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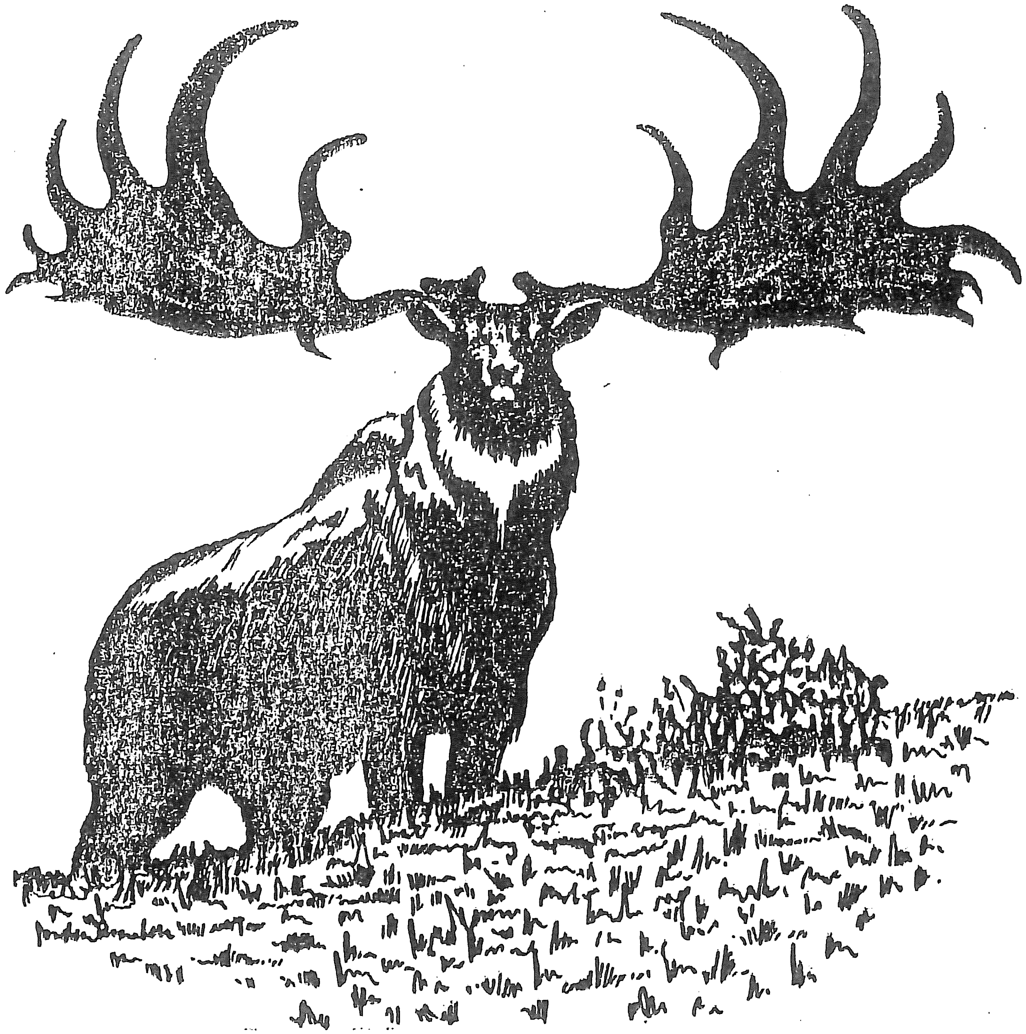

## Field Guide No. 3

## COUNTY TYRONE, NORTHERN IRELAND

IRISH ASSOCIATION FOR QUATERNARY STUDIES

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## County Tyrone, Northern Ireland

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## 1980 FIELD MEETING OCTOBER 31st - NOVEMBER 1st

## COUNTY TYRONE, NORTHERN IRELAND

This field guide has been edited by K.J. Edwards on behalf of the I.Q.U.A. committee. The contributors and field leaders are;


George Dardis (Ulster Polytechnic)
Kevin Edwards (University of Birmingham)
Ken Hirons (The Queen's University of Belfast)
Brian Williams (Archaeological Survey of Northern Ireland)
Peter Woodman (Ulster Museum)


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Maps : O.S. 1 inch series, sheets 4 and 5
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Bartholomew ¼ inch series, sheet 1


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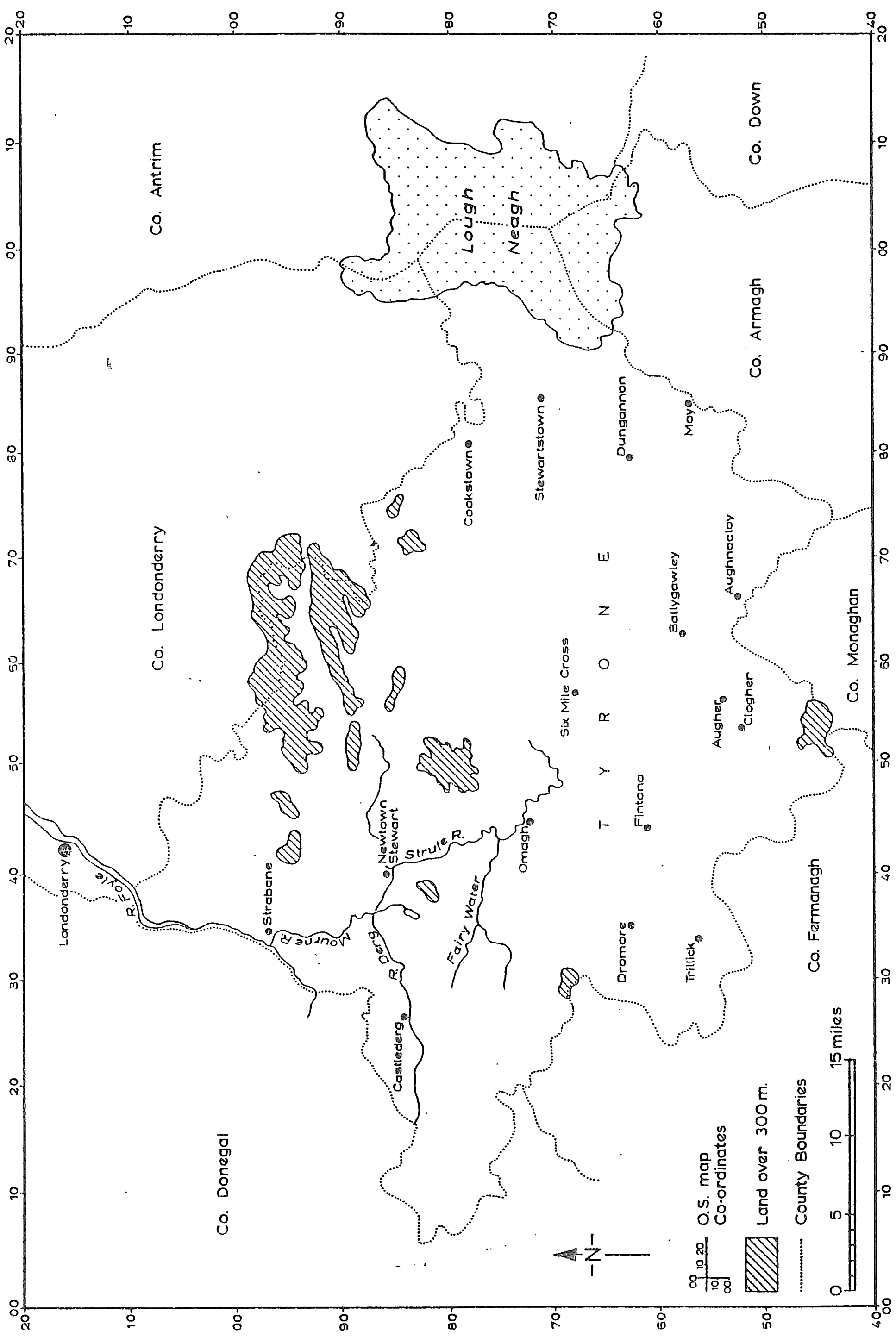

CONTENTS





## The Quaternary sediments of Central Ulster

(G.F. Dardis - School of Environmental Sciences, Ulster Polytechnic).

### INTRODUCTION

Central Ulster (Fig. 1) contains the southern portion of the Sperrin Mountains, the Tyrone Uplands, the western Lough Neagh Basin and the southern portion of the Bann Valley. The Tyrone Uplands are composed of Dalradian schist and gneiss, pre-Caledonian basic igneous rocks, Ordovician volcanics and acid igneous rocks of various ages. The Sperrin Mountains are composed largely of Dalradian lithologies striking toward the NE. The Lough Neagh Basin is composed largely of clastics and carbonates of Carboniferous age, overlain by Cretaceous chalk, Tertiary basalts and the Lough Neagh Clays, also Tertiary in age. The Bann Valley runs along a north-south axial plane of the Tertiary lava field of north-east Ireland.

Topography and geological structure are therefore intimately related in central Ulster, and have acted in the early and late stages of Glaciation to define the pattern and nature of ice movement and decay.

The whole of central Ulster has been covered by an ice sheet at least once during the Quaternary Period as is shown by glacial smoothing on rock surfaces and the presence of glacial sediments overlying bedrock. The early literature for this area (Portlocke, 1843; Cruise, 1887; Kilroe, 1888; Close, 1867) was concerned with describing glacial and fluvio-glacial phenomena without regard to genesis. Classification seldom went beyond differentiation of stratified and un-stratified sediments.

Kilroe (1888) proposed two glacial systems on the basis of glacial striae; the Scottish Glacial System and the Irish Glacial System. The former was believed to have occured prior to the latter. Dwerryhouse (1923) and Charlesworth (1924) concluded that the Irish Glacial System did not develop as a lowland ice sheet. They attributed glacial phenomena in the lowland basins to ice streaming from centres of ice accumulation in Donegal. Three distinct glacial episodes were outlined; an early invasion of north-east Ireland by Scottish Ice; glaciation of north-west Ireland by Donegal Ice; retreat of Donegal Ice and readvance of Scottish Ice to the Armoy moraine. Charlesworth (1939) attributed the drumlins of north-east Ireland to the last main Glaciation, associated with the confluence of Scottish Ice and Donegal Ice in the Lough Neagh Basin.

Synge and Stephens (1960) considered Charlesworth's model of glaciation to be inconsistent; they believed that ice streams from the last Glaciation flowed from sources in Ireland, and were not derived from extraneous sources. This view has been substantiated by later workers in north-east Ireland (Hill and Prior, 1968; Creighton, 1977; Stephens et al; 1975), the Sperrin Mountains (Colhoun, 1968, 1971) and south-west Ulster (McCabe, 1969).

Colhoun (1968) maintained that the Sperrin Mountains were overrun by an ice mass emanating from central Ulster, which decayed by southward retreat through the Sperrins into central Tyrone. The final dissolution of the Irish ice sheet is believed to have taken place in Tyrone, resulting in formation of a typical 'dead-ice' landscape (Synge, 1979).

STRATIGRAPHIC NOMENCLATURE

One sub-till organic horizon has been identified in central Ulster, at Benburb, Co. Tyrone (Boulter and Mitchell, 1977). The organic horizon is overlain by a light-brown till (7.5YR/6/3), whose stratigraphic significance is questionable since the till may have been redeposited from higher levels by mass-movement. The organic horizon contains abundant plant macrofossils, comparable to acknowledged Gortian sites in Ireland, suggesting that the overlying glacial deposits are post-Gortian in age. The Gortian Interglacial is traditionally believed to be equivalent to the Hoxnian Interglacial of British Regional Stages (Mitchell et al, 1973). Recent work however, suggests that the Gortian sites in Ireland may relate to the Ipswichian Interglacial (Warren, 1979). If the latter view is accepted then the Benburb site suggests that the majority of glacial deposits in central Ulster relate to the last Cold Stage, though it has proven difficult to relate the deposits at this site to superimposed till units elsewhere in the area. Following the recommendations of the American Commision on Stratigraphic Nomenclature (1961), drift sub-division has been based on a system of formations, subdivided where necessary into members (cf. McCabe, 1970).

The term 'formation' is used as the basic mapping unit and describes sediments associated with a single phase of glaciation, periglaciation, or interglaciation. Members define laterally or vertically equivalent parts of a formation that differ recognisably. Both formations and members can be of variable scale, ranging from major ice sheet glaciations,



to glacier readvances (in the case of formations). and ranging from landform-sediment associations to individual beds (in the case of members).

One interglacial formation, three glacial formations and one periglacial formation have been recognised in central Ulster (Table 1). In addition a late-glacial limnic sequence has also been recognised.

SEQUENCE OF EVENTS

1. Benburb phase.

The oldest known deposit of Pleistocene age in central Ulster is the organic horizon at Benburb. It is thought that the overlying till and the till in adjacent areas are younger in age, though this is difficult to establish. The organic horizon has been dated to older than 46,000 years bp (Boulter and Mitchell, 1977).

The overlying till appears to be in situ though the site occupies a moderately dipping tributary of the River Blackwater, which incised the glacial deposits at Benburb to a depth of 100 metres. It is possible, therefore, that the till was redeposited from a higher level by mass-movement.
The problem of placing this organic horizon within the context of Irish Regional Stages has been mentioned above.

2. Mullybrannon phase.

Temporary exposures in cutting the M2 motorway extension to Ballygawley revealed four till units and one sand unit in a drumlin at Mullybrannon, near Dungannon (Fig. 2). Till units D and E are overlain by a grey till found throughout the Lough Neagh lowlands, and which relates to the Late Midlandian Glaciation. The underlying tills are seperated from each other and the overlying till by erosional boundaries, and therefore existed prior to deposition of the upper tills. The tills have been grouped together into the Mullybrannon Formation. Differentiation of two members at Mullybrannon was based on an erosional contact between units D and E. These members differ markedly from the darker tills overlying them. Both members are limestone tills containing a high percentage of sandstone. They are dark brown in colour (7.5YR/3/3) and contain minor amounts of basalt and chalk. This suggests that they may have originated from the north-east, within the western Lough Neagh lowlands by an ice movement

Table 1 : Glacial stratigraphy in Central Ulster

| Phase/Formation | Associated sediments and landforms | Typesite/Area |
|---|---|---|
| 11. Moneymore B. | Blue clay and sands overlain by soliflucted boulder layer and post-glacial peat. Inter-drumlin hollow. | Glovers quarry (H 869845), Moneymore. |
| 10. Moneymore interstadial. | Peat layer overlying blue clay and fluvioglacial sands and silts, and overlying blue clay of phase 11. Inter-drumlin hollow. | Glovers quarry (H 869845), Moneymore. |
| 9. Moneymore A. | Blue clay overlying fluvioglacial sediments. Inter-drumlin hollow | Glovers quarry (H 869845), Moneymore. |
| 8. Lowertown. | Ice wedges, cryoturbation structures, talus deposits in fluvioglacial and lateglacial sediments. May have occurred in both phases 9 and 11. | Lowertown (H 825625), Dungannon. |
| 7. Curglassan. | South Derry gravel complex(?). Annahavil gravel complex. Coalisland sediment complex. Six Mile Water Laminates. Lowertown delta. Slieve Gallion cirque(?). | Annahavil margine and outwash sander (H 792695), Dungannon. |
| 6. Carndaisy. | Carndaisy channel. | Carndaisy Glen (H 837860), Moneymore. |
| 5. Central Tyrone. | Central Tyrone gravel complex. | |
| 4. Broughderg phase. | Drumglass till member. Tamnadoey till member. | A.P.C.M. shale quarry (H 795643), Dungannon. |
| 3. Dungannon. | Ardgivna gravel member. Brackaville till member. Brown Hill member. Tamnadoey member(?). Ballyeglish member. | A.P.C.M. shale quarry (H 795643), Dungannon. |
| 2. Mullybrannon. | Mullybrannon upper till. Mullybrannon lower till. | Mullybrannon (H 805596) Dungannon. |
| 1. Benburb. | Lignite below till (>46,000 bp). | Benburb (H 813520) |



toward the south-west. It is not possible to relate the ice movements at this site to those at Benburb.

3. Dungannon phase.

A brownish-black till (10YR/3/1) exposed in the A.P.C.M. Ltd shale quarry near Dungannon, contains numerous erratics derived from the Tyrone Uplands. It is primarily composed of limestone and mudstone, both of which are locally derived. This till (the Drumglass member) is underlain by sorted gravel (the Ardgivna member) which contains 13.4% Tyrone granite erratics. The Drumglass and Ardgivna members also contain erratics derived from the east (namely Cretaceous chalk and Tertiary basalt). The Ardgivna member is believed therefore to have been deposited prior to the Drumglass member, and may have been responsible for initial dispersal of Tyrone erratics into the Lough Neagh lowlands. The Drumglass member forms largely the morphology of a drumlin at this site and may have been remobilised during its formation. A number of other till members in the Lough Neagh lowlands contain erratics derived from the west; they occur at Coalisland (the Barckaville member), at Lindsayville (the Brown Hill member), at Moneymore (the Tamnadoey member) and at Ballyeglish (the Ballyeglish member).

Elsewhere in the north of Ireland, radial dispersal of Tyrone granite has been used to indicate or invalidate models of ice dispersion. These erratic have been noted as far as the Mourne Mountains, having been deposited during the Mourne and Ballyreel phases of the Late Midlandian Glaciation (McCabe, 1980), in the Bann valley (Creighton, 1977) and in Co. Fermanagh (McCabe, 1969). Tyrone erratics have also been noted to the west of Lough Neagh (Hill, 1958). Colhoun (1968) used evidence of dispersal of Tyrone erratics across the Sperrin Mountains to determine the pattern of ice movement during the last Glaciation.

4. Broughderg phase.

The Drumglass till member, while containing erratics from the Tyrone Igneous Series, contains erratics derived from the east. At Moneymore, the Tamnadoey member contains granite erratics and is contained by a drumlin related to ice flow from the Lough Neagh Basin. This evidence suggests that the Drumglass till member was largely deposited prior to the Drumlin Substage.

The Dungannon Formation is therefore a complex till containing materials that may have been reworked many times over. The formation comprises most of the Drumlins of the central Tyrone Drumlin Field and the western Lough Neagh drumlin fields (a and b, Fig. 3). The Dungannon Formation is therefore equivalent to Colhoun's (1971) definition of the Gelvin Till Formation, i.e. formed during the last Glaciation. The Drumglass till has been modified by ice flow during the Broughderg phase.

Indications of ice flow during the Broughderg phase are indicated by drumlin orientations, glacial striae and erratic dispersals. Drumlins of the central Tyrone drumlin field terminate in the Broughderg lowland within the limits of the Lough Fea-Fir Mountain moraines (c, Fig. 3). Evidence of erratic dispersal northward also terminates in the Broughderg lowland (Colhoun, 1968). On morphostratigraphic grounds, therefore, there is no evidence to suggest that the Sperrin Mountains were overtopped by ice during the Drumlin substage. It further suggests that the Drumlin Substage limits duplicated the Glacial Maximum ice limits in lowland valleys, while the Sperrin Mountains remained ice-free. Proposed Ice limits in central Tyrone during the Drumlin Substage are outlined in (Fig. 3, inset map).

Along the ice limits of the Broughderg phase, considerable quantities of meltwater were being released, and are responsible for formation of a wide belt of fluvioglacial sands and gravels, formed along the southern slopes of the Beleevnamore Mountain - Slieve Gallion range (c, Fig. 3). This ice-marginal accumulation marks the northern extent of the Evishanoran esker system (d, Fig. 3) which is continuous for 20 km across central Tyrone. The esker commences at Bernisk Col and terminates west of the Lough Fea sandur.

5. Central Tyrone phase.

The distribution and orientation of drumlins in the central Tyrone and western Lough Neagh drumlin fields suggests that two centres of ice dispersion existed during the Drumlin Substage, here termed the Tyrone Glacier and the Lough Neagh Ice. The Tyrone Gravel Complex (Fig. 3) is situated astride the western watershed of the Lough Neagh Basin, and is bordered to the east by the western Lough Neagh drumlin field, and on the west by the central drumlin field. The landform assembleges present within the complex include kame terraces, glaciolacustrine deltas, beaded eskers and irregular hummocky fluvio glacial deposits. The position of the complex with respect to the drumlin fields suggests that it may be an interlobate assemblage formed between the Lough Neagh Ice and the Tyrone Glacier systems.



The interlobate assemblage is complex and largely relates to the formation of ice-lakes in the interlobate environment (Dardis, 1980). The precise size of the ice-lake and its evolution during ice-decay is still a matter of continuing research, though it appears to have been maintained at 235 metres Irish OD in the Tyrone Gravel complex and reduced to 215 metres as ice-decay proceeded southward. The 235m level is evidenced by the boundary between topsets and foresets in the Gortacladdy Delta. The 215m level is indicated by terrace level 1 and the height of the Todd's Leap delta, which was largely controlled by the level of the Bernisk Col (Fig. 3).

The central Tyrone phase is very complex and the implications of the occurances of deltas in many places in the Tyrone Uplands have not yet been unravelled. Nevertheless it is apparent that the landform assemblages do not conform to the arcuate moraine concept of Charlesworth (1924), though they conform to some extent to Charlesworth's ice-dammed lake hypothesis, which was established from other lines of evidence. The deposits of the Tyrone Uplands have not previously been interpreted in terms of Glaciolacustrine sedimentation. The occurances of deltas throughout central Tyrone suggests that Colhoun's model of deglaciation is untenable for central Ulster. Some of the deltas indicate discharge across the central Tyrone drumlin field, and glaciolacustrine laminates have been observed overlying the Evishanoran esker, which further suggests that the ice-lake may have extended across the drumlin field into the Owenra Owenreagh valley. During this time ice remained in the Lough Neagh basin and acted to support the ice-lake along its eastern side. The Todd's Leap delta, the Pomeroy complex and the Knockaleery gravel complex all suggest that ice lay to the south-east of the Fintona Hills supporting an ice-lake in central Tyrone. In the vicinity of the Moyola Valley, the ice mass may have blocked its exit into the Bann Valley, thereby isolating the ice lake from an outlet to the north coast. Similarly, an outlet along the Foyle valley may have been blocked at Newtownstewart by ice blocking the western exit of the Owenkillew valley.

Ice decay during this phase therefore appears to have occured firstly in central Tyrone, where the Drumlin Substage ice mass fragmented along the western watershed of the Lough Neagh basin. Moraine lines extending from the Cashel Burn Sandur into the Strule valley toward Newtownstewart suggest that the Omagh basin was partially occupied by ice during this phase.

6. Carndaisy phase.

It seems likely that the ice-lake existed for a considerable period of time, though exactly how long is difficult to establish. There is little evidence to suggest that as deglaciation proceeded, the ice-lake grew proportionately. As deglaciation proceeded, catastrophic release of water may have occured via the Carndaisy Glen Meltwater channel (Fig. 4) or by break-up of the ice barriers in the Moyola and Strule valleys.

Moraines and eskers formed in the Strule valley and in the vicinity of Moneymore suggest that ice decayed against the hill sides and backwasted in lowland environments.

During the same phase, much of the Tyrone Uplands were ice-free, with ice existing in lowland environments. Moraines formed in the western Lough Neagh lowlands suggest that ice retreated southward toward Dungannon.

7. Curglassan Phase.

Ice-marginal Gilbert-type deltas consisting largely of bed-load sediments are exposed in the South Derry Complex (Fig. 4), at Carmean (H 865875) and Boherboy Cottage (H 848847), terminating at a height of about 61m OD. The deltas are characterised by coarse gravels spread across steeply dipping forsets.

Deltas and other fluvioglacial accumulations have been found to either occur or terminate close to the 61m lake level associated with the deltas in the South Derry Complex. For example, the Annahavil Moraine is characterised by a proglacial sandur (?) which terminates in the western Lough Neagh lowlands at this level. The Cookstown Gravel accumulation, the Coalisland sand complex and the Lowertown delta similarly terminate close to this level. Widespread occurances of fluvioglacial sequences terminating at or close to 61m suggests that an extensive lake existed throughout the Lough Neagh basin.

This occurance of a series of morphological sequences grading to particular base levels (cf. Koteff, 1974) has wide-ranging implications in the Lough Neagh Basin. The 61m level corresponds to a fluvial terrace formed at Loughrey College, Cookstown, to a terrace on the Grange Water at Desert-martin, Co. Londonderry, and to a kame terrace (or delta) at Doagh, Co. Antrim, along the Six Mile Water.

The spatial extent of these deposits and related phenomena suggest that



the 61m lake extended into the Bann valley, along the Six Mile Water and along the Lagan valley. The terrace sequence terminates at the Armoy Moraine, in the Bann valley and at the Lisburn Moraine in the Lagan valley. Outflow may also have occured along the Poyntz Pass - Newry channel, toward Carlingford Lough. Laminated sands, silts and clays have been deposited (McGreal, personal communication) at the exit of the Six Mile Water. They are approximately 12m in thickness and form a terrace terminating at about 29.5m OD. It is suggested that they are bottom sediments relating to this lake level. Laminated silts and clays have also been reported in the Bann valley (Creighton, 1977), terminating below 30m OD. They occur along the southern side of the Armoy Moraine and may relate to this lake level. They do not relate to the level of 'Glacial Lough Neagh' (Charlesworth, 1939), which was believed to exist to 31m.

The laminated sediments are underlain by shingle gravels which may have formed as a single bar between opposing currents in the Six Mile Water estuary. The occurance of the gravels suggests that a low lake level existed prior to formation of the laminated sediments.

The Curglassan phase was characterised by the following events :

(a) a low lake level prior to formation of laminated sediments at Greenmount Agricultural College, at the exit of the Six Mile Water.

(b) Formation of an extensive lake at c.61m terminating at the Armoy Moraine and at the Lisburn Moraine. This suggests that an ice barrier extended across the Bann and Lagan valleys relating to Readvance of North Channel Ice (c. 13500 years bp).

(c) A number of terraces occur between 60 - 20m and relate to a reduction in the extent of the lake, possibly due to the retreat of ice from coastal areas.

(d) The number of laminae occuring in the Six Mile Water sequence if assumed to be annual phenomena, suggest that the lake level existed for a long period of time, perhaps one thousand years. The laminae have not been examined in detail and therefore this figure is approximate.

8. Lowertown phase.

Five ice-wedge psuedomorphs have been observed on top of the Lowertown delta (believed to relate to the Curglassan phase), which indicate a phase of periglaciation late in the period of deglaciation. Ice wedges have been noted at various other sites, notably in association with fluvioglacial sediments.

A classical late glacial limnic sequence of clay-peat-clay has been observed at Moneymore which suggests that two distinct cold phases occured in central Ulster, seperated by an interstadial. Details of this site are in preparation (Hirons and Dardis). It has not proven possible to establish whether the periglacial phase was confined to one or other of these cold phases or to both.

9. Moneymore Cold phase A.

This phase is shown by the occurence of blue clay above fluvioglacial sands at Glovers roadstone quarry, Moneymore.

10. Moneymore Interstadial

This is suggested by the occurence of a peat layer above the clay at Moneymore. The pollen content suggests similarity to pollen zone II.

11. Moneymore Cold phase B.

Blue clay and sands overlie the Moneymore Interstadial peat. Pollen content suggests a return to cold conditions. Evidence of solifluction has been noted at the top of this horizon, which may be evidence of periglaciation (Fig. 5). It has proven difficult to establish whether mass movement at this site relates to periglaciation or whether it is a local phenomenon occuring as a result of reduced vegetation cover as suggested by pollen analysis of the underlying sediments. This cold phase may be contemporaneous with renewal of glaciation at Lough Nahanagan (Watts, 1977).

While no dates have been obtained from this site, it is expected that they will be forthcoming in the near future. This cold phase is believed to have lasted for approximately 1300 years in central Ulster (Smith et al, 1971).

COMMENT

The sequence of events in central Ulster suggests a complex pattern of ice growth and decay. Previous models of glaciation and deglaciation failed to establish a formal stratigraphy in central Ulster. The present work attempts to rectify this situation. New limits for the Drumlin Substage in central Ulster are proposed together with the existence of extensive water bodies in central Tyrone and the Lough Neagh Basin during the period of deglaciation. Future work will consider the spatial limits of the bodies and the genesis of phenomena formed above, below and at the water margin.



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REFERENCES


AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE, 1961, Code of stratigraphic nomenclature, Bull. Am. Assoc. Petrol. Geol., 45, 645-665.

BOULTER, M. and MITCHELL, W.I., 1977, Middle Pleistocene (Gortian) deposits from Benburb, Northern Ireland, Ir. Nat. J., 19, 2-3.

CHARLESWORTH, J.K., 1924, The glacial geology of north-west Ireland, Proc. R. Ir. Acad., 36B, 174-314.

CHARLESWORTH, J.K., 1939, Some observations of the glaciation of north-east Ireland, Proc. R. Ir. Acad., 45B, p 255-95

CLOSE, M.H., 1867, Notes on the general glaciation of Ireland, J.R. geol. Soc. Ir. 1, 207-42.

CRUISE, R.J., 1887, Explanatory memoir to accompany sheet 46 of the maps of the Geological Survey of Ireland, (Dublin).

COLHOUN, E.A., 1968, The glacial geomorphology of the Sperrin Mountains and adjacent areas in Co. Tyrone, Co. Londonderry and Co. Donegal, Northern Ireland. Ph.D. Thesis, Q.U.B. 338 pp.

COLHOUN, E.A., 1971, The glacial stratigraphy of the Sperrin Mountains and its relation to the glacial stratigraphy of north-west Ireland, Proc. R. Ir. Acad., 71B, 37-52.

COLHOUN, E.A., 1970, On the nature of the glaciation and final deglaciation of the Sperrin Mountains and adjacent areas in the north of Ireland. Ir. Geogr., 6, 162-185

COLHOUN, E.A., 1971, Late-Weichselian periglacial phenomena of the Sperrin Mountains and adjacent areas, Northern Ireland, Proc. R. Ir. Acad., 71B, 53-71.

COLHOUN, E.A., 1972, The deglaciation of the Sperrin Mountains and adjacent areas in counties Tyrone, Londonderry and Donegal, northern Ireland, Proc. R. Ir. Acad., 72B 91-147.





COLHOUN, E.A., DICKSON, J.H., McCABE, A.M., and SHOTTON, F.W., 1972, A middle Midlandian freshwater series at Derryvree, Maguiresbridge, Co. Fermanagh, Northern Ireland, Proc. R. Soc. Lond., 180B, 273-292.

CREIGHTON, R., 1977, The glacial geomorphology of north-central Ulster, Northern Ireland, Ph.D. Thesis, Q.U.B.

DARDIS, G.F., 1980, Evidence for an ice-dammed lake, Co. Tyrone, Northern Ireland, Abstract, Irish Geographers Conference, May, 1980.

DREIMANIS, A., 1979, The problem of water-laid tills, in Schlunchter, C. (ed.), Moraines and varves, Proc. INQUA symposium, Zurich 1978, 167-177.

DWERRYHOUSE, A.R., 1923, The glaciation of north-east Ireland, Q. Jl. geol. Soc. Lond., 79, 352-422.

HILL, A.R., 1968, An analysis of the spatial distribution and origin of drumlins in north Down and south Antrim, Northern Ireland, Ph.D. Thesis, Q.U.B., 329pp.

HILL, A.R., and PRIOR, D.B., 1968, Directions of ice movement in north-east Ireland, Proc. R. Ir. Acad., 66B, 71-84.

HULL, E., 1878, Physical Geology and Geography of Ireland, (London).

KILROE, J.R., 1888, Directions of ice-flow in the north of Ireland, Q. Jl. Geol. Soc. Lond., 14, 827-833.

KOTEFF, C., 1974, The morphological sequence concept and pattern of deglaciation in New England, in Coates, D.R., (eds)., Glacial Geomorphology (Binghampton).

McCABE, A.M., 1969, The glacial deposits of the Maguiresbridge area, Co. Fermanagh, Northern Ireland, Ir. Geogr., 6, 63-77.

McCABE, A.M., 1980, Field Guide, South Co. Down, Ir. Assoc. Quat. Stud., 1, 31pp.

PORTLOCKE, 1843, Report of the Geology of Londonderry and of parts of Tyrone and Fermanagh, (Dublin), 743 pp.

SMITH, A.G., PEARSON, G.W., and PILCHER, J.R., 1973, Belfast Radiocarbon Dates V, Radiocarbon, 15, 212-228.

STEPHENS, N., CREIGHTON, R., and HANNON, M., 1975, The late Pleistocene period in north-east Ireland, an assessment 1975, Ir. Geogr., 8, 1-23.

SYNGE, F.M., and STEPHENS, N., 1960, The Quaternary period in Ireland - an assessment, Ir. Geogr., 4, 121-130.

SYNGE, F.M., 1970, The Irish Quaternary : current views 1969, in STEPHENS, N., and GLASSCOCK, R.E., (eds)., Irish Geographical Studies, (Queen's University : Belfast), 34-38.

SYNGE, F.M., 1979, Quaternary glaciation in Ireland, Quat. Newsletter, 28, 1-12.

WARREN, W.A., 1979, Stratigraphic position and age of the Gortian interglacial deposits, Geol. Surv. Ir. Bull., 2, 315-332.

WATTS, W.A., 1979, The Late Devensian vegetation of Ireland, Phil Trans. R. Soc. Lond., B 280, 273-293.

WILKINSON, S.J., and KILROE, J.R., 1886, Explanatory memoir to accompany sheet 33 of the maps of the Geological Survey of Ireland, (Dublin).

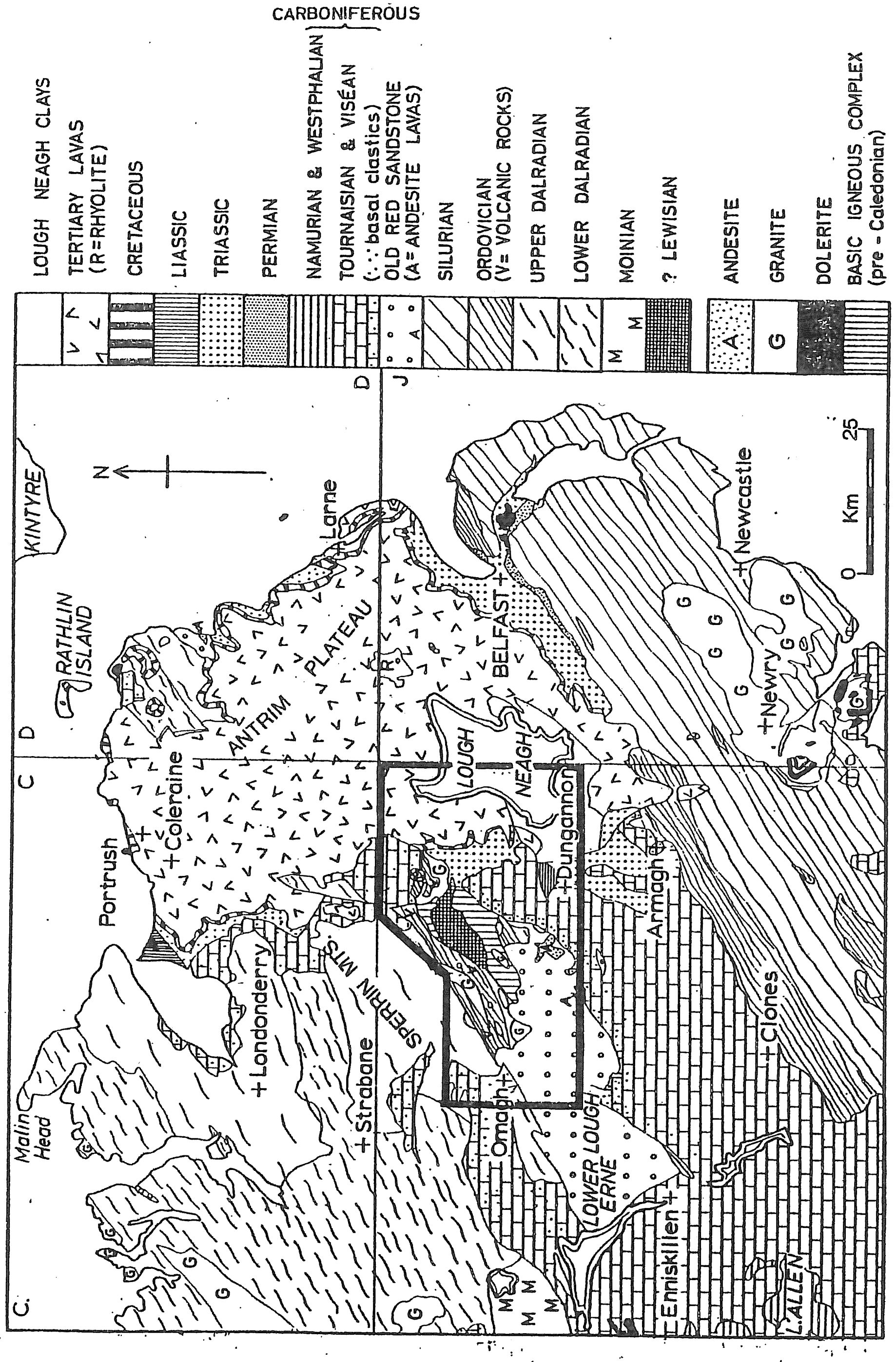


Fig. 1 Solid geology of northern Ireland (excluding north-west Ireland) showing central Ulster (in block).

Mullybrannon, Dungannon (H 805 593)

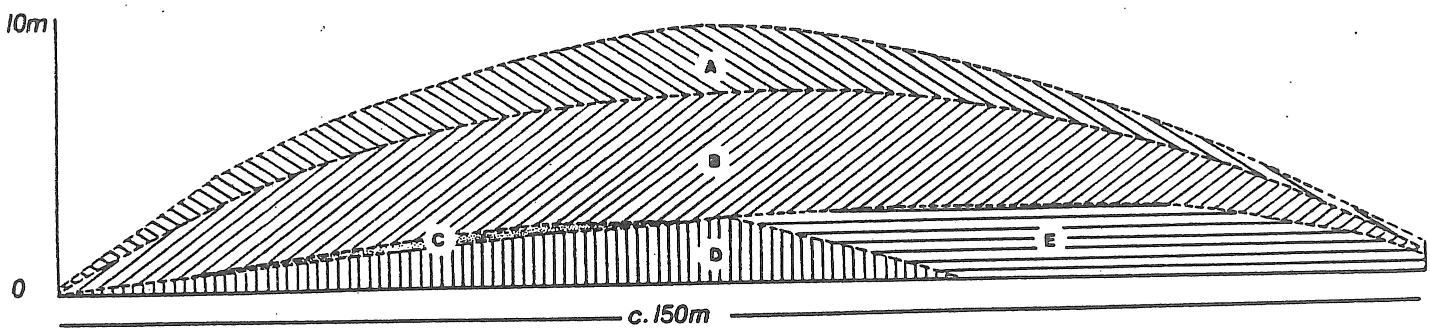


Fig. 2 Section in drumlin Mullybrannon, Dungannon. Units D and E relate to Mullybrannon phase. Units C (sand member) and B (Till member) relate to the Dungannon phase. Unit A (Till member) may be a weathered top of B.



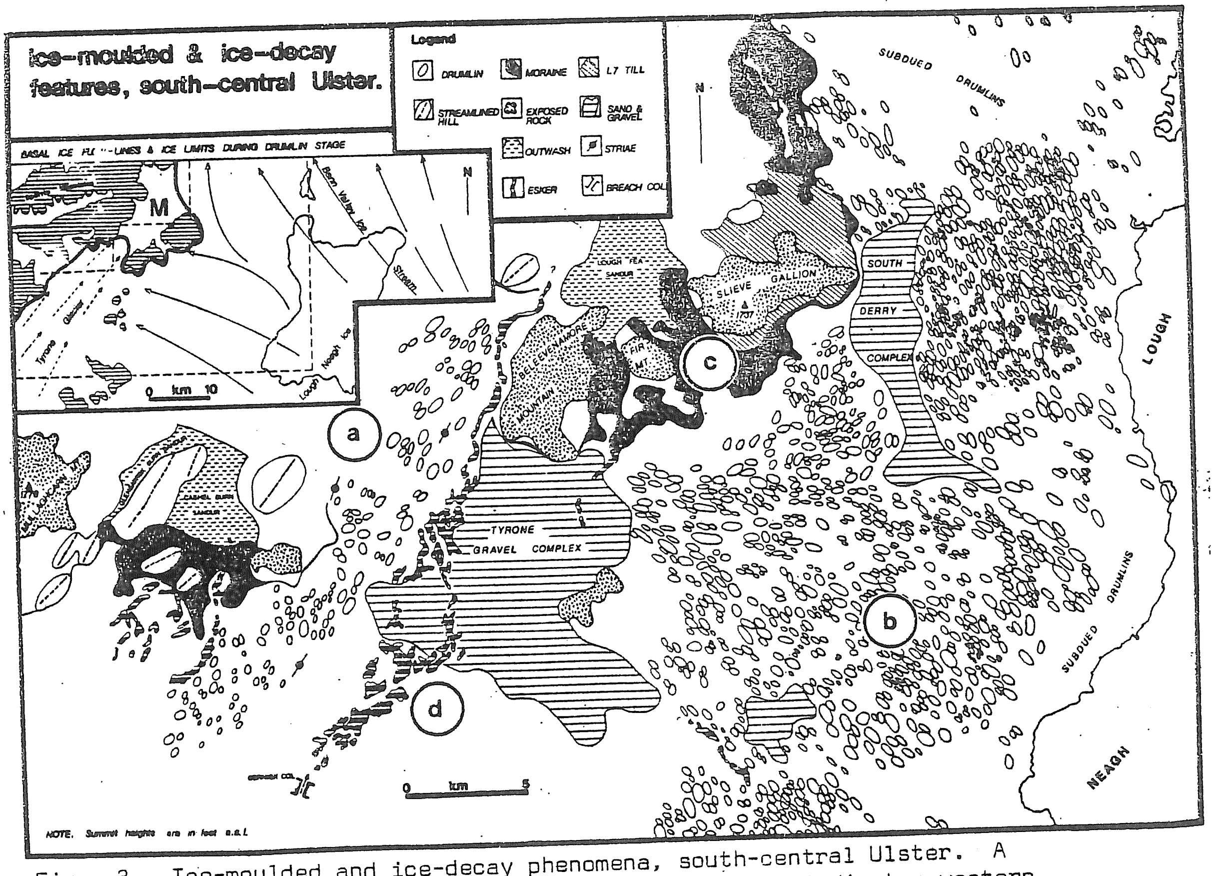


Fig. 3 Ice-moulded and ice-decay phenomena, south-central Ulster. A indicates the central Tyrone drumlin field; B indicates western Lough Neagh drumlin field; C indicates Lough Fea-Fir Mountain moraines; D indicates the Evishanoran esker. Inset map indicates flow-lines during Drumlin Substage. M indicates location of Moyola valley.

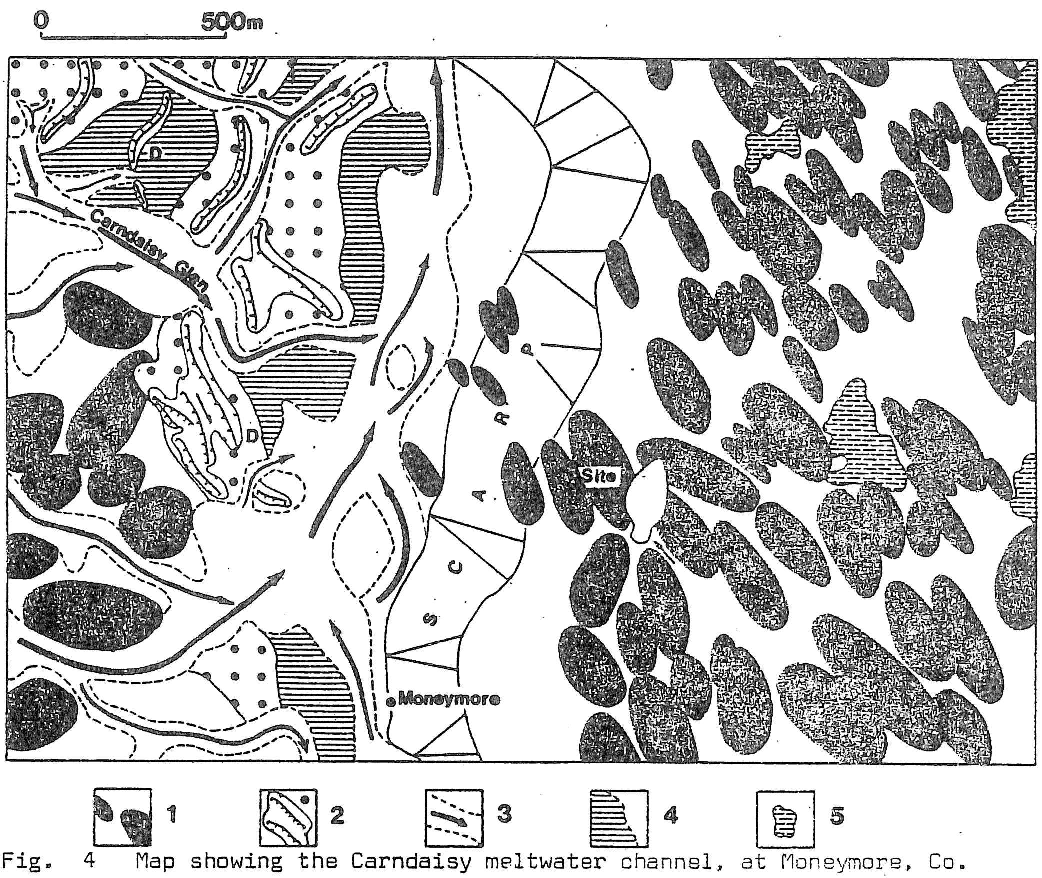


Fig. 4 Map showing the Carndaisy meltwater channel, at Moneymore, Co. Derry. 1 indicates drumlins; 2 indicates moraine ridges; 3 indicates directions of meltwater flow; 4 indicates outwash terraces formed in association with the Boherboy Delta (marked D); 5 indicates interdrumlin peats, 'Site' marks the location of the Moneymore late-Glacial site.



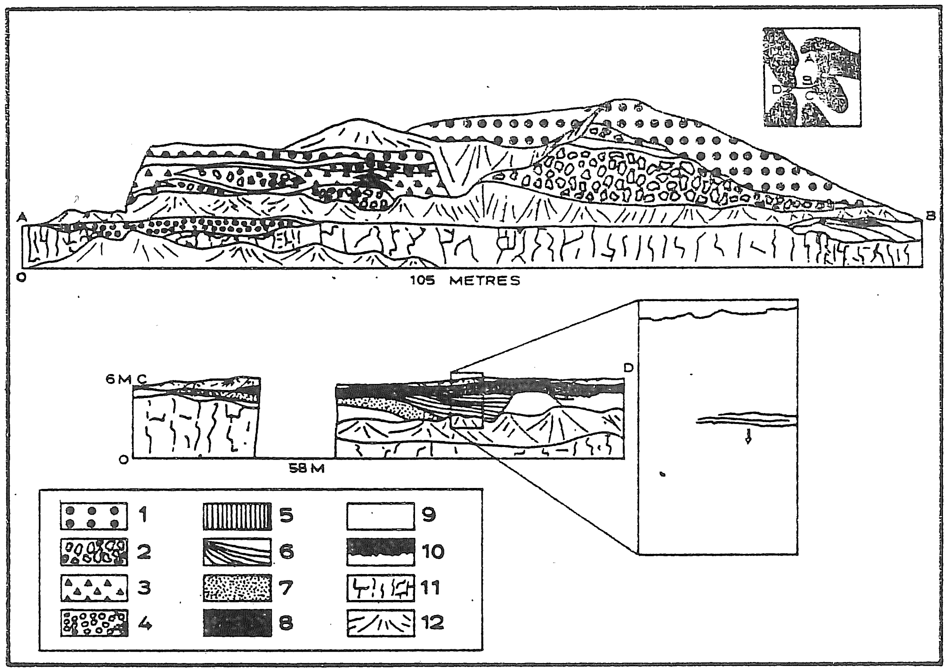


Fig. 5 Moneymore

1. Upper till unit
2&3. Lower till unit showing lensing of till
4. Rhythmite laminations (graded) of glaciolacustrine origin
5. Sand lens in lower till unit
6. Fluvioglacial deposits in inter-drumlin hollow (I.D.H.)
7. Gravel in I.D.H.
8. Lateglacial limnetic sequence
9. Till in I.D.H.
10. Boulder layer in zone III
11. Weathered bedrock
12. Slumped debris

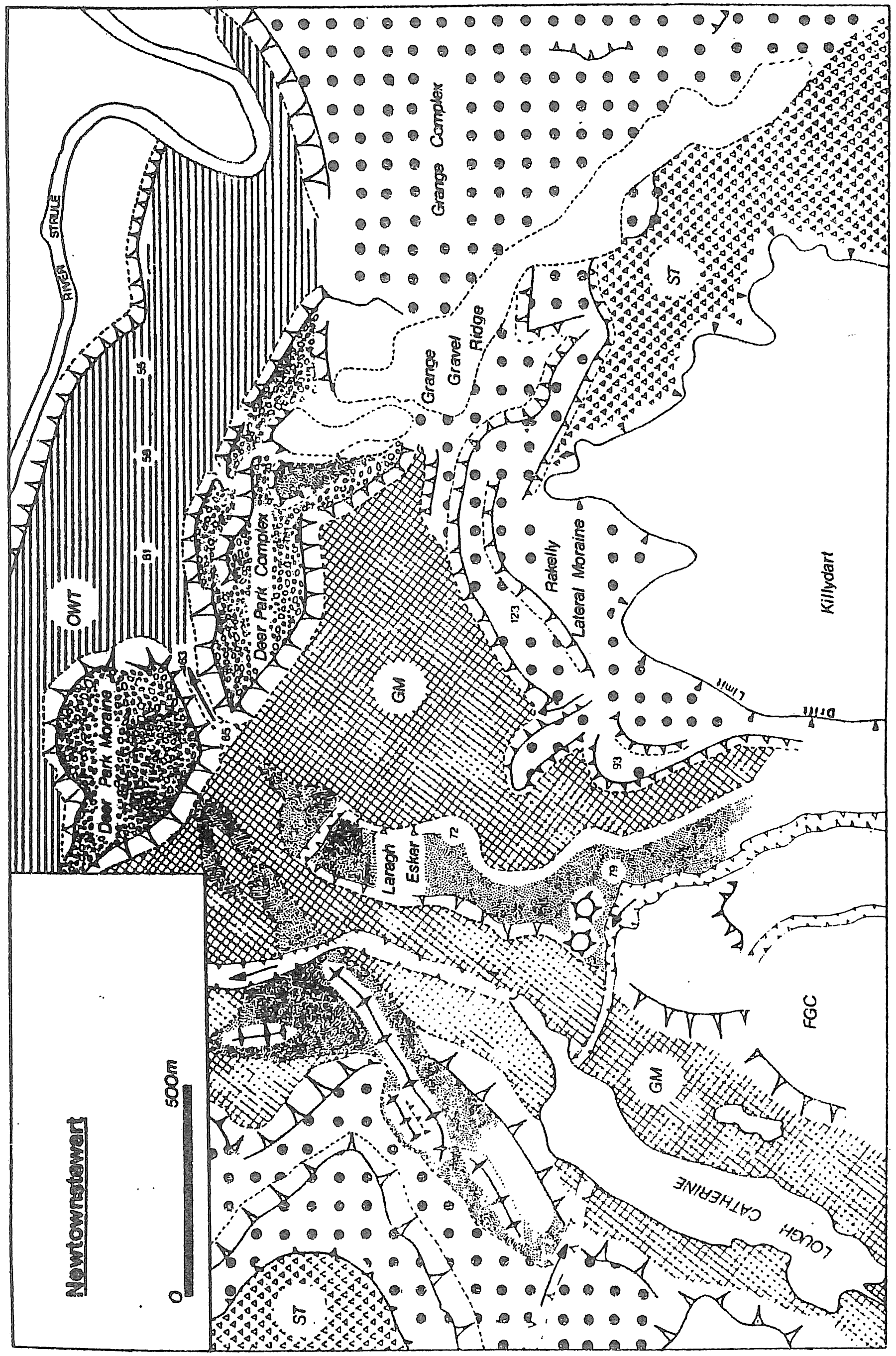


Fig. 6 Newtownstewart Moraine.
ST = schist till; GM = ground moraine; OWT = outwash terrace;
FGC. = fluvioglacial complex; Fine stipple = eskers and medial formations.

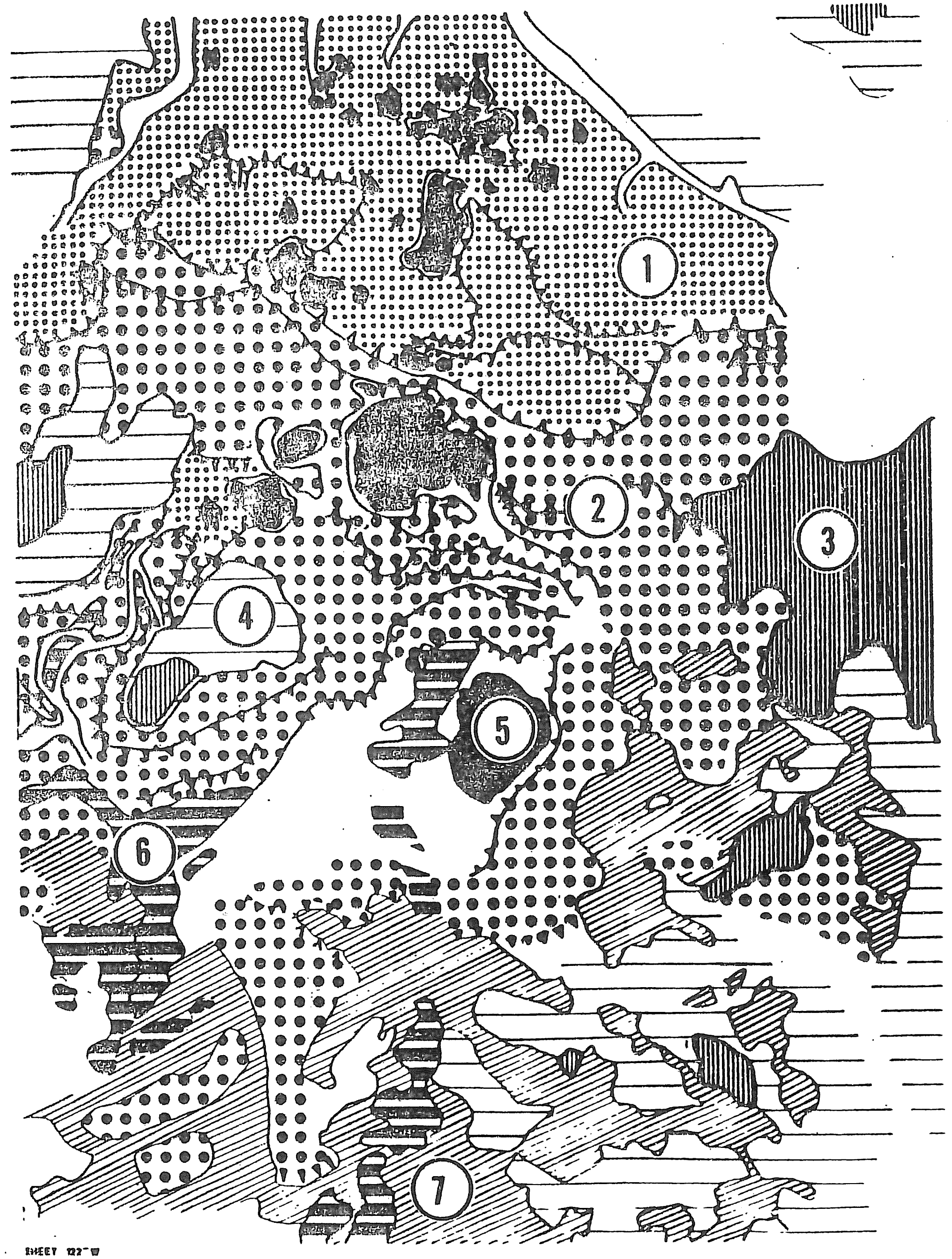


Fig. 7 Cashel Burn.
1 = outwash; 2 = morainic sand and gravel; 3 = exposed roc
4 = till; 5 = kettle-holes; 6 = eskers; 7 = peat.

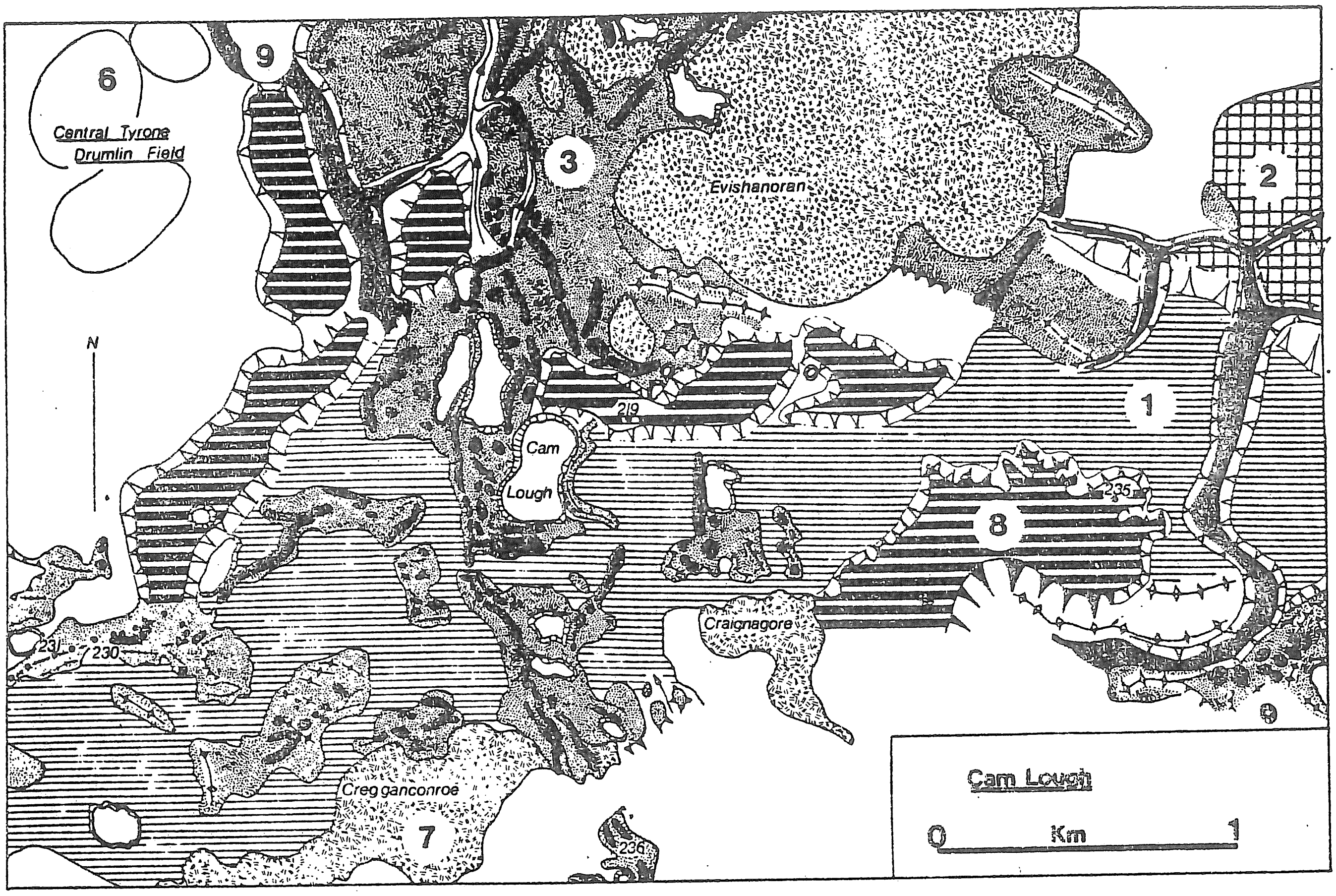


Fig. 8 Camlough.
1 = outwash terrace; 2 = lower outwash terrace; 3 = morainic sands and esker gravels; 4 = meltwater channels; 5 = peat (not shown); 6 = Drumlins; 7 - exposed rock; 8 = Gortacladdy delta; 9 = channel flowing away from Evishanoran Delta.



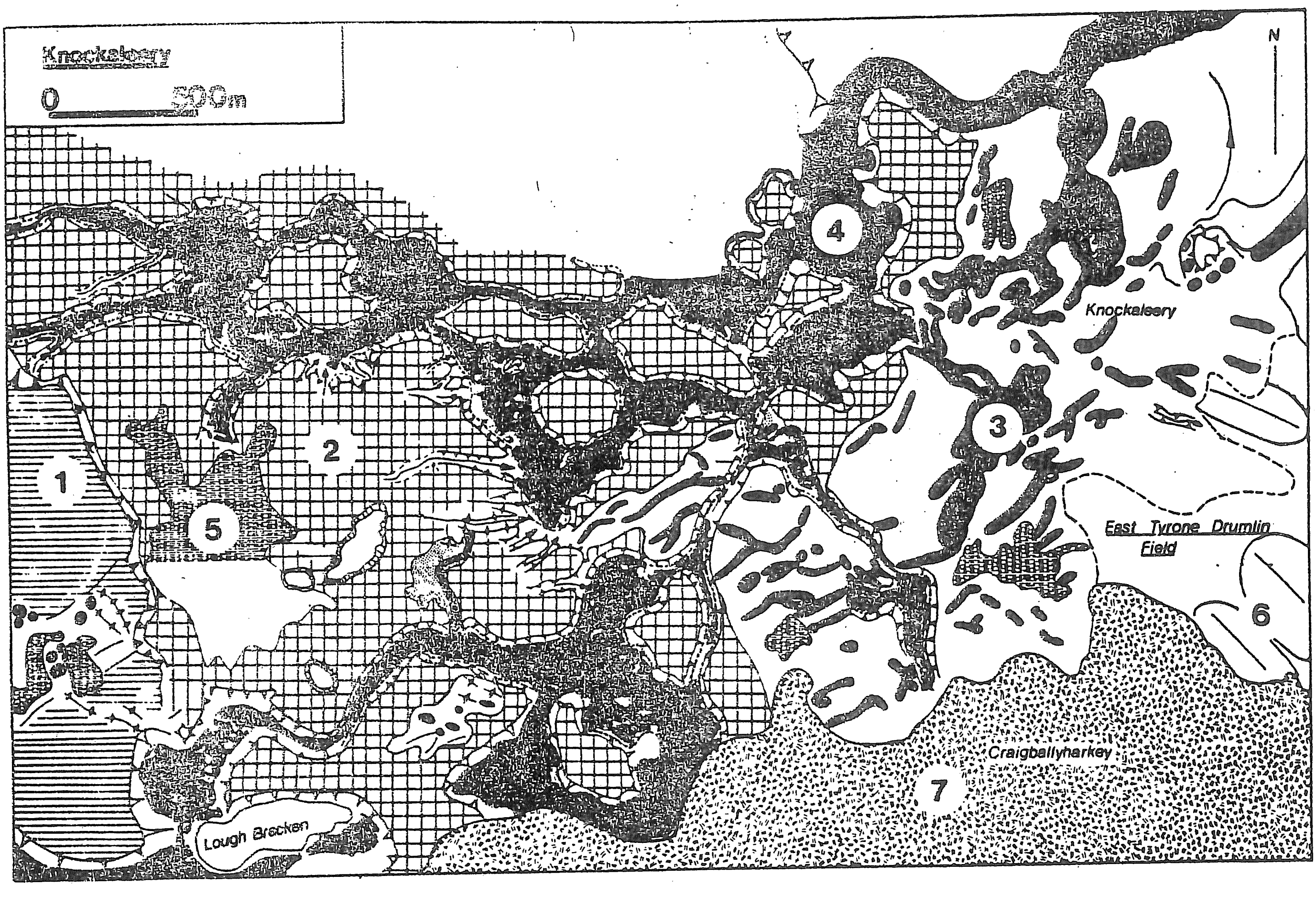


Fig. 9 Knockaleery.
1-7 as fig. 8.

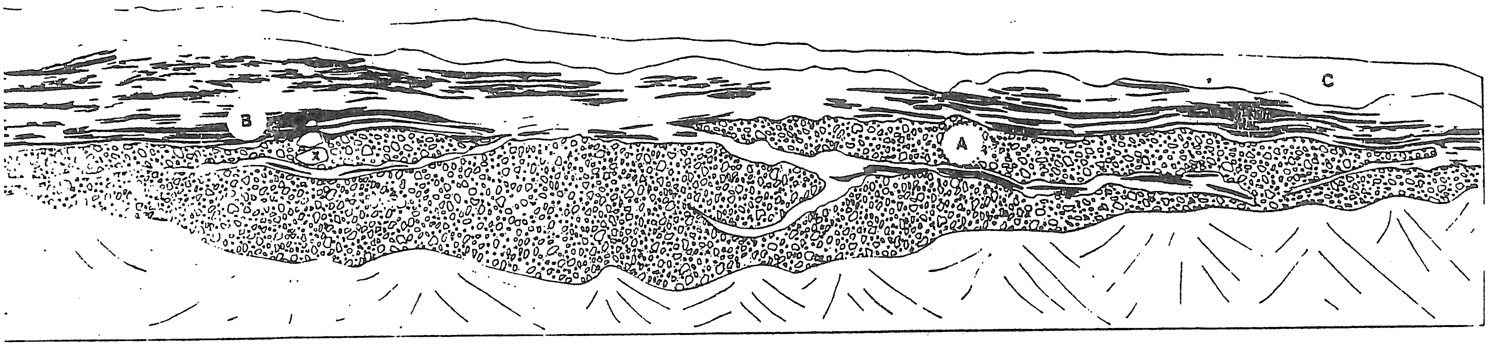


Fig. 10 Shale Quarry Dungannon.
A is flow till or waterlaid till(?); B = bottom deposits; C = soil.

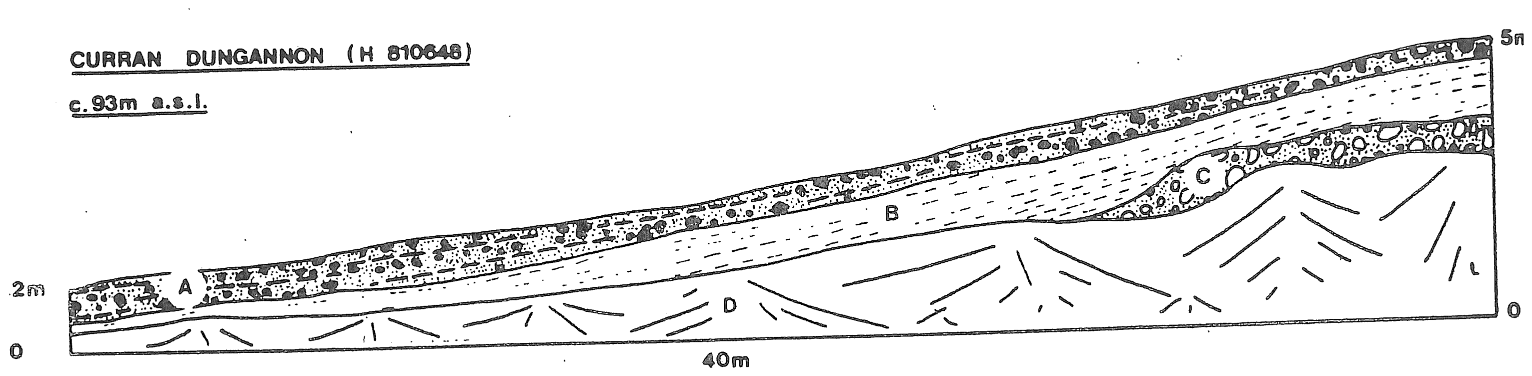


Fig. 11 Curran Dungannon.
A = flow till; B = laminated sands and silts; C = till unit;
D = talus.

## The lateglacial and pre-interference forest period of Co. Tyrone

(K.R. Hirons - Department of Geography and Palaeoecology Laboratory,
The Queen's University of Belfast).

There are, as yet, few published pollen diagrams from Co. Tyrone, those available being from the foothills of the Sperrin Mountains at Beaghmore (Mitchell, 1951; Pilcher 1969) and Ballynagilly (Pilcher and Smith, 1979). Nearby sites in Co. Londonderry (Pilcher, 1970, 1973; Smith, 1961) and an unpublished site at Sluggan Moss Co. Antrim (Goddard, 1971), provide comparative material for discussion. Other work of lateglacial importance from the North of Ireland centre on Lecale (Singh, 1970) and Roddan's Port (Morrison and Stephens, 1965) in Co. Down. These sites and others mentioned in the text are shown in Figure 1.

The division of pollen diagrams into pollen zones provides a convenient framework for discussion although, as will be seen, the chronological division of periods considered in this paper is still poorly defined. The recent revision of the Irish lateglacial period (Watts, 1977) is followed here, whilst the early postglacial zonation follows that of Jessen (1949) and Mitchell (1951)

### THE LATEGLACIAL PERIOD

Recent literature relating to the lateglacial period in Ireland has seen the abandonment of the tripartite zonation scheme (Jessen and Farrington, 1938; Jessen, 1949) in favour of the more flexible system of "pollen assemblage zones" (cf. Cushing, 1967). This alternative scheme attempts to define sedimentary sequences of characteristic fossil pollen composition without reference to any pre-existing system. Such assemblage zones are therefore only interpreted initially in terms of the "local pollen assemblages" from the individual sites from which they are derived, and contain no assumptions of synchroneity or climatic change (American Code of Stratigraphic Nomenclature, 1961). An Irish system of lateglacial regional pollen assemblage zones has been suggested by Watts (1977) whilst Craig (1973, 1978) has defined sub-regional type-sites for south-east Ireland. A simplified outline of the proposed system, comparison with the old pollen zones as adapted by Singh (1970), and a tentative dating scheme are illustrated in Figure 2. Such pollen assemblage zones have a spatial component as well as a temporal one and they show considerable variation within Ireland (Mitchell, 1976) and between Ireland and the British mainland (see Pennington, 1977). Correlation of pollen assemblage zones as defined above can only be undertaken given an acceptable chronology based for example, on radiocarbon dating. This reservation illustrates the speculative nature of exercises such as that attempted in Figure 2. It does, however, provide a useful basis for discussion.



In Co. Tyrone there are no published records of the investigation of lateglacial deposits and work now in progress at the Palaeoecology Laboratory of The Queen's University of Belfast, whilst covering both west and east Tyrone, is at a preliminary stage only. Figure 2 shows a composite, schematic pollen diagram of selected taxa found in these investigations as they compare with the two zonation schemes. In west Co. Tyrone, lateglacial lake deposits show basal zones with a Gramineae-Empetrum (grass-crowberry) pollen assemblage which seems to have no equivalent in the scheme of Watts. At this time Betula (birch) and Juniperus (juniper) pollen is relatively higher than in succeeding zones but, since both taxa are prolific producers of readily dispersed pollen and their representation is still low, this suggests that only small extra-local stands or long-range pollen transport are involved.

The zone is replaced by Artemisia - Caryophyllaecae (mugwort - pinks), Gramineae-Rumex (grass - sorrel), Juniperus - Filipendula (juniper - meadowsweet) and Betula - Salix - Dryopteris (birch - willow - fern) assemblages. The grass- heath community is thus replaced by tall herbs and then by successive communities indicating progressively increased stabilit

Empetrum pollen values are relatively high throughout the lateglacial and a characteristic peak in the pollen curves just below the Juniperus - Filipendula assemblage is also found at Cannons Lough, Co. Londonderry (Smith, 1961) and Glenveagh, Co. Donegall (Watts, 1977). Its presence at other sites, particularly from western Ireland, e.g. Roundstone (Jessen, 1949) and three sites investigated by Watts from Co. Clare and Co. Kerry (Watts, 1963), is notable. The prevalence of Empetrum pollen is characteristic of the lateglacial record of North-west Britain and is considered a function of oceanic influence (Jessen, 1949). There appears to be a characteristic succession of "peak zones" at this change from late to postglacial, clearly indicating transitional events for which the chronology and ecology are poorly understood.

At Glovers Quarry, Moneymore, Co. Londonderry (H868844) preliminary palynological investigations of a short late- and postglacial sequence indicates that the basal sediment is characterised by a Gramineae - *Empetrum* assemblage. This means that no deposits containing the preceeding *Juniperus* - *Empetrum* assemblage, which may represent the warmest phase of the lateglacial (see Watts, 1977) have been sampled. Here again *Empetrum* values are relatively high, tree pollen frequencies are low and *Salix* pollen is abundant.

Mackereth six metre cores (Mackereth, 1958) from both east and west Co. Tyrone (Loughs Catherine and Killymaddy) have shown full sequences of post-glacial deposits and have penetrated early postglacial *Betula* and *Juniperus* zones (Figs. 2 and 3; Edwards, this volume, Fig. 1). Killymaddy Lough (H783620) is an inter-drumlin lake and peripheral cones along with long cores from an adjacent lake, Weir's Lough (H784612, Fig. 3), show that inter-drumlin hollow lakes of this part of the mid- Ireland drumlin field contain thick, inorganic, lake-clays beneath postglacial organic muds. At Killymaddy Lough the upper lateglacial clay may be at least 2m thick at the periphery whilst at Weir's Lough a 9.5m core passed through 1.5m of grey-pink clay and penetrated a few centimetres into darker organic mud.

## CHRONOLOGY

Lateglacial deposits from the North of Ireland have been comprehensively dated at only two sites - Roddan's Port (Morrison and Stephens, 1965; Dresser 1970) and Sluggan Moss (Goddard 1971). Problems with dating of disturbed and highly minorogenic sediments (Dresser, 1970; Sutherland, 1980) mitigate against reliance on cross-correlation of these dates with the Co. Tyrone Sites. Organic debris has been shown to have been accumulating in the kettleholes of north-west Britain since c. 14 500 years bp (Pennington, 1970, 1975a; Coope and Brophy, 1972) and at many more sites before 13 000 years bp (Pennington, 1975, 1977). In Ireland the earliest lateglacial, published dates known to the author are later than this (Table 1). Lack of evidence, again, makes consideration of the dating of

Table 1 : Selected lateglacial dates

| Site | Source | Lab - no | Date (ybp) |
|---|---|---|---|
| Sluggan Moss | Goddard, 1971 | UB-299F | 12470 ± 125 |
| Roddan's Port | Morrison and Stephens 1965 | Q-360 | 12110 ± 150 |
| Coolteen | Craig, 1978 | D-109 | 1247 ± 155 |
| Belle Lake | Craig, 1978 | D-110 | 12235 ± 260 |



lateglacial- postglacial transitions in Co. Tyrone difficult, but a date of 9145 ± 185 bp (UB-239, K. Edwards, per. comm.) related to the *Corylus* (Zone V) maximum at Lough Catherine provides a minimum date. O'Connell (1980) has considered the lateglacial - postglacial pollen boundary approximately synchronous with other north-west European sites at 10 000 years bp and there is evidence from the north of Ireland to support this assertion (Goddard 1971; A. Goddard 1971). Pilcher (1973) has shown however, that altitudinal effects may modify both chronology and direction of vegetational changes. More detailed information regarding the lateglacial palaeoecology in this part of Ireland awaits the investigation of kettle-holes and esker-bound lakes of Mid-Tyrone and the Murrins.

## THE POSTGLACIAL PERIOD

The postglacial period is taken as beginning where the juniper curve begins to rise. It does so at the very bottom of the Lough Catherine diagram and a few samples from the base of the Weir's Lough profile. This is rapidly succeeded by a birch - willow zone. The three taxa were probably present in nearby refugia and a rapid amelioration of climate would have allowed them to spread over newly stabilised soils. The high proportion of juniper pollen is again characteristic of north-west Britain and results presented here tend to support the apparent increase in magnitude of the juniper pollen peak from the east to west of Ireland as suggested by Pilcher (1970). Proportions as high as 70 percent of total land pollen at Lough Catherine are usually associated with *Filipendula* pollen peaks together with evidence of *Dryopteris* and possibly other ferns. *Juniperus* requires open and disturbed soils for seedling establishment and it is likely that expanding birch and willow quickly supressed the juniper (Singh, 1970).

This period is clearly one of transition in Co. Tyrone since proportions of *Salix* and *Betula* pollen are increasing whilst the remnants of the lateglacial herbaceous flora decline. The declining pollen types are *Empetrum*, *Rumex*, Caryophyllaceae and Ranunculaceae. By the start of the Boreal period, *Empetrum* is no longer evident in the pollen record and proportions of grass and sedge are at a minimum.

Throughout these first two postglacial zones (collectively the pre-Boreal zone IV) the existence in the lake sediments of shells, the deposition of marl (Killymaddy Lough) together with the chemical analysis of lake-sediments, show that active leaching of soil-substratum minerals was in progress. The situation changes rapidly as the *Betula* and *Corylus* assemblages proceed and the nutrient cycling of soils appears to be stabilised. Lake deposits become highly organic and are comprised largely of autochthonously produced organic matter and inwashed or eroded organic material is at a minimum. These factors lead to extremely low rates of sediment accumulation and in the lakes of both east and west Tyrone the sedimentary record is much compressed from here until the period of early agriculture.

The appearance of hazel at the expense of birch and willow marks the immigration of the first component of the mixed oak forest. Migration was very rapid and it is possible that Corylus refugia may have been very near to Northern Ireland, perhaps off the west Wales coast with others possibly in the Mayo-Sligo area (Farrington, 1954; Deacon, 1974). Corylus remains the dominant species in the pollen record until the true forest trees arrived in the area. First to arrive was Ulmus (elm), followed quite closely by Quercus (oak) accompanied by a characteristic rise in Pinus (pine) and, somewhat later, Alnus (alder).

Jessen's zone V, characterised by the Corylus expansion, is a zone which is little represented in the lacustrine deposits of east or west Co. Tyrone, a factor which can perhaps be attributed to low resolution resulting from the slow accumulation rates for such sediments. Zone VI, the later Boreal period and all of its sub-zones are well represented. This period encompasses the hazel maximum (VIa), the first elm maximum (VIb) and the pine maximum with hazel minimum (VIc). At Lough Catherine the Pinus and Quercus pollen frequencies increase at the apparent expense of Corylus and to a lesser extent Ulmus values. Oldfield (1965) suggests that a similar event in north-west England may be a consequence of soil development but it could result from climatic dryness or the ability of pine to colonise bog surfaces (cf. Birks, 1975). The hazel pollen decline itself may be an artifact of proportional pollen data presentation (Smith, 1970).

The question of long-range pollen transport of Pinus is problematical. An examination of Figure 1 in Edwards (this volume) and Figure 3 (this paper) shows that at this time, pine was far more important at Lough Catherine that at Weir's Lough. This contrast suggests that conditions in the sand and gravel soils near Lough Catherine were more suitable for Pinus than the relatively base-rich till soils near Weir's and Killymaddy Loughs. When pollen proportions of such a widely dispersed type as Pinus are at the low levels found at Weir's Lough, it is difficult to assess whether Pinus was a member of the local flora at all, though a few small pine stumps



were observed when the water level of Lough Eskragh (H773618) was lowered in 1952 and 1973 (M. Baillie. per. comm., see also Collins and Seaby, 1960). As Lough Eskragh is about 1 km from Weir's Lough, such trees may well have contributed to the pollen rain. The boggy areas of the Sperrin foothills to the north of Weir's Lough would appear to have provided suitable habitats for the pine and explain the higher Pinus percentages in the relevant pollen diagrams (Pilcher, 1970, 1973; Pilcher and Smith, 1979).

The next major change in the composition of the postglacial forests occurs with the appearance of Alnus pollen and its rapid expansion to 20-30 per-cent of the total land pollen sum. Alder pollen is more abundant at the smaller lakes in east Tyrone than the site at Lough Catherine, perhaps due to over representation by local stands. The Lough Catherine profile is in closer agreement with investigations of the Tyrone peats such as Slieve Gallion. At Lough Catherine as at many sites in Britain, the beginning of the major Alnus expansion is also the period of the Pinus pollen maximum which, after expanding throughout zones V and VI begins to decline as the alder pollen increases its representation. These changes signify the Boreal-Atlantic transition (Mitchell, 1951) which, although generally accepted as a consequence of increased climatic wetness, has been found to vary considerably when the pollen zone boundary has been dated by the radiocarbon method (Smith, 1970; Smith and Pilcher, 1973; Turner et al., 1973). This phenomenon is presumably a local expression of the climate-vegetation-soils- migration complex with lowland sites being dated in some cases millenia earlier than upland sites. Absolute pollen investiga-tions may help to determine to what extent these variations relate to the proportional nature of the pollen data.

It is generally accepted that the replacement of pine pollen by that of alder in the palynological record is not simply reflected in vegetational terms since the species' ecological requirements suggest they would not come into direct competition. The increased wetness of the Atlantic period is considered to have favoured the spreading of alder whilst the decline of pine may have resulted from the expansion of elm and oak woodland (Smith, 1972, Oldfield, 1965). In other circumstances a reduction of Pinus could be effected by the increase in bog wetness or its spread, leading to the demise of pine growing on raised/blanket bogs and marginal soil sites (cf. Birks, 1975).

The Atlantic period, Irish Zone VII, is considered to be one of relative stability (Smith, 1970) and evidence from the lake sediments of Co. Tyrone suggests that the period was one of stable soils with few events reflected in the pollen record. Mesolithic man was, however, certainly present in Ireland (Mitchell, 1976) although his environmental impact, if any, has yet to be convincingly demonstrated (Edwards, this volume). Fraxinus (ash), the last major native tree, begins to appear in the pollen record towards the end of the Atlantic period, presumably expanding from refugia, in forest openings characterised by base-rich soils (Birks, 1979). Jessen (1949) had devided Zone VII into two sub-zones subsequently added to and adapted by Mitchell (1965). As more detailed work is carried out it becomes clear that local edaphic and altitudinal variations make individual sites more difficult to fit into a rigid scheme (see O'Connell, 1980). More work is required to examine the effects of these two variables in Co. Tyrone. Pilcher's work at Slieve Gallion (1973) is particularly interesting in this respect.

## CHRONOLOGY

The establishment chronology for the forest trees of the Northern Irish postglacial period is really a chronology of invasion and expansion. This complex subject is now under investigation in the Department of Geography, The Queen's University of Belfast, by M.M. Crucickshank. Although no systematic effort has yet been directed at examining synchroneity of the pollen zone boundaries in a small area, the data available at present show that most of the boundaries are time-transgressive. Whilst later events, notably the Ulmus decline and possibly the final Pinus decline, may be less diachronous, clearly proximity of refugia, rates of dispersion and colonisation, edaphic and topographic factors, are primary controls affecting time of arrival (Watts, 1973). These must make synchroneity the exception rather than the rule (as Smith and Pilcher, 1973, point out the less diachronous horizons are declines rather than arrivals) and the evidence suggests this to be true.

These factors must also account for the supposed failure of other forest trees, notably Fagus (beech) and Tilia (lime), to enter Ireland before the inundation of postglacial land-bridges (Mitchell, 1976), though arguments for their actual presence have been advanced by A. Goddard (1971).



## REFERENCES


AMERICAN COMMISION ON STRATIGRAPHIC NOMENCLATURE, 1961, Code of Stratigraphic Nomenclature, Bull, Am. Assoc. Petrol. Geol., 45, 645-665.

BIRKS, H.H., 1975, Studies in the Vegetational History of Scotland, IV. Pine stumps in Scottish blanket peats., Phil. Trans. R. Soc. Lond., B270, 181-226.

BIRKS, H.J.B., 1977, The Flandrian Forest History of Scotland : a preliminary synthesis, in Shotton, F.W. (ed), British Quaternary Studies; Recent Advances, (Oxford University Press), 119-135.

CASE, H.J., DIMBLEBY, G.W., MITCHELL, G.F., MORRISON, M.E.S., and PROUDFOOT, V.B., 1969, Land-use in Goodland Townland, Co. Antrim from Neolithic times until today, J. Soc. Antiq. Ireland, 99, 39-53.

COLLINS, A.E.P., and SEABY, W.A., 1960, Structures and small finds discovered at Lough Eskragh, Co. Tyrone. Ulster J. Arch., 23, 25-37.

COOPE, G.R., and BROPHY, J.A., 1972, Late-glacial environmental change indicated ay a coleopteran succession from North Wales, Boreas, 1, 97-142.

COOPE, G.R., DICKSON, J.H., McCUTCHEON, J.A., and MITCHELL, G.F., 1979, The lateglacial and early postglacial deposit at Drumurcher, Co. Monaghan. Proc. R. Ir. Acad., 79B, 63-85.

COOPE, G.R., and JOACHIM, M.J., 1980, Lateglacial environmental changes interpreted from fossil caleoptera from St. Bees, Cumbria N.W. England. In J.J. Lowe, Gray, J.M., and Robinson, J.E., (eds), Studies in the lateglacial of North-West Europe, (Pergannon : Oxford).

CRAIG, A.J., 1973, Studies in the Ecological history of South-East Ireland using pollen influx analysis and other methods, Ph.D. thesis, Trinity College Dublin.

CRAIG, A.J., 1978, Pollen percentage and influx analyses in S.E. Ireland. A contribution to the ecological history of the Late-glacial period, J.Ecol., 66, 297-324.

CUSHING, E.J., 1967, Late Wisconsin Pollen Stratigraphy and the Glacial Sequence in Minnesota, In Cushing, E.J., and Wright, H.E., (eds), Quaternary Palaeoecology, (New Haven : Yale U.P.), 59-88.

DEACON, J., 1974, The location of Refugia of Corylus avellana. L., during the Weichselian Glaciation, New. Phytol., 73, 1055-1063.

DIMBLEBY, G.W., 1962, The Development of British Heathlands and their soils, Oxford Forestry Memoirs, No 23.

DRESSER, P.Q., 1970, A Study of Sampling and Pretreatments of Materials for Radiocarbon Dating, Ph.D. thesis, Q.U.B.

FARRINGTON, A., 1954, Glacial refuges off the West coast and within the country, in Charles-Worth J.K. (ed), The History of the Irish Flora and Fauna, Adv.Sci., 10, 40-41.

GODDARD, A., 1971, Studies of the Vegetational Changes Associated with Initiation of Blanket Peat Accumulation in North-East Ireland, Ph.D. thesis, Q.U.B.

GODDARD, I.C., 1971, The Palaeoecology of some sites in the North of Ireland, M.Sc. thesis, Q.U.B.

GODWIN, H., 1956, The History of the British Flora, (Cambridge University Press).

JESSEN, K., 1949, Studies in Late Quaternary Deposits and Floral History of Ireland, Proc. R. Ir. Acad., 52B 85-290.

JESSEN, K. and FARRINGTON, A., 1938, The Bogs at Ballybetagh, near Dublin, with remarks on Late-Glacial conditions in Ireland, Proc. R. Ir. Acad., 44B, 205-260.

MACKERETH, F.J.H., 1958, A portable Core Sampler for Lake Deposits, Limnol. Oceanogr., 3, 181-191.

MITCHELL, G.F., 1951, Studies in Irish Quaternary deposits; No 7, Proc. R. Ir. Acad., 53B, 111-206.

MITCHELL, G.F., 1965, Littleton Bog Tipperary : An Irish Vegetational Record. Geol. Soc. Amer. Spec. Pap. 84, 1-16.

MITCHELL, G.F., 1976, The Irish Landscape, (Collins : London).

MORRISON, M.E.S. and STEPHENS, N., 1965, A submerged Late-Quaternary deposit at Roddan's Port on the North-East coast of Ireland. Phil. Trans. R. Soc. Lond., B. 249, 221-255.

O'CONNELL, M., 1980, The Developmental History of Scragh Bog, Co. Westmeath and the Vegetational History of its Hinterland. New Phytol., 85, 301-319.



OLDFIELD, F., 1965, Problems of mid post-glacial pollen zonation in part of North-West England, J. Ecol., 53, 247-60.

PENNINGTON, W., 1970, Vegetational History in the North-West of England, Walker, D., and West, R.G., (eds), Studies in the Vegetational History of the British Isles, (Cambridge University Press), 41-79.

PENNINGTON, W., 1975, A Chronostratigraphic comparison of Late-Weichselian and Late-Devension subdivisions; illustrated by two radio-carbon dated profiles from Western Britain, Boreas, 4, 157-171.

PENNINGTON, W., 1975a, Climatic changes in Britain, as interpreted from lake sediments between 15 000 and 10 000 years ago, Palaeolimnology of Lake Biwa and the Japanese Pleistocene, 3, 536-569.

PENNINGTON, W., 1977, The Late Devensian flora and vegetation of Britain; Phil. Trans. R. Soc. Lond., B 280, 247-71.

PILCHER, J.R., 1969, Archaeology, palaeoecology and 14C dating of the Beaghmore stone circle site, Ulster J. Arch., 32, 73-90.

PILCHER, J.R., 1970. Palaeoecology and Radiocarbon dating of sites in Co. Tyrone, Northern Ireland, Ph.D. thesis, Q.U.B.

PILCHER, J.R., 1973, Pollen Analysis and Radiocarbon dating of a peat on Slieve Gallion, Co. Tyrone, Northern Ireland, New Phytol., 72, 681-689.

PILCHER, J.R., and SMITH, A.G., 1979, Palaeoecological Investigations at Ballynagilly, A Neolithic and Bronze Age settlement in County Tyrone, Northern Ireland, Phil. Trans, R. Soc. Lond., B 286, 345-369.

PROUDFOOT, V.B., 1958, Problems of soil History, Podsol development at Goodland and Torr Townlands, Co. Antrim, Northern Ireland. J. Soil. Sci., 9, 187-197.

SINGH, G., 1970, Late-glacial vegetational history of Lecale, Co. Down, Proc. R. Ir. Acad., 69B, 189-216.

SMITH, A.G., 1961, Cannons Lough, Kilrea, Co. Derry : Stratigraphy and Pollen Analysis, Proc. R. Ir. Acad., 61B, 369-383.

SMITH, A.G., 1970, Late and post-glacial vegetational and climatic history of Ireland : a review, in Stephens, N., and Glassock, R.E., (eds), Irish Geographical Studies, (Queen's University : Belfast), 65-88.

SMITH, A.G., and PILCHER, J.R., 1973, Radiocarbon dates and Vegetational History of the British Isles, New Phytol., 72, 703-914.

SMITH, R.T., 1972, A reconsideration of the role of climate in the development of post Weichselian forest types, in Taylor, J.A., (ed), Research Papers in Forest Meteorology, (Aberystwyth).

TURNER, J., HEWETSON, V.P., HIBBERT, F.A., LOWRY, K.H. and CHAMBERS, C., 1973, The History of the Vegetation and Flora of Widdybank Fell and the Low Green Reservoir basin, Upper Treesdale, Phil. Trans. R. Soc. Lond., B 265, 327.

WATTS, W.A., 1963, Late glacial pollen zones in Western Ireland, Ir. Geogr. 4, 367-376.

WATTS, W.A., 1973, Rates of change and stability in Vegetation in the perspective of long periods of time, in Birks, H.J.B., and West, R.G., (eds), Quaternary Plant Ecology, (Blackwell : Oxford), 195-206.

WATTS, W.A., 1977, The Late Devensian Vegetation of Ireland, Phil. Trans. R. Soc. Lond., B 280, 273-293.


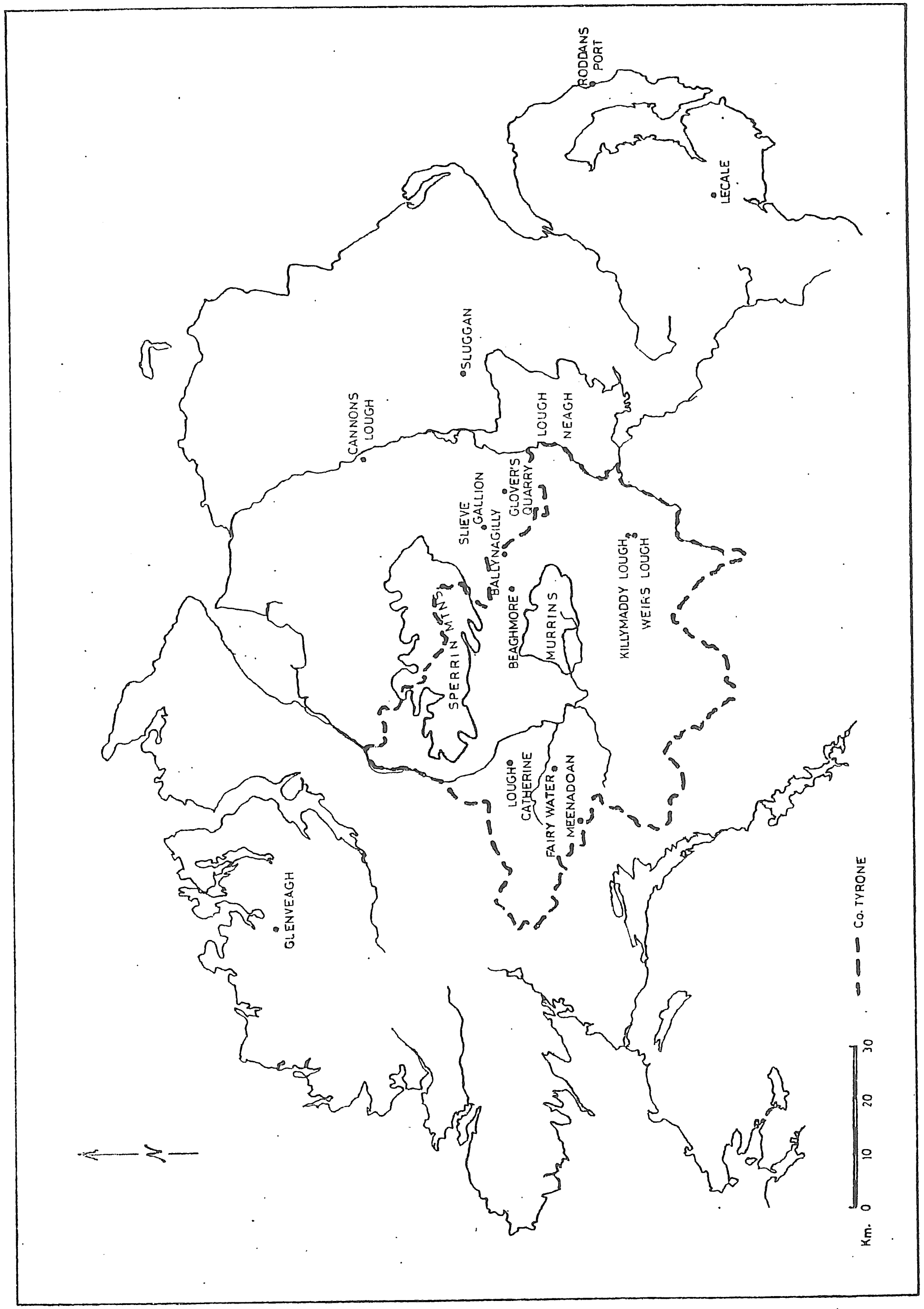


Fig. 1 Sites mentioned in the text

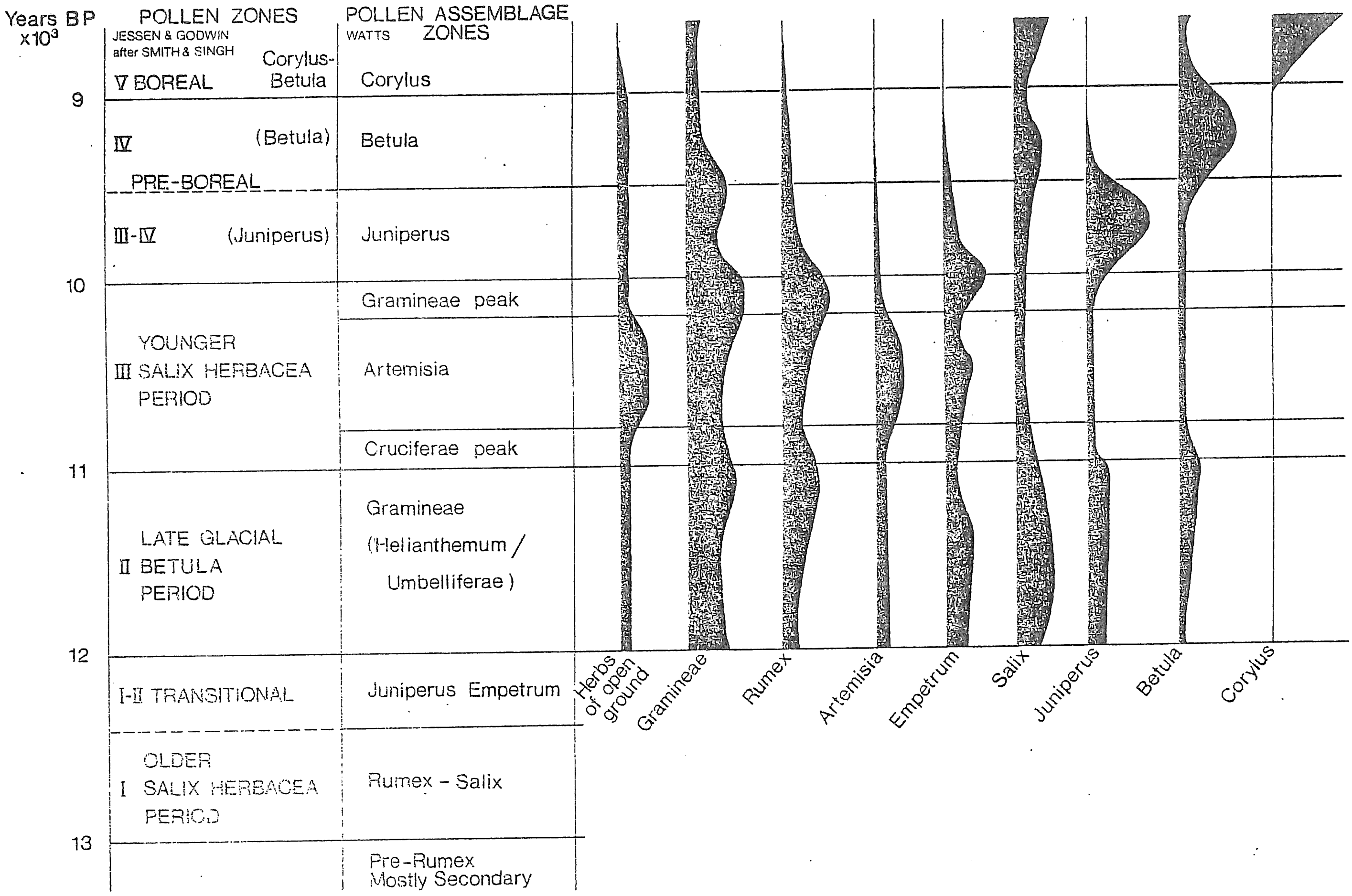


Fig. 2 Comparison of lateglacial zonation systems and schematic pollen diagram for selected taxa from Co. Tyrone



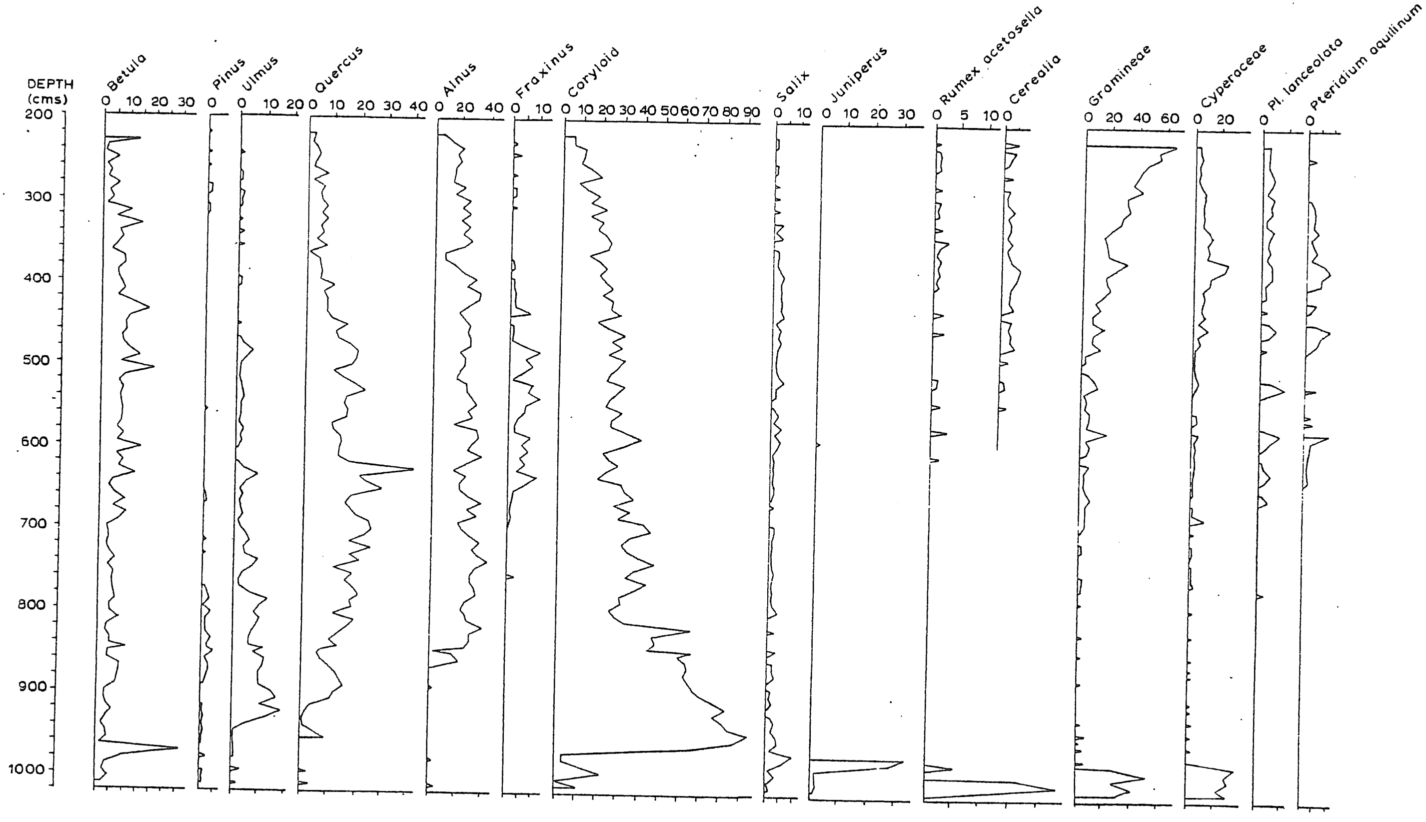


Fig. 3 Pollen diagram from Weir's Lough, Co. Tyrone - selected taxa

## Vegetational changes associated with man in Co. Tyrone

(K.J. Edwards - Department of Geography and Palaeoecology Laboratory, The Queen's University of Belfast)*

The forest complex which existed until the mid-postglacial period (Littletonian stage) in Co. Tyrone (Hirons, this volume) would appear to have undergone subsequent changes of types usually associated with the influence of man. These changes were, however, relatively gradual though their ultimate effect has been to alter the vegetational landscape of Tyrone out of all recognition from its primeval state. The evidence for the erstwhile flora of mid-Ulster is unfortunately based on only a few published pollen diagrams (Fig. 1, Hirons) supplemented by unpublished work by the writer and Mr. Robert Larmour of the Palaeoecology Laboratory and Geography Department of The Queen's University of Belfast.

The earliest modifications to the early woodland in Co. Tyrone have been suggested for the settlement site a Ballynagilly (8 km west of Cookstown). The elm decline here is estimated by interpolation from radiocarbon determinations to have occurred around 3270 bc but this is preceded by short-term pollen fluctuations extending back to about 3700 bc (Pilcher and Smith, 1979). A temporary decline for the pollen curves of Betula (birch) and Corylus (hazel), peaks for such non-arboreal taxa as Cyperaceae and Umbelliferae together with some Chenopodiacea pollen, and a single cereal-sized grass pollen grain may indicate the presence of man. These levels coincide with the first macrofragments of charcoal to be found in the peat core and compare closely with four 'Early Neolithic' $^{14}C$ dates from archaeological contexts at the site. Ecologically, the pollen record does not point to undoubted anthropogenic interference but similar pre-Ulmus decline perturbations were detected (though with the added occurrence of the cultural indicator pollen of Plantago lanceolata) at the Co. Antrim sites of Newferry (Smith and Collins, 1971) and Ballyscullion (Smith, 1975). The cultural assignation of possible signs of initial human impact in Northern Ireland is further complicated by the discovery of polished stone axes in Mesolithic contexts at Newferry, Co. Antrim, dating back to around 5500 bc (Woodman, 1978) as well as circular wooden dwellings at Mount Sandel, Co. Londonderry, dating from 7000 bc (Woodman, 1971).

* Present address: Department of Geography, University of Birmingham.



Less problematic in terms of cultural dating, though ever elusive regarding causative explanation is the phenomenon of the elm decline. In Co. Tyrone seven estimates of the date for the decline in elm pollen frequencies are available (Table 1). All of the dates fall within the

Table 1 : Elm decline dates for Co. Tyrone

| Site | Source | Lab-no | Date (ybp) | Comments |
|---|---|---|---|---|
| Meenadoan Bog | Pearson, 1979 | UB-2110 | 4810±125 | |
| Fairy Water | Larmour | UB-2234 | 4860±90 | Late part of decline |
| Lough Catherine II | Edwards | UB-2266 | 5280±80 | Centre of lake |
| Lough Catherine VI | Edwards | UB-2386 | 5190±95 | Side of lake |
| Beaghmore | Pilcher, 1969 | UB-99 | 5285±70 | |
| Ballynagilly | Pilcher and Smith, 1979 | UB-253 | 5145±70 | |
| Slieve Gallion | Pilcher, 1973 | UB-275 | 4695±65 | |

range for the elm decline found at other sites from within the British Isles. If this horizon is truly synchronous (see discussion in Smith and Pilcher, 1973) then the differences may be ascribed to variations in the nature of the material dated (different peat types or lake muds) or the limits of the radiocarbon method. The difference in the $^{14}C$ determinations for the two Lough Catherine samples may be especially noted in these respects. If, however, Neolithic peoples were primarily responsible for the elm decline as is now generally accepted (Godwin, 1975; Mitchell, 1976) then it should not be too surprising to discover that early communities practicing similar forms of agriculture were in different places at different times - the dates do, after all, span half a millenium even without dendrochronological correction! A feature common to the elm decline portions of detailed pollen diagrams from Tyrone is the reduction of Pinus (pine) values and expansions in frequencies for Betula (birch), Quercus (oak), Alnus (alder) and sometimes Coryloid (probably hazel) pollen. This would argue for elm growing in quite pure stands on fertile soils and its selective removal or utilization for agricultural purposes. The expansions in representation for the other arboreal taxa is thus inferred to be a statistical artifact of the pollen percentage calculations - as yet pollen influx diagrams have not been constructed but work on absolute pollen frequencies from Lough Catherine (Edwards and Larmour) is in preparation. This does not explain the reduction in Pinus values. This might suggest that fast spreading pine had successfully colonised good soils in the pre-man period and was being removed along with the elm (though it is unlikely to have stood on the same sites as the Ulmus). Accidental burning of pine or its domestic use has also been proposed for the upland sites of Tyrone (Pilcher, 1975).

The longevity and nature of prehistoric clearance phases in east Co. Tyrone and west Co. Antrim have been discussed by Pilcher et al.,(1971). Three early stages are distinguished from the elm decline onwards with clearance and possible arable farming (100 to 400 years) leading on to mainly pastoral farming with some regeneration (150 to 200 years) and finally forest restoration over a 50 to 100 year period. At Lough Catherine in west Co. Tyrone the primary episode is marked by indications of pastoral rather than arable activity, with pastoral and arable agriculture appearing to distinguish a subsequent and partial regeneration phase. The specific nature and purpose of the clearance process in pollen diagrams are very difficult to determine with a high degree of confidence and in addition the long duration of clearance phases such as are found in Tyrone argues for a continuity of practice in different areas close to the sampling sites (Edwards, 1979).

An indication of the impact on the landscape at this time is provided by additional sedimentary analyses at Lough Catherine. The elm decline coincides with an increase in inorganic bases (e.g. potassium) and a fall in the organic carbon content of the sediments, suggesting a surfeit in erosional mineral input into the lake (Mackereth, 1966). There is also a rise in magnetic susceptibility values which probably results from the increased erosion of catchment soils containing ferrimagnetic minerals - this can be compared with the similar findings regarding human impact at Lough Neagh further east (Thompson et al., 1975). To these data can be added the fact that the depth-time curve at Lough Catherine steepens after the elm decline providing further evidence for the disturbance and erosion of catchment soils resulting from the agricultural activity of Neolithic peoples.

These Neolithic clearances proper were subject to woodland recovery



almost to the extent of full regeneration from the Beaker and early Bronze Age periods onwards (around 2000 bc) up to the Iron Age (c.500 bc). Total tree pollen frequencies began to drop from about 90 to 70 percent of the total land pollen sum in most lowland pollen diagrams. The principal reductions continued to occur to elm and pine representation though many diagrams also display adverse trends for other taxa, for example in alder, oak and birch at the east Tyrone sites of Ballynagilly and Beaghmore, and oak at the more westerly sites of Fairy Water and Lough Catherine. Constant values or proportional rises in Alnus and Coryloid representation in the Beaghmore and Lough Catherine diagrams are probably a result of percentage calculations. In the case of the Coryloid curves, this may partly arise from the spread of Myrica gale, the bog myrtle, whose pollen is difficult to separate from that of Corylus avellana, the hazel. This is particularly likely at this time since the place of the arboreal taxa in the pollen record is increasingly usurped by herbaceous types indicative of boggy and impoverished land, notably the Cyperaceae (sedges) and Ericaceae (heaths, mostly heather). This pattern occurs around 500 bc at Fairy Water, a few centuries ad at Lough Catherine and much earlier at Beaghmore (c. 2050 bc) and Ballynagilly (c.200 bc), with around 2200 bc for the upland site of Slieve Gallion. These temporal differences may result from a multiplicity of factors which could conceivably influence the degeneration of soils and the spread of blanket peats which cloak many of the Tyrone slopes. The possibility that intensified or merely continuous farming in the Bronze and Iron Ages led to soil deterioration, waterlogging and encouraged peat formation must be compounded with the factors of differential topography, soils and settlement location. The probability of climatic deterioration acting as a backdrop and prompt to this scenario must also be considered. Like the elm decline, the landscape deterioration of the later Bronze and Iron Ages is another tantalising imponderable.

The transition to the historical period at Lough Catherine is marked very strikingly by peaks in chemical and magnetic indicators of erosion and after about 800 ad, a reversed suite of radiocarbon dates. This is probably explained by the erosion of soils containing old carbon and has been found in Lough Neagh (O'Sullivan et al., 1973) as well as elsewhere in the British Isles (Pennington et al., 1976; Edwards and Rowntree, 1980). At Lough Catherine the disturbance occurs after increased cereal representation in the pollen record. The process might best be viewed as a legacy of sustained agriculture over many centuries rather than as a discrete event beginning shortly before the Anglo-Norman Conquest.

The historical period in Co. Tyrone is not so well served by palynology owing to the unpredictable (and frequent cessation) of peat growth at bog sites and the general swamping effect of wetland pollen taxa as non-tree pollen values decrease to the levels expected from open landscapes. The increased presence of cereal pollen at many sites attests to the importance of a mixed agricultural economy up to the present day. The rise in values for pine, beech, lime, sycamore and spruce at the top of the pollen diagram from Lough Catherine derives from woodland planted in the eighteenth century on the Baronscourt Estate which surrounds the lake's catchment. In general, the vegetation history of the recent past, certainly as far as woodland is concerned, is best investigated from documentary sources (Praeger, 1934; McCracken, 1971).

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REFERENCES

EDWARDS, K.J. 1979, Palynological and temporal inference in the context of prehistory, with special reference to the evidence from lake and peat deposits, J. Arch. Sci., 6, 255-270.

EDWARDS, K.J. and ROWNTREE, K.M. 1980, Radiocarbon and palaeoenvironmental evidence for changing rates of erosion at a Flandrian stage site in Scotland, in Cullingford, R.A., Davidson, D.A. and Lewin, J. (eds), Timescales in Geomorphology, (John Wiley: Chichester), 207-223.



GODWIN, H. 1975, History of the British Flora, 2nd ed., (Cambridge University Press).

MACKERETH, F.J.H. 1966, Some chemical observations on post-glacial lake sediments, Phil. Trans. R. Soc. Lond., B.250, 165-213.

McCRACKEN, E. 1971, The Irish Woods since Tudor Times, (David and Charles: Newton Abbot).

MITCHELL, F. 1976, The Irish Landscape, (Collins: London).

O'SULLIVAN, P.E., OLDFIELD, F. and BATTERBEE, R.W. 1973, Preliminary studies of Lough Neagh sediments, I. Stratigraphy, chronology and pollen analyses, in Birks, H.J.B. and West, R.G. (eds.), Quaternary Plant Ecolcgy, Blackwell: Oxford), 267-278.

PEARSON, G.W. 1979, Belfast Radiocarbon Dates IX, Radiocarbon, 21, 274-290.

PENNINGTON, W., CAMBRAY, R.S., EAKINS, J.D. and HARKNESS, D.D. 1976, Radionuclide dating of the recent sediments of Blelham tarn, Freshwater Biol., 6, 317-331.

PILCHER, J.R. 1969, Archaeology, palaeoecology and $^{14}C$ dating of the Beaghmore stone circle site, Ulster J. Arch., 32, 73-91.

PILCHER, J.R. 1973, Pollen analysis and radiocarbon dating of a peat on Slieve Gallion, Co.Tyrone, Northern Ireland, New Phytol., 72, 681-689.

PILCHER, J.R. 1975, Speculations on Neolithic land clearance, Ir. Arch. Res. Forum,11, 1-6.

PILCHER, J.R., SMITH, A.G., PEARSON, G.W. and CROWDER, A. 1971, Land clearance in the Irish Neolithic : new evidence and interpretation, Science, 172, 560-562.

PILCHER, J.R. and SMITH, A.G. 1979, Palaeoecological investigations at Ballynagilly, a Neolithic and Bronze Age settlement in County Tyrone, Northern Ireland, Phil. Trans. R. Soc. Lond., B.286, 345-369.

PRAEGER, R.Ll. 1934, The Botanist in Ireland, (Hodges, Figgis : Dublin).

SMITH, A.G. 1975, Neolithic and Bronze Age landscape changes in Northern Ireland, in Evans, J.G., Limbrey, S. and Cleere, H. (eds.), The Effect of Man on the Landscape : The Highland Zone, C.B.A. Res. Rep. II, 64-74.

SMITH, A.G. and COLLINS, A.E.P. 1971, The Stratigraphy, palynology and archaeology of the diatomite deposits at Newferry, Co. Antrim, Northern Ireland, Ulster J. Arch., 34, 3-25.

SMITH, A.G. and PILCHER, 1973, Radiocarbon dates and vegetational history of the British Isles, New Phytol., 72, 903-914.

THOMPSON, R., BATTARBEE, R.W., O'SULLIVAN, P.E. and OLDFIELD, F. 1975, Magnetic susceptibility of lake sediments, Limnol. Oceanog., 20, 687-698.

WOODMAN, P. 1977, Mount Sandel, Current Arch., 5, 372-376.

WOODMAN, P.C. 1978, The chronology and economy of the Irish Mesolithic : some working hypotheses, in Mellars, P. (ed.), The Early Postglacial Settlement of Northern Europe (Duckworth : London), 333-369.



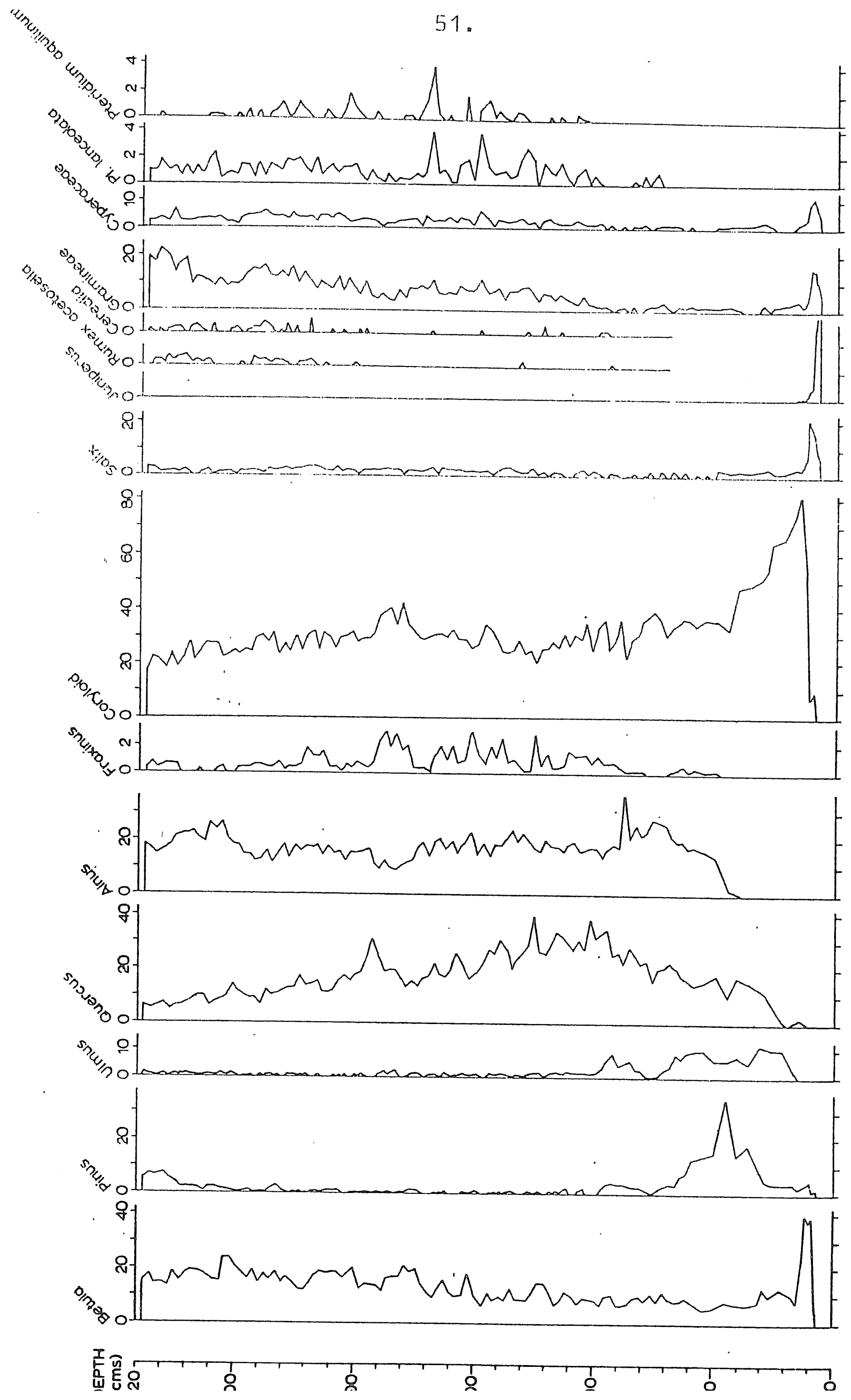


Fig. 1 Pollen diagram from Lough Catherine, Co. Tyrone - selected taxa

## Prehistoric Archaeology in Co. Tyrone

(P.C. Woodman - Department of Antiquities, The Ulster Museum)

Considering the size of Co. Tyrone and the topographical variation in the landscape - from the Mourne Valley to the shores of L. Neagh and from Gortin Glen to Clogher Valley - it is hardly surprising that it is difficult to present a coherent picture of the prehistory of this area. With its low population level and its distance from major areas of population, Co. Tyrone has not received, with notable exceptions, much attention during the 1960's and 1970's when rescue has been the main reason for excavation.

### MESOLITHIC

Our knowledge of the Mesolithic period in Tyrone could best be described as nominal as there are only two recorded find spots from the county. If adjacent areas are included, however, then the number of sites increases slightly. All of these lie on the eastern edge of the area.

Two excavations - Tullywiggan Co. Tyrone and Coney Island in Lough Neagh (Woodman, 1978), have produced Early Mesolithic material of a type similar to that found at Mount Sandel, i.e. geometric microliths. In both instances these excavations have inadvertently produced material from what would appear to be transitory sites. In the case of Tullywiggan this may have been only a couple of composite implements. Material from these sites can be presumed to date to before 6000 bc.

The more heavy bladed Later Mesolithic is represented by scatters of material on the shores of Lough Eskragh (Collins and Seabey, 1960) and dredged up from the mouth of the Ballinderry River (Woodman, 1978).

It is significant that the Cookstown area which has been covered thoroughly by Brennan, Barnett and Freeburn as well as the adjacent Draperstown area examined by Gunn, have produced no distinctive Mesolithic material, therefore while we can be certain that the Mesolithic of Tyrone still awaits discovery, its distribution, like that of Antrim, could be orientated towards lake and riverside sites.

While the presence of flint is not usually the determining factor in the areas settled by prehistoric man it can allow prehistoric sites to be found through surface collecting. Thus sites in the east of the county would be more easily found while flint would be curated in the west and



other raw materials might even be substituted.

### NEOLITHIC

As significant concentrations of Neloithic material are found in several parts of the county, this period does not suffer from the problems of the preceding Mesolithic. The difficulty is in providing a theme for the Neolithic. While the eastern sites are partially tied in with recent research those in the Baronscourt area in the north-west are associated with the earlier work of Davies.

Obviously one must begin any examination of the Neolithic with Ballynagilly, near Cookstown (ApSimon, 1975). Here a Neolithic settlement has been dated to the 4th millenium bc while the remains of a house, perhaps part of a larger more substantial structure, has been dated to 3200 bc. Several $^{14}C$ dates indicate that there could be a significantly earlier phase of occupation. The interpretation of this group of dates is crucial to our understanding of the inception of the Irish and British Neolithic. While faunal remains are absent from this site, work on pollen analysis suggests that extensive clearances may have been made in this area and held open for a significant length of time. Whatever the role of arable farming in the initial clearance phase, grazing seems to have been the most important factor in keeping the clearance(s) open (Pilcher and Smith, 1979).

There are other sites which could belong to the earlier part of the Neolithic, i.e. before 2500 bc. At Beaghmore (Pilcher, 1969), there is again pollen evidence of man's activity although the excavation has concentrated on the exposure of a later period monument. Similarly at the Bronze Age burial monument of Dun Ruadh (Davies, 1937) there is an earlier Neolithic phase of activity which Case (1961), on the basis of the pottery styles, would place early in the Irish Neolithic. Unfortunately it is impossible to ascertain the true nature of the ditched enclosure which surrounds the Bronze Age cairn and it is not known how the Neolithic pottery related to the enclosure. This enclosure has sometimes been referred to as a 'Henge' but this stretches the term to a point where it becomes meaningless.

The Later Neolithic is superbly represented by the island site of Island MacHugh (Davies, 1950) where large quantities of decorated pottery were found with an extensive scatter of flint hollow scrapers. Although it is not necessarily as late, a scatter of Neolithic material was also found at Tullywiggan near Cookstown. This material consisted of a late form of western Neolithic pottery and Carrowkeel ware. The site, which comprised a series of pits and perhaps a deep ditch, was placed on a sandy ridge just south of Cookstown. A third site which can only be referred to as Neolithic was found at Clogher where excavations of the hillfort have produced a scatter of Neolithic flint work and one complete bowl (Warner, pers. comm.). This material comes from a drumlin in the centre of the Clogher Valley.

Tyrone is rich in megalithic tombs. There are over twenty court cairns presently known in the county. These are presumed to be the earliest form of Neolithic burial monument. Unfortunately three of the examples were excavated before the war and so could not be $^{14}C$-dated while one of the more recent excavations, Barnes Lower (Collins, 1966), was of a rather anomolous site which had been partially destroyed. The tombs in this area are usually considered to be very local in character with numerous dual courts. There is, however, no reason why some tombs such as Clady Halliday (Davies and Bradford, 1937) could not be early and certainly at Carnanloane Ballybriest (Evans, 1939) in neighbouring South Co. Londonderry, a pre-construction phase has been dated to about 3000 bc. While portal dolmens are scattered through the area one site in particular must be singled out. This is Ballrennan (Davies, 1937) which is usually explained as a complex portal dolmen consisting of two pairs of single chambers. These sites are usually placed at the end of the Neolithic yet the pottery found here would suggest an earlier date. It is therefore interesting to note there have been suggestions that the portal dolmens could derive from the Court Cairns. The latter have produced the same type of material as that found at Ballyrennan. Sites such as Ballyrennan and Tirnoney in Co. Londonderry could form part of the development from the earlier Court Cairns through to the portal dolmens.

While most of the Court Cairns are in the Sperrins in the northern part of the county, the passage graves are best represented in the south. There would appear to have been small cemeteries at Sess Kilgreen and Knockmany (Herity, 1974), though many of the tombs have disappeared. While these were not large examples they are unique in a northern context, in that they are highly decorated in a style of passage grave art that is slightly distinct from that found in the Boyne Valley area. Their real distinction lies in the fact that aside from an occasional



casual incision, these are the only decorated tombs in the north.

In summary the Neolithic of Co. Tyrone is neither lacking in field monuments nor settlements. Considering the casual interest taken in Co. Tyrone, the amount which has been noted may well indicate a wealth of material still awaiting discovery.

## BEAKER PERIOD (?)

The distribution of Beaker material in any part of Ireland tends to be rather patchy and there are only three known find spots of this period in Tyrone. The best known site is Ballynagilly (ApSimon, 1975) where three concentrations of beaker material were found. These have been dated to between 2100 and 1900 bc. Large quantities of pottery and flint work were found but no actual traces of houses were recovered. This type of pottery has been classified by ApSimon as Northern - Middle Rhine.

Beaker pottery has also been found in two wedge-shaped gallery graves. These are both in the Loughash area in the north of the county (Davies, 1939; Davies and Mullin, 1940), and this type of tomb is relatively common in Tyrone. The problems of the Tyrone wedges are those of their class. Are these tombs an intrusive element brought in by the Beaker people or are they a local type which existed at the end of the Neolithic period? Certainly the Loughash tombs have produced some Neolithic material and the style of Beaker pottery found in them are best seen as local forms.

## BRONZE AGE

There are few specific characteristics of the Tyrone Bronze age. The numerous finds of pottery - usually in a funerary context - reflect discovery through agricultural activity and also reflect the large land area of this county. This pottery can either be found as individual burials or in larger groups such as at Drumnakilly or Dun Ruadh. Most types of bowl, vase and urn are present with the exception of the collared urn which is rather rare (the type is much commoner in the east of Ireland).

Besides the range of burial monuments this area is at the centre of a group of stone circles and alignements which are also found in Counties Londonderry and Fermanagh. The classic example is Beaghmore (Pilcher, 1969).

In comparison to Co. Antrim and even parts of Co. Down, early metal work is not very common. Interest has been shown, however, in the presence of alluvial gold in the Sperrins. It has been suggested that this could be a source of gold for the manufacture of Early Bronze Age gold work. Without a detailed progame of chemical trace analysis this must remain a tantalising prospect rather than a fact.

Perhaps the most distinctive trait of the Bronze Age of this area is the presence of three settlement sites of Later Bronze Age date. These are Lough Eskragh, recently re-excavated by B. Williams, where the remains of the posts of dwellings were found; Clogher, where R.B. Warner's excavation has shown that a hill fort could have been started in the Later Bronze Age, and finally at Island MacHugh, where large concentrations of material were recovered from the small island (Davies, 1950)

EARLY IRON AGE

In this least satisfactory portion of Ireland's prehistory, only the southern part of the county has any concentration of material. The area can best be seen (Warner pers. comm.) as an extension of the Armagh Plain around Navan Fort. Besides La Tène objects, several possible hill forts which could have Iron Age connections are present in the area.

SUMMARY

It is impossible to provide any synthesis of changing land use for this area. Each period has tended to derive information from different sources so that the bias in types of sites is often a product of the method of discovery. Perhaps a filling up of the landscape after the introduction of agriculture might be seen but lowlying sites such as Island MacHugh could easily represent a broadening of an economic base rather than a move onto poorer land. If anything characterises the prehistory of Co. Tyrone, it would be the fact that many monument types are represented owing to its geographical location.



REFERENCES


ApSIMON, A., 1969, The Earlier Bronze Age in the North of Ireland, Ulster. J. Arch., 32, 28-72.

ApSIMON, A., 1975, Ballynagilly and the Beginning and End of the Irish Neolithic, in, De Lael, S.J. (ed.), Acculturation and Continuity in Atlantic Europe, 15-30.

CASE, H., 1961, Irish Neolithic Pottery : Distribution and Sequence, Proc. Prehist. Soc., 27, 174-233.

COLLINS, A.E.P., 1966, Barnes Lower Court Cairn, Co. Tyrone, Ulster. J. Arch., 29, 43-75.

COLLINS, A.E.P., and SEABEY, 1960, Structures and small finds discovered at Lough Eskragh, Co. Tyrone. Ulster. J. Arch., 23, 25-37.

DAVIES, O., 1937, Excavations at Dun Ruadh, Proc. Rep. Belfast Natur. Hist. and Phil. Soc., Ser 1, 2, 50-75.

DAVIES, O., 1937a, Excavations at Ballyrennan, Co. Tyrone, J.R. Soc. Antiq. Ir., 67, 89-100.

DAVIES, O., 1939, Excavations at the Giants Grove, Loughash, Ulster. J. Arch., 2, 254-68.

DAVIES, O., 1950, Excavations at Ireland MacHugh (Belfast).

DAVIES, O., and BRADFORD, R., 1937, Excavations of the cairn of Clady Halliday, Proc. Belfast Nat. Hist. and Phil. Soc., 2, 76-85.

DAVIES, O., and MULLIN, J.B., 1940, Excavations at Cashelbone cairn J.R. Soc. Antiq. Ir., 70, 143-63.

EVANS, E.E., 1939, Excavations at Carnonbone, Co. Londonderry, Proc. R. Ir. Acad., 45, 1-12.

HERITY, M., 1974, Irish Passage Graves, (Dublin).

PILCHER, J.P., 1969, Archaeology, Palaeoecology and C14 Dating of the Bearhmore Stone Circle Site Ulster. J. Arch., 32, 73-91.

PILCHER, J.P., and SMITH, A.G., 1979, Palaeoecological investigations at Ballynagilly, a Neolithic and Bronze Age settlement in County Tyrone, Northern Ireland, Phil. Trans. R. Soc. Lond., 286, 345-369.

WOODMAN, P.C., 1978, The Irish Mesolithic, B.A.R. 58. (Oxford).




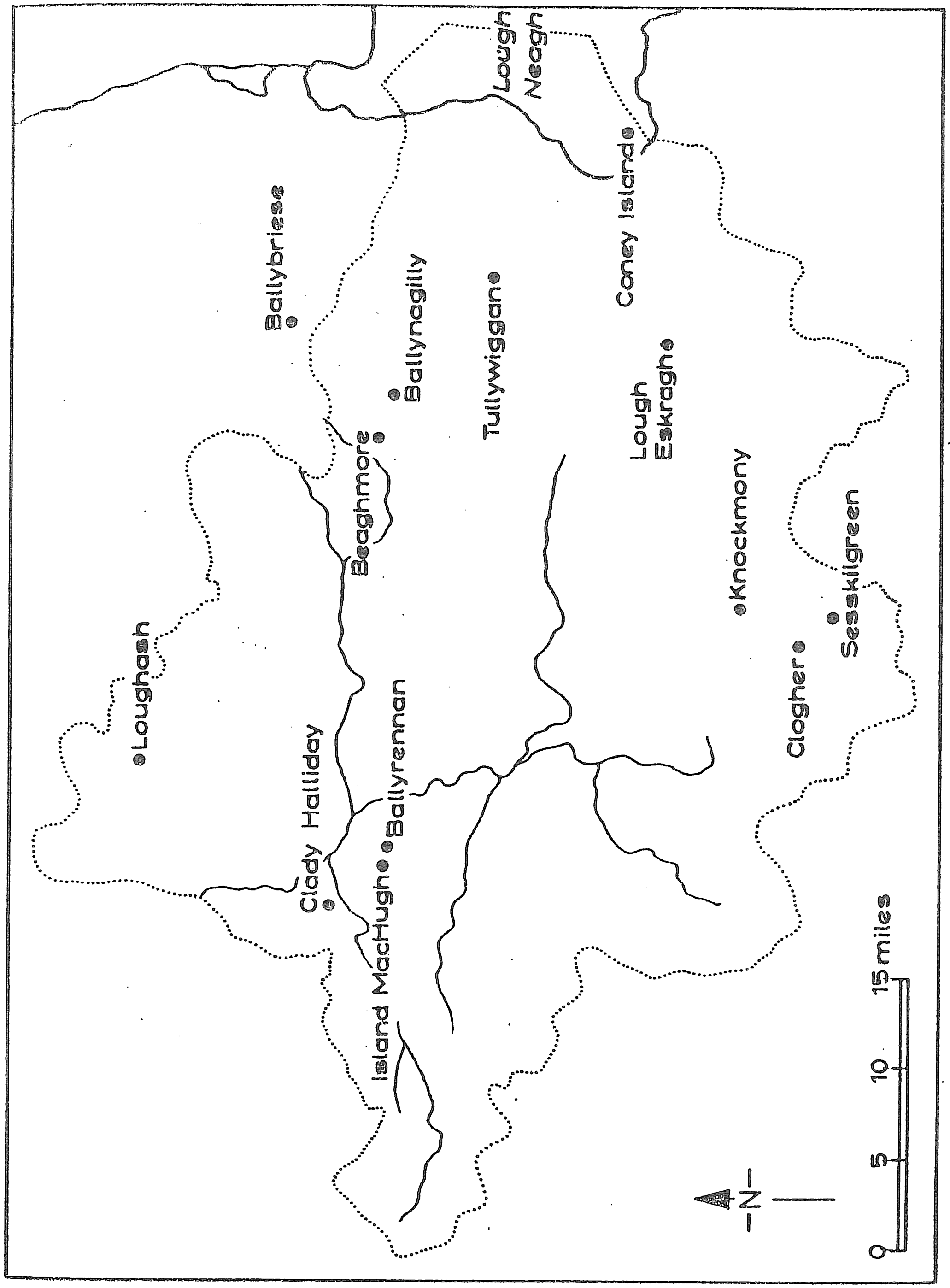


Fig. 1 Archaeological Sites

ININERARY

GEOMORPHOLOGY

1. Lower Beltany, Omagh-Newtownstewart road. (H 412821)

Temporary road cuttings along the main A5 road between Omagh and Newtownstewart reveal talus and coarse grained head deposits overlying fluvioglacial outwash deposits. The periglacial phenomena have been formed by slumping of materials down the western slopes of the Strule Valley either during or following the period of deglaciation.

2. Newtownstewart (H 380850; Fig. 6).

In the vicinity of Newtownstewart and at Wood Hills (H 379859), a fine moraine limit is marked by the Deer Park Moraine and the Deer Park Complex. This retreat stage is equivalent to glacial stage 10 in the Foyle-Mourne valley (after Colhoun, 1972).

The moraine, collectively known as the Wood Hills moraine (Colhoun, 1972), is an impressive ice-contact stratified sand and gravel deposit, marking the northern exit of the Baronscourt valley. Behind the moraine, the topography is relatively subdued, resulting from burial of relief forms in a ground moraine/ablation moraine complex (GM). A number of esker-like forms run along the central parts of the Baronscourt valley and disappear at the Wood Hills. A meltwater channel cuts through the Wood Hills moraine at this point, and may represent a continuation of the meltwater conduit associated with the 'esker' form. The meltwater channel finds an outlet onto an outwash terrace fronting the moraine (OWT).

The glacio dynamic condition of the ice mass associated with the Wood Hills moraine appears to be one of stagnation, since no significant retreat stage has been found within the Baronscourt valley. The valley sides are marked by high relief hummocky moraine forms which mark the lateral limits of the ice mass in the valley.

Lough Catherine (H 360840) is elongate and parallel to the flow direction associated with ice movement northward and appears to have been formed as a result of glacial scouring by active ice along the central portion of the valley. The lake is presently surrounded by drift formed by a combination of subglacial meltwater deposition and supraglacial ablation.



3. Cashel Burn (H 570800; Fig. 7).

Approximately 17 km east of Omagh town, along the A505 toward Cookstown, the main road crosses the Cashel Burn sandur; the moraines associated with this retreat stage are visible from the roadway.

The sandur surface is gentley undulating and pitted with numerous kettle-holes, known locally as 'the Seven Sisters'. The kettle-holes are relatively heavily concentrated in the centre of the sandur, and may have developed as a result of melting of an extensive body of ice. The kettles are elongate, suggesting that they either developed from a buried ice mass of similar dimensions or may have been modified by the action of permafrost.

The sandur is presently being commercially exploited for gravel, as are the bedded sands and gravels of the moraines. Hummocky moraine exposed along the roadside is composed of sandy till. This till unit is exposed over a wide area south of Cashel Burn.

4. Cam Lough (H 668767; Fig. 8)

Along the B46, between Greggan (H 625786) and Carrickmore village (H 615725), an extensive area of fluvioglacial and glaciolacustrine landforms exist and extend toward Cam Lough a magnificent kettle-hole formed in outwash associated with ice withdrawal toward the south. The Cam Lough kettle-hole marks the course of the Evishanoran ridge system, which runs directly north through the Cam Lough area and across Evishanoran Mountain (H 675777) toward Davagh Forest (H 699864).

The Cam Lough area is characterised by retreat of ice southward and by development of an ice-lake, associated with the formation of the Malinn Delta (H 689765). The Evishanoran gravel system has been modified in the Camlough area, either by wave action along the esker top or by this portion of the esker functioning as a delta during the period of existence of the ice-lake. The sand plateau at Cam Lough is similarly related by height to the formation of the ice-lake. Accordance of height has been observed between the Malinn delta, the sand plateau and the flat-topped portion of the Evishanoran system - landforms terminating between 230m-235m.

Ice retreat in the vicinity of the ice-lake is characterised by development of a beaded esker ridge running north-south immediately west of Cam Lough and displaying a significant beaded morphology indicative of deposition in ponded water.

5. Evishanoran (H 675777) to Davagh Forest (H 699864)

The Evishanoran ridge system crosses the A505 approximately 15 km west of Cookstown, and continues northward, terminating in the Broughderg low-lands north of Davagh Forest.

Mapping of the ridge system indicates that it commences north of Bernisk Glen (H 606β75) some 20 km south of Davagh Forest. Pebble analysis of the gravels contained by the system indicates that it formed by meltwaters flowing across Evishanoran Mountain and across the Ballinderry valley. The system is therefore an esker form.

Exposures in Davagh Forest in the ridge system, known locally as the 'Davagh Eskers', show lacustrine clays occuring in combination with sands and gravels formed in a high energy hydraulic regime. This suggests that the esker was formed in association with an ice-lake; similar combinations of eskers and lacustrine clays have been observed in Scandinavia (Lundqvist, 1972) and have been described as characteristic of the formation of small bodies of water near the margin of a stagnant ice mass.

Description of the Evishanoran ridge system as an esker by the local people is evident in the naming of the Davagh Eskers and naming of the Eskera Bar, a public house in Dunnamore (H 684812), which is built into one of the ridges crossing the Bellinderry valley. In the same area a number of exposures in the ridge display arch bedding, characteristic of a deposit formed in an ice-walled channel.

6. Knockaleery (H 737779; Fig. 9)

Terraces associated with the Malinn delta continue toward the east, and into the Ballinderry valley. They terminate in the area of the Knockaleery ridge system readily seen along the A505, 8 km west of Cookstown. The confinement of the terraces by the Knockaleery system suggests that this concentration of material acted firstly as an ice barrier and secondly as a drift barrier, confining meltwaters associated with the ice-lake formed in central Tyrone.

Palaeocurrents in the system indicate that meltwater was being deposited from the south-east. It is uncertain whether the sedimentary structures present within the complex represent deltaic structures or whether they developed as wave cut progradation terraces. The system shows well developed forest bedding (i.e. cross-bedding) with a thin veneer of coarse topset bedding.



Glaciotectonic structures in the ice-proximal portion of the system at Crockadoo (H 725765) suggest that ice may have been active at the ice margin, and subject to minor periodic fluctuations. Minor till units have been observed at this locality and in the vicinity of Knockaleery townland (H 732773) and differ radically from the fluvioglacial materials within which they occur; they are of more local origin and have a sandy matrix, indicative of formation as ablation debris. Some of the till units show evidence of flowage.

Ice-wedges and related cryoturbation structures have been observed at Crockadoo, occuring in topset beds at approximately 185m OD. A good example is exposed in the Crockadoo gravel pit.

7. Moneymore (H 869845; Fig. 5).

Drift exposures in a roadstone (basalt) quarry, 8 km northwest of Cookstown along the A31, have revealed a complete section in one of the drumlins on the Antrim Plateau, and a lateglacial sequence in an interdrumlin hollow.

Two till members are present and have been found to be underlain by a fine series of rhythmites, displaying a well developed cyclic fining-upward sequence. The rhythmites are interpreted as forming in a pond of water on the rock surface and may represent erosion of till in the vicinity by meltwater. The upper till unit (AP-A) is similar to the lower till (AP-B), except it is devoid of chalk.

At the time when the drumlin was first exposed, minor colour variations were observed within the drumlin and when carefully logged, indicated lensing of some till units within a younger till.

Tyrone Igneous Erratics has been observed throughout the tills in this exposure. Dispersal of the Tyrone erratics may have occured either by a west to north-east ice dispersal prior to the Drumlin Formation Stage, or by reworking of till deposited in the Lough Neagh Basin to the south. Ice movement associated with the Drumlin Formation Stage in this area occured from south to north.

Till unit AP-A may have developed as a result of decalcification of till unit AP-B. Otherwise AP-A may be a comminuted till derived from AP-B, and associated with the ice dispersal from the south. AP-B contains sand lenses, which have been incorporated during meltout, from englacial or subglacial meltwater conduits. No structures were observed in the sands.

The inter-drumlin hollow contains fluvioglacial sands and gravels, overlain by a lateglacial and postglacial sequence of peat, sand and inorganic mud. The lateglacial sequence has been sampled and the significance of the site will be reported at a later date (Hirons and Dardis, in preparation). Between the peat horizon of pollen zone II and the postglacial sequence, a boulder layer has been observed at the top of the zone III deposits. This boulder layer comprises both flint and basalt lithologies, and may represent mass-movement of materials downslope during a period of reduced vegetation cover. It is uncertain whether the boulder layer has been soliflucted in a cold permafrost environment.

8. Annahavil (H 792695)

10 km south of Cookstown, along the B34, a sand pit is exposed at Annahavil Hill. Palaeocurrent directions and pebble analysis indicate that meltwater associated with formation of the sediments was deposited from south to north. Ice recession therefore occured from north to south.

The presence of 'drop-stones', fining-up sequences and of topsets and foresets suggest that the environment of deposition was glaciolacustrine. The pattern and character of deglaciation is different to that envisaged by Charlesworth (1924, 1939).

The deposition sequence exposed at Annahavil and elsewhere in the vicinity of this retreat stage suggests that an extensive body of ponded water covered the area of east Tyrone during the period of deglaciation.

A wide range of sedimentary structures have been observed in the sand pit, and are presently being investigated. The sequence as a whole indicates a diminishing high-energy palaeoflow regime, indicated by fining-up and fining-out sedimentation units.

9. A.P.C.M. Ltd. Shale Quarry, Dungannon (H 795643; Fig. 10).

Surficial exposures in a Shale quarry, 5 km north of Dungannon on the B34, shows wavy laminates of sand, silt and clay, overlying a limestone till.

The till is dark grey (10 YR/3/1) and is composed of limestone, mudstone (mainly forming the till matrix) and sandstone. Numerous pebbles from the Tyrone Igneous complex are present within the till. Part of the till unit has been passively incorporated into the overlying drape laminations;



no destruction of the underlying bedding has been observed to indicate that the till flowed into the sedimentary basin. It is likely therefore that the till is a waterlaid till (Dreimanis, 1979), formed as a suspension deposit in a manner equivalent to the enclosing sediments. The wavy laminations are interpreted as bottomset beds formed by deposition from suspension.

Similar lenses of till have been observed in glaciolacustrine deposits in Late Wisconsin deposits of the Lake Erie Basin (Dreimanis, 1979).

10. Mullybrannon, Dungannon (H 805596; Fig. 2)

Recent excavations in the M2 motorway extension from Dungannon to Ballygawley has resulted in the excavation of a number of drumlins.

One such excavation at Mullybrannon has revealed four till members and one stratified member in a drumlin. The significance of the various members is not yet known, though a number of sites in east Tyrone have revealed a stratigraphy equivalent to the two uppermost tills at Mullybrannon.

The till members are defined as LN-A, LN-B, LN-C and LN-D. The stratified member is only a few centimetres thick and underlies till member LN-B. The erosional boundaries between these till units indicates that they were formed by different ice advances. LN-A is reddish brown and contains pebbles derived from the Tyrone igneous Complex. LN-B is dark grey and is similar to the till exposed at site no. 9. The lower tills are inclined to the horizontal and have been truncated obliquely.

Prior to uncovering of this section, no site in central Ulster has revealed a multiple stratigraphy. The site was first uncovered before the present study was undertaken and is presently landscaped. Photographs have been taken of the site prior to landscaping, and sampling of the till units carried out.

11. Curran, Dungannon (H 813647; Fig. 11)

An exposure in a disused brick pit, on the A29 between Dungannon and Coalisland, shows laminated sands and silts overlain by flow till. The sequence is underlain by a till, moulded into drumlins in the surrounding area. The flow till was derived from the flank of a drumlin, while the laminated material was formed in a meltwater channel associated with dispersal of meltwater northward and ponding of waters at a low level in the eastern Lough Neagh lowlands.

12. Coalisland (H 842667).

Two till members are exposed in a disused brick pit. Numerous other till units are exposed in the pit but are reported to have been stripped by man, and are therefore stratigraphically insignificant.

The lower till is composed of local mudstone and has a high clay content. It is underlain in places by lenses. The upper till is composed of both local and far travelled erratics and is brown in colour. Tyrone erratics have been observed within the upper till.

13. Benburb

Gortian lateglacial site.

14. Cookstown

Delta underlying the golf course and relating to the Curglassan phase.

(G.F.D.)

PALAEOECOLOGY

Lough Catherine (H 365840).

The glacial ribbon lake of Lough Catherine has produced sediments extending back from the present day to the lateglacial period. Pollen, chemical, magnetic, and radiocarbon evidence (Edwards and Larmour, in prep.) have all contributed to environmental reconstruction at the site.

(K.J.E.)

Glover's Quarry Moneymore, Co. Londonderry (H 868844).

At Glover's Quarry excavations to facilitate basalt quarrying exposed sections through Pleistocene deposits including a short lateglacial and postglacial sequence (see Dardis this vol.). These deposits represent two fen-peats separated by a layer of grey sandy-clay with a thin, blue, basal clay overlying sands and gravels. Preliminary palynological investigation has shown no pollen recoverable from the thin basal clay which appears to have effectively sealed the underlying sands and gravels allowing peats to form in the resultant wet interdrumlin hollow. The basal peat layer is amorphous, very highly humified and probably represents the periphery of the fen deposit.



Presence of birch and alder wood in the postglacial peat and the considerable rootlet penetration will make dating by $^{14}C$ problematical and may necessitate fractionation.

Further excavation of the sequence exposed larger pebbles in the top of the upper clay. These may have been transported by solifluction process and palynological work is being carried out to relate these to the main sequence.

Weir's Lough and Killymaddy Lough, Dungannon (H 784612, H 783620).

Any palaeoenvironmental record is the product of a complex sequence of abstractions interacting to confound interpretation and inference based upon palynological study. In recent years an increasing variety of techniques have been used, based particularly upon lake sediments, in order to attempt to extend and clarify this record. Close proximity of the two inter-connected drumlin lakes at Dungannon facilitates methodological comparison of several palaeoecological techniques. These studies will help to define the reliability of small-scale palynological changes and comparability of other techniques, particularly sediment chemistry and palaeomagnetism.

(K.R.H.)

ARCHAEOLOGY

Island MacHugh (H 365840)

Island MacHugh lies in the south centre of Lough Catherine. It is a crannog which has been occupied from the Neolithic into the Bronze Age periods. A ruined castle on the crannog was in use from the Early Christian period up to the sixteenth century.

(K.J.E.)

Creggandevesky court grave (H 643750).

Currently being excavated, this is a trapezoidal cairn with a semi circular fore-court in the south east giving access to a series of burial chambers apparently intact within the cairn. This is a text-book example and one of the most complete of a group of over three hundred sites found in the north of Ireland.

Plough marks in a layer under that on which the tomb is built and well sealed by bog provide evidence for the cultivation of this area prior to the building of this tomb.

Dunnamore wedge grave (H 685808).

A good example built in the local schist, and known as 'Dermot and Grania's Bed'. A long gallery which is still partly roofed was entered through a complex entrance to the north. The gallery was surrounded by an outer stone wall and covered in cairn material which has been almost totally removed.

Beaghmore stone circles (H 685842).

Large complex of stone circles, aligments and cairns which had been buried by blanket peat and excavated in 1945-49 and in 1965. Some evidence of Neolithic occupation was associated with hearth pits, and the rest of the site may be attributed to the Bronze Age.

Ballymully glebe 'Tullaghoge Fort' (H 825740).

Hilltop ring fort traditionally the crowning place of the O'Neills and capital of Tyrone until the fourteenth century AD.

(B.W.)



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