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Quaternary Research Association

QN QUATERNARY NEWSLETTER

25th Anniversary 1964 – 1989

QUATERNARY NEWSLETTER

Editor: Dr D.T. Holyoak
Department of Geography and Geology
The College of St. Paul and St. Mary
The Park
Cheltenham, Glos. GL50 2RH

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PRESIDENTS REPORT

The Quaternary Research Association 1989, the Present Structure and Prospects for the Future

1989 sees the 25th anniversary of the Quaternary Research Assocaition (including its early years as the Quaternary Field Study Group). With about 1000 members, and unprecented academic and public awareness the problems of environmental change, which is indeed the essence of Quaternary Research, I wish to take this opportunity to look at the present structure of the QRA and outline some of the developments and intentions for the immediate future.

The QRA was born out of an enthusiasm among academics in Britain to examine the evidence for environmental change over the past 3 or so million years. As the main body of this evidence consists of rock, landforms and plant-remains within a geographical context, the Association began as a field studies group, and retains to this day, a structure built around an Annual Field Meeting. This approach has the unparalleled advantage of providing an informal meeting place where members can examine evidence *at first hand* and evaluate and discuss its quality and significance with colleagues from a wide range of disciplines. As clearly illustrated by Peter Worsley's reflections on the foundations of the Association (see below) the greatest success of the QRA has been this ability to bring together individuals from a such a wide range of disciplines, professions and experience, and the pleasure and intellectual stimulus of sharing expertise is something that must have been experienced by all participating members. This approach has not only created enjoyment but has stimulated academic innovation and excellence and is something which we must strive to maintain.

This effective, yet informal approach has been reflected in the publications of the Association. The *Circular* communicates the business of the Association. *Quaternary Newsletter* (founded by Graham Jardine) is an outlet for current research, new concepts and controversy. The fact that publication is rapid and that the contents are brief and widely read, means that its influence far greater than would be implied by its hitherto rather informal production. The QRA *Field Guides* (first introduced by Frank Mitchell), in which evidence can be recorded when it is topical and in a detail that is often not possible in more formal publications, have become an unrivalled source of detailed information about the Quaternary of Britain, and adjacent parts of Europe. The *Technical Guide* series (introduced by Phil Gibbard) were developed as a complement to the Field Guides, and their success in providing detailed technical information is reflected in their sales. The introduction of the *Journal of Quaternary Science* jointly with Longman Group UK Ltd (given birth under the editorship of John Lowe) is a recent venture by the Association, and as a formal publication with an international scope it reflects the current activities and intentions of the Quaternary Research Association.

As already implied, the arrangement of meetings of the Association focus around the *Annual Field Meeting* held at different geographical venues at Eastertime. Also an annual event is the *Discussion Meeting* held just after the New Year. Usually the Annual Field Meeting is concerned with a regional Quaternary problem, whereas the topic of the Discussion Meeting is thematic. Other meetings take place on an irregular basis. The most frequent is *'Short' Field Meeting* of one to several days on subjects that are topical as a result of recent research or available site access. Joint conferences with other organisations on subjects that are of common interest have long been a feature of the QRA, but occur on a very irregular basis. *Overseas Study Courses* occur at infrequent intervals, usually organised in collaboration with overseas members or Associations (there is no doubt that the first, whichs was led by Rob Price to Iceland, had significant impact on many senior British Quaternary geologists). *Technical Courses* are recent developments, and have been concerned with subjects such as palynology and micromorphology, reflecting the increasing need for technical training by QRA members. This structure of meetings has been highly successful, and it is my belief that up to now it has served the British Quaternary community very well.

However times — like the environment — change, and Quaternary Research is no longer solely an intellectual excitement for the fortunate few. Every day sees problems of current and future environmental change discussed on the media, and these issues are now a matter of political concern in Britain and internationally. Only the Quaternary can provide analogues by which we can evaluate many of the predictive scenarios about which we hear so much, and only the Quaternary can provide a framework by which we can investigate the way these environmental and geological processes operate through time.

At the national level, the NERC has initiated, through Jim Briden, the Director of Earth Sciences, an Expert Group Review of Quaternary Science in order to identify and focus the topics of current concern and the critical issues for future development. This led to a proposal for a NERC Special Topic on the subject of the Palaeoclimate of the Last Glacial/Interglacial Cycle. At the national level also, the ABRC has instituted the concept of Interdisciplinary Research Centres (IRC), and NERC has invited bids for a centre to investigate the topic of Geological Evidence for Global Change.

Most of all, the scope of the subject has changed. It is no longer satisfactory to examine the Quaternary of the British Isles for its own sake, no matter how interesting and exciting that may be. Within the scientific climate of the present time the Quaternary of the British Isles must be viewed as a test bed on which to develop the analytical methods and understand the processes of environmental change, and to provide information of global significance about a climatically sensitive region on the northeastern margin of the North Atlantic. Our concern must be to provide a critical contribution to the 'grander scheme' of Global Environmental Change. We are fortunate enough to be in the right place, and we have demonstrated in the past that we have the right credentials. The Quaternary of the British Isles is more important than just a local environmental history, and the analytical techniques that we have applied have more than of local application. We have an obligation to do them justice.

With these developments in mind, the QRA has taken some first initiatives. With the belief that the stimulus must be provided at both the *'grass roots'* and at *'cutting edge'*, these initiatives will take two directions. At the *'grass roots'* level it is our intention to stimulate participation in the activities of the Association. By its very nature, the Annual Field Meeting can only allow participation by about 8% of the membership, and as this occurs only once a year it is hardly effective. 'Short' meetings can often increase participation, but often contributors are daunted by perceived (incorrectly) obligations of organisation and to produce Guides. It is the intention of the Association, therefore to positively encourage the growth of the local regional groups, focussed around local field meetings and seminar series. We anticipate that this will be achieved either by new initiatives or by alliance with existing regional Geological Societies. Links with London Quaternary Lecture Series, and the Midland Quaternary Seminar Series have already been established (see *Quaternary Newsletter* No. 56, page 40, 1988), and the Association is eager to support similar ventures elsewhere.

At the *cutting edge* it is the intention of the Association to introduce *major international meetings* on topics of current importance that are of sufficient importance and topicality as to receive media coverage. These will probably be on a biennial basis, although more frequently if appropriate. The first of these has been organised by Geoffrey Boulton on the topic of *The Late Cenozoic Ice Age* for July 3rd — 5th 1989 and is in association with the Royal Society of Edinburgh. Already planned for the future are meetings to: i) coordinate and communicate the results of major research projects, ii) consider the rôle of Quaternary analogues for understanding current environmental changes. Positive steps have also been taken to increase collaboration with other learned societies, and in this respect we have now completed our first year as a member of the Joint Association for Quaternary Research along with the Geological Society of London. With the aim of promoting the Association in both the academic and public domain the Association has instituted the External Affairs Committee and we may expect to see the fruits of their initiatives within the near future.

Including these recent developments it is possible to look at the meetings of the QRA as a hierarchical structure:

International Thematic Meetings
(Biennially)

Annual Field Meeting (Eastertime)	Annual Discussion Meeting (Early New Year)

'Short' Meetings on Topical Aspects of Quaternary Research
Overseas Study Courses/Technical Study Courses at irregular intervals
(These may be at any time of the year and may involve liason
and collaboration with other organisations)

Locally Based Groups — these with promote Field Meetings,
Regional Research Programmes, Seminar/Lecture Series

Altogether the future for Quaternary Research and the Quaternary Research Association is challenging and potentially very rewarding. Specifically, I am able to state here that NERC are confident of some Special Topic support from 1989-90 onwards for research into the subject of the *Palaeoclimate of the Last Glacial/Interglacial Cycle*. This has arisen out of the Quaternary Science Expert Group Report and members of the Association, hopefully as effective research groups, should now be in a position to take advantage of this opportunity. For the future also, we must give attention to the identification and development of issues that are critical to past, present or future environmental change, because it is Quaternary scientists through their training, insight and understanding who are most prepared to meet the challenge.

Professor J. Rose,
President, Quaternary Research Association.
February 1989.

25 YEARS AGO—SOME REMINISCENCES OF THE FIRST QUATERNARY FIELD STUDY GROUP MEETING AND EARLIER RELATED EVENTS

Peter Worsley

A transcript of Richard Hey's lecture to the 20th anniversary meeting of the Q.R.A. can be found in the *Newsletter* (No. 43, June 1984). This recalls that the initial idea for a 'Quaternary Field Study Group' arose during a field meeting of the Yorkshire Geological Society (incidentally that *Newsletter* account is incorrect in referring to the Quaternary Field Studies Group). The Y.G.S. meeting was based on the White House at Caistor in north Lincolnshire and the abstract on the cover of the field excursion hand-out says:

'the excursion is designed to illustrate the geological history of North Lincolnshire from a study of the physiography, structure and stratigraphy of the Mesozoic rocks. The topography of the northernmost Wolds will be demonstrated and the party taken to exposures of the Lower Cretaceous, Middle Jurassic and Lower Jurassic rocks'.

The leaders were P. E. Kent, J. W. Neale and Allan Straw. An account of the field meeting may be found within the Y.G.S. Annual Report for 1962 (*Proc. Yorks. Geol. Soc.* 34, 112–116). As Richard Hey has previously noted an 'eminent Mesozoic geologist' expressed some impatience over the interest generated by the Quaternary aspects of the meeting and this can be gauged in the light of the above abstract giving the perceived field meeting objectives. Admittedly that now rarely used word physiography is featured and also topography but of Quaternary or indeed glacial geology there is no mention. This is despite the fact that the itinerary included the interglacial site at Kirmington and the Y.G.S. had only three years previously published Bill Watts's paper on the site.

I attended the meeting as a newly graduated student from Keele who was shortly to take up a D.S.I.R. research studentship to work on a then as yet unspecified topic but it was my intent that it would be focussed on an aspect of the Quaternary. At that time the work of Brian Sissons was electrifying the world of glacial geomorphology and the opportunity of participating in a meeting which would impinge on such matters was not to be missed. Being a native of the area was an added attraction and through the pages of the *East Midlands Geographer I* was aware of the current research of Allan Straw. On the Saturday morning I was startled to discover that the rather spartan bus provided was very familiar to me for previously it had been owned by Keele and used for the shuttle between the campus and Newcastle under Lyme but just before my final year it was sold in favour of a contract service.

I retain a memory of intensive debate on the modes of glacial meltwater drainage and through this came to personally know Allan Straw and Edward Francis. Both were to have a significant influence on my forthcoming research. The vigorous discussion of Quaternary related matters totally eclipsed the Mesozoic. An illustration of this may be gleaned from the Y.G.S. report when we read '. . . was seen by some members of the party . . .' and in this instance it relates to the aeolian coversands which mantle the landsurface at the Crosby Warren Quarry, Scunthorpe, when a breakaway group found the uppermost strata more attractive than an overdose of Liassic ironstone. I think that the first open consideration of a specifically Quaternary orientated field meeting occurred in the garden behind the pub in Binbrook on the first day.

I first heard from Francis Synge, who was in regular contact with Frank Mitchell, that positive moves towards the implementation of the ideas formulated on the Y.G.S. trip were being made. Thus on 13 April 1964 I registered with Russell Coope, the first local secretary, at the Department of Geology in Birmingham and the Quaternary Field Study Group was underway. Three years later in Canterbury the Q.R.A. *sensu stricto* was spawned from the Q.F.S.G.

Comparison of the first field programme with that proposed for the return visit in 1989 reveals an uncanny similarity in basic structure. Back in 1964 each of the three days were devoted respectively to (a) Cheshire–Shropshire, (b) the Middle Severn Valley and (c) the Coventry–Leamington area including what was to become the 'Wolstonian' type site. The first excursion was not without incident for following a visit to Wood Lane Quarry, Ellesmere, one member was inadvertently left behind, something which is easily done when two buses are being used and to this day I am unsure whether the leaders were aware of this. However the person concerned—D. F. W. Baden Powell—much to his credit took the incident in good humour and furthermore managed to spring a surprise. When those of us staying in the Hall of Residence returned, out popped a gleeful BP who was delighted to show us that he had managed to beat us back to Birmingham even after using public transport. One wonders in the aftermath of the Beeching slaughter of rural railways if this would be possible today for the former railway junction of Ellesmere is now totally erased from the rail network.

Unlike the practice of late, where the evenings are normally devoted exclusively to the bar, after dinner the time was utilised as part of the organised programme. I can remember a stimulating lecture given by Geoff Kellaway who, in his usual enthusiastic manner, gave us some impressions arising from a recent visit which he had made to the Alaskan permafrost. One particular story of his can be recalled and this was the case of animal adaptation to climatic change with the moral being can we be certain whether an animal was adapted to cold by the growth of fur, e.g. were the last interglacial Yorkshire Hippopotamuses the same as the modern inhabitants of Africa?

The tale related that those engaged in the transoceanic transport of meat had a perpetual problem with the rat population on the sailing ships of the day. Becoming becalmed meant that less meat would make the final destination through the rat consumption of the cargo. This was until the advent of refrigeration when the shippers of the time thought that the problem was solved. Indeed it was, for the rats simply could not endure the sub-zero temperatures in the ship holds. However the respite was short lived within a few years natural selection processes had led to the development of a rat population adapted to the cold by the growth of thick fur coats.

Apart from an evening lecture session, I learned from Francis Synge that it was hoped to have an open discussion of some contentious issues related to the Midlands Quaternary. Thus one evening we assembled in a room at the University. I recall that the proceedings were making little progress by way of discussion. Bearing in mind what Francis had told me and without further thought I rose to my feet and asked Fred Shotton if he still maintained the view expressed in the classic Upton Warren paper in which it was argued that a direct link between the Upton Warren stratigraphy and the glacial limit across the Severn at Bridgnorth could be established. This led to the conclusion that the glacial event culminated around 50 000 years BP. By that time my own work in Cheshire had led me to the view that there was no evidence for a glacial advance at this time and hence I had the suspicion that the correlation of the Main Terrace of the Severn with the sequence at Upton Warren was in error. I received a very short but courteous reply to the effect that there was no reason to doubt the written record. Alas the session was not a success since no serious debate was generated. Afterwards no other person than Brian Sissons came up to me and had a friendly word in my ear to the effect that my future interests would be better served if I refrained from challenging the established wisdom especially when it had been promulgated by a very senior professor. I was shocked to learn that I had been judged to have transgressed the limits of conventional behaviour for my motives had been to simply liven up what some had hoped would be a useful discourse. Happily I can report that this incident had no observable reaction from the Professor concerned.

It is hard to appreciate that all this was 25 years ago. In retrospect I believe that one Q.R.A. tradition of particular importance which was initially established related to informality. Of course the rigours of field work do not respect age or rank but from the start there has been a concern for the sharing of experience and the welfare of those who are new entrants to the field of Quaternary research. In these days of pressure for increased professionalism I hope we shall not overlook the needs of those who will ultimately succeed the current establishment. I certainly cherish the memories of 1964 and the opportunity to rub shoulders with those of much greater experience than myself.

Professor Peter Worsley
Dept. of Geography
University of Nottingham
University Park
Nottingham NG7 2RD

THE FLANDRIAN HISTORY OF LLANBWCHLLYN LAKE IN MID WALES

David M. Wilkinson

The history of Llanbwchllyn Lake is outlined using the methods of paleo and historical ecology. A flora and Molluscan fauna thought to be of early Flandrian date is also described. The Molluscan fauna is of particular interest since there are few lacustrine faunas of this date described for the United Kingdom. The potential for future studies is outlined.

Introduction

Llanbwchllyn (Grid Ref. SO 1246) is a small lake situated about 9 km south-east of Builth Wells at an altitude of 295 m. It is roughly elliptical with a major axis of approximately 600 m and a minor axis of 300 m (Figure 1). The lake is fed by an underground spring and a couple of small streams. It has been used as a reservoir since 1967 and in the winter of 1975 its capacity was increased by building a small earth dam across the outlet, which raised the water level by approximately one metre. The current vegetation has been described by Cragg *et al.* (1981).

There is historical evidence of a major flood event in the area. The Twelfth century chronicler Giraldus Cambrensis relates that on the death of Henry I (1135 AD) two lakes in mid Radnorshire burst their banks; one of these was Llanbwchllyn which was said to have moved to a new site during the flood (Slater, 1988).

The nearest sites for which Flandrian paleoecological data are available are Rhosgoch Common (Bartley, 1960) about 7 km to the east of Llanbwchllyn and Beilibedw Mire (Wilkinson, 1988) 10 km to the north east. Other local sites are listed by Wilkinson (1988).

Historical Changes in Lake Shape

Examination of modern vegetation maps of Llanbwchllyn (e.g. Cragg *et al.* 1981) shows that both the western and northern shores have bays of *Carex* and *Juncus* well back from the present lake margin. In the field it was found that these were growing on shallow peat deposits (Figure 1). A series of cores taken using a Russian Sediment borer (Jowsey, 1966) showed that these peats were generally shallow (20–50 cm), composed of poorly humified *Carex* (and in some places at the western end *Typha*) and underlain by lacustrine clays. This suggests that the lake was originally of rather different shape with a pointed western end, the shadow of which can still be seen on aerial photographs of the site, and a large bay along its northern shore (Figure 1).

The dating of these changes in lake shape is problematic. Examination of the Ordnance Survey map of the area for 1833 (the bulk of the field work for which was carried out between 1815–1821) suggests that the western bay was at this time part of the lake. This gives a maximum formation time of around 150 years for the 20 cm of *Typha* peat recorded in a sediment core taken from this area. Moore (1987) quotes rates of formation of *Typha* peats of 0.5–1.0 mm a^{-1}, this is slightly slower than the rate identified at Llanbwchllyn, however, the poorly humified and uncompacted nature of the Llanbwchllyn peat may account for the discrepancy. The 1833 map does not, however, show any sign of the bay on the northern shore, which must therefore antedate the survey. It is interesting to speculate that the loss of the bay could be connected with the flood event and reported change in site of the lake chronicled by Giraldus Cambrensis.

Early Flandrian Flora and Mollusca Fauna

At the eastern end of the lake (Figure 1) erosion of the bank has revealed a thin band of peat overlying a lacustrine clay containing shells (Figure 2). This is higher than the current lake level and also higher than the peats associated with the present lake margins. This clay was calcareous, effervescing strongly with HCl.

Samples were taken from a cleaned surface of the peat band for pollen analysis. The samples were prepared following standard methods (Faegri and Iversen, 1975; Moore and Webb, 1978); because of a high level of mineral material in the peat the samples would have benefitted from HF treatment, however facilities for this were not available. The results of the pollen analysis are shown in Figure 3.

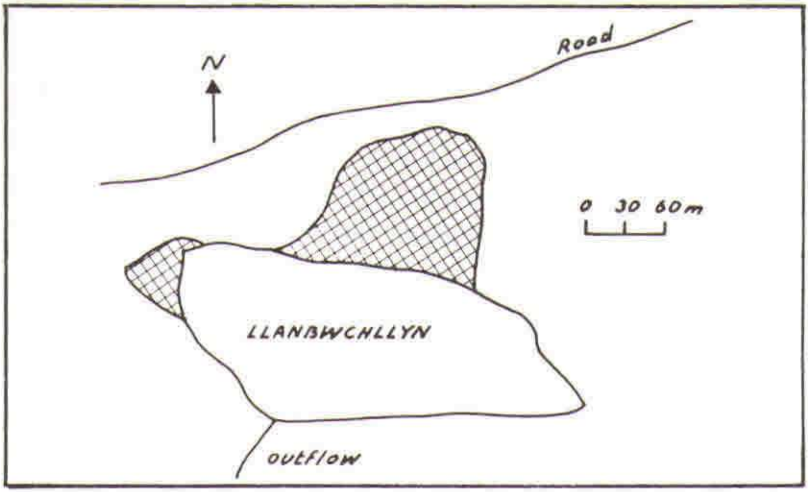

Figure 1 Map of Llanbwchllyn showing the locations of the fossil bays (hatched) and the site of the early Flandrian peat band (x).

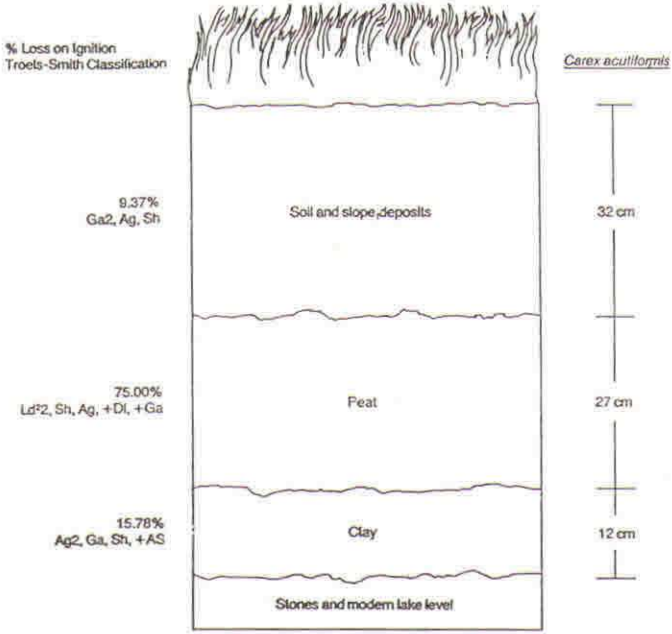

Figure 2 Stratigraphic profile through the early Flandrian peat band. The figures on the left of the diagram show % loss on ignition at 550°C. and the characterization of the sediments according to the scheme of Troels-Smith (1955).

Comparison between these data and local pollen diagrams (Bartley, 1960; Moore and Chater, 1969) suggests an early Flandrian date for the base of the peat band. While none of the local pollen diagrams have been radiocarbon dated comparison with pollen diagrams for other areas with a good radiocarbon chronology would suggest a date of at least 8000 BP (Godwin, 1975).

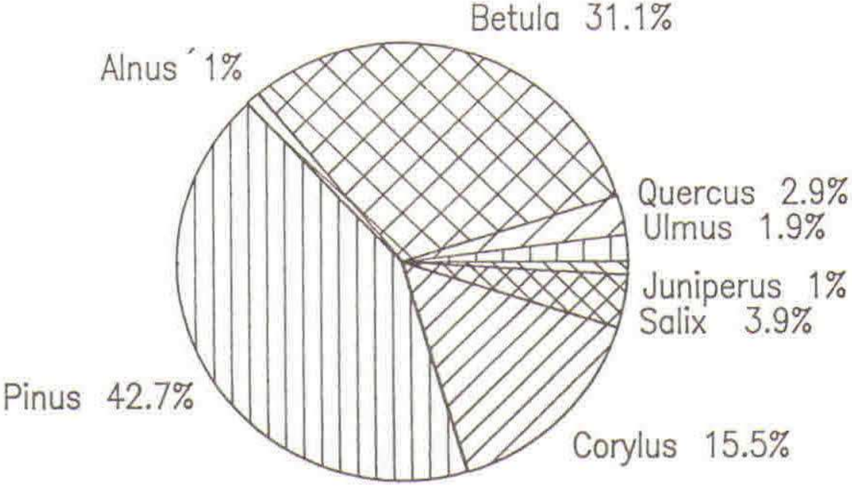

Figure 3 Pollen analysis of the base of the peat band showing the results for tree and shrub pollen.

Approximately four kg wet weight of the lacustrine clay underlying the peat band was sampled for macrofossil analysis. The clay was dissociated in 10% NaOH then washed through a 0.5 mm sieve and oven dried (Moore, 1986), this method extracted the mollusca shells along with a number of plant macrofossils. The identifiable plant material consisted of the cone scales of *Pinus*, the fruits of *Carex* and *Potamogeton* and *Chara* oospores; along with woody material tentatively identified as *Pinus* bark. The plentiful *Pinus* macrofossils are consistent with the high levels of *Pinus* pollen from the peat band above the clay.

The molluscan assemblage comprised just four identifiable taxa and was dominated by the bivalve *Pisidium* (Table 1). There appear to be at least two species of *Pisidium* present although all the larger shells were broken. The three species of gastropod are very catholic in their requirements but the presence of the two species of *Valvata* suggests both open water and areas of vegetation for *V. cristata* (Keen, pers. comm.); the latter is confirmed by the *Potamogeton* and *Chara* remains. A small number of Ostracoda were also found.

There are relatively few early Flandrian molluscan faunas described from lakes in the United Kingdom (Keen, Jones and Robinson, 1984). The only comparable fauna from mid Wales appears to be that described by Bartley (1960) from Rhosgoch Common. He lists a similar assemblage to that identified at Llanbwchllyn (two unidentified species of *Pisidium*, *Valvata piscinalis*, *V. cristata* and *Lymnaea* *peregra*) from sediments he assigned to Godwin pollen zone IV; a similar age to the Llanbwchllyn fauna. Bartley was primarily interested in the stratigraphy and palaeobotany and consequently did not list the relative abundance of the different molluscan species, however his recollection (Bartley, pers. comm.) is that *Pisidium* was much more abundant than the gastropods. *V. piscinalis*, *L. peregra* and *Pisidium* spp. were also among the members of a more diverse late Devensian/early Flandrian fauna from a kettle-hole site at Kildale in north-east Yorkshire (Keen, *et al.* 1984). This suggests that these species were early colonizers of medium sized water-bodies on the retreat of the ice sheets.

Table 1 Molluscan fossils from the clay band (extracted from 4 kg wet weight of clay)

BIVALVIA	
Pisidium spp.	53 intact valves + many fragments
GASTROPODA	
Valvata cristata	3
V. piscinalis	6
Lymnaea peregra	2

Further studies

The work reported in this paper describes sediments from the early Flandrian and the historical period, however there is an obvious gap covering much of the Flandrian. It is likely that none of the lake margin peats cover this period of time. Lake sediment cores should provide a much fuller record. The analysis of such cores, as has been carried out at Llangorse Lake about 25 km south of Llanbwchllyn (Jones, Benson-Evans and Chambers, 1985), should help elucidate the apparently complex hydrological history of the site. Allowing changes in water level to be correlated with their effects on the aquatic vegetation.

Acknowledgements

I should like to thank David Keen for help with the identification of the gastropods and for introducing me to the Quaternary while an undergraduate. Also D. D. Bartley who provided unpublished data and John O'Halloran and Fred Slater who made helpful comments on the manuscript. The Welsh Water Authority and Nature Conservancy Council provided access to the site. I would also like to thank the British Ecological Society for financial support and the Llysdinam Charitable Trust for facilities provided.

Llysdinam Field Centre
School of Pure and Applied Biology
University of Wales College of Cardiff
Newbridge-on-Wye
Llandrindod Wells
Powys, Wales, UK

Current address
Dept. Architecture and Landscape
Manchester Polytechnic
Manchester, UK

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QN: meeting report

JOINT MEETING OF THE CONCHOLOGICAL SOCIETY AND QUATERNARY RESEARCH ASSOCIATION

Workshop on land and freshwater Mollusca in the Quaternary, held in the School of History and Archaeology, University of Wales College of Cardiff, 14th May 1988

Summary of papers

1 AN APPLICATION OF MULTIVARIATE ANALYSIS TO SUBFOSSIL MOLLUSCAN ASSEMBLAGES

The molluscan assemblages from a column taken through the sequence of alluvium and blown sand at Gunwalloe III, south Cornwall (Peters, 1987), were used to illustrate the potential of multivariate analysis.

The detrended correspondence analysis program DECORANA (Hill, 1979) was used firstly to identify the data which was "noise", due, for example, to contamination in sampling.

Subsequently, DECORANA was used to determine the underlying structure of the data. Firstly, a contrast between the Succineidae and *Lymnaea truncatula* on the one hand, and *Discus rotundatus* and *Vitrea contracta* on the other was demonstrated. This is not fully understood ecologically but suggests a contrast between fen and drier vegetation. Secondly, a contrast between *Lymnaea peregra, Armiger crista* and *Anisus leucostoma* on the one hand, and *Candidula intersecta, Cernuella virgata* and *Cochlicella acuta* on the other was identified, and this is more easily understood as a contrast between pools and grassland respectively.

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Annie Milles
School of History and Archaeology
University of Wales College of Cardiff
P.O. Box 909
Cardiff CF1 3XU

2 THE MOLLUSCAN FAUNA OF THE WOODSTON BEDS, PETERBOROUGH

The Woodston Beds outcrop over several square kilometres to the south of Peterborough, Cambridgeshire. The deposits consist of a series of silts, fine sands and gravels which overlie the Jurassic bedrock and are in turn overlain by terrace deposits of the R. Nene. They have been known as a prolific source of molluscan fossils since at least 1861, but no comprehensive evaluation of the fauna has been attempted since that of Kennard and Woodward (1922). The current investigations have centred on three localities in the Woodston area, all of which were originally found by officers of the B.G.S. during a mapping programme in the 1970s.

One of the sites, Hick's Pit, was resampled in 1986. The others, the "Type" and "L" sections, were sampled for Mollusca by the B.G.S. and this account is a result of an examination of speciments in both the B.G.S. and new collection.

The fauna at Hick's Pit comprises about 80 taxa of Mollusca which indicate an environment of a slow-flowing river with banks under woodland, marsh and grassland. The excellent preservation of many of the terrestrial shells and the large quantity of wood suggest that many of the shells became incorporated by river bank collapse and from fallen trees. Particular taxa in the Hick's Pit samples included *Anodonta cygnea, Ancylus fluviatilis, Truncatellina callicratis, T. cylindrica,* six species of *Vertigo* including *V. alpestris, Discus rotundatus, D. ruderatus* and *Perforatella rubiginosa*. The extinct helicelline, *Candidula crayfordensis*, recorded by Kennard and Woodward was also present. At 70 cm from the base there were three shells of *Hydrobia ventrosa*, which suggests brackish influence.

The two samples collected by the B.G.S. were similar to those of Hick's Pit in their terrestrial and freshwater components, but in addition there were large numbers of brackish-water taxa. Most numerous as indictors of encroaching marine transgression was *Hydrobia ventrosa*, but *H. ulvae, Pseudamnicola confusa* and *Scrobicularia plana* were also found. *Semisalsa stagnorum* (recorded by Kennard and Woodward as *Paludestrina deani*) was also found among the brackish elements.

The Mollusca give no indication of the age of the Woodston Beds, but an associated pollen diagram done for the B.G.S. by Dr L. Schon suggests an age in Hoxnian zone II. The Woodston Mollusca are unlike those from other major supposed Hoxnian fluvial sites such as Swanscombe with its numbers of extinct taxa (the 'Rhenish' fauna). Although uncertainties of age within the interglacial and the distance between the Thames and Wash may be sufficient explanation for these differences, the possibility of Swanscombe and Woodston representing two different interglacials cannot be ruled out.

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D. H. Keen
Department of Geography
Coventry Polytechnic
Priory Street
Coventry CV1 5FB

3 THE LOCATION OF REFUGIA FOR WOODLAND SNAILS DURING COLD STAGES OF THE QUATERNARY

There is plentiful evidence that the woodland snails of Britain and other parts of northern Europe recolonised these regions at the end of the last (Devensian) cold stage and in the early Flandrian (Holocene). The limited evidence from earlier interglacials shows essentially similar patterns of recolonisation. Each time, the picture is of the arrival and establishment of the first stenotopic woodland snails from about the time birch and pine woodlands become established, with other species arriving later, some not until the mixed-oak forest is established. It is also clear that conditions during the colder stadials of the cold stages (for example 30–15 thousand years ago) were too severe for either forest trees or woodland snails to have survived in Britain (Holyoak, 1982; cf. Ant, 1969).

Thus there is little doubt that during cold stadials both the forest trees and the woodland snails would have survived only in 'refugia' with milder climates, presumably in southern Europe. Surprisingly little attention has been paid to the extent and location of such refuges. Data on tree pollen (e.g. Huntley and Birks, 1983) imply that most of the refugia for forest trees were located around the Mediterranean, in the S Iberian peninsula, Italy and the Balkans.

Comparable direct evidence for the location of cold-stage refugia for woodland snails is almost lacking. This must in part be due to a general paucity of detailed studies of Quaternary Mollusca in southern Europe. However, it may also relate to small size of refugia and lack of deposits with Mollusca, so palaeontological proof of the locations of many refugia may always be elusive.

It is proposed that a novel source of information on the likely locations of cold-stage refugia for woodland snails is provided by the modern ranges of extremely localised woodland species, that is those known from a single locality or a single small region. It is argued that at least most of these have survived more or less *in situ* through the last cold stage and subsequently.

The example of *Laminifera pauli* may be instructive here. This species is now confined to woodland in a small region of the W Pyrenees, but is known as a Middle Pleistocene interglacial fossil as far north as England. One can reasonably speculate that in a Middle Pleistocene interglacial it extended over much of western Europe, whereas in the present interglacial it has not spread much beyond its Devensian refuge.

Thus by mapping ranges of the rarest woodland snails of S Europe it should be possible to judge likely cold stage refugia for woodland snails in general. As a first step, maps have been prepared for the rare woodland species in some groups of taxa with fairly well known systematics at species level, namely Aciculidae, Clausiliidae and Helicacea. Considered together, these maps reveal the likelihood of there having been numerous small refugia extending across southern Europe from the Cantabrians in the west to various parts of the Balkans and Caucasus in the east. Refugia are particularly evident around both ends of the Pyrenees, in the SW Alps and around the S and SE Alps. There is such scant evidence of woodland refugia north of the Alps that their occurrence there may reasonably be discounted.

The implications of forest refugia around the Pyrenees and southern Alps differ from the patterns shown by Huntley and Birks' pollen data. However, forest areas in montane valleys may have been too small to produce a regional pollen record, but large enough to have served as refugia for trees and snails.

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Holyoak, D. T. 1982. *Malacologia*, 22, 727–30.

Huntley, B. and Birks, H. J. B. 1983. *An atlas of past and present pollen maps for Europe: 0–13,000 years ago.* Cambridge: Cambridge University Press.

D. T. Holyoak
School of Geography and Geology
College of St Paul and St Mary
Cheltenham
Glos. GL50 2RH

4 QUATERNARY MOLLUSCS IN A CORE FROM WALLYWASH GREAT POND, JAMAICA

Wallywash Great Pond is a fault-bounded lake, 8 m above sea level, located between the limestone plateau of the Pedro Plains and a southern extension of the Lower Morass in St Elizabeth, Jamaica. Springs from the Tertiary White Limestone feed the lake which has Ca-Mg-CO_3-dominated waters. Systematic variations in the Ca/Mg hardness ratio in the lake are caused by biologically induced precipitation of calcium carbonate. Data suggest the lake to be currently close to isotopic equilibrium with the atmosphere.

A 9.23-m core shows cyclical changes in sediment type from white marl, rich in ostracods and snails, to swamp peats and clays. Laboratory analyses included δ C-13, δ O–18, bulk geochemistry, carbonate content, loss on ignition, magnetic susceptibility, pollen and snails. Dating was by radiocarbon and uranium series methods.

Six deep-lake phases are represented by white marls. Three are Holocene and three occurred between c.119 and 93 ka BP. Positive δ O–18 values and high magnetic susceptibility characterize the last glacial as a period of aridity. δ C-13 values vary greatly in relation to changes in the dominant carbon source and local hydrology.

Molluscs were picked (by P.H.) selectively from more than 100 levels, mostly 1 cm thick, and identified by C.R.C.P. 18 freshwater (three possibly new) and several terrestrial species occur throughout the core, although some samples were barren. The freshwater fauna includes 4 prosobranch, 11 pulmonate and 2 bivalve species. High diversity faunas occur at −8.64 to −6.70 m (c.120−104 ka BP) and at −4.39 to −1.61 m (c.9.5−1.0 ka BP). They may be compound, with two events in the lower and three in the upper levels. Low diversity faunas occur below, between and above these levels and consist of *Physa* alone or with a small valvatid below −1.62 m and with the hydrobiid '*Potamopyrgus*' *coronatus* above −1.61 m. The reason for the change at −1.61 m is unknown. High diversity faunas include the three taxa mentioned, with up to 9 species of planorbids, two freshwater limpets and the bivalves *Pisidium* and *Eupera*. Possible new taxa are a sharply keeled planorbid, a bizarre limpet that almost completely seals the aperture, and a small hydrobiid with the outer lip thickened externally. Changes in mollusc diversity do not coincide with changes in lithology, but often with sharp changes in δC-13 values.

Philip Hales
Department of Geography
Oxford University
Mansfield Park Road
Oxford

Christopher R. C. Paul
Department of Earth Sciences
The University
P.O. Box 147
Brownlow Street
Liverpool L69 3BX

5 LATE QUATERNARY MOLLUSCA OF PORTO SANTO, MADEIRAN ISLANDS

The molluscan fauna of the Madeiran archipelago is of special interest because of its c.190 endemic taxa which include Tertiary-relict groups. Presence of extensive fossiliferous deposits offers scope for studying the history of these peculiar faunas. Porto Santo is one of the smallest islands (roughly 10 × 4 km), but it has the greatest number of endemics in relation to land area. The islands were first colonised by man around 1420 AD when they apparently had an almost complete forest cover.

Research has concentrated on sediments containing rich assemblages of fossil land snails exposed in cliff and quarry sections. They are composed of calcarenite (partly lithified sands) and sandy colluvium reaching thicknesses of c.30 m, with interstratified palaeosols locally.

The most detailed record is from nearly 30 m of blown marine sands on the north coast. These accumulated when sea level was low during the Pleistocene, deriving by deflation especially from an area to the NW. A radiocarbon date of c.21 ka BP implies a last cold-stage age for the top 3 m of sands. However, there is no date for the main thickness of the sands, although TL-dating of quartz sand grains may be possible.

The fossil Mollusca in the dated sands are mostly species of dry grassland and sand dune areas today. Similar assemblages occur in the sand facies throughout the section.

Intercalated with the blown sands are three well-defined palaeosols that have assemblages differing from those in the sand facies. There is greater overall diversity of species in the palaeosols than in the sands. Among species represented only in the palaeosols are some now confined to the few remnants of woodland on hill tops, together with *Craspedopoma mucronatum* which is extinct on the island. These require moist habitats which are usually shaded by trees. Hence the palaeosols represent moist environments during periods of depositional stability, whereas the sand facies represent drier environments in periods of sand accumulation. It is thus possible that the palaeosols correspond to wetter stages of the Pleistocene with higher sea level, perhaps interglacials.

Elsewhere are thick stratified deposits containing endemic species now extinct. The age of these deposits is unknown so the rate of extinction, due to climatic change or human colonisation, cannot be evaluated. Nevertheless, records from surficial colluvium show that some species now restricted to one or two hill-top localities were once widespread. Their reduction may relate to deforestation since the 15th century, leading to desiccation and slope instability.

Modern shells often show evidence of predation by house mice *Mus musculus*. Comparable rodent-predated shells are never found in the deposits so mouse predation may also have been a cause of decline among endemic snails.

Mary B. Seddon
School of Geography and Geology
College of St Paul and St Mary
Cheltenham
Glos GL50 2RH

6 THE POST-GLACIAL COLONIZATION OF IRELAND: NEW EVIDENCE FROM MOLLUSCAN BIOSTRATIGRAPHY

In contrast to the wealth of palaeobotanical studies in Ireland, there have been very few comparable studies devoted to Irish faunal history. It has long been known that Ireland has an impoverished vertebrate fauna compared with Britain, and many familiar British animals such as voles, moles and snakes are quite unknown there. Conversely a variety of plants and animals occurs in Ireland which is absent from Britain. This includes the so-called lusitanian element whose modern distribution today extends from Iberia (and parts of the Mediterranean coast) along the western seaboard into Brittany and thence to Ireland. As well as several ericaceous taxa (e.g. *Daboecia cantabrica, Erica mackaiana, Arbutus unedo*) and a few other plants the group also comprises various animal taxa including the spotted slug *Geomalacus maculosus*. The problems surrounding the occurrence of these lusitanian elements in Ireland concern, to a lesser extent, the whole of the Irish biota. Three theories emerged to account for their occurrence: (1) per-glacial survival; (2) late-glacial or early Post-glacial entry via a terrestrial route; (3) accidental human introduction (trans-marine).

The only secure way of testing these hypotheses is by recourse to the fossil record. Shells of non-marine snails rival plant remains in their abundance in a range of Quaternary deposits. Tufa (spring chalk) deposits are particularly valuable from a palaeoecological standpoint since they often contain continuous records of autochthonous molluscan communities for much of the Post-glacial. A detailed investigation of such deposits at Newland Cross, Co. Dublin, has demonstrated a typical Post-glacial succession with an early open-country fauna, including several arctic-alpine taxa, radiocarbon dated to 9720 ± 300 BP being replaced by woodland communities by 8000 BP. The arrival of several shade-demanding thermophiles, such as *Discus rotundatus* at 8200 BP suggests that the flooding of the Irish Sea apparently had little retarding effect on the entry of these late immigrants. Some form of passive dispersal is implicated but the exact mechanism(s) remain elusive. This molluscan evidence is a total contrast to Corbet's assessment of the Irish vertebrate fauna as having 'such an erratic composition as to suggest a series of chance introductions rather than an orderly sequence of arctic, followed by more temperate, faunas, until at some stage the supply had suddenly stopped due to severance of the land connexion'.

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R. C. Preece
Department of Zoology
Downing Street
University of Cambridge
Cambridge CB2 3EJ

7 SNAILS AND ARCHAEOLOGY IN THE WALLOP VALLEY, HAMPSHIRE

Archaeologists today are less concerned with individual sites than with their landscape, especially how it was settled and utilised. Consequently, sources of archaeological and environmental information have been sought from the areas surrounding known sites. Valley bottom sediments are one such source. The origin of these has generally been attributed to anthropogenic rather than climatic causes, and, as such, they can be integrated with archaeological evidence of settlement and land division.

Excavations of the Iron Age hillfort at Danebury have produced a large amount of environmental information for a mixed farming economy that exploited a wide variety of environmental zones, theoretically between the Rivers Bourne and Test. Aerial survey has shown evidence of settlement in these areas and it is on this basis that an auger survey of the valley floors of the Test, Anton and Wallop was made. Both the Test and the Anton contain peat deposits overlain by alluvium and interspersed by tufa mounds. In the Wallop valley, tufa is replaced downstream by peat and palaeosols.

At Houghton in the Wallop valley, a section through a lynchet down onto the valley floor produced the following sequence, from the base: gravel; silt and clay lenses; peat, grading laterally into organic clay; palaeosol; alluvial silt; colluvium.

Molluscan analysis suggested that during deposition of the gravel, silt and clay lenses, and peat there was the development of increasingly dense woodland. At the same time, decrease in the freshwater Mollusca indicates a changing hydrology from overbank flooding (silt and clay) to a high water table (peat). In the Test valley, peat in a similar stratigraphical position is ascribed to the Boreal/Atlantic transition, and the presence of *Discus rotundatus* in the silts and clays at Houghton does not contradict this dating.

Soil formation took place during or after the Neolithic period, as indicated by Neolithic axes on the peat surface, and there was contemporaneous woodland clearance as indicated by the open-country molluscan assemblage. The high proportion of intermediate species, equal to that of the open-country species, indicates tall grass, possibly hay meadow. The succeeding alluviation brought about little faunal change, but there was probably an impact on the land use of the flood plain. Increasingly dense vegetation, perhaps of hedges, was succeeded by colluviation during the Iron Age, as dated by pottery. Further clearance and increased sedimentation took place, probably as a result of increased agriculture. This last episode saw the appearance of *Cernuella virgata, Candidula intersecta* and *Helix aspersa*.

Diane Williams
School of History and Archaeology
University of Wales College of Cardiff
P.O. Box 909
Cardiff CF1 3XU

8 HOLOCENE ASSEMBLAGES FROM THE UPPER KENNETT RIVER VALLEY AT WEST OVERTON, WILTSHIRE

A study of river valley deposits and their molluscan assemblages at West Overton is part of a broader investigation into the interaction of past human communities and environment in the upper Kennett.

Early Holocene deposits at the edge of the valley comprised a sequence of (from the base) marl, tufa, clay loam and silt. Above this was a palaeosol, dated by radiocarbon and archaeology to between the Neolithic and later Bronze Age. This was overlain by alluvial silt, probably of the 1st millenium BC, which covered the entire valley bottom.

The fauna from the deposits is a mixed one of freshwater and land components and is thus essentially allochthonous. However, in the environment of a winterbourne, which the river is today and which it may also have been in the past, and on a floodplain where there is standing water for only a part of the year it is likely that freshwater species and land species lived and bred on the same spot but not at the same times of the year. So that in addition to, or instead of, taphonomic mixing there may be ecological mixing. Interpretation thus requires an understanding of both the taphonomy and the ecology, and these were assessed from the relative proportions of land and freshwater shells, the lithology, the ecological groups and the likely communities.

The following are the main assemblage zones from the base:

(a) Marl. *Armiger crista* (with *Anisus leucostoma* and *Lymnaea peregra*); permanent water. Allochthonous, open-country land assemblage of the early Holocene.

(b) Tufa and humic clay loam. *Lymnaea truncatula* and *Anisus leucostoma*; swamp. Autochthonous shaded woodland assemblage of the middle Holocene. *Discus ruderatus* gives way to *Discus rotundatus* c.8000 BP as dated by C-14 of a wild boar tusk.

(c) Silt. *Lymnaea peregra*; overbank flooding. Allochthonous open-country land assemblage reflecting Neolithic clearance.

(d) Palaeosol. No aquatic assemblage. Autochthonous open-country land assemblage.

(e) Alluvium. *Lymnaea peregra*; overbank flooding. Sparse land assemblage, probably allochthonous.

The freshwater assemblages are of low diversity throughout the sequence, reflecting, with the exception of the basal *Armiger crista* assemblage, the winterbourne nature of the channel or the temporary nature of the floodplain. The implied seasonal presence of water has implications for settlement and especially cattle farming in the area in prehistory.

Rosina Mount
School of History and Archaeology
University of Wales College of Cardiff
P.O. Box 909
Cardiff CF1 3XU

9 LAND MOLLUSCA FROM ARCHAEOLOGICAL DEPOSITS AT FRESWICK, CAITHNESS

Excavations in an area of blown shell sand at Freswick Bay, Caithness, uncovered structural evidence of Norse occupation and substantial spreads of midden material, underlain in places by traces of cultivation. Bulk samples of midden deposits, cultivation layers, and blown sand were wet-sieved on a 1-mm mesh on site, primarily for the recovery of artefacts, shells of marine Mollusca, and bones. This also produced numerous small assemblages of non-marine Mollusca, and these were identified and quantified with a view to providing some palaeoenvironmental information.

Through the period of Norse occupation, the dune system seems to have borne relatively lush grassland, probably with stands of herbaceous vegetation, and with small freshwater pools and trickles. Samples attributed to 'clean sand' or 'turf lines' typically gave assemblages of low diversity, dominated by *Vallonia excentrica* and *Cochlicopa lubrica*, and with a minority component of *Clausilia bidentata*, Zonitidae and *Cepaea* sp(p). Only one 'turf line' gave a relatively diverse, apparently fully developed, malacofauna, which differed from less diverse examples chiefly in having a substantial minority component of *Vertigo pygmaea* and *Carychium* sp(p).

Where samples were taken in, or close to, the temporary site of a former water body, *Lymnaea truncatula* and *Oxyloma pfeifferi* were common. The midden deposits gave very distinctive malacofaunas dominated by *Oxychilus alliarius*, sometimes to the virtual exclusion of other taxa.

Some midden faunas were more diverse, with *Vitrea contracta* and *Cepaea* sp(p) being numerous. It is thought that the samples in which *O. alliarius* is particularly dominant represent midden layers which were quickly buried and which thus contain only this carnivorous, presumably colonising, species, whilst the more diverse faunas represent midden layers which were uncovered for a greater length of time, allowing secondary colonisation by less opportunistic taxa. The rate at which moulds and fungi formed on and around the bones and shells of the midden deposits must have been a factor in determining the sequence of colonisation of the deposit by Mollusca.

The Freswick samples raise some interesting questions about molluscan species associations in short-lived, man-made habitats, such as midden heaps, and about the development of species-rich 'climax' malacofaunas in stable habitats as against the species-poor malacofaunas seen in unstable habitats such as dune systems. Perhaps such characteristics as colonising ability and rate of population increase would be useful parameters to consider when attempting an interpretation of archaeological terrestrial mollusc assemblages.

T. P. O'Connor
Environmental Archaeology Unit
University of York
York YO1 5DD

10 *COCHLICELLA ACUTA* (MÜLLER) AND *HELICELLA ITALA* (LINNE) IN NORTHERN COASTAL SHELL-SAND DEPOSITS

Molluscan sequences from shell-sand deposits on the western and northern coasts of Britain and Ireland have shown that *Cochlicella acuta* and *Helicella itala* arrive some time after the beginning of sand deposition and then become more abundant than previously numerous species, notably *Cochlicopa* spp., *Pupilla muscorum* and *Vallonia* spp.

Helicella itala was present in Britain in the Devensian Late-glacial. But it was not until later prehistory that it spread into the sand areas, shortly before the appearance of *Cochlicella acuta* in the same localities (Evans, 1977). Dates for the arrival of the two species in such contexts are rare. The earliest is Gwithian, Cornwall, where Spencer (1975) recorded *Cochlicella acuta* in the Early Bronze Age. At Ardnave, Islay, Evans (1983) found specimens of both species in Early Bronze Age layers, although these were not from a sequence but from samples processed during excavation. Only two specimens of *Cochlicella acuta* were recorded.

In a study by the writer at Baleshare, North Uist, Outer Hebrides, the two species were found in Late Bronze Age layers dating to c.3100 BP (C-14). During the Iron Age (c.2400 to 2050 BP), *Helicella itala* became well established but *Cochlicella acuta* remained rare.

In the same study at Hornish Point, South Uist, both species were present from the Early Iron Age (2500 BP), *Helicella itala* being already well established. During subsequent Iron Age levels, *Cochlicella acuta* became more abundant than *Helicella itala*.

These early occurrences are the beginnings of a framework plotting the arrival and northward spread of *Cochlicella acuta* and *Helicella itala* in the west of the British Isles.

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Nigel Thew
7 Court Close
Bitterne
Southampton SO2 5EJ

PALAEOECOLOGY AND PALAEOENVIRONMENTS RECORDED IN KETTLE HOLES IN THE VALE OF MOWBRAY, NORTH YORKSHIRE, ENGLAND

Jeremy R. A. Giles

M.Phil Thesis, Department of Geography, University of Sheffield 1987

This thesis records an investigation of the sedimentology, palaeoecology and palaeoenvironment of a group of kettle holes near Dishforth in North Yorkshire, England. The results of the sedimentological studies into the three kettle holes include sediment description, following the Troels-Smith scheme, moisture content, loss-on-ignition and calcium carbonate equivalent studies.

The palaeoecology was investigated using pollen and molluscs recovered in cored auger samples from two of the kettle holes. The results are presented in a series of pollen percentage diagrams, pollen concentration diagrams and mollusc diagrams. Each of the diagrams were subdivided on the basis of the taxa recorded, into local assemblage zones which were interpreted in terms of the former ecological conditions within and around the kettle holes.

The information from the sediments, pollen and molluscs was reviewed in the context of other published studies in the region and a palaeoenvironmental synthesis was produced. The environment around the kettle holes was shown to change with time in response to the major climatic changes that occurred during the late Devensian and Flandrian.

Prior to this study there were only two published pollen diagrams from this region which recorded the full sequence of climatic changes from the Dimlington Stadial to the Flandrian. The diagram for Dishforth Bog is therefore a significant addition to the data of the region.

A STRATIGRAPHICAL, SEDIMENTOLOGICAL AND PALAEO-ENVIRONMENTAL ANALYSIS OF HOLOCENE AND PRESENT-DAY COASTAL SEDIMENTATION: WIGTOWN BAY, SW SCOTLAND

Ann H. Griffiths

PhD Thesis, Department of Geology, University of Glasgow, 1988

Evidence of Holocene marine transgression and regression in SW Scotland is exhibited in the stratigraphical record of present and former coastal deposits. Remnant areas of Holocene coastal (including marine) sediments are preserved at the heads of marine inlets and estuaries along the northern shore of the Solway Firth and may extend up to 10 km inland, indicating significant changes in coastal configuration as a result of marine transgression and regression during the last 10 000 years.

At the head of Wigtown Bay, former Holocene coastal deposits are well exposed along the incised meanders of the upper Cree estuary and Palnure Burn. Referred to in the literature as 'carse deposits', these sediments are products of several different environments.

During late-Pleistocene times and very early in the Holocene Epoch, the upper Cree estuary area north of Creetown was a low-lying boggy environment. The area was marginally marine in character. The exact position of the palaeo-Cree is uncertain but the river flowed in a general NW–SE direction and may have been braided. The marine waters of the Holocene marine transgression flooded northwards, penetrating the upper Cree estuary c.7 900 years BP, leading to the deposition of low to high tidal-flats. By c.6480 ± 107 years BP local regression had begun, and seaward progradation of high upper tidal-flats and marsh had commenced. This environmental situation prevailed until c.5000 years BP, when incision occurred and terrestrial conditions became dominant.

In the lower Cree estuary, waters of the Holocene marine transgression initially flooded the lower courses of streams and rose to flood the hollows in the uneven surface of the fluvioglacial deposits flanking the estuary. Accumulation of low tidal-flat deposits gave way to upper tidal-flat and marsh deposits as the transgression diminished. The transgressive event was short-lived. Sediments were deposited at the 'feather edge' of the transgression. North of Creetown and the Moneypool Burn, upper tidal-flat and marsh deposits rest directly on fluvioglacial deposits. As regression occurred, seaward progradation and incision of the carse deposits proceeded.

A pause in regression at c.2000 years BP resulted in formation of certain morphological features observed in the Cassencarie area. Storm conditions resulted in the reworking of marginal fluvioglacial deposits to form a spit, and to the south (between Cassencarie and Carsluith) coarse marine sands and gravels were transported landwards to form shore-parallel and oblique bars. At Carsluith, similarly-derived material forms a thinly-developed beach blanket. Recession of the sea has proceeded since 2000 years BP to the present day.

LATE HOLOCENE PEAT STRATIGRAPHY AND CLIMATIC CHANGE—A MACROFOSSIL INVESTIGATION FROM THE RAISED MIRES OF NORTH WESTERN EUROPE

Christopher John Haslam

PhD Thesis, Dept. of Geography, University of Southampton, 1988

The present study combines palaeoecological, radiocarbon and chemical analyses of Holocene peat sequences to yield detailed information on the nature and causal mechanisms responsible for the formation of the main humification change (MHC) in north west European raised mires. A suite of 18 sites between western Ireland and north-eastern Poland have been considered. The work has focused directly on the measurement, analysis and interpretation of close-interval macrofossil data. A semi-quantitative technique to assess macrofossil abundance has been developed, facilitating more accurate statements regarding palaeovegetation dynamics.

From the palaeoecological data obtained, a series of semi-quantitative curves for the moisture conditions at each site have been calculated using simple weighted averages ordination. A pronounced increase in surface wetness, associated with an expansion of local wet vegetation, may be recognised in the immediate pre-MHC matrix. Short, sharp dry-wet fluctuations characterise each sequence. In the pre-boundary peats of several western maritime profiles, these oscillations are marked by an unusual *Sphagnum* sect. *Acutifolia* (cf. *S. capillifolium*)-*Sphagnum* sect. *Cuspidata* (cf. *S. cuspidatum*) association. It is suggested that the frequency and severity of these dry-wet shifts excluded other competing Sphagna. DECORANA ordination of macrofossil data has given the opportunity to discriminate between the various mechanisms involved in MHC formation. A shift to more maritime conditions appears important in western maritime areas whilst increased continentality is associated with western continental profiles. The absence of an MHC-type feature in north-eastern Poland confirms that whilst changes in peat formation were being initiated in western maritime and western continental areas, the climatic shift was of insufficient magnitude to trigger unhumified peat formation in more continental regions.

Radiocarbon dates indicate greater diachroneity than was formerly assumed. Based upon these and previously published dates, five periods favouring recurrence-surface formation are identified between 4500–500 B.P. Some correspondence with phase shifts recorded elsewhere in Europe is suggested. Antecedent moisture conditions appear to play an important role in determining the data at which mire stability thresholds were transgressed. Hydrological modelling indicates that variations in surface area, the front of effective efflux, topographic situation and effective precipitation modify the climatic 'sensitivity' of mire systems. Based upon DECORANA sample scores and available radiocarbon dates for the MHC, a proxy climatic curve has been constructed for the period 4500–500 B.P. in north-western Europe.

EARLY-PLEISTOCENE TIDAL AND FLUVIATILE ENVIRONMENTS IN THE SOUTHERN NETHERLANDS AND NORTHERN BELGIUM

Kees Kasse

PhD Thesis, 1988, Institute for Earth Sciences, Free University, P.O. Box 7161, 1007 MC Amsterdam, The Netherlands

The study area is situated in the Dutch-Belgian border region at the southern rim of the Quaternary North Sea basin (Figure 1). During the Early-Pleistocene perimarine deposition occurred at the mouths of the Rhine, Meuse and Scheldt (Tegelen Formation, Kedichem Formation). In this study the perimarine sedimentary environments and the paleogeomorphological evolution during the Early-Pleistocene have been reconstructed, in relation to glacial and interglacial climatic conditions. Two major breaks have been found in the Early-Pleistocene sedimentary sequence. The first break occurred at the transition of the warm temperate Tiglian to the cold Eburonian, when tide dominated environments were replaced by fluvial environments. During the Tiglian C3 and Tiglian C5 interglacials inshore, distal (landward) and proximal (seaward) tidal deposits were formed in fresh to brackish water, micro- to mesotidal environments. The tidal range of approximately 1 to 2 meters is based on the vertical range of certain sedimentary structures. The sediments were supplied by the Rhine in the east and by the Scheldt in the western part of the tidal basin. Tidal litter zones dominated by Chenopodiaceae species, developed at the mean high water level along the southern fringe of the tidal environment.

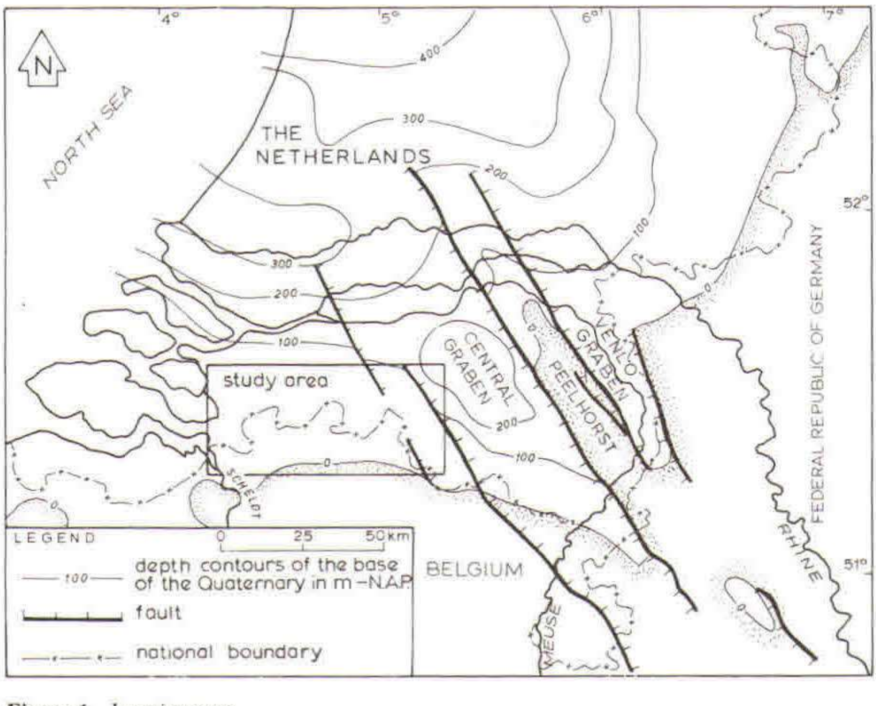

Figure 1 Location map

Between the warm temperate Tiglian C3 and Tiglian C5 a major cooling of the climate took place during the Tiglian C4 (Beerse Glacial). A temporary eustatic sea-level fall occurred and eolian sand-sheets and fluvial sediments from the Scheldt basin were formed on the distal tidal deposits of the Tiglian C3 period. The type and intensity of the periglacial structures point to a mean annual temperature of $-5°C$.

During the warm temperate Tiglian C5 sea-level rose strongly and the previously deposited Tiglian C4 sediments were severely eroded. Therefore, the interglacial Tiglian C5 deposits are often found directly on deposits of Tiglian C3 age. Only at the most southern margins of the tidal sedimentary basin have the periglacial sediments been preserved against erosion. The lower part of the Tiglian C5 deposits were probably formed during the Olduvai magnetozone (1.66–1.87 my). The normal polarities in the upper 1.5 m of the Tiglian C5 unit are explained by remagnetisation during Weichselian periglacial conditions (liquefaction). After the Tiglian the sea finally withdrew from the Dutch-Belgian border area.

During the Eburonian and Waalian, sediments were laid down by rivers from the Scheldt basin, which eroded the Tertiary formations in Central Belgium. The succession of glacial (Eburonian) and interglacial (Waalian) climatic conditions was reflected by changes in the river system and associated sedimentary sequence. Widespread, fine-grained sand-beds developed during the Eburonian in shallow, shifting fluvial channels and in overbank environments. Isolated loam and peat-beds were formed in pools outside the active river courses. In contrast to the Eburonian period, fluvial deposition during the Waalian was less widespread. The lateral migration of up to 10 m deep, meandering channels resulted in fining-upward sequences, which are capped by clay- and peat-beds, deposited in backswamp environments.

The second major break in the Early-Pleistocene paleogeographic evolution took place during the Menapian glacial, when low energy (fine-grained) river systems, characteristic of the Eburonian and Waalian, changed into high energy (coarse-grained) river systems. This break possibly reflects an increased tectonic activity of the Belgian hinterland. The Meuse followed a northwestern course in the study area during the Menapian. The rivers from the Scheldt basin flowed to the northeast and coarse-grained channel sediments were deposited by sandy, braided river systems in the confluence area of Meuse and Scheldt. The sediments are characterised by stable heavy minerals and Scheldt gravel with an admixture of Meuse components in the coarse gravel fractions.

At the end of the Menapian the Rhine re-entered the Central Graben from the southeast. During the next Bavel Interglacial (Bavelian) the Rhine filled a deep (10–20 m) valley at the western side of the Central Graben with fine-grained sediments, which were deposited in channels and meander cut-offs. The start of the Jaramillo magnetozone (0.97 my) was established at the base of the infilling.

During the beginning of the Middle-Pleistocene (Cromerian) the fault activity of the Central Graben increased. The uplift west of the Central Graben caused the cessation of the deposition by the Rhine, Meuse and rivers from the Scheldt basin in the study area. It was followed by erosion of the Early-Pleistocene deposits during the Middle- and Late-Pleistocene.

TERRACES, UPLIFT AND CLIMATE, KARAKORAM MOUNTAINS, NORTHERN PAKISTAN

Lewis Andrew Owen
PhD thesis, University of Leicester, 1988

The Karakoram mountains are one of the most dynamically-active tectonic and geomorphic areas in the world. The valleys hold great thicknesses of Quaternary and recent valley fill sediments comprising glacial, debris flow, fluvial and aeolian sediments. These have been eroded to form terraces. Their development was controlled by tectonic and climatic factors, recording information about the last few million years of uplift and climatic changes. No simple relationship exists between terrace heights, degree of incision and terrace deformation, and the tectonic and climatic history of the area on the other. Allocyclic processes further complicate the interpretation of terrace formation. The sedimentology of different types of terraces was examined. These comprise:

1 **Morainic terraces**
The large glacial systems produce large deposits of till, dominantly of supraglacial meltout type. Three extensive glaciations have been recognised during Quaternary time and at least five minor advances during the Holocene. The morainic terraces have been used to reconstruct the extent and number of glaciations.

2 **Glaciofluvial terraces**
Considerable thicknesses of glaciofluvial deposits infill small palaeovalleys typically of ice-contact facies reflecting deposition by high-gradient streams.

3 **Fluvial terraces**
These form a minor component and are common near the present river level. They were produced mainly by allocyclic processes related to the highly variable discharges of the glacially-fed rivers.

4 **Debris terraces**
These widespread features were produced by failure of steep valley sides or by the resedimentation of debris, frequently till. Processes include debris flow, flowslide, rockslide, debris slide, rotational slide, creep, and slumps.

5 **Lacustrine terraces**
Great thicknesses of silt were deposited rapidly in short-lived lakes. Incision produced terraces after the lakes drained.

6 **Fan terraces**
These are polygenetic landforms comprising the sediments described above, but dominated by debris flow deposits of resedimented till. These formed early in the deglaciation of the area and represent a major phase of deposition which filled the valley bottoms. Fluvial aggradation and small mass movement processes modified their surfaces to produce typical fan geometries with varying surface gradients. Fan-head entrenchment and fan-toe truncation indicates that these are relic features.

Tectonically deformed terraces are rare, but active faulting has been recognised near Rakhiot. Glaciotectonic processes, slope processes and dewatering may also deform terraces, and examples are described. Three planation surfaces were recognised and probably represent tectono-climatic cycles, punctuated by uplift and denudation in successive glaciations. A discordant drainage pattern reflects an early Karakoram structural grain modified by differential uplift of the Great Himalaya and the Nanga Parbat-Haramosh massif which produced the concordant drainage of the Indus River.

LATE HOLOCENE PALAEOECOLOGY AND ENVIRONMENTAL ARCHAEOLOGY OF SIX LOWLAND LAKES AND BOGS IN NORTH SHROPSHIRE

Simon Nicholas Twigger
PhD Thesis, Dept. of Geography, University of Southampton, 1988

The pollen spectra from four lakes and two peat bogs in lowland north Shropshire show that in the Neolithic and earlier Bronze Age periods human impact on the woodlands of the area was localised and mainly slight. Impact increased in the late Bronze Age and during the Iron Age wide areas were denuded of woodland. Land abandonment led to woodland regeneration over much of the area at the end of the Iron Age although some clearings remained in use; woodland clearance was renewed in the mid Roman period. Evidence for Anglo-Saxon farming is seen and wider areas of pasture appear to have been created in later historic times.

Inter- and intra-site comparisons of the pollen spectra are made. Inter-site contrasts in the pollen spectra suggest that the dominant pollen source areas at the smaller sites were very restricted. There are also indications that relatively localised pollen sources were important at the larger sites. Numerical zonation of the pollen spectra shows that the most significant change in the pollen content of the lake sediments occurred in the later Bronze Age; mineral magnetic analyses point to intensified soil erosion during the later Bronze Age and early Iron Age. Theoretical models relating basin size to pollen source area are reviewed in the light of the results of this study: multiple-coring is confirmed as a productive strategy in palaeoecology.

FIELD TRIP FOR I.N.Q.U.A./GEOLOGICAL SOCIETY OF LONDON CONFERENCE ON GLACIMARINE ENVIRONMENTS

A field trip to accompany the conference is being held at Cromer, Norfolk from 18th–20th March 1989. Coach travel from London (Burlington House) has been arranged. For details contact: Dr Jane K. Hart, School of Geography, University of Manchester, Manchester M13 9PL, U.K. (telephone 061 275 3647).

ASSOCIATION FOR ENVIRONMENTAL ARCHAEOLOGY 10TH ANNIVERSARY CONFERENCE

This Conference with the overall theme 'Aims and achievements in environmental archaeology' will be held in London from 30th June to 4th July 1989. Details from: AEA 10th Anniversary Conference 1989, Department of Human Environment, Institute of Archaeology, University College, London, 31–34 Gordon Square, London WC1H 0PY, U.K. (telephone 01 387 7050 extension 4758; Fax number 01 387 8050).

THE LATE GLACIAL OF NW. EUROPE

An international conference on 'Human adaptations and environmental change at the end of the ice age' will be held at Oxford University Department for External Studies from 19th–22nd September 1989. Details from: Archaeology/Local History Course Secretary, Oxford University Department for External Studies, Rewley House, 1 Wellington Square, Oxford OX1 2JA.

LANDSCAPE ECOLOGICAL IMPACT OF CLIMATIC CHANGE

The European Conference on Landscape Ecological Impact of Climatic Change will be held in Lunteren, The Netherlands from 3rd–7th December 1989. The first circular and call for papers are available from: LICC Conference Secretariat, Department of Nature Conservation, Agricultural University of Wageningen, Ritzema Bosweg 32 A, 6703 AZ Wageningen, The Netherlands.

EDITORIAL NOTICE

The editor wishes to express grateful thanks to Dr Brian Taylor of B.G.S. for editing QN 56 while he was working overseas. It is planned to continue the new format which Dr Taylor initiated.

CALENDAR OF MEETINGS

16th–17th March 1989	INQUA/Geological Society Marine Studies Group, Meeting on Glacimarine Environments: Processes and Sediments, at Geological Society, London (see Newsletter 54, p.50).
18th–20th March 1989	Field trip to Cromer, Norfolk in association with INQUA/Geological Society 'Glacimarine Environments' meeting (see notice above).
14–17th May 1989	Geological Association of Canada/Mineralogical Association of Canada joint annual meeting in Montreal, Canada (see Newsletter 55, p.33).
30th June –4th July 1989	Association for Environmental Archaeology 10th Anniversary Conference in London (see notice above)
9th–19th July 1989	28th International Geological Congress to be held at Washington, D.C., U.S.A. (see Newsletter 48, p.44).
31st August –6th September 1989	Vth International Symposium on Paleolimnology, at Ambleside, Cumbria, U.K. (see Newsletter 55, p.34).
10th–14th September 1989	Geological Society/International Association of Engineering Geology Conference on 'Quaternary Engineering Geology' at Heriot-Watt University, Edinburgh (see Newsletter 56, p.43).
19th–22nd September 1989	The Late Glacial of NW. Europe Conference in Oxford (see notice above).
25th–29th September 1989	Second Iberian Quaternary Meeting in Madrid, Spain (see Newsletter 53, p.42).
3rd–7th December 1989	European Workshop on Landscape Ecological Impact of Climatic Changes to be held in Lunteren, The Netherlands (see notice above).
2nd–9th August 1991	XIII INQUA Congress in Beijing, China (see Newsletter 56, p.26).

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