.)

Once over the escarpment edge the debris from both the 1945 and the 1984 flows entered the headwaters of the small unnamed stream which rises in Straduff Townland (Figure 25). From this point on the flows were confined within the small incised valley of the stream until the valley broadens out on the lowlying land near Geevagh.

Evidence of the passage of the 1945 flow is no longer present but deposits of peat on both the valley sides and the valley bottom mark clearly the passage of the 1984 flow.

In order to analyse the behaviour of the 1984 flow during its passage downstream a number of sections were studied in more detail and these are shown in Figure 25. At all the sites estimates of discharge and velocity were made using Manning's equation and a sketch map and cross sections drawn to show the extent, width and depth of the bog flow material. The details of section F are given at Site 12 a and sections FP3 and E at Site 12 b. The remaining sections are dealt with in Alexander, Coxon and Thorn (1985).

Site 12 a

The gradient on this part of the stream is up to 170 m km^{-1} and the flow dynamics and morphology were complicated due to local quarrying, a ford and a track built within the valley (see sketch map on Fig. 29). The flow through the confined reach of this section (see cross sections F1 and F2 on Fig. 29) was great with an estimated velocity of 6 m s^{-1} and a discharge of 139 cumecs.

Where the constricted channel opens at the quarry a large volume of debris formed ramparts 1 - 2 m high. The deposition occurred as a result of the widening of the available channel and a slight fall in gradient (to 130 m km^{-1}) downstream from the quarry. The dumped material caused the stream to divert its course on to the man made track and in so doing eroded the track and destroyed the ford.

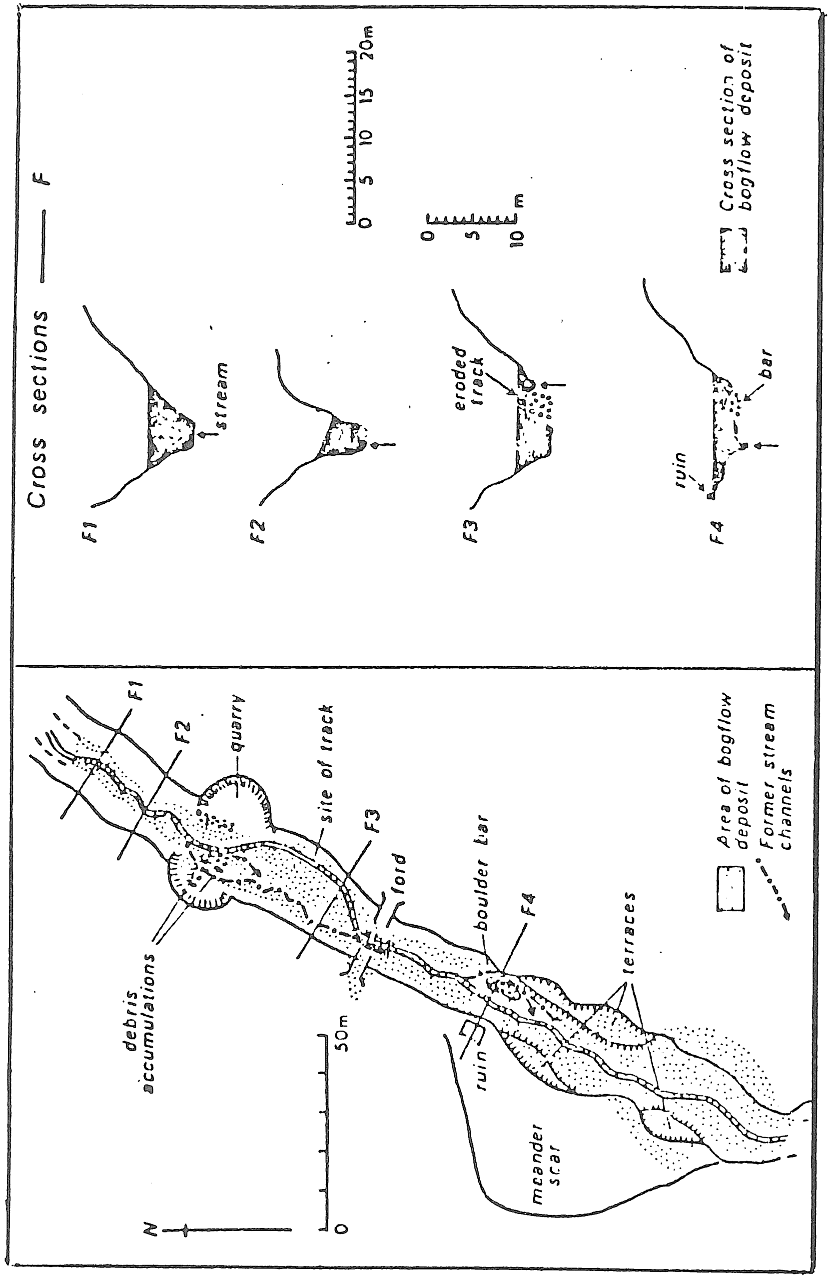


Figure 29 Sketch map and cross sections at F

After Alexander, Coxon and Thorn, 1985)

Site 12 b

At this point the flow overtopped the confining stream banks and spread into the lowlying ground inundating the local GAA pitch and about 40 ha of pasture land (Fig. 30). At the road bridge in FP3 the flow was over 180 m wide and 60-80 cm deep. Calculations of velocity and discharge are less reliable for this section but were considerably lower than further up the channel. The flow was diverted back into the channel by a small ditch and bank and where, apart from some minor overbank spillage (as at E, Fig. 30), it mained.

The flow continued in the stream and joined the Feorish river which flows into the Shannon. The water works at Carrick-on-Shannon had to be shut down following the event when the suspended solids content rose from 30 to 300 mg l^{-1}.

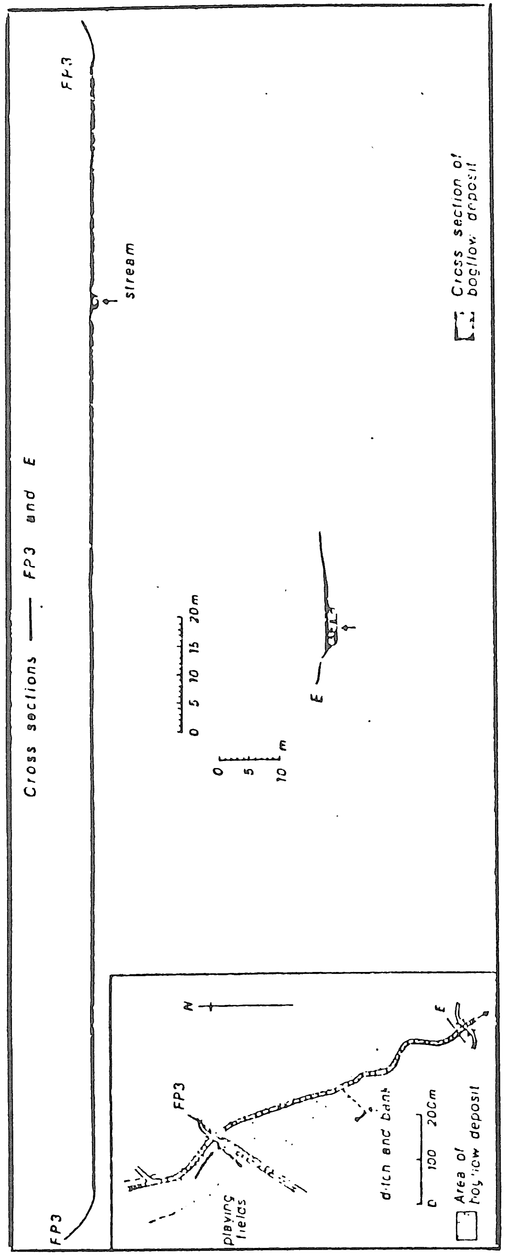


Figure 30 Sketch map and cross sections at FP3 and E

(After Alexander, Coxon and Thorn, 1985))

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